# Keysight U5040A Open RAN Studio

5G O-RAN Radio Unit (O-RU) Testing and Validation

# User Guide



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#### Safety Summary

	The following general safety precautions must be observed during all phases of operation of this instrument. Failure to comply with these precautions or with specific warnings or operating instructions in the product manuals violates safety standards of design, manufacture, and intended use of the instrument. Keysight Technologies assumes no liability for the customer's failure to comply with these requirements. Product manuals are provided on the Web. Go to www.keysight.com and type in your product number in the Search field at the top of the page.
General	This product is a Protection Class 1 instrument (provided with a protective earth terminal) and has been manufactured and tested according to international safety standards. The protective features of this product may be impaired if it is used in a manner not specified in the operation instructions.
	All Light Emitting Diodes (LEDs) used in this product are Class 1 LEDs as per IEC 60825-1:2014.
Environment Conditions	This instrument is intended for indoor use in an Overvoltage Category II, pollution degree 2 environment. It is designed to operate at a maximum relative humidity of 85% RH, non-condensing and at altitudes of up to 2000 meters. Refer to the specifications tables for the AC mains voltage requirements and ambient operating temperature range.
Temperature	The instrument should be protected from temperature extremes and changes in temperature that may cause condensation within it.
	The operating temperature is from 5 °C to +40 °C.
	The storage temperature is from -40 °C to +70 °C.
Before Applying Power	Verify that all safety precautions are taken. The power cable inlet of the instrument serves as a device to disconnect from the mains in case of hazard. The instrument must be positioned so that the operator can easily access the power cable inlet. When the instrument is rack mounted the rack must be provided with an easily accessible mains switch.
Ground the Instrument	To minimize shock hazard, the instrument chassis and cover must be connected to an electrical protective earth ground. The instrument must be connected to the AC power mains through a grounded power cable, with the ground wire firmly connected to an electrical ground (safety ground) at the power outlet. Any interruption of the protective (grounding) conductor or disconnection of the protective earth terminal will cause a potential shock hazard that could result in personal injury.
Do Not Operate in an Explosive Atmosphere	Do not operate the instrument in the presence of flammable gases or fumes.
Do Not Remove the Instrument Cover	Operating personnel must not remove instrument covers. Component replacement and internal adjustments must be made only by qualified personnel. Instruments that appear damaged or defective should be made inoperative and secured against unintended operation until they can be repaired by qualified service personnel.

#### Instrument Markings

Instrument Marking	Description	
	The instruction manual symbol. The product is marked with this warning symbol when it is necessary for the user to refer to the instructions in the manual.	
Ф	Standby supply. Unit is not completely disconnected from AC mains when switch is off.	
ICES/NMB-001	The CE mark is a registered trademark of the European Community.	
C C S B S S S S S S S S S S S S S S S S	The CSA mark with the 'c' and 'us' subscript indicates the instrument is certified to the applicable Canadian and United States of America standards respectively.	
	The RCM mark is a registered trademark of the Australian Communications and Media Authority	
R-R-K-St- 3E16526	The KC mark is the Korean certification mark. This equipment is Class A suitable for professional use and is for use in electromagnetic environments outside of the home.	
Ś	The recycling symbol indicates the general ease with which the instrument can be recycled.	
40	China Restricted Substance Product Label. The EPUP (environmental protection use period) number in the center indicates the time period during which no hazardous or toxic substances or elements are expected to leak or deteriorate during normal use and generally reflects the expected useful life of the product.	

#### Compliance and Environmental Information

Safety Symbol	Description
	The crossed out wheeled bin symbol indicates that separate collection for waste electric and electronic equipment (WEEE) is required, as obligated by the EU DIRECTIVE and other National legislation. Please refer to http://www.keysight.com/go/takeback to understand your Trade in options with Keysight in addition to product takeback instructions.

#### Table 1 Compliance and Environmental Information

#### Declaration of Conformity

Declarations of Conformity for this product and for the Keysight products may be downloaded from the Web. Go to http://www.keysight.com/go/conformity. You can then search by product number to find the latest Declaration of Conformity.

Contact Keysight Technologies

To contact an expert, visit www.keysight.com/find/contactus.

#### Acronyms

The following acronyms are used in this document:

- O-RU O-RAN Radio Unit
- **O-DU** O-RAN Distributed Unit
- **mmWave** millimeter wave
- **OTA** Over the Air
- O-RAN CUS O-RAN Control, User, and Synchronization Plane
- **RF** Radio Frequency
- **DL** Downlink
- UL Uplink
- **PBCH** Physical Broadcast Channel
- PDCCH Physical Downlink Control Channel
- **PDSCH** Physical Downlink Shared Channel
- PSS Primary Synchronization Signal
- SSS Secondary Synchronization Signal
- **PUSCH** Physical Uplink Shared Channel
- PUCCH Physical Uplink Control Channel
- **PRACH** Physical Random Access Channel
- · CSI-RS Channel State Information Reference Signal
- GUI Graphical User Interface
- IQ In-Phase, Quadrature
- symInc symbol number increment command
- rb resource block indicator
- **reMask** resource element mask
- **rbgSize** resource block group size
- **rbgMask** resource block group bit mask
- symbolMask symbol bit mask

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Keysight U5040A Open RAN Studio

User Guide

# 1. Introduction

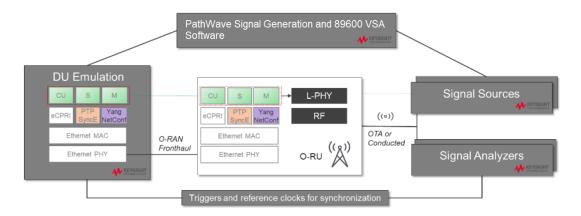
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#### Section 1.1: Overview

Open RAN Studio provides a test environment that includes and integrates with Keysight tools, in both RF and Protocol Domains, to help you completely exercise an O-RAN CUS (Control, User, and Synchronization Plane) compliant Radio Unit (O-RU).

To ensure measurement consistency between both RF and Baseband sides of the O-RU, Open RAN Studio software leverages the same industry leading 5G signal generation and measurement science used in Keysight spectrum analyzers and signal sources. This tight coupling ensures CU-plane messages and baseband information match exactly with the signals captured on the RF side of the Radio Unit.



Designed for LTE and 5G O-RAN Radio Unit (O-RU) testing, Keysight Open RAN Studio provides powerful, yet easy to use, capabilities to:

- Build O-RAN compliant CUS-plane test vectors.
- Emulate an O-RAN Distributed Unit (O-DU) to generate the test vectors against a Device Under Test (DUT).
- · Capture and accurately timestamp the DUT's responses.
- Perform measurements needed to validate if the O-RU meets standard compliant operation and radio performance.

Open RAN Studio includes powerful O-RAN focused tools to construct, play, capture, and measure O-RAN traffic over 10 Gbps / 25 Gbps (fronthaul) Ethernet interfaces. Out of the box integration with Keysight's industry-leading PathWave Signal Generator and 89600 VSA software enables sophisticated 5G signal creation and easy capture, extraction, and export of IQ vectors – for advanced modulation analysis of received RF / mmWave signals and radio performance. Additionally, when combined with Keysight spectrum analyzers and signal sources, the integrated Open RAN Studio solution delivers the most comprehensive cross domain, multi-channel RF / mmWave and O-RAN protocol measurements available in the industry, for both FR1 and FR2 radios, downlink (DL) and uplink (UL) paths.

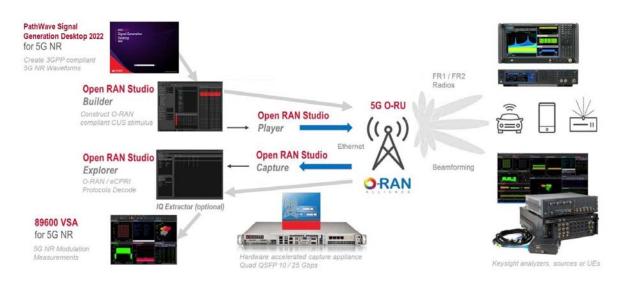


Figure 1 Integrated Open RAN Studio solution for comprehensive O-RU testing

Figure 1 illustrates a simplified architecture for the Open RAN Studio suite of integrated tools and optional elements, which include:

- PathWave Signal Generation Desktop 2022 creates 3GPP compliant 5G NR waveforms for emulation through Open RAN Studio to an O-RU / DUT and subsequent transmission to a downstream signal analyzer, DUT, or complaint UE.
- 2 N7624C Signal Studio Pro for LTE/LTE-Advanced FDD and N7625C Signal Studio Pro for LTE/LTE-Advanced TDD create 3GPP compliant LTE FDD/TDD waveforms. These waveforms can be imported using the Open RAN Studio FDD/TDD Support applications and then loaded into Open RAN Studio for emulation and subsequent transmission to a downstream signal analyzer, DUT, or complaint UE.

- 3 Open RAN Studio integrates five powerful O-RAN development tools to construct, play, capture, measure, and extract IQ vectors for split option 7.2x O-RAN traffic over a 10 or 25 Gbps fronthaul Interface.
  - Open RAN Studio Builder helps you easily construct diverse O-RAN test vectors. The PCAPNG formatted output file includes the complete Ethernet / VLAN / eCPRI / O-RAN stack.
  - b Open RAN Studio Player is a hardware-based exerciser that emulates a DU and transmits ORAN Studio build test vectors to an O-RU / DUT through the O-RAN interface – honoring O-RAN CUS-plane timing windows.
  - c Open RAN Studio Capture is a hardware-based analyzer that captures the bidirectional Tx and Rx information flows between the DU and O-RU over the O-RAN interface.
  - *d* Open RAN Studio Explorer decodes and visualizes the O-RAN protocol information and enables measurement in both protocol and RF / mmWave domains.
  - e Open RAN Studio IQ Extractor is an optional application that reconstructs a time domain IQ file from an O-RAN trace capture for further modulation measurements with 89600 VSA software.
- 4 *89600 VSA for 5G NR* may optionally receive captured IQ vectors from Open RAN Studio IQ Extractor to perform 5G NR modulation and radio performance measurements.

#### 1.1.1: 5G NR Channels/Signals supported by O-RAN Studio

The O-RAN Studio supports the following 5G NR Channels/Signals:

Downlink Physical Channels

- Physical Broadcast Channel (PBCH)
- Physical Downlink Control Channel (PDCCH)
- Physical Downlink Shared Channel (PDSCH)

Downlink Physical Signals

- Primary Synchronization Signal (PSS)
- Secondary Synchronization Signal (SSS)

Uplink Physical Channels

- Physical Uplink Shared Channel (PUSCH)
- Physical Random Access Channel (PRACH)

#### Section 1.2: References

- For conceptual information about the various elements in the Open RAN standards, refer to the *O-RAN Fronthaul Control, User and Synchronization Plane Version 4.0 (ORAN-WG4.CUS.0-v4.00).*
- To download a copy of the specification, visit https://www.o-ran.org/specifications.

#### Section 1.3: BittWare Hardware

Figure 3 shows the front view of a BittWare TeraBox 1000S FPGA server. The SMB male connectors connect O-RU and Keysight instrumentation. Note that the Clock Input can either be a 10 MHz square waveform or 100 MHz sine or square waveform.



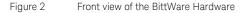
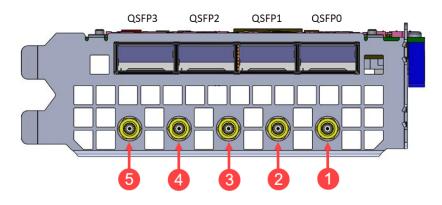


Figure 3 depicts the right side of the front panel of BittWare server:





It has the following input/output ports:

- 1 CLK IN This is a reference clock in that is used for the internal clock reference.
- 2 PPS IN This is a Pulse Per-Second (PPS) in that can be used for reference. (Not implemented in the current version).

З	TRIG IN – This is used for trigger in, which means it will start playing
	+ delta, whatever is queued up to be play by ORAN Studio. (Not
	implemented in the current version).

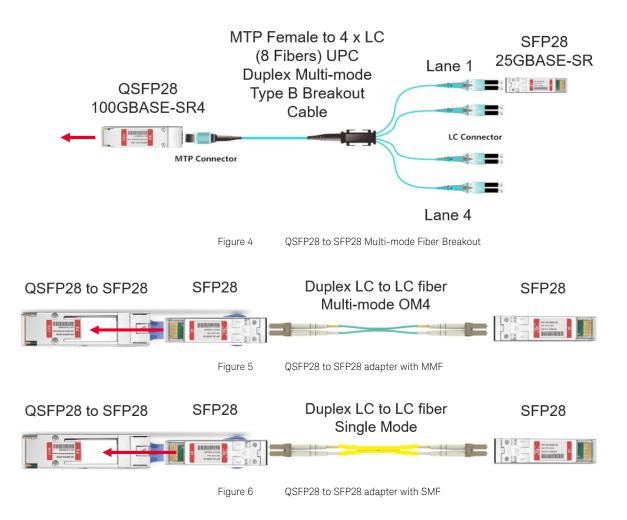
- 4 TRIG OUT This is used to generate trigger output when Player or Recorder starts ± delta.
- 5 PPS OUT This is an output Pulse Per-Second (PPS) that can be used for reference.

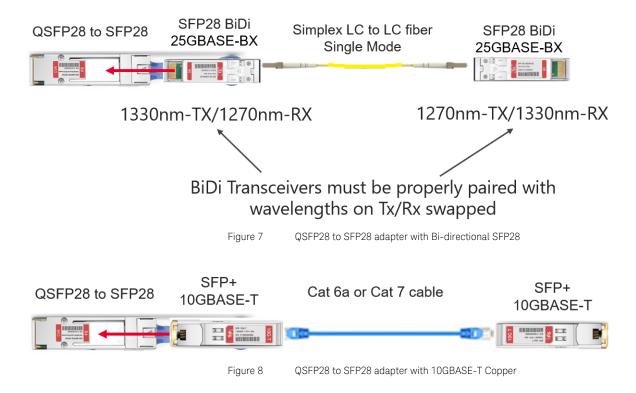
#### NOTE

In the BittWare hardware, QSFP0 and QSFP2 are the only slots that can be currently used. Only the first 10G/25G set of lanes on that QSFP can be used.

#### Section 1.4: Understanding SFP / QSFP modules & Cable types

This section describes the various cable types, various SFP and QSFP modules along with their insertion/removal procedures. To understand these parts, let us consider the various connectivity options available with the BittWare server. Note that the left side of each illustration (with the module inserted into the QSFP28 to SFP28 adapter) is connected into the BittWare server.





1.4.1: Cable types

For the connectivity option shown in Figure 4, the MTP Female to 4 x LC (8 Fibers) Duplex Multi-mode Type B Breakout Cables are shown in Figure 9. Type B indicates that it crosses over Tx and Rx in the fibers as required.

These cables are required to connect from a QSFP28 100GBASE-SR4 modules. The four fiber pairs, which are available with the LC connectors, are labeled 1 to 4, which correspond to the four Ethernet lanes in the QSFP28 module. Table 2 shows the mappings of the lanes to fibers.

Note that there a 12 fibers in the MPO connector, but for the 25G/100G Ethernet, fibers 5 to 8 are not used. Each lane has two fibers for Tx / Rx.

#### Table 2 Lane-to-fiber mapping

Lane	Fibers
1	1/12
2	2/11
3	3/10
4	4/9

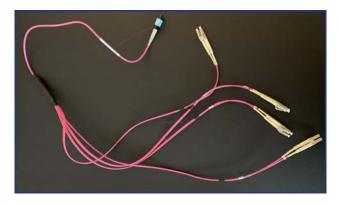


Figure 9 MTP Female to 4 x LC cables (full-length view)

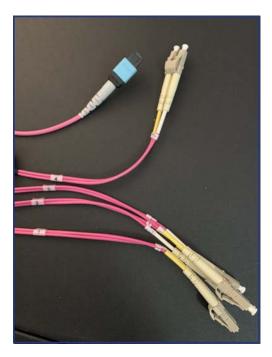


Figure 10 MTP Female to 4 x LC cables (close-up)

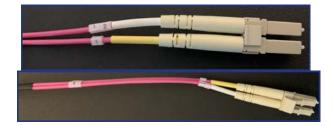


Figure 11 LC connector (close-up view)



Figure 12 MTP Fe

MTP Female connector (top view)





The Cat-5 cable, as depicted in Figure 8, is inserted into the SFP and the BittWare server.

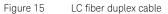


Figure 14

Cat-5 cable (connected to SFP and server)



The LC Duplex cable, shown in Figure 15, can be used for loopback connections.



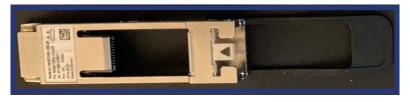
#### 1.4.2: Modules

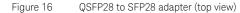
The modules that you may use with the BittWare server are:

- SFP Small Form-Factor Pluggable modules. The three categories are:
  - SFP supports 100 Mbps to 4 Gbps per lane
  - SFP+ supports up to 10 Gbps per lane
  - SFP28 supports up to 25 Gbps per lane
- QSFP Quad Small Form-Factor Pluggable modules. The three categories are:
  - QSFP supports up to 4 Gbps (4 lanes x 1 Gbps per lane)
  - QSFP+ supports up to 40 Gbps (4 lanes x 10 Gbps per lane)
  - QSFP28 supports up to 100 Gbps (4 lanes x 25 Gbps per lane)

Note that the BittWare server has four QSFP28 ports. You may plug in QSFP modules without adapters.

Also, SFP28 modules can be used with QSFP28 to SFP28 adapters. Similarly, SFP+ modules can be used with QSFP+ to SFP+ adapters.







#### Figure 17 QSFP28 module (lateral view)





SFP28 module (top view)





Keysight recommends that if you are using 10G data rates, use 10G only NOTE (SFP+) modules, or if using SFP28 25G optics, verify that CRC errors are 0 for a sustained time on both ends of the link (which means inspecting O-RU statistics as well).

#### 1.4.3: Inserting & removing modules and cables

#### Inserting MTP connector to QSFP28 module

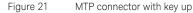
The MTP connector is keyed, so it cannot be inserted upside down. Figure 20 shows the QSFP28 module with the key down and Figure 21 shows the MTP connector with the key up.

Figure 22 show how to insert the MTP connector to the QSFP28 module.



#### Figure 20 QSFP28 module (rear view) with key down





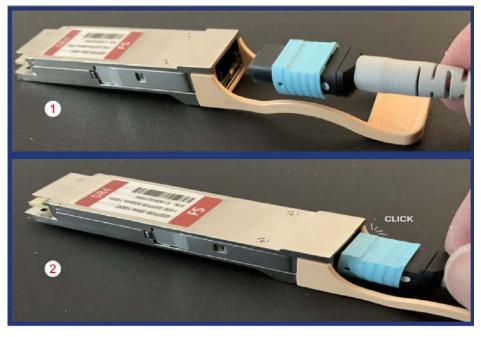


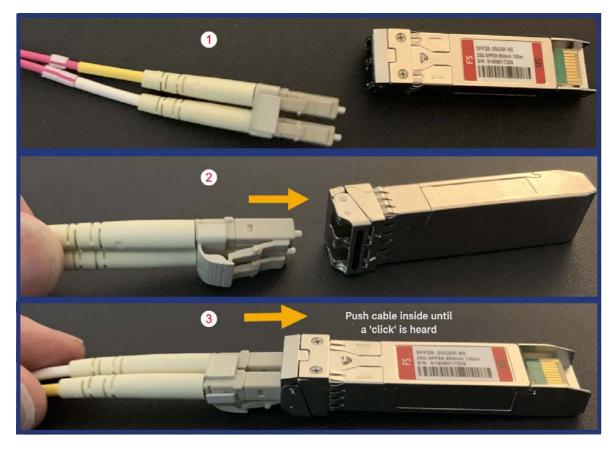
Figure 22 Inserting MTP Connector to the QSFP28 module

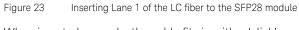
When inserted properly, the MTP connector fits in with a 'click'.

#### Inserting LC fiber connectors to SFP28 module

After inserting the MTP connector into the QSFP28 module, let us insert the other end of the cable (LC fibers) into an SFP28 25GBASE-SR module. Note that the Lane 1 is inserted into the module.

Figure 22 shows how to insert the LC fibers into the SFP28 module. Notice that the clip on the fiber must face the lower end of the SFP28 module.





When inserted properly, the cable fits in with a 'click'.

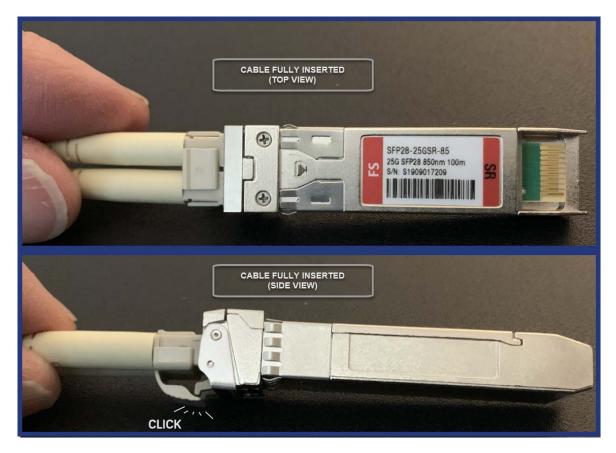
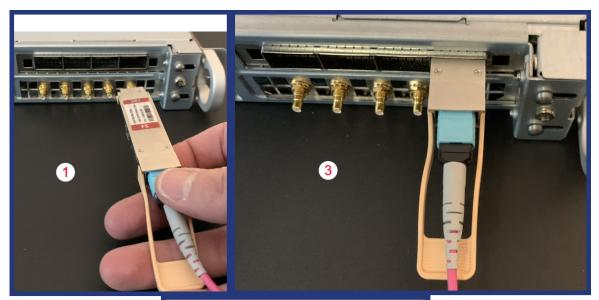


Figure 24 SFP28 module after LC fiber connectors are inserted

#### Inserting QSFP28 module into BittWare server

Figure 25 shows the flow to insert the QSFP28 module into the BittWare server. When inserted properly, the module fits in with a 'click'.



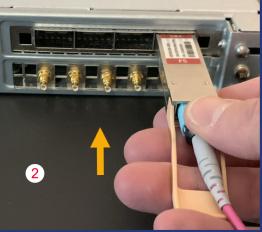


Figure 25

Inserting QSFP28 module into BittWare server

#### Removing QSFP28 module from the BittWare server

Figure 26 shows how to hold and pull the clasp in the outward direction to release the QSFP28 module.

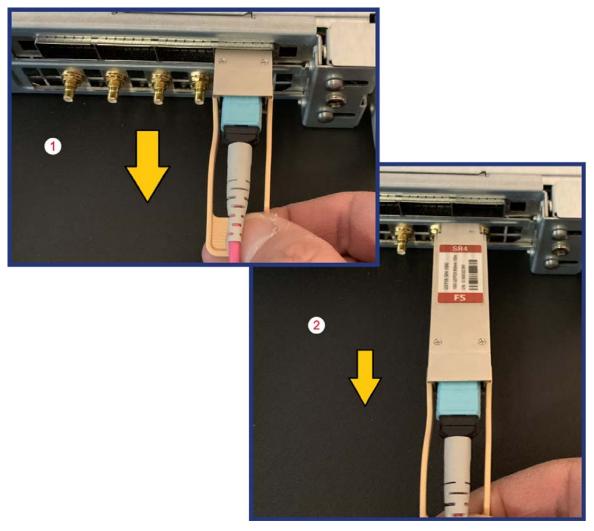


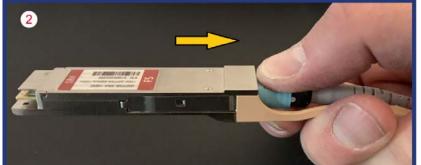
Figure 26

Removing QSFP28 module from BittWare server

#### Removing MTP Connector from the QSFP28 module

Figure 27 shows how to hold and pull back the blue clasp to release the MTP connector from the QSFP28 module.





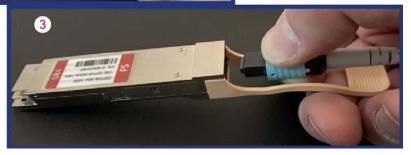


Figure 27 Removing MTP Connector from the QSFP28 module

#### Removing LC fiber connectors from the SFP28 module

Figure 28 shows how to pinch the clips to release the LC fibers from the SFP28 module.

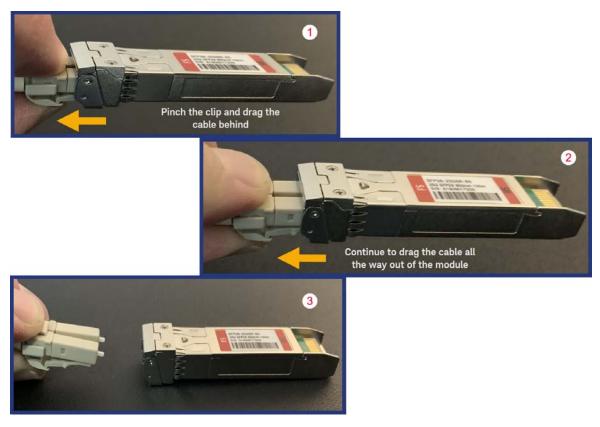


Figure 28 Removing LC fiber connectors from the SFP28 module

#### Inserting SFP28 module into a QSFP28 to SFP28 adapter

Figure 29 shows how to insert an SFP28 module into a QSFP28 to SFP28 adapter.

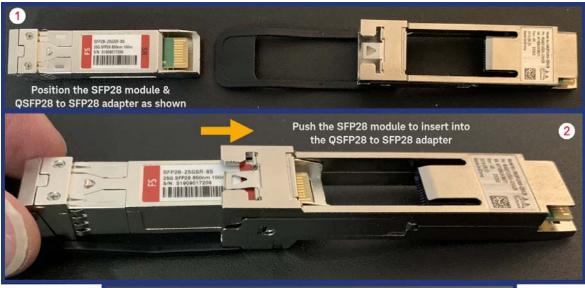




Figure 29 Inserting SFP28 module to a QSFP28 to SFP28 adapter

#### Removing SFP28 module from the QSFP28 to SFP28 adapter

Figure 30 shows how to remove an SFP28 module from a QSFP28 to SFP28 adapter.

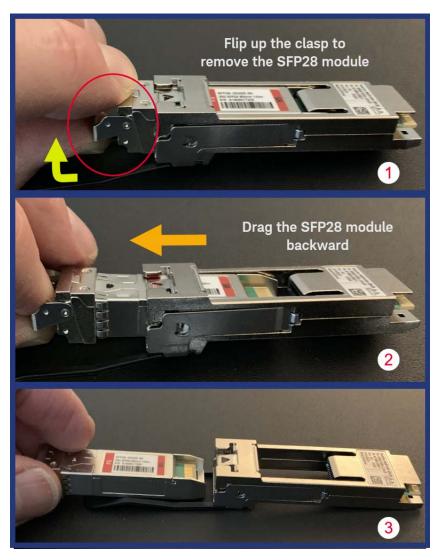


Figure 30 Removing SFP28 module to a QSFP28 to SFP28 adapter

#### Inserting the QSFP28 to SFP28 adapter into the BittWare server

Figure 31 shows how to insert the QSFP28 to SFP28 adapter, with the SFP28 module within, into Slot 0 of the BittWare server.

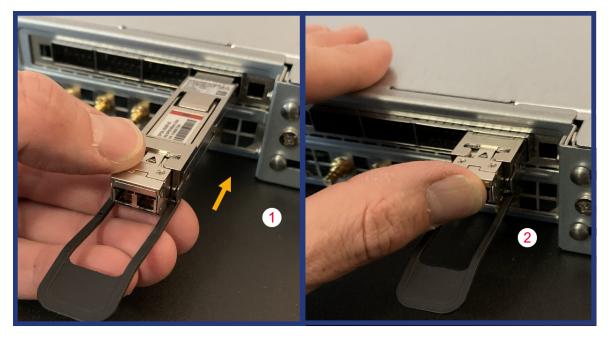


Figure 31 Inserting QSFP28 to SFP28 adapter into Slot 0 of BittWare server

#### Inserting LC fiber connector into the SFP28 module

Figure 32 shows how to insert the LC fiber connector to the SFP28 module, which has been inserted into Slot 0 of the BittWare server. When inserted properly, it should fit with a 'click', as shown in Figure 23.

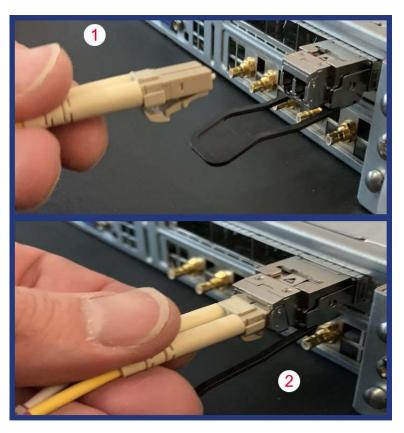


Figure 32 Inserting LC fiber connector into the SFP28 module

#### Removing LC fiber connector from the SFP28 module

Figure 33 shows how to remove the LC fiber connector from the SFP28 module, which has been inserted into the QSFP28 to SFP28 adapter. The procedure is same as that shown in Figure 28, where you must pinch the clip to remove the cable.

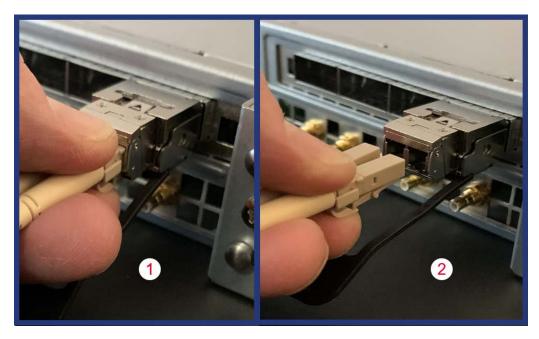


Figure 33 Removing LC fiber connector from the SFP28 module

#### Removing SFP28 module from the QSFP28 to SFP28 adapter

Figure 34 shows how to remove the SFP28 module from the QSFP28 to SFP28 adapter, which has been inserted into Slot 0 of the BittWare server. The procedure is same as that shown in Figure 30, where you must flip up the clasp to remove the module.

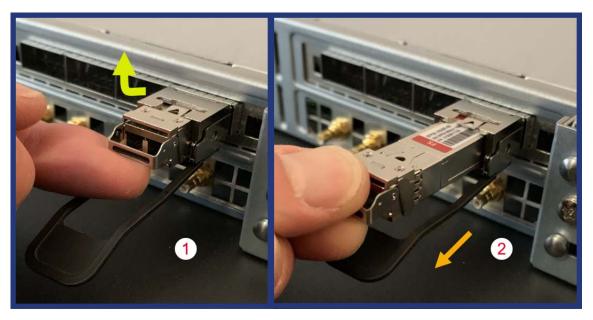


Figure 34 Removing SFP28 module from the QSFP28 to SFP28 adapter

#### Removing the QSFP28 to SFP28 adapter from the BittWare server

Figure 35 shows how to remove the QSFP28 to SFP28 adapter from the Slot 0 of the BittWare server. Pull out the black clasp to release it.

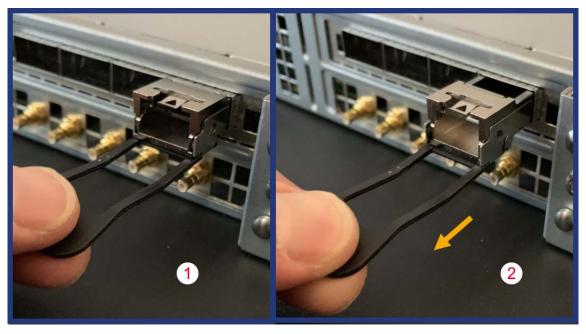


Figure 35

Removing SFP28 module from the QSFP28 to SFP28 adapter

### 1.4.4: Copper SFP module for M-Plane Passthrough

## NOTE

In this section, an SFP+ 10GBASE-T module is shown for the purpose of illustration. While they are almost identical in appearance, for M-Plane Passthrough, a 1000BASE-T SFP module (1G) is actually required.

#### Inserting the Copper SFP module into a QSFP28 to SFP28 adapter

The process for inserting the Copper SFP module is the same as that of inserting a fiber SFP28 module. See Inserting SFP28 module into a QSFP28 to SFP28 adapter on page 35. The inverted position of the QSFP28 to SFP28 adapter, with the Copper SFP module inserted within, is shown in Figure 36.



Figure 36 Inserting a Copper SFP module into a QSFP28 to SFP28 adapter

#### Inserting the QSFP28 to SFP28 adapter into the BittWare server

The process for inserting the QSFP28 to SFP28 adapter, with the Copper SFP module, is the same as that of Inserting the QSFP28 to SFP28 adapter into the BittWare server on page 37. The only difference here is that this unit should be plugged into the QSFP Slot 2, which is the second slot from the left. A QSFP28 to SFP28 adapter being plugged into Slot 2 is shown in Figure 37.

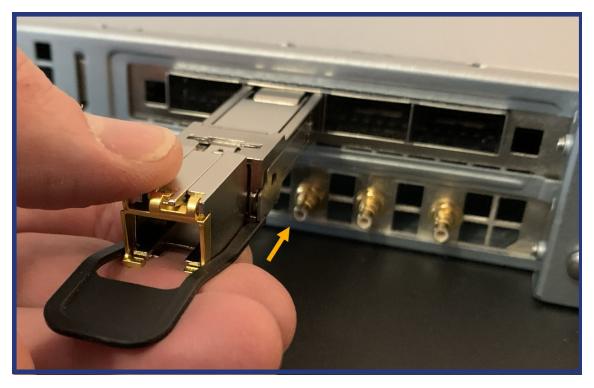


Figure 37 Inserting the QSFP28 to SFP28 adapter to Slot 2 of BittWare server

#### Inserting the Cat-5 cable

One end of a Cat-5 cable is inserted into the Copper SFP module, within the QSFP28 to SFP28 adapter, as shown in Figure 38.

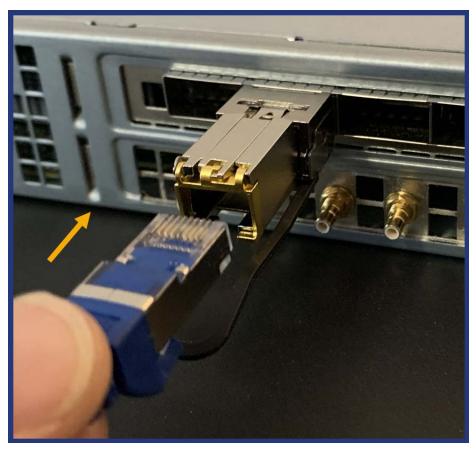


Figure 38 Inserting the Cat-5 cable to the Copper SFP module



The other end of the Cat-5 cable is inserted into the secondary Ethernet port on the BittWare server, as shown in Figure 39.

Figure 39 Inserting the Cat-5 cable to the secondary Ethernet port

#### BittWare Server Connections

Figure 40 shows the overall BittWare server configuration, where:

- a QSFP28 module with MTP fiber is connected into the QSFP slot 0
- the other end is connected to the O-RU, where the LC fiber connector is inserted into an SFP28 25GBASE-SR module
- the Copper SFP module is connected via a QSFP28 to SFP28 adapter into the QSFP slot 2 and the secondary Ethernet port using a Cat-5 cable

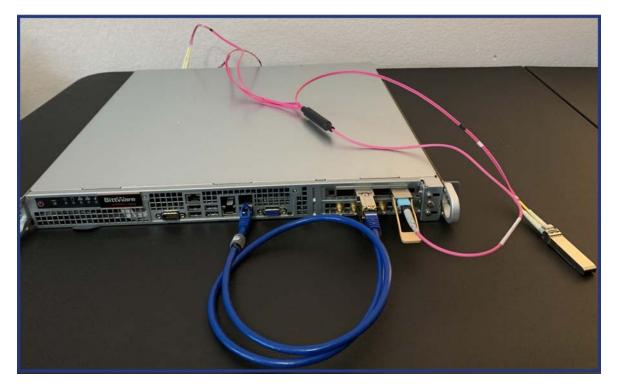


Figure 40 BittWare server after all connections are made

## 1.4.5: Creating a Loopback Fiber from a Duplex LC cable

In order to test an SFP28 25GBASE-SR or LR module, when there is no loopback available, an alternative method is to hold together two LC connectors at each end at a clip. If the clip is removed, you can connect both ends of the same fiber into the SFP, thereby, creating a loopback. Note the color coding on the fibers (one fiber has a yellow sleeve on each end).

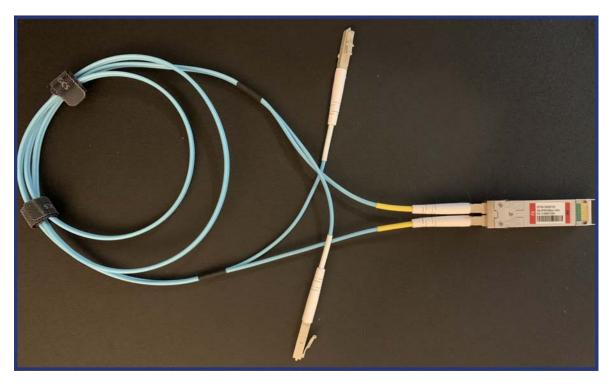


Figure 41 Creating a Loopback Fiber

#### 1 Introduction

Keysight U5040A Open RAN Studio

User Guide

# 2.

# Understanding the O-RAN Studio GUI

Launching O-RAN User Interface / 50 Exploring O-RAN User Interface / 53 Configuration Tool / 70 Instrument Configuration / 91 C/U-Plane Builder / 100 Explorer / 106 Interface Monitor / 114 Overview on M-Plane in O-RAN Studio / 117



## Section 2.1: Launching O-RAN User Interface

NOTE

For installation instructions, refer to the *Keysight U5040A Open RAN Studio Getting Started Guide* document, which is available on the U5040BSCA Open RAN Studio for O-RAN Radio Unit (O-RU) Testing and Validation Technical Support page.

You may launch the O-RAN Studio either in online or in offline mode.

In the online mode, the software is connected to BittWare hardware; whereas, hardware connection is neither required nor available in the offline mode. Moreover, several other features, including Player or Recorder functionality are not available in the offline mode.

To launch the O-RAN Studio interface in online mode, click **Start** > **Keysight Open RAN Studio** > **U5040A Open RAN Studio**.



Figure 42 O-RAN Studio listed on the Start menu

Click either **U5040A Open RAN Studio** or **U5040A Open RAN Studio** - **Offline** to launch the O-RAN Studio interface in online mode or offline mode, respectively.



A splash screen is displayed as shown in Figure 43.

Figure 43

Open RAN Studio splash screen

The default user interface for the O-RAN Studio appears as shown in Figure 44. To understand the elements in the order shown in the image below, see Exploring O-RAN User Interface on page 53.

👫 KEYSIGHT Open RAN Studio 1	- 🗆 X
File Control Setup Test Models View Help 2	
C-Plane Builder Explorer Interface Monitor	4
Component Carriers Carrier Numerology	Radio Control Plane Data
	μ Subframe Slot ID RB Start RB Number Sym Start Sym Number Channel
Select Carrier:	
Attribute Value	
Flow/eAxC ID	
Flow/eAXC ID	
Resource Allocations	
Select Allocation:	6 Radio Allocations
Attribute Value	
Attribute Value	20
	Frame Index 0 🗘
File: 5	Size: 0 Port Status: 250 16 PTP: Slave SyncE: Disabled

Figure 44 Default win

Default window of the O-RAN Studio (online)

## Section 2.2: Exploring O-RAN User Interface

The O-RAN user interface consists of the following GUI elements:

- 1 Title Bar
- 2 Menu Bar
- 3 Tool Bar
- 4 C-Plane Builder / Explorer / Interface Monitor
- 5 Status Bar
- 6 Dockable planes

The detailed information on these GUI elements are described in the following sections.

#### 2.2.1: Title Bar

The title bar contains the Keysight logo, product name, and standard buttons to minimize, maximize or to close the window.

	Open RAN Studio		$\times$
Figure 45	Title bar elements in the Open RAN Studio		

#### 2.2.2: Menu Bar

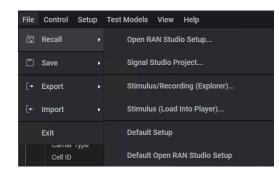
The menu bar consists of various drop-down sub-menu options, which provide access to different functions, and launch interactive GUI controls.

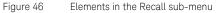
The menu bar includes the following drop-down menu options:

#### File Menu

The File menu provides the following selections:

1 **Recall**-This sub-menu item contains the following options:





- **Open RAN Studio Setup...** Launches the **Open** dialog, where you can navigate to select and load a O-RAN Studio setup file ('.orstx' file).
- Signal Studio Project... Launches the Open dialog, where you can navigate to select and load a PathWave Signal Generator / Signal Studio project file ('.scp' file).
- Stimulus/Recording (Explorer)... Launches the Open dialog, where you can navigate to select and load a Packet Capture file ('.pcap' file), which may either be a "stimulus" file created with O-RAN Studio or a "recording" captured with the Open RAN O-DU Emulator.
- **Stimulus (Load Into Player)...** Launches the **Open** dialog, where you can navigate to select and load a Wireshark Capture file ('.pcap' file), which is just a "stimulus" file created with O-RAN Studio.
- Default Setup Clears any loaded project (.scp file) and Open RAN Studio Setup ('.orstx' file) configuration and restores to default settings.
- Default Open RAN Studio Setup Clears any loaded Open RAN Studio Setup ('.orstx' file) configuration only and restores to default settings.

File	e Control	Setup	Test Models	View	Help		
ß	Recall			[+	$\triangleright$	Ш	٢
Ľ	] Save		Open R	AN Studio	Setup		
[-	<ul> <li>Export</li> </ul>			AN Studio	Setup as	3	
[•	- Import		, NR C	arrier 1 (DL)	~		
	Exit		Value				

2 **Save**-This sub-menu item contains the following options:

Figure 47 Elements in the Save sub-menu

- Open RAN Studio Setup Saves the current settings from the O-RAN Studio setup (as a '.orstx' file) to the currently associated file name. If a file name is not associated, the software prompts you to use the 'Open RAN Studio Setup as...' option first.
- **Open RAN Studio Setup as...** Launches the **Save As** dialog, where you can save the current settings from the O-RAN Studio setup (as a '.orstx' file) with a file name of your choice.

3 **Export**-This sub-menu item contains the following option:





- **Generate Stimulus File** Functions in the same manner as the "Export O-RAN Stimulus File" toolbar button (For details, see Tool Bar on page 63).
- Generate BLER XML File See Measuring BER / BLER on page 249 for more details.
- 4 **Import**-This sub-menu item contains the following option:

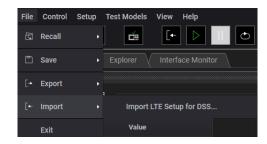
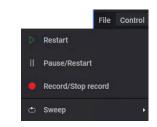


Figure 49 Elements in the Import sub-menu

- Import LTE Setup for DSS Lets you add an LTE SCP to a preloaded 5G NR SCP. For more details, see Configuring LTE Coexistence -DSS on page 203.
- 5 Exit Close the Open RAN Studio software.

#### Control menu

The **Control** menu provides the following selections:

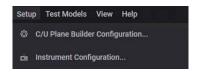




- **Restart** Functions in the same manner as the "Play Stimulus" toolbar button. For details, see Tool Bar on page 63.
- Pause/Restart Functions in the same manner as the "Pause Stimulus" toolbar button. For details, see Tool Bar on page 63.
- **Record/Stop record** Functions in the same manner as the "Record" toolbar button. For details, see Tool Bar on page 63.
- **Sweep** Functions in the same manner as the "Single / Continuous Sweep" toolbar button. For details, see Tool Bar on page 63.

#### Setup menu

The Setup menu provides the following selections:





- C/U Plane Builder Configuration... Opens the C/U Plane Builder Configuration dialog to generate O-RAN test vectors. For details, see C/U-Plane Builder on page 100.
- **Instrument Configuration...** Opens the Instrument Configuration dialog. For details, see Instrument Configuration on page 91.

Test Models menu

The **Test Models** menu provides the following selections:

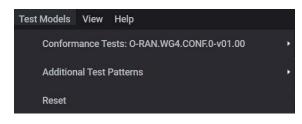


Figure 52 Elements in the Test Models menu

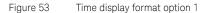
- Conformance Tests: O-RAN.WG4.CONF.O-v1.00 Displays the stock data test model patterns based on the O-RAN specification that can be applied to the loaded SCP / PCAP file to check for conformance of the data. For more information, see Applying Stock Data Test Definitions on page 267.
- Additional Test Patterns Displays test patterns that may not completely adhere to the O-RAN specification but are tailored to verify conformance of user-defined data. For more information, see Applying Additional Test Patterns on page 279.
- **Reset** Resets the SCP / PCAP file contents to its original state.

#### View menu

The **View** menu provides the following selections:

 Time Display Format > UTC Time of Day (01:02:03. 123456789) — Displays the capture time for each packet in the U-Plane, C-Plane Messages in the format HH:MM:SS.ninth decimal digit of seconds (same as the format for PTP epoch, which is 31 December 1969 23:59:51.999918 UTC).

3 [[→	\$\$*	Time Disp	play Format			UTC	Time of D	ay (01:02	:03.123456789	) 🕨		
C-Plane Builder Explorer Seconds Since Begining of Capture (0.123456789s)												
						Seco	onds Since	e Previous	s Displayed Pac	ket (0.1234567	89s)	
U-Plane	, C-Plane Messages: —				U-PI	ane:						
	Time	Source	Destination			Dir	eAxC	μ	DU Port	Band Sector	сс	7
	08:02:49.639995061	08 00 00 00 00 02	02 04 06 08 0A 0C			DL	0001	(1)				
	08:02:49.639998393	08 00 00 00 00 02	02 04 06 08 0A 0C		<							
	08:02:49.640034109	08 00 00 00 00 02	02 04 06 08 0A 0C									
	08:02:49.649995047	08 00 00 00 00 02	02 04 06 08 0A 0C		C-PI	ane: -						
	08:02:49.649998430	08 00 00 00 00 02	02 04 06 08 0A 0C		#	Dir	eAxC	u	DU Port	Band Sector	сс	
	08:02:49.650034133	08 00 00 00 00 02	02 04 06 08 0A 0C		#							
	08:02:49.659995065	08 00 00 00 00 02	02 04 06 08 0A 0C			DL	0001	(1)			0	Ľ



 Time Display Format > Seconds Since Beginning of Capture (0.123456789s) — Displays the seconds elapsed, in the format of *ninth decimal digit of seconds*, in capturing each packet since the beginning of capture of U-Plane, C-Plane Messages.

e Setup	Test Models Vie	w Help										
₫ [+	¢	Time Disp	olay Format			UTC	Time of D	ay (01:02	2:03.123456789			
C-Plane Builder Explorer Seconds Since Begining of Capture (0.123456789s)												
						Seco	onds Since	Previou	s Displayed Pac	ket (0.1234567	89s)	
U-Plane,	C-Plane Messages:				U-Pla	ine:						
	Time	Source	Destination			Dir	eAxC	μ	DU Port	Band Sector	сс	$\nabla$
	0.00000000s	08 00 00 00 00 02	02 04 06 08 0A 0C			DL	0001	(1)				
	0.000003332s	08 00 00 00 00 02	02 04 06 08 0A 0C		<					_		
	0.000039048s	08 00 00 00 00 02	02 04 06 08 0A 0C									
	0.009999986s	08 00 00 00 00 02	02 04 06 08 0A 0C		C-Pla	ne: –						
	0.010003369s	08 00 00 00 00 02	02 04 06 08 0A 0C		#	Dir	eAxC	u	DU Port	Band Sector	сс	
	0.010039072s	08 00 00 00 00 02	02 04 06 08 0A 0C									
	0.020000004s	08 00 00 00 00 02	02 04 06 08 0A 0C		0	DL	0001	(1)	0		0	
<					<							



Time display format option 2

 Time Display Format > Seconds Since Previous Displayed Packet — Displays the seconds, in the format of *ninth decimal digit of seconds*, elapsed since the last packet was captured in the U-Plane, C-Plane Messages.

File Setu	ıp Test Models V	ïew Help										
-] E	→	Time Disp	play Format		۲.	UTC	Time of D	ay (01:02	2:03.123456789	)		
C-Plane Builder Explorer Seconds Since Begining of Capture (0.123456789s)												
300000000000						Seco	onds Since	Previou	s Displayed Pac	ket (0.1234567	89s)	k
U-Plan	e, C-Plane Messages				U-Pla	ine:						
#	Time	Source	Destination			Dir	eAxC	μ	DU Port	Band Sector	сс	$\nabla$
1	0.000000000s	08 00 00 00 00 02	02 04 06 08 0A 0C	. 📤		DL	0001	(1)				
2	0.000003332s	08 00 00 00 00 02	02 04 06 08 0A 0C		<					_		
3	0.000035716s	08 00 00 00 00 02	02 04 06 08 0A 0C									
4	0.009960938s	08 00 00 00 00 02	02 04 06 08 0A 0C		C-Pla	ne: –						
5	0.000003383s	08 00 00 00 00 02	02 04 06 08 0A 0C		#	Dir	eAxC	u	DU Port	Band Sector	сс	
6	0.000035703s	08 00 00 00 00 02	02 04 06 08 0A 0C									
7	0.009960932s	08 00 00 00 00 02	02 04 06 08 0A 0C		0	DL	0001	(1)	0	0		
<					<	_	_	_		_		

Figure 55 Time displa

Time display format option 3

#### Help menu

The **Help** menu provides the following selections:

Help
Show Help
Search Help
Show C-Plane Builder API Help
Show REST API Help
U5040A Open RAN Studio Website
License Manager
Technical Support
Modules
About U5040A Open RAN Studio

Figure 56 Elements in the Help menu

- Show Help... Opens the O-RAN Studio Online Help.
- **Search Help...** Allows you to search for any content in the O-RAN Studio Online Help.
- Show C-Plane Builder API Help... Opens the O-RAN Studio C-Plane Builder API Online Help.
- Show REST API Help... Opens the O-RAN Studio REST API Online Help.
- U5040A Open RAN Studio Website... Launches the Open RAN Studio Software download page.
- License Manager... Opens the Keysight License Manager 5 application.
- Technical Support... Launches the U5040BSCA Open RAN Studio for O-RAN Radio Unit (O-RU) Testing and Validation Technical Support page.
- **Modules...** Opens "Open RAN Studio Diagnostic Information" window that displays all loaded DLL files. See Figure 57.

Name	File Version	Assembly Version	Timestamp	
5G_NR.dll	1.2.10611.0	1.2.10611.0	2021-01-10 16:20:4	4
Accessibility.dll	4.8.3752.0 built by: NET48REL1	4.0.0.0	2019-03-19 10:16:4	9
Accessibility.ni.dll	4.8.3752.0 built by: NET48REL1		2020-11-06 08:41:0	0
ActiproSoftware.Charts.Wpf.dll	18.1.673.0	18.1.673.0	2020-12-21 12:20:3	6
ActiproSoftware.Docking.Wpf.dll	18.1.673.0	18.1.673.0	2020-12-21 12:20:3	6
ActiproSoftware.Editors.Wpf.dll	18.1.673.0	18.1.673.0	2021-01-10 16:17:2	2
ActiproSoftware.Gauge.Wpf.dll	18.1.673.0	18.1.673.0	2020-12-21 12:20:3	6
ActiproSoftware.Shared.Wpf.dll	18.1.673.0	18.1.673.0	2020-12-21 12:20:3	4
ActXPrxy.dll	10.0.18362.1171 (WinBuild.160101.0800)		2020-12-04 16:12:4	7
ADVAPI32.dll	10.0.18362.1 (WinBuild.160101.0800)		2020-11-05 22:05:2	4
apphelp.dll	10.0.18362.1 (WinBuild.160101.0800)		2020-11-05 22:05:4	2
AssignedAccessRuntime.dll	10.0.18362.815 (WinBuild.160101.0800)		2020-11-05 22:05:2	8
atlthunk.dll	10.0.18362.900 (WinBuild.160101.0800)		2020-11-05 22:05:2	6.
<				

Figure 57 O-RAN Studio Diagnostic Information window

 About U5040A Open RAN Studio... - Opens the "About U5040A Open RAN Studio" window that displays product information including current version, release date, build information and web link for product support. See Figure 58.

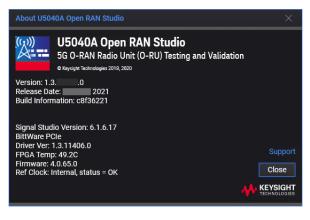


Figure 58 About O-RAN Studio window

2.2.3: Tool Bar

The tool bar provides the following convenient functions:

Table 3 Tool bar

Elements	Name	Function
G	Open File Dialog	This button allows you to navigate to an ".SCP" file containing an RF designed created under PathWave Signal Generation Desktop 2022/Signal Studio or to a ".pcap" file, which may either be a "stimulus" file created with Oran Studio or a "recording" captured with the Open RAN O-DU Emulator.
[+	Export O-RAN Stimulus File	This button is used to create the CU-Plane "stimulus" file that encapsulates the required C-Plane signaling and the U-Plane payload necessary to represent the RF design in the ".SCP" file. This export functionality will also utilize any CU-Plane configurations you make.
ŝ	C/U-Plane Builder Configuration	This button allows you to manually tune and adapt CU-Plane parameters used in the creation of a "stimulus" CU-Plane ".pcap" file. For details, see Configuration Tool on page 70.

Elements	Name	Function
Ť	Instrument Configuration	This button only shows up when connected to BittWare Hardware. This opens a dialog used for configuring the BittWare Hardware related features. For details, see Instrument Configuration on page 91.
[⊷	Load Stimulus	This button loads a stimulus PCAP file to the Open RAN O-DU Emulator.
$\square$	Play Stimulus	This button is used to remotely control playout of a "stimulus" file on the Open RAN O-DU Emulator.
II	Pause/Restart Stimulus	This button is used to remotely pause "stimulus" playout on the Open RAN O-DU Emulator.
$\odot$	Single/Continuous Sweep	This button is used to remotely control single or continuous "stimulus" playout on the Open RAN O-DU Emulator. In single mode the stimulus file is played "once" per press of the Play Stimulus button.
•	Record O-RAN Stimulus/Response between O-DU and O-RU	This button remotely initiates recording on the Open RAN O-DU Emulator of traffic between the O-DU Emulator and the O-RU DUT. Note that this feature interleaves downlink and uplink traffic into a single ".pcap" recording.
1 ~	Record Length (in units of Radio Frames)	This button remotely controls the maximum number of RF frames recorded by the O-DU Emulator. You can chose a number of frames from the pull down menu or enter a value like "10" RF frames.

#### 2.2.4: Functional tabs

The U5040A Open RAN Studio consists of three tabs where you can perform various functions:

- C-Plane Builder For detailed information, see C/U-Plane Builder on page 100.
- Explorer For detailed information, see Explorer on page 106.
- Interface Monitor For detailed information, see Interface Monitor on page 114.

### 2.2.5: Status Bar

The status bar is located at the bottom of the O-RAN user interface, as shown in Figure 59:

File: C:\Users\dvutest\Desktop\test\test.scp	Size: 67606 Port Status: 250 16 PTP: Slave SyncE: Master
	Figure 59 Appearance of the Status bar
	<ul> <li>It displays the following information:</li> <li>File - Displays captured file name</li> <li>Size - Displays captured file size</li> </ul>
	File and Size are context sensitive depending on which tab is selected: C/U-Plane Builder – displays the currently loaded PathWave Signal Generator/Signal Studio (.scp) file.
	Explorer – displays the currently loaded stimulus/capture (.pcap) file.
	<ul> <li>Interface Monitor – displays the currently loaded stimulus file used for playback.</li> </ul>
	<ul> <li>Port Status - Displays the actual port speed, which is color coded depending on the link status.</li> </ul>
	Table 4         Speed displayed in the Port Status field
	Speed Description
	10G         Indicates that the port is running at 10Gbps
	25G Indicates that the port is running at 25Gbps

200	indicates that the port is raining at 2005ps
Disabled	Indicates that the port is disabled
LOOP	Indicates that the port is in Loopback mode

#### Table 5 Color coding displayed in the Port Status field

Color Code	Description
Green	Indicates that the link is 'up' on the port
Red	Indicates that the link is 'down' on the port
Grey	Indicates that the port is disabled

• PTP - Displays the current status of PTP synchronization and is color coded depending on the current state.

PTP Mode	PTP Status	Color Code	Description			
Master	Master	Green	Indicates that PTP is in 'Master' mode			
			Note: This status does not give any indication if there is a synchronized PTP slave or not.			
	Slave	Red	Indicates that PTP is attempting to synchronize with a Master, but the time offset is greater than 0.1 seconds			
Slave	Slave	Yellow	Indicates that PTP is synchronizing with a Master and the offset is between 100 nanoseconds and 0.1 seconds			
Slave	Slave	Green	Indicates that PTP is synchronized with a Master and the offset is less than 100 nanoseconds			
	Listen	Red	Indicates that PTP is in Slave mode, but has not detected a suitable Master to synchronize with			
Disabled	Disabled	Grey	Indicates that PTP is disabled			

#### Table 6 Possible PTP states and color codes

• SyncE - Displays the PTP configuration mode

#### Table 7 SyncE modes and color codes

SyncE mode	Color Code	Description
Master	Green	Indicates that PTP is configured for 'Master' mode
Disabled	Grey	Indicates that PTP is either disabled or configured for 'Slave' mode

#### 2.2.6: Dockable Planes

The functional planes under each of the three tabs can now be moved or resized.

To move a plane from its default position, do one of the following:

• Click the white band (on top) of the plane you wish to move. Notice that the band turns blue. Hold down and drag the cursor to any of the positions that appear as you move the plane around.

KEYSIGHT Open RAN Studio - Offline		– 🗆 ×
File Setup Test Models View Help		
C-Plane Builder Explorer		
Component Carriers	Radio Control Plane Data	
Carrier Numerology Select Carrier:	μ Subframe Slot ID RB Start RB Number Sym Start Sym Number Channel	
Attribute Value		
Flow/eAxC ID	Radio Allocations	
Resource Allocations		
Select Allocation:		
Attribute Value		
	Frame In	ndex (0 🗘
File	Skee 0	

Figure 60 Drag positions for dockable planes

 Alternatively, right-click the white / blue band (on top) or click the "Options" menu (as highlighted in Figure 61) of the plane you wish to move. Click "Float" to displace the selected plane.

Radio Control Plane Data	Float	
Subframe Slot ID RB Start RB	Number Sym S Dock	ction ID Channel Beam Index

Figure 61 Options menu for dockable planes

To resize a plane that is "floating":

- Use the two-headed arrows that appear at the edges of the "floating plane to resize it to a custom size.
- Double-click the blue band or click the "Maximize" button to expand the "floating" plane to the maximum display size.

To dock a "floating" plane:

• Right-click the white / blue band (on top) or click the "Options" menu (as highlighted earlier) of the plane you wish to dock. Click "Dock" to reposition the selected plane.

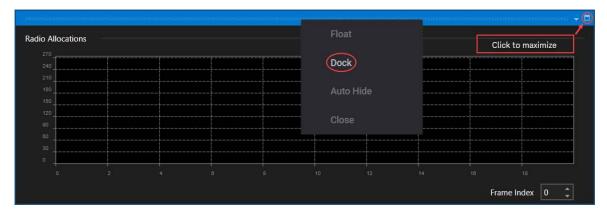


Figure 62 D

Docking and Maximizing options for dockable planes

## Section 2.3: Configuration Tool

The Configuration Tool is used to configure hardware as well as C/U-Plane specific parameters. The changes made through this tool are stored in a "persistence" meta data file (.orstx file) and recalled when you reload the same ".SCP" file.

## NOTE

## For any changes made to the "Configuration Tool" to take effect in the stimulus player, you must perform the following steps:

1. (Re)generate the stimulus file. From the main menu, click File > Export > Generate Stimulus File.

2. (Re)load the stimulus into the player. From the main menu, click File > Recall > Stimulus (Load Into Player)....

C/U Plane Builder	Configuration Tool ×					
Flow/eAxC	Flow Fields Allocation					
Compression	eAxC ID fields bitwidth patterns 44.4.4 v + X (applied to all eAxC IDs)					
Numerology	Flows DL					
Beamforming	eAxC ID DU Port ID Band Sector ID Component Carrier ID RU Port ID Group Number of DL flows +					
Timing	0001 0 0 0 1					
Options						
DSS						
	Flows UL					
	eAxC ID DU Port ID Band Sector ID Component Carrier ID RU Port ID Group Number of UL flows +					
	0001 0 0 0 1					
	Flow Summary This represents the number of streams or spatial streams supported in your O-RU. The values entered here will persist with subsequent invocation of this application but can easily be modified. The number of flows in the downlink and uplink can be different, but the assigned eAxC ID can be the same. You may add/delete more flows for eAxC ID mapping if required. Each eAxC ID is represented as its "hex" value and depending on the field bit width pattern selected you can see how this value is assigned to each of the four ORAN field components. The eAxC ID value can also be changed by editing the cell value in the table. The bit width pattern's combo box is editable, and one can add new patterns for testing.					

#### Figure 63 shows an example of Configuration Tool:

Figure 63 Default view of the ORAN Interface Configuration Tool

It provides the following tabs:

- Flow/eAxC ID
- Compression
- C/U-Plane Coupling
- Numerology
- Beamforming
- Timing
- Options

Each tab allows you to perform some settings which is explained in the sections that follow.

#### 2.3.1: Flow/eAxC ID

Figure 64 shows settings provided by the "Flow/eAxC ID" tab:

C/U Plane Builder Configuration Tool								
Flow/eAxC	Flow Fields Allocation							
Compression	eAxC ID fields bitwidth patterns 4,4,4,4 ~ (applied to all eAxC IDs)							
Numerology	Flows DL							
Beamforming	eAxC ID	DU Port ID	Band Sector ID	Component Carrier ID	RU Port ID	Group	Number of DL flows	
Timing	0001	0	0	0	1			
Options								
DSS								
	Flows UL							
	eAxC ID	DU Port ID	Band Sector ID	Component Carrier ID	RU Port ID	Group	Number of UL flows	
	0001	0	0	0	1			

Figure 64 Flow/eAxC options in the ORAN Interface Configuration Tool

For details of the settings, refer to the "Flow Summary" provided in this tab.

The "Flow/eAxC ID" tab can be used to:

- Set a pattern for eAxC ID bit map to DU, BS, CC and RU field sizes (total size 16-bits).
- Use the default mapping of 4-bits each or add/remove new bitwidth patterns.
- Presently, the DU, BS, CC and RU fields cannot be edited separately, only the eAxC ID value (hex) can be edited (and thereby indirectly editing the DU, BS, CC and RU fields).

- The eAxC ID values are set individually for downlink and uplink flows.
- The configured flow parameters will be stored in setup file and thus may "persist" between Open RAN studio invocations.
- In the "C-Plane Builder", assign a Flow/eAxC ID to each "Carrier".

#### 2.3.2: Compression

Figure 65 shows settings provided by the "Compression" tab:

C/U Plane Builder	Configuration Tool				$\times$
Flow/eAxC	DL U-Plane IQ Data Compressio	on:			
Compression	eAxC ID	0001	$\mathbf{x}_{\mathbf{x}}$	Apply to All DL Flows	
Numerology	Static Compression (	no udCompHdr in U	-Plane)		
Beamforming	Compression Method	no compression	~		
Timing	IQ Bitwidth	15	~		
Options	UL U-Plane IQ Data Compressio	on:			
DSS	eAxC ID	0001	~	Apply to All UL Flows	
	Static Compression (	no udCompHdr in U	-Plane)		
	Compression Method	no compression	~		
	IQ Bitwidth	15	~		

Figure 65 Compression options in the ORAN Interface Configuration Tool

For details of the settings, refer to the "Compression Summary" provided in this tab.

The "Compression" tab can be used to:

- Select compression strategy and method to be applied to downlink and uplink U-Plane PRBs on a per eAxC ID basis.
- Select between "static" or "dynamic" configuration. Under static mode, udCompHdr(s) are not used in U-Plane packet per PRB.
- The compression methods available are:
  - no compression

- block floating point Changes the IQ samples for each PRB into floating point format, where the data appear as a compressed bit sign, a mantissa and a shared exponent.
- block scaling Similar to block floating point, except that data is shown by post-scaled values and a multiplicative scale value, which are shared within a block.
- $\mu$ -law Shifts a bit (for dynamic range) followed by combining with a nonlinear sub-function approximation, where for implementation efficiency,  $\mu$ =8 and the sign & mantissa are 1 and 2-bits respectively.
- modulation compression (available for Downlink U-Plane messages only) - Uses limited number of I and Q bits to represent modulated data symbols.

For more information about these compression methods, refer to *Annex A Compression Methods* in the O-RAN specification.

- Full range of IQ bit widths is supported.
- A compression setting can be applied to all eAxC's (DL or UL) by selecting the "Apply to All DL Flows" and "Apply to All UL Flows" buttons.

### 2.3.3: Numerology

Figure 66 shows settings provided by the "Numerology" tab:

C/U Plane Builder	Configuration Tool			X
Flow/eAxC	Slot IDs relative to	highest numerol	ogy in carrier FR	
Compression	Bandwidth			FR1 100 MHz 🗸 🗸
Numerology	Resource Grid:			
Beamforming	Numerology	Grid Size	Grid Enabled	
Timing	μ = 0: 15kHz	270		Enable a grid to facilitate carrier IQ
Options	µ = 1: 30kHz	273		recovery from a recording.
DSS	µ = 2: 60kHz	135		
	Ref. Point A: 950.	86 MHz at -49.1	4 MHz from center	
	PRACH IQ Recovery			
	🗌 Use PRACH IQ R	ecovery Options		
	PRACH Format	Format0		
	PRACH SCS	1.25 kHz		
	Frequency Offset			
	Options			
	Use LTE IQ Reco	very Options		
	Add null DC si	ubcarrier (use wi	th LTE only)	

Figure 66 Numerology tab of the Configuration tool

For details of the settings, refer to the "Numerology Summary" provided in this tab.

The "Numerology" tab can be used to:

- Create carriers with slot numbering schemes that reflect section "5.3.2 *Mixed Numerology and PRACH Handling*" in the ORAN CUS-Plane specification. Use the tick box to enable this feature when creating a signal or when recovering a carrier from a recording.
- Configure the bandwidth (drop-down options) and enable the carrier's grid (Resource Grid), when recovering an IQ carrier from a recording, so that Open RAN Studio reassembles U-Plane data correctly.
- Configure Open RAN Studio to recover PRACH IQ carrier by identifying such PCAP files, which have not been generated using Open RAN Studio. Make sure that the PRACH Format, SCS and Freq. Offset values match with those that appear in the C-Plane PRACH message.
- Recover IQ data from the LTE signal, where you may additionally choose the option to include the null DC subcarrier during IQ recovery from the PCAP/ORSTX files for LTE signals only.

### 2.3.4: Beamforming

### Figure 67 shows settings provided by the "Beamforming" tab:

C/U Plane Builder	Configuration Tool				×
Flow/eAxC	Beamforming Met	hod:			
Compression	no beamforming	Į	×		
Numerology	Size of beam r	napping table 0	+ ×		
Beamforming	Beamforming Map	opings:			
Timing	Beam IDs	Beam Weights	Flexible Weights	Beam Attributes	Beam Channel Information
Options	Table Index	Beam ID			
DSS					

Figure 67 Beamforming tab of the Configuration tool

For details of the settings, refer to the "Beamforming Summary" provided in this tab.

The "Beamforming" tab can be used to:

- Select a beamforming strategy. Available beamforming strategies are:
  - no beamforming: (default) indicates that no beamforming has been applied.
  - predefined-beam beamforming: an index to indicate a specific beam to use
  - weight-based dynamic beamforming: an index to indicate the weight vector for a beam (with a specific Table Index value) along with compression technique
  - attribute-based dynamic beamforming: an index to indicate a specific beam to use, along with specific attributes (described in *Chapter 5.4.7.2* of the O-RAN specification).
  - channel-information-based beamforming: an index based on channel information, for a specific ueID (instead of beamID)

flexible weight-based dynamic beamforming: an index to indicate
the weight vector for a beam (with a specific beamID value) along
with compression technique

- For the selected method, provide beam IDs, weights, attributes to be used with subsequent signals. See Setting Beam IDs / Ue IDs for Radio Allocations on page 303 to understand how to correctly configure Beam / Ue IDs.
- If 'channel-information-based beamforming' is the selected method, you must include a file containing the beam channel information. See Applying Channel-information-based beamforming on page 341 for more details.
- Configure flow parameters, which will be stored in setup file and thus may "persist" between Open RAN studio invocations.
  - Once these tables are set up, creating a new stimulus signal with a different strategy is simplified
  - Use the radio buttons to activate strategy before creating the stimulus signal
  - Ensure correct "Beam IDs" / "uelds" are assigned to relevant sections in "C-Plane Builder"

# NOTE

# Beamforming in SRS Channel is supported in version 1.3 (and higher) of the U5040A Open RAN Studio software.

For more information about the beamforming methods and the associated properties, refer to *Beamforming Guidelines* in the O-RAN specification.

### 2.3.5: Timing

Figure 68 shows settings provided by the "Timing" tab:

C/U Plane Builder	Configuration Tool			×
Flow/eAxC	Stimulus Alignment:			
Compression	Delay Relative to Frame Boundary	0	+/- microseconds	
Numerology	C-Plane Timing Alignment	symbol boundaries 🗸 🗸		
Beamforming	Downlink Timing:			
Timing	DL C-Plane Time Advance (T1a_cp_dl)	5000	nanoseconds	
Options	DL U-Plane Time Advance (T1a_up_dl)	2000	nanoseconds	
DSS	C-Plane Time Advance (Tcp_adv_dl)	3000	nanoseconds	
	Uplink Timing:			
	UL C-Plane Time Advance (T1a_cp_ul)	5000	nanoseconds	
	UL U-Plane Time Delay (Ta3_up_ul)	2000	nanoseconds	

Figure 68 Timing tab of the Configuration tool

For details of the settings, refer to the "Timing Summary" provided in this tab.

The "Timing" tab can be used to:

- Configure a fixed time displacement (relative to frame boundary) for all message times (Stimulus Alignment).
- Configure the method to define the boundaries (symbol / slot) from where to consider the timings for C-Plane (and U-Plane) messages on both DL & UL data. See example for Viewing C/U-Plane Timing Alignment in Explorer on page 82 to understand the difference in timing alignment based on this setting.
- For DL data, configure timing (as advance) for C-Plane messages and U-Plane messages. To understand timing relations per symbol IQ in DL, refer to Figure B-2 in Annex B Delay Management Use Cases in the ORAN specification.

- For UL data, configure the advance time for C-Plane messages and delay for U-Plane messages. To understand timing relations per symbol IQ in UL, refer to Figure B-3 in Annex B Delay Management Use Cases in the O-RAN specification.
- The O-RAN Studio GUI provides several parameters for configuring stimulus timing of radio frames used when generating the stimulus file, which are:
  - The "Delay relative to frame boundary" parameter specifies how many of every total radio frame (holding the inter frame distribution of C-Plane and U-Plane messages dependent on "*Tcp\_adv\_dl*" parameter) is advanced (- value) or delayed (+ value) with respect to radio frame boundaries.
  - Determine "Data message timing method" as either 'symbol boundaries' or 'slot boundaries'. A radio frame always has the duration of 10 ms and consists of several slots (10, 20, 40) depending on numerology. A slot always consists of 14 symbols. ORS radio frames are played out relative to radio frame boundaries. C-Plane messages are always played out relative to slot boundaries. ORS U-Plane messages are played out relative to either slot boundaries or symbol boundaries.
  - The "Tcp\_adv\_dl" parameter in the Downlink Timing is used to define inter radio frame distribution of C-plane and U-plane messages. The "Tcp\_adv\_dl" value specifies how many nanoseconds in advance to symbol boundaries the C-Plane messages starts to playout.

Note that "C-Plane Time Advance (Tcp\_adv\_dl)" is a 'read-only' field and is calculated automatically as the difference of C-Plane and U-Plane Time Advance:

Tcp\_adv\_dl = T1a\_cp\_dl - T1a\_up\_dl

The block diagram depiction of the timing of C-Plane messages and U-Plane messages in a DL carrier is shown in Figure 69.

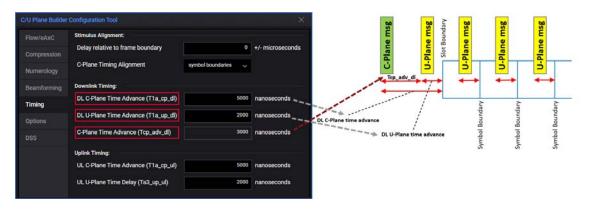


Figure 69 Timings for C-Plane and U-Plane messages (DL)

 The block diagram depiction of the timing of C-Plane messages and U-Plane messages in a UL carrier is shown in Figure 70.

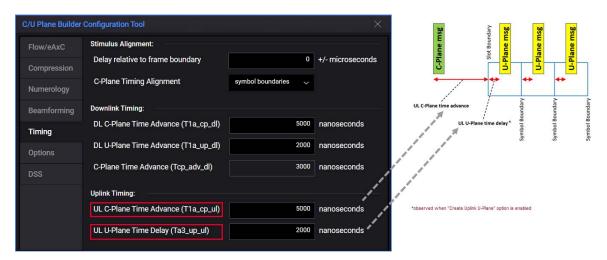


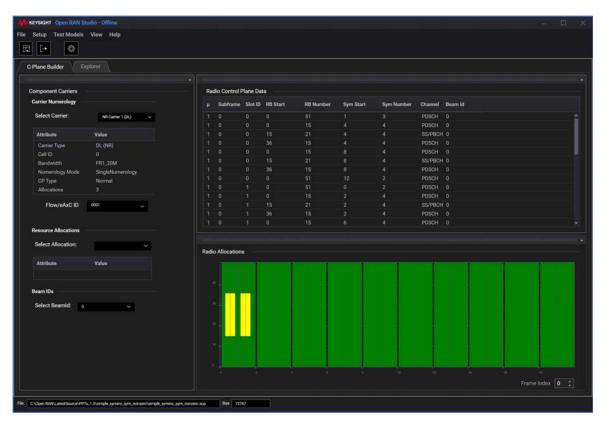
Figure 70 Timings for C-Plane and U-Plane messages (UL)

Note that by default, the Uplink carrier does not contain U-Plane messages. The "UL U-Plane Time Delay" is determined after you enable the "Create Uplink U-Plane" option in the "Options" tab of the "C/U Plane Builder Configuration Tool". For more information on how to generate U-Plane data on Uplink carrier, see Creating U-Plane messages in Uplink Carrier on page 170.

### Viewing C/U-Plane Timing Alignment in Explorer

This section shows an example of how the C-Plane (and U-Plane) timing depends on the "C-Plane Timing Alignment" setting in the Timing tab of the C/U Plane Builder Configuration Tool. The SCP file used for this example has a section in slot 0 that starts on symbol 1.

- 1 Open the SCP file in O-RAN Studio.
- 2 Assign the "Flow/eXAC ID".





By default, the "C-Plane Timing Alignment" setting is configured to 'symbol boundaries'.

3 Export the O-RAN Stimulus file to generate the corresponding PCAP file. See Exporting O-RAN Stimulus File on page 122 for more information.

lane	Builder V Explorer	7											
lane,	, C-Plane Messages:						U-Pla	ne:				- Message Inte	
	Time	Source	Destination	Protocol	Length	Description		Dir	eAxC		DU Port		rsion : 1 incatenation : 0
	00:00:00.010030714	00 00 00 00 00 00	80 09 02 03 04 05	AE FE		[PCAP] C-Plane, Sect 🖄			0001				essage : 0 wload : 2309
						[PCAP] U-Plane, Fran						eCPRI Cor	nponent eAxC ID (U-Plane
	00:00:00.010069429	00 00 00 00 00 00	80 09 02 03 04 05			[PCAP] U-Plane, Fran						DuPort	ID : 0 sctorID : 0
	00:00:00.010105143		80 09 02 03 04 05			[PCAP] U-Plane, Fran						CcID : C	
	00:00:00.010137857	00 00 00 00 00 00 00		AE FE		[PCAP] C-Plane, Sect						RuPort - eCPRI Sec	
	00:00:00.010137857		80 09 02 03 04 05			[PCAP] C-Plane, Sect	C-Pla	ne: –				Sequer	celD : 0
	00:00:00.010137857	00 00 00 00 00 00 00 00			60 2343	[PCAP] C-Plane, Sect [PCAP] U-Plane, Fran		Dir	eAxC		DU Port	E:1	uencelD : 0
	00.00.00.010140857	00 00 00 00 00 00 00			2343	[PCAP] U-Plane, Fran		DL	0001			- U-Plane C	ommon Header
	00:00:00.010212286		80 09 02 03 04 05		2343	[PCAP] U-Plane, Fran			1001				ection : 1 IVersion : 1
	00:00:00.010248000		80 09 02 03 04 05	AE FE	2343	[PCAP] U-Plane, Fran						FilterIn	dex:0
	00:00:00.010280714	00 00 00 00 00 00	80 09 02 03 04 05			[PCAP] C-Plane, Sect v						Framel Subfra	
-							<					Slotid :	0
												Symbo	
												Section	
x Pay	foad:						Reo	overed	IQ .	Constellation		RB : 0 Symbo	
lex	00 01 02 03 04 0	5 06 07 08 09	0A 08 0C 0D	OE OF /	LSCII		PRR-	(none s	elected)				rPrbu : 51
	80 09 02 03 04 0	15 00 00 00 00	0 00 00 81 00				RE		mpl	uCmpQ		udCom	pHdr:240 ∋d:0
		05 00 01 00 80					RE	uu	and a	ounpd		- PRB 0	
												IqSam (IgBitW	leBlock : [5a, 82, b5,] idth : 15)
												(Comp	ession : no compression)
	D2 BF 5A 82 B5 0											- PRB 1 IgSamp	leBlock : [a5, 7f, 4a,]
	BF A5 7F 4A FE 9											(IqBitW	idth : 15)
	A5 7E B5 06 95 F B2 B5 05 6A 0D 2											· PRB 2	ession : no compression)
	B5 06 95 FA D4 1											IqSam	leBlock : [5a, 82, b5,]
	FD 6A 0A D4 1A 5												idth : 15) ression : no compression)
	95 FA D4 15 A8 3											- PRB 3	
			F 5A 83 4A FE									IqSam (InRitW	leBlock : [5a, 83, 4a,]

4 Load the updated stimulus / recording PCAP file into O-RAN Studio. The C-Plane symbol boundary alignment is displayed in Figure 72.

Figure 72 PCAP file showing C-Plane symbol boundary timing alignment

- 5 Launch the "C/U-Plane Builder Configuration Tool" window in the Open RAN Studio software.
- 6 Click the "Timing" tab.
- 7 Select 'slot boundaries' from the C-Plane Timing Alignment drop-down options.

C-Plane Timing Alignment	slot boundaries
	symbol boundaries
	✓ slot boundaries

Figure 73 Changing C-Plane Timing Alignment setting

- 8 Exit the "C/U-Plane Builder Configuration Tool" window.
- 9 Export the O-RAN Stimulus file again for the configuration changes to take effect. See Exporting O-RAN Stimulus File on page 122 for more information.
- 10 Load the updated stimulus / recording PCAP file into O-RAN Studio.

The C-Plane slot boundary alignment is displayed in Figure 74.

1         000000009999000         0000000009999000         80 09 02 03 04 05         AE FE         60         IPCAPI C-Plane, Sect           2         000000009999000         0000000000         80 09 02 03 04 05         AE FE         60         IPCAPI C-Plane, Sect         IPCAPI C-Plane, Sect           3         00000000099995000         0000000000         80 09 02 03 04 05         AE FE         60         IPCAPI C-Plane, Sect           4         000000009995000         00000000000         80 09 02 03 04 05         AE FE         60         IPCAPI C-Plane, Sect           5         0000000009995000         0000000000         80 09 02 03 04 05         AE FE         60         IPCAPI C-Plane, Sect           6         0000000009995000         00000000000         80 09 02 03 04 05         AE FE         60         IPCAPI C-Plane, Sect           9         000000001006473         00000000000         80 09 02 03 04 05         AE FE         2331         IPCAPI UPlane, Frant           10         000000010106473         00000000000         80 09 02 03 04 05         AE FE         2331         IPCAPI UPlane, Frant           12         000000011064737         000000000000000000000000000000000000	AxC µ DU Port 2001 3 0 AxC µ DU Port 2001 1 0 →	♥ V V Ethe eCP C C C C C C C C C C C C C	Interpretation: IN VLAN anTroString : PCP(7), DEI(0), VID(0 anTroString : PCP(7), DEI(0), VID(0 Type alue : AE FE 10 Common Header priVersion : 1 priPconcatenation : 0 priPlococatenation : 0 priPlococatenation : 0 Bromponent eAxC ID (C-Plane) WortID : 0 andSectorID : 0 all : 0
1         0:0:0:0:0:0:09995000         0:0:0:0:0:0:0:000995000         0:0:0:0:0:0:0:0:000995000         0:0:0:0:0:0:0:0:000995000         0:0:0:0:0:0:0:0:000995000         0:0:0:0:0:0:0:0:000995000         0:0:0:0:0:0:0:0:0:0000         0:0:0:0:0:0:0:0:0:0:0:0:0:0:0:0:0:0:0:	0001 1 0 → AxC µ DU Port	♥ v Ethe eCP eCP eCP eCP eCP eCP eCP eCP eCP eC	lanTypeString: 81 00 lanToString: PCP(7), DEI(0), VID(0 Type laue: AE FE 81 Common Header 81 Common Header 91 Component eNAC ID 10 Component eNAC ID (C-Plane) WortID: 0 andSectorID : 0 20 : 0
2         00.0000.009995000         00.000.0000         80.09.02.03.04.05         AE FE         60         [PCAP] C-Plane, Sect           3         00.0000.009995000         00.000.000.000         80.09.02.03.04.05         AE FE         60         [PCAP] C-Plane, Sect           4         00.000.000.09995000         00.000.000.000         80.09.02.03.04.05         AE FE         60         [PCAP] C-Plane, Sect           5         00.000.000.09995000         00.000.000.000         80.09.02.03.04.05         AE FE         60         [PCAP] C-Plane, Sect           6         00.000.000.000.00         80.09.02.03.04.05         AE FE         60         [PCAP] C-Plane, Sect           7         00.000.000.000.00         80.09.02.03.04.05         AE FE         60         [PCAP] C-Plane, Sect           9         00.000.000.000.00         80.09.02.03.04.05         AE FE         60         [PCAP] C-Plane, Sect           9         00.000.000.000.00         80.09.02.03.04.05         AE FE         2331         [PCAP] C-Plane, Fair           11         00.000.000.000.00         80.09.02.03.04.05         AE FE         2331         [PCAP] U-Plane, Frair           12         00.000.01/01.51.40.05         00.000.00.00         80.09.02.03.04.05         AE FE         2331         [PCAP] U-Plane, Fr	× ArC μ DU Port	Ebbe v v eCP eCP eCP eCP B B C C R R C C R C C R C R C C R C R C	rType alue: AE FE 81 Common Header :spriVersion: 1 spriVersion: 2 spriAessage: 2 spriAesyade: 20 81 Component eAvC ID (C-Plane) uPortID: 0 andSectorID: 0 eD: 0
3         000000000000000000000000000000000000		ecp ecp ecp ecp ecp B B C C R B B C C R B B C C R B B C R B B C R B C R C R	R Common Header pr/Version : 1 pr/Oncatenation : 0 pr/Message : 2 pr/Payload : 20 R Component eAxC ID (C-Plane) uPortID : 0 andSectorID : 0 eID : 0
4         0030300.009995000         00 00 00 00 00         80 09 02 03 04 05         AE FE         60         [PCAP] C Plane, Sect           5         000000.00995000         00 00 00 00 00 00         80 09 02 03 04 05         AE FE         60         [PCAP] C Plane, Sect           6         000000.00995000         00 00 00 00 00         80 09 02 03 04 05         AE FE         60         [PCAP] C Plane, Sect           7         000000.00995000         00 00 00 00 00         80 09 02 03 04 05         AE FE         60         [PCAP] C Plane, Sect           8         000000.00000         80 09 02 03 04 05         AE FE         60         [PCAP] C Plane, Sect         0         Dir eAcC           9         0000000.01000 0000         80 09 02 03 04 05         AE FE         60         [PCAP] C Plane, Sect         0         Dir eAcC           10         0000000.0100 00000         80 09 02 03 04 05         AE FE         2331         [PCAP] U Plane, Frant         0         Dir eAcC           12         000000.010105143         000 00 00 000         80 09 02 03 04 05         AE FE         2343         [PCAP] U Plane, Frant         Y           12         000000.010105427         000 00 00 0000         80 09 02 03 04 05         AE FE         2343         [PCAP] U Plane, Frant		e e P C C C C C C C C C C C C C C C C C	spriVersion : 1 spriConcatenation : 0 spriPayload : 20 al Component eAxC ID (C-Plane) uPortID : 0 andSectorID : 0 eID : 0
5         00:00:00:009995000         00:00:00:00:00:00         80:09:02:03:04:05         AE FE         60         [PCAP] C Plane, Sect           6         00:00:00:009995000         00:00:00:00:00:00         80:09:02:03:04:05         AE FE         60         [PCAP] C Plane, Sect           7         00:00:00:00:009995000         00:00:00:00:00:00         80:09:02:03:04:05         AE FE         60         [PCAP] C Plane, Sect         Dir         AAC           9         00:00:00:00:00:00:00:00         80:09:02:03:04:05         AE FE         60         [PCAP] C Plane, Sect         Dir         AAC           9         00:00:00:00:00:00:00:00:00         80:09:02:03:04:05         AE FE         2331         [PCAP] C Plane, Franc         Dir         AAC           10         00:00:00:00:00:00:00:00:00:00:00:00:00:		CP CP CP CP CP CP CP CP CP CP CP CP CP C	priMessage : 2 priPayload : 20 81 Component eAxC ID (C-Plane) uPortID : 0 andSectorID : 0 cID : 0
S         D0000000009995000         D00000000000         B009020304 05         AE HE         SO         [PCAP] CHame, Sect           7         000000009995000         00000000000         8009020304 05         AE HE         60         [PCAP] CHame, Sect           7         000000000995000         0000000000000         8009020304 05         AE HE         60         [PCAP] CHame, Sect           8         000000000995000         00000000000         8009020304 05         AE FE         60         [PCAP] CHame, Sect           9         000000001003714         00000000000         8009020304 05         AE FE         2331         [PCAP] UHame, Frant           10         00000001010164429         00000000000         8009020304 05         AE FE         2331         [PCAP] UHame, Frant           12         00000001010140573         0000000000         8009020304 05         AE FE         2331         [PCAP] UHame, Frant           12         00000001010140573         0000000000         8009020304 05         AE FE         2343         [PCAP] UHame, Frant           12         0000000101140657         0000000000         8009020304 05         AE FE         2343         [PCAP] UHame, Frant           12         00000000101140657         00000000000         8009020304 05		CPI B CPI CPI CPI CPI E	priPayload : 20 81 Component eAxC ID (C-Plane) uPortID : 0 andSectorID : 0 cID : 0
7         0000000009995000         0000000000         800902030405         AE FE         60         IPCAPI C-Plane, Sect           8         000000000995000         0000000000         800902030405         AE FE         60         IPCAPI C-Plane, Sect         Dir         AACC           9         00000000000000         00000000000         800902030405         AE FE         60         IPCAPI C-Plane, Sect         Dir         AACC         Dir         Dir         AACC         Dir         Dir         AACC         Dir         Dir         AACC         Dir         Dir <td< td=""><td></td><td>E CPI B C C C C C C C C C C C C C C C C C C</td><td>Ri Component eAxC ID (C-Plane) uPortID : 0 andSectorID : 0 cID : 0</td></td<>		E CPI B C C C C C C C C C C C C C C C C C C	Ri Component eAxC ID (C-Plane) uPortID : 0 andSectorID : 0 cID : 0
B         000000000000000000000000000000000000		B C R eCP S E	andSectorID : 0 cID : 0
x Payload:         x Paylo		C R eCPI S E	
0         0000000010069429         000000000000000000000000000000000000		- eCPI S E	
11         000000010105143         00 00 00 00 00 00         80 09 02 03 04 05         AE FE         2331         [PCAP] U-Plane, France           12         0000000.0101140857         00 00 00 00 00 00         80 09 02 03 04 05         AE FE         2343         [PCAP] U-Plane, France           x Payload:			uPortID : 1 3 Sequence ID
12         00:00:00:00:010140857         00:00:00:00:00:00         80:09:02:03:04:05         AE FE         2343         [PCAP] U Pfane, Franty         >           x Payfoad:			equenceID : 0
x Payload: tex: 00 01 02 03 04 05 06 07 08 09 0A 08 0C 00 06 0F ASCII PBB: (none selected 0 00 00 02 03 04 05 00 00 00 00 00 10 05 00			: 1 ubsequenceID : 0
Her 00 01 02 03 04 05 06 07 08 09 0A 08 0C 00 0E 0F ASCII PR8:(none selected		D	ane Common Header ataDirection : 1 avloadVersion : 1
Hex 00 01 02 03 04 05 06 07 08 09 0A 08 0C 0D 0E 0F ASCII PR8:(none selected on the second se		• F	ayload version : 1 IterIndex : 0 rameld : 0
A RO DO DZ DZ DZ DZ DA DZ DO DO DO DO RO DO REI DO ED DO	Constellation	S	ubframeld : 0 lotid : 0
0 80 09 02 03 04 05 00 00 00 00 81 00 60 00	ted)		tartSymbolid : 1 umberOfSections : 1
RE uCmpl	uCmpQ I		ectionType : 1 Data Compression Header
		k	BitWidth: 15
			ompression : no compression rved
48 00 00 00 00 00 00 00 00 00 00 00		v	alue : 0
		- C-Pl	ane Section Type 1 ectionID : 0
			B:0
			mbolinc: 0
			tartPrbc : 0 umberPrbc : 51
			eMask : 1111111111111b
			umSymbol: 3

Figure 74 PCAP file showing C-Plane slot boundary timing alignment

For more information about the timing methods and the associated properties, refer to *Annex B Delay Management Use Cases* in the O-RAN specification.

### 2.3.6: Options

The following figure shows settings provided by the "Options" tab:

C/U Plane Builder	Configuration Tool
Flow/eAxC	Network Layer:
Compression	Maximum transmission unit (MTU) 9000
Numerology	Disable VLAN Tags VLAN ID: 0
Beamforming	Set Sequence IDs to '0'
Timing	C-Plane Section Handling:
	🗌 Use reMask
Options	Use syminc
DSS	Use RB indicator
	Use Extension Type 6
	Use Extension Type 10 (MIMO only)
	PRACH Type 3 as Type 1 Message
	C-Plane Section Type 0 Messages:
	don't generate 🗸 🗸
	U-Plane Package:
	Create Uplink U-Plane
	Digital Power Scaling (IQ Data):
	0 FS adjustment (FS_Offset, default 0 is no scaling)
	Apply fixed 256QAM scaler
	0 Additional IQ power scaling (default 0 dBFS is no scaling)

Figure 75 Options tab in the Configuration tool

For details of the settings, refer to the "Options Summary" provided in this tab.

The "Options" tab can be used to:

• Set CU-Plane packet MTU size. This automatically invokes Application Layer Fragmentation (ALF), if required.

- Enable or disable the addition of VLAN Tags in CU-Plane packets.
- Specify the VLAN ID that will be used in the generated stimulus.
- Set eCPRI sequence numbers to "0" in stimulus file.
  - Currently, sequence numbers wrap per 10ms frame and hence possibly before reaching "255".
- reMask defines the Resource Element (RE) mask within a PRB. Each bit setting in the reMask indicates if the section control is applicable to the RE sent in U-Plane messages (0=not applicable; 1=applicable). MSB indicates the value for the RE of the lowest frequency in a PRB. Table 8 gives you an overview of the reMask feature for each carrier.

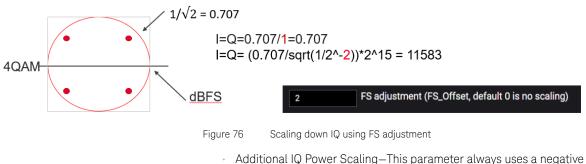
Carrier	Format	Behavior when "Use reMask" is enabled
	UCI	Divided into payload and DM-RS.
Uplink	PUSCH	Sections are split according to the positions of DM-RS and PT-RS. The reMask field is populated accordingly. Message bundling occurs, if "Use symInc" is also enabled.
	SRS	The reMask covers the reference signal.
PRACH	-	Not applicable.
	SS/PBCH	Divides the SS-block into PSS, SSS, and PBCH parts, but without use of reMask.
Downlink	PDCCH/DCI	Divided into payload and DM-RS.
DOWININK	PDSCH	Divided into payload, DM-RS, and PT-RS.
	CSI-RS	The reMask covers the reference signal, even for zero power. Separate mask for the case when RE used for PDSCH is false.

#### Table 8 reMask overview per carrier

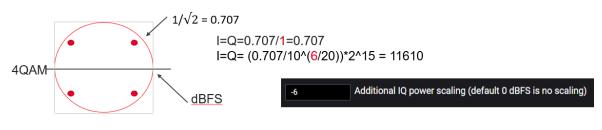
- symInc indicates the symbol number that is relevant to the given sectionId. It is expected that for each C-Plane message a symbol number is maintained and starts with the value of startSymbolid. The same value is used for each section in the message as long as symInc is zero.
- RB Indicator indicates if every RB is used or every other RB is used. The starting RB is defined by startPrbc and total number of used RBs is defined by numPrbc.

- External Type 6 is a section extension that applies only to Section Types 1 and 3. This section extension enables allocation of non-contiguous sets of PRBs (Resource Block Groups, or RBGs) in frequency and time domain. This reduces significantly the C-Plane overhead when users or channels are allocated with non-contiguous sets of PRBs in time and frequency.
- External Type 10 is a section extension that applies only to Section Types 1 and 3. This section extension can be used along with a 'representative eAxC ID' to reduce C-plane overhead of sending multiple messages to the overhead of sending one single C-plane message.
- Enable "PRACH Type 3 as Type 1 Message" option to change the messages from 'Type 3' messages to 'Type 1' in the Message Interpretation area of the C-Plane Section.
- The "Section Type 0 Configurations" allows control of the instance to insert such C-Plane packets in the "stimulus" signal.
  - Selecting generation of Section Type 0 messages will "grey out" the identified area(s) in the "Radio Allocations" grid in "C-Plane Builder".

- Configure the Digital Power Scaling (IQ data) according to Section 6.1.3.1 Definition of IQ Power in dBFS in the O-RAN specification.
  - FS adjustment (FS\_Offset, default 0 is no scaling)—Adjust the FS (Full Scale) parameter to match with the FS\_Offset parameter in the M-Plane. The value '0' indicates that this parameter is not supported by the O-RU or not set by the O-DU. This parameter always uses a positive value to scale down IQ. The following example shows the representation of the constellation along with the formula to calculate IQ, when the value '2' is set for scaling down IQ.



value to scale down IQ. The following example shows the representation of the constellation along with the formula to calculate IQ, when the value '-6' is set for scaling down IQ. The lower the value for the IQ Power Scaling, the smaller is the 'udCompParam' value in case of block floating point compression.





Note that the denominator in the scaling formulas is different for the two parameters. Normally, only one of these parameters is used for scaling, but not both.

Apply fixed 256QAM Scaler—Enabling this option scales down all modulations to the same level as the 256QAM scaler. The following example shows the representation of mixed constellations, with 256QAM being the highest.

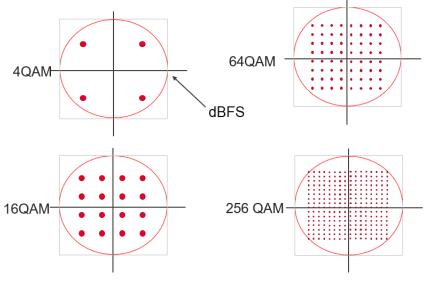


Figure 78 Applying fixed 256QAM scaling

Refer to *Appendix I: IQ Scaling Flow* in this document for additional details about IQ scaling flow.

2.3.7: DSS

This configuration tab lets you combine 5G NR and LTE carriers, such that the configurations of the LTE carrier matches the LTE coexistence settings of the 5G NR carrier it is combined with.

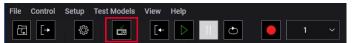
The functionality of this tab is explained in the subsection *Configuring DSS in Open RAN Studio software* in the section Configuring LTE Coexistence – DSS on page 203.

# Section 2.4: Instrument Configuration

The Instrument Configuration is used to configure hardware settings. These settings are stored in a global file in the 'Documents' folder called "*xRAN\_StudioModuleConfig.xml*". This is automatically saved and the settings are restored when you start the application.

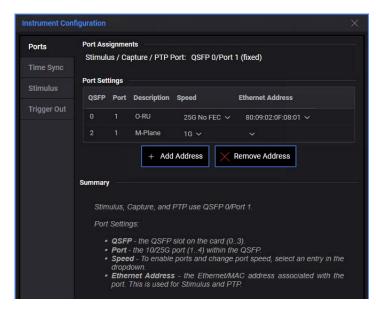
The Open RAN Studio Player software and Integrated Hardware Appliance will playback Open RAN Studio Builder generated stimulus files to an O-RU Radio Unit over an Ethernet based O-RAN interface. The Open RAN Studio Player emulates and is seen by the DUT (O-RU) as an O-DU. The Keysight Open RAN Studio Player application is provided for use on the Integrated Hardware Appliance.

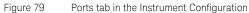
The Player/Recorder Tool window can be opened by clicking on the Player/Recorder Tool button available on the toolbar.



This toolbar button is only visible when running the O-RAN Studio with the BittWare FPGA card (U5040A Open RAN Studio online mode).

Once, you click this toolbar, the Player/Recorder Tool window appears as shown in Figure 79:





This window has the following tabs:

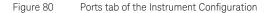
- Ports
- Time Sync
- Stimulus
- Trigger Out

These tabs are described in the sections that follow.

### 2.4.1: Ports Tab

The "Ports" tab allows you to configure port settings.

	Port Assignments	
Time Sync	Stimulus / Capture / PTP Port: QSFP 0/Port 1 (fixed)	
Stimulus	Port Settings	
ounduo	QSFP Port Description Speed Ethernet Address	
Trigger Out	0 1 O-RU 25G No FEC 🗸 80:09:02:0F:08:01 🗸	
	2 1 M-Plane 1G V V	
	Stimulus, Capture, and PTP use QSFP 0/Port 1. Port Settings:	



The "Ports" tab provides the following settings:

- Port Assignments
  - The Stimulus / Capture / PTP Port is QSFP slot 0, port 1. This is not configurable.
- Port Settings
  - QSFP this is the QSFP slot number of the port. Note that the M-Plane is configured on QSFP Slot 2.
  - Port this is the port within the QSFP.
  - Speed this is a drop-down that can be used to select the port speed:
    - Disabled the port is disabled and will not transmit or receive data.
    - 10G Speed is 10 Gbps. Note that there is no option for FEC in the 10G Ethernet standard.

- 25G No FEC Speed is equivalent to the "25G" setting in version 1.0 of the Open RAN Studio software. No FEC indicates that Forward Error Correction (FEC) is disabled.
- 25G RS-FEC Speed is 25Gbps with Reed-Solomon Forward Error Correction (FEC) enabled. Note that KR-FEC is another FEC mode, which is not supported.
- Loopback Sets the interface to do an internal loopback with a link speed of 25 Gbps. This setting is normally only used for demonstrations.
- 1G (M-Plane) Speed of the 1 Gbps copper connection on the M-Plane Passthrough Port
- Ethernet Address this is a drop down that allows you to configure the Ethernet MAC Address of the port. All Stimulus and PTP played through the port will use this as the Ethernet source address set to this value. The O-RU (Destination) Ethernet Address is configured under the "Stimulus" tab. For M-Plane, the default Ethernet Address is configured.

### 2.4.2: Time Sync Tab

The "Time Sync" tab is used to configure time synchronization settings.

Ports	Clock Settings				
	Reference Clock:	Internal			
Time Sync	РТР				
Stimulus	Mode:	Slave 🗸			
Trigger Out	Multicast:	Forwardable			
nggerour	Domain:	24			
	Priority2:	128			
	UTC Offset:	37 secon	is		
	System Frame Numbe	er			
	Beta:	0			
	Summary				
	External 1 connected External 1 be connec PTP can be cor G.8275.1 profile System Frame on PTP time (se	Clock setting of neluding PTP: Uses the interail <b>10 MHz</b> - Requir to the Ref Cloc <b>00 MHz</b> - Requir ted to the Ref C offigured for <b>Mas</b> e. <b>Number (SFN</b> ee O-RAN-WG4 is parameter is	ietermines the oscillator on t es a 10 MHz <b>s</b> k In port. ires a 100 MH lock In port. <b>:ter, Slave</b> , or ) assigns radi CUS.0-v2.00,	clock frequency ne BittWare FPG <b>quare wave</b> sig z square or sine <b>Disabled</b> . PTP i o frame number	y source A card. nal to be wave to uses the s based

Figure 81 Time Sync tab of the Instrument Configuration

The "Time Sync" tab provides the following settings:

- Clock Settings The Reference Clock setting determines the clock frequency source for the system including PTP.
  - Internal (default) This setting uses the internal oscillator on the BittWare FPGA card for its clock.
  - External 10 Mhz This mode is used when connecting to an external 10 MHz reference clock on the "Ref Clock In" Port (refer to BittWare Hardware on page 18). Note that when you use a 10 MHz external reference clock, make sure that the input clock waveform is a square wave with 50% duty cycle.

- External 100 Mhz This mode is used when connecting to an external 100 MHz reference clock on the "Ref Clock In" Port (refer to BittWare Hardware on page 18). Note that when you use a 100 MHz reference clock, it can be a square wave or a sine wave.
- PTP uses the G.8275.1 profile
  - Mode:
    - Master
    - Slave (default) For the "Slave" mode, the Open RAN Studio software synchronizes in time with a PTP Master.
    - Disabled
  - Multicast:
    - Forwardable (default): multicast address 01-1B-19-00-00-00, which is forwarded through switches
    - Not Forwardable: multicast address 01-80-C2-00-00-0E, which is not forwarded through switches. Addresses in the range of 01-80-C2-00-00 to 01-80-C2-00-00-0F are not relayed by Ethernet switches conforming to IEEE 802.1D.
  - Domain: 24
    - The G.8275.1 profile allows values in the range of 24 to 43.
    - This value must match what the radio is configured for or else the radio will ignore this value as a PTP source.
  - Priority2: 128
    - Priority2 is used in determining the Best Master Clock. Lower values for this field give a higher priority.
  - UTC Offset:
    - Specifies the offset between PTP time and UTC time. PTP time does not include leap seconds, whereas UTC time does.
- System Frame Number (SFN) assigns radio frame numbers based on PTP time and is implemented according to *Section 9.7.2* of the O-RAN specification. The eCPRI Frame Number is computed based on the current PTP time. In the previous versions of the software, it always started at '0' and incremented for each frame transmitted.
  - Beta: This parameter can be used to adjust the eCPRI Frame number forward or backwards.

### 2.4.3: Stimulus Tab

The "Stimulus" tab configures settings related to stimulus played at the Ethernet port in the Integrated Hardware Appliance. These settings determine the timing of stimulus as well as the O-RU address to which the stimulus will be sent.

Instrument Con	ifiguration ×	
Ports Time Sync	Ethernet Addresses         O-RU Ethernet Address:         02:04:06:08:0A:0C         +	
Stimulus	Summary	
Trigger Out	Stimulus packets will be sent to the <b>O-RU Etnernet Address</b> . <b>NOTE:</b> The O-DU Emulator Ethernet Addresses for specific ports are configured in the Port configuration tab.	

Figure 82 Stimulus tab of the Instrument Configuration

The "Stimulus" tab provides the following settings:

• Ethernet Address - The O-RU Ethernet Address configures the address of the O-RU (radio).

# NOTE

# If Ethernet Address does not match with that on the O-RU, the latter discards all C/U-Plane packets.

### 2.4.4: Trigger Out Tab

The "Trigger Out" tab configures settings used to generate external Trigger out signals from the BittWare FPGA card.

Instrument Con	figuration	×
Ports	✓ Trigger Out Trigger Activation Conditions	
Time Sync	Mode: Trigger on Start Stimulus ~	
Stimulus	Delay nanoseconds	
Trigger Out	Characteristics	
	Pulse Duration: 30 microseconds	
	Polarity: Positive	
	Output Level: TTL	
	Summary	
	<ul> <li>When Trigger Out is enabled, it will generate a trigger based on one the Mode:</li> <li>Pulse Per Second – pulses once per second.</li> <li>Pulse Per Radio Frame (10ms) – pulses every 10ms radio frame interval.</li> <li>Trigger on Start Stimulus - pulses when the stimulus starts.</li> <li>Trigger on Start Stimulus, repeat every 10 ms - pulses when the stimulus starts and repeats every 10ms until stimulus stops.</li> <li>Trigger on Start Capture – pulses when capture starts.</li> <li>Trigger on Start Capture, repeat every 10ms – pulses when capture starts and repeats every 10ms until capture stops.</li> <li>Trigger on Start Capture, repeat every 10ms – pulses when capture starts and repeats every 10ms until capture stops.</li> <li>MOTE: When PTP is enabled, PPS is aligned to 1 second PTP time and triggers are alligned to 10ms radio frame bounaries based on PTP time. Otherwise PPS and triggers are aligned to the Internal Reference Clock.</li> <li>Delay - delays the trigger by the specified period in nanoseconds (must be positive)</li> <li>Pulse Duration - defines the duration of the trigger / pulse in microseconds. Note that in Pulse Per 10ms modes, the pulse duration cannot be more than 9500 microseconds.</li> </ul>	

Figure 83 Trigger Out tab of the Instrument Configuration

When **Trigger Out** is enabled, it will generate a trigger based on one of the following modes:

- Pulse Per Second pulses once per second.
- Pulse Per Radio Frame (10ms) pulses every 10ms radio frame interval.
- Trigger on Start Stimulus pulses when the stimulus starts.
- Trigger on Start Stimulus, repeat every 10 ms pulses when the stimulus starts and repeats every 10ms until stimulus stops.
- Trigger on Start Capture pulses when capture starts.
- Trigger on Start Capture, repeat every 10ms pulses when capture starts and repeats every 10ms until capture stops.

# NOTE

### When PTP is enabled, PPS is aligned to 1 second PTP time and triggers are aligned to 10ms radio frame boundaries based on PTP time. Otherwise, PPS and triggers are aligned to the Internal Reference Clock.

The other features in this tab are:

- Delay delays the trigger by the specified period in nanoseconds (must be positive).
- Pulse Duration defines the duration of the trigger / pulse in microseconds. Note that in Pulse Per 10ms modes, the pulse duration cannot be more than 9500 microseconds.

#### Keysight U5040A Open RAN Studio User Guide

### Section 2.5: C/U-Plane Builder

Keysight Open RAN Studio Builder lets you quickly, easily, and reliably generate O-RAN test vectors compliant with the O-RAN specification. The generated test vectors represent Ethernet based O-RAN messages from a distributed unit to the device being tested – the O-RU (Radio Unit).

Open RAN Studio Builder is integrated with PathWave Signal Generation Desktop 2022 to create 3GPP NR standard-compliant signals and construct the corresponding Ethernet based O-RAN protocol test vectors, including complete and consistent C-plane and U-plane messages, ready for playout.

Downlink test vectors include both O-RAN C-plane and U-plane messages. C-plane messages are constructed to fully represent the allocations defined in the 5G NR signal definition, and the U-plane messages include frequency domain IQ for each resource block.

Uplink test vectors include only C-plane messages, as U-plane messages will be generated by the DUT. To ensure consistency, the C-plane messages match with the uplink test signal generated by Keysight signal sources.

The RF designs are generally created in PathWave Signal Generation Desktop / Signal Studio and the resulting file has the (.scp) extension, by default.

For further details on its application and key features, refer to the product datasheet available on www.keysight.com.

The "C-Plane Builder" tab enables you to select the appropriate (.scp) file from the system.

# NOTE

For any changes made to the "Configuration Tool" to take effect in the stimulus player, you must perform the following steps:

1. (Re)generate the stimulus file. From the main menu, click File > Export > Generate Stimulus File.

2. (Re)load the stimulus into the player. From the main menu, click File > Recall > Stimulus (Load Into Player)....

To do so, follow the steps below:

- 1 With the "C-Plane Builder" tab selected, click the **Open** 🔟 icon.
- 2 On the "Open" dialog that appears, select the appropriate (.scp) file, and then click **Open**.

The "C-Plane Builder" tab displays the information stored in the selected (.scp) file.

[• Ø											
-Plane Builder 🔰 🗈											
		-									
Component Carriers		- F	adio Control	Plane Da	la						
Carrier Numerology			Subframe	Slot ID	RB Start	RB Number	Sym Start	Sym Number	Channel	Beam Id	
Select Carrier:	Carrier 1 (DL)							14	PDSCH		
		1							PDSCH		
Attribute	Value	1							PDSCH		
Carrier Type	DL (NR)	1							PDSCH		
Cell ID	0	1						14	PDSCH		
Bandwidth	FR1_100M										
Numerology Mode	SingleNumerology										
CP Type	Normal										
Allocations	1										
Flow/eAxC ID	0001	2000									
		Ra	dio Allocation	IS							
Resource Allocations			270_								
2 X			319								
Select Allocation:	DL-9CH1 V		150								
Attribute	Value		100								
Name of allocation	DL-SCH1		* -								
Numerology	SCS30k		81 - 20								
Modulation	QPSK		-								
Slots	0:4										



The "C-Plane Builder" tab provides the following options:

- 1 Component Carriers
- 2 Resource Allocations
- 3 Radio Allocations
- 4 Radio Control Plane Data

2.5.1: Component Carriers (CC)

This pane displays the CCs and the relevant numerology set up in the RF design stage with PathWave Signal Generator/Signal Studio. At this point, by selecting a CC, you may assign an "eAxC ID" to each CC. The eAxC IDs for Uplink and Downlink carriers can be configured separately in the "Flow/eAxC" tab of the "C/U Plane Builder Configuration Tool".

Select Carrier:	Carrier 1 (DL)	
Attribute	Value	
Carrier Type	DL (NR)	
Cell ID		
Bandwidth	FR1_100M	
Numerology Mode	SingleNumerology	
СР Туре	Normal	
Allocations		

Figure 85 Component Carriers in the C/U Plane Builder

When the Flow/eAxC ID is not assigned to one or more carriers, the O-RAN Studio software returns the following error when you export the stimulus file:

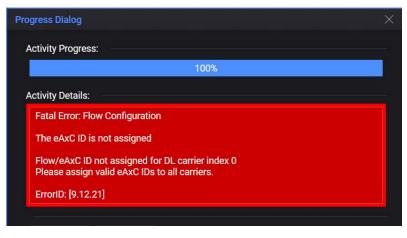


Figure 86 Error when one or more carriers are not assigned eAxC ID

### 2.5.2: Resource Allocations

This pane enables you to select an allocation per channel level using the Resource Allocation drop-down list. Based on the channel allocation selected, the resource allocations per user, designed with PathWave Signal Generator/Signal Studio, are summarized. The details of the attributes listed depends on the channel allocation. There should be a 1-to-1 mapping of allocation to blocks drawn in the "Radio Allocation" grid view.

Resource Allocations —		
Select Allocation:	DL-SCH1	~
Attribute	Value	
Name of allocation	DL-SCH1	
Numerology	SCS30k	
Modulation	QPSK	
Slots	0:4	
First Symbol		
Last Symbol	13	
Number of Symbols	14	
RB Offset		
RB Number	273	
Beam IDs Select Beamld:	~	

Figure 87 Resource Allocations in the C/U Plane Builder

The "Select BeamId" drop-down box lets you select the Beam table index per channel allocation. The values here depend on the values set for "Beam IDs" for each 'Table Index' in the 'Beamforming Mappings' area of the' Beamforming' tab in the 'C/U Plane Builder Configuration Tool'. The value is zero for 'no beamforming'. For the 'channel-information-based beamforming' method, the GUI displays "Select Ueld" instead of "BeamId". See Applying Channel-information-based beamforming on page 341 for more information about "UeIDs".

### 2.5.3: Radio Allocations

This pane displays the allocations designed using *PathWave Signal Generation Desktop 2022* interface.

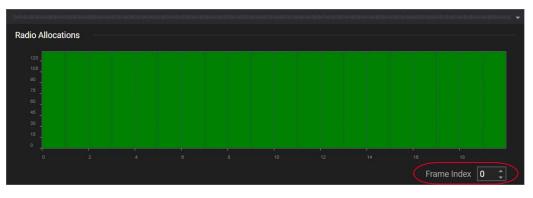




Figure 88 highlights the "Frame Index" element, which enables switching between frame allocations using the index values. This feature works in the same manner as the 'FrameInd' feature in the PathWave Signal Generation Desktop 2022 interface.

### 2.5.4: Radio Control Plane Data

This pane displays the first logical break down into CU-Plane sections per slot. The section IDs are only unique per "slot" and are auto generated. This data is utilized to construct C-Plane messages per slot and to drive the application level fragmentation of PRBs into U-Plane packets.

μ	Subframe	Slot ID	RB Start	RB Number	Sym Start	Sym Number	Channel	Beam Id
1	0	0	0	273	0	14	PDSCH	0
1				273		14	PDSCH	
1				273		14	PDSCH	
				273		14	PDSCH	
1	2			273		14	PDSCH	

Figure 89

Radio Control Plane Data in the C/U Plane Builder

## Section 2.6: Explorer

Radio Units combine O-RAN protocol operation with RF transmit and receive performance, creating new test challenges. Analysis and validation of O-RU performance requires cross-domain measurements in both RF and Protocol domains.

With the optional Open RAN Studio IQ extractor, Open RAN Studio Explorer helps you visualize and fully decode the captured trace and enables IQ centric extraction, which enables RF centric measurements and vector analysis using *Keysight 89600 Vector Signal Analyzer (VSA)*.

Plane,	C-Plane Messages:			U-Pla	ine:							Message Interpretation:
	Time	Source	Destination		Dir	eAxC		DU Port	Band Sector	cc	$\nabla$	
	00:00:00.009995000		80 09 02 03 04 05			0001						
	00:00:00.009995000		80 09 02 03 04 05									
	00:00:00.009995000		80 09 02 03 04 05									
	00:00:00.009995000		80 09 02 03 04 05									
	00:00:00.009995000		80 09 02 03 04 05									
	00:00:00.009995000		80 09 02 03 04 05	C-Pla								
	00:00:00.009995000		80 09 02 03 04 05									
	00:00:00.009995000		80 09 02 03 04 05		Dir	eAxC		DU Port	Band Sector	CC		
	00:00:00.009995000		80 09 02 03 04 05		PRACH	0001						
	00:00:00.009998000		80 09 02 03 04 05			0001						
	00:00:00.009998000		80 09 02 03 04 05			0001						
	00:00:00.010033714	00 00 00 00 00 00	80 09 02 03 04 05									
x Payl	load:			Rec	overed IC		Constellat	ion				
							constenat					
				PRB:	(none se	lected)						
				RE	uCm	pl	uCmpQ					

Figure 90 Default view of the Explorer tab when PCAP file is loaded

### 2.6.1: Loading a PCAP File

- 1 With the "Explorer" tab selected, click the Open 🙆 button.
- 2 On the "Open" dialog that appears, select the appropriate ".pcap" file, and click Open.

🚰 Open	×
$\leftarrow$ $\rightarrow$ $\checkmark$ $\uparrow$ 📜 « SS scp files $>$ LP2 $>$ Multi-Carrie	r V Ö Search Multi-Carrier
Organize • New folder	₿== ▾
Desktop ^ Name	Type Date modified
Documents DL_UL_PRACH.pcap	PCAP File 1/25/2021 6:34 PM
Downloads	
Music	
Network_Hari	
Network-Others	
E Pictures	
Videos	
🐛 OSDisk (C:) 🗸 🗸	>
File name: DL_UL_PRACH.pcap	PCAP Files (*,pcap)     Open     Cancel

Figure 91 Open dialog for selecting pcap file

3 The "Explorer" tab displays the information stored in the selected ".pcap" file.

	Builder Y Explorer											
				•								*
	C-Plane Messages:	1			U-Pla				12122700		10000	Message Interpretation: Address
	Time	Source	Destination			Dir	eAxC		DU Port	Band Sector	cc	Value : 80 09 02 03 AddrType : DA
1	00:00:00.009995000	00 00 00 00 00 00					0001					isIndividualAddress
3	00:00:00.009995000	00 00 00 00 00 00 00										IsGloballyUnique : T
3	00:00:00.009995000	00 00 00 00 00 00 00 00										Address Value : 00 00 00 00
	00:00:00.009995000	00 00 00 00 00 00 00								-		AddrType : SA
6	00:00:00.009995000	00 00 00 00 00 00 00										isIndividualAddress isGloballyUnique : T
	00:00:00.009995000	00 00 00 00 00 00 00			C-Pla	ine: —						802.10 VLAN
	00:00:00.009995000	00 00 00 00 00 00	80 09 02 03 04 05			Dir	eAxC		DU Port	Band Sector	CC	VlanTypeString : 81 VlanTciString : PCPI
	00:00:00.009995000	00 00 00 00 00 00	80 09 02 03 04 05		0	PRACH	0001	0			0	EtherType
	00:00:00.009998000	00 00 00 00 00 00	80 09 02 03 04 05			DL	0001		0	0	0	Value : AE FE eCPRI Common Heade
	00:00:00.009998000	00 00 00 00 00 00	80 09 02 03 04 05				0001					5 ecpriVersion : 1
	00:00:00.010033714	00 00 00 00 00 00	80 09 02 03 04 05									ecpriConcatenation
<i< td=""><td></td><td></td><td></td><td></td><td></td><td></td><td>_</td><td></td><td></td><td>-</td><td></td><td>ecpriMessage : 2 ecpriPayload : 20</td></i<>							_			-		ecpriMessage : 2 ecpriPayload : 20
												eCPRI Component eAx
												DuPortID : 0 BandSectorID : 0
lex Payl	load				1.00							CcID : 0
iex Hay	ioau.				Rec	overed IC	\$	Constellat	tion			RuPortID : 1 • eCPRI Sequence ID
Hex (	00 01 02 03 04 0	05 06 07 08 09	9 OA OB OC OL	OE	PRB:	(none se	ected)					SequenceID : 0
	80 09 02 03 04 0	05 00 00 00 0	0 00 00 81 0		RE			uCmpQ		Q		E : 1 SubsequenceID : 0
	AE FE 10 02 00	14 00 01 00 8	0 90 00 00 00		RE	uci	45.1	acmpo		ų		C-Plane Common Head
	F0 00 00 00 00 0	00 FF F4 00 0	0 00 00 00 00									DataDirection: 1
		00 00 00 00 0	0 00 00									PayloadVersion : 1 FilterIndex : 0
												Frameld : 0
												Subframeld : 0 Slotid : 0
												StartSymbolid : 0
												NumberOfSections SectionType : 1
												Section Type : 1 User Data Compression
		3								(4)		lqBitWidth : 15
												Compression : no co



The "Explorer" tab displays the following sections:

- 1 U-Plane, C-Plane Messages
- 2 Message Interpretation
- 3 Hex Payload
- 4 Detected Flows
- 5 PRB View

#### 2.6.2: U-Plane, C-Plane Messages

The U-Plane, C-Plane Messages pane displays a list of recovered packets from the ".pcap" file. It provides a quick and optimal description of the packet contents (frame, subframe, slot, symbol and PRB allocations).

## **NOTE** The timestamp accuracy for captured packets is currently about 80 ns. As a result, small consecutive packets may occasionally carry the same timestamp.

#### 2.6.3: Message Interpretation

On selecting a message from the list in *U-Plane, C-Plane Messages*, the packet is fully decoded into a structure that has a "tree" like view.

This displays the interpreted contents of each header and payload that make up the packet.

#### 2.6.4: Hex Payload

When you select a message from the *U-Plane, C-Plane Messages* list, its full "hex payload" is displayed.

Selecting a particular header or body part from the tree view highlights the "cells" with the exact hex data that makes up that field.

#### 2.6.5: PRB View

The PRB View window enables you to ensure that the compression method and IQ bit-width reflects the settings used when creating the "stimulus" file (Configuration Tool settings). If it is a "recording" and you don't know what these values are, look at a C-Plane message Type 1 and in particular at the "User Data Compression Header" in the *Message Interpretation* tree view.

Adjust these parameters accordingly in Configuration Tool and "reload" the file for correct decoding or "select" a new message to trigger re-loading with new parameters.

#### Recovered frequency domain IQ

Selecting a PRB in the Message Interpretation tree view will not only highlight the "hex data" that makes it up but will also show the 12 RE's values recovered:

- Decompressed format (uCmpl and uCmpQ)
- Mapping to standard constellation (I and Q)

This data is visible in the "Recovered IQ" tab. The "Constellation" tab shows a mapping of these 12 REs on a constellation chart.

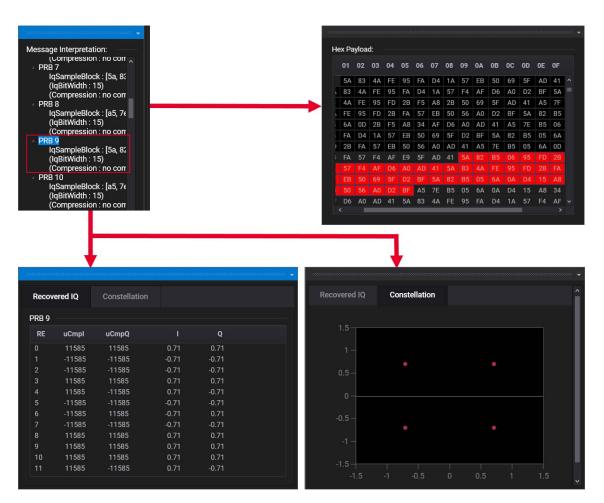


Figure 93

Recovered RE values of the selected PRB view

#### 2.6.6: Detected Flows

The "Detected Flows" view shows the "auto detected" flow of data by the "Explorer".

ŧ	Dir	eAxC	μ	DU Port	Band Sector	CC
0	DL	0001				0
DI -						
Pla	ne:					
Pla ‡	ne: Dir	eAxC	U	DU Port	Band Sector	сс
		eAxC	u	DU Port	Band Sector	CC
•		<b>eAxC</b> 0001	μ 1	DU Port	Band Sector	<b>CC</b>

Figure 94 Detected Flows displaying 'auto-detected' data flow

These flows are distinguished through:

- ecpriPcid in U-Plane packets
- ecpriRtcid in C-Plane packets

In both cases, this 16-bit integer represents the ORAN eAxC ID. Due to required signaling in the downlink for uplink data, depending on the analyzed recording, there may be more eAxC IDs in the C-Plane than in the U-Plane.

## NOTE

## The U-Plane and C-Plane flows match if both the eAxC ID and Direction match.

Note that the number of flows in the downlink, uplink (and if available, PRACH) carriers may be different, but the assigned eAxC ID can be the same. Figure 95 shows such an instance, where different carriers have the same eAxC ID.

#	Dir	eAxC	μ	DU Port	Band Sector	CC	2
0	DL	0001				0	-
<							
	ane: —						Ľ
	ane: Dir	eAxC	μ	DU Port	Band Sector	> CC	Ľ
)-Pla			ų O	DU Port 0	Band Sector		٣
-Pla #	Dir					cc	Ľ



Same eAxC ID for DL, UL and PRACH

ŧ	Dir	eAxC	μ	DU Port	Band Sector	CC	RU Port	7
	UL	0001	(?)			0		
								1
Pla	ane:							
ŧ	Dir	eAxC	μ	DU Port	Band Sector	CC	RU Port	res

When U-Plane flow is added to the Uplink carrier, the Numerology ( $\mu$ ) displays a (?), as shown in Figure 96.



In such cases, it is recommended to manually assign/verify the correct Numerology from the 'Resource Grid' of the 'Numerology' tab in the 'C/U Plane Builder Configuration Tool'.

C/U Plane Builder	Configuration Tool				$\times$
Flow/eAxC	Slot IDs relative	to highest numero	ology in carrier FR		
Compression	Bandwidth			FR1 100 MHz 🗸 🗸	
Numerology	Resorce Grid:				
Beamforming	Numerology	Grid Size	Grid Enabled		
Timing	μ = 0: 15kHz	270		Enable a grid to facilitate carrier IQ	?
Options	µ = 1: 30kHz	273		recovery from a recording.	
DSS	µ = 2: 60kHz	135			
	Ref. Point A: 9	50.86 MHz at -49.	14 MHz from center		



## Section 2.7: Interface Monitor

The "Interface Monitor" tab displays the counters and port status of the hardware settings. This tab is only available when running with the BittWare FPGA card (U5040A Open RAN Studio online mode).

KEYSIGHT Open RAN Studio File Control Setup Test Mode	ls View Help	_		- 🗆 X
E [• 🕸 📺	[+ D O	1 ~		
C-Plane Builder C-Plane Builder	Interface Monitor			
			*	-
Counters and KPIs				Downlink
Counter	Value			Southannon and States
Rx Bytes	3480			10 25 Mar
Rx Packets				CUS-Plane
Rx Packets Bad FCS				Speedometer
Tx Bytes	576			i≣ s 28
Tx Packets				
Tx Packets Bad FCS				
Duration (msec)	1002.8399			Downlink
Port Status			• 	Uplink
Port Link Configuration	Link Speed FEC Tx Packe	ts Rx Packets CRC Errors		Multima Annual
0 Up 25G RS-FEC	25G RS 9			US-Plane
				Speedometer
				1 5
			•	
PTP Status				
PTP Status:	Slave	Clock StdDev:	0.00000026	0.03 Gbps
Clock Offset:	0.00000045	Clock Variance:	6.62E-016	Mbps
File:		Size: 0	Port Status: 250 PTP: Siare 5	JymcE: Disabled

Figure 98 Interface Monitor tab in the online O-RAN Studio

The "Interface Monitor" tab displays the following sections:

- 1 Counters and KPIs
- 2 Port Status
- 3 PTP Status

#### 2.7.1: Counters and KPIs

The "Counter" fields in this segment are:

- Rx Bytes Received Bytes
- Rx Packets Received Packets
- Rx Packets Bad FCS Received Packets with bad FCS (Frame Check Sequence)
- Tx Bytes Transmitted Bytes
- Tx Packets Transmitted Packets
- Tx Packets Bad FCS Transmitted Packets with bad FCS (Frame Check Sequence)
- · Duration (msec) the duration in milliseconds of the statistics sample

#### 2.7.2: Port Status

The fields in this segment for each port are:

- Port the port number
- Link current status (Up / Down) of the Link
- Configuration current configured speed for the port (10G, 25G, and so on)
- · Link Speed the actual link speed
- FEC the values that appear are:
  - N/A not applicable (only applies for 25G)
  - None no Forward Error Correction
  - RS Reed Solomon Forward Error Correction
- Tx Packets number of packets transmitted in the last one second
- · Rx Packets number of packets received in the last one second
- CRC Errors number of packets received with CRC Errors / Bad FCS (Frame Check Sequence)

#### 2.7.3: PTP Status

Shows the status of PTP Master / Slave. The fields in this segment are:

- PTP Status shows the current status of the PTP (the values that are displayed here are the same as those described for "PTP Status" in Functional tabs on page 64). If PTP Status displays "Slave" mode, the following fields are also displayed:
  - Clock Offset the current computed offset of the PTP Slave Clock relative to the PTP Master Clock

- Clock StdDev the standard deviation of the offset between the PTP Slave Clock and the PTP Master Clock
- Clock Variance the variance of the offset between the PTP Slave Clock and the PTP Master Clock

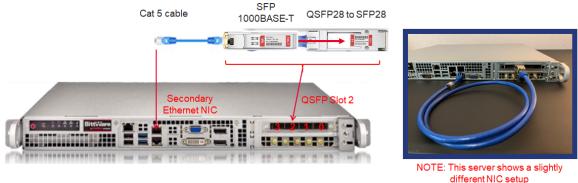
## Section 2.8: Overview on M-Plane in O-RAN Studio

This section describes only an overview on the M-Plane and M-Plane Pass-through implementation in the U5040A Open RAN Studio software. Detailed information will be provided in *Implementing M-Plane & M-Plane* Passthrough in ORAN Studio Solution (v1.1) Reference Guide.

The M-Plane Toolkit (including M-Plane software and FPGA Pass-through) is installed along with version 1.2 of the U5040A Open RAN Studio Software. The M-Plane Pass-through performs packet forwarding similar to the Ethernet switch, based on MAC address. Only packets between the BittWare FPGA and O-RU are recorded.

The M-Plane is capable of functioning as a DHCP server for IP address assignment and includes various M-Plane specific parameters to send Option 43: Vendor Specific Information: encoded IP address of the NETCONF controller and to receive/parse Option 60: Vendor Class Identifier.

The NETCONF controller comprises of an XML script that allows custom sequences and can be easily modified.



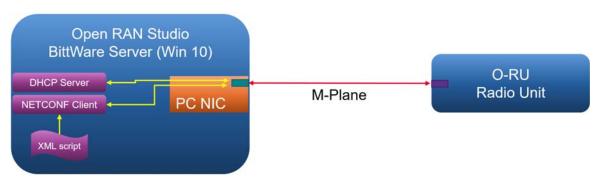
different Nic Setup

Figure 99 M-Plane Pass-through connection on BittWare HW with own NIC

Figure 99 shows a 1 Gb connection from M-Plane Pass-through port on FPGA to secondary Ethernet NIC on BittWare server, which is depicted in the second block diagram below. Following block diagrams represent the physical connections for M-Plane and M-Plane Pass-through.

1 Connection from any PC to an O-RU using M-Plane only

This block diagram depicts a system where the Network Interface Controller (NIC) port on the BittWare server is connected directly to the O-RU port via 1 Gbps Copper M-Plane connection to send configuration messages only.





Because of the port limitation on the O-RU, an Ethernet Fronthaul Switch is required that can receive the M-Plane messages from the NIC port via a 1Gbps / 10Gbps Copper connection and also the CUS-Plane messages from QSFP port 0 of the BittWare Server to send them together to the O-RU.

As depicted further, the M-Plane Pass-through helps you in sending M-Plane and CUS-Plane messages together without the need of the Ethernet Fronthaul Switch.

2 Connection using M-Plane Pass-through on the BittWare hardware with BittWare NIC

This block diagram depicts a system where the M-Plane Pass-through port has been used. The M-Plane Pass-through port has a 1 Gbps Copper connection from the FPGA using QSFP28 to SFP28 adapter + 1G SFP Module. You can form a loopback connection from the BittWare NIC port as shown in the image below. Here, the O-RU is connected to QSFP port 0 of the BittWare Server. Both the CUS-Plane and M-Plane messages are transmitted over an Ethernet connection at 25G No FEC speed.

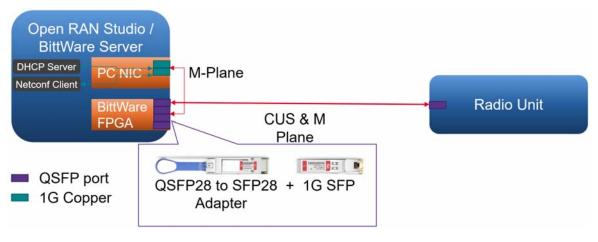


Figure 101 M-Plane Pass-through connection on BittWare HW with own NIC

3 Connection using M-Plane Pass-through with an external M-Plane source

This block diagram depicts a system where the M-Plane Pass-through port has been used to establish connection with a remote machine hosting the M-Plane client. In this case, the NIC port of the remote hardware is connected to the BittWare FPGA as shown in the image below. Here, the O-RU is connected to QSFP port 0 of the BittWare Server. Both the CUS-Plane and M-Plane messages are transmitted over an Ethernet connection at 25G No FEC speed.

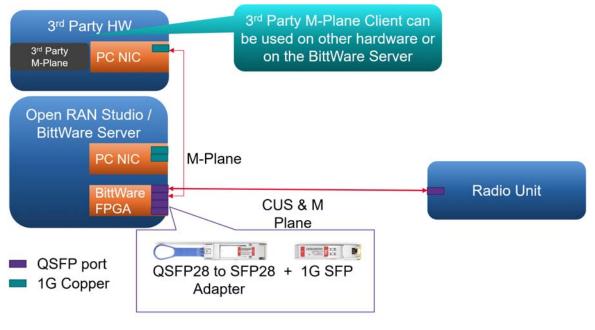


Figure 102 M-Plane Pass-through connection with external M-Plane source

Keysight U5040A Open RAN Studio

User Guide



# Configuring Features in the O-RAN Studio GUI

Exporting O-RAN Stimulus File / 122 Data Flow Filtering / 124 Data Flow IQ Extraction / 127 Emulating the Uplink Carrier / 143 Emulating the PRACH Carrier / 178 Working with LTE signals / 190 Measuring BER / BLER / 249 Mixed Numerology Configuration / 265 Conformance to Stock Data Test Models / 266 Applying Compression Methods / 284 Understanding Configuration of Beam / Ue IDs / 303 Configuring C-Plane Section Handling Options / 350 Missing Configuration for eAxC ID's / 410



## Section 3.1: Exporting O-RAN Stimulus File

The Export O-RAN Stimulus File button uses the following information to create a CU-Plane packet "stimulus" in a ".pcap" file format.

- C-Plane configuration parameters inherited from (.scp) file.
- Frequency domain IQ files generated by PathWave Signal Generator/Signal Studio.
- The configuration data that you provide via the C/U Plane Builder Configuration Tool.

This stimulus represents the 10 ms radio frame designed with PathWave Signal Generator/Signal Studio formatted as CU-Plane packets. If specified in PathWave Signal Generator/Signal Studio, the ".pcap" file may contain several radio frames (but with identical IQ data).

Opening the RAN Studio will step through each carrier and generate intermediate IQ data in ".setx" format. The resulting pcap file will have the base name from the (.scp) file and extension ".pcap". Note that for the Uplink carrier, the Open RAN Studio software generates two ".pcap" files, one for C-Plane messages and the other for U-Plane messages. The name for the ".pcap" file containing U-Plane messages is suffixed with '\_UL'. See Creating U-Plane messages in Uplink Carrier on page 170 for more information about the two ".pcap" files. The ".pcap" file is viewable with Wireshark but the Open RAN Studio software enables you to correctly interpret packet payloads.

During export, if empty frames are detected in the SCP file, the O-RAN Studio software returns the following warning message:

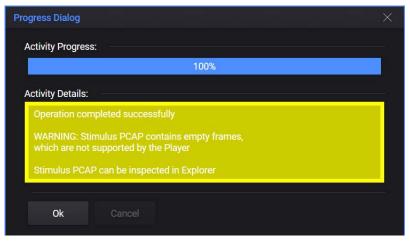


Figure 103 Warning when stimulus detects empty frames

You can load the ".pcap" stimulus file onto the Open RAN Studio "Explorer" tab. This file also needs to be loaded onto the Open RAN O-DU Emulator for playback towards the O-RU DUT via "Load Stimulus" button.

## Section 3.2: Data Flow Filtering

Figure 104 shows the features within the Open RAN Studio software that enable filtering of data flow:

U-Pla	ane: –							
#	Dir	eAxC	μ	DU Port	Band Sector	сс	RU Port	1 7
0	DL	0001						2 사
C-Pla	ane: –							3 ×
#	Dir	eAxC	μ	DU Port	Band Sector	CC	RU Port	
	DL	0001						4

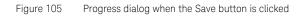
Figure 104 An example of Data Flow Filtering

- 1 Filter on Selected Flow–Select a flow and click the "Filter on Selected Flow" icon (appears like a funnel). Doing this populates the list view for both the C-Plane and U-Plane packets that match the eAxC ID.
- 2 Recover IQ Waveform Click the "Recover IQ Waveform" icon (appears like a waveform) to extract IQ data. See Data Flow IQ Extraction on page 127 for more information about sample IQ data and the process to recover IQ data.
- 3 Clear Filter Click the "Clear Filter" icon (Red X appearance) to select another flow for filtering.
- 4 Save filtered messages to JSON encoded file Click the "Save filtered messages to JSON encoded file" (appearance of a standard Save button) to generate a JSON file that has the same base name from the SCP file.

In this example, the data flow shown in Figure 104 belongs to a PCAP file named "DL\_VSA.pcap", derived from "DL\_VSA.scp".

	IT Open RAN Studio - C	Mine						- 🗆 X
File Setup	Test Models View	Help						
G [•	\$							
C-Plane	Builder Explorer							
LI Diana	C-Plane Messages:				U-Plane:			Message Interpretation:
#		<b>0</b>			ornane.		-	
	Time	Source	Des	Progress Dialog		×	Y	
1	00:00:00.009995000 00:00:00.009998000	00 00 00 00 00 00 00 00 00 00 00 00 00		Activity Progress:				
	00:00:00.009998000	00 00 00 00 00 00 00	80		100%			
	00:00:00.010033714	00 00 00 00 00 00						
	00:00:00.010033714	00 00 00 00 00 00	80	Activity Details:				
б	00:00:00.010069429	00 00 00 00 00 00		Operation complete	d successfully			
	00:00:00.010069429	00 00 00 00 00 00	80					
Hex Pay	load:							
				Ok C	Cancel			
					RE uCmpl uCmpQ			
File: C:\Open #	WW\SCP\SS sop files\LP2\Recov	enq/bt_vsA.pcap		Sin	# 174276			

• When you click the save button, a 'Progress Dialog' is displayed.



- Click OK.

- 📜 | 🛃 📜 🗢 | RecoverIQ  $\times$ Share View ? Home ₽-👗 Cut 刘 Open 🝷 ⋪ **\***]• N- Copy path Belect none 📝 Edit Pin to Quick Copy Paste Move Сору Delete Rename New Properties 🖻 Paste shortcut 💾 Invert selection History folder access to to Organize Clipboard New Open Select « SCP > SS scp files > LP2 > RecoverIQ Search RecoverIQ Ö 4 ~ 个 ~ ~ ^ Name Туре Size Date modified Quick access V Today (2) Desktop . 🎜 DL\_VSA.json JSON File 1,037 KB 1/25/2021 2:05 PM Downloads \* DL\_VSA.orstx ORSTX File 6 KB 1/25/2021 2:05 PM ~ Documents \* v < 5 ;== 14 items 1 item selected 1.01 MB
- Navigate to the folder where the SCP file is placed to find the corresponding JSON encoded file.

Figure 106 JSON encoded file created by ORAN Studio software

### Section 3.3: Data Flow IQ Extraction

After filtering on a flow, clicking the "Waveform" button ensures that the software will attempt to recover the IQ and convert this to time domain IQ. If this is performed on a "stimulus" file for which we have "all" the necessary meta data in the working directory, no further action is required.

The time domain IQ data will be saved as a ORB file in the same directory with and extension type of ".iqt.orb"; implying IQ in time domain. This ORB file will also contain a small header, which conveys the sampling frequency so that it can be interpreted by VSA.

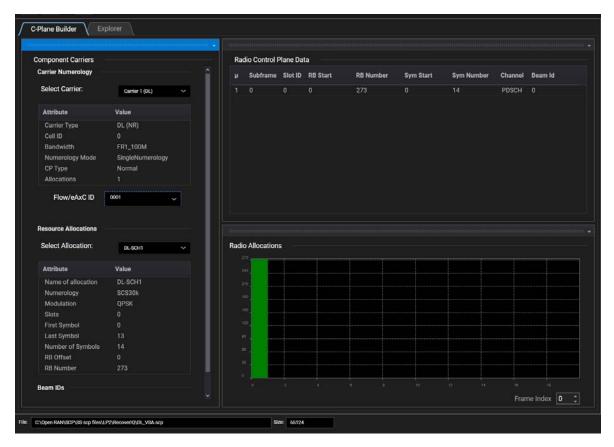
If this is performed on a "recording", it is important that the numerology is configured correctly in the "Numerology" tab of the "C/U Plane Builder Configuration Tool" to comply with actual numerology in the recorded file.

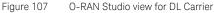
#### 3.3.1: Recovering IQ flow in O-RAN Studio & 89600 VSA

This section describes step-by-step instructions to extract IQ flow and for its proper interpretation by the 89600 VSA software. The process for recovering IQ for DL and UL carriers is the same, except that recovering IQ carrier from UL involves the additional steps of creating Uplink U-Plane messages, so that the UL PCAP file can be processed in the same manner as the DL PCAP file.

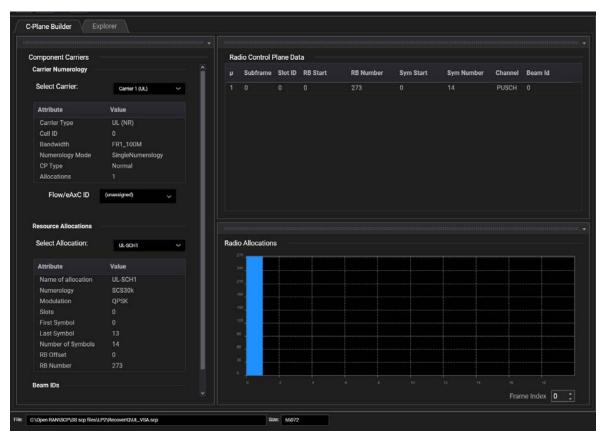
- 1 Open the SCP file in O-RAN Studio.
- 2 Assign the "Flow/eXAC ID".

#### Downlink





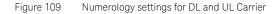
#### Uplink



#### Figure 108 O-RAN Studio view for UL Carrier

- 3 Launch the "C/U-Plane Builder Configuration Tool" window.
- 4 Depending on the configuration of the SCP file, ensure that the proper configuration options (such as Compression method, IQ Bitwidth, Numerology settings, and so on) are selected (or cleared) for the respective DL / UL carrier.

C/U Plane Builder	Configuration Tool			×
Flow/eAxC	Slot IDs relative to highe	est numerology in car	rrier FR	
Compression	Bandwidth		FR1 100 MHz	-
Numerology	Resource Grid:			
Beamforming	Numerology Grid	l Size Grid E	Enabled	
Timing	μ = 0: 15kHz 270		Enable a grid to facili	
Options	μ = 1: 30kHz 273		recovery from a recol	rding.
DSS	μ = 2: 60kHz 135			
	Ref. Point A: 950.86 M	1Hz at -49.14 MHz fro	om center Check these value and DL carriers.	s for both UL
	Use PRACH IQ Recov	ery Options		
	PRACH Format	Format0		
	PRACH SCS	1.25 kHz		
	Frequency Offset			
	Options			
	Use LTE IQ Recovery	Options		
	Add null DC subcar	rrier (use with LTE on		



5 For the UL carrier, ensure that "Create Uplink U-Plane" is checked (see Creating U-Plane messages in Uplink Carrier on page 170 for more information).

C/U Plane Builder	Configuration Tool		X
Flow/eAxC	Network Layer:		
Compression	Maximum transmission unit (MTU)	10	
Numerology	🗌 Disable VLAN Tags 🛛 VLA	N ID: 0	
Beamforming	Set Sequence IDs to '0'		
Timing	C-Plane Section Handling:		
inning	🗌 Use reMask		
Options	🗌 Use symInc		
DSS	Use RB indicator		
	Use Extension Type 6		
	Use Extension Type 10 (MIMO only)		
	PRACH Type 3 as Type 1 Message		
	C-Plane Section Type 0 Messages:		
	don't generate 🗸 🗸		
	U-Plane Package:		
	Create Uplink U-Plane	ble U-Plane messages in	
	Digital Power Scaling (IQ Data):		
	0 FS adjustment (FS_Offset, d	lefault 0 is no scaling)	
	Apply fixed 256QAM scaler		
	0 Additional IQ power scaling	(default 0 dBFS is no scaling)	

Figure 110 Creating Uplink U-Plane for UL Carrier

- 6 Export the O-RAN Stimulus file to generate the corresponding PCAP file. See Exporting O-RAN Stimulus File on page 122 for more information.
- 7 Load the updated stimulus / recording PCAP file into O-RAN Studio. For the UL carrier, make sure that the PCAP file suffixed '\_UL' is loaded.
- 8 Select a row in the "U-Plane" area and click the "Filter on selected row" icon.

#### Downlink

Plane	, C-Plane Messages: —			U-PI	ane:						Message Interpretation:
	Time	Source	Destination		Dir	eAxC		DU Port	Band Sector	$\nabla$	
1	00:00:00.009995000	00 00 00 00 00 00	80 09 02 03 04 🗠							, N	
	00:00:00.009998000	00 00 00 00 00 00	80 09 02 03 04								
	00:00:00.009998000	00 00 00 00 00 00	80 09 02 03 04								
4	00:00:00.010033714	00 00 00 00 00 00	80 09 02 03 04	<							
	00:00:00.010033714	00 00 00 00 00 00	80 09 02 03 04								
	00:00:00.010069429	00 00 00 00 00 00	80 09 02 03 04	C-PI	ane: -						
	00:00:00.010069429	00 00 00 00 00 00	80 09 02 03 04	#	Dir	eAxC	н	DU Port	Band Sector		
	00:00:00.010105143	00 00 00 00 00 00	80 09 02 03 04								
	00:00:00.010105143	00 00 00 00 00 00	80 09 02 03 04	0		0001					
10	00:00:00.010140857	00 00 00 00 00 00	80 09 02 03 04								
11	00:00:00.010140857	00 00 00 00 00 00	80 09 02 03 04 🗸								



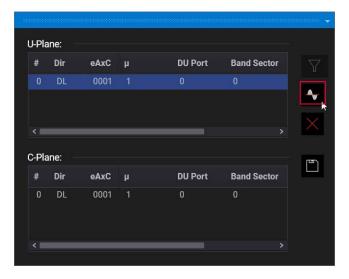


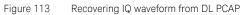
<u> </u>	C-Plane B	Builder Explorer										
ι.	-Plane, C	C-Plane Messages: —			U-P	lane:						Message Interpretation:
		Time	Source	Destination		Dir	eAxC		DU Port	Band Sector	$\nabla$	
		00:00:00.010002000	80 09 02 03 04 05	00 00 00 00 🛆							- <b>x</b>	
		00:00:00.010002000	80 09 02 03 04 05	00 00 00 00 00								
		00:00:00.010037714	80 09 02 03 04 05	00 00 00 00 00								
		00:00:00.010037714	80 09 02 03 04 05	00 00 00 00 00	<							
		00:00:00.010073429	80 09 02 03 04 05	00 00 00 00 00 📕								
		00:00:00.010073429	80 09 02 03 04 05	00 00 00 00 00	C-P	lane:						
		00:00:00.010109143	80 09 02 03 04 05	00 00 00 00 00	#	Dir	eAxC	u	DU Port	Band Sector		
		00:00:00.010109143	80 09 02 03 04 05	00 00 00 00 00		611	enao	•	boron	Dana Gector		
		00:00:00.010144857	80 09 02 03 04 05	00 00 00 00 00								
		00:00:00.010144857	80 09 02 03 04 05	00 00 00 00 00								
		00:00:00.010180571	80 09 02 03 04 05	00 00 00 00 00 🗸								
	<											

Figure 112 Explorer view for UL PCAP

9 Click the icon for "Recover IQ waveform" to proceed with IQ extraction in O-RAN Studio software.

#### Downlink





#### Uplink

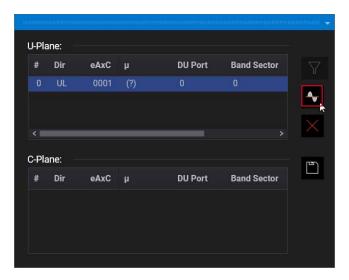


Figure 114 Recovering IQ waveform from UL PCAP

- 10 To view the recovered IQ data and the corresponding Constellation diagram for a U-Plane message in O-RAN Studio,
  - a Highlight a row in the "U-Plane, C-Plane Messages" area that contains a U-Plane message.
  - *b* In the "Message Interpretation" area, click a PRB slot.

The "Hex Payload" area auto-highlights the corresponding data for the selected PRB slot.

The "Recovered IQ" tab shows the corresponding extracted IQ data. The "Constellation" tab shows the plotted IQ data in constellation format.

#### Downlink

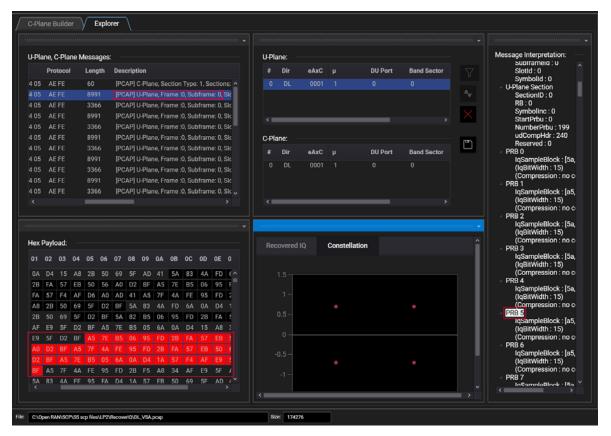


Figure 115

Recovered IQ data per PRB slot for DL Carrier

#### Uplink

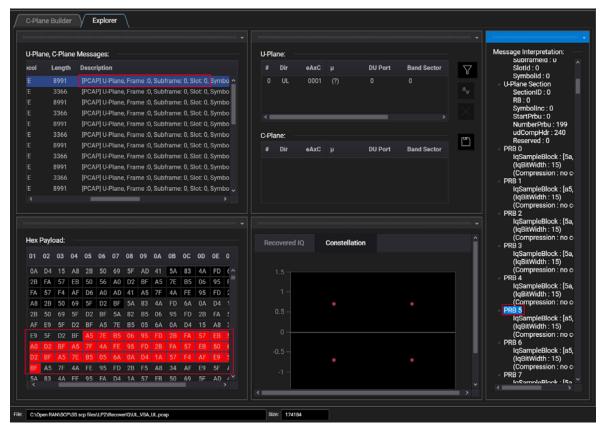
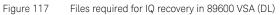


Figure 116 Recovered IQ data per PRB slot for UL Carrier

11 Notice that the folder location, where the original SCP file is saved, now contains additional files, including the SETX and ORB files, which are supported by the 89600 VSA software, for IQ analysis.

#### Downlink

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Clipboard	Organize	New	Open	Selec
← → • ↑ 🖡 «	LP2 > RecoverIQ	v Ū	, ○ Search	RecoverIQ
<ul> <li>✓ Quick access</li> <li>✓ Desktop</li> <li>✓ Downloads</li> <li>✓</li> <li>✓ Documents</li> <li>✓</li> <li>✓ Pictures</li> <li>✓</li> <li>✓ LP_SigSt</li> <li>✓ LP</li> </ul>	Name DL_VSA.1_mu1_ant1.iqt. DL_VSA.Carrier_1_DL.set DL_VSA.orstx DL_VSA.pcap DL_VSA.scp		Type ORB File SETX File ORSTX File PCAP File Text Docu	-
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#### Uplink

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📌 Quick access	UL_VSA.Carrier_1_UL.set	tx	SETX File					
📃 Desktop 🛛 🖈	UL_VSA.orstx		ORSTX File	e				
🖶 Downloads 🖈	UL_VSA.pcap		PCAP File					
🖹 Documents 🖈	UL_VSA.scp	Text Document						
📰 Pictures 🛛 🖈	UL_VSA_UL.1_mu1_ant1	.iqt.orb	ORB File					
LP_SigSt	UL_VSA_UL.pcap		PCAP File					
📙 LP2								

Figure 118 Files required for IQ recovery in 89600 VSA (UL)

- 12 Launch the 89600 VSA software.
- 13 From the main menu, click File > Recall > Recall Setup....
- 14 On the Recall Setup window that appears, navigate to the folder where the SETX file, generated along with other stimulus files by the O-RAN Studio software, is located.
- 15 Select the SETX file and click Open.

#### Downlink

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dBm			a Recall Setup								×	
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dB /div			Quick access						Analyzer2	1030	_	
	M	1 AAA	Desktop									m
-70	γ vv	VYY	-									
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dB /div				<			>	•			•	
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Markere												. n. x.
Walkers											•	Ť.
SIMULATE	Measuremen	:								INT R	EF CAL	: None

Figure 119 Loading SETX file for DL Carrier in 89600 VSA

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LogMag		Look in:	RecoverIQ				Contained Me	asurements:			
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10		Quick access	DL_VSA.Carri		1/17/2021 8:59 PM 1/18/2021 12:33 AM	SETX File SETX File	Meas01	NewRadio Analyzer2	1 User		
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uo vpr											
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/div			File name:	UL_VSA.Carrier_1_UL.setx	•	Open	Append r	measurements to current setu	ID		
			Files of type:	State Files (*.setx, *.set)	•	Cancel		h current measurement			
-80 dBVpk											رک
Start (	] Sec									Stop 3.818	4 uSec
Markers											+ û ×

Figure 120 Loading SETX file for UL Carrier in 89600 VSA

The setup file contents are plotted in 89600 VSA. However, this data is not sufficient for IQ measurements. For the VSA software to measure IQ data, you must load the ORB file that was generated by the O-RAN Studio software along with the other stimulus files.

Also, note that since we are loading a stimulus file, the amount of data is smaller and can be played for a duration of about 10ms, as compared to that of a recording. Since that amount of data is not sufficient for the 89600 VSA software to perform the required IQ measurements, we must configure the frames to appear in a repetitive mode.

16 From the main menu, click File > Recall > Recall Recording....

- 17 On the Recall Recording window that appears, all stimulus files are displayed, which are associated with the SETX file loaded in the previous step. Select the ORB file.
- 18 On the right pane, under "Padding Selection", select 'Repetition'.
- 19 Modify "Factor" field to '3'.
- 20 Click Open.

#### Downlink

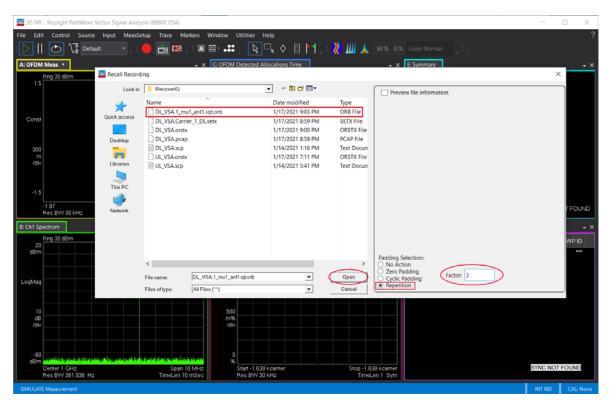
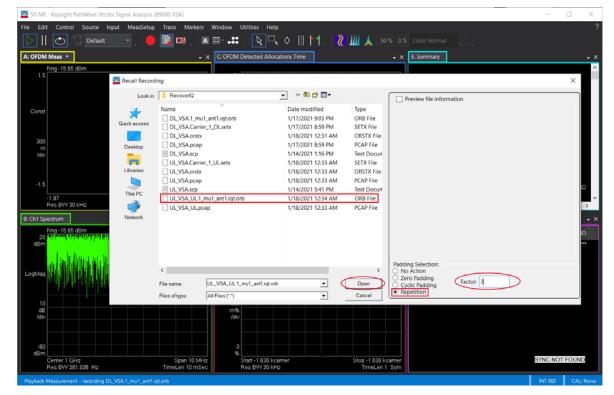


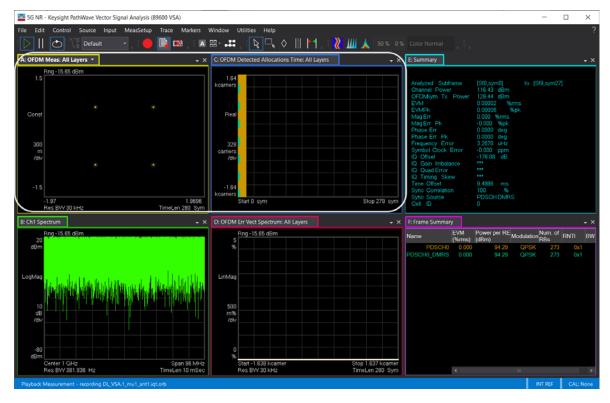
Figure 121 Loading DL ORB file for IQ measurement in 89600 VSA



#### Uplink

Figure 122 Loading UL ORB file for IQ measurement in 89600 VSA

The constellation data for the recovered IQ and the radio frame allocations can be seen in the first two panels of the 89600 VSA and match those that were plotted by the O-RAN Studio software.



#### Downlink

Figure 123 Recovered IQ data for DL in 89600 VSA



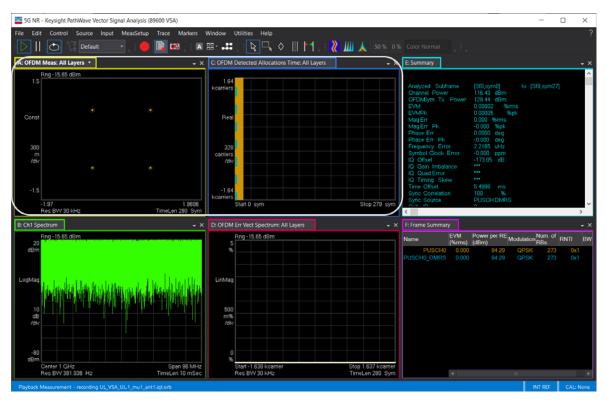


Figure 124 Recovered IQ data for UL in 89600 VSA

This section only describes the basic steps that must be performed to measure IQ carrier in the 89600 VSA software. For more information about the various features and the functionality of the VSA software, refer to the *PathWave Vector Signal Analysis (89600 VSA) Online Help.* 

## Section 3.4: Emulating the Uplink Carrier

#### 3.4.1: Support for UCI format

Open RAN Studio supports Signal Generator project files for the uplink carrier, which has been configured by enabling the UCI format in the PathWave Signal Generation Desktop 2022 interface, as displayed in Figure 125. Note that the following configuration also includes the UL-SCH format.

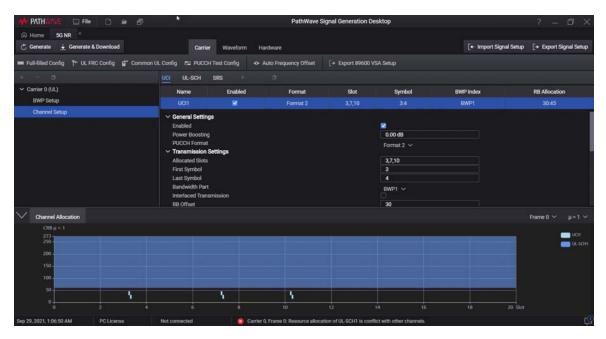
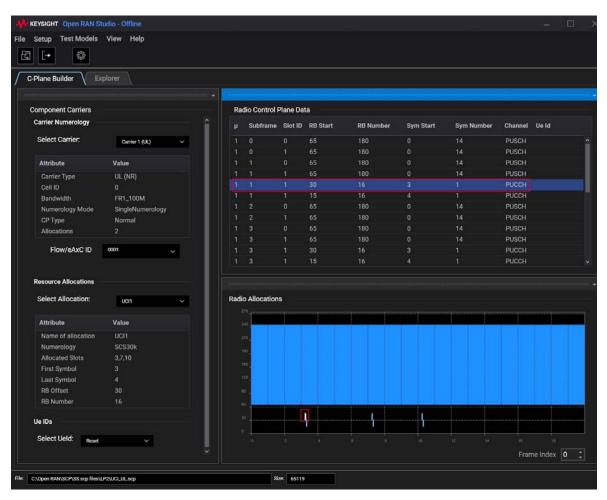
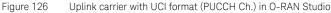


Figure 125 Uplink carrier generated in PWSG with UCI format (PUCCH Ch.)

- 1 Generate an SCP file after you have completed the configuration in PathWave Signal Generator.
- 2 On the O-RAN Studio software, click **File** > **Recall** > **Signal Studio Project...** to open that SCP file.

The SCP file contents are displayed as shown in Figure 126.





Notice how the corresponding Frame allocation for UCI format is highlighted when the PUCCH Channel entry is selected.

#### 3.4.2: Support for SRS format

Along with the UCI format, Open RAN Studio software version 1.3 (and higher) also support Signal Generator project files for the uplink carrier, which has been configured by enabling the SRS format in the *PathWave Signal Generation Desktop 2022* interface, as displayed in Figure 127. Note that the following configuration also includes the UL-SCH and UCI formats.

PATHWAVE 🖸 File 🗋 🖨 🗗		Paulivares	Signal Generation Des	ктор		? – 🗆
ລ Home 5GNR ×						
🖔 Generate 🛓 Generate & Download	Carrier Waveform	Hardware			+ Import Signal S	etup [+ Export Signal Set
Full-filled Config 🍸 UL FRC Config 🚦 Comm	on UL Config 🖼 PUCCH Test Config	<ul> <li>Auto Frequency Offset</li> </ul>	Export 89600 VSA S	letup		
	UCI UL-SCH SRS +					
Carrier 0 (UL)	Name	Enabled	Slot	BWP In	dex	Symbol
BWP Setup	SRS1			BWP		
Channel Setup		5)		0.00 d8 1		
Channel Allocation					Frame 0 🗸	µ=1 🗸 🔡 Display D
GR µ = 1 271 250 150 150 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	8 10 12	14 16 19	20 Slot	son 12	SRS1	

Figure 127 Uplink carrier generated in PathWave Signal Generator with SRS format

NOTE

Configurations with multiple UL channels (including combinations of SRS, UCI, PUSCH) are supported in the Open RAN Studio software. However, make sure that the SRS Channel does not overlap with either PUSCH or PUCCH Channels.

- MIMO configuration is enabled if you configure "Antenna Port(s) Generated" to a logical antenna port value, such as 'p0', 'p1', and so on.
- You may find "asymmetric masks" in the Radio Allocations if you set "SRS-for-positioning" to 'On'.
- 1 Generate an SCP file after you have completed the configuration in PathWave Signal Generation Desktop 2022 software.
- 2 On the O-RAN Studio software, click **File** > **Recall** > **Signal Studio Project...** to open that SCP file.

Plane Builder V E	xplorer											
omponent Carriers	-	Rac	lio Control	Plane Da	ta							
arrier Numerology			Subfram	e Slot ID	RB Start	RB Number	Sym Start	Sym Number	Channel	Beam Id		
Select Carrier:	NR Carrier 1 (UL)								PUSCH			
									PUSCH			
Attribute	Value	1	0	0	20	253	3	11		0		
Carrier Type	UL (NR)		0	0	0	4	8	1	SRS PUCCH	0		
Cell ID									PUCCH			
Bandwidth	FR1_100M				20	253			PUSCH			
Numerology Mode	SingleNumerology Normal					253			PUSCH			
CP Type Allocations	Normal 3								PUSCH			
viocations									PUSCH			
Flow/eAxC ID	0001 ~								PUSCH			
									PUSCH			
source Allocations												
Select Allocation:	A											
	UCII	Radio	Allocatio	ns								
Attribute												
	UL-SCH1											
	961											
am IDs												
elect Beamld:	~											

The SCP file contents are displayed as shown in Figure 128.

Figure 128 Uplink carrier with SRS format (SRS Ch.) in O-RAN Studio

Notice that the corresponding Frame allocation for SRS format is highlighted when the SRS Channel entry is selected.

Following images illustrate the appearance of Radio Allocations for various configuration of the SRS Channel in Open RAN Studio.

### Configuration 1: No hopping and not periodic

component Carriers	the first of the second	and the second										
		R	adio Control	Plane Da	ita							
Carrier Numerology			Subfram	s Slat ID	RB Start	RB Number	Sym Start	Sym Number	Channel	Beam Id		
Select Carrier:	NR Carrier 1 (UL)								SRS			
Attribute	Value											
Carrier Type	UL (NR)											
Cell ID												
Bandwidth	FR1_100M											
Numerology Mode CP Type	SingleNumerology Normal											
Allocations	Normai 1											
Resource Allocations												
Resource Allocations Select Allocation:	SRS1 V	Par	lio Allocatio	05								
	SRS1 V	Rac	lio Allocatio	ns								
Select Allocation:	Value SRS1	Rac	lio Allocatio	ns								
Select Allocation: Attribute Name of allocation Numerology	Value SRS1 SCS15k	Rad		ns								
Select Allocation: Attribute Name of allocation Numerology Periodicity	Value SRS1 SCS15k 0	Rad	141	ns								
Select Allocation: Attribute Name of allocation Numerology Periodicity Siot Offset	Value SRS1 SCS15k 0 0	Rad	140 240	ns								
Select Allocation: Attribute Name of allocation Numerology Periodicity Slot Offset Allocated Slots	Value SRS1 SCS15k 0 0 0	Rad	140 210 700 100									
Attribute Name of allocation Numerology Periodicity Slot Offset	Value SRS1 SCS15k 0 0	Rac	140 210 100	ns								
Select Allocation: Attribute Name of allocation Numerology Periodicity Slot Offset Allocated Slots Start Position	Value SRS1 SCS15k 0 0 0 11	Rac	140 250 100 100 100	ns								
Select Allocation: Attribute Name of allocation Numerology Periodicity Site Offset Allocated Slots Start Position Number of symbols	Value SRS1 SCS15k 0 0 1 1 1 1 2	Rac	140 210 100	ns								



100 - 100 - 100 - 100												
omponent Carriers		Ra	dio Control	Plane Da	ta							
Carrier Numerology			Subframe	Slat ID	RB Start	RB Number	Sym Start	Sym Number	Channel	Beam Id		
Select Carrier:	NR Carrier 1 (UL)				200	36			SRS			
									SRS			
Attribute	Value								SRS			
Carrier Type	UL (NR)				200				SRS			
Cell ID			4		200 200	36 36		4	SRS SRS			
Bandwidth	FR1_100M				200	36 36			SRS	0		
Numerology Mode	SingleNumerology				200	36		4	SRS			
CP Type	Normal 1				200	36			SRS			
Allocations			- a									
Allocations Flow/eAxC ID Resource Allocations	0001				200	36			SRS			
Flow/eAxC ID									SRS			
Flow/eAxC ID Resource Allocations	0001								SRS			
Flow/eAxC ID Resource Allocations Select Allocation: Attribute Name of allocation	SRS1 Value SRS1	0 Radi						243	SRS	10))		
Flow/eAxC ID Resource Allocations Select Allocation: Attribute Name of allocation Numerology	SRS1 V SRS1 V Value SRS1 SCS15k	0 Radi	9 o Allocation					4	SRS	0		
Flow/eAxC ID Resource Allocations Select Allocation: Attribute Name of allocation Numerology Periodicity	aren v Value SRS1 SCSTSk 1	Rad	9 o Allocation					4	SRS	0		
Flow/eAxC ID Resource Allocations Select Allocations Attribute Name of allocation Numerology Pariodicity Sict Offreet	SRS1 Value SRS1 V SRS1 SCSISk 1 0	Rad	9 o Allocation					4	SRS	0		
Flow/eAxCID Resource Allocations Select Allocation Attribute Name of allocation Numerology Periodicity Solic Offset Allocated Siets	0001 V 9631 V Value SRS1 SCS15k 1 0 0,1,2,3,4,5,6,7,8,9	Radi	9 o Allocation					4	SRS	0		
Flow/eAxC ID Resource Allocations Select Allocation: Attribute Name of allocation Numerology Periodicity Silot Offset	SRS1 Value SRS1 V SRS1 SCSISk 1 0	Radi	9 o Allocation					4	SRS	0		
Flow/eAxCID Resource Allocations Select Allocation Attribute Name of allocation Namerology Periodicity Sidi Offset Allocated Slots Statt Position	sest            Value            SRS1            SCS15k         1           0         0.12.3.45.67.8.9           11	Radu	9 o Allocation					4	SRS	0		
Flow/eAxCID Resource Allocations Select Allocations Attribute Name of allocation Nameology Periodicity Sict Offset Allocated Slots Start Position Namber of symbols	8001 8631 Value SRS1 SGS15k 1 0 0.123.45.67.8.9 11 4	Rad	9 o Allocation					4	SRS	0		

Configuration 2: No hopping but periodic

Figure 130 SRS Channel without hopping but periodic only enabled

In this configuration, allocation spans over multiple symbols when reMask is disabled or when reMask is same on neighboring symbols.

Plane Builder V Ex	plorer										
Component Carriers		Ra	lio Control F	lane Da	ta						
Carrier Numerology			Subframe			RB Number	Sym Start	Sym Number	Channel	Beam Id	
Select Carrier:	NR Carrier 1 (UL)								SRS		
n The second					12 60				SRS		
Attribute	Value				60 24				SRS SRS		
Carrier Type	UL (NR)				24 36				SRS		
Cell ID					0				SRS		
Bandwidth	FR1_100M				48				SRS		
Numerology Mode	SingleNumerology				12				SRS		
CP Type	Normal	Ö							SRS		
Allocations					24				SRS		
Flow/eAxC ID	0001				36		4		SRS		
									SRS		
					48				SRS		
Resource Allocations											
Select Allocation:	SRS1 V										
		Radi	Allocation	s —							
Attribute	Value		and the second second								
Name of allocation	SRS1		*2								
Numerology	SCS15k										
Periodicity	2										
Slot Offset											
Allocated Slots	1,3,5,7,9										
Start Position			20								
Number of symbols											
Repetition Factor					-		_			_	
						···················	<b>1</b>	- 1 <sup>1</sup> -		······	
Beam IDs											·····

#### Configuration 3: Both hopping and periodic

Figure 131 SRS Channel with both hopping and periodic enabled

NOTE

Configurations with multiple SRS Channels in the same carrier are supported in the Open RAN Studio Software. However, overlapping of SRS Channels is currently not supported.

For the multi-frame SRS configuration, if you enable Uplink Emulation (as explained in Creating U-Plane messages in Uplink Carrier on page 170), a warning is displayed, as shown in Figure 132, when you generate the Uplink PCAP file. This warning message is displayed only when you export

the stimulus file after selecting the "Create Uplink U-Plane" option in the "Options" tab of the C/U Plane Builder Configuration Tool and the SRS configuration is not supported.

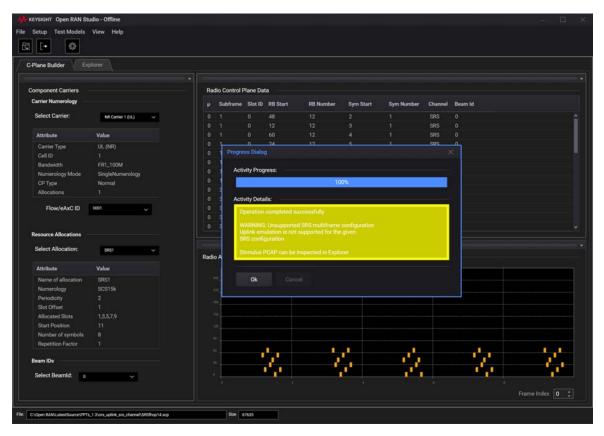


Figure 132 Warning displayed for unsupported SRS configuration

#### Configuration 4: Multi-frame SRS configuration

Currently, Uplink Emulation for multi-frame SRS configuration is supported only when hopping is disabled and SRS allocations are identical in every frame.

Component Carriers		- R	adio Contro	Plane Da	ta							
Carrier Numerology					RB Start	RB Number	Sym Start	Sym Number	Channel	Beam Id		
Select Carrier:	NR Carrier 1 (UL)								SRS			
									SRS			
Attribute	Value	0				20			SRS			
Carrier Type	UL (NR)					20 20		4	SRS			
Cell ID						20		4	SRS			
Bandwidth	FR1_100M					20			SRS	0		
Numerology Mode	SingleNumerology					20		4	SRS			
CP Type	Normal	0				20			SRS			
Allocations												
Flow/eAxC ID	0001								SRS			
Flow/eAxC ID	9851 V				0	20	2	4	SRS			
Flow/eAxC ID Resource Allocations Select Allocation:	9851 V		9 Ilo Allocatio		0	20	2	4	SRS			
Flow/eAxC ID Resource Allocations Select Allocation: Attribute	SRS1 V Value		lio Allocatio			20 :: 111 - 111 - 111 - 111 - 111 - 111 - 111 - 111 - 111 - 111 - 111 - 111 - 111 - 111 - 111 - 111 - 111 - 111 - 111	2	4	SRS			
Flow/eAxCID Resource Allocations Select Allocation: Attribute Name of allocation	sion Value SRS1					20 :: HI H	2	4	SRS			
Flow/eAxCID Resource Allocations Select Allocation: Attribute Name of allocation Numerology	sest Value SRS1 SCS15k		lio Allocatio			20	2	4	SRS			
Flow/eAxC ID Resource Allocations Select Allocation: Attribute Name of allocation Numerology Periodicity	sest ~ Value SRS1 SCS1Sk 1		lio Allocatio				2	4	SRS			
Flow/eAxC ID Resource Allocations Select Allocation: Attribute Name of allocation Numerology Periodicity Silot Offset	aren Value SRS1 SCS15k 1 0		lio Allocatio				2	4	SRS			
Flow/eAxCID Resource Allocations Select Allocation: Attribute Name of allocation Numerology Periodicity Select Offset Allocated Slots	SRS1           SRS1           SCS1Sk           1           0           0.12.34,567,89		lio Allocatio			20	2	4	SRS			
Flow/eAxC ID Resource Allocations Select Allocation: Attribute Name of allocation Numerology Periodicity Slet Offset Allocated Slots Start Position	aren Value SRS1 SCS15k 1 0					20	2	4	SRS			
Flow/eAxCID Resource Allocations Select Allocation: Attribute Name of allocation Numerology Periodicity Select Offset Allocated Slots	sest            Value            SRS1            SCS15k         1           0         0.12.3.45.67.8.9           11					20	2	4	SRS			
Flow/eAxC ID Resource Allocations Select Allocations Attribute Name of allocation Numerology Penodicity Silet Offset Allocated Slots Start Position Number of symbols Repetition Factor	961 Value SR51 SC515k 1 0 0,12,3,4,5,6,7,8,9 1 4					20	2	4	SRS	0		
Flow/eAxCID Resource Allocations Select Allocation: Attribute Nume of allocation Numerology Periodicity Siot Offset Allocated Siots Start Position Number of symbols	961 Value SR51 SC515k 1 0 0,12,3,4,5,6,7,8,9 1 4							4	SRS			

Figure 133 SRS Channel with both hopping and periodic enabled

Use the "Frame Index" feature in Open RAN Studio to switch between frames.

#### Enabling reMask with SRS Channel

In an Uplink carrier with SRS Channels, when you enable the reMask configuration option, allocations on two neighboring symbols are not merged because REs are in different patterns. To understand this behavior, consider the following steps:

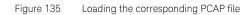
1 Load a UL SCP file with SRS Channels.

C-Plane Builder Ex	plorer										
Component Carriers		- Day	lio Control F	lane Da							
Carrier Numerology		μ	Subframe			RB Number	Sym Start	Sym Number	Channel	Beam Id	
Select Carrier:	NR Carrier 1 (UL)								SRS		
									SRS		
Attribute	Value								SRS		
Carrier Type	UL (NR)								SRS		
Cell ID									SRS		
Bandwidth	FR1_100M								SRS		
Numerology Mode	SingleNumerology								SRS		
CP Type	Normal					20			SRS		
Allocations			4		0 20	20 20	4		SRS		
Flow/eAxC ID	0001	0				20			SRS		
How/endo ib		ů			20				SRS		
									SRS		
Resource Allocations											
Select Allocation:	SRS1 V										
		Radi	Allocation	s —							
Attribute	Value		12-10-10-10-10-10-10-10-10-10-10-10-10-10-								
Name of allocation	SR51		e:								
Numerology	SCS15k										
Periodicity											
Slot Offset											
Allocated Slots											
Start Position											
Number of symbols											
Repetition Factor											
Beam IDs					_	_				_	
					-						
Select Beamld: 0											

Figure 134 Loading a UL SCP file with SRS Channels

- 2 Select the Flow/eXAC ID.
- 3 Export the O-RAN Stimulus file to generate the corresponding PCAP file.
- 4 Switch to Explorer tab and load the stimulus file.

-Plane, C-Pla								
	ane Messages:	U-Plan	16:				-	Aessage Interpretation:
Length De	escription		Dir	eAxC		DU Por	Υ	VianTypeString: 81 00
60 (F 60 (F 60 (F	PCAP[ C-Plane, Section Type 1, Sections: 1, Frame 0, Subframe: 0, Slot 0, Symbol Start 2, PRB 0-19  PCAP[ C-Plane, Section Type 1, Sections: 1, Frame 0, Subframe: 0, Slot 0, Symbol Start 4, PRB 2039 PCAP[ C-Plane, Section Type 1, Sections: 1, Frame 0, Subframe: 1, Slot 0, Symbol Start 2, PRB 0-19 PCAP[ C-Plane, Section Type 1, Sections: 1, Frame 0, Subframe: 5, Slot 0, Symbol Start 2, PRB 0-19 PCAP[ C-Plane, Section Type 1, Sections: 1, Frame 0, Subframe: 5, Slot 0, Symbol Start 2, PRB 0-19 PCAP[ C-Plane, Section Type 1, Sections: 1, Frame 0, Subframe: 5, Slot 0, Symbol Start 2, PRB 0-19 PCAP[ C-Plane, Section Type 1, Sections: 1, Frame 0, Subframe: 5, Slot 0, Symbol Start 2, PRB 0-19 PCAP[ C-Plane, Section Type 1, Sections: 1, Frame 0, Subframe: 5, Slot 0, Symbol Start 2, PRB 0-19 PCAP[ C-Plane, Section Type 1, Sections: 1, Frame 0, Subframe: 5, Slot 0, Symbol Start 2, PRB 0-19 PCAP[ C-Plane, Section Type 1, Sections: 1, Frame 0, Subframe: 5, Slot 0, Symbol Start 2, PRB 0-19 PCAP[ C-Plane, Section Type 1, Sections: 1, Frame 0, Subframe: 5, Slot 0, Symbol Start 2, PRB 0-19 PCAP[ C-Plane, Section Type 1, Sections: 1, Frame 0, Subframe: 5, Slot 0, Symbol Start 2, PRB 0-19 PCAP[ C-Plane, Section Type 1, Sections: 1, Frame 0, Subframe 2, Slot 0, Symbol Start 2, PRB 0-19 PCAP[ C-Plane, Section Type 1, Sections: 1, Frame 0, Subframe 2, Slot 0, Symbol Start 2, PRB 0-19 PCAP[ C-Plane, Section Type 1, Sections: 1, Frame 0, Subframe 2, Slot 0, Symbol Start 2, PRB 0-19 PCAP[ C-Plane, Section Type 1, Sections: 1, Frame 0, Subframe 2, Slot 0, Symbol Start 2, PRB 0-19 PCAP[ C-Plane, Section Type 1, Sections: 1, Frame 0, Subframe 2, Slot 0, Symbol Start 2, PRB 0-19 PCAP[ C-Plane, Section Type 1, Sections: 1, Frame 0, Subframe 2, Slot 0, Symbol Start 2, PRB 0-19 PCAP[ C-Plane, Section Type 1, Sections: 1, Frame 0, Subframe 2, Slot 0, Symbol Start 2, PRB 0-19 PCAP[ C-Plane, Section Type 1, Sections: 1, Frame 0, Subframe 2, Slot 0, Symbol Start 2, PRB 0-19 PCAP[ C-Plane, Section Type 1, Sections: 1, Frame 0, Subframe 2, Slot 0,							VianTciString : PCP(7), DEI(0), VI = EtherType Value : AE FE = eCPRI Common Header = ecpriVersion : 1 = ecpriConcatenation : 0 = ecpriMessage : 2
60 [F	PCAP] C-Plane, Section Type: 1, Sections: 1, Frame :0, Subframe: 2, Slot 0, Symbol Start: 4, PRB: 20-39 PCAP] C-Plane, Section Type: 1, Sections: 1, Frame :0, Subframe: 3, Slot: 0, Symbol Start: 2, PRB: 0-19	C-Plan		eAxC		DU Por		ecpriPayload : 20 • eCPRI Component eAxC ID (C-Plane DuPortID : 0 BandSectorID : 0
40 [F 60 [F 60 [F	PCAP[ CPlane, Section Type: 1, Sections: 1, Frame 0, Subframe 3, Slot: 0, Symbol Start 4, PRB: 2039 PCAP] CPlane, Section Type: 1, Sections: 1, Frame 0, Subframe 4, Slot: 0, Symbol Start 2, PRB: 0-19 PCAP] CPlane, Section Type: 1, Sections: 1, Frame 0, Subframer, 4, Slot: 0, Symbol Start 2, PRB: 0-19 PCAP] CPlane, Section Type: 1, Sections: 1, Frame 0, Subframer, 5, Slot: 0, Symbol Start 2, PRB: 0-19 PCAP] CPlane, Section Type: 1, Sections: 1, Frame 0, Subframer, 5, Slot: 0, Symbol Start 2, PRB: 0-19 PCAP] CPlane, Section Type: 1, Sections: 1, Frame 0, Subframer, 5, Slot: 0, Symbol Start 4, PRB: 20-39 >>	0		0001				CoID : 0 RuPortID : 1 = cCPRI Sequence ID SequenceID : 0 E : 1 SubsequenceID : 0 - CPlane Common Header DataDirection : 0 PavloadVersion : 1
ex Payload:		Reco	overed IQ		Constellation			FilterIndex : 0 Frameld : 0 Subframeld : 0 Slottd : 0
Hex 00 0	01 02 03 04 05 06 07 08 09 0A 08 0C 0D 0E OF ASCII	PRB: (	(none sel	ected)				Storid : U StartSymbolid : 2 NumberOfSections : 1
16 AE F 32 F0 0	99 02 03 04 05 00 00 00 00 00 00 00 00 20 00 00 00 00	RE	uCm	pl	uCmpQ			SectionType 1 User Data Compression Header IghtWidth : 15 Compression : no compression Reserved Value : 0 C-Plane Section Type 1 SectionID: 0 RB : 0 Symbolinc : 0 StartPho: 0



- 5 Launch the "C/U-Plane Builder Configuration" window in the Open RAN Studio software.
- 6 Click the "Options" tab.
- 7 Select the "Use reMask" check box.

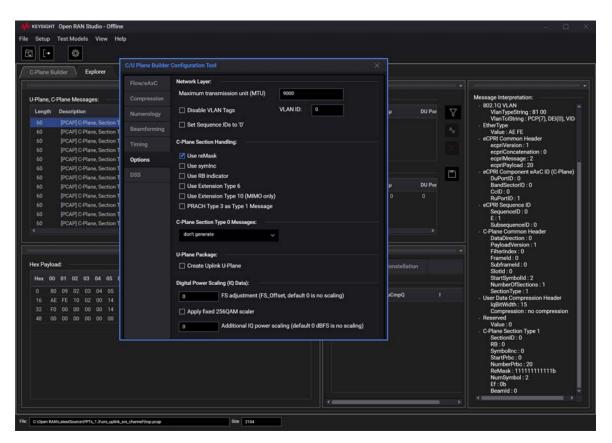


Figure 136 Enabling the 'Use reMask' configuration option

- 8 Exit the "C/U-Plane Builder Configuration Tool" window.
- 9 Export the O-RAN Stimulus file again for the configuration changes to take effect.
- 10 In the Explorer tab, open the regenerated stimulus file.
- 11 In the 'U-Plane, C-Plane Messages' area, highlight the first row of C-Plane messages, which correspond to StartSymbolId: 2, as shown in Figure 137.

Plane, C-Plane Messages:	U-Plane:					Message Interpretation:
Length Description	# Dir	eAxC	Р	DU Por	$\nabla$	<ul> <li>BUZ. IQ VL/VN</li> <li>VlanTypeString : 81 00</li> </ul>
60 [PCAP] C-Plane, Section Type: 1, Sections: 1, Frame: 0, Subframe: 0, Slot: 0, Symbol Sta	rt 2. PRB 0-19					VlanTciString : PCP(7), DEI(0), V EtherType
60 [PCAP] C-Plane, Section Type: 1, Sectiona: 1, Frame :0, Subframe: 0, Slot: 0, Symbol Sta						Value : AE FE
60 [PCAP] C-Plane, Section Type: 1, Sections: 1, Frame :0, Subframe: 0, Slot: 0, Symbol Sta	rt: 4, PRB: 20-39					<ul> <li>eCPRI Common Header</li> <li>ecpriVersion : 1</li> </ul>
60 [PCAP] C-Plane, Section Type: 1, Sections: 1, Frame :0, Subframe: 0, Slot: 0, Symbol Sta	rt: 5, PRB: 20-39					ecpriConcatenation : 0
60 [PCAP] C-Plane, Section Type: 1, Sections: 1, Frame :0, Subframe: 1, Slot: 0, Symbol Sta						ecpriMessage : 2 ecpriPayload : 20
60 [PCAP] C-Plane, Section Type: 1, Sections: 1, Frame :0, Subframe: 1, Slot: 0, Symbol Sta	C-Plane:				m	eCPRI Component eAxC ID (C-Plan
60 [PCAP] C-Plane, Section Type: 1, Sections: 1, Frame: 0, Subframe: 1, Slot: 0, Symbol Sta		eAxC		DU Por		DuPortID : 0 BandSectorID : 0
<ol> <li>[PCAP] C-Plane, Section Type: 1, Sections: 1, Frame :0, Subframe: 1, Slot: 0, Symbol Sta</li> <li>[PCAP] C-Plane, Section Type: 1, Sections: 1, Frame :0, Subframe: 2, Slot: 0, Symbol Sta</li> </ol>	IT 3, PRD: 20-39	0001		0		CcID:0
<ol> <li>[PCAP] C-Plane, Section Type: 1, Sections: 1, Frame 0, Subframe: 2, Slot: 0, Symbol Sta</li> <li>[PCAP] C-Plane, Section Type: 1, Sections: 1, Frame 0, Subframe: 2, Slot: 0, Symbol Sta</li> </ol>		0001				RuPortID : 1 - eCPRI Sequence ID
60 [PCAP] C-Plane, Section Type: 1, Sections: 1, Frame :0, Subframe: 2, Slot: 0, Symbol Sta						SequenceID : 0
<ol> <li>[PCAP] C-Plane, Section Type: 1, Sections: 1, Frame :0, Subtrame: 2, Stot: 0, Symbol Sta</li> <li>[PCAP] C-Plane, Section Type: 1, Sections: 1, Frame :0, Subframe: 2, Slot: 0, Symbol Sta</li> </ol>	rt: 4, PRB: 20-39					SequenceID : 0 E : 1 SubsequenceID : 0
	rt: 4, PRB: 20-39	_				E : 1 SubsequenceID : 0 - C-Plane Common Header
	rt: 4, PRB: 20-39 rt: 5, PRB: 20-39	_				E : 1 SubsequenceID : 0 C-Plane Common Header DataDirection : 0 PayloadVersion : 1
	rt: 4, PRB: 20-39 rt: 5, PRB: 20-39					E : 1 SubsequenceID : 0 - C-Plane Common Header DataDirection : 0
60 [PCAP] C-Plane, Section Type: 1. Sections: 1. Frame: 0, Subframe: 2, Slot: 0, Symbol Sta	rt: 4, PRB: 20-39 rt: 5, PRB: 20-39	d IQ	Constellation			E : 1 SubsequenceID : 0 C-Plane Common Header DataDirection : 0 PayloadVersion : 1 FilterIndex : 0 Frameld : 0 Subframeld : 0
60 [PCAP] C.Plane, Section Type: 1. Sections: 1. Frame: 0. Subframe: 2. Slot: 0. Symbol Sta ex Payload:	rt: 4, PRB: 20:39 rt: 5, PRB: 20:39 × Recovere		Constellation			E : 1 SubsequenceID : 0 C-Plane Common Header DataDirection : 0 PayloadVersion : 1 FilterIndex : 0 Frameld : 0
60 [PCAP] C.Plane, Section Type: 1, Sections: 1, Frame: 0, Subframe: 2, Slot 0, Symbol Sta ex Payload: Hex 00 01 02 03 04 05 06 07 08 09 0A 08 0C 0D 0E 0F ASCII	rt 4, PRB: 20-39 vrt 5, PRB: 20-39 >		Constellation			E:1 SubsequenceID:0 - C-Plane Common Header DataDilection:0 PayloadVersion:1 Frameld:0 Subframeld:0 Subframeld:0 StartSymbolid:2 NumberOfSections:1
60 [PCAP] C.Plane, Section Type: 1, Sections: 1, Frame 0, Subframe: 2, Slot 0, Symbol Sta xx Payload: Hex 00 01 02 03 04 05 06 07 08 09 0A 08 0C 00 0E 0F ASCII 0 80 09 02 03 04 05 00 00 00 00 00 01 00 E1 00	rt 4, PRB: 20-39 rt 5, PRB: 20-39 Recovere PRB: (nonk RE		Constellation			E:1 SubsequenceID:0 CPlane Common Header DataDirection:0 PayloadVersion:1 FilterIndex:0 Subframeld:0 StartSymbolid:2 StartSymbolid:2
60 [PCAP] C.Plane, Section Type: 1, Sections: 1, Frame 0, Subframe: 2, Slot 0, Symbol Sta 20 Payload: Hex 00 01 02 03 04 05 06 07 08 09 0A 08 0C 00 0E 0F ASCII 0 80 09 02 03 04 05 00 00 00 00 00 01 10 00 E0 00 16 AE FE 10 02 00 14 00 01 00 80 10 00 00 02 01 01	rt: 5, PRB: 20.39 rt: 5, PRB: 20.39 Recovere PRB: (none RE (none)	selected)				E:1 SubsequenceID:0 CPlane Common Header DataDirection:0 PayloadVersion:1 FilterIndex:0 Subfameld:0 StartSymbolid:2 NumberOfSections:1 SectionSpe:1 User Data Compression Header IgBWMdh:15
60         [PCAP] C.Plane, Section Type: 1, Sections: 1, Frame: 0, Subframe: 2, Slot 0, Symbol Sta           x Payload:	rt: 5, PRB: 20.39 rt: 5, PRB: 20.39 Recovere PRB: (none RE (none)	selected)				E:1 SubsequenceID:0 C-Plane Common Header DataDirection:0 PayloadVersion:1 Framed:0 Subframed:0 Subframed:0 StartSymbolic:2 NumberOfSections:1 SectionType:1 UserData Compression Header
60         [PCAP] C.Plane, Section Type: 1, Sections: 1, Frame: 0, Subframe: 2, Slot 0, Symbol Sta           x Payload:	rt: 5, PRB: 20.39 rt: 5, PRB: 20.39 Recovere PRB: (none RE (none)	selected)				E:1 SubsequenceID:0 C-Plane Common Header DataDirection:0 PayloadVersion:1 FilterIndex:0 FrameId:0 SubframeId:0 SubframeId:0 StartSymbolid:2 NumberOfSections:1 SectionType:1 UterData Compression Header IgBitWidth:15 Compression: no compression Reserved Value:0
60         [PCAP] C.Plane, Section Type: 1, Sections: 1, Frame: 0, Subframe: 2, Slot 0, Symbol Sta           x Payload:	rt: 5, PRB: 20.39 rt: 5, PRB: 20.39 Recovere PRB: (none RE (none)	selected)				E:1 SubsequenceID:0 C-Plane Common Header DataDirection:0 PayloadVersion:1 FilterIndex:0 SubframeId:0 SubframeId:0 SubframeId:2 NumberOfSections:1 SectionType:1 Uter Data Compression Header IgBitWidth:15 Compression : no compression Reserved Value:0 Collaue:0 SectionType 1 SectionType 1
60         [PCAP] C.Plane, Section Type: 1, Sections: 1, Frame: 0, Subframe: 2, Slot 0, Symbol Sta           x Payload:	rt: 5, PRB: 20.39 rt: 5, PRB: 20.39 Recovere PRB: (none RE (none)	selected)				E:1 SubsequenceID:0 CPlane Common Header DataDirection:0 PayloadVersion:1 FilterIndex:0 Subfameld:0 StartSymbolid:2 NumberOfSections:1 SectionType:1 User Data Compression Header IgBWdht:15 Compression:no compression Reserved Value:0 CPlane SectionType 1 SectionID:0 RB:0
60         [PCAP] C.Plane, Section Type: 1, Sections: 1, Frame: 0, Subframe: 2, Slot 0, Symbol Sta           xx Payload:	rt: 5, PRB: 20.39 rt: 5, PRB: 20.39 Recovere PRB: (none RE (none)	selected)				E:1 SubsequenceID:0 CPlane Common Header DataDirection:0 PayloadVersion:1 FilterIndex:0 Subfameld:0 Subfameld:0 StartSymbolid:2 NumberOfSections:1 SectionType:1 User Data Compression Header IgBWdht:15 Compression :no compression Reserved Value:0 CPlane SectionType 1 SectionID:0 QB:0 StartPhbe:0 2 StartPhbe:0 2 StartPhbe:0
60         [PCAP] C.Plane, Section Type: 1, Sections: 1, Frame: 0, Subframe: 2, Slot 0, Symbol Sta           xx Payload:	rt: 5, PRB: 20.39 rt: 5, PRB: 20.39 Recovere PRB: (none RE (none)	selected)				E:1 SubsequenceID:0 - C-Plane Common Header DataDirection:0 RayloadVersion:1 FilterIndex:0 Subfameld:0 Subfameld:0 StartSymbolid:2 NumberOfSections:1 Section type:1 - User Data Compression Header IgBWMdh:15 Roompression:no compression Verbue:0 - C-Plane Section Type 1 SectionD:0 StartPhb:0 NumberPhb:20
60         [PCAP] C-Plane, Section Type: 1, Sections: 1, Frame: 0, Subframe: 2, Slot 0, Symbol State           ex Poyload:         100         00         01         02         03         04         05         06         07         08         09         0A         0B         0C         0D         0E         0F         ASCII           0         80         09         02         03         04         05         06         07         08         09         0A         0B         0C         0D         0E         0F         ASCII           0         80         09         02         03         04         05         00         00         00         00         01         00 <td>rt: 5, PRB: 20.39 rt: 5, PRB: 20.39 Recovere PRB: (none RE (none)</td> <td>selected)</td> <td></td> <td></td> <td></td> <td>E:1 SubsequenceID:0 CPlane Common Header DataDirection:0 PayloadVersion:1 FilterIndex:0 Subfameld:0 Subfameld:0 StartSymbolid:2 NumberOfSections:1 SectionType:1 User Data Compression Header IgBWdht:15 Compression :no compression Reserved Value:0 CPlane SectionType 1 SectionID:0 QB:0 StartPhbe:0 2 StartPhbe:0 2 StartPhbe:0</td>	rt: 5, PRB: 20.39 rt: 5, PRB: 20.39 Recovere PRB: (none RE (none)	selected)				E:1 SubsequenceID:0 CPlane Common Header DataDirection:0 PayloadVersion:1 FilterIndex:0 Subfameld:0 Subfameld:0 StartSymbolid:2 NumberOfSections:1 SectionType:1 User Data Compression Header IgBWdht:15 Compression :no compression Reserved Value:0 CPlane SectionType 1 SectionID:0 QB:0 StartPhbe:0 2 StartPhbe:0 2 StartPhbe:0

Figure 137 Viewing reMask pattern for StartSymbolld: 2

12 Similarly, highlight the second row of C-Plane messages, which correspond to the neighboring StartSymbolId: 3, as shown in Figure 138.

	a destruction					
Plane, C Plane Messages:	U-Plane:					Message Interpretation:
Length Description	# Dir	eAxC		DU Per	$\nabla$	<ul> <li>BUZ IQ VLAN</li> <li>VlanTypeString: 81 00</li> </ul>
60 [PCAP] C-Plane, Section Type: 1, Sections: 1, Frame (0, Subframe: 0, Slot: 0, Symbol Start: 2, PRB: 0-19						VlanTciString : PCP(7), DEI(0), VID
<ol> <li>[PCAP] C-Plane, Section Type: 1, Sections: 1, Frame 0, Subframe: 0, Slot: 0, Symbol Start: 3, PRB: 0-19</li> <li>[PCAP] C-Plane, Section Type: 1, Sections: 1, Frame 0, Subframe: 0, Slot: 0, Symbol Start: 3, PRB: 0-19</li> </ol>						<ul> <li>EtherType Value : AE FE</li> </ul>
60 [PCAP] C-Plane, Section Type: 1, Sections: 1, Frame :0, Subframe: 0, Slot: 0, Symbol Start: 4, PRB: 20-39						<ul> <li>eCPRI Common Header</li> </ul>
60 [PCAP] C-Plane, Section Type: 1, Sections: 1, Frame :0, Subframe: 0, Slot: 0, Symbol Start: 5, PRB: 20-39						ecpriVersion : 1 ecpriConcatenation : 0
60 [PCAP] C-Plane, Section Type: 1, Sections: 1, Frame :0, Subframe: 1, Slot: 0, Symbol Start: 2, PRB: 0-19						ecpriMessage : 2
60 [PCAP] C-Plane, Section Type: 1, Sections: 1, Frame :0, Subframe: 1, Slot: 0, Symbol Start: 3, PRB: 0-19	C-Plane:				THE N	ecpriPayload : 20 eCPRI Component eAxC ID (C-Plane)
60 [PCAP] C-Plane, Section Type: 1, Sections: 1, Frame :0, Subframe: 1, Slot: 0, Symbol Start: 4, PRB: 20-39						DuPortID : 0
60 [PCAP] C-Plane, Section Type: 1, Sections: 1, Frame :0, Subframe: 1, Slot: 0, Symbol Start: 5, PRB: 20-39	# Dir	eAxC		DU Por		BandSectorID : 0 CcID : 0
60 [PCAP] C-Plane, Section Type: 1, Sections: 1, Frame :0, Subframe: 2, Slot: 0, Symbol Start: 2, PRB: 0-19		0001				RuPortID : 1
60 [PCAP] C-Plane, Section Type: 1, Sections: 1, Frame :0, Subframe: 2, Slot: 0, Symbol Start: 3, PRB: 0-19						<ul> <li>eCPRI Sequence ID</li> </ul>
						SequencelD - 1
60 [PCAP] C-Plane, Section Type: 1, Sections: 1, Frame :0, Subframe: 2, Slot: 0, Symbol Start: 4, PRB: 20-39						SequenceID : 1 E : 1
<ol> <li>PCAPI C Plane, Section Type: 1, Sections: 1, Frame 10, Subframe: 2, Slot 0, Symbol Start 4, PRB: 20.39</li> <li>[PCAPI C Plane, Section Type: 1, Sections: 1, Frame: 0, Subframe: 2, Slot 0, Symbol Start 5, PRB: 20.39</li> </ol>						E : 1 SubsequenceID : 0
		_				E : 1 SubsequenceID : 0 - C-Plane Common Header DataDirection : 0
						E:1 SubsequenceID:0 - C-Plane Common Header DataDirection:0 PayloadVersion:1
60 [PCAP] C Plane, Section Type: 1, Sections: 1, Frame: 0, Subframe: 2, Slot: 0, Symbol Start: 5, PRB: 20-39		1				E:1 SubsequenceID:0 C-Plane Common Header DataDirection:0 PayloadVersion:1 FilterIndex:0 Frameld:0
	Recover	ed IQ	Constellatio			E:1 SubsequenceID:0 C-Plane Common Header DataDirection:0 PayloadVersion:1 FilterIndex:0 FrameId:0 SubframeId:0
60 [PCAP] C Plane, Section Type: 1, Sections: 1, Frame 0, Subframe: 2, Slot: 0, Symbol Start: 5, PRB: 20-39	Recover		Constellation			E:1 SubsequenceID:0 - C-Plane Common Header DataDirection:0 PayloadVersion:1 FitterIndex:0 Farmeld:0 Subfameld:0 Slotd:0 StartSymbold:3
60 [PCAP] C Plane, Section Type: 1, Sections: 1, Frame 0, Subframe: 2, Slot: 0, Symbol Start: 5, PRB: 20-39 ex Payload: Hex 00 01 02 03 04 05 06 07 08 09 0A 08 0C 0D 0E 0F ASCII	• Recover	e selected)				E:1 SubsequenceID:0 - C-Plane Common Header DataDirection:0 PayloadVersion:1 Fibrefinder:0 Frameld:0 Subframeld:0 Subframeld:3 NumberOfSections:1
60         [PCAP] C.Plane, Section Type: 1, Sections: 1, Frame 0, Subframe: 2, Slot 0, Symbol Start 5, PRB: 20:39           ex Payload:           Hex 00 01 02 03 04 05 06 07 08 09 0A 08 0C 0D 0E 0F ASCII           0         80 09 02 03 04 05 06 00 00 00 00 00 00 81 00 E0 00	• Recover		Constellatio uCmpQ			E:1 SubsequenceID:0 C-Plane Common Header DataDirection:0 PayloadVersion:1 FilterInder:0 Frameld:0 Subframeld:0 StartSymbolld:3 NumberOfSections:1 SectionType:1 User Data Compression Header
60 [PCAP] C Plane, Section Type: 1, Sections: 1, Frame 0, Subframe: 2, Slot: 0, Symbol Start: 5, PRB: 20-39 ex Payload: Hex 00 01 02 03 04 05 06 07 08 09 0A 08 0C 0D 0E 0F ASCII	• Recover	e selected)				E:1 SubsequenceID:0 - C-Plane Common Header DataDirection:0 PayloadVersion:1 FitterIndex:0 Subframed:0 Subframed:0 Statf:ymbold:3 NumberOf/Sections:1 SectionType:1 User Data Compression Header iqBitWith:15
60 [PCAP] C.Plane, Section Type: 1, Sections: 1, Frame 0, Subframe: 2, Slot: 0, Symbol Start: 5, PR8: 20:39 > ex Payload: Hex 00 01 02 03 04 05 06 07 08 09 0A 08 0C 0D 0E 0F ASCII 0 80 09 02 03 04 05 00 00 00 00 00 00 01 01 00 E0 00 16 AE FE 10 02 00 14 00 01 01 80 10 00 00 30 101	• Recover	e selected)				E:1 SubsequenceID:0 - C-Plane Common Header DataDirection:0 PayloadVersion:1 FitterIndex:0 Subfamed:0 Subfamed:0 Subfamed:0 Subfamed:0 Subfamed:1 SateSymbold:3 NumberOf/Sections:1 SectionType:1 User Data Compression Header IngBitWith:15 Compression: no compression Reserved
60         [PCAP] C.Plane, Section Type: 1, Sections: 1, Frame 0, Subframe: 2, Slot 0, Symbol Start: 5, PR8: 20.39           ex Payload:	• Recover	e selected)				E:1 SubsequenceID:0 C-Plane Common Header DataDirection:0 PayloadVersion:1 Filterindex:0 Frameld:0 Subframeld:0 Subframeld:0 StartSymbolid:3 NumberOfSections:1 SectionType:1 User Data Compression Header IqBitWidth:15 Compression:ne compression Reserved Value:0
60         [PCAP] C.Plane, Section Type: 1, Sections: 1, Frame 0, Subframe: 2, Slot 0, Symbol Start: 5, PR8: 20.39           ex Payload:	• Recover	e selected)				E:1 SubsequenceID:0 C-Plane Common Header DataDirection:0 PhyloadVersion:1 Filterindes:0 Subframeld:0 Subframeld:0 Subframeld:0 Subframeld:0 Section1ype:1 Section1ype:1 Section1ype:1 Compression:no.compression Reserved Value:0 C-Plane Section Type 1 Section1D:1
60         [PCAP] C.Plane, Section Type: 1, Sections: 1, Frame 0, Subframe: 2, Slot 0, Symbol Start: 5, PR8: 20.39           ex Payload:	• Recover	e selected)				E:1 SubsequenceID:0 C-Plane Common Header DataDirection:0 PayloadVersion:1 Fitterindex:0 Subframed:0 Subframed:0 Subtid:0 StartSymbold:3 NumberOfSections:1 SectionType:1 Compression:no.compression Reserved Value:0 C-Plane Section Type 1 SectionTD:1 B :0
60         [PCAP] C.Plane, Section Type: 1, Sections: 1, Frame 0, Subframe: 2, Slot 0, Symbol Start: 5, PR8: 20.39           ex Payload:	• Recover	e selected)				E:1 SubsequenceID:0 C-Plane Common Header DataDirection:0 PhyloadVersion:1 Filterindes:0 Subframeld:0 Subframeld:0 Subframeld:0 Subframeld:0 Section1ype:1 Section1ype:1 Section1ype:1 Compression:no.compression Reserved Value:0 C-Plane Section Type 1 Section1D:1
60         [PCAP] C-Plane, Section Type: 1, Sections: 1, Frame 0, Subframe: 2, Slot 0, Symbol Start: 5, PR8: 20-39           ex Payload:	• Recover	e selected)				E:1 SubsequenceID:0 -C-Plane Common Header DataDirection:0 PayloadVersion:1 FitterIndex:0 Formeld:0 Subfame
60         [PCAP] C-Plane, Section Type: 1, Sections: 1, Frame 0, Subframe: 2, Slot 0, Symbol Start: 5, PR8: 20-39           ex Payload:	• Recover	e selected)				E:1 SubsequenceID:0 C-Plane Common Header DataDirection:0 PayloadVersion:1 FitterIndex:0 Subfarmed:0 S

Figure 138 Viewing reMask pattern for neighboring StartSymbolld: 3

- 13 Switch to the C-Plane Builder tab to view the Radio Allocations and highlight the first symbol.
- 14 Open the regenerated SCP file (with reMask enabled) in the PathWave Signal Generation Desktop 2022 software.

Figure 139 validates the behavior of the SRS Channel, which was described earlier, when reMask is enabled. The RB Resource Mapping for SRS1 shows the startsymbolID on the corresponding pattern.

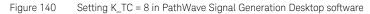
p	Subframe	Slot ID	RB Start	RB Number	Sym Start	Sym Number	Channel	Beam Id	
0									
0		0	0	20	3	1	SRS	0	
0	0	0	20	20			SRS	0	
0			20	20			SRS		
0				20	2		SRS		
0							SRS		
0							SRS		
0							SRS		
0							SRS		
0							SRS		
0							SRS		
0							SRS		
0							SRS		
Rad	lio Allocation	is —							
	240								
	114								
	110								
	150								
	120								

Figure 139 Viewing allocations on two neighboring symbols

### Enabling reMask and K\_TC = 8 with SRS Channel

Let us consider the case where the SCP file from the previous example is modified in the PathWave Signal Generation Desktop 2022 software, such that the "Transmission Comb Number ( $K_TC$ )" value is changed to '8'.

Name	Enabled	Slot		BWP Index	Symbol
SRS1		0,1,2,3,4,5,6,7,8,9,10,11,12,13,14,15,16,17,18,19		BWP1	
✓ General Set	tings				
Enabled		2 C C C C C C C C C C C C C C C C C C C			
Power Boos	ting		0.00 dB		
Number of A	Intenna ports	1			
Antenna Por	t(s) Generated		p0 >		
SRS-for-posi	itioning	S			
∼ Time Doma	in Resource				
Periodicity (	T_SRS)				
Slot Offset (	T_offset)		0		
Allocated Sl			0,1,2,3,4,5,6,7,8,9,10,11,12,13,14,15,		
Start Positio	n (l_offset)		11		
Number of s	ymbols (N_symb_SRS)	4			
Repetition F		2			
	Domain Resource				
Bandwidth P	Part	В	WP1 🗸		
		••••••	×		
	n Comb Offset (k_TC)		0		
	dth index (B_SRS)				
	dth index (C_SRS)		11		
	lopping (b_hop)		0		
	omain Shift (n_shift)		0		
	omain Position (n_RRC)		0		
Sequence G					
	nceHopping		0		
	Config (n_SRS_cs)		0		
Sequence id	entity (n_ID_SRS)		0		



When the PCAP file is generated in Open RAN Studio software for this SCP file with the "Use reMask" option enabled, you shall notice separate allocation on each PRB. This is because SRS REs are in every 8th RE resulting in different reMask values for neighboring PRBs on a symbol. This behavior is displayed in the Message Interpretation area for neighboring PRBs, as shown in Figure 141 and the RB Resource Mapping for SRS1 from the PathWave Signal Generation Desktop 2022 software and its corresponding allocation is shown in Figure 142.

•	
Message Interpretation:	Message Interpretation:
<ul> <li>802.10 VLAN VlanTypeString: 81 00 VlanTolString: PCP(7), DEI(0), VID</li> <li>EtherType Value: AE FE</li> <li>eCPRI Common Header ecpriVersion: 1 ecpriConcatenation: 0 ecpriMessage: 2 ecpriPayload: 20</li> <li>eCPRI Component eAxC ID (C-Plane) DuPortID: 0 BandSectorID: 0 CcID: 0 RuPortID: 1</li> <li>eCPRI Sequence ID SequenceID : 1 E: 1 SubsequenceID : 0</li> <li>C-Plane Common Header DataDirection: 0 FrameId: 0 SlotId: 0 SlotId: 0 SlotId: 0 SlotId: 2 NumberOfSections: 1 SectionType: 1</li> <li>User Data Compression Header IgBitWidth: 15 Compression: no compression</li> <li>Reserved Value: 0</li> <li>C-Plane Section Type 1 SectionID: 36 RB: 0 SymbolInc: 0 StartPrbc: 18</li> </ul>	<ul> <li>802.1Q VLAN VlanTypeString : 81 00 VlanTciString : PCP(7), DEI(0), VID</li> <li>EtherType Value : AE FE</li> <li>eCPRI Common Header ecpriVersion : 1 ecpriOcocatenation : 0 ecpriMessage : 2 ecpriPayload : 20</li> <li>eCPRI Component eAxC ID (C-Plane) DuPortID : 0 BandSectorID : 0 CcID : 0 CcID : 0 CcID : 0 CcID : 0 E : 1 SubsequenceID : 0 E : 1 SubsequenceID : 0 E : 1 SubsequenceID : 0</li> <li>eC-Plane Common Header DataDirection : 0 PayloadVersion : 1 FilterIndex : 0 Frameld : 0 SlotId : 0 SlotId : 0 SlotId : 2 NumberOfSections : 1 SectionType : 1</li> <li>User Data Compression Header IgBitWidth : 15 Compression : no compression</li> <li>Reserved Value : 0</li> <li>C-Plane Section Type 1 SectionID : 38 RB : 0 SymbolInc : 0 StartPrbc : 19</li> </ul>
NumberPrbc : 1	NumberPrbc : 1 ReMask : 000000010000b NumSymbol : 1 Ef : 0b
Beamld : 0 v	Beamld : 0 ~

Figure 141 Viewing Message Interpretation area for reMasks

μ	Subframe	Slot ID	RB Start	RB Number	Sym Start	Sym Number	Channel	Beam Id	
0									
0	0	0	1		2		SRS	0	
0							SRS		
0							SRS		
0							SRS		
0							SRS		
0							SRS		
0							SRS		
0							SRS		
0							SRS		
0							SRS		
0							SRS		
0							SRS		
	io Allocatio	15			enennenne 1				
	200	is							
	200	IS							
	200	15							
	200	IS							
	240	IS							
	240	is —							
	240	IS .							

Figure 142 Viewing allocations and corresponding mapping

#### Enabling reMask in a MIMO configuration of SRS Channel

REs can be shifted for different antennas in a MIMO SRS configuration for same PRB. This can be checked by comparing reMasks in C-plane message with where the IQ data is placed in the U-plane message.

To view this behavior, perform the following steps:

1 Load an SCP file (for example, *hop\_n\_SRS\_cs.scp*) with a MIMO configuration having two or more antennas and SRS Channel allocation.

-Plane Builder 🔪 Expl	lorer										
Component Carriers		Rad	lio Control F	lane Da	a						
Carrier Numerology		μ	Subframe	Slot ID	RB Start	RB Number	Sym Start	Sym Number	Channel	Beam Id	
Select Carrier:	NR Carrier 1 (UL), Antenn					20			SRS		
	<ul> <li>NR Carrier 1 (UL), Antenna 0 (MIMO)</li> </ul>								SRS		
Attribute					20	20			SRS	0	
Carrier Type	L NR Carrier 1 (UL), Antenna 1 (MIMO)			0		20 20			SRS SRS	0	
Cell ID	NR Carrier 1 (UL), Antenna 2 (MIMO)			0	0	20			SRS	0	
Bandwidth	F S NR Certier 1 (UL) Antenna 3 (MIMO)				20	20			SRS		
Numerology Mode	5 NR Carrier 1 (UL), Antenna 3 (MIMO) Normal				20	20			SRS		
CP Type Allocations	1								SRS		
Philodebolits									SRS		
Flow/eAxC ID	0001								SRS		
									SRS		
Resource Allocations											
Select Allocation:	SRS1 🗸	Radi	o Allocation:	s —							
Attribute	Value										
Name of allocation	SRS1		**								
Numerology	SCS15k		10								
Periodicity			si								
Slot Offset											
Allocated Slots	0,1,2,3,4,5,6,7,8,9										
Start Position											
Number of symbols			•								
Repetition Factor			Q.,								
Beam IDs				_		_		1			
Colore Description			- <b>-</b>								
Select Beamld: 0											



Loading a MIMO SCP file with SRS Channel allocation

- 2 Launch the "C/U Plane Builder Configuration Tool" and perform the following settings, as shown in Figure 144.
  - · Select the "Use reMask" check box
  - Select the "Use Extension Type 10 (MIMO Only)" check box
  - Select the "Create Uplink U-Plane" check box

C-Plane Builder 🛛 🖉 📮	(plorer				
	C/U Plane Builder	Configuration Tool X			
Component Carriers	Flow/eAxC	Network Layer:			
Carrier Numerology	Compression	Maximum transmission unit (MTU) 9000	Sym Number	Channel	Beam Id
Select Carrier:		Disable VLAN Tags     VLAN ID: 0		SRS	
	Numerology			SRS	
Attribute	Beamforming	Set Sequence IDs to '0'		SRS SRS	0 0
Carrier Type Cell ID	Timing	C-Plane Section Handling:		SRS	
Bandwidth		🕑 Use reMask		SRS	
Numerology Mode	Options	Use syminc		SRS	
СР Туре		Use RB Indicator		SRS	0
Allocations		Use Extension Type 6		SRS	0
Flow/eAxC ID		Use Extension Type 10 (MIMO only)		SRS	
		PRACH Type 3 as Type 1 Message		SRS	
Resource Allocations		C-Plane Section Type 0 Messages:		ene.	
		don't generate			
Select Allocation:					
Attribute		U-Plane Package:			
		Create Uplink U-Plane			
Name of allocation Numerology					
Periodicity		Digital Power Scaling (IQ Data):			
Slot Offset		0 FS adjustment (FS_Offset, default 0 is no scaling)			
Allocated Slots		Apply fixed 256QAM scaler			
Start Position		0 Additional IQ power scaling (default 0 dBFS is no scaling)			
Number of symbols Repetition Factor		0 Additional IQ power scaling (default 0 dBFS is no scaling)			
Contract de la contra			_		
Beam IDs					

Figure 144 Setting configuration options for shifting REs

- 3 Exit the "C/U-Plane Builder Configuration Tool" window.
- 4 Export the O-RAN Stimulus file for the configuration changes to take effect.

- 5 In the Explorer tab,
  - a Open the PCAP file (*hop\_n\_SRS\_cs.pcap*) containing C-Plane messages.
  - b Highlight the first C-Plane message in the U-Plane, C-Plane Messages area.

Notice the reMask pattern for the selected PRB, as highlighted in the Message Interpretation area in Figure 145.

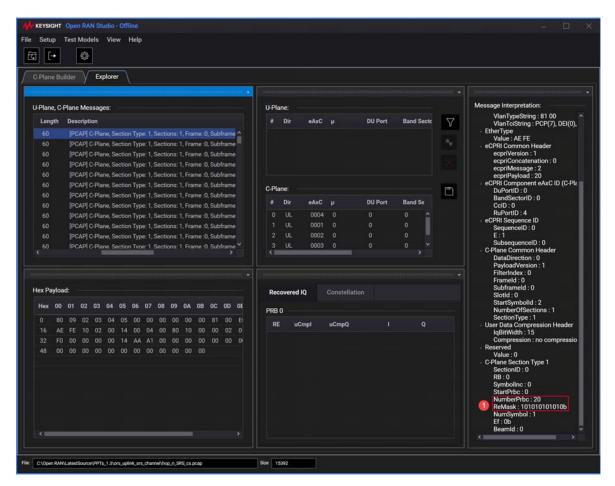


Figure 145 reMask patt

reMask pattern for the selected PRB

c Highlight the second row in the U-Plane, C-Plane Messages area.

Plane Bu	ilder	У	Explo	rer	١.																	
Plane, C-	Plane	Mes	ages:										-	U-Pla	ane:							Message Interpretation:
Length	Desc	riptio	n												Dir	r eAx			DU Port	Band	Secto	VlanTypeString : 81 00 VlanTciString : PCP(7), DEI(
	[PC	AP] C	Plane,	Sect	tion Ty	/pe:	1, Se	tion	s: 1, F	ram	e :0, Su	ofram	e^									EtherType
			Plane,																			Value : AE FE eCPRI Common Header
60	[PC	AP] C	Plane,	Sec	tion Ty	/pe:	1, Se	ction	s: 1, F	ram	e :0, Su	ofram	e									ecpriVersion : 1
	[PC	AP] C	Plane,	Sect	tion Ty	/pe:	1, Se	tior	s: 1, F	ram	e :0, Su	ofram	е									ecpriConcatenation : 0 ecpriMessage : 2
	[PC	AP] C	Plane,	Sec	tion Ty	/pe:	1, Se	tior	s: 1, F	ram	e :0, Su	ofram	e									ecpriPayload : 20
			Plane,											C-Pla	ane:							eCPRI Component eAxC ID (C- DuPortID : 0
			Plane,												Dir		C u		DU Port	Band		BandSectorID : 0
			Plane,																		34	CcID:0 RuPortID:3
			Plane,												U						î	eCPRI Sequence ID
60			Plane,												U U					0 0		SequenceID:0 E:1
			Plane, Plane												U		3 0			0		SubsequenceID : 0
	IPG	API C	Plane.	Sec	tion In	/be:	1. Se	stior	SC 1. F	ram	e o su	ofram		<	0	L 000	3 0	-				C-Plane Common Header DataDirection : 0
ex Payloa Hex 00		02	03 04	i o	5.04	5 1	17 0		19 0		B 00	00	OF.	Rec	cove	rred IQ	Conste	ellation				Payload/version : 1 FilterIndex : 0 Frameld : 0 Subframeld : 0 Slottd : 0 StartSymbolid : 2
														PRB	0							NumberOfSections : 1 SectionType : 1
			03 04		05 0		00 0		00 0		00 81			RE		uCmpl	uCmp	Q				User Data Compression Heade
			02 0		14 0				BO 1			02										IqBitWidth : 15 Compression : no compres
			00 0																			Reserved
						u u																Value : 0 C-Plane Section Type 1 SectionID : 0 Symbolinc : 0 StartPrb: 0 NumberPrbc : 20 NumberPrbc : 20 Numbyrmbol : 1 Ef : 0b Beamid : 0

Notice the shift in the reMask pattern for the same PRB, as highlighted in the Message Interpretation area in Figure 146.

Figure 146 Shift in reMask pattern for the selected PRB

- *d* To view the shift in the Recovered IQ data for the same PRBs, load the PCAP file (*hop\_n\_SRS\_cs\_UL.pcap*) containing U-Plane messages.
- e Highlight the first U-Plane message in the U-Plane, C-Plane Messages area.
- f Highlight PRB0 in the Message Interpretation area to view the corresponding Recovered IQ data, as shown in Figure 147. This data corresponds to the reMask selected in Figure 145.

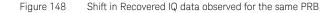
3 [-•	<b>Ø</b>							
C-Plane B	uilder V Explorer							
U-Plane. C	- Plane Messages:	U-Pla	ne:					essage Interpretation:
Length	Description		Dir e	AxC u	DU Port	Band Se	$\nabla$	Value : AE FE
936	[PCAP] U-Plane, Frame :0, Subframe: 0, Slot: 0, Symbol: 2, Section	0	UL (	1004 (?)	0			eCPRI Common Header ecpriVersion : 1
936	[PCAP] U-Plane, Frame :0, Subframe: 0, Slot: 0, Symbol: 2, Section		UL	003 (?)	0	0		ecpriConcatenation : 0 ecpriMessage : 0
936	[PCAP] U-Plane, Frame :0, Subframe: 0, Slot: 0, Symbol: 2, Section:			002 (?)		0		ecpriPayload : 914
936	[PCAP] U-Plane, Frame :0, Subframe: 0, Slot: 0, Symbol: 2, Section:			001 (?)				eCPRI Component eAxC ID (U-PIa
936	[PCAP] U-Plane, Frame :0, Subframe: 0, Slot: 0, Symbol: 3, Section			2010 - 1020	and a second sec			DuPortID : 0 BandSectorID : 0
936	[PCAP] U-Plane, Frame :0, Subframe: 0, Slot: 0, Symbol: 3, Section.	C-Pla					100	CcID:0
	[PCAP] U-Plane, Frame :0, Subframe: 0, Slot: 0, Symbol: 3, Section							RuPortID : 4 eCPRI Sequence ID
936	[PCAP] U-Plane, Frame :0, Subframe: 0, Slot: 0, Symbol: 3, Section:		Dir e	AxC µ	DU Port	Band Secto		SequenceID : 0
	[PCAP] U-Plane, Frame :0, Subframe: 0, Slot: 0, Symbol: 4, Section:							E : 1 SubsequenceID : 0
	[PCAP] U-Plane, Frame :0, Subframe: 0, Slot: 0, Symbol: 4, Section:							U-Plane Common Header
	[PCAP] U-Plane, Frame :0, Subframe: 0, Slot: 0, Symbol: 4, Section							DataDirection : 0
936	IPCAPI U-Plane. Frame :0. Subframe: 0. Slot: 0. Svmbol: 4. Section							PayloadVersion : 1 FilterIndex : 0
								Frameld : 0
								Subframeld : 0
								Slotid : 0
								SlotId : 0 Symbolid : 2
Hex Paylo	v.	Rec	overed IQ	Constellat			-	
Hex Paylo Hex 00				Constellat			Ĵ	Symbolid : 2 U-Plane Section SectionID : 0 RB : 0
Hex O	0 01 02 03 04 05 06 07 08 09 0A 0B 0C 0D	PRB	0				Î	Symbolid : 2 U-Plane Section SectionID : 0
Hex 00	0 01 02 03 04 05 06 07 08 09 0A 08 0C 0D 0 00 00 00 00 00 80 09 02 03 04 05 81 00 🏠		0	Constellat			Î	Symbolid : 2 U-Plane Section SectionID : 0 RB : 0 Symbolinc : 0 StartPrbu : 0 NumberPrbu : 20
Hex 00 0 0 16 A	0 01 02 03 04 05 06 07 08 09 0A 08 0C 0D 0 00 00 00 00 00 80 09 02 03 04 05 81 00 ^ E FE 10 00 03 92 00 04 00 80 10 00 00 02	PRB	0 uCmpl 0	uCmpQ 0	ion 1 0.00	Q 0.00	Î	Symbolid : 2 U-Plans Section Section10: 0 RB: 0 Symbolinc : 0 StartPrbu : 0 NumberPrbu : 20 udCompHdr: 240
Hex 00 0 0 16 A 32 0	0         01         02         03         04         05         06         07         08         09         0A         0B         0C         0D           0         00         00         00         00         80         09         02         03         04         05         81         00           E         FE         10         00         3         92         00         04         05         81         00         00         22           0         14         FO         00         00         00         00         00         07         FE         80         00         00         00	PRB RE 0 1	0 uCmpl 0 4095	uCmpQ 0 0	I 0.00 0.25	0.00 0.00	Î	Symbolid : 2 U-Plane Section Section(D: 0 R8: 0 Symboline: 0 StanPrbu : 0 NumberPrbu : 20 udCompHdr : 240 Reserved : 0 PRB 0
Hex 00 0 0 16 A 32 0 48 0	0         01         02         03         04         05         06         07         08         09         0A         0B         0C         0D           0         00         00         00         00         80         09         02         03         04         05         81         00           E         FE         10         00         392         00         04         08         10         00         00         22           0         14         FO         00         60         00         00         00         07         FF         F8         00         00         00	PRB RE 0 1 2	0 uCmpl 0 4095 0	uCmpQ 0 0 0	I 0.00 0.25 0.00	0.00 0.00 0.00		Symbolid : 2 U-Plane Section SectionID : 0 RB : 0 Symbolinc : 0 StartPrbu : 20 udCompHdr : 240 Reserved : 0 PRB 0 IqSampleBlock : [00, 00, 00,]
Hex 00 0 0 16 A 32 0 48 0 64 7	0         01         02         03         04         05         06         07         08         09         0A         0B         0C         0D           0         00 <td>PRB 0 1 2 3</td> <td>0 uCmpl 0 4095 0 903</td> <td>uCmpQ 0 0 3995</td> <td>I 0.00 0.25 0.00 0.06</td> <td>0.00 0.00 0.00 0.24</td> <td></td> <td>Symbolid : 2 U-Plane Section Section(D: 0 R8: 0 Symboline: 0 StanPrbu : 0 NumberPrbu : 20 udCompHdr : 240 Reserved : 0 PRB 0</td>	PRB 0 1 2 3	0 uCmpl 0 4095 0 903	uCmpQ 0 0 3995	I 0.00 0.25 0.00 0.06	0.00 0.00 0.00 0.24		Symbolid : 2 U-Plane Section Section(D: 0 R8: 0 Symboline: 0 StanPrbu : 0 NumberPrbu : 20 udCompHdr : 240 Reserved : 0 PRB 0
Hex 00 0 0 16 A 32 0 48 0 64 7 80 4	0         0         02         03         04         05         06         07         08         09         0A         0B         0C         0D           0         00	PRB 0 1 2 3 4	0 uCmpl 0 4095 0 903 0	uCmpQ 0 0 3995 0	1 0.00 0.25 0.00 0.06 0.00	0.00 0.00 0.24 0.00		Symbolid : 2 U-Plane Section SectionID : 0 RB : 0 Symbolinc : 0 StartPrbu : 0 NumberPrbu : 20 udCompHdr : 240 Reserved : 0 PRB 0 IqSampleBlock : [00, 00, 00, (IqBitWidth : 15) (Compression : no compressii PRB 1
Hex         00           0         0           16         A           32         0           48         0           64         7           80         4           96         0	0         0         02         03         04         05         06         07         08         09         0A         0B         0C         0D           0         00	PRB 0 1 2 3	0 uCmpl 0 4095 0 903	uCmpQ 0 0 3995 0 2534	1 0.00 0.25 0.00 0.06 0.00 -0.20	0.00 0.00 0.24 0.00 0.15		Symbolid : 2 U-Plane Section SectionID : 0 RB : 0 Symbolinc : 0 StartPrbu : 0 NumberPrbu : 20 udCompHdr : 240 Reserved : 0 PRB 0 IqSampleBlock : (00, 00, 00, (lqBitWidth : 15) (Compression : no compressi PRB 1 IqSampleBlock : (00, 00, 00,
Hex 00 0 0 16 A 32 0 48 0 64 7 80 4 96 0 112 0	0         01         02         03         04         05         06         07         08         09         04         08         0C         0D           a         0	PRB 0 1 2 3 4 5	0 uCmpl 0 4095 0 903 0 -3217	uCmpQ 0 0 3995 0	1 0.00 0.25 0.00 0.06 0.00	0.00 0.00 0.24 0.00	Î	Symbolita : 2 U-Plane Section Section(D: 0 RB: 0 Symbolinc: 0 StartPrbu : 0 NumberPrbu : 20 udCompHdr : 240 Reserved : 0 PRB 0 IqSampleBlock : [00, 00, 00, (IqBitWidth : 15) (Compression : no compressi IqSampleBlock : [00, 00, 00, (IqBitWidth : 15)
Hex         00           0         0           16         A           32         0           48         0           64         7           80         4           96         0           112         0           128         0	0         10         02         03         04         05         66         07         08         09         0A         0B         0C         0D           0         00         00         00         00         00         80         09         02         03         04         05         81         00           6         FE         10         00         03         92         00	PRB 0 1 2 3 4 5 6	0 uCmpl 4095 0 903 0 -3217 0	uCmpQ 0 0 3995 0 2534 0	I 0.00 0.25 0.00 0.06 0.00 -0.20 0.00	0.00 0.00 0.24 0.00 0.15 0.00		Symbolid : 2 U-Plane Section SectionID : 0 RB : 0 Symbolinc : 0 StartPrbu : 0 NumberPrbu : 20 udCompHdr : 240 Reserved : 0 PRB 0 IqSampleBlock : (00, 00, 00, (IqBitWidth : 15) (Compression : no compressi (IqBitWidth : 15) (Compression : no compressi (IqBitWidth : 15) (Compression : no compressi PRB 1
Hex         00           0         0           16         A           32         0           48         0           64         7           80         4           96         0           112         0           128         0           144         0	0         0         02         03         04         05         66         07         08         09         04         08         00 <td>PRB 0 1 2 3 4 5 6 7</td> <td>0 uCmpl 0 4095 0 903 0 -3217 0 -3982</td> <td>uCmpQ 0 0 3995 0 2534 0 -958</td> <td>I 0.00 0.25 0.00 0.06 0.00 -0.20 0.00 -0.24</td> <td>0.00 0.00 0.24 0.00 0.15 0.00 -0.06</td> <td></td> <td>Symbolita : 2 U-Plane Section Section(D: 0 RB: 0 Symbolinc: 0 StartPrbu : 0 NumberPrbu : 20 udCompHdr : 240 Reserved : 0 PRB 0 IqSampleBlock : [00, 00, 00, (IqBitWidth : 15) (Compression : no compressi IqSampleBlock : [00, 00, 00, (IqBitWidth : 15)</td>	PRB 0 1 2 3 4 5 6 7	0 uCmpl 0 4095 0 903 0 -3217 0 -3982	uCmpQ 0 0 3995 0 2534 0 -958	I 0.00 0.25 0.00 0.06 0.00 -0.20 0.00 -0.24	0.00 0.00 0.24 0.00 0.15 0.00 -0.06		Symbolita : 2 U-Plane Section Section(D: 0 RB: 0 Symbolinc: 0 StartPrbu : 0 NumberPrbu : 20 udCompHdr : 240 Reserved : 0 PRB 0 IqSampleBlock : [00, 00, 00, (IqBitWidth : 15) (Compression : no compressi IqSampleBlock : [00, 00, 00, (IqBitWidth : 15)
Hex         00           0         0           16         A           32         0           48         0           64         7           80         4           96         0           112         0           128         0           144         0	0         01         02         03         04         05         06         07         08         09         0A         0B         0C         0D           0         00         00         00         00         00         80         09         02         03         04         05         81         00         7           FE         10         00         03         92         00         04         08         80         10         00	PRB 0 1 2 3 4 5 6 7 8	0 uCmpl 0 4095 0 903 0 -3217 0 -3982 0	uCmpQ 0 0 3995 0 2534 0 -958 0	1 0.00 0.25 0.00 0.06 0.00 -0.20 0.00 -0.24 0.00	0.00 0.00 0.24 0.00 0.15 0.00 -0.06 0.00		Symbolita : 2 U-Plane Section SectionID : 0 RB : 0 Symbolinc : 0 StartPrbu : 0 NumberPrbu : 20 udCompHdr : 240 Reserved : 0 PRB 0 IqSampleBlock : [00, 00, 00, (IqBitWidth : 15) (Compression : no compressi PRB 1 IqSampleBlock : [00, 00, 00, (IqBitWidth : 15) (Compression : no compressi PRB 2 IqSampleBlock : [00, 00, 00,

Figure 147 Re

Recovered IQ data for the selected PRB

- g Highlight the second row in the U-Plane, C-Plane Messages area.
- *h* Highlight PRB0 in the Message Interpretation area to view the corresponding Recovered IQ data, as shown in Figure 147. This data corresponds to the reMask selected in Figure 145.

[• 🗇					
Plane Builder V Explorer					
Plane, C-Plane Messages:	U-Plane:				Message Interpretation:
				1000	Value AF FF
Length Description	# Dir eAx			Band Se	Value: AE PE
936 [PCAP] U-Plane, Frame :0, Subframe: 0, Slot: 0, Symbol: 2, Section: ^	0 UL 00			o î	ecpriVersion : 1 ecpriConcatenation : 0
936 [PCAP] U-Plane, Frame :0, Subframe: 0, Slot: 0, Symbol: 2, Section	1 UL 00			0	ecpriMessage : 0
936 [PCAP] U-Plane, Frame :0, Subframe: 0, Slot: 0, Symbol: 2, Section	2 UL 00				ecpriPayload : 914 eCPRI Component eAxC ID (U-P
936 [PCAP] U-Plane, Frame :0, Subframe: 0, Slot: 0, Symbol: 2, Section.	3 UL 00	01 (?)			DuPortID : 0
936 [PCAP] U-Plane, Frame :0, Subframe: 0, Slot: 0, Symbol: 3, Section:					BandSectorID:0 CcID:0
936 [PCAP] U-Plane, Frame :0, Subframe: 0, Slot: 0, Symbol: 3, Section.	C-Plane:				RuPortID: 3
936 [PCAP] U-Plane, Frame :0, Subframe: 0, Slot: 0, Symbol: 3, Section.	# Dir eAx	Сµ	DU Port I	Band Secto	eCPRI Sequence ID
936 [PCAP] U-Plane, Frame :0, Subframe: 0, Slot: 0, Symbol: 3, Section:					SequenceID : 0 E : 1
936 [PCAP] U-Plane, Frame :0, Subframe: 0, Slot: 0, Symbol: 4, Section: 936 [PCAP] U-Plane, Frame :0, Subframe: 0, Slot: 0, Symbol: 4, Section:					SubsequenceID : 0
					<ul> <li>U-Plane Common Header</li> <li>DataDirection : 0</li> </ul>
936 [PCAP] U-Plane, Frame :0, Subframe: 0, Slot: 0, Symbol: 4, Section. 936 [PCAP] U-Plane, Frame: 0, Subframe: 0, Slot: 0, Symbol: 4, Section: *					PayloadVersion : 1
930 IPCAPI C+hane. Prame U. Subtrame U. Siot: U. Symbol: 4. Section.					FilterIndex : 0
					Frameld : 0 Subframeld : 0
					- SlotId:0
					Symbolid : 2
*					<ul> <li>U-Plane Section</li> </ul>
ex Payload:	Recovered IQ	Constellation			SectionID : 0
ex Payload: Hex 00 01 02 03 04 05 06 07 08 09 0A 0B 0C 0D	Recovered IQ PRB 0	Constellation			
	PRB 0				SectionID : 0 RB : 0 Symbolinc : 0 StartPrbu : 0
Hex 00 01 02 03 04 05 06 07 08 09 0A 08 0C 0D	PRB 0 RE uCmpl	uCmpQ	1	q	SectionID: 0 RB: 0 Symbolinc: 0 StartPrbu: 0 NumberPrbu: 20
Hex         00         01         02         03         04         05         06         07         08         09         0A         0B         0C         0D           0         00 </td <td>PRB 0 RE uCmpl 0 4095</td> <td>uCmpQ 0</td> <td>0.25</td> <td>0.00</td> <td>Section10 : 0 RB : 0 Symbolinc : 0 StartPhu : 0 NumberPhu : 20 udCompHd: : 240 Reserved : 0</td>	PRB 0 RE uCmpl 0 4095	uCmpQ 0	0.25	0.00	Section10 : 0 RB : 0 Symbolinc : 0 StartPhu : 0 NumberPhu : 20 udCompHd: : 240 Reserved : 0
Hex         00         01         02         03         04         05         06         07         08         09         0A         0B         0C         0D           0         00 </td <td>PRB 0 RE uCmpl 0 4095 1 0</td> <td>uCmpQ 0 0</td> <td>0.25 0.00</td> <td>0.00 0.00</td> <td>SectionID:0 R8:0 Symbolinc:0 StartPrbu:0 NumberPrbu:20 udCompHdr:240 Reserved:0 2 PR80</td>	PRB 0 RE uCmpl 0 4095 1 0	uCmpQ 0 0	0.25 0.00	0.00 0.00	SectionID:0 R8:0 Symbolinc:0 StartPrbu:0 NumberPrbu:20 udCompHdr:240 Reserved:0 2 PR80
Hex         00         01         02         03         04         05         06         07         08         09         0A         0B         0C         0D           0         00 </td <td>PRB 0 RE uCmpl 0 4095 1 0 2 3995</td> <td>uCmpQ 0 0 -903</td> <td>0.25 0.00 0.24</td> <td>0.00 0.00 -0.06</td> <td>Section10 : 0 RB : 0 Symbolinc : 0 StartPhu : 0 NumberPhu : 20 udCompHd: : 240 Reserved : 0</td>	PRB 0 RE uCmpl 0 4095 1 0 2 3995	uCmpQ 0 0 -903	0.25 0.00 0.24	0.00 0.00 -0.06	Section10 : 0 RB : 0 Symbolinc : 0 StartPhu : 0 NumberPhu : 20 udCompHd: : 240 Reserved : 0
Hex         00         01         02         03         04         05         06         07         08         09         0A         0B         0C         0D           0         00 </td <td>PRB 0 RE uCmpl 0 4095 1 0 2 3995</td> <td>uCmpQ 0 0</td> <td>0.25 0.00</td> <td>0.00 0.00</td> <td>SectionID: 0 RB: 0 Symboline: 0 StartPrbu: 0 NumberPrbu: 20 udCompitd: 240 Reserved: 0 PBB0 IqSampleBlock: [1f, fe, 00, (lqBitWidth: 15) (Compression: no compress</td>	PRB 0 RE uCmpl 0 4095 1 0 2 3995	uCmpQ 0 0	0.25 0.00	0.00 0.00	SectionID: 0 RB: 0 Symboline: 0 StartPrbu: 0 NumberPrbu: 20 udCompitd: 240 Reserved: 0 PBB0 IqSampleBlock: [1f, fe, 00, (lqBitWidth: 15) (Compression: no compress
Hex         00         01         02         03         04         05         06         07         08         09         0A         0B         0C         0D           0         00 </td <td>RE         uCmpl           0         4095           1         0           2         3995           3         0</td> <td>uCmpQ 0 -903 0</td> <td>0.25 0.00 0.24 0.00</td> <td>0.00 0.00 -0.06 0.00</td> <td>SectionID:0 R8:0 Symbolinc:0 StartPrbu:0 NumberPrbu:20 udCompHdr:240 Reserved:0 PRB0 IqSampleBlock:[1f, fe, 00, (ugBtrWith:15) (Compression: no compress PRB1</td>	RE         uCmpl           0         4095           1         0           2         3995           3         0	uCmpQ 0 -903 0	0.25 0.00 0.24 0.00	0.00 0.00 -0.06 0.00	SectionID:0 R8:0 Symbolinc:0 StartPrbu:0 NumberPrbu:20 udCompHdr:240 Reserved:0 PRB0 IqSampleBlock:[1f, fe, 00, (ugBtrWith:15) (Compression: no compress PRB1
Hex         00         01         02         03         04         05         06         07         08         09         0A         0B         0C         0D           0         00         00         00         00         00         09         02         03         04         05         81         00           16         AE         FE         10         00         03         92         00         30         80         10         00         00         23           20         14         FO         00         17         16         86         00         17         0C         1C           48         00         00         00         19         23         18         68         00         00         00         00         77         0C         1C           64         00         00         00	PRB 0           RE         uCmpl           0         4095           1         0           2         3995           3         0           4         3217	uCmpQ 0 -903 0 -2534	0.25 0.00 0.24 0.00 0.20	0.00 0.00 -0.06 0.00 -0.15	SectionID:0 RB:0 Symbolinc:0 StartPrbu:20 udCompHdr:240 Reserved:0 PBB0 IqSampleBlock:[1f,fe,00, (q8irtWidth:15) (Compression:no.compress PRB 1 IqSampleBlock:[fe, ac, 3f, (q8irtWidth:15)
Hex         00         01         02         03         04         05         06         07         08         09         0A         05         0         0           0         00 <td>RE         uCmpl           0         4095           1         0           2         3995           3         0           4         3217           5         0</td> <td>uCmpQ 0 -903 0 -2534 0</td> <td>0.25 0.00 0.24 0.00 0.20 0.20 0.00</td> <td>0.00 0.00 -0.06 0.00 -0.15 0.00</td> <td>SectionID : 0 RB : 0 Symbolinc : 0 StartPrbu : 0 NumberPrbu : 20 udCompHdr : 240 Reserved : 0 PRB 0 IqSampleBlock : [1f, fe, 00, (qBtWidth : 15) (Compression : no compress PRB 1 IqSampleBlock : [fe, ac, 3f, (qBtWidth : 15) (Compression : no compress</td>	RE         uCmpl           0         4095           1         0           2         3995           3         0           4         3217           5         0	uCmpQ 0 -903 0 -2534 0	0.25 0.00 0.24 0.00 0.20 0.20 0.00	0.00 0.00 -0.06 0.00 -0.15 0.00	SectionID : 0 RB : 0 Symbolinc : 0 StartPrbu : 0 NumberPrbu : 20 udCompHdr : 240 Reserved : 0 PRB 0 IqSampleBlock : [1f, fe, 00, (qBtWidth : 15) (Compression : no compress PRB 1 IqSampleBlock : [fe, ac, 3f, (qBtWidth : 15) (Compression : no compress
Hex         00         01         02         03         04         05         06         07         08         09         0A         0B         0C         0D           0         00 </td <td>RE         uCmpl           0         4095           1         0           2         3995           3         0           4         3217           5         0           6         958</td> <td>uCmpQ 0 -903 0 -2534 0 -3982 0 -3252</td> <td>0.25 0.00 0.24 0.00 0.20 0.00 0.00 0.06</td> <td>0.00 0.00 -0.06 0.00 -0.15 0.00 -0.24</td> <td>SectionID:0 RB:0 Symbolinc:0 StartPrbu:20 udCompHdr:240 Reserved:0 PBB0 IqSampleBlock:[1f,fe,00, (q8irtWidth:15) (Compression:no.compress PRB 1 IqSampleBlock:[fe, ac, 3f, (q8irtWidth:15)</td>	RE         uCmpl           0         4095           1         0           2         3995           3         0           4         3217           5         0           6         958	uCmpQ 0 -903 0 -2534 0 -3982 0 -3252	0.25 0.00 0.24 0.00 0.20 0.00 0.00 0.06	0.00 0.00 -0.06 0.00 -0.15 0.00 -0.24	SectionID:0 RB:0 Symbolinc:0 StartPrbu:20 udCompHdr:240 Reserved:0 PBB0 IqSampleBlock:[1f,fe,00, (q8irtWidth:15) (Compression:no.compress PRB 1 IqSampleBlock:[fe, ac, 3f, (q8irtWidth:15)
Hex         00         01         02         03         04         05         06         07         08         09         0A         0B         0C         0D           0         00 </td <td>RE         uCmpl           0         4095           1         0           2         3995           3         0           4         3217           5         0           6         958           7         0           8         -2489           9         0</td> <td>uCmpQ 0 -903 0 -2534 0 -3982 0 -3252 0</td> <td>0.25 0.00 0.24 0.00 0.20 0.00 0.00 0.06 0.00 -0.15 0.00</td> <td>0.00 0.00 -0.06 0.00 -0.15 0.00 -0.24 0.00 -0.20 0.00</td> <td>SectionID: 0 RB: 0 Symbolinc: 0 StartPrbu: 20 udCompHd: :240 Reserved: 0 PBB 0 IqSampleBlock: [1f, fe, 00, (lqBitWidth : 15) (Compression : no compress PRB 1 IqSampleBlock: [fe, ac, 3f, (lqBitWidth : 15) (Compression : no compress PRB 2 IqSampleBlock: [fe, ac, 3f, (lqBitWidth : 15)</td>	RE         uCmpl           0         4095           1         0           2         3995           3         0           4         3217           5         0           6         958           7         0           8         -2489           9         0	uCmpQ 0 -903 0 -2534 0 -3982 0 -3252 0	0.25 0.00 0.24 0.00 0.20 0.00 0.00 0.06 0.00 -0.15 0.00	0.00 0.00 -0.06 0.00 -0.15 0.00 -0.24 0.00 -0.20 0.00	SectionID: 0 RB: 0 Symbolinc: 0 StartPrbu: 20 udCompHd: :240 Reserved: 0 PBB 0 IqSampleBlock: [1f, fe, 00, (lqBitWidth : 15) (Compression : no compress PRB 1 IqSampleBlock: [fe, ac, 3f, (lqBitWidth : 15) (Compression : no compress PRB 2 IqSampleBlock: [fe, ac, 3f, (lqBitWidth : 15)
Hex         00         01         02         03         04         05         06         07         08         09         0A         05         0C         0D           0         00         00         00         00         00         00         80         09         02         03         04         05         81         00           16         AE         FE         10         00         392         00         03         00         00         00         00         02         03         04         05         81         00           32         00         14         F0         00         17         FE         00 <td>RE         uCmpl           0         4095           1         0           2         3995           3         0           4         3217           5         0           6         958           7         0           8         -2489</td> <td>uCmpQ 0 -903 0 -2534 0 -3982 0 -3252</td> <td>0.25 0.00 0.24 0.00 0.20 0.00 0.00 0.06 0.00 -0.15</td> <td>0.00 0.00 -0.06 0.00 -0.15 0.00 -0.24 0.00 -0.20</td> <td>SectionID : 0 RB : 0 Symbolinc : 0 StartPrbu : 0 NumberPrbu : 20 udCompHdr : 240 Reserved : 0 PRB 0 IqSampleBlock : [1f, fe, 00, (lqBitWidth : 15) (Compression : no compress PRB 1 IqSampleBlock : [6e, ac, 3f, (lqBitWidth : 15) (Compression : no compress PRB 2 IqSampleBlock : [02, 38, 3f,</td>	RE         uCmpl           0         4095           1         0           2         3995           3         0           4         3217           5         0           6         958           7         0           8         -2489	uCmpQ 0 -903 0 -2534 0 -3982 0 -3252	0.25 0.00 0.24 0.00 0.20 0.00 0.00 0.06 0.00 -0.15	0.00 0.00 -0.06 0.00 -0.15 0.00 -0.24 0.00 -0.20	SectionID : 0 RB : 0 Symbolinc : 0 StartPrbu : 0 NumberPrbu : 20 udCompHdr : 240 Reserved : 0 PRB 0 IqSampleBlock : [1f, fe, 00, (lqBitWidth : 15) (Compression : no compress PRB 1 IqSampleBlock : [6e, ac, 3f, (lqBitWidth : 15) (Compression : no compress PRB 2 IqSampleBlock : [02, 38, 3f,



3.4.3: Applying reMask for PUSCH Channel

### NOTE

#### Transform Precoding in UL-SCH format of Uplink carrier is currently not supported.

Applying the reMask configuration option causes a recalculation of the sections displayed in the C-Plan Builder tab of the Open RAN Studio software.

This section shows the appearance of Radio Allocations in the Open RAN Studio Software and the appearance of RB Resource Mapping for UL-SCH1, caused by enabling reMask (see Using reMask only on page 352) for PUSCH Channel, which has DM-RS setting inside PUSCH, DM-RS setting outside PUSCH and DM-RS setting with additional position.

#### Scenario 1: reMask enabled with DM-RS setting inside PUSCH

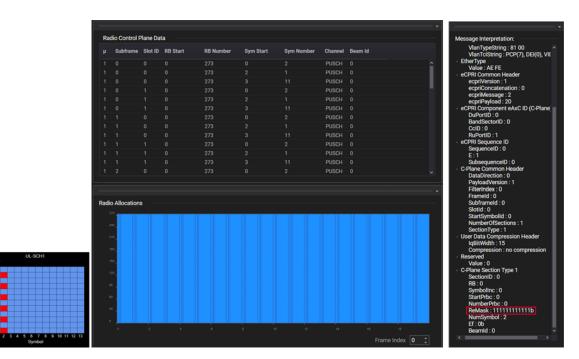
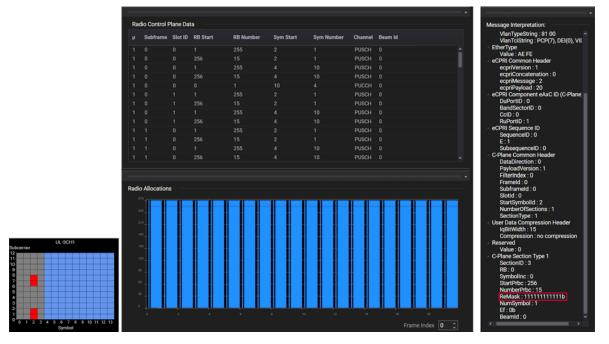


Figure 149

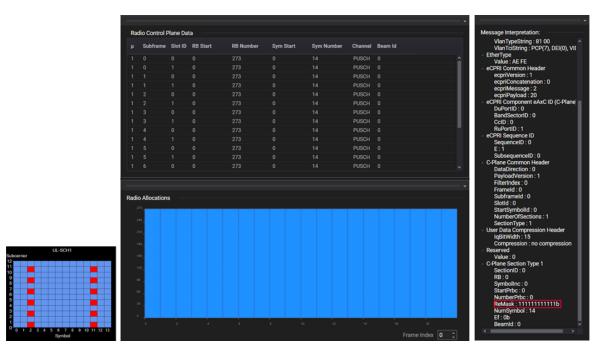
Radio allocations for DM-RS inside PUSCH with reMask enabled



Scenario 2: reMask enabled with DM-RS setting outside PUSCH, where DM-RS is 2 REs high

Figure 150

Radio allocations for DM-RS outside PUSCH with reMask enabled



#### Scenario 3: reMask enabled with DM-RS setting with additional position

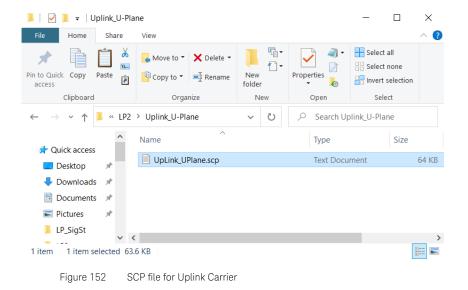
Figure 151 Radio allocations for DM-RS with additional position and reMask enabled

3.4.4: Creating U-Plane messages in Uplink Carrier

By default, the uplink carrier contains only C-Plane messages. However, certain operations, such as extracting IQ flow is not possible without U-Plane messages in the carrier.

The "Create Uplink U-Plane" option in Configuration Tool of the Open RAN Studio software lets you create separate files for Uplink U-Plane messages.

1 Save a PathWave Signal Generation Desktop / Signal Studio project for the Uplink carrier with the Channel setup for UCI/UL-SCH/SRS formats.



# NOTE

### IQ recovery of Mixed Numerology in UL carrier is currently not supported.

2 In the Open RAN Studio software, open the .scp file for the uplink carrier.

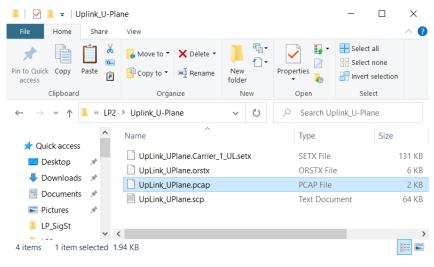
-Plane Builder 🚶 🗈											
Component Carriers			tadio Control F	Plane Da	ta						
Carrier Numerology		î i	Subframe	Slot ID	RB Start	RB Number	Sym Start	Sym Number	Channel	Beam Id	
Select Carrier:	Carrier 1 (UL)					273		14	PUSCH		
									PUCCH		
Attribute	Value	1				273		14	PUSCH		
Carrier Type	UL (NR)								PUCCH		
Cell ID		1						14	PUSCH		
Bandwidth	FR1_100M	1									
Numerology Mode	SingleNumerology					273		14	PUSCH		
CP Type	Normal	1									
Allocations								14	PUSCH		
	0001										
Flow/eAxC ID	~								PUSCH PUCCH		
Resource Allocations		-									
Select Allocation:	ucn y	Ra	dio Allocation	s							
Attribute	Value		340								
Name of allocation	UCI1		210								
Numerology	SCS30k		105								
Allocated Slots	2,4,6,8,10,12,14,16,18		150								
First Symbol			ALC: NOT								
Last Symbol			100						-		
RB Offset			40								
RB Number									-		
			- 20							-	
Beam IDs			-								

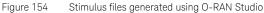
Figure 153 SCP file for Uplink Carrier opened in O-RAN Studio

3 Select the Flow/eXAC ID.

4 Export the O-RAN Stimulus file to generate the corresponding PCAP file. See Exporting O-RAN Stimulus File on page 122 for more information.

The folder that contained the SCP file now contains the additional files, including the PCAP file.





			Luni-					1	Message Interpretation:
-Plane Messages:	6	Destination	U-Plane:	10.0		DUIDert	Road Contas		measage interpretation.
			# UIP	eAxC	μ	DU Port	band Sector	Y	
		그 잘 가슴 밖에 가슴 밖에 가슴 옷에 다 들었다.							
		그는 사람이 가지 않는 것이 없는 것이 없는 것이 없다.							
								12200	
00:00:00.012995000			C-Plane:					-	
00:00:00.013495000	00 00 00 00 00 00	80 09 02 03 04	No. of Concession, Name			DUDert	Barri Carrier		
00:00:00.013995000	60 00 00 66 00 00	80 09 02 03 04							
00:00:00.014495000	00 00 00 00 00 00	80 09 02 03 04	0 UL						
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00

5 Switch to Explorer tab and load the stimulus file.

Figure 155 Viewing the Uplink PCAP file contents in Explorer tab

Notice that the UL stimulus file consists of C-Plane messages only but not U-Plane message.

- 6 Launch the "C/U-Plane Builder Configuration Tool" window in the Open RAN Studio software.
- 7 Click the "Options" tab.
- 8 In the 'U-Plane Package' area, select the check box for 'Create Uplink U-Plane'.

🙌 кеүзіднт Оре	n RAN Studio - Offline							X
File Setup Test	Models View Help							
63 [→	Ø							
/ C-Plane Builder	Explorer							
100010000000000000000000000000000000000								
U-Plane, C-Plan	e Messages:		U-Plane:					Message Interpretation: —
# Time	Source Destin:	ation	# Dir eAxC	μ	DU Port	Band Sector	Y	
C/U Plane Builder	Configuration Tool							
Flow/eAxC	Network Layer:							
FIOW/EAXC	Maximum transmission unit (MTU)	9000						
Compression								
Numerology	Disable VLAN Tags	VLAN ID: 0						
Beamforming	Set Sequence IDs to '0'				DU Port	Band Sector		
beamforming	C-Plane Section Handling:			1				
Timing	Use reMask							
Options	Use syminc							
	Use RB indicator							
	Use Extension Type 6							
	Use Extension Type 10 (MIMO only)							
	PRACH Type 3 as Type 1 Message			onstellati	on			
	C-Plane Section Type 0 Messages:							
	don't generate			CmpQ				
	U-Plane Package:							
	Create Uplink U-Plane							
	Digital Power Scaling (IQ Data):							
	0 FS adjustment (FS_Offs	et. default 0 is no	scalino)					
	Apply fixed 256QAM scaler							
	0 Additional IQ power scal	ling (default 0 dBF	FS is no scaling)					
			Press Process					
File: C:\Open RAN\SCP\:	SS scp files\LP2\Uplink_U Plane\UpLink_UPlane.pcap		Size: 1996					

Figure 156 Selecting option to create PCAP file with Uplink U-Plane messages

9 Exit the "C/U-Plane Builder Configuration Tool" window.

10 Export the O-RAN Stimulus file again for the configuration changes to take effect. See Exporting O-RAN Stimulus File on page 122 for more information.

The folder that contained the SCP file now contains an additional PCAP file, which has '\_UL' suffixed to the file name. This PCAP file consists of only U-plane UL messages and can be used for operations similar to that for a DL PCAP.

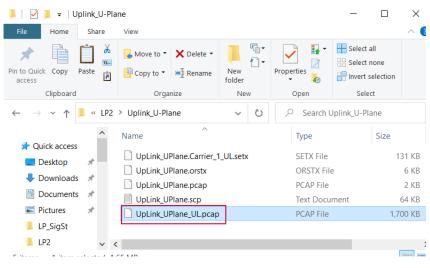


Figure 157 PCAP file with '\_UL' suffix

🖳 Open					×
$\leftarrow \rightarrow \checkmark \uparrow$ 📕 « SS so	cp files > LP2 > Uplink_U-Plane	~ Ü		Jplink_U-Plane	
Organize 🔹 New folder				· · ·	?
Desktop ^	Name	Date r	modified	Туре	
Documents	UpLink_UPlane.pcap	1/17/2	2021 12:34 PM	PCAP File	
Downloads	UpLink_UPlane_UL.pcap	1/17/2	2021 12:34 PM	PCAP File	
Music					
Network_Hari					
Network-Others					
Pictures					
Videos					
🐛 OSDisk (C:) 🗸 🗸					>
File name	: UpLink_UPlane_UL.pcap	~	PCAP Files (*.	ocap)	~
			Open	Cancel	

11 In the Explorer tab, open the new stimulus file (which has the '\_UL' suffixed by O-RAN Studio software).

Figure 158 Opening the PCAP file with Uplink U-Plane messages

The U-Plane UL PCAP file contents are visible in the Explorer tab and it does not contain any C-Plane messages. You may treat this file as you would process a DL PCAP file, especially for IQ extraction.

Plane,	C-Plane Messages:			U-Plane	e:					Message Interpretation:
	Time	Source	Destination	# 0	Dir eAxC		DU Port	Band Sector	$\nabla$	
	00:00:00.010502000	80 09 02 03 04 05	00 00 00 00 00 🛕	0	UL 0001					
	00:00:00.010502000	80 09 02 03 04 05	00 00 00 00 00						Ĩ	
	00:00:00.010537714	80 09 02 03 04 05	00 00 00 00 00						1.00	
	00:00:00.010537714	80 09 02 03 04 05	00 00 00 00 00	۲.						
	00:00:00.010573429	80 09 02 03 04 05	00 00 00 00 00	-						
5 -	00:00:00.010573429	80 09 02 03 04 05	00 00 00 00 00	C-Plane	s:					
7	00:00:00.010609143	80 09 02 03 04 05		# C	Dir eAxC		DU Port	Band Sector		
1 )	00:00:00.010609143	80 09 02 03 04 05 80 09 02 03 04 05	00 00 00 00 00 00							
, 10	00:00:00:010644857	80 09 02 03 04 05	00 00 00 00 00							
	00:00:00.010680571		00 00 00 00 00 .							
x Payl	oad:				vered IQ	Constellatic	n			
				PRB: (n	ione selected)					
				RE	uCmpl	uCmpQ				

Figure 159 Viewing the PCAP file contents with Uplink U-Plane messages

## Section 3.5: Emulating the PRACH Carrier

The Open RAN Studio supports PRACH sequences in both 5G NR and LTE-TDD / LTE-FDD signals and allows you to:

- Generate PCAP files for PRACH C-plane
- Generate PCAP files for PRACH U-plane (currently for 5G NR signals only)
- View the PCAP files for PRACH in the Explorer tab
- Recover IQ data in frequency and time domains (currently for 5G NR signals only)

You may also add PRACH bursts to an LTE signal. See Configuring LTE signals with PRACH bursts on page 236 for more information.

Let us understand the format of the PRACH sequence for 5G NR signals, which is generated using the PathWave Signal Generation Desktop 2022.

🚸 PATHWAVE 🗀 File		PathWave Sigr		? – 🗆 X					
A Home 5G NR ×									
🖒 Generate 🛓 Generate	& Download	Carrier W	aveform Hardware					+ Import Signal Setup	[+ Export Signal Setup
JL PRACH Test Preambles Con	ifig 🛛 🗢 Auto Frequency Offset	[+ Export 89600 V	SA Setup						
+ - 0		CH Time-domain R	esource						
<ul> <li>Carrier 0 (PRACH)</li> </ul>		figuration Table				FR1 - Unpaired S	Spectrum 🗸		
✓ Channel Setup		figuration Index CH Format				79			
PRACH Burst		cH Format ne Period							
Proyun ourst		ne Offset							
		Index							
	Nur	ber of PRACH slots	within a subframe						
	Nun	ber of time-domain l	PRACH occasions within	a PRACH slot					
	PRA	CH duration							
	Sym	bol Start							
		CH Frequency-dom							
		carrier Spacing for Pf	RACH			15 kHz 🗡			
		ve Uplink BWP							
		lumerology B Offset (N_BWP_st				0 = 1:30 kHz M			
		B Number (N_BWP_) 1 Frequency Start (n				273 0			
		1 FDM	Jocumity			1 2			
		CH Sequence Gene	ration			1.~			
		CH Root Sequence In				0			
						11			
	LR					139 ~			
	N_C	s							
Channel Allocation									Frame 0 V µ = 1 V
Frequency (MHz)									PRACH
60									
40									
20									
0									
-20									
-40									
-60	1 2		4	5	0	7	8	9 10 Ms	
Sep 29, 2021, 4:57:03 PM	PC License Not conne	cted	Carrier 0, Frame 0	Resource allocation	of SRS1 is conflict wit	th other channels.			Ċ

Figure 160 Setting up PRACH Channel in PathWave Signal Generation Desktop 2022

As seen in Figure 160, PRACH carrier consists of a single PRACH channel. PRACH channel can have multiple bursts (of same preamble format) spread in time and frequency domains. The image above shows a single burst only but you can add more bursts to the PRACH Channel.

### 3.5.1: Generating & viewing PCAP files for PRACH

1 Load the SCP file that contains the PRACH sequence into the O-RAN Studio software.

component Carriers			adio Control I	21000 Do	•						
Select Carrier:	Carrier 1 (FRACH)	μ	Subframe			RB Number	Sym Start	Sym Number	Channel	Beam Id	
Attribute	Value								PRACH		
Carrier Type	PRACH (NR)										
Cell ID	1										
Bandwidth	FR1_100M										
Numerology Mode	SingleNumerology										
CP Type	Normal										
Allocations	1										
Flow/eAxC ID	0001 ~										
Resource Allocations											
Select Allocation:	Prach Burst(0)										
Attribute	Value										
Name of allocation	Prach Burst(0)	Rad	lio Allocation	s —							
Numerology	SCS15k		175								
Modulation	PRACH										
Config Table	FR1_UnpairedSpectrum		240								
Config Index	79		210								
Format	FormatA1		185								
Symbol Start	0										
n DA start	g										
n_RA_start Subframe/slot idx	1		170								
n_RA_start Subframe/slot idx n_RA_t	10.10										
Subframe/slot idx	0										
Subframe/slot idx n_RA_t	0 0										
Subframe/slot idx n_RA_t n_RA_slot			-								

Figure 161 Loading SCP file with the PRACH sequence

- 2 Assign a 'Flow/eAxC ID'.
- 3 Note down the details that are highlighted in Figure 161, which are required for configuration settings.
- 4 Export the O-RAN Stimulus file to generate the corresponding PCAP file. See Exporting O-RAN Stimulus File on page 122 for more information.

		der	уе	xplore	a. /	<u>.</u>																
Plan	e, C-F	Nane I	/essa	qes:										U	-Plane:							Message Interpretation:
Lengt	th I	Descri	tion												# Dir	eAx	Cμ		DU Port	Ban	$\nabla$	<ul> <li>eCPRI Component eAxC ID (C-Plane)</li> <li>DuPortID : 0</li> </ul>
		PCAF					3, Sect			ie :0, S												BandSectorID: 0 CcID: 0
																						RuPortID : 1 • eCPRI Sequence ID SequenceID : 0
																						E : 1 SubsequenceID : 0
														c	-Plane:						Ľ	<ul> <li>C-Plane Common Header DataDirection : 0 PayloadVersion : 1</li> </ul>
															# Dir	eAa	¢μ		DU Port	Ban		FilterIndex : 3 FrameId : 0
															0 PR	ACH OD	0 0					Subframeld : 9 Slotid : 0 StartSymbolid : 2 NumberOfSections : 1
					_	_		_11							(	_	_	-				SectionType : 3 Frame Timing TimeOffset : 4688 (time_offset : 0.0001526041666666667) FrameStructure : 208
y Da	yloa	•																				(fft_size : 1536) (scs_delta_f : 15 kHz) (N_slot_subframe : 1)
			2 01	04	05	06	07 0	8 09	0.0	AB.	00	00 0	OF (		Recover	ed IQ		stellatio				(slot_length : 1000 µs)
0								00 00		00		00		P		e selecte	ed)					CpLength : 0 (CP_length : 0)
		FE				00		00 80		00		02			RE	uCmpl	uC	mpQ				<ul> <li>User Data Compression Header</li> <li>IqBitWidth : 15</li> </ul>
								00 00														Compression : no compression C-Plane Section Type 3
	68	00	10 0	00 0	00	00	00 0	00 00	00	.00												SectionID:0 RB:0
																						Symbolinc : 0 StartPrbc : 0
																						NumberPrbc:12 ReMask:111111111111b
																						NumSymbol : 2 Ef : 0b
																						Beamld : 0
																						<ul> <li>Frequency Offset</li> </ul>
48																						FreqOffset : -6552 (frequency_offset : -49140000)

5 Load the stimulus / recording PCAP file into O-RAN Studio.

Figure 162 Loading PCAP file with the PRACH sequence

Open RAN standard uses C-plane Section Type 3 for PRACH. As seen in Figure 162, the U5040A Open RAN Studio software currently supports a single C-plane message for each PRACH burst. Each PRACH sequence repetition is considered as a separate symbol. PRBs are numbered from '0' for each burst.

# 3.5.2: Viewing PRACH Type 3 as Type 1 messages

- 1 Load the stimulus / recording PCAP file into O-RAN Studio that contains Section Type 3 C-Plane messages for the PRACH carrier. See Figure 162.
- 2 Launch the "C/U Plane Builder Configuration Tool" window.
- 3 In the 'Options' tab, select the "PRACH Type 3 as Type 1 Message" check box in the 'C-Plane Section handling' area.

Plane Builder V Explorer	C/U Plane Builde	Configuration Tool		
	Flow/eAxC	Network Layer:		······································
I-Plane, C-Plane Messages:	Compression	Maximum transmission unit (MTU) 9000		Message Interpretation: eCPRI Component eAxC ID (C-Plane)
Length Description 60 [PCAP] C-Plane, Secti		Disable VLAN Tags VLAN ID: 0	$\nabla$	DuPortID : 0 BandSectorID : 0
ou (Power ornane, secu	Numerology	Set Sequence IDs to '0'		CcID : 0 RuPortID : 1
	Beamforming			eCPRI Sequence ID SequenceID : 0
	Timing	C-Plane Section Handling:		E:1
	Options	Use reMask	195	SubsequenceID : 0 C-Plane Common Header
		Use symlnc		DataDirection : 0 PayloadVersion : 1
		Use Extension Type 6		FilterIndex : 3 Frameld : 0
		Use Extension Type 10 (MIMO only)		Subframeld : 9 Slotid : 0
		PRACH Type 3 as Type 1 Message		StartSymbolid : 2
		C-Plane Section Type 0 Messages:		NumberOfSections : 1 SectionType : 3
c		don't generate 🗸 🗸		<ul> <li>Frame Timing TimeOffset : 4688</li> </ul>
				(time_offset : 0.000152604166666667) FrameStructure : 208
		U-Plane Package:		(fft_size : 1536) (scs_delta_f : 15 kHz)
ex Payload:		Create Uplink U-Plane		(N_slot_subframe : 1) (slot_length : 1000 µs)
Hex 00 01 02 03 04 0		Digital Power Scaling (IQ Data):		CpLength : 0
0 80 09 02 03 04		0 FS adjustment (FS_Offset, default 0 is no scaling)	Q	(CP_length : 0) User Data Compression Header
16 AE FE 10 02 00 32 12 50 D0 00 00		Apply fixed 256QAM scaler		IqBitWidth : 15 Compression : no compression
48 68 00 00 00 00				C-Plane Section Type 3 SectionID : 0
		0 Additional IQ power scaling (default 0 dBFS is no scaling)		RB : 0 Symbolinc : 0
				StartPrbc: 0 NumberPrbc: 12 ReMask: 111111111b NumSymbol: 2 E1: 0b Beamld: 0 Frequency Offset FreqOffset: -6552 (frequency_Offset: -49140000) Reserved



4 Close the "C/U Plane Builder Configuration Tool" window.

- 5 Export the O-RAN Stimulus file to generate the corresponding PCAP file.
- 6 Load the modified stimulus / recording PCAP file into O-RAN Studio.

KEYSIGHT Open RAN Studio - Offline	<u> </u>	- 🗆 ×
File Setup Test Models View Help		
		i .
C-Plane Builder Explorer		
		••] <sup>1</sup>
U-Plane, C-Plane Messages:		terpretation:
Description	# Dir eAxC µ DU Port Ban 🕎 isInd	Type : SA ^ //
[PCAP] C-Plane, Section Type: 1, Sections: 1, Frame :0, Subframe: 9, Slot: 0, Symbol	802.10	ballyUnique : True VLAN
	Vian Vian	TypeString : 81 00 FciString : PCP(7), DEI(0), VID(0)
	EtherTyr	pe : AE FE
	ecot	ommon Header Version : 1
	ecpri	Concatenation : 0 Message : 2
	# Dir eAxC µ DU Port Ban ecpri	Payload : 20 omponent eAxC ID (C-Plane)
	0 PRACH 0001 1 0 0 DuPo	rrtID:0 SectorID:0
	CcID	:0 rtID:1
	- eCPRI S	equence ID enceID : 0
<	Contraction of the second s	and the second se
	C-Plane	equenceID : 0 Common Header
	Paylo	Direction : 0 padVersion : 1
Hex Payload:	Fram	Index : 3 eld : 0
Hex 00 01 02 03 04 05 06 07 08 09 0A 0B 0C 0D 0E (	PRB: (none selected) Slotte	
0 80 09 02 03 04 05 00 00 00 00 00 00 81 00 E0 16 AE FE 10 02 00 14 00 01 00 80 13 00 90 02 01	Num	Symbolid : 2 berOfSections : 1
32 F0 00 00 00 00 0C FF F2 00 00 00 00 00 00 00	Secti User Da	onType : 1 ta Compression Header
48 00 00 00 00 00 00 00 00 00 00 00 00	IqBit	Width : 15 pression : no compression
	Reserve	d
	C-Plane	Section Type 1
	RB:	
	Start	polinc : 0 Prbc : 0
	ReMa	berPrbc : 12 ask : 111111111111b
	Ef:0	
<	Bean	nłd : 0 👻
File: C/Open RAN/SCIPSS scp files/PRACH/FormatA1 pcap St	240	
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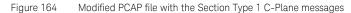


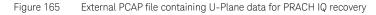
Figure 164 shows Section Type 1 C-Plane Messages instead of Type 3 Messages for the PRACH carrier.

# 3.5.3: Recovering IQ data from PRACH carrier

If you have a PCAP file that is not produced by the U5040A Open RAN Studio software and has been captured from an O-RU device, the "PRACH IQ Recovery" option enforces Open RAN Studio software to treat the U-Plane flow as PRACH flow during IQ recovery.

1 Load the PCAP file, containing a U-Plane flow, captured from an external source into O-RAN Studio.

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File Setup Test Models View Help									
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C-Plane Builder Explorer									
	-						11.4		
U-Plane, C-Plane Messages:	U-Plane:							Message Interpretation:	
Description	# Dir	eAxC		DU Port	Band Sector	сс	Y,		
[PCAP] U-Plane, Frame 0, Subframe 9, Slot: 0, Symbol: 2, Section: 0, PR8: 0-11 [PCAP] U-Plane, Frame 0, Subframe 9, Slot: 0, Symbol: 3, Section: 0, PR8: 0-11							Ar		
[PCAP] U-Plane, Frame :0, Subframe: 9, Slot: 0, Symbol: 3, Section: 0, Pkb: 0-11	<	-							
	C-Plane:								
	# Dir	eAxC		DU Port	Band Sector	сс			
· · · · · ·									
Hex Payload:	Recovered		Constellation						
	PRB: (none								
	RE U	Cmpl	uCmpQ						
File: C:\Open RAN\SCP\S8 scp files\LP2\PRACH\FormatA1_UL.pcap	Size: 1464								



2 Launch the "C/U Plane Builder Configuration Tool" window.

- 3 In the 'Numerology' tab, perform the following configuration:
  - a check that the Bandwidth of the carrier and the Numerology are configured correctly
  - *b* In the 'PRACH IQ Recovery' area, select the "Use PRACH IQ Recovery Options" check box
    - *i* Select the correct "PRACH Format" from the drop-down list.
    - *ii* Select the correct "PRACH SCS" value.
    - *iii* Enter the correct "Frequency Offset" value.

Values for PRACH SCS and Frequency Offset can be looked up in C-plane messages, as text in GUI hints.

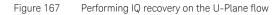
and the second s	C/U Plane Builder	r Configuration Tool				<	
C-Plane Builder V U-Plane, C-Plane Mes	Flow/eAxC Compression	Slot IDs relative	to highest numero	logy in carrier FR	FR1 100 MHz		Message Interpretation:
h Description	Numerology	Resource Grid:				<b>c</b> $\Delta$	
[PCAP] U-Plane, P [PCAP] U-Plane, P	Beamforming	Numerology	Grid Size	Grid Enabled		0	
	Timing	µ = 0: 15kHz	270		Enable a grid to facilitate carrier IQ		
	Options	µ = 1: 30kHz	273		recovery from a recording.	CC	
	DSS µ=2	μ = 2: 60kHz	135			Ľ	
Nex Payload:		Ref. Point A: 9		14 MHz from center			
Hex 00 01 02		🗹 Use PRACH IO	I IQ Recovery Options				
		PRACH Format	FormatA1				
		PRACH SCS	15 kHz				
		Frequency Offset	:	0			

Figure 166 Numerology configuration required for PRACH IQ recovery

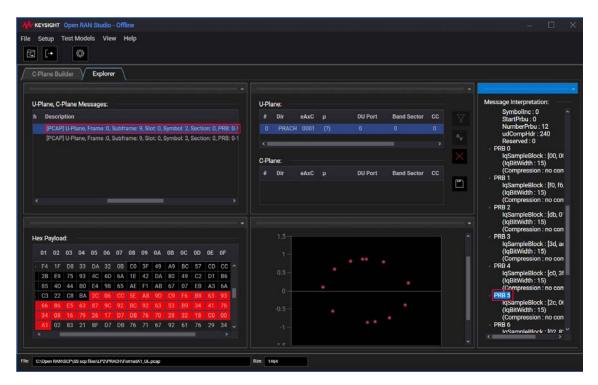
- 4 Close the "C/U Plane Builder Configuration Tool" window.
- 5 Select a U-Plane flow to filter the data.
- 6 Click the icon to "Filter on Selected Flow".

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File Setup Test Models View Help		
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C-Plane Builder Explorer		
U-Plane, C-Plane Messages:	U-Plane:	Message Interpretation:
h Description (PCAP) U-Plane, Frame :0, Subframe: 9, Slot: 0, Sy	Progress Dialog ×	
[PCAP] U-Plane, Frame :0, Subframe: 9, Slot: 0, Sy	Activity Progress:	
	100%	
	Activity Details: CC Operation completed successfully	
	Operation completed successfully	
Hex Payload:		
Hex 00 01 02 03 04 05 06 07 08 0	Ok Cancel	
<	* Ucitipi Ucitipi I V	
File: C10pen RAN\SCP\SS scp files\LP2\PRACH\FormatA1_UL.pcap	Size: 1464	

7 Click the icon to "Recover IQ Waveform".



8 Click "OK" when the 'Activity Progress' on the 'Progress Dialog' reaches 100%.



9 Select a row in the 'U-Plane, C-Plane Messages' area and click a PRB slot to view the Constellation diagram for the recovered IQ data.

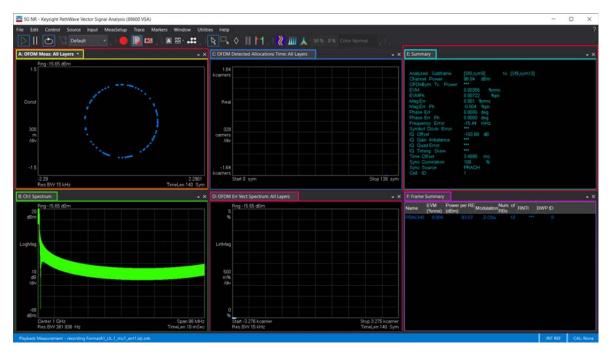
Figure 168 Performing IQ recovery on the U-Plane flow

- 10 Launch the 89600 VSA software.
- 11 From the main menu, click File > Recall > Recall Setup....
- 12 On the Recall Setup window that appears, navigate to the folder where the SETX file, corresponding to the PCAP file captured by the O-RU device, is located.
- 13 Select the SETX file and click Open.
- 14 From the main menu, click File > Recall > Recall Recording....
- 15 On the Recall Recording window that appears, all stimulus files are displayed, which are associated with the SETX file loaded in the previous step. Select the ORB file.
- 16 On the right pane, under "Padding Selection", select 'Repetition'.
- 17 Modify "Factor" field to '3'.

2 56 NR - 10	eysight PathWave \	lector Signal Analys	sis (89600 VSA)						n (	I X
File Edit	Control Source	Input MeasSet	tup Trace Mi	rkers Window Utilit	ies Help					?
	🖒 🚺 Defai		10 million	88						
A: OFDM Me				- ×	C: OFDM Detected Allocation		- ×	E: Summary		
	g - 15.65 dBm				C Critini Delected Hildeador		USED.	C. Sector and F.		
1.5	g=18.85 0011			SYNC NOT FOUND	1.64		SYNC NOT FOUND	Analyzed Subframe ***		
					koarriers			Offennel Power ***		
		-	2023					- Data		
Const		Recall Record	ing					×		
or strike		Look in	PRACH		• 🖬 🗂 🔊 •		Preview file information			
		4	Name	~	Date modified	Type				
300		Quick access		L1_mu1_ant1.iqt.orb	1/27/2021 6:10 PM	ORB File				
m /div			FormatA1_U	Lpcap	1/27/2021 5:48 PM	PCAP File				
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Re	s BW 15 kHz	This PC								11000110
B: Ch1 Spect	num	10010								
Rn	g - 15.85 dBm	Network							Modulation Num. of RNTI BWP ID	
20 dBm		records							NaN	
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10			Files of type:	All Files (*.*)	•	Cancel	Repetition		J.	
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-80					0					
dBm Cer	nter 1 GHz			Span 10 MHz	Start -3 276 koamer Res BW 15 kHz		Stop -3.278 kicemer TimeLen 1. Sym		SYNC NOT F	OUND
Re	s BW 391.936 Hz			TimeLen 10 mSec	Res BW 15 kHz		TimeLen 1. Sym			
Playback Mer	asurement - recordin	g FormatA1_UL1_m	u1_ant1.iqt.orb						INT REF	CAL: None

Figure 169 Loading ORB file to extract IQ data in the 89600 VSA software

18 Click Open.



The Constellation diagram for the PRACH IQ data is plotted along with the summary of the data measured.

Figure 170 Recovered PRACH IQ data in the 89600 VSA software

Note that if the PCAP files are generated by the O-RAN Studio software, you do not have to enable the "PRACH IQ Recovery Options" check box.

# Section 3.6: Working with LTE signals

# 3.6.1: Configuring LTE along with Multi-Standard Radio (MSR)

Beginning with ver. 1.3 of the U5040A Open RAN Studio software, you can load the LTE-FDD / LTE-DD SCP projects directly into the software; thereby, skipping the process of generating a Psuedo SCP file using an external LTE-FDD / LTE-TDD application.

To generate SCP files for LTE carrier consisting of PRACH bursts, you require the *N7624C Signal Studio Pro for LTE/LTE-Advanced FDD* software for LTE FDD signals and the *N7625C Signal Studio Pro for LTE/LTE-Advanced TDD* software for LTE TDD signals.

Currently, the Open RAN Studio software supports the following properties in an LTE SCP file:

- Only single carrier per CA
- Carrier BW only 5, 10, and 20 MHz, SCS only 15kHz
- Single frame only
- · Radio allocations become slot "blankets"
- PRACH only format 0, only default positions
- No support for UpLink emulation
- No support for MIMO configuration

# NOTE

You can neither load nor switch between both SCP files for LTE-FDD and LTE-TDD signals in a single instance / session of the U5040A Open RAN Studio software. After working on one of the SCP files for either LTE-FDD or LTE-TDD signal, you must restart the instance of the Open RAN Studio software to work on the other SCP file.

#### Loading the SCP file for LTE only

Similar to loading the SCP file for a 5G NR signal, you can now load an LTE-FDD / LTE-TDD SCP file in the Open RAN Studio software, using the File menu option to Recall Signal Studio Project.

· Click File > Recall > Signal Studio Project....

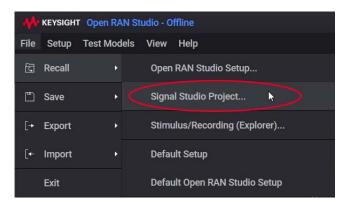


Figure 171 Opening the LTE-FDD/LTE-TDD SCP file similar to 5G NR SCP file

• From the "Open" dialog box that is displayed, select the SCP file for LTE-FDD signal and click 'Open'.

🏪 Open			$\times$
← → • ↑ <mark> </mark> « pp	Ts_1.3 → ors_Ite_interoperability_msr	<ul> <li>         ・ C         ・ Search ors_Ite_interoperabili     </li> </ul>	it
Organize 👻 New folde		E 🕶 🔳 🧯	?
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Documents	simple_5gnr.scp	Text Document	3/
Downloads	simple_Itefdd.scp	Text Document	3/
🁌 Music			
Network_Hari			
Network-Others			
E Pictures			
🚦 Videos			
😓 OSDisk (C:) 🗸 🗸	<		>
File nar	ne: simple_ltefdd.scp	SCP Files (*.scp)	
		Open 🔻 Cancel	_ :

Figure 172 Accessing LTE-FDD/LTE-TDD SCP file for loading

Plane Builder 🔪 Eq												
Component Carriers		Ra	dio Contro Subfram		RB Start	RB Number	Sym Start	Sym Number	Channel	Beam Id		
Select Carrier:	LTE Cerrier 1 (DL)							14	PDSCH			
ocation outries.	Contraction of the second	) Ö						14	PDSCH			
Attribute	UTE Carrier 1 (DL)								PDSCH			
Carrier Type	DL (LTE)								PDSCH			
Cell ID	0								PDSCH			
Bandwidth	FR1_5M								PDSCH			
Numerology Mode	SingleNumerology								PDSCH			
CP Type	Normal								PDSCH			
Allocations						25 25		14	PDSCH			
Resource Allocations												
Resource Allocations Select Allocation:	RasicLT[_FDD-DI. 🗸 🗸											
	Resict TE_FOD OL 🛛 🗸	Rad	io Allocati	ns								
Select Allocation: Attribute Name of allocation	Value Basic.LTE_F00-DL	Rad	io Allocati	NTS								
Select Allocation: Attribute Name of allocation Numerology	Value Basic_LTE_F0D-DL SCS15k	Rad	io Allocati	ns								
Select Allocation: Attribute Name of allocation Numerology Modulation	Value Basic.LTE_F00-DL SCS15k	Rad	io Allocati	ns								
Select Allocation: Attribute Name of allocation Numerology	Value Basic_LTE_F0D-DL SCS15k	Rad	io Allocati	ms								
Select Allocation: Attribute Name of allocation Numerology Modulation Slots	Value Basic.LTE_F00-DL SCS15k - 0-9	Rad	io Allocati	ms								
Select Allocation: Attribute Name of allocation Numerology Modulation Slots First Symbol Last Symbol Number of Symbols	Value Basic.LTE.FDD-DL SCS15k - - 0;9 0 13 13 14	Rad	io Allocati	ms								
Select Allocation: Attribute Name of allocation Numerology Modulation Slots First Symbol Last Symbol Last Symbol Number of Symbols RB Offset	Value Basic LTE_FOD-DL SCS15k - 0 13 14 0	Rad	io Allocati	ns								
Select Allocation: Attribute Name of allocation Numerology Modulation Slots First Symbol Last Symbol Number of Symbols	Value Basic.LTE.FDD-DL SCS15k - - 0;9 0 13 13 14	Rad	io Allocati	ms								
Select Allocation: Attribute Name of allocation Numerology Modulation Slots First Symbol Last Symbol Number of Symbols RB Offset RB Number	Value Basic LTE_FOD-DL SCS15k - 0 13 14 0	Rad	io Allocati	ms								
Select Allocation: Attribute Name of allocation Numerology Modulation Slots First Symbol Last Symbol Number of Symbols RB Offset RB Number Beam IDs	Value Basic LTE_FOD-DL SCS15k - 0 13 14 0	Rad	io Allocati	in in the second s								
Select Allocation: Attribute Name of allocation Numerology Modulation Slots First Symbol Last Symbol Number of Symbols RB Offset RB Number	Value Basic LTE_FOD-DL SCS15k - 0 13 14 0	Rad	io Allocati	in in the second s								
Select Allocation: Attribute Name of allocation Numerology Modulation Slots First Symbol Last Symbol Number of Symbols RB Offset RB Number Beam IDs	Value Basic LTE_FD0-DL SSI 5k - - 0 0 13 13 14 0 25	Rad	io Allocati e	XTS .								
Select Allocation: Attribute Name of allocation Numerology Modulation Slots First Symbol Last Symbol Number of Symbols RB Offset RB Number Beam IDs	Value Basic LTE_FD0-DL SSI 5k - - 0 0 13 13 14 0 25	Rad	io Allocati	NTS .								

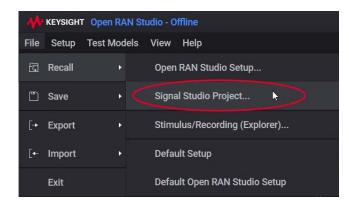
The "Select Carrier" drop-down field shows only the "LTE Carrier".

Figure 173 Appearance of LTE-FDD/LTE-TDD SCP file contents

#### Loading the SCP files for 5G NR and LTE in the same instance

An alternate way to load the LTE-FDD / LTE-TDD SCP file in the Open RAN Studio software is by using the File menu option to Import LTE Setup for DSS. However, you must load an SCP file for 5G NR signal first.

• Click File > Recall > Signal Studio Project....





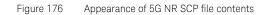
• From the "Open" dialog box that is displayed, select the SCP file for 5G NR signal and click 'Open'.

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Downloads	simple_Itefdd.scp	Text Document 3
Music		
Network_Hari		
Network-Others		
Pictures		
🚪 Videos		
🈓 OSDisk (C:) 🛛 🗸 🤞		×
File name:	simple_5gnr.scp	SCP Files (*.scp)
		Open 🔽 Cancel

Figure 175 Accessing 5G NR SCP file for loading

The "Select Carrier" drop-down field shows only the "NR Carrier".

Plane Builder 🔪 🗈	xplorer										
omponent Carriers		Rai	tio Control F	Plane Dat	ta						
Carrier Numerology		ų	Subframe	Slot ID	RB Start	RB Number	Sym Start	Sym Number	Channel	Beam Id	
Select Carrier:	NR Carrier 1 (DL)								PDSCH		
	Contract of the Party of the					126	4				
Attribute	<ul> <li>NR Carrier 1 (DL)</li> </ul>								SS/PBCH		
Carrier Type	DL (NR)					126					
Cell ID	0										
Bandwidth	FR1_100M								SS/PBCH		
Numerology Mode	SingleNumerology								PDSCH		
CP Type	Normal								PDSCH		
Allocations									PDSCH		
									PDSCH		
Flow/eAxC ID	(unassigned)								SS/PBCH		
									PDSCH		
									PDSCH		
Resource Allocations									SS/PBCH		
Select Allocation:	DL-SCH1 Y									n	
Attribute	Value	0.4									
Name of allocation	DL-SCH1		Allocation	5							
Numerology	SCS30k										
Modulation	QPSK										
Slots											
First Symbol											
Last Symbol			e.								
Number of Symbols											
RB Offset											
RB Number											
Beam IDs			¢ _								
P-I			0								
Select Beamld:											



 To load the SCP file for the LTE carrier, click File > Import > Import LTE Setup for DSS....

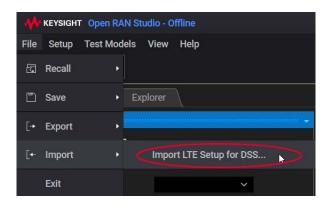


Figure 177 Importing the LTE SCP file in addition to 5G NR SCP file

• From the "Open" dialog box that is displayed, select the SCP file for LTE signal and click 'Open'.

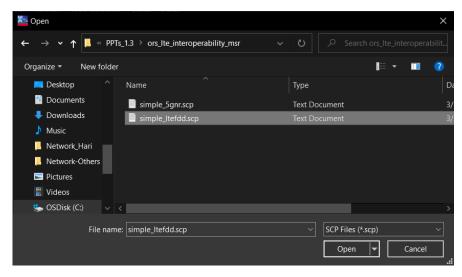


Figure 178 Accessing LTE SCP file for importing

Nomencion         Nomencion <t< th=""><th>Plane Builder 🔪 🖽</th><th>plorer</th><th></th><th></th><th></th><th></th><th></th><th></th><th></th><th></th><th></th></t<>	Plane Builder 🔪 🖽	plorer									
Carrier Numerology         V         Utclame         V         Utclame         V <th< th=""><th></th><th></th><th>-</th><th></th><th></th><th></th><th></th><th></th><th></th><th></th><th></th></th<>			-								
Select Carrie:         V						DB Number	Even Start	Sum Number	Channel	Berry Id	
Attribute         V	Select Carrier										
Attribute         V         Utclaver (pc)           Carrier Type         •         <	Select Conter.	MR Carrier 1 (DL)									
Carrier Type Carrier Type Carrier Type Carrier Type Carrier Type Carrier Type Sindwidth       I       0       0       147       126       4       4       PDSCH       0         Mumerology CP Type Normal       SingleNumerology CP Type Normal       I       0       0       147       126       8       4       PDSCH       0         Mumerology CP Type Normal       Normal       1       0       0       147       126       8       4       PDSCH       0         Minecations       1       0       0       147       126       8       4       PDSCH       0         Numerology Select Allocation       1       0       0       126       2       4       SSPBCH       0         Numerology Solets       0       1       0       126       2       4       SSPBCH       0         Numerology First Symbol       0       1       126       21       6       4       SSPBCH       0         Numerology Solets       0       1       1       126       21       6       4       SSPBCH       0         Numerology Solets       0       1       1       126       21       6       4       SSPBCH       0	Attribute	UTE Carrier 1 (DL)									
Celt ID       0       0       126       8       4       PDSCH       0         Bandwidth       FR1_5M       Numerology       SingleNumerology       0       126       21       8       4       SSPBCH       0         Allocations       1       0       0       126       21       8       4       SSPBCH       0         Allocations       1       0       0       273       12       2       PDSCH       0         Allocations       1       0       0       273       12       2       PDSCH       0         Resource Allocations       1       0       1       0       126       2       4       PDSCH       0         Select Allocation:       sextr_resource       1       0       1       126       21       6       4       PDSCH       0         Name of allocation:       sextr_resource       sextr_resource       1       0       1       126       21       6       4       SSI/PBCH       0         Numerology       SCS15k       0       1       0       1       126       21       6       4       SSI/PBCH       0         1       0       <		NR Carrier 1 (DL)									
Bandwidth       FR1_5M         Numerology Mode       SingleNumerology         CPType       Normail         Allocations       1         Flow/eAXC ID       cmessignet)         Consergent)       1         Bandwidth       -         Select Allocations       1         Select Allocation       -         Numerology       SCS15k         Modulation       -         Numerology       SCS15k         Mode Bortist       13         Numerology       13         Resource Allocations       13         Numerology       SCS15k         Mode Bortist       13         Numerology       SCS15k         Mode Bortist       13         Numerology       SCS15k         Modulation       -         First Symbol       13         Ratio Allocations       13         BB Offset       0         BB Offset       0         CP       14         BB Offset       0         CP       14         BB Offset       0         CP       -         CP       -         CP <t< td=""><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td>PDSCH</td><td></td><td></td></t<>									PDSCH		
Numerology Mode CP Type         SingleNumerology Normal           Allocations         1           I         0         0         273         12         2         PDSCH         0           Allocations         1         0         0         273         12         2         PDSCH         0           Flow/eAXCID         cmessigned         -         -         273         12         2         PDSCH         0           Select Allocations         1         0         1         0         126         2         4         Sp/PBCH         0           Select Allocation:         Select Allocation:         1         0         1         0         126         2         4         Sp/PBCH         0           Name of allocation:         Basic.LTE_FDD DL         -         147         126         21         6         4         Sp/PBCH         0           Numerology         SCS13k         -         -         147         126         21         6         4         Sp/PBCH         0           Last Symbol         0         1         0         147         147         147         147         147         147         147         147									SS/PBCH		
CP Type       Normal         Allocations       1         Flow/BAXC ID       rewayse()         Flow/BAXC ID       rewayse()         Select Allocation:       1         Select Allocation:       1         Select Allocation:       1         Name of allocation:       1         Name of allocation:       1         Name of allocation:       1         Numerol 3       1         Number of Symbols       14         PB Offset       0         B Offset       0									PDSCH		
Allocations       1       0       173       0       2       POSCH       0         Flow/eAXC ID       (messgent)       1       0       1726       2       4       POSCH       0         Resource Allocations       1       0       1       126       21       2       4       POSCH       0         Select Allocation:       mestructod.       *       *       *       POSCH       0       1       126       21       2       4       POSCH       0         Select Allocation:       *       *       *       *       *       *       POSCH       0         Numerology       SCS15k       *									PDSCH		
Flow/eAXCID         twosspecity         Image: Constrained by the c									PDSCH		
Attribute         Value           Numerology         SCS15k           Modulation         -           Stots         0-9           First Symbola         0           Number of Symbola         13           Number of Symbola         14           RB Offset         0           B Offset         0											
Attribute         Value           Name of allocation         Basic.LTE_FDD.DL           Name of allocation         Basic.LTE_FDD.DL           Numerology         SCS13k           Modulation         -           First Symbol         0           1         1           BB Offset         0           RB Offset         0	Flow/eAxC ID	(unassigned)									
Resource Allocations Select Allocation  Instruction Resource Allocation  Instruction Resource Allocation  Instruction Resource Allocation Resource											
Select Allocation:       Market TURBOR       Market TURBOR         Attribute       Value         Numerology       SCS1 5k         Modulation       -         Stots       0.9         First Symbol       0         Last Symbol       1         Radio Allocations       -         Bit Offset       0         RB Offset       0       0         RB Offset       0       0       0         RB Offset       0       0       0       0         RB Offset       0       0       0       0       0       0         RB Offset       0       0 <td>Descurse Allocations</td> <td></td>	Descurse Allocations										
Select Allocation:     Basic LTF_Dock       Attribute     Value       Name of allocation     Basic LTE_FDD DL       Numerology     SCS1sk       Modulation     -       First Symbol     0       Last Symbol     13       Number of Symbols     14       BB Offset     0       RB Mumber of Symbols     14	Resource Allocations										
Name of allocation     Basic.LTE_FDD DL       Numerology     SCS15k       Modulation     -       Stots     0.9       First Symbol     0       Last Symbol     13       Number of Symbols     14       BB Offset     0       RB Number of Symbols     14	Select Allocation:	BasicLTE_FDD-DL V									
Name of allocation Basic ITE_F00-DL Numerology SCS1 5k Modulation - Stots 0-9 First Symbol 0 Last Symbol 13 Number of Symbols 14 RB Offset 0 RB Number 25 Source State Stat	Attribute	Value	Radi	Allocation	s						
Modulation     -     image: constraint of the second secon	Name of allocation	Basic LTE_FOD-DL									
Siots     0.9       First Symbol     0       Last Symbol     13       Number of Symbols     14       RB Number     25	Numerology										
First Symbol 0 Last Symbol 13 Number of Symbols 14 RB Otflaet 0 BB Number 25				9							
Last Symbol 13 III Number of Symbols 14 RB Number 25											
Number of Symbols 14 BB Offset 0 BB Number 25											
RB Offset 0 RB Number 25											
HB Order U RB Number 25				64	-						
	the features										
Beam Us	Beam IDs			0 .							
Select Beamld: o v v v v v v v v v v v v v v v v v v	Select Beamld: 0										

The "Select Carrier" drop-down field shows both the "NR Carrier" and "LTE Carrier".



• Toggle between the carrier to view the respective Radio Allocations.

# Viewing PCAP files & recovering IQ for 5G NR and LTE in the same instance

After loading both the 5G NR and LTE SCP files, as seen in Figure 179 of the previous section, perform the following steps:

- 1 In the C/U-Plane Builder Configuration Tool, add at least one more flow to match the number of carriers.
- 2 Assign a Flow/eAxC ID to each carrier.

-Plane Builder \chi 🛛 Ex											
Component Carriers		Ra	tio Control F	Plane Da	ta						
Carrier Numerology		t l	Subframe	Slot ID	RB Start	RB Number	Sym Start	Sym Number	Channel	Beam Id	
Select Carrier:	LTE Carrier 1 (DL)	0	0			25	0	14	PDSCH		
									PDSCH		
Attribute	Value								PDSCH		
Carrier Type	DL (LTE)								PDSCH		
Cell ID									PDSCH		
Bandwidth	FR1_5M								PDSCH		
Numerology Mode	SingleNumerology								PDSCH		
CP Type	Normal								PDSCH		
Allocations									PDSCH		
Flow/eAxC ID	0002								PDSCH		
Resource Allocations											
Select Allocation:	Basic LTE_F00-0L										
		Radi	Allocation	s —							
Attribute	Value										
Name of allocation	Basic.LTE_FDD-DL										
Numerology											
Modulation											
Slots	0:9										
First Symbol											
Last Symbol											
Number of Symbols RB Offset											
RB Number	0 25										
HD NUMBER											
Beam IDs											

Figure 180 Assigning Flow/eAxC ID to each carrier

- 3 Without making any further configuration changes, export the O-RAN Stimulus file.
- 4 Switch to the Explorer tab and load the PCAP file.

		1	1									_								
-Plane, C-P	lane Mes:	ages:										• •	Plane:							Message Interpretation:
Length	Descripti	n											E Dir	eAxC	μ	DU Port	Band Sector	CC	Y	VlanTypeString: 81 00
	[PCAP] C	Plane, S	ection Tr	/pe: 1:		at 1.	Frame	:0. Si		ie: 0. 1	lot ~		O DL	0002						VlanTciString : PCP(7), DEI(0), EtherType
60	[PCAP] C													0001						Value : AE FE eCPRI Common Header
	[PCAP] U	Plane, Fr	ame :0,	Subfra	me: 0, 9	lot: (	0, Sym	ool: 0	Secti	on: 0,	PRB									ecpriVersion : 1
8991	[PCAP] U																			ecpriConcatenation : 0 ecpriMessage : 2
3366	[PCAP] U																			ecpriPayload : 20
8991	(PCAP) U											c.	Plane:							<ul> <li>eCPRI Component eAxC ID (C-Pla DuPortID : 0</li> </ul>
3366 1161	[PCAP] U												Dir	eAxC	u.	DU Port	Band Sector	CC		BandSectorID : 0
8991	[PCAP] U																	0		CcID:0 RuPortID:2
3366	[PCAP] U												0 DL 1 DL	0002						eCPRI Sequence ID
8991	[PCAP] U													0001						SequenceID : 0 E : 1
3366	[PCAP] U	Plane, Fr	ame :0,	Subfra	me: 0, 9	flot: (	0, Symi	ool: 3	, Secti	on: 0,	PR8 🖕									E : I SubsequenceID : 0
			-	-									_	_	_					<ul> <li>C-Plane Common Header DataDirection : 1</li> </ul>
																				PayloadVersion : 1
																				FilterIndex : 0 Frameld : 0
ex Payload	È												lecover	-110	Constella	ation				Subframeld : 0
Hex 00			ar. ar				DA 08				-		lecoven	au ing	Constein	10011				SlotId : 0 StartSymbolid : 0
												P	RB: (non	e selected)						NumberOfSections : 1
													RE	uCmpl	uCmpQ					SectionType : 1 User Data Compression Header
	FE 10																			IqBitWidth : 15
	00 00								00-00	-00	00									Compression : no compression Reserved
		00 00	00 UL		00 0		10 UL													Value : 0
																				<ul> <li>C-Plane Section Type 1 SectionID : 0</li> </ul>
																				RB:0
																				Symbolinc : 0 StartPrbc : 0
																				NumberPrbc : 25
																				ReMask : 1111111111111 NumSymbol : 14

Figure 181 Viewing PCAP file contents with the default configuration

- 5 Launch the "C/U-Plane Builder Configuration Tool".
- 6 Click the "Numerology" tab.
- 7 Perform the following settings to match the properties of the LTE carrier.
  - a Set Bandwidth to "FR1 5 MHz"
  - b Set SCS to "15kHz"
  - c Enable "Use LTE IQ Recovery Options" check box.
  - *d* Disable "Add null DC subcarrier (use with LTE only)" in case it is enabled

lane, C-Plane Messages: Length Description	C/U Plane Builder	Configuration Tool	U-Plane:			ssage Interpretation: VlanTypeString : 81 00
						VlanTciString : PCP(7), DEI(0),
60 [PCAP] C-Plane, Section Type: 1 60 [PCAP] C-Plane, Section Type: 1	Flow/eAxC	Slot IDs relative t	a highast sumar	alogu in corrier CD		EtherType Value : AE FE
1161 [PCAP] U-Plane, Frame :0, Subfr	Compression		o highest numer	ology in camer PK		eCPRI Common Header
8991 [PCAP] U-Plane, Frame :0, Subf	Compression	Bandwidth			FR1 5 MHz 🗸	ecpriVersion : 1 ecpriConcatenation : 0
3366 [PCAP] U-Plane, Frame :0, Subfr	Numerology	Resource Grid:				ecpriMessage : 2 ecpriPayload : 20
8991 [PCAP] U-Plane, Frame :0, Subfr						eCPRI Component eAxC ID (C-Pla
3366 [PCAP] U-Plane, Frame :0, Subfr	Beamforming	Numerology	Grid Size	Grid Enabled		DuPortID : 0 BandSectorID : 0
1161 [PCAP] U-Plane, Frame :0, Subfr	Timing	µ = 0: 15kHz	25			CcID:0
8991 [PCAP] U-Plane, Frame :0, Subfr 3366 [PCAP] U-Plane, Frame :0, Subfr		p = o, rowne.	.25		Enable a grid to facilitate carrier IQ recovery from a recording.	RuPortID:2
8991 [PCAP] U-Plane, Frame :0, Subfr	Options	µ = 1: 30kHz				eCPRI Sequence ID SeguenceID : 0
3366 [PCAP] U-Plane, Frame :0, Subfr						E:1
		µ = 2: 60kHz	N/A			SubsequenceID : 0 C-Plane Common Header
		Def Deire Ar da	0.004840-04.40	8 MHz from center		DataDirection : 1
		Rel. Point AC 99	6.02 MHZ at -1.9	o Minz nom center		PayloadVersion : 1 FilterIndex : 0
		PRACH IQ Recovery				Frameld : 0
( Payload:		,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,				Subframeld : 0 SlotId : 0
ex 00 01 02 03 04 05 06 07		Use PRACH IQ	Recovery Option	15		StartSymbolld : 0 NumberOfSections : 1
80 09 02 03 04 05 00 00		PRACH Format	Format0			SectionType : 1
6 AE FE 10 02 00 14 00 02		C				User Data Compression Header IgBitWidth : 15
2 FO 00 00 00 00 19 FF FE		PRACH SCS				Compression : no compression
8 00 00 00 00 00 00 00 00		Enter Office		0		Reserved Value : 0
		Frequency Offset				C-Plane Section Type 1
						SectionID:0 RB:0
		Options				Symboline : 0
		Use LTE IQ Rec	overy Options			StartPrbc : 0 NumberPrbc : 25
			subcarrier (use v			ReMask: 1111111111111

Figure 182 Setting configuration options for recovering IQ from LTE

- 8 Exit the "C/U-Plane Builder Configuration Tool".
- 9 Export the O-RAN Stimulus file again.
- 10 Load the regenerated PCAP file.
- 11 Select the flow corresponding to the LTE carrier in the U-Plane area, as shown in Figure 183.
- 12 Click the icon to "Filter selected row".

				****					•••••	
	-Plane Messages:	U-PI								ge Interpretation:
Length	Description		Dir	eAxC		DU Port	Band Sector			
	[PCAP] C-Plane, Section Type: 1, Sections: 1, Frame :0, Subframe: 0, Slot: (									
	[PCAP] U-Plane, Frame :0, Subframe: 0, Slot: 0, Symbol: 0, Section: 0, PRB:			0001					*	
	[PCAP] U-Plane, Frame :0, Subframe: 0, Slot: 0, Symbol: 1, Section: 0, PRB:									
	[PCAP] U-Plane, Frame: 0, Subframe: 0, Slot: 0, Symbol: 2, Section: 0, PRB:	101								
	[PCAP] U-Plane, Frame :0, Subframe: 0, Slot: 0, Symbol: 3, Section: 0, PRB:	<								
1161	[PCAP] U-Plane, Frame :0, Subframe: 0, Slot: 0, Symbol: 4, Section: 0, PRB:	C-PI	ane:						۳ <b>۵</b>	
1161 1161	[PCAP] U-Plane, Frame :0, Subframe: 0, Slot: 0, Symbol: 5, Section: 0, PRB: [PCAP] U-Plane, Frame :0, Subframe: 0, Slot: 0, Symbol: 6, Section: 0, PRB:		Dir	eAxC		DU Port	Band Sector	CC		
1161	PCAPJ 0-Prane, Frame 0, Subtrame: 0, Slot: 0, Symbol: 0, Section: 0, PRB: [PCAP] U-Plane, Frame 0, Subframe: 0, Slot: 0, Symbol: 7, Section: 0, PRB:									
1161	[PCAP] U-Plane, Frame 0, Subframe: 0, Slot: 0, Symbol: 8, Section: 0, PRB:			0002						
1161	[PCAP] U-Plane, Frame 0, Subframe: 0, Slot: 0, Symbol: 9, Section: 0, PRB:			0001						
1161	[PCAP] U-Plane, Frame :0, Subframe: 0, Slot: 0, Symbol: 10, Section: 0, PRI									
		C II	_							
x Paylo lex 00	ad: 01 02 03 04 05 06 07 08 09 0A 08 0C 0D 0E OF .			l IQ selected) Cmpl	Constell: uCmpQ	I				



13 Click the icon for "Recover IQ waveform.

Linght       Description         60       (PCAP) C-Plane, Section Type: 1, Sections: 1, Frame 0, Subframe: 0, Su	Image: The Unit of the Constraints of t	 - Plane Messages:	U-PI							Message Interpretation:
60       (PCAP) C Plane, Section Type: 1, Section: 1, Frame :0, Subframe: 0, Subtr. 1, Section: 0, PR8:         1161       (PCAP) U Plane, Frame :0, Subframe: 0, Subt. 0, Symbol: 1, Section: 0, PR8:         1161       (PCAP) U Plane, Frame :0, Subframe: 0, Subt. 0, Symbol: 3, Section: 0, PR8:         1161       (PCAP) U Plane, Frame :0, Subframe: 0, Subt. 0, Symbol: 3, Section: 0, PR8:         1161       (PCAP) U Plane, Frame :0, Subframe: 0, Subt. 0, Symbol: 4, Section: 0, PR8:         1161       (PCAP) U Plane, Frame :0, Subframe: 0, Subt. 0, Symbol: 4, Section: 0, PR8:         1161       (PCAP) U Plane, Frame :0, Subframe: 0, Subt. 0, Symbol: 4, Section: 0, PR8:         1161       (PCAP) U Plane, Frame :0, Subframe: 0, Subt. 0, Symbol: 4, Section: 0, PR8:         1161       (PCAP) U Plane, Frame :0, Subframe: 0, Subt. 0, Symbol: 8, Section: 0, PR8:         1161       (PCAP) U Plane, Frame :0, Subt. 0, Symbol: 8, Section: 0, PR8:         1161       (PCAP) U Plane, Frame :0, Subframe: 0, Subt. 0, Symbol: 8, Section: 0, PR8:         1161       (PCAP) U Plane, Frame :0, Subframe: 0, Subt. 0, Symbol: 10, Section: 0, PR8:         1161       (PCAP) U Plane, Frame :0, Subframe: 0, Subt. 0, Symbol: 10, Section: 0, PR8:         1161       (PCAP) U Plane, Frame :0, Subframe: 0, Subt. 0, Symbol: 10, Section: 0, PR8:         1161       (PCAP) U Plane, Frame :0, Subframe: 0, Subt. 0, Symbol: 10, Section: 0, PR8:         1161       (PCAP) U Plane, Frame :0, Subframe: 0	0       (PCAP] C Plane, Section Type: 1, Sections: 1, Frame :0, Subframe: 0, Sub (: 0, Symbol: 0, Section: 0, PR8:         161       (PCAP] U Plane, Frame :0, Subframe: 0, Sub (: 0, Symbol: 1, Section: 0, PR8:         161       (PCAP] U Plane, Frame :0, Subframe: 0, Sub (: 0, Symbol: 2, Section: 0, PR8:         161       (PCAP] U Plane, Frame :0, Subframe: 0, Sub (: 0, Symbol: 3, Section: 0, PR8:         161       (PCAP] U Plane, Frame :0, Subframe: 0, Sub (: 0, Symbol: 3, Section: 0, PR8:         161       (PCAP] U Plane, Frame :0, Subframe: 0, Sub (: 0, Symbol: 5, Section: 0, PR8:         161       (PCAP] U Plane, Frame :0, Subframe: 0, Sub (: 0, Symbol: 5, Section: 0, PR8:         161       (PCAP] U Plane, Frame :0, Subframe: 0, Sub (: 0, Symbol: 5, Section: 0, PR8:         161       (PCAP] U Plane, Frame :0, Subframe: 0, Sub (: 0, Symbol: 5, Section: 0, PR8:         161       (PCAP] U Plane, Frame :0, Subframe: 0, Sub (: 0, Symbol: 8, Section: 0, PR8:         161       (PCAP] U Plane, Frame :0, Subframe: 0, Sub (: 0, Symbol: 10, Section: 0, PR8:         161       (PCAP] U Plane, Frame :0, Subframe: 0, Sub (: 0, Symbol: 10, Section: 0, PR8:         161       (PCAP] U Plane, Frame :0, Subframe: 0, Sub (: 0, Symbol: 10, Section: 0, PR8:         161       (PCAP] U Plane, Frame :0, Subframe: 0, Sub (: 0, Symbol: 10, Section: 0, PR8:         161       (PCAP] U Plane, Frame :0, Subframe: 0, Sub (: 0, Symbol: 10, Section: 0, PR8:         161       (PCAP] U Plan				eAxC	 DU Port	Band Sector	CC.		
1161       IPCAPJ UPJane, Frame 0, Subframe: 0, Slot: 0, Symbol: 1, Section: 0, PR8:         1161       IPCAPJ UPJane, Frame 0, Subframe: 0, Slot: 0, Symbol: 2, Section: 0, PR8:         1161       IPCAPJ UPJane, Frame 0, Subframe: 0, Slot: 0, Symbol: 2, Section: 0, PR8:         1161       IPCAPJ UPJane, Frame 0, Subframe: 0, Slot: 0, Symbol: 3, Section: 0, PR8:         1161       IPCAPJ UPJane, Frame 0, Subframe: 0, Slot: 0, Symbol: 4, Section: 0, PR8:         1161       IPCAPJ UPJane, Frame 0, Subframe: 0, Slot: 0, Symbol: 4, Section: 0, PR8:         1161       IPCAPJ UPJane, Frame 0, Subframe: 0, Slot: 0, Symbol: 5, Section: 0, PR8:         1161       IPCAPJ UPJane, Frame 0, Subframe: 0, Slot: 0, Symbol: 5, Section: 0, PR8:         1161       IPCAPJ UPJane, Frame: 0, Subframe: 0, Slot: 0, Symbol: 7, Section: 0, PR8:         1161       IPCAPJ UPJane, Frame: 0, Subframe: 0, Slot: 0, Symbol: 7, Section: 0, PR8:         1161       IPCAPJ UPJane, Frame: 0, Subframe: 0, Slot: 0, Symbol: 7, Section: 0, PR8:         1161       IPCAPJ UPJane, Frame: 0, Subframe: 0, Slot: 0, Symbol: 10, Section: 0, PR8:         1161       IPCAPJ UPJane, Frame: 0, Subframe: 0, Slot: 0, Symbol: 10, Section: 0, PR8:         1161       IPCAPJ UPJane, Frame: 0, Subframe: 0, Slot: 0, Symbol: 0, Section: 0, PR8:         1161       IPCAPJ UPJane, Frame: 0, Subframe: 0, Slot: 0, Symbol: 0, Section: 0, PR8:         1161       IPCAPJ UPJane, Frame: 0, Subframe: 0, Slot: 0, Symbol: 0, Section:	161       IPCAPJ U Plane, Frame 0, Subframe: 0, Siot 0, Symbol: 0, Section: 0, PR8:         161       IPCAPJ U Plane, Frame 0, Subframe: 0, Siot 0, Symbol: 2, Section: 0, PR8:         161       IPCAPJ U Plane, Frame 0, Subframe: 0, Siot 0, Symbol: 2, Section: 0, PR8:         161       IPCAPJ U Plane, Frame 0, Subframe: 0, Siot 0, Symbol: 3, Section: 0, PR8:         161       IPCAPJ U Plane, Frame 0, Subframe: 0, Siot 0, Symbol: 3, Section: 0, PR8:         161       IPCAPJ U Plane, Frame 0, Subframe: 0, Siot 0, Symbol: 5, Section: 0, PR8:         161       IPCAPJ U Plane, Frame 0, Subframe: 0, Siot 0, Symbol: 5, Section: 0, PR8:         161       IPCAPJ U Plane, Frame 0, Subframe: 0, Siot 0, Symbol: 7, Section: 0, PR8:         161       IPCAPJ U Plane, Frame 0, Subframe: 0, Siot 0, Symbol: 7, Section: 0, PR8:         161       IPCAPJ U Plane, Frame 0, Subframe: 0, Siot 0, Symbol: 7, Section: 0, PR8:         161       IPCAPJ U Plane, Frame 0, Subframe: 0, Siot 0, Symbol: 7, Section: 0, PR8:         161       IPCAPJ U Plane, Frame 0, Subframe: 0, Siot 0, Symbol: 7, Section: 0, PR8:         161       IPCAPJ U Plane, Frame 0, Subframe: 0, Siot 0, Symbol: 10, Section: 0, PR8:         161       IPCAPJ U Plane, Frame 0, Subframe: 0, Siot 0, Symbol: 10, Section: 0, PR8:         161       IPCAPJ U Plane, Frame 0, Subframe: 0, Siot 0, Symbol: 10, Section: 0, PR8:         161       IPCAPJ U Plane, Frame 0, Subframe: 0, Siot 0, Symbol: 10, Section: 0, PR4: <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td>									
1161       [PCAP] UPlane, Frame 0, Subframe: 0, Slot: 0, Symbol: 1, Section: 0, PR8:         1161       [PCAP] UPlane, Frame 0, Subframe: 0, Slot: 0, Symbol: 2, Section: 0, PR8:         1161       [PCAP] UPlane, Frame 0, Subframe: 0, Slot: 0, Symbol: 4, Section: 0, PR8:         1161       [PCAP] UPlane, Frame 0, Subframe: 0, Slot: 0, Symbol: 4, Section: 0, PR8:         1161       [PCAP] UPlane, Frame 0, Subframe: 0, Slot: 0, Symbol: 4, Section: 0, PR8:         1161       [PCAP] UPlane, Frame 0, Subframe: 0, Slot: 0, Symbol: 5, Section: 0, PR8:         1161       [PCAP] UPlane, Frame 0, Subframe: 0, Slot: 0, Symbol: 5, Section: 0, PR8:         1161       [PCAP] UPlane, Frame: 0, Subframe: 0, Slot: 0, Symbol: 5, Section: 0, PR8:         1161       [PCAP] UPlane, Frame: 0, Subframe: 0, Slot: 0, Symbol: 10, Section: 0, PR8:         1161       [PCAP] UPlane, Frame: 0, Subframe: 0, Slot: 0, Symbol: 10, Section: 0, PR8:         1161       [PCAP] UPlane, Frame: 0, Subframe: 0, Slot: 0, Symbol: 10, Section: 0, PR8:         1161       [PCAP] UPlane, Frame: 0, Subframe: 0, Slot: 0, Symbol: 10, Section: 0, PR8:         1161       [PCAP] UPlane, Frame: 0, Subframe: 0, Slot: 0, Symbol: 10, Section: 0, PR8:         1161       [PCAP] UPlane, Frame: 0, Subframe: 0, Slot: 0, Symbol: 10, Section: 0, PR8:         1161       [PCAP] UPlane, Frame: 0, Subframe: 0, Slot: 0, Symbol: 10, Section: 0, PR8:         1161       [PCAP] UPlane, Frame: 0, Subframe: Slot: 0, Symbol: 10, Sect	161       IPCAPJ U-Plane, Frame 0, Subframe: 0, Siot 0, Symbol: 1, Section: 0, PR8:         161       IPCAPJ U-Plane, Frame 0, Subframe: 0, Siot 0, Symbol: 4, Section: 0, PR8:         161       IPCAPJ U-Plane, Frame 0, Subframe: 0, Siot: 0, Symbol: 4, Section: 0, PR8:         161       IPCAPJ U-Plane, Frame 0, Subframe: 0, Siot: 0, Symbol: 4, Section: 0, PR8:         161       IPCAPJ U-Plane, Frame 0, Subframe: 0, Siot: 0, Symbol: 5, Section: 0, PR8:         161       IPCAPJ U-Plane, Frame 0, Subframe: 0, Siot: 0, Symbol: 5, Section: 0, PR8:         161       IPCAPJ U-Plane, Frame 0, Subframe: 0, Siot: 0, Symbol: 6, Section: 0, PR8:         161       IPCAPJ U-Plane, Frame 0, Subframe: 0, Siot: 0, Symbol: 7, Section: 0, PR8:         161       IPCAPJ U-Plane, Frame 0, Subframe: 0, Siot: 0, Symbol: 7, Section: 0, PR8:         161       IPCAPJ U-Plane, Frame 0, Subframe: 0, Siot: 0, Symbol: 7, Section: 0, PR8:         161       IPCAPJ U-Plane, Frame 0, Subframe: 0, Siot: 0, Symbol: 8, Section: 0, PR8:         161       IPCAPJ U-Plane, Frame 0, Subframe: 0, Siot: 0, Symbol: 10, Section: 0, PR8:         161       IPCAPJ U-Plane, Frame 0, Subframe: 0, Siot: 0, Symbol: 10, Section: 0, PR8:         161       IPCAPJ U-Plane, Frame 0, Subframe: 0, Siot: 0, Symbol: 10, Section: 0, PR8:         161       IPCAPJ U-Plane, Frame 0, Subframe: 0, Siot: 0, Symbol: 10, Section: 0, PR8:         162       IPCAPI U-Plane, Frame: 0, Subframe: 0, Siot: 0, Symbol: 10, Section: 0, PR									
11161       IPCAPI U-Plane, Frame 0, Subframe: 0, Siot 0, Symbol: 2, Section: 0, PRB:         1161       IPCAPI U-Plane, Frame 0, Subframe: 0, Siot 0, Symbol: 3, Section: 0, PRB:         1161       IPCAPI U-Plane, Frame 0, Subframe: 0, Siot: 0, Symbol: 5, Section: 0, PRB:         1161       IPCAPI U-Plane, Frame 0, Subframe: 0, Siot: 0, Symbol: 6, Section: 0, PRB:         1161       IPCAPI U-Plane, Frame 0, Subframe: 0, Siot: 0, Symbol: 6, Section: 0, PRB:         1161       IPCAPI U-Plane, Frame 0, Subframe: 0, Siot: 0, Symbol: 6, Section: 0, PRB:         1161       IPCAPI U-Plane, Frame 0, Subframe: 0, Siot: 0, Symbol: 8, Section: 0, PRB:         1161       IPCAPI U-Plane, Frame 0, Subframe: 0, Siot: 0, Symbol: 8, Section: 0, PRB:         1161       IPCAPI U-Plane, Frame 0, Subframe: 0, Siot: 0, Symbol: 10, Section: 0, PRB:         1161       IPCAPI U-Plane, Frame 0, Subframe: 0, Siot: 0, Symbol: 10, Section: 0, PRB:         1161       IPCAPI U-Plane, Frame 0, Subframe: 0, Siot: 0, Symbol: 10, Section: 0, PRB:         1161       IPCAPI U-Plane, Frame 0, Subframe: 0, Siot: 0, Symbol: 10, Section: 0, PRB:         1161       IPCAPI U-Plane, Frame 0, Subframe: 0, Siot: 0, Symbol: 10, Section: 0, PRB:         1161       IPCAPI U-Plane, Frame 0, Subframe: 0, Siot: 0, Symbol: 10, Section: 0, PRB:         1161       IPCAPI U-Plane, Frame 0, Subframe: 0, Siot: 0, Symbol: 10, Section: 0, PRB:         1161       IPCAPI U-Plane, Frame 0, Subframe: 0, Siot: 0, Symbol:	161       IPCAPJ U-Plane, Frame 0, Subframe: 0, Siot 0, Symbol: 2, Section: 0, PR8:         161       IPCAPJ U-Plane, Frame 0, Subframe: 0, Siot: 0, Symbol: 3, Section: 0, PR8:         161       IPCAPJ U-Plane, Frame 0, Subframe: 0, Siot: 0, Symbol: 5, Section: 0, PR8:         161       IPCAPJ U-Plane, Frame 0, Subframe: 0, Siot: 0, Symbol: 5, Section: 0, PR8:         161       IPCAPJ U-Plane, Frame 0, Subframe: 0, Siot: 0, Symbol: 5, Section: 0, PR8:         161       IPCAPJ U-Plane, Frame 0, Subframe: 0, Siot: 0, Symbol: 6, Section: 0, PR8:         161       IPCAPJ U-Plane, Frame 0, Subframe: 0, Siot: 0, Symbol: 8, Section: 0, PR8:         161       IPCAPJ U-Plane, Frame 0, Subframe: 0, Siot: 0, Symbol: 8, Section: 0, PR8:         161       IPCAPJ U-Plane, Frame 0, Subframe: 0, Siot: 0, Symbol: 8, Section: 0, PR8:         161       IPCAPJ U-Plane, Frame 0, Subframe: 0, Siot: 0, Symbol: 8, Section: 0, PR8:         161       IPCAPJ U-Plane, Frame 0, Subframe: 0, Siot: 0, Symbol: 10, Section: 0, PR8:         161       IPCAPJ U-Plane, Frame 0, Subframe: 0, Siot: 0, Symbol: 10, Section: 0, PR8:         161       IPCAPJ U-Plane, Frame 0, Subframe: 0, Siot: 0, Symbol: 10, Section: 0, PR8:         162       IPCAPJ U-Plane, Frame 0, Subframe: 0, Siot: 0, Symbol: 10, Section: 0, PR8:         163       IPCAPJ U-Plane, Frame 0, Subframe: 0, Siot: 0, Symbol: 10, Section: 0, PR8:         164       IPCAPJ U-Plane, Frame 0, Subframe: 0, Siot: 0, Symbol: 10, Section: 0, P									
1161       IPCAPJ U-Plane, Frame 0, Subframe: 0, Sito 0, Symbol: 4, Section: 0, PR8:         1161       IPCAPJ U-Plane, Frame 0, Subframe: 0, Sito 0, Symbol: 5, Section: 0, PR8:         1161       IPCAPJ U-Plane, Frame 0, Subframe: 0, Sito 0, Symbol: 5, Section: 0, PR8:         1161       IPCAPJ U-Plane, Frame 0, Subframe: 0, Sito 0, Symbol: 7, Section: 0, PR8:         1161       IPCAPJ U-Plane, Frame 0, Subframe: 0, Sito 0, Symbol: 7, Section: 0, PR8:         1161       IPCAPJ U-Plane, Frame 0, Subframe: 0, Sito: 0, Symbol: 9, Section: 0, PR8:         1161       IPCAPJ U-Plane, Frame 0, Subframe: 0, Sito: 0, Symbol: 10, Section: 0, PR8:         1161       IPCAPJ U-Plane, Frame 0, Subframe: 0, Sito: 0, Symbol: 10, Section: 0, PR8:         1161       IPCAPJ U-Plane, Frame 0, Subframe: 0, Sito: 0, Symbol: 10, Section: 0, PR8:         1161       IPCAPJ U-Plane, Frame 0, Subframe: 0, Sito: 0, Symbol: 10, Section: 0, PR8:         1161       IPCAPJ U-Plane, Frame 0, Subframe: 0, Sito: 0, Symbol: 10, Section: 0, PR8:         1161       IPCAPJ U-Plane, Frame 0, Subframe: 0, Sito: 0, Symbol: 0, Section: 0, PR8:         1161       IPCAPJ U-Plane, Frame 0, Subframe: 0, Sito: 0, Symbol: 0, Section: 0, PR8:         1161       IPCAPJ U-Plane, Frame 0, Subframe: 0, Sito: 0, Symbol: 0, Section: 0, PR8:         1161       IPCAPJ U-Plane, Frame 0, Subframe: 0, Sito: 0, Symbol: 0, Section: 0, PR8:         1161       IPCAPJ U-Plane, Frame 0, Subframe: 0, Sito: 0, Symbol: 0, Se	161       IPCAPJ U Plane, Frame 0, Subframe: 0, Siot: 0, Symbol: 4, Section: 0, PRB:         161       IPCAPJ U Plane, Frame 0, Subframe: 0, Siot: 0, Symbol: 5, Section: 0, PRB:         161       IPCAPJ U Plane, Frame 0, Subframe: 0, Siot: 0, Symbol: 7, Section: 0, PRB:         161       IPCAPJ U Plane, Frame 0, Subframe: 0, Siot: 0, Symbol: 7, Section: 0, PRB:         161       IPCAPJ U Plane, Frame 0, Subframe: 0, Siot: 0, Symbol: 7, Section: 0, PRB:         161       IPCAPJ U Plane, Frame 0, Subframe: 0, Siot: 0, Symbol: 8, Section: 0, PRB:         161       IPCAPJ U Plane, Frame 0, Subframe: 0, Siot: 0, Symbol: 8, Section: 0, PRB:         161       IPCAPJ U Plane, Frame 0, Subframe: 0, Siot: 0, Symbol: 8, Section: 0, PRB:         161       IPCAPJ U Plane, Frame 0, Subframe: 0, Siot: 0, Symbol: 10, Section: 0, PRB:         161       IPCAPJ U Plane, Frame 0, Subframe: 0, Siot: 0, Symbol: 10, Section: 0, PRB:         161       IPCAPJ U Plane, Frame 0, Subframe: 0, Siot: 0, Symbol: 10, Section: 0, PRB:         161       IPCAPJ U Plane, Frame 0, Subframe: 0, Siot: 0, Symbol: 10, Section: 0, PRB:         161       IPCAPJ U Plane, Frame 0, Subframe: 0, Siot: 0, Symbol: 10, Section: 0, PRB:         162       IPCAPJ U Plane, Frame 0, Subframe: 0, Siot: 0, Symbol: 10, Section: 0, PRB:         163       IPCAPJ U Plane, Frame 0, Subframe: 0, Siot: 0, Symbol: 10, Section: 0, PRB:         164       IPCAPJ U Plane, Frame 0, Subframe: 0, Siot: 0, Symbol: 10, Section: 0									
11161       IPCAPJ U-Plane, Frame 3, Subframe: 0, Stot 0, Symbol: 5, Section: 0, PR8:         1161       IPCAPJ U-Plane, Frame 3, Subframe: 0, Stot 0, Symbol: 6, Section: 0, PR8:         1161       IPCAPJ U-Plane, Frame 3, Subframe: 0, Stot 0, Symbol: 6, Section: 0, PR8:         1161       IPCAPJ U-Plane, Frame 3, Subframe: 0, Stot 0, Symbol: 8, Section: 0, PR8:         1161       IPCAPJ U-Plane, Frame 3, Subframe: 0, Stot 0, Symbol: 8, Section: 0, PR8:         1161       IPCAPJ U-Plane, Frame 3, Subframe: 0, Stot 0, Symbol: 10, Section: 0, PR8:         1161       IPCAPJ U-Plane, Frame 3, Subframe: 0, Stot 0, Symbol: 10, Section: 0, PR8:         1161       IPCAPJ U-Plane, Frame 3, Subframe: 0, Stot 0, Symbol: 10, Section: 0, PR8:         1161       IPCAPJ U-Plane, Frame 3, Subframe: 0, Stot 0, Symbol: 10, Section: 0, PR8:         1161       IPCAPJ U-Plane, Frame 3, Subframe: 0, Stot 0, Symbol: 10, Section: 0, PR8:         1161       IPCAPJ U-Plane, Frame 3, Subframe: 0, Stot 0, Symbol: 10, Section: 0, PR8:         1161       IPCAPJ U-Plane, Frame 3, Subframe: 0, Stot 0, Symbol: 10, Section: 0, PR8:         1161       IPCAPJ U-Plane, Frame 3, Subframe: 0, Stot 0, Symbol: 10, Section: 0, PR8:         1161       IPCAPJ U-Plane, Frame 3, Subframe: 0, Stot 0, Symbol: 10, Section: 0, PR8:         1161       IPCAPJ U-Plane, Frame 3, Subframe: 0, Stot 0, Symbol: 10, Section: 0, PR8:         1161       IPCAPJ U-Plane, Frame 3, Subframe: 0, Stot 0, Symbol: 10, Sectio	161       IPCAPJ U-Plane, Frame 0, Subframe: 0, Siot: 0, Symbol: 5, Section: 0, PR8:       Image: C-Plane:       Image: C-Plane: <thimage: c-plane:<="" th="">       Image: C-Plane:&lt;</thimage:>	[PCAP] U-Plane, Frame :0, Subframe: 0, Slot: 0, Symbol: 3, Section: 0, PRB:								
Other       Other       Other       Dir       eAxC       µ       DU Port       Band Sector       CC         1161       IPCAPJ U-Flane, Frame 0, Subframe: 0, Siot 0, Symbol: 5, Section: 0, PR8:       0       0       0       0       0       0       0       0       0       0       0       1       DL       0001       1       0       0       0       0       1       DL       0001       1       0       0       0       1       DL       0001       1       0       0       0       0       1       DL       0001       1       0	101       IPCAPJ Prane, Frame 0, Subframe. 0, Sico 0, Symbol: 0, Section. 0, PR8:         101       IPCAPJ U-Pfane, Frame 0, Subframe. 0, Sico 0, Symbol: 7, Section. 0, PR8:         101       IPCAPJ U-Pfane, Frame 0, Subframe. 0, Sico 0, Symbol: 7, Section. 0, PR8:         101       IPCAPJ U-Pfane, Frame 0, Subframe. 0, Sico 0, Symbol: 7, Section. 0, PR8:         101       IPCAPJ U-Pfane, Frame 0, Subframe. 0, Sico 0, Symbol: 7, Section. 0, PR8:         101       IPCAPJ U-Pfane, Frame 0, Subframe. 0, Sico 0, Symbol: 10, Section. 0, PR8:         101       IPCAPJ U-Pfane, Frame 0, Subframe. 0, Sico 0, Symbol: 10, Section. 0, PR8:         101       IPCAPJ U-Pfane, Frame 0, Subframe. 0, Sico 0, Symbol: 10, Section. 0, PR8:         101       IPCAPJ U-Pfane, Frame 0, Subframe. 0, Sico 0, Symbol: 10, Section. 0, PR8:         101       IPCAPJ U-Pfane, Frame 0, Subframe. 0, Sico 0, Symbol: 10, Section. 0, PR8:         101       IPCAPJ U-Pfane, Frame 0, Subframe. 0, Sico 0, Symbol: 10, Section. 0, PR8:         101       IPCAPJ U-Pfane, Frame 0, Subframe. 0, Sico 0, Symbol: 10, Section. 0, PR4:         101       IPCAPJ U-Pfane, Frame 0, Subframe. 0, Sico 0, Symbol: 10, Section. 0, PR4:         101       IPCAPJ U-Pfane, Frame 0, Subframe. 0, Sico 0, Symbol: 10, Section. 0, PR4:         101       IPCAPJ U-Pfane, Frame 0, Subframe. 0, Sico 0, Symbol: 10, Section. 0, PR4:         101       IPCAPJ U-Pfane, Frame 0, Subframe. 0, Sico 0, Symbol: 10, Section. 0, PR4:	[PCAP] U-Plane, Frame :0, Subframe: 0, Stot: 0, Symbol: 4, Section: 0, PRB:							195	
1161       IPCAPJ U-Plane, Frame 0, Subframe: 0, Slot 0, Symbol: 7, Section: 0, PRB:         1161       IPCAPJ U-Plane, Frame 0, Subframe: 0, Slot 0, Symbol: 8, Section: 0, PRB:         1161       IPCAPJ U-Plane, Frame 0, Subframe: 0, Slot: 0, Symbol: 10, Section: 0, PRB:         1161       IPCAPJ U-Plane, Frame 0, Subframe: 0, Slot: 0, Symbol: 10, Section: 0, PRB:         1161       IPCAPJ U-Plane, Frame 0, Subframe: 0, Slot: 0, Symbol: 10, Section: 0, PRB:         1161       IPCAPJ U-Plane, Frame 0, Subframe: 0, Slot: 0, Symbol: 10, Section: 0, PRB:         1161       IPCAPJ U-Plane, Frame 0, Subframe: 0, Slot: 0, Symbol: 10, Section: 0, PRB:         1161       IPCAPJ U-Plane, Frame 0, Subframe: 0, Slot: 0, Symbol: 10, Section: 0, PRB:         1161       IPCAPJ U-Plane, Frame 0, Subframe: 0, Slot: 0, Symbol: 10, Section: 0, PRB:         1161       IPCAPJ U-Plane, Frame 0, Subframe: 0, Slot: 0, Symbol: 10, Section: 0, PRB:         1161       IPCAPJ U-Plane, Frame 0, Subframe: 0, Slot: 0, Symbol: 10, Section: 0, PRB:         1161       IPCAPJ U-Plane, Frame 0, Subframe: 0, Slot: 0, Symbol: 10, Section: 0, PRB:         1161       IPCAPJ U-Plane, Frame 0, Subframe: 0, Slot: 0, Symbol: 10, Section: 0, PRB:         1161       IPCAPJ U-Plane, Frame 0, Subframe: 0, Slot: 0, Symbol: 10, Section: 0, PRB:         1161       IPCAPJ U-Plane, Frame 0, Subframe: 0, Slot: 0, Symbol: 10, Section: 0, PRB:         1161       IPCAPJ U-Plane, Frame 0, Subframe: 0, Slot: 0, Sy	161       IPCAPJ U-Plane, Frame 0, Subframe: 0, Siot 0, Symbol: 7, Section: 0, PRB:         161       IPCAPJ U-Plane, Frame 0, Subframe: 0, Siot 0, Symbol: 8, Section: 0, PRB:         161       IPCAPJ U-Plane, Frame 0, Subframe: 0, Siot 0, Symbol: 9, Section: 0, PRB:         161       IPCAPJ U-Plane, Frame 0, Subframe: 0, Siot 0, Symbol: 9, Section: 0, PRB:         161       IPCAPJ U-Plane, Frame 0, Subframe: 0, Siot 0, Symbol: 10, Section: 0, PRB:         161       IPCAPJ U-Plane, Frame 0, Subframe: 0, Siot 0, Symbol: 10, Section: 0, PRB:         161       IPCAPJ U-Plane, Frame 0, Subframe: 0, Siot 0, Symbol: 10, Section: 0, PRB:         161       IPCAPJ U-Plane, Frame 0, Subframe: 0, Siot 0, Symbol: 10, Section: 0, PRB:         162       O 01 02 03 04 05 06 07 08 09 0A 06 0C 00 0E 0F         Recovered IQ Constellation         PRB: (none selected)	[PCAP] U-Plane, Frame :0, Subframe: 0, Slot: 0, Symbol: 5, Section: 0, PRB:	C-PI	ane:						
1161       [PCAP] U Plane, Frame 0, Subframe: 0, Stot 0, Symbol: 8, Section: 0, PRB:         1161       [PCAP] U Plane, Frame 0, Subframe: 0, Stot 0, Symbol: 9, Section: 0, PRB:         1161       [PCAP] U Plane, Frame 0, Subframe: 0, Stot 0, Symbol: 9, Section: 0, PRB:         1161       [PCAP] U Plane, Frame 0, Subframe: 0, Stot 0, Symbol: 9, Section: 0, PRB:         1261       [PCAP] U Plane, Frame 0, Subframe: 0, Stot 0, Symbol: 10, Section: 0, PRB:         1261       [PCAP] U Plane, Frame 0, Subframe: 0, Stot 0, Symbol: 10, Section: 0, PRB:         1261       [PCAP] U Plane, Frame 0, Subframe: 0, Stot 0, Symbol: 10, Section: 0, PRB:         1261       [PCAP] U Plane, Frame 0, Subframe: 0, Stot 0, Symbol: 10, Section: 0, PRB:         1261       [PCAP] U Plane, Frame 0, Subframe: 0, Stot 0, Symbol: 10, Section: 0, PRB:         1261       [PCAP] U Plane, Frame 0, Subframe: 0, Stot 0, Symbol: 10, Section: 0, PRB:         1261       [PCAP] U Plane, Frame 0, Subframe: 0, Stot 0, Symbol: 10, Section: 0, PRB:         1261       [PCAP] U Plane, Frame 0, Subframe: 0, Stot 0, Symbol: 10, Section: 0, PRB:         1261       [PCAP] U Plane, Frame 0, Subframe: 0, Stot 0, Symbol: 10, Section: 0, PRB:         1261       [PCAP] U Plane, Frame 0, Subframe: 0, Stot 0, Symbol: 10, Section: 0, PRB:         1261       [PCAP] U Plane, Frame 0, Subframe: 0, Stot 0, Symbol: 10, Section: 0, PRB:         1262       [PCAP] U Plane, Frame 0, Stot 0, Symbol: 10, Section: 0, PRB: <td>161       IPCAPJ U-Plane, Frame 0, Subframe: 0, Slot: 0, Symbol: 0, Section: 0, PRB:         161       IPCAPJ U-Plane, Frame 0, Subframe: 0, Slot: 0, Symbol: 9, Section: 0, PRB:         161       IPCAPJ U-Plane, Frame 0, Subframe: 0, Slot: 0, Symbol: 10, Section: 0, PRB:         161       IPCAPJ U-Plane, Frame 0, Subframe: 0, Slot: 0, Symbol: 10, Section: 0, PRB:         170       0         171       0         172       0         173       0         174       0         175       IPCAPJ U-Plane, Frame 0, Subframe: 0, Slot: 0, Symbol: 10, Section: 0, PRB:         175       IPCAPJ U-Plane, Frame 0, Subframe: 0, Slot: 0, Symbol: 10, Section: 0, PRB:         175       IPCAPJ U-Plane, Frame 0, Subframe: 0, Slot: 0, Symbol: 10, Section: 0, PRB:         176       IPCAPJ U-Plane, Frame 0, Subframe: 0, Slot: 0, Symbol: 10, Section: 0, PRB:         177       IPCAPJ U-Plane, Frame 0, Subframe: 0, Slot: 0, Symbol: 10, Section: 0, PRB:         178       IPCAPJ U-Plane, Frame 0, Subframe: 0, Slot: 0, Symbol: 10, Section: 0, PRB:         179       IPCAPJ U-Plane, Frame 0, Subframe: 0, Slot: 0, Symbol: 10, Section: 0, PRB:         170       IPCAPJ U-Plane, Frame 0, Subframe: 0, Slot: 0, Symbol: 0, Section: 0, PRB:         171       IPCAPJ U-Plane, Frame 0, Subframe: 0, Slot: 0, Symbol: 0, Section: 0, PRB:         171       IPCAPJ U-Plane, Frame 0, Subframe: 0, Slot: 0, S</td> <td></td> <td></td> <td>Dir</td> <td>eAxC</td> <td>DU Port</td> <td>Band Sector</td> <td>CC</td> <td></td> <td></td>	161       IPCAPJ U-Plane, Frame 0, Subframe: 0, Slot: 0, Symbol: 0, Section: 0, PRB:         161       IPCAPJ U-Plane, Frame 0, Subframe: 0, Slot: 0, Symbol: 9, Section: 0, PRB:         161       IPCAPJ U-Plane, Frame 0, Subframe: 0, Slot: 0, Symbol: 10, Section: 0, PRB:         161       IPCAPJ U-Plane, Frame 0, Subframe: 0, Slot: 0, Symbol: 10, Section: 0, PRB:         170       0         171       0         172       0         173       0         174       0         175       IPCAPJ U-Plane, Frame 0, Subframe: 0, Slot: 0, Symbol: 10, Section: 0, PRB:         175       IPCAPJ U-Plane, Frame 0, Subframe: 0, Slot: 0, Symbol: 10, Section: 0, PRB:         175       IPCAPJ U-Plane, Frame 0, Subframe: 0, Slot: 0, Symbol: 10, Section: 0, PRB:         176       IPCAPJ U-Plane, Frame 0, Subframe: 0, Slot: 0, Symbol: 10, Section: 0, PRB:         177       IPCAPJ U-Plane, Frame 0, Subframe: 0, Slot: 0, Symbol: 10, Section: 0, PRB:         178       IPCAPJ U-Plane, Frame 0, Subframe: 0, Slot: 0, Symbol: 10, Section: 0, PRB:         179       IPCAPJ U-Plane, Frame 0, Subframe: 0, Slot: 0, Symbol: 10, Section: 0, PRB:         170       IPCAPJ U-Plane, Frame 0, Subframe: 0, Slot: 0, Symbol: 0, Section: 0, PRB:         171       IPCAPJ U-Plane, Frame 0, Subframe: 0, Slot: 0, Symbol: 0, Section: 0, PRB:         171       IPCAPJ U-Plane, Frame 0, Subframe: 0, Slot: 0, S			Dir	eAxC	DU Port	Band Sector	CC		
Payload:         Recovered IQ         Constellation           Payload:	161       IPCAPJ U-Plane, Frame 0, Subframe: 0, Siot 0, Symbol: 9, Section: 0, PRB:         161       IPCAPJ U-Plane, Frame 0, Subframe: 0, Siot 0, Symbol: 10, Section: 0, PRF         2       2         Payload:       *         x       00       01       02       03       04       05       06       07       08       00       00       0E       0F         Recovered IQ       Constellation       PRB: (none selected)       PRB: (none selected)       PRB: (none selected)       PRB: (none selected)				0002					
It61         IPCAP[ U-Plane, Frame: 0, Slubframe: 0, S	161       [PCAP] U-Plane, Frame :0, Subframe: 0, Sight :0, Symbol: 10, Section: 0, PRI         >       >         Payload:				0001					
Payload: Recovered IQ Constellation PRB: (none selected)	Payload: x 00 01 02 03 04 05 06 07 08 09 0A 08 0C 00 0E 0F PR8:(none selected)									
Recovered IQ         Constellation           PRB: (none selected)         PRB: (none selected)	Payload: x 00 01 02 03 04 05 06 07 08 09 0A 08 0C 00 0E 0F PRB: (none selected)	[PCAP] U-Plane, Frame :0, Subframe: 0, Slot: 0, Symbol: 10, Section: 0, PRI								
re uumpi uumpi i u			PRB	: (none	selected)					

Figure 184 Recovering IQ waveform for the selected flow

The ORB file is generated, which contains the recovered IQ data, is required to view the recovered data in the *89600 VSA* software. The files can be found in the same folder where the PCAP, ORSTX and SCP files are located.

simple_5gnr.2_mu0_ant1.iqf	IQF File	7/7/2021 7:02 PM	2,673 KB
simple_5gnr.2_mu0_ant1.iqt.orb	ORB File	7/7/2021 7:02 PM	608 KB
simple_5gnr.orstx	ORSTX File	7/7/2021 7:02 PM	8 KB
simple_5gnr.pcap	PCAP File	7/7/2021 7:01 PM	3,566 KB
simple_5gnr.NR_Carrier_1_DL.setx	SETX File	7/7/2021 7:01 PM	135 KB
simple_5gnr.scp	Text Document	3/18/2021 4:20 PM	67 KB
simple_ltefdd.scp	Text Document	3/18/2021 4:20 PM	1,293 KB

Figure 185 Recovering IQ waveform for the selected flow

Since the IQ data has been recovered from the 5G NR signal, you require the SETX and ORB files to view the recovered IQ data in the 89600 VSA software. See Recovering IQ flow in O-RAN Studio & 89600 VSA on page 128 to see how to view the recovered IQ data in the 89600 VSA software

Note that the O-RAN Studio software does not generate a SETX file from the SCP file for LTE. Instead, you can proceed with loading the ORB file containing the IQ data. See Recovering IQ from LTE on page 241 for more information on recovering IQ data from LTE signal using the *89600 VSA* software.

#### 3.6.2: Configuring LTE Coexistence - DSS

DSS (Dynamic Spectrum Sharing), also known as NR and LTE coexistence, enables 5G to share the same spectrum used by LTE today. This allows gradual migration from 4G to 5G. Operators can keep LTE service while deploying 5GNR on top. DSS must make the combined 5G/LTE downlink to be seamless for LTE UEs because most of the LTE UEs were deployed before 5G NR was introduced.

When 5GNR subcarrier spacing (SCS) is 15kHz, it is possible to configure sharing spectrum with LTE, since the LTE subcarrier spacing is the same. To avoid signal scheduling conflicts, the 5GNR overlay must avoid known LTE channels and signals (including PDCCH, CRS, PSS/SSS/PBCH) that are always transmitted. If 5GNR uses these same resources, the LTE UE will not receive the LTE DL signal correctly. At the same time, 5G NR devices must detect the 5G synchronization signal block (SSB) to access the network. To prevent a conflict between 5G SSB and LTE cell-specific reference signal (CRS), a combination of MBSFN (Multimedia Broadcast Single Frequency Network) and normal LTE subframes are used.

**NOTE** Since Open RAN Studio is designed primarily for the measurement of 5G NR signals, the 5G NR SCP file must be loaded first and subsequently, you can add the LTE SCP file to obtain DSS. You cannot add 5G NR SCP after loading LTE SCP file.

To configure a combined LTE and 5G NR waveform, we shall use one LTE MBSFN subframe to transmit NR SSBlock and seven LTE Normal subframes to transmit 5G NR PDCCH and PDSCH plus LTE control channels.

Figure 186 shows a graphical view of the LTE Normal subframe configuration used in this example (MBSFN not shown). LTE CRS is always ON. When 5G-NR physical downlink shared channel (PDSCH) uses 15 kHz SCS, the subcarriers of LTE and 5G-NR are also orthogonal. A 5G-NR user is configured with the LTE CRS frequency information so that you can calculate the LTE CRS positions as reserved resources, and the 5G-NR PDSCH rate will match around those reserved resources. By rate matching, 5G-NR PDSCH can also be scheduled on the OFDM symbols with CRS, but on the subcarriers not occupied by CRS, as shown below in grey and green.

The additional 5G PDSCH Demodulation Reference Signal (DMRS) additional position should have been on Symbol #11. However, for DSS, because there is an LTE CRS on Symbol #11, the DMRS must move to Symbol #12 as shown here. Such configuration is supported by the 89600 VSA software and Signal Studio software.

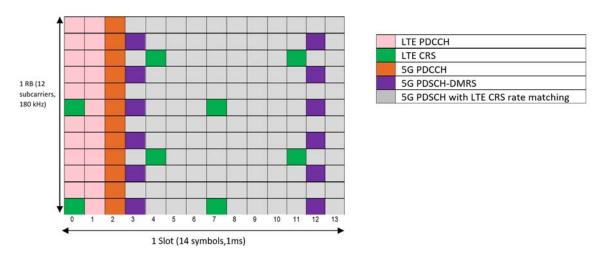


Figure 186 Graphical view of the LTE Normal subframe configuration

Perform the following LTE and 5G NR configuration:

### Table 9 LTE Configuration for DSS

Parameter	Value
Cell ID	0
# of antennas	1
Duplex type	FDD
System Bandwidth	20MHz
Allocated Normal subframes	#0, #5
Allocated MBSFN subframe	#1
Modulation Type	64QAM
PDCCH symbols	2 (that is, symbols 0 & 1)

Parameter	Value
Cell ID	0
# of antennas	1
Duplex type	FDD
System Bandwidth	20MHz
Allocated subframes	#1-4, #6-9
Modulation Type	64QAM
Downlink Control Information (DCI) first symbol	2 (Symbols 0 & 1 used by LTE PDCCH)
PDSCH symbol allocation	3-13
DMRS Additional Position	1 (that is, there is a 2 <sup>nd</sup> DMRS transmitted)

#### Table 10 5G NR Configuration for DSS

#### LTE-FDD Configuration in N7624C Signal Studio

Perform the following configuration in the N7624C Signal Studio software:

- 1 Delete Carrier and add carrier as LTE-A Pro FDD, Advanced FDD Downlink CA, E-UTRA Downlink CC.
- 2 Under the **Downlink** node on the left under Component Carrier 1, select a **Predefined Config** as **Full Filled 64QAM 20MHz (100RB)**.
- 3 Confirm **Cell ID** is set to **0**.
- 4 Under the **Channel Setup** node on the left, select **#1 DCI** (first row of the table), set **PDCCH Allocations** to **2,2,2,2,2,2,2,2,2,2,2**. All PDCCHs will occupy 2 symbols per subframe. See the pink boxes in the resource element diagram in Figure 186.
- Still under the Channel Setup node, select #3 DL-SCH1, and set Transmission Configuration Length (under transmission settings) to 10 ms.
- 6 Select the **Transmission Configuration** row and click [...] at the far right to open **DL-SCH1 Tx Sequence** window.
  - Under State, clear all except for Subframe #0 and #5 and click OK to close.
- 7 Under Channel Setup, select #13 MCH to make MBSFN settings.
- 8 Set State to ON.
- 9 Set **Allocation Bitmap** = 1,0,0,0,0 (only the first possible MBSFN subframe will be used to transmit 5G NR SSB).

10 Set **Transmit PMCH and MBSFN RS on MBSFN Region** to **OFF**. Note that this step is possible only with the latest version of the Signal Studio software.

# NOTE

The "Non-MBSFN Region Length" is set to 2 by default, which shall be used for the configuration. MBSFN subframe contains a control region of length one or two OFDM symbols, these are same control symbols as the normal subframe. The rest of the symbols are used for MBSFN.

The LTE Channel allocation should appear as shown in Figure 187. Notice that nothing (even CRS) is transmitted in the MBSFN region (Slots 2-3 or Subframe #1). This makes room for 5GNR to use for SSB transmission.

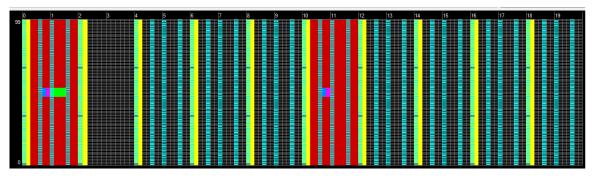


Figure 187 LTE Channel Allocation after configuration for DSS

### 5G NR Configuration in PathWave Signal Generation Desktop 2022

Perform the following configuration in the PathWave Signal Generation Desktop 2022 software using the default Downlink carrier:

- Under "Carrier 1 (DL)", click Full-Filled Config button at the top. In the dialog that results, select FR1 20MHz for Bandwidth, u=0: 15kHz for Numerology and 64QAM for Modulation. Then, click OK.
- 2 Under Channel Setup, click SS/PBCH tab.
- 3 Set **Active Indices** to **2:3**. The blank space in slots 2 and 3 from the LTE setup transmits SSB only within the MBSFN subframe, to avoid conflict with LTE-CRS.
- 4 Click **DCI** tab. Select **Enabled** to **ON**. Set **Allocated Slots** to **2:4**, **6:9** (ignore the conflict error message that you may see).

5 Set First Symbol to 2. Note that LTE PDCCH is occupying symbols 0 &
1. Use default settings for the other DCI parameters.

You additionally need the RNTI (that is, 0) and aggregation level (that is, 4) information for 'Demod.' Note these values as the VSA default for these parameters are not the same as that in Signal Studio.

- 6 Click **DL-SCH** tab. Under **Resource Allocation**, set **Allocated Slots** to **2:4, 6:9**. Then, set **First Symbol** to **3** (after CORESET symbol).
- 7 Under **DMRS Settings**, set **DMRS-add-pos** to **1** (an additional DMRS is transmitted on Symbol #11, which is typically done to help with channel estimation. However, it moves to Symbol #12, when DSS is enabled).
- 8 Set **DMRS-typeA-pos** to **3** (that is, the DMRS is transmitted on the first symbol of DL-SCH, which is Symbol #3).
- 9 Click **LTE Coexistence** tab. Set **Enabled** to **ON**.
- 10 Set LTE Bandwidth to 20MHz.
- 11 Set **LTE Carrier Offset** to **Point A** to **636**. This sets LTE and 5GNR center to be the same.

NOTE

This parameter sets positioning of the LTE carrier against 5G NR. When single numerology is selected, Point A is the lower edge of 5G NR carrier. The offset specifies the LTE carrier center location from Point A with the number of subcarriers. For 20 MHz BW and 15kHz SCS, there are 106 RBs in the resource grid. So, we use 636 (=53RB \* 12) to have the LTE and 5G NR center to be the same.

- 12 Set MBSFN Subframes to 1.
- 13 Set Number of CRS Antenna Ports to 1 and v-shift to 0. These parameters determine LTE-CRS position (which the 5G NR PDSCH must avoid from using). 'v-Shift' is derived from LTE Cell ID with 'cell ID mod 6'. Set LTE Cell ID to 0, so that v-Shift value is 0.
- 14 Set **additionalDMRS-DL-Alt** to **ON**. This moves the additional 5G PDSCH DMRS position to Symbol #12 (from Symbol #11). Note that this is a UE capability. The UE must notify the network, where it supports this feature.

At this point, the channel allocation should look like that which is shown in Figure 188. White line indicates LTE CRS. Notice that 5GNR DL-SCH occupies the same frequency as LTE where CRS is transmitted.

	0 = 8			PathWave Signal Ge	eneration Deskt	ор		? – 🗆 X
A Home 5G NR ×								
🖒 Generate 🛓 Generate &	Download	Carrier Wave	orm Hardware				+ Import Signal Setu	p [→ Export Signal Setup
🚥 Full-filled Config 🛛 🕇 DL. Tes	t Model 👩 DL FRC Confi	ig 🔷 Auto Frequency Offset	Export 89600	VSA Setup				
+ - 0		SS/PBCH DCI DL-SCH	CSI-RS PRS					
Carrier 0 (DL)     BWP Setup     Channel Setup						20 MHz (100585) ~ 50 MHz (100585) ~ 50 (01z) 1 (01z) 1 ~ 0		
Channel Allocation							Frame 0 🗸	µ = 0 🏏 🗾 Display Detail
				9 10 \$	DL-SCHI DC11 SLIVICH UTE Consisten ICE Consisten	SubCarrier 12 10 8 6 4 2 0 0 2	LIE Coesistence	10 12 14
Sep 29, 2021, 5:04:35 PM	PC License	Not connected	Carrier 0->DL-SCH1	DMRS is conflict with LTE	E-CRS, the generate	ed signal may not be correct.		Ç.

Figure 188 LTE Coexistence (5G NR Channel Allocation) configuration for DSS

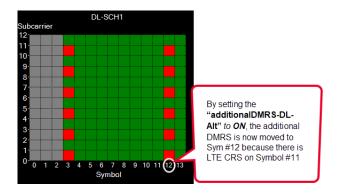


Figure 189 Position of additional DMRS

15 Finally, click **File/Export Waveform Data**, and set waveform file name as "5GNR DL 20MHz DSS.wfm".

#### MSR Configuration in the N7624C Signal Studio software

- 1 Under Waveform Setup, click Add Carrier and add Imported Waveform. New carrier is added as Carrier 1 and LTE Downlink carrier is now Carrier 2.
- 2 With **Carrier 1** selected on the left pane, click **Source Waveform File Name**, click [...] and select *5GNR DL 20MHz DSS.wfm* that was saved in the previous section.
- 3 Click **File/Export Waveform Data**, save as DSS 5GNR LTE.wfm. (Or, if you are connected to a signal generator, click generate and download button, and skip step #5)
- 4 Load the WFM file to your signal generator for playback.

#### Configuring DSS in Open RAN Studio software

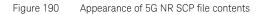
This section shows the configuration of DSS feature to pair the LTE and NR carriers and its functionality with the Extension Type 9 in the Open RAN Studio software.

To begin with, perform the same steps as discussed in Loading the SCP files for 5G NR and LTE in the same instance on page 192.

1 Load an SCP file for 5G NR signal.

The "Select Carrier" drop-down field shows only the "NR Carrier".

Plane Builder / Ex											
Component Carriers		Ra	dio Control F	Plane Da	ta						
Carrier Numerology			Subframe	Slot ID	RB Start	RB Number	Sym Start	Sym Number	Channel	Beam Id	
Select Carrier:	NR Carrier 1 (DL)								SS/PBCH		
									SS/PBCH		
Attribute	Value								PDCCH		
Carrier Type	DL (NR)								PDSCH		
Cell ID									PDCCH		
Bandwidth	FR1_20M										
Numerology Mode	SingleNumerology								PDCCH		
CP Type	Normal								PDSCH		
Allocations									PDCCH		
Flow/eAxC ID	0001	0				106 24			PDSCH PDCCH		
Flow/exactio	0001 ~			0		106			PDCCH		
		0	8	0		24			PDSCH		
Resource Allocations									PDCCH		
Select Allocation:	DCI1 V										
		Radi	o Allocation	s							
Attribute	Value										
Name of allocation	DCI1		a.								
Numerology	SCS15k										
Allocated Slots First Symbol	2:4,6:9 2							-			-
Aggregation Level					_						
Auguregation Cever											
Beam IDs											
Select Beamld: 0								••••••	+		



2 Load the SCP file for the LTE carrier by clicking **File** > **Import** > **Import LTE Setup for DSS...**.

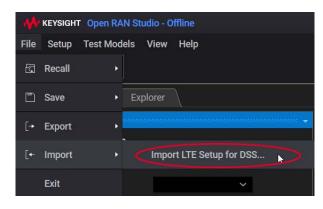


Figure 191 Importing the LTE SCP file in addition to 5G NR SCP file

Plane Builder 🔪 🛛 Ex	plorer								
omponent Carriers		Ra	dio Control F	Nane Dat					
Select Carrier:	LTE Carrier 1 (DL)	μ	Subframe		RB Number	Sym Start	Sym Number	Channel	Beam Id
Attribute	Value				100			PDCCH	
Carrier Type	DL (LTE)				100			PDSCH	
Cell ID	0				100			PDCCH	
Bandwidth	FR1_20M				100			PDCCH	
Numerology Mode	SingleNumerology								
CP Type	Normal				100			CRS	
Allocations	1							CRS	
					100			PDCCH	
Flow/eAxC ID	0001 🗸				100			CRS	
					100			CRS	
Resource Allocations					100			CRS	
Select Allocation:	Advanced.LTE_FDD-DL V	Radi	o Allocation	s					
Attribute	Value		-						
Name of allocation	Advanced.LTE_FDD-DL		* -						
Numerology	SCS15k								
Modulation	-								
Slots	0:9		•						
First Symbol	0								
Last Symbol	13								
Number of Symbols	14		* -						
RB Offset	0								
RB Number	100								

The "LTE Carrier" is displayed in the C-Plane Builder tab. The LTE displays Channels like CRS.

Figure 192 Appearance of LTE Carrier in the C-Plane Builder tab

3 Assign a Flow/eAxC ID to each carrier.

Note that if you assign the same eAxC ID (for example, 0001) to both the LTE and NR carrier, it triggers the generation of Extension Type 9 in C-Plane for DSS.

- 4 Launch the C/U Plane Builder Configuration Tool to make the following configuration changes.
  - In the Options tab, enable the "Use reMask" feature.

C/U Plane Builder	Configuration Tool ×	
Flow/eAxC	Network Layer:	
Compression	Maximum transmission unit (MTU) 9000	
	Disable VLAN Tags VLAN ID: 0	
Numerology	Set Sequence IDs to '0'	
Beamforming		
Timing	C-Plane Section Handling:	
Options	Use reMask	
	Use RB indicator	
DSS	Use Extension Type 6	
	Use Extension Type 10 (MIMO only)	
	PRACH Type 3 as Type 1 Message	
	C-Plane Section Type 0 Messages:	
	don't generate 🗸 🗸	
	U-Plane Package:	
	Create Uplink U-Plane	
	Digital Power Scaling (IQ Data):	
	0 FS adjustment (FS_Offset, default 0 is no scaling)	
	Apply fixed 256QAM scaler	
	0 Additional IQ power scaling (default 0 dBFS is no scaling)	

Figure 193 Enabling remask feature in Configuration Tool

In the DSS tab,

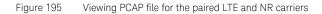
- Select "Enable DSS" check box.
- ii Select the 5G NR Carrier and LTE Carrier in the respective drop-down field.
- iii Click the '+' icon to pair the LTE and NR carrier.

C/U Plane Builder	Configuration Tool
Flow/eAxC	Dynamic Spectrum Sharing :
Compression	🗹 Enable DSS 🕕 👘
Numerology	5GNR Carrier: NR Carrier 1 (DL) V LTE Carrier: LTE Carrier 1 (DL) V +
Beamforming	5G NR Carrier LTE Carrier
Timing	NR Carrier 1 (DL) LTE Carrier 1 (DL)
Options	The added LTE - NR carrier pair is displayed here.
DSS	

Figure 194 Enabling DSS feature in Configuration Tool

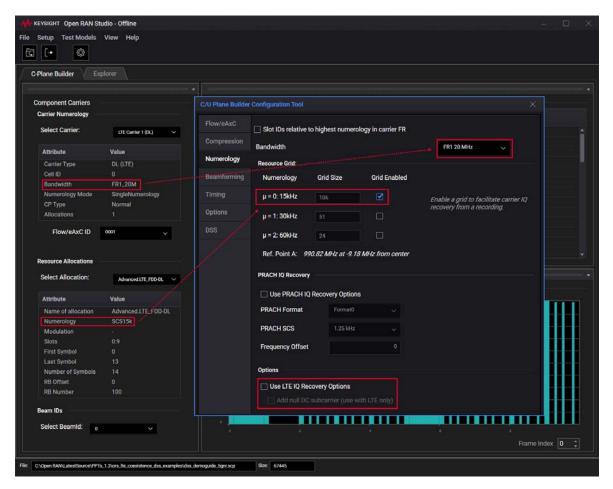
- 5 Exit the C/U Plane Builder Configuration Tool.
- 6 Export the O-RAN Stimulus file.
- 7 Switch to the Explorer tab and load the PCAP file.
- 8 Find the C-Plane message with subframe 2 and symbol 4. Notice in Figure 195 that in this case the NR PDSCH overlaps with LTE CRS. Also,
  - There are two C-Plane messages for this symbol, one below LTE null DC subcarrier, and one above, which is due to reMask mapping to the same resource grid as the carrier type is of DSS.
  - There is Extension Type=9 on each section description
  - · Use of reMask to separate IQ data for LTE and NR, respectively
  - One U-Plane message with IQ data for both LTE and NR, which is also separate in the part below the LTE null DC subcarrier and the part above.

Setup	Test Models View Help			
-Plane B	uilder V Explorer			
-Plane, C	Plane Messages:	U-Plane:	Message Interpretation:	
Length	Description	# Dir eAxC L	NumberOfSections : 2 SectionType : 1	
60 4581 4581	[PCAP] C-Plane, Section Type: 1, Sections: 1, Frame :0, Subframe: 2, Slot: 0, Symbol Start: 0, PRB: : ^ [PCAP] U-Plane, Frame: 0, Subframe: 2, Slot: 0, Symbol: 0, Section: 9, PRB: 3-103 [PCAP] U-Plane, Frame: 0, Subframe: 2, Slot: 0, Symbol: 1, Section: 9, PRB: 3-103	0 DL 0001	User Data Compression Header IqBitWidth : 15 Compression : no compression Reserved	
60	[PCAP] C-Plane, Section Type: 1, Sections: 2, Frame :0, Subframe: 2, Slot: 0, Symbol Start: 2, PR8: (	C-Plane Section C-Plane: # Dir eAxC t Symbolic C: StarPhrb: 55	Value : 0 - C-Plane Section Type 1	
	[PCAP] U-Plane, Frame :0, Subframe: 2, Slot: 0, Symbol: 2, Section: 0, PRB: 0-23		SectionID : 13	
60	[PCAP] C-Plane, Section Type: 1, Sections: 2, Frame :0, Subframe: 2, Slot: 0, Symbol Start: 3, PRB: (		RB : 0 Symbolinc : 0 StartPrbc : 53	
4806	[PCAP] U-Plane, Frame :0, Subframe: 2, Slot: 0, Symbol: 3, Section: 1, PRB: 0-105			
60	[PCAP] C-Plane, Section Type: 1, Sections: 1, Frame: 0, Subframe: 2, Slot: 0, Symbol Start: 4, PRB: 1	0 DL 0001	NumberPrbc : 50	
60 60	[PCAP] C-Plane, Section Type: 1, Sections: 2, Frame :0, Subframe: 2, Slot: 0, Symbol Start: 4, PRB: 1 [PCAP] C-Plane, Section Type: 1, Sections: 2, Frame :0, Subframe: 2, Slot: 0, Symbol Start: 4, PRB: 5		ReMask : 010000010000b NumSymbol : 1	
		< > >	Ef : 1b Beamld : 0 • Section Ext Command Ef : False ExtType : 9	
lex Paylo	ad:	Recovered IQ Constellation	ExtLen : 1 Dynamic Spectrum Sharing Ext Technology : 0 (LTE)	
Hex 00	0 01 02 03 04 05 06 07 08 09 0A 0B 0C 0D 0E 0F ASCII	PRB: (none selected)	<ul> <li>C-Plane Section Type 1</li> </ul>	
0 80	0 09 02 03 04 05 00 00 00 00 00 81 00 E0 00		SectionID : 13 RB : 0	
	E FE 10 02 00 24 00 01 13 80 90 00 20 04 02 01\$	RE uCmpl uCmpQ	Symboline : 0	
	0 00 00 D0 35 32 41 01 80 00 09 01 00 00 00 D0		StartPrbc: 53	
48 35	5 32 BE F1 80 00 09 01 01 00 00 00 52		NumberPrbc : 50 ReMask : 101111101111b	
			NumSymbol: 1 Ef: 1b Beamld: 0 Section Ext Command Ef: False ExtType: 9 ExtLen: 1 Dynamic Spectrum Sharing Ext	



# Recovery of time domain IQ data for inspection in VSA

- 9 Launch the C/U Plane Builder Configuration Tool again to make the following configuration changes, as shown in Figure 196.
  - In the Numerology tab,
    - i Configure Bandwidth
    - ii Configure Numerology
    - iii Disable "Use LTE IQ Recovery Options", if enabled
    - iv Disable "Add null DC subcarrier (use with LTE only)", if enabled





10 Exit the C/U Plane Builder Configuration Tool.

- 11 In the U-Plane area,
  - a Select the flow.
  - b Click icon to filter the selected row.
  - c Click icon to recover IQ waveform.





This creates the ".orb" file containing time domain IQ data for VSA, as shown in Figure 198.

## NOTE

### A ".setx" file is also created, but that cannot be used for DSS analysis.

dss_demoguide_5gnr.1_mu0_ant1.iqf	IQF File
dss_demoguide_5gnr.1_mu0_ant1.iqt.orb	ORB File
dss_demoguide_5gnr.NR_Carrier_1_DL.setx	SETX File
dss_demoguide_5gnr.orstx	ORSTX File
dss_demoguide_5gnr.pcap	PCAP File
dss_demoguide_5gnr.scp	Text Document
dss_demoguide_Itefdd.scp	Text Document

Figure 198 Folder contents where ORB file is created

When this ORB file is loaded into the 89600 VSA software with a Repetition Factor '3', you can view the NR in Measurement 1 windows to the left and LTE in Measurement 2 windows to the right, as shown in Figure 199.

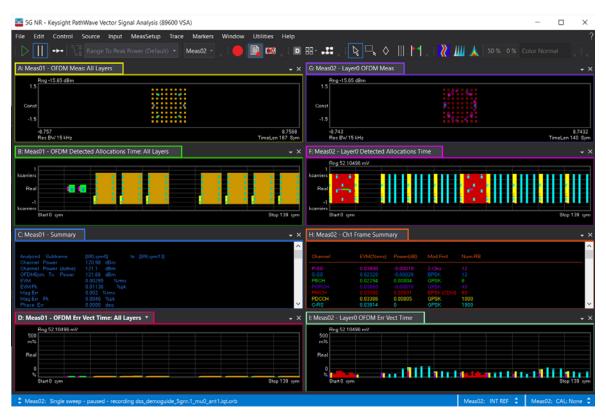


Figure 199 VSA showing NR on left and LTE on right

For more information about how to perform signal analysis in the 89600 VSA software when DSS is used, see Analyzing the signal using the 89600 VSA software on page 219.

#### Analyzing the signal using the 89600 VSA software

To understand the process to analyze the signal using the 89600 VSA software, the following example uses the DSS feature with multi-measurement to demodulate the 5G NR and LTE signals, simultaneously.

- 1 Launch the 89600 VSA software.
- 2 Select NR mode.

From the main menu, click MeasSetup > Measurement Type > Cellular > 5G NR.

3 Set the trace layout to Grid 2x3, and configure center frequency, and input range.

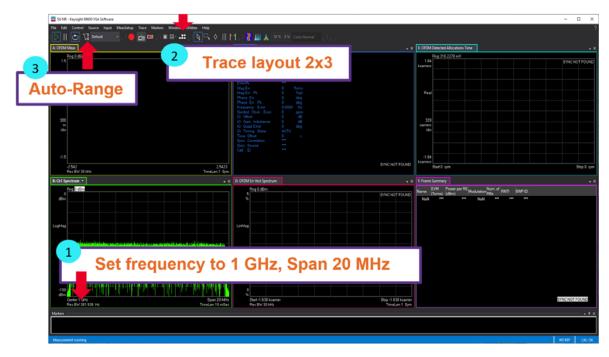


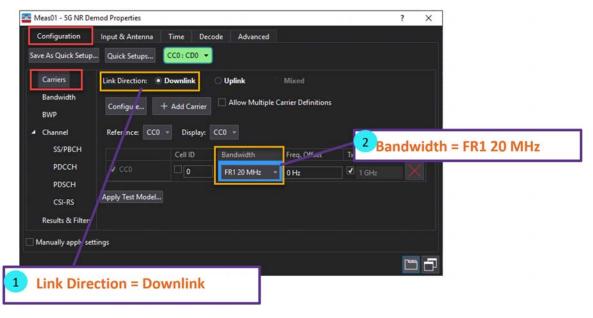
Figure 200 Setting various characteristics for the NR mode



To improve setup speed in the 89600 VSA software, pause the measurement until all parameters are correctly configured and then run the measurement.

4 Open 5G NR Demod Properties panel and start by setting the Carrier Type to the appropriate bandwidth.

From the main menu, click MeasSetup > 5G NR Demod Properties... > Configuration > Carriers.





5 Configure Bandwidth properties.

From the main menu, click MeasSetup > 5G NR Demod Properties... > Configuration > Bandwidth.

Meas01 - 5G NR Dem	od Properties		? ×	Resource Grid
Configuration	Input & Antenna Time D	code Advanced		
Save As Quick Setup	Quick Setups CC0 : CD0	2		Numerology = $\mu$ = 0: 15kHz
Carriers Bandwidth BWP Channel SS/PBCH PDCCH	Bandwidth: FR1 20 MHz Resource Grid Numerology Grid Start µ = 0: 15kHz 0 RB µ = 1: 30kHz 0 RB	Grid Size	Grid Enablied	Note: DSS or "Rate Match LTE CRS" is only enabled when numerology 15kHz is enabled for this carrier. Otherwise, the "Rate Match LTE CRS" parameter group is grayed out.
PDSCH	μ = 2 : 60kHz: 0 RB	24 RB		
CSI-RS	Ref. Point A: -9.54 MHz at -9.	54 MHz from center		Select "Rate Match LTE CRS"
Results & Filters	Rate Match LTE CRS     LTE Center Freq: 636 Sub     LTE CRS Ports: 1     MBSFN Subframes: 1	LTE CRS vShift		LTE Center Freq = 636 subcarriers LTE Bandwidth = 20 MHz LTE CRS Ports = 1 - sets the number of LTE-CRS antenna ports. LTE CRS vShift = 0 - sets the LTE carrier CRS frequency mapping shift
Manually apply setting	ngs		6	value. MBSFN Subframes = 1

Figure 202 Setting Bandwidth properties for 5G NR

6 Configure Bandwidth Part (BWP) properties to configure the DL BWP allocation within the component carrier and the control resource set (CORESET). CORESET is used for PDCCH configuration.

From the main menu, click **MeasSetup** > **5G NR Demod Properties...** > **Configuration** > **BWP**.

	Input & Antenna Time	Decode	Advanced					
Save As Quick Setup	Quick Setups CC0 : CD							211/2
Carriers			Numerology	RB Offset	RB Number			BWP:
Bandwidth	3 Initial-DL-BWP	0	$\mu=0:15kHz$	0 RB	273 RB			
BWP.	✓ DL-BWP		µ = 0:15 kHz +	O RB	106 RB			DL-BWP 1
Channel	DL-BWP	2	µ = 0 : 15 kHz -	0 RB	273 RB			
SS/PBCH	DL-BWP		µ = 0 : 15 kHz =	0 RB	273 RB			Numerology = $\mu$ = 0: 15 kHz
PDCCH		ы	Numerology	RB Offset	RB Number			
PDSCH	Initial-UL-BWP		u = 0: 15 kHz +		51 RB			RB offset = 0
CSI-RS	CORESETs					۲		RB Number = 106
Results & Filters	Add CORESET Remov							
	CORESET: 0						Г	
	CORESET ID:		SWP IC		BWP1 +		И	Use default CORESET settings
	Symbol Number:		+ DMRS	Scrambling ID:				,
	CORESETO RB Offset:		CCET	REG Mapping Type	Non-interleaved			
	CORESETO RB Number:							
	Allocated RB Groups (6RBs	): 0:7						
			Precod	ler Granularity:	Same as REG bund			
	ngs							



7 Configure Channel's SS/PBCH settings.

From the main menu, click MeasSetup > 5G NR Demod Properties... > Channel > SS/PBCH.

As Quick Setup	Quick Setups	CC0: CD0 👻			
Carriers	SS/PBCH				Select SS/PBCH
Bandwidth	Lmax	L4 ·	SSB Transmitted:	Þ:3	
BWP	Auto Detect Ac	tive Block	Det Power Threshold:	-30	SSB Transmitted = 2:3
Channel SS/PBCH	RB Offset(15kHz):	43 RB	Numerology:	μ = 0 : 15 kHz 👻	Use default for all other values
PDCCH	kSSB(15kHz):				
PDSCH	Periodicity:	10 ms =	3.6 MHz bandwidth 0	MHz from center	
CSI-RS	Power Boosting				
Results & Filters	PSS power boost	ting 0 dB	PBCH power boo	sting 0 dB	
	3GPP Version:	.atest (2019-06) =			



8 Configure Channel's PDCCH settings.

From the main menu, click MeasSetup > 5G NR Demod Properties... > Channel > PDCCH.

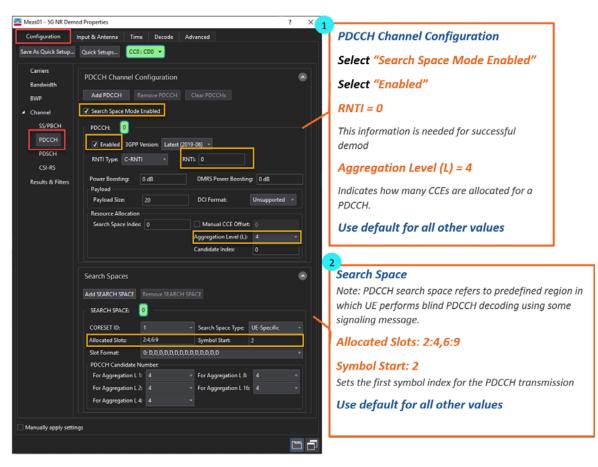


Figure 205 Setting PDCCH properties for 5G NR

9 Configure Channel's PDSCH settings.

From the main menu, click MeasSetup > 5G NR Demod Properties... > Channel > PDSCH.

🔁 Meas01 - 5G NR Dem	od Properties			? ×	
Configuration Save As Quick Setup Carriers Bandwidth BWP 4 Channel SS/PBCH PDCCH PDSCH	Add PDSCH Remove PDSCH PDSCH: 0		-	•	
CSI-RS	RV Index: 0 MCS Table: Table 64OAM ×	Allocated Slots: 2:4,6:9 Slot Format: 0: D.D.D.D.D.	0.D.D.D.D.D.D.D.D.D		
Results & Filters	MCS: 17	DL X Symbols:		2	
	TB Scaling Factor S: 1 -	Mapping Type TypeA	TypeA Pos: Pos3		Time/Freq Allocation:
	xOverhead: 0 ~ Coding Rate: 0.427734375	First Symbol: 3 Resulting Format: DDDDDD	Last Symbol: 13		Allocated Slots = 2:4,6:9
	Modulation: QAM64	RB Ref CORESET ID: -1	<ul> <li>RA Type: Type1</li> </ul>		Anocated 51013 - 2.4,0.5
	Transport Block Size: 32776	RB Offset: 0 RB	RB Number: 106 RB		TypeA Pos = 3
	ng Source Cell ID +	RA Configuration: Config2 Allocated RBGs:	<ul> <li>RBG Size (P): 16</li> </ul>		First Symbol = 3
	no 0 CORESET ID: -1 *		BWP Max RB: 106→ 5 79.5 I RBs = Allocated RBs		Last Symbol = 13
	RS Sequence	Unused	Allocated NDS	•	RB Offset = 0 RB
	DMRS Config Type1 -	n <sub>D</sub> Source Cell ID +	Enable PTRS		RB Number = 106 RB
	DMRS Max Length 1	np <sup>Nscd</sup> 0	KPTRS 2	•	
	DMRS Length Single-Symbol -	Nscid: 0 Support AdditionalDMRS-DL-Alt	LPTRS 1 PTRS RE Offset 00	•	
	DMRS AddPos Pos1 * DMRS Map Ref CR80 *	DMRS Init Option: NR Standard *	DMRS Init: 0	- I	
		3			
	Power Boosting		RS Sequence:		
	Antenna Port		DMRS AddPos	= Pos1	
Manually apply setti	ngs				
			Select Suppor	t Auditio	onalDMRS-DL-Alt"

- Figure 206 Setting PDSCH properties for 5G NR
- 10 Enable 3GPP Conformance Test and DC Punctured (or Compensate IQ Offset).

From the main menu, click **MeasSetup** > **5G NR Demod Properties...** > **Advanced**.

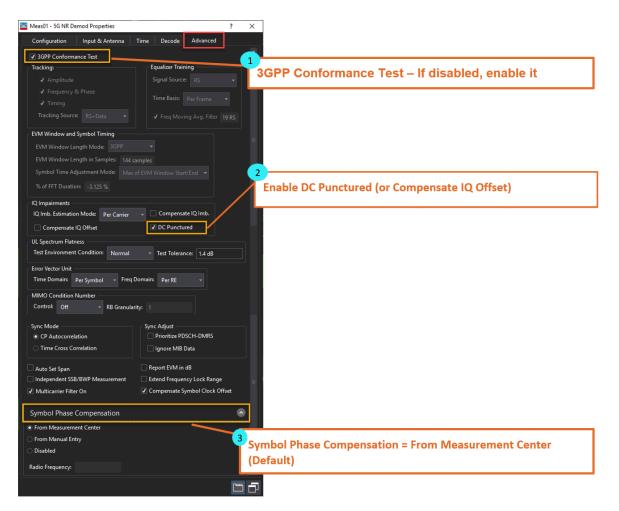


Figure 207 Enabling 3GPP Conformance Test and DC Punctured

The configuration shown in Figure 207 is explained below:

- 1 As part of conformance test, 3GPP has defined different equalizer training and tracking for EVM measurements.
- 2 5G NR counts the DC subcarrier as a valid subcarrier for rate-matching purposes. High LO feedthrough will impact demodulation and EVM performance of the input signal. DC Puncture will remove the DC subcarrier from EVM computation and from all traces (except the IQ Offset reading) in the Summary Table.

Compensate IQ Offset will measure & display DC subcarrier and will compensate it in the EVM result.

- Per symbol phase compensation is a 3GPP requirement and it is enabled by default. It is used to compensate for phase differences between symbols caused by upconversion or downconversion. Getting this setting wrong will cause demodulation issue. In this example, it is set to ON and it is applied at the center frequency.
- 11 At this stage, if you run the measurement, you should see a successful demodulation, as shown in Figure 208.

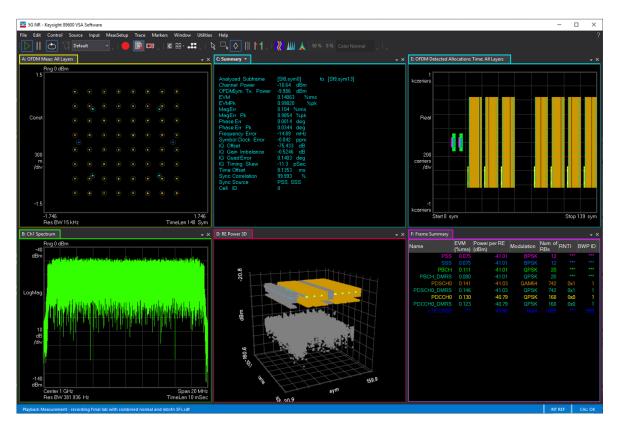


Figure 208 Viewing 3D plot for successful 5G NR demodulation

In Trace D, energy (gray color) can be seen at the same power level as 5G NR channels but it is not recognized as the active channel. These are the LTE channels that are not being recognized as 5G NR. VSA recognizes the LTE-CRS within the 5G NR application, but not the

other LTE channels. In such cases, the LTE application must be used to demodulate the LTE channels. However, by viewing the power level, we can find it as being present.

12 Remove the inactive Channel from the 3D plot shown in Figure 208.

From the main menu, click MeasSetup > 5G NR Demod Properties... > Results & Filters.

On the right pane, clear the check box for "Inactive" (see Figure 209).

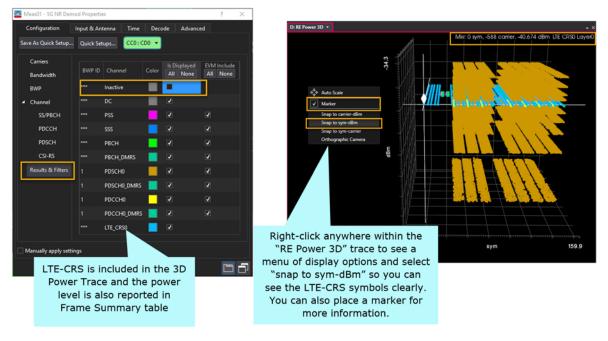


Figure 209 Removing inactive channel from the 3D plot

- 13 To add LTE measurement, you must first reduce the number of 5G NR traces to "4", so that LTE can be included.
  - i Add LTE measurement using VSA's multi-measurement feature.

From the main menu, click **MeasSetup** > + **New Measurement** > **Cellular** > **LTE**.

🔁 5G NR - K	eysight 89600 VSA Software									
File Edit	Control Source Input MeasSetup	,	Trace	Mar	kers	Winde	w	Util	lities	H
	Frequency		<u>i</u>	X	D	88 -			Γ	
	ResBW									10
A: OFDM Me	č Time									
Rn	g Average									
1.5	+ New Measurement +	1	Ve	ctor						
	Duplicate Measurement		Po	ower S	pectrui	m			۲	
		_	Gr	eneral	Purpos	e		•		
	GSM/EDGE/EDGE Evolution		Ce	llular				۲	<u> </u>	٢
Const	W-CDMA (3GPP)/HSPA		W	ireless	Conne	ectivity		۲	<b>•</b>	
	cdma2000/1xEV-DV		Ra	ıdar Aı	nalysis			۲		
	TD-SCDMA		Ot	her sta	andard	forma	ts	۲	▣	_
	1xEV-DO	P					۲			•
300	NB-IoT									
m /div	LTE		٢	٢	۲	۲	٢		٢	۲
	LTE Advanced		۲					6	0	0
	5G NR		0.	0	٩	0	•		•	•
	Pre-5G						۲		▣	
-1.5										

Figure 210

Menu item to add LTE measurement

ii Setup shared data acquisition for simultaneous 5G and LTE measurements.

From the main menu, click **MeasSetup** > **Measurements**.

Measurements Measurements Acquisition Mode Synchronous Sequenced	Use <b>Synchronous</b> Acquisition Mode and <b>Share</b> the analyzer configuration and data acquisition to perform simultaneous measurement of 5G NR and LTE.
Selected Measurement Name/Type	Analyzer Configuration Shared Trig Data Out From Sweep
Analyzer2 (shared) Meas01 5G NR Meas02 LTE	Analyzer2  Analyzer2 Analyzer2
	Figure 211 Setting up shared data acquisition

iii Set appropriate values for Center, Span and Range.

NOTE

You may delete the additional two traces, so that you have four 5G NR and four LTE traces (or, if using an external monitor, you can use more traces).

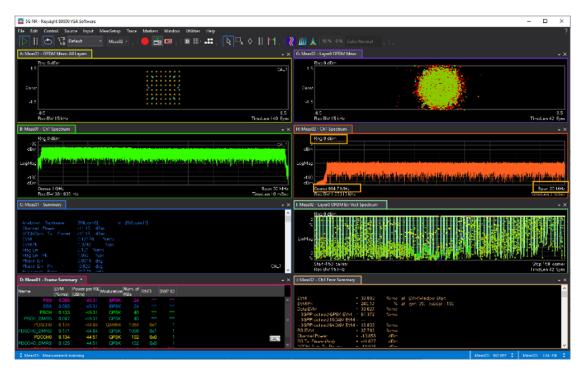


Figure 212 Setting Center, Span and Range for measurements

iv Change LTE Bandwidth.

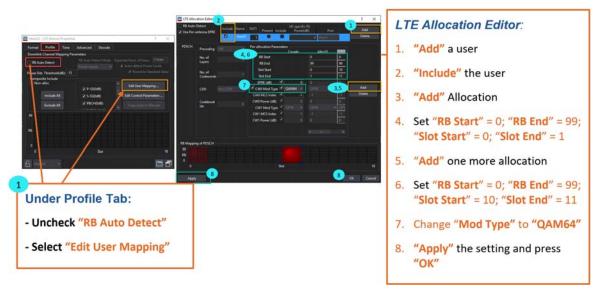
In this example, bandwidth is set to 20MHz (100 RB). From the main menu, click **MeasSetup** > **LTE Demod Properties...** > **Format**.

🚰 Meas02 - LTE Democ	l Properties	;				?	×
Format Profile	Time	Advanced	Deco	de			
Duplex Mode	D				Direction: Downlink Bandwidth: 20 MHz (10	▼ 0 RB) ▼	
Sync Type	Cell ID			RS-PRS			
P-SS     C-RS	<ul> <li>Aut</li> <li>Mai</li> </ul>	o nual	0	<ul> <li>3GP</li> <li>Cus</li> </ul>		Preset to Sta	ndard
Sync Slot : 0	0 E-T						

Figure 213 Changing bandwidth for LTE demodulation

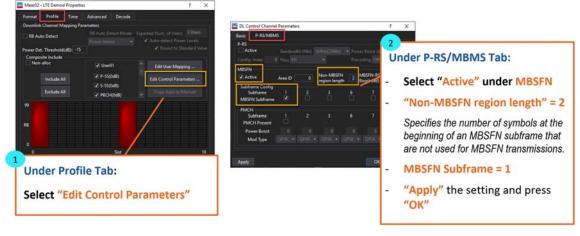
v Configure the "Normal" (that is, Non-MBSFN) subframe.

From the main menu, click **MeasSetup** > **LTE Demod Properties...** > **Profile**.



- Figure 214 Configuring Normal (non-MBSFN) subframes
  - vi Configure MBSFN subframe (that is, Subframe #1).

From the main menu, click **MeasSetup** > **LTE Demod Properties...** > **Profile**.

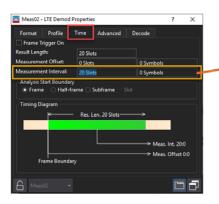




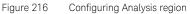


vii Configure Analysis Region.

From the main menu, click **MeasSetup** > **LTE Demod Properties...** > **Time**.







viii Change one of the traces to Detected Allocations.

Figure 217 shows a successful demodulation of both 5G NR (Meas01) and LTE (Meas02). The multi-measurement with simultaneous capture is a big differentiator of the 89600 VSA software.

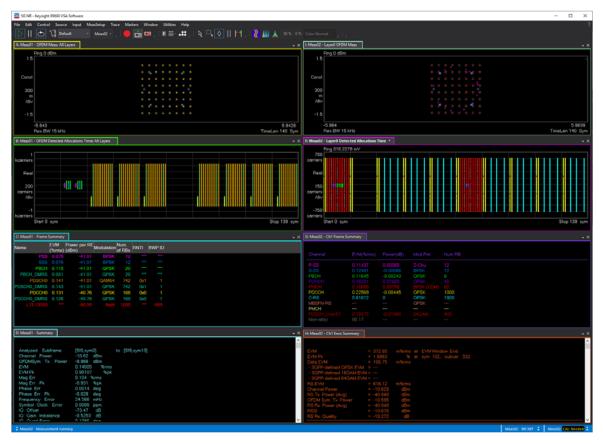


Figure 217 Simultaneous plotting of 5G and LTE demodulated data

#### 3.6.3: Configuring LTE signals with PRACH bursts

Figure 218 shows the format of the PRACH burst in an LTE-FDD signal, which is generated using the *N7624C Signal Studio Pro for LTE/LTE-Advanced FDD* software. You may configure the format of the PRACH burst in an LTE-TDD signal in the same manner, but using the *N7625C Signal Studio Pro for LTE/LTE-Advanced TDD* software.

ile View Control System Tools	5 Help							
) 😅 🖬   🔯 1 🎞   🛃								
Quick Setups Hardware	Configuration : Use	r Defined (Mo	dified)					
Instrument	+ Add Burst		st 🛛 🕺 Colum	Preset				
Waveform Setup	# St., Power	Frame#	Subframe #	Preamble F	Logical Roo.	. RB Offset		
⊡-Carrier 1 ⊡-Uplink	1 On 0.000		0	0	0	0		
Channel Setup	2 On 0.000		1	0	0	0		
	PRACH Burst 2							🗌 Hii
	PRACH Burst N	umber		2				
	State			0	'n			
	Power			0.	000 dB			
	Frame Number			0				
	Subframe Numb			1				
	Resource Block			0				
	Auto-configurati				A Configuration			
	Preamble Forma			0				
	Logical Root Se			0				
	Logical Root Se			0		1.0.1		
	Cyclic Shift Set (		ag)		nrestricted (Nor	mal Mode)		
	Ncs Configuration	on		0				
	Ncs value Preamble Index			0				
	Physical Root S			-	29			
	Cyclic Shift v	equence indes	(	0				
	Preamble Time	Offect		-	0 us			
	a 0 1 2	3 4	5 6 7	8 9	10 11 12	2 13 14 15	5 16 17	18 19
	24							
	0 =							

Figure 218 LTE carrier generated in N7624C Signal Studio with PRACH bursts

The LTE carrier with two PRACH bursts is generated with Preamble Format 0. When compared with the PRACH bursts for 5G NR, the LTE PRACH has a much simpler configuration, wherein, the latter comprises of less formats and less numerologies, features simpler frequency offset calculation as

there are no k0 and BWP offsets for LTE PRACH in the respective Signal Studio software. In the time domain, LTE PRACH always starts at symbol 0 in slot 0.

As discussed earlier, you may directly load the SCP file generated for the LTE carrier into the Open RAN Studio software (same as loading a 5G NR carrier file), without having to generate a Psuedo SCP file compatible with Open RAN Studio software.

1 Load the LTE SCP file that contains the PRACH bursts into the O-RAN Studio software.

-Plane Builder \chi 🛛 Ex	plorer											
Component Carriers		Ra	dio Control F	Plane Da	ta							
Carrier Numerology			Subframe	Slot ID	RB Start	RB Number	Sym Start	Sym Number	Channel	Beam Id		
Select Carrier:	LTE Carrier 1 (PRACH) 🗸 🗸	0			0				PRACH PRACH			
Attribute	Value								Рюден			
Carrier Type	PRACH (LTE)											
Cell ID Bandwidth	0 FR1_5M											
Numerology Mode	SingleNumerology											
CP Type	N/A											
Allocations												
Flow/eAxC ID	0001											
PIOW/EAXC ID	0001											
Resource Allocations												
Select Allocation:	Death D ank/0											
Select Allocation:	Prach Burst(0)											
Select Allocation:	Prach Burst(0) ~	Pad	io Allocation									
		Rad	io Allocation	s								
Attribute	Value	Rad	io Allocation	s								
Attribute Name of allocation	Value Prach Burst(0)	Rad	io Allocation	s —								
Attribute Name of allocation Numerology Modulation Config Table	Value Prach Burst(0) SCS15k PRACH N/A		io Allocation	5								
Attribute Name of allocation Numerology Modulation Config Table Config Index	Value Prach Burst(0) SCS15k PRACH N/A ?			s								
Attribute Name of allocation Numerology Modulation Config Table Config Index Format	Value Prach Burst(0) SGS15k PRACH N/A ? 0			5								
Attribute Name of allocation Numerology Modulation Config Table Config Index Format Symbol Start	Value Prach Burst(0) SCS15k PRACH N/A ? 0 0			5								
Attribute Name of allocation Numerology Modulation Config Table Config Table Config Index Format Symbol Start n_RA_start	Value Prach Burst(0) SCS15k PRACH N/A ? 0 0 0			s								
Attribute Name of allocation Numerology Modulation Config Table Config Index Format Symbol Start n,RA,start Subframe/slot idx	Value Prach Burst(0) SCS15k PRACH N/A ? 0 0 0 0 0			5								
Attribute Name of allocation Numerology Modulation Config Table Config Index Format Symbol Start n_RA_start Subframe/slot idx n_RA.1	Value Prach Burst(0) SCS15K PRACH N/A ? 0 0 0 0 0 0 0 0			5								
Attribute Name of allocation Numerology Modulation Config Table Config Index Format Symbol Start n,RA_start Subframe/slot idx	Value Prach Burst(0) SCS15k PRACH N/A ? 0 0 0 0 0			5								
Attribute Name of allocation Numerology Modulation Config Table Config Index Format Symbol Start n_RA_start Subframe/slot idx n_RA_stot n_RA_stot n_RA_1	Value Prach Burst(0) SCS15k PRACH N/A 7 0 0 0 0 0 0 0 0 0 0 0 0 0			5								
Attribute Name of allocation Numerology Modulation Config Table Config Index Format Symbol Start n_RA_start Subframe/slot idx n_RA_stort	Value Prach Burst(0) SCS15k PRACH N/A 7 0 0 0 0 0 0 0 0 0 0 0 0 0			5								



Loading LTE SCP file with PRACH bursts

- 2 Assign a 'Flow/eAxC ID'.
- 3 Without making any configuration changes, export the O-RAN Stimulus file to generate the corresponding PCAP file. See Exporting O-RAN Stimulus File on page 122 for more information.
- 4 Load the stimulus / recording PCAP file into O-RAN Studio.

Plar	ie, C-F	Plane I	Message	s:							_	U-Pla	ane:							Message Interpretation:
		Time			Source			stinatio		Protoco			Dir	eAxC		DU Port	Band Sector	cc	Y	<ul> <li>eCPRI Component eAxC ID (C-Pla DuPortID : 0</li> </ul>
1			00.00999		00 00 00														A.	BandSectorID : 0 CcID : 0
																				RuPortID : 1 • eCPRI Sequence ID
																				SequenceID:1 E:1
																				SubsequenceID : 0 - C-Plane Common Header
												C-Pla	ane:							DataDirection : 0 PayloadVersion : 1
													Dir	eAxC		DU Port	Band Sector	cc		FilterIndex : 1 Frameld : 0
													PRACH	1.0001	SCS1250					Subframeld : 1
																				Slotid : 0 StartSymbolid : 0
																				StartSymbolid : 0 NumberOfSections : 1 SectionType : 3
	_																-			StartSymbolid : 0 NumberOfSections : 1 SectionType : 3 Frame Timing TimeOffset : 3168
	_	_																		StartSymbolid: 0 Number0fSections: 1 SectionType: 3 Frame Timing TimeOffset: 3168 (time_offset: 0.000103125) FrameStructure: 156
	_	_	_																	StartSymbolid : 0 NumberOfSections : 1 SectionType : 3 Frame Timing Timeoffset : 3168 (time_offset : 0.000103125) FrameStructure : 156 (fft_size : 512) (ses_deta_f: 1: 25 kHz)
ex P	syloa	d:											covered I	Q	Constellatic	n -				StartSymbolid : 0 NumberOfSections : 1 SectionType : 1 Frame Timing Timeoffset : 3168 (time_offset : 0.000103125) FrameStructure : 156 (fft_size : 512) (scs_deta_f: 1.25 kHz) (N_slot_subframe : 1) (slot_ength : 1 ms)
			72 03	04 05	06 07	08 0	9 0	A 08	0C 00	) OE 0		Rec				n II				StartSymbolid : 0 NumberOfSections : 1 SectionType : 1 Frame Timing Timeoffset : 3168 (time_offset : 0.000103125) FrameStructure : 156 (fft_size : 512) (scs_deta_f: 1.25 kHz) (N_siot_subframe : 1) (slot_length : 1 ms) CpLength : 0 (CP_length : 0)
Hex D	<b>00</b> 80		02 03	04 05	00 0		0 0		81 00			Rec	: (none si	elected)		n	Q			StartSymbolid: 0 NumberOfSections: 1 SectionType: 3 Frame Timing TimeOffset: 0.000103125) FrameStructure: 156 (fft.size: 512) (k.sc. delta_f: 1.25 kH2) (k.sc. udelta_ft: 1.25 kH2) (csc. delta_f: 1.25 kH2) (csc. delta_ft: 1.25
Hex 0 16	00 80 AE	01 0 09 FE	02 03 10 02	04 05 00 10	00 0	00 00	0 0	0 00	81 00 10 00	) EO O	F A 0 - 3 -	Rec	: (none si	elected)		n I	Q			StartSymbolid: 0 NumberOfSections: 1 SectionType: 3 Frame Timing TimeOffset: 0.000103125) FrameStructure: 156 (fft.size: 512) (x.sc. delta_f: 1.25 kHz) (x.sc. delta_f: 1.25 kHz) (x.sc. delta_f: 1.25 kHz) (x.sc. delta_f: 1.25 kHz) (z) Length: 0 (z) Length: 0 (z) Length: 15 Compression: no compression
Hex 0 16 32	00 80 AE 0C	01 0 09 FE 60	02 03 10 02	04 05 00 10 00 F0	00 0 00 0 00 0	0 00 0 0 01 6 0 00 4	0 0 0 1 8 F	0 00 1 00 F F1	81 00 10 00		F A 0 - 3 -	Rec	: (none si	elected)		n	q			StartSymbolid: 0 NumberOfSections: 1 SectionType: 3 Frame Timing TimeOffset: 0.000103125) FrameStructure: 156 (fft.size: 512) (k.sc. delta_f: 1.25 kHz) (k.sc. delta_f: 1.25 kHz) (k.sc. ubdframe: 1) (slot_length: 1 ms) CpLength: 0 (CP_Jength: 0) User Data Compression Header IgBitWidth: 15 Compression: no compression C-Plane Section Type 3 SectionID: 0
lex ) 16 32	00 80 AE 0C	01 0 09 FE 60	02 03 10 02 9C 00	04 05 00 10 00 F0	00 0 00 0 00 0	0 00 0 0 01 6 0 00 4	0 0 0 1 8 F	0 00 1 00 F F1	81 00 10 00	) EO O	F A 0 - 3 -	Rec	: (none si	elected)		n :	q			StartSymbolid: 0 NumberOfSections: 1 SectionType: 3 Frame Timing TimeOffset: 0.000103125) FrameStructure: 156 (fft.size: 512) (k.sc. delta_f: 1.25 kHz) (k.sc. delta_f: 1.25 kHz) (k.sc. ubdframe: 1) (slot_length: 1 ms) cpt.ength: 0 (CP_jength: 0) User Data Compression Header IgBitWidth: 15 Compression: no compression C-Plane Section Type 3 SectionID: 0 RB: 0 Symboline: 0
lex ) 16 32	00 80 AE 0C	01 0 09 FE 60	02 03 10 02 9C 00	04 05 00 10 00 F0	00 0 00 0 00 0	0 00 0 0 01 6 0 00 4	0 0 0 1 8 F	0 00 1 00 F F1	81 00 10 00	) EO O	F A 0 - 3 -	Rec	: (none si	elected)		n : I	Q			StartSymbolid: 0 NumberOSections: 1 SectionType: 3 Frame Timing TimeOffset: 0.000103125) FrameStructure: 156 (fft.size: 512) (K.sc. delta_f: 1.25 kHz) (K.sc. delta_f: 1.25 kHz) (K.sc. delta_f: 1.25 kHz) (CP_Jength: 0) (CP_Jength: 0) (CP_Jength: 0) (CP_Jength: 0) (CP_Jength: 0) Compression: no compressio C-Plane Section Type 3 SectionID: 0 RB: 0 Symboline: 0 StartPrbc: 0 NumberPrbc: 72
Hex 0 16 32	00 80 AE 0C	01 0 09 FE 60	02 03 10 02 9C 00	04 05 00 10 00 F0	00 0 00 0 00 0	0 00 0 0 01 6 0 00 4	0 0 0 1 8 F	0 00 1 00 F F1	81 00 10 00	) EO O	F A 0 - 3 -	Rec	: (none si	elected)		n : I	٩			StartSymbolid: 0 NumberOSections: 1 SectionType: 3 Frame Timing TimeOffset: 3168 (time.offset: 0.000103125) FrameStructure: 155 (ffLsize: 572) (cst_oftar_f: 1.25 kHz) (N_slot_subframe: 1) (slot_length: 1 ms) CpLength: 0 (C)_length: 1 ms) CpLength: 0 (C)_length: 1 ms) Ceplangth: 0 SectionID: 0 StartProb: 0 StartProb: 0 StartProb: 0 NumberProb: 72 ReMask: 1111111111b
	00 80 AE 0C	01 0 09 FE 60	02 03 10 02 9C 00	04 05 00 10 00 F0	00 0 00 0 00 0	0 00 0 0 01 6 0 00 4	0 0 0 1 8 F	0 00 1 00 F F1	81 00 10 00	) EO O	F A 0 - 3 -	Rec	: (none si	elected)		n : I	Q			StartSymbolid: 0 NumberOSections: 1 SectionType: 3 Frame Timing TimeOffset: 3168 (time offset: 0.000103125) FrameStructure: 155 (ffLsize: 572) (cdS.delta_f: 1.25 kHz) (N_slot_subframe: 1) (slot_length: 1 ms) CpLength: 0 (CD_length: 1 ms) CpLength: 0 (CD_length: 1 ms) Ceplane Section Type 3 SectionID: 0 StartPrbc: 0 NumberPrbc: 72 ReMask: 1111111111b NumSymbol: 1 Ef: 0b
Hex 0 16 32	00 80 AE 0C	01 0 09 FE 60	02 03 10 02 9C 00	04 05 00 10 00 F0	00 0 00 0 00 0	0 00 0 0 01 6 0 00 4	0 0 0 1 8 F	0 00 1 00 F F1	81 00 10 00	) EO O	F A 0 - 3 -	Rec	: (none si	elected)		n - I	Q			StartSymbolid: 0 NumberOSections: 1 SectionType: 3 Frame Timing TimeOffset: 0.000103125) FrameStructure: 156 (fft.size: 512) (N.slot.subframe: 1) (slot,length: 1 ms) cpLength: 0 (CP_Jength: 0) User Data Compression Header IgBitWidth: 15 Compression: no compression C-Plane Section Type 3 SectionID: 0 RB: 0 Symboline: 0 StartPrbc: 0 NumberPrbc: 727 ReMask::11111111111

Figure 220 Loading PCAP file for LTE carrier with the PRACH bursts

Similar to the 5G NR carrier, Open RAN standard uses C-plane Section Type 3 for PRACH even for LTE carrier. As seen in Figure 220, the U5040A Open RAN Studio software currently supports a single C-plane message for each PRACH burst. Each PRACH sequence repetition is considered as a separate symbol. PRBs are numbered from '0' for each burst.

#### Viewing PRACH Type 3 as Type 1 messages for LTE signal

- 1 Load the stimulus / recording PCAP file into O-RAN Studio that contains Section Type 3 C-Plane messages for the PRACH carrier. See Figure 221.
- 2 Launch the "C/U Plane Builder Configuration Tool" window.
- 3 In the 'Options' tab, select the "PRACH Type 3 as Type 1 Message" check box in the 'C-Plane Section handling' area.

Plane, C-Plane Messages:		U-Plane:			Message Interpretation:
Time	C/U Plane Builder	Configuration Tool	< Band Sector CC	Y	<ul> <li>eCPRI Component eAxC ID (C- DuPortID : 0</li> </ul>
1 00:00:00.0099950 2 00:00:00.0109950	Flow/eAxC	Network Layer:			BandSectorID : 0 CcID : 0
2 00:00:00.0109950		Maximum transmission unit (MTU) 9000			RuPortID : 1 eCPRI Sequence ID
					SequenceID : 1
	Numerology	Disable VLAN Tags VLAN ID: 0			E : 1 SubsequenceID : 0
	Beamforming	Set Sequence IDs to '0'			<ul> <li>C-Plane Common Header</li> <li>DataDirection : 0</li> </ul>
		C-Plane Section Handling:	Band Sector CC		PayloadVersion : 1 FilterIndex : 1
	Timing	🗆 Use reMask	0 0		Frameld : 0 Subframeld : 1
	Options	Use syminc			Slotid : 0
		Use RB indicator			StartSymbolid : 0 NumberOfSections : 1
		Use Extension Type 6			SectionType : 3 Frame Timing
( II		Use Extension Type 10 (MIMO only)	-		TimeOffset : 3168
		PRACH Type 3 as Type 1 Message			(time_offset : 0.000103125 FrameStructure : 156
		C-Plane Section Type 0 Messages:			(fft_size : 512)
lex Payload;		don't generate			(scs_delta_f : 1.25 kHz) (N_slot_subframe : 1)
Hex 00 01 02 03 04					(slot_length : 1 ms) CpLength : 0
		U-Plane Package:			(CP_length : 0)
0 80 09 02 03 04 16 AE FE 10 02 00		Create Uplink U-Plane	٩		<ul> <li>User Data Compression Heade IqBitWidth : 15</li> </ul>
32 OC 60 9C 00 00					Compression : no compress C-Plane Section Type 3
48 FO 00 00 00 00		Digital Power Scaling (IQ Data):			SectionID:0 RB:0
		0 FS adjustment (FS_Offset, default 0 is no scaling)			Symboline : 0
		Apply fixed 256QAM scaler			StartPrbc : 0 NumberPrbc : 72
		0 Additional IQ power scaling (default 0 dBFS is no scaling)			ReMask: 1111111111111
					NumSymbol : 1 Ef : 0b



4 Close the "C/U Plane Builder Configuration Tool" window.

- 5 Export the O-RAN Stimulus file to generate the corresponding PCAP file.
- 6 Load the modified stimulus / recording PCAP file into O-RAN Studio.

C-Plan	e Bui	ilder	y	Expl	orer	1_	_					_	_	_											
J-Plan	e, C-I	Plane	Mes	ages	5											ч	Plane:								Message Interpretation:
			0.00.0			Sou 00		00 0	0 00		tinati 09 02			Proto AE FI			Dir		eAxC		DU Port	Band Sector		V	AddrType : SA isIndividualAddress : True isGloballyUnique : True 802.10 VLAN
																									VlanTypeString : 81 00 VlanTciString : PCP(7), DEI(0), V EtherType Value : AE FE
																CI	Plane:							۵	<ul> <li>eCPRI Common Header ecpriVersion : 1 ecpriConcatenation : 0 ecpriMessage : 2</li> </ul>
																	Dir		eAxC		DU Port	Band Sector	cc		ecpriPayload : 20 • eCPRI Component eAxC ID (C-Plan
<	_	_	_	_														_	_	_					BandSector10:0 CclD:0 RuPortID:1 eCPRISequence1D Sequence1D:1 E:1 Subsequence1D:0 C-Plane Common Header DataDirection:0 PavioadVersion:1
iex Pa	iyloa	id:														R	tecover	red IQ		Constellat					FilterIndex : 1 FilterIndex : 1 Frameld : 0
Hex	00		02	03 (	4 0	5 0	5 07	08	09	04	08	00	00	0E	OF A	PF	RB: (nor	ne sel	ected)						Subframeld : 1 Slotid : 0
0 16 32 48	AE F0			02 00	00 1	4 0 8 F	0 01 F F1	01	80	11	00	10 00					RE	uCmj		uCmpQ					StartSymbolid : 0 NumberOfSections : 1 SectionType : 1 User Data Compression Header IqBitWidth : 15 Compression : no compression
																									Reserved           Value:0           C-Plane Section D:0           Section D:0           Section D:0           Symboline:0           Symboline:0           StariPrbc:0           NumberPrbc:72           ReMask:1111111111           NumberPrbc:70           Bemand:0

Figure 222 Modified PCAP file with the Section Type 1 C-Plane messages

Figure 222 shows Section Type 1 C-Plane Messages instead of Type 3 Messages for the PRACH burst in the LTE signal.

NOTE

Uplink emulation (generation of UL PCAP files) and consequently, IQ recovery are not supported for LTE PRACH in Open RAN Studio software.

#### 3.6.4: Recovering IQ from LTE

The Open RAN Studio software helps you recover IQ data from the LTE carrier, using the "Add null DC subcarrier (use with LTE only)" feature in "Numerology" tab of the C/U Plane Builder Configuration Tool.

The following example uses an LTE FDD DL carrier of 5 MHz bandwidth. You may apply the same steps to recover IQ from an LTE TDD DL carrier.

1 Load the SCP file with the LTE carrier with LTE-FDD allocations. The SCP file contents are visible in Open RAN Studio.

Setup Test Models	View Help													
-Plane Builder V Ex	plorer													
Component Carriers			Radi	o Control I	Plane Da'	ta								
Carrier Numerology				Subframe	Slot ID	RB Start	RB Number	Sym Start	Sym Number	Channel	Beam Id			
Select Carrier:	LTE Carrier 1 (DL)	<b>*</b>			0	0	25 25	0		PDSCH PDSCH	0 0			
Attribute	Value						25		14	POSCH				
Carrier Type	DL (LTE)									PDSCH				
Cell ID	0									POSCH				
Bandwidth	FR1_5M									PDSCH				
Numerology Mode	SingleNumerology									PDSCH				
CP Type	Normal									PDSCH				
Allocations										PDSCH				
Flow/eAxC ID	(unassigned)									PDSCH				
Resource Allocations Select Allocation:	Basic.LTI_FDD-DL	~												
Attribute	Value		Radio	Allocation	s									
Name of allocation	Basic LTE_FDD-DL													
Numerology Modulation	SCS15k													
Slots														
First Symbol														
Last Symbol														
Number of Symbols														
RB Offset														
RB Number														
Beam IDs														
Select Beamld:	×					1		ii.				Frame	Index 0	

Figure 223

Viewing the LTE FDD SCP file contents in O-RAN Studio

- 2 Select the 'Flow/eAxC ID' in the C-Plane Builder tab.
- 3 Make sure that the "Numerology" settings in the 'C/U Plane Builder Configuration Tool' are configured correctly.

Plane Builder Exp							
omponent Carriers		C/U Plane Builde	r Configuration Tool				
Carrier Numerology		Cardon States					
Select Carrier:	LTE Carrier 1 (DL) 🗸 🗸	Flow/eAxC	Slot IDs relative to	highest numerok	ogy in carrier FR		
		Compression	Bandwidth			FR1 5 MHz	
Attribute	Value	Numerology				PAT SHIPE	
Carrier Type Cell ID	DL (LTE) O	Humerology	Resource Grid:				
Bandwidth	FR1_5M	Beamforming	Numerology	Grid Size	Grid Enabled		
Numerology Mode	SingleNumerology	Timing	μ = 0: 15kHz				
CP Type	Normal	10000	μ=0: TSKHZ	25		Enable a grid to facilitate carrier IQ recovery from a recording.	
Allocations		Options	µ = 1: 30kHz			recovery non a recording.	
Flow/eAxC ID	0001 🗸	DSS /					
		1	µ = 2: 60kHz	N/A			
		1	Ref. Point A: 998	02 MHz at -1.98	MHz from center		
lesource Allocations		1					
Select Allocation:	Basic LTE_FDD OL 🛛 🗸 🏏	/	PRACH IQ Recovery				
			Use PRACH IQ				
Attribute	Value						
Name of allocation Numerology	Basic.LTE_FDD-DL SCS15k		PRACH Format				
Modulation	(SU310K		PRACH SCS	1.25 kHz			
Slots							
First Symbol			Frequency Offset				
Last Symbol							
Number of Symbols RB Offset			Options				
RB Number			Use LTE IQ Reco	overy Options			
Beam IDs		L.	Contraction of the local division of the loc				

Figure 224 Checking Numerology settings for the loaded SCP file

## Scenario 1: "Add null DC subcarrier (use with LTE only)" option disabled (default)

- 4 Export the O-RAN Stimulus File without selecting the "Add null DC subcarrier (use with LTE only)" check box in the 'Option' area of the 'Numerology' tab in the C/U Plane Builder Configuration Tool.
- 5 Load the generated PCAP file.
- 6 Select the flow from the U-Plane messages, which you wish to filter and perform IQ recovery.

												1
Plane Messages:				U-Pi	ane:							Message Interpretation:
Time	Source	Destination	Protocol		Dir	eAxC		DU Port	Band Sector		$\nabla$	
00:00:00.009995000	00 00 00 00 00 00	80 09 02 03 04 05										
00:00:00.009998000	00 00 00 00 00 00	80 09 02 03 04 05	AE FE									
00:00:00.010069429												
00:00:00.010140857												
00:00:00.010212286												
				C.Pl	ane:						(W)	
						0001						
00.00.00.010712286	00 00 00 00 00 00 00	80 09 02 03 04 05	AEFE ¥									
ad: 01 02 03 04 0	5 06 07 08 09	0A 0B 0C 00	OE OF .				Constella					
							uCmpQ					
	Time 00:00:00:009995000 00:00:00:009995000 00:00:00:000995000 00:00:00:01014287 00:00:00:010128574 00:00:00:010285743 00:00:00:010424590 00:00:00:010424590 00:00:00:010569429 00:00:00:010569429 00:00:00:010712286	Time         Source           05:05:00.0099995000         00:00:00:00:00:00:00           00:05:00.0099995000         00:00:00:00:00:00:00           00:05:00.0099995000         00:00:00:00:00:00:00           00:05:00.0101212286         00:00:00:00:00:00:00           00:00:00.010212286         00:00:00:00:00:00:00           00:00:00.010235143         00:00:00:00:00:00:00           00:00:00.010456571         00:00:00:00:00:00:00           00:00:00.010456571         00:00:00:00:00:00:00           00:00:00.010456571         00:00:00:00:00:00:00           00:00:00.010456571         00:00:00:00:00:00:00           00:00:00.010426571         00:00:00:00:00:00:00           00:00:00.010426571         00:00:00:00:00:00:00           00:00:00.010426571         00:00:00:00:00:00           00:00:00.010426571         00:00:00:00:00:00           00:00:00:01054269         00:00:00:00:00           00:00:00:01054269         00:00:00:00:00           00:00:00:0101712286         00:00:00:00:00           00:00:00:00:00:00:00:00:00         00:00:00:00:00	Time         Source         Destination           00.00.00.009995000         00.00.00.00.00         80.09.02.03.04.05           00.00.00.009995000         00.00.00.00.00         80.09.02.03.04.05           00.00.00.009995000         00.00.00.00.00         80.09.02.03.04.05           00.00.00.010112286         00.00.00.00.00         80.09.02.03.04.05           00.00.00.010121286         00.00.00.00.00         80.09.02.03.04.05           00.00.00.010121286         00.00.00.00         80.09.02.03.04.05           00.00.00.010321314         00.00.00.00.00         80.09.02.03.04.05           00.00.00.010325143         00.00.00.00.00         80.09.02.03.04.05           00.00.00.010245657         00.00.00.00         80.09.02.03.04.05           00.00.00.010251428         00.00.00.00         80.09.02.03.04.05           00.00.00.010255143         00.00.00.00         80.09.02.03.04.05           00.00.00.010255142         00.00.00.00         80.09.02.03.04.05           00.00.00.0100.00         80.09.02.03.04.05         80.09.02.03.04.05           00.00.00.00.00.00         80.09.02.03.04.05         80.09.02.03.04.05           00.00.00.00.00         80.09.02.03.04.05         80.09.02.03.04.05           00.00.00.00.00.00         80.09.02.03.04.05         80.09.02.03.04.05	Time         Source         Destination         Protocol           00:00:00:009999000         00:00:00:00:00         80:09:02:03:04:05         AE         FE           00:00:00:00:09999000         00:00:00:00:00:00         80:09:02:03:04:05         AE         FE           00:00:00:00:01:01:12286         00:00:00:00:00:00         80:09:02:03:04:05         AE         FE           00:00:00:01:01:12286         00:00:00:00:00:00         80:09:02:03:04:05         AE         FE           00:00:00:01:01:12286         00:00:00:00:00:00         80:09:02:03:04:05         AE         FE           00:00:00:01:01:12286         00:00:00:00:00         80:09:02:03:04:0	Time         Source         Destination         Protocol           00:00:00:009995000         00:00:00:00:00:00         80:09:02:03:04:05         AE FE         0           00:00:00:009995000         00:00:00:00:00:00         80:09:02:03:04:05         AE FE         0           00:00:00:00:00:00:00:00:00:00:00:00:00         80:09:02:03:04:05         AE FE         0           00:00:00:00:01:01:2266         00:00:00:00:00:00:00:00:00:00:00:00:00:	Time         Source         Destination         Protocol           00:00:00:009995000         00:00:00:00:00:00:00:00:00:00:00:00:00:	Time         Source         Destination         Protocol           00:00:00:009999000         00:00:00:00:00:00:00:00:00:00:00:00:00:	Time         Source         Destination         Protocol           00:00:00:009999000         00:00:00:00:00:00:00:00:00:00:00:00:00:	Time         Source         Destination         Protocol           00:00:00:00999500         00:00:00:00:00:00:00:00:00:00:00:00:00:	Time         Source         Destination         Protocol           00:00:00:009995000         00:00:00:00:00         80:09:02:03:04:05         AE FE         0         0L:00:01:0         0	Time         Source         Destination         Protocol           000000.0009999000         00 00 00 00 00 00 00 00 00 00 00 00 00	Time         Source         Destination         Protocol           00:00:00:009999000         00:00:00:00:00:00:00:00:00:00:00:00:00:

Figure 225 Filtering U-Plane flow to perform IQ recovery

The recovered files are stored in the same folder, where the LTE SCP, PCAP and ORSTX files are located.

simple_ltefdd.1_mu0_ant1.iqf	IQF File
simple_ltefdd.1_mu0_ant1.iqt.orb	ORB File
simple_Itefdd.orstx	ORSTX File
simple_ltefdd.pcap	PCAP File
simple_ltefdd.scp	Text Document

Figure 226 Files generated after recovering IQ waveform

7 Launch the 89600 VSA software.

8 From the main menu, click MeasSetup > Measurement Type. If you see any value other than 'LTE' or 'LTE-Advanced', point to the sub-menu option "Cellular" and select either "LTE" or "LTE-Advanced" to be able to view the LTE IQ data.

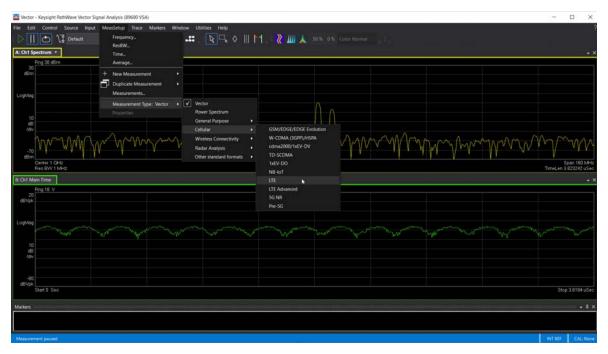


Figure 227 Checking Measurement Setup option in 89600 VSA

The O-RAN Studio software does not generate a SETX file from the SCP file for LTE. Instead, you can proceed with loading the ORB file containing the IQ data.

- 9 From the main menu, click **File** > **Recall** > **Recall Recording...**.
- 10 On the Recall Recording window that appears, select the ORB file.
- 11 On the right pane, under "Padding Selection", select 'Repetition'.
- 12 Modify "Factor" field to '3'.
- 13 Click Open.

-4	Name	Date modified	Туре	Size	
*	simple_5gnr.2_mu0_ant1.iqf	7/7/2021 7:02 PM	IOF File	SILC	
k access	simple_5gnr.2_mu0_ant1.iqt.orb	7/7/2021 7:02 PM	ORB File		
	simple_5gnr.NR_Carrier_1_DL.setx	7/7/2021 7:01 PM	SETX File		
	simple_5gnr.orstx	7/7/2021 7:02 PM	ORSTX File		
esktop	simple_5gnr.pcap	7/7/2021 7:01 PM	PCAP File		
-	simple_5gnr.scp	3/18/2021 4:20 PM	Text Document		
braries	simple_sgim.scp	7/7/2021 7:53 PM	IQF File		
	simple_Itefdd.1_mu0_ant1.iqt.orb	7/7/2021 7:53 PM	ORB File		
ihis PC	simple_Itefdd.orstx	7/7/2021 7:50 PM	ORSTX File		
(B)	simple_ltefdd.pcap	7/7/2021 7:50 PM	PCAP File		
٢	simple_Itefdd.scp	3/18/2021 4:20 PM	Text Document		
etwork					
	<			>	Padding Selection:
	(			>	O No Action

Figure 228 Opening ORB file in 89600 VSA

Notice that there is no IQ data recovered when the "Add null DC subcarrier (with LTE only)" Numerology option is disabled.

TE - I	eysight PathWav	e Vector Signal Analysis (89600 VSA)						- 0	×
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	Res BW 15 kHz							TimeLen 4	
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	Center 1 GHz Res EW 1,4853	1 kHz						Span TimeLen 2:571484	6 MHz mSec
Markers									x
Measures	nent paused							INT REF CA	1 None

Figure 229 No IQ data when Add null DC Subcarrier (with LTE only) is disabled

#### Scenario 2: "Add null DC subcarrier (use with LTE only)" option selected

14 With the Pseudo SCP (or corresponding PCAP) file loaded, select the "Add null DC subcarrier (use with LTE only)" check box in the 'Option' area of the 'Numerology' tab in the C/U Plane Builder Configuration Tool.

C/U Plane Builder	Configuration Tool			×
Flow/eAxC	Slot IDs relative to hig	hest numerolo	ogy in carrier FR	
Compression	Bandwidth			FR1 5 MHz 🗸
Numerology	Resource Grid:			
Beamforming	Numerology Gr	id Size	Grid Enabled	
Timing	μ = 0: 15kHz 25	5	<ul><li>✓</li></ul>	Enable a grid to facilitate carrier IQ
Options	μ = 1: 30kHz 11			recovery from a recording.
DSS	μ = 2: 60kHz N/	/A		
	Ref. Point A: 998.02	MHz at -1.98	MHz from center	
	PRACH IQ Recovery			
	Use PRACH IQ Reco	overy Options		
	PRACH Format	Format0		
	PRACH SCS	1.25 kHz		
	Frequency Offset			
	Options			
	Use LTE IQ Recover			
	Add null DC subc	arrier (use wit	th LTE only)	

Figure 230 Enabling the Add null DC subcarrier (use with LTE only) option

- 15 Load the generated PCAP file.
- 16 Select the flow from the U-Plane messages, which you wish to filter and perform IQ recovery.

- 17 Switch to the 89600 VSA software.
- 18 Make sure that the "Measurement Setup" is set to either 'LTE' or 'LTE-Advanced'.
- 19 Repeat steps 13 to 17 to open the updated ORB file in the 89600 VSA software.

Notice that a proper constellation is plotted and the IQ data is recovered successfully in the 89600 VSA software, when the "Add null DC subcarrier (with LTE only)" Numerology option is enabled.

LTE - I	Keysight PietWave Vector Signal Analysis (89600 VSA)	2.772	D ×	
File Ed	it Control Source Input MeasSetup Trace Markers Window Ublities Help			?
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				l
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				l
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	Res BW 127315 HHz	Tin	eLen 3 mSec	
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## Section 3.7: Measuring BER / BLER

NOTE

For seamless transmission of data, it is imperative to measure (and if possible, eradicate) errors, if any. Beginning with version 1.2, the Open RAN Studio software provides a functionality to measure the Bit Error Ratio and the Block Error Ratio by measuring the ratio of incorrectly received bits / blocks to the total bits / blocks received from the O-RU.

The Bit Error Ratio (BER) is defined as the ratio of the bits wrongly received to all data bits sent. Current measurement type compares the transmitted bits with PN9 sequence and calculates error rate (that is, how many bits did not match PN9).

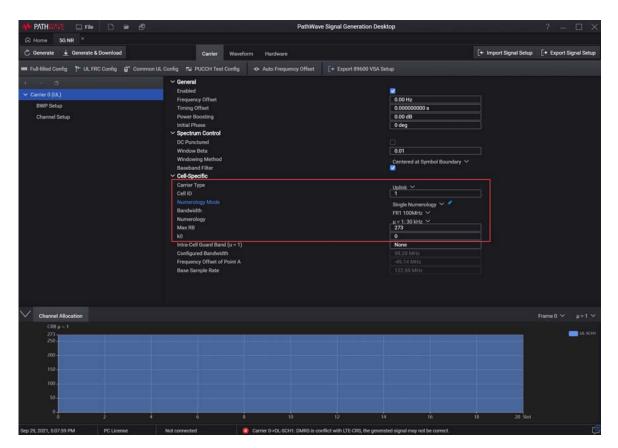
A Block Error Ratio (BLER) is defined as the ratio of the number of erroneous blocks received to the total number of blocks sent. Current measurement type compares the transmitted demodulated data sequence and may correct some error bits. For example, if we transmit data sequence "00000000", but the demodulated bits are "01000000" due to noise (1 bit error / total 8 bits). After decoding this bit sequence, the original bit sequence "00000000" can be obtained, as the decoder correct error bits.

Before we proceed to understand how to measure the BER / BLER, let us understand the prerequisites for the O-RAN Studio software to identify the data correctly to perform proper measurements.

# You must install the license option U5040MULA to use the BER / BLER measurement application.

The SCP file, generated using the PathWave Signal Generation Desktop 2022 interface, must have the following characteristics, based on which the Open RAN Studio software captures data for BER / BLER measurements:

- Carrier Type: Uplink (other carrier types are currently not supported for BER / BLER measurements)
- Data taken from SCP file for measurements:
  - Bandwidth
  - Numerology
  - Max RB





- Channel Setup (UL-SCH)
  - Channel Coding = Off (for BER) / On (for BLER)
  - Payload Data = 'PN9' sequence

✓ Modulation and Coding	
Channel Coding	
MCS Table	
MCS	0
xOverhead	0
Coding Rate	0.1171875
Modulation	
Transport Block Size	9984
BaseGraph	
LBRM	
Payload Data	PN9

Figure 233 C

Channel Coding and Payload settings in SCP file for BER

✓ Modulation and Coding	
Channel Coding	
MCS Table	
MCS	0
xOverhead	0
Coding Rate	0.1171875
Modulation	
Transport Block Size	9984
BaseGraph	
LBRM	
Payload Data	PN9

Figure 234 Channel Coding and Payload settings in SCP file for BLER

Generate an SCP file with the characteristics for measuring either BER or BLER.

Note that for the purpose of illustration, the SCP files for BER and BLER have been saved in two separate folders named 'BER' and 'BLER' respectively, which were manually created, in the local disk (C:) of the machine, as shown in Figure 235. The entire folder path is required to define the required file names during the BER/BLER measurements using the manual process, as is explained further.

Refer to the Measuring BER / BLER using ORAN Studio Solution (v1.2) Reference Guide that explains the process of using OpenTAP automation for BER / BLER measurement using the U5040A Open RAN Studio software.

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File Home Share View				~ 🕐
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Figure 235 Manually created folders to save SCP files for BER/BLER

The following example displays the steps to measure BLER. The flow for BER measurement is the same with some differences, which are explained along.

Plane Builder											
omponent Carriers		Ra	dio Control	Plane Da	ta						
Select Carrier:	Carrier 1 (UL)		Subframe	Slot ID	RB Start	RB Number	Sym Start	Sym Number	Channel	Beam Id	
Attribute	Value	1				273 273		14			
Carrier Type Cell ID	UL (NR) 1				0	273 273	0		PUSCH PUSCH	0	
Bandwidth	FR1_100M	1		0		273		14			
Numerology Mode	SingleNumerology				0	273	0	14		0	
CP Type	Normal					273					
Allocations		l II 🕂				273		14	PUSCH	0	
		i i				273	0	14		0	
Flow/eAxC ID	(unassigned) 🤍	i i				273		14	PUSCH		
		1				273	0	14	PUSCH		
		1				273			PUSCH		
Resource Allocations		1							PUSCH		
Select Allocation:	ul-schi v										
Attribute	Value	Rad	io Allocatior	is —							
Name of allocation	UL-SCH1		270								
Numerology	SCS30k		14								
Modulation	QPSK .		210								
Slots	0:19										
First Symbol			<sup>10</sup> .								
Last Symbol			150								
Number of Symbols											
RB Offset											
RB Number			P								
Beam IDs			9 20								
Select Beamld:											

1 Load the SCP file into the Open RAN Studio software.

Figure 236 SCP file loaded in O-RAN Studio

- 2 Assign a Flow/eAxC ID to the selected carrier.
- 3 Launch the "C/U-Plane Builder Configuration Tool" window.
- 4 In the 'Options tab', select the "Create Uplink U-Plane" check box in the 'U-Plane Package' area. See Creating U-Plane messages in Uplink Carrier on page 170 for more information.

j [→ 🐼									
Component Carriers			Radio Control Plane Data						
Select Carrier:	Carrier 1 (UL)		μ Subframe Slot ID RB Start	RB Number	Sym Start	Sym Number		Beam Id	
Attribute	Value	C/II Plana Builde	er Configuration Tool	273		W X	PUSCH		
	UL (NR)	0/0 Mane Bullu					PUSCH		
Carrier Type Cell ID	UL (NR) 1	Flow/eAxC	Network Layer:				PUSCH	0	
Bandwidth	FR1_100M		Maximum transmission unit (MTU)	9000			PUSCH		
Numerology Mode	SingleNumerolo	Compression					PUSCH		
CP Type	Normal	Numerology	Disable VLAN Tags	VLAN ID:	0		PUSCH		
Allocations		maniciogy	Set Sequence IDs to '0'				PUSCH		
-		Beamforming					PUSCH		
Flow/eAxC ID	0001		C-Plane Section Handling:				PUSCH		
		Timing	Use reMask				PUSCH		
Resource Allocations		Options					PUSCH		
			Use RB indicator				PUSCH	0	
Select Allocation:	UL-SCH1	DSS	Use Extension Type 6			1			
			Use Extension Type 10 (MIMO onl						
Attribute	Value								
Name of allocation	UL-SCH1		PRACH Type 3 as Type 1 Message	(i					
Numerology	SCS30k		C-Plane Section Type 0 Messages:						
Modulation Slots	QPSK 0:19		don't generate						
First Symbol	0								
Last Symbol			U-Plane Package:						
Number of Symbols	14		Create Uplink U-Plane						
RB Offset									
RB Number			Digital Power Scaling (IQ Data):						
			0 FS adjustment (FS_	Offset, default (	) is no scaling)				
Beam IDs			a substantia (i co		19/				
Select Beamld:	~		Apply fixed 256QAM scaler						
			0 Additional IQ power	scaling (defau	t 0 dBFS is no s	caling)			
4 10								Frame In	ndex 0

Figure 237 Modifying configuration of the loaded file

- 5 Close the "C/U-Plane Builder Configuration Tool" window.
- 6 Export the O-RAN Stimulus file to generate the corresponding PCAP file, with the '\_UL' suffix.
- 7 From the main menu, click File > Export > Generate BLER XML File.



Figure 238 Generating XML file for BER/BLER measurement

The following Progress Dialog is displayed when the XML file is being generated.

Progress Dialog				
Activity Progress:				
		30%		
Activity Details:				
Opening VSA				
Ok	Cancel			

Figure 239 Activity progress for XML file generation

8 Click 'OK' after the Activity Progress reaches 100%.

The folder, where the SCP and the corresponding uplink U-Plane message PCAP and ORSTX files are located, shows an XML file with the same name as the SCP file. The folder in Figure 240 shows the files required for BLER measurement. If measuring BER, the file set will be similar, as shown in Figure 241.

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> 💩 Creative Cloud File		XML Document	2/12/2021 4:24 AM	55 KB
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Figure 240 Folder f

Folder for BLER containing all files reqd. for measurement

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📜 images 🛛 🖈 ^	Name	Date modified	Туре	Size
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Images	UL_BER.orstx	2/12/2021 4:45 AM	ORSTX File	6 KB
LatestSource	V PCAP File (2)			
QES	UL_BER.pcap	2/12/2021 4:46 AM	PCAP File	3 KB
Creative Cloud File	UL_BER_ULpcap	2/12/2021 4:46 AM	PCAP File	3,398 KB
	SETX File (2)			
OneDrive	UL BER.Carrier 1 UL.setx	2/12/2021 4:45 AM	SETX File	128 KB
🗢 This PC	UL_BER.setx	2/12/2021 4:46 AM	SETX File	128 KB
🗊 3D Objects	V Text Document (1)			
Desktop	UL_BER.scp	1/19/2021 1:53 PM	Text Document	64 KB
Documents	<ul> <li>XML Document (1)</li> </ul>			
🖶 Downloads	UL BER.xml	2/12/2021 4:46 AM	XML Document	55 KB
👌 Music 🗸 🗸		_,,		55115
7 items				

Figure 241 Folder for BER containing all files reqd. for measurement

The set of files generated previously (SCP and WFM) and the stimulus file generated in this section (PCAP\_UL) are used as inputs to a BittWare system, with triggering and automation enabled.

After the files required for BER/BLER measurement are generated, you may use an OpenTAP automated process to generate the PCAP file for measurement of BER/BLER on the BittWare server. Another option is to use either a manual process or your own automation application to generate the JSON files that contain the measurement data. This is depicted in Figure 242.

This document explains the steps for measurement using manual process only, which you may automate using your custom methods. Refer to the *Measuring BER / BLER using ORAN Studio Solution (v1.2) Reference Guide* to understand how to use the OpenTAP Application's automation.

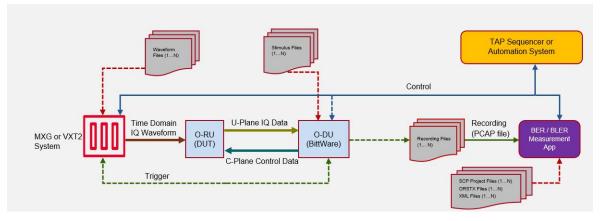
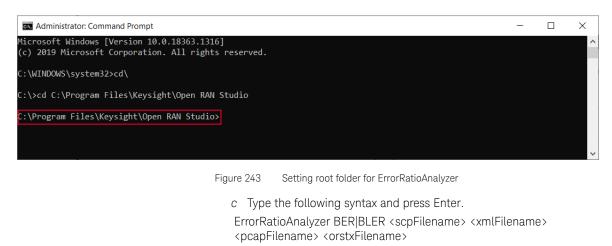


Figure 242 BittWare System generating PCAP file for BER / BLER measurement

Note that before proceeding with either the manual or your own automation process for BER/BLER measurements, you must automate the captured O-RU response on a BittWare setup. This requires coordination of the O-DU and the signal generator to make sure that it sends the signal when the O-RU expects it. Once the captured file has been created, save it in the same folder where the other files (SCP, ORSTX and XML) are placed for BER or BLER measurements. Proceed with the measurements either manually or through your own automation system.

#### Measurement using manual process or custom automation

- *a* From the **Start** menu on your machine, launch the Command Prompt window.
- *b* Set the root folder as "*C*:\*Program Files\Keysight\Open RAN* Studio", where the *ErrorRatioAnalyzer.exe* is installed during the installation / upgradation of the U5040A Open RAN Studio software ver. 1.2 or higher.



Note that in this syntax,

- ErrorRatioAnalyzer is the executable file that is installed in the folder "C:\Program Files\Keysight\Open RAN Studio" when you install Open RAN Studio software ver. 1.2 or higher.
- Either 'BER' or 'BLER' must be entered to indicate the measurement you are performing
- scpFilename>: enter full path for the SCP file
- <xmlFilename>: enter full path for the XML file
- operation of the captured PCAP file
- <orstxFilename>: enter full path for the ORSTX file

Refer to Figure 244 and Figure 245 for BLER and BER, respectively.

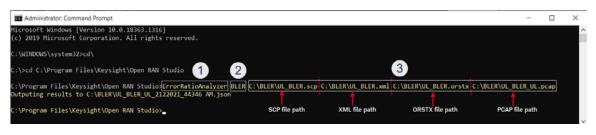
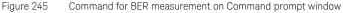


Figure 244 Command for BLER measurement on Command prompt window





where,

1 - ErrorRatioAnalyzer

2 - BER or BLER, depending on what you are measuring

3 - Full paths to the SCP, PCAP, XML and ORSTX files (in any order) separated by a single space. Note that in the examples above, the complete folder location for each file is shown, such as C:\BLER\UL\_BLER.scp and so on.

If successful, the command prompt window displays the message *Outputing results to <JSON file name>*.

In both cases, the measurement result is written to a file in JSON format. File name of this JSON is of the format (name of PCAP file + date + time).

The folder, where the SCP, PCAP, XML and ORSTX files are located, now shows the JSON file generated.

I I I I I I I I I I I I I I I I I I I	View			×
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← → × ↑ 🖡 > Tr	nis PC > OSDisk (C:) > BLER	~	ර 🔎 Search BL	ER
BSP Help	Name	Туре	Date modified	Size
LatestSource	UL_BLER_UL.1_mu1_ant1.iqf	IQF File	2/12/2021 4:43 AM	29,342 KB
o Creative Cloud File	<b>J</b> UL_BLER_UL_2122021_44346 AM.json	JSON File	2/12/2021 4:43 AM	1 KB
OneDrive This PC	V ORSTX File (1) UL_BLER.orstx V PCAP File (2)	ORSTX File	2/12/2021 4:45 AM	6 KB
<ul> <li>3D Objects</li> <li>Desktop</li> <li>Documents</li> </ul>	UL_BLER.pcap	PCAP File PCAP File	2/12/2021 4:22 AM 2/12/2021 4:22 AM	3 KB 3,398 KB
<ul> <li>Downloads</li> <li>Music</li> </ul>	<ul> <li>SETX File (2)</li> <li>UL_BLER.Carrier_1_UL.setx</li> <li>UL_BLER.setx</li> </ul>	SETX File SETX File	2/12/2021 4:22 AM 2/12/2021 4:23 AM	128 KB 128 KB
Network_Hari Network-Others Pictures	<ul> <li>Text Document (1)</li> <li>UL_BLER.scp</li> </ul>	Text Document	1/19/2021 12:05 PM	64 KB
Videos  OSDisk (C:)  9 items 1 item selected	VXML Document (1) UL_BLER.xml 225 hytes	XML Document	2/12/2021 4:24 AM	55 KB
s tems - r tem selected	220 09100			

Figure 246

Folder for BLER containing the final JSON file output

L   ☑ L = IBER File Home Share	View			- 🗆 ×
	Cut Copy path Paste shortcut Paste shortcut	New item • New folder	Properties	Select all Select none
Clipboard	Organize	New	Open	Select
← → × ↑ 📜 > Th	is PC > OSDisk (C:) > BER	~	ර 🔎 Search BE	ĒR
BSP Help	Name	Date modified	Туре	Size
<ul> <li>Images</li> <li>LatestSource</li> <li>QES</li> </ul>	<ul> <li>✓ IQF File (1)</li> <li>☐ UL_BER_UL.1_mu1_ant1.iqf</li> <li>✓ JSON File (1)</li> </ul>	2/12/2021 4:52 AM	IQF File	29,342 KB
o Creative Cloud File	J UL_BER_UL_2122021_45241 AM.json	2/12/2021 4:52 AM	JSON File	1 KB
OneDrive This PC	VORSTX File (1)	2/12/2021 4:45 AM	ORSTX File	6 KB
<ul> <li>3D Objects</li> <li>Desktop</li> </ul>	V PCAP File (2) UL_BER.pcap UL_BER_UL.pcap	2/12/2021 4:46 AM 2/12/2021 4:46 AM	PCAP File PCAP File	3 KB 3,398 KB
<ul> <li>Documents</li> <li>Downloads</li> <li>Music</li> </ul>	V SETX File (2)	2/12/2021 4:45 AM	SETX File	128 KB
Network_Hari	UL_BER.setx	2/12/2021 4:46 AM	SETX File	128 KB
Network-Others Pictures	UL_BER.scp	1/19/2021 1:53 PM	Text Document	64 KB
Videos	V XML Document (1)	2/12/2021 4:46 AM	XML Document	55 KB
9 items 1 item selected	222 bytes			

Figure 247 Folder for BER containing the final JSON file output

Keysight U5040A Open RAN Studio User Guide

The JSON file structure contains:

```
🔚 UL_BLER_UL_2122021_44346 AM.json 🔀
  1
     ₽{
  2
         "MeasurementType": "BLER",
  3
         "FileName": "C:\\BLER\\UL BLER UL.pcap",
         "FinishedAt": "2021-02-12T04:43:46.1812048+05:30",
  4
  5
         "Frames": [
     þ
  6
     E
           {
  7
             "ErrorRatioInPercent": 0.0,
  8
             "FrameNumber": 1
  9
 10
         ]
 11
```



- Measurement type
- File name of recording
- · Date and time when the measurement was finished
- Error ratio in percentage and frame number for each frame

The JSON file shown above is generated manually.

For a better understanding of the JSON file would appear, consider the following image (Figure 249), which shows a sample JSON file generated through the automated process and has result for BER measurement with 4 frames in the recording.

```
{
  "MeasurementType": "BER",
  "FileName": "4frames.pcap",
  "FinishedAt": "2021-01-11T19:46:18.4342047+02:00",
  "Frames": [
    {
      "ErrorRatioInPercent": 2.1526929860263193,
      "FrameNumber": 1
    },
    {
      "ErrorRatioInPercent": 2.1526929860263193,
      "FrameNumber": 2
    },
    {
      "ErrorRatioInPercent": 2.1526929860263193,
      "FrameNumber": 3
    },
    {
      "ErrorRatioInPercent": 2.1526929860263193,
      "FrameNumber": 4
    }
  ]
}
```

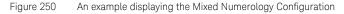


Each frame has PN9 sequence with 11 bits altered. The Bit Error Ratio (BER) is calculated as  $11/511 \sim 2.15\%$ .

## Section 3.8: Mixed Numerology Configuration

For handling mixed numerology, follow normal procedures to configure the overall carrier properties:

Plane Builder V Ex	plorer							
			C/U Plane Builde	r Configuration Tool				
omponent Carriers		Radi	Flow/eAxC					
Carrier Numerology		î u		Slot IDs relativ	e to highest numero	ology in carrier FR	2	
Select Carrier:	Carrier 1 (DL)	1		Bandwidth			FR1 100 MHz	
		1	Numerology					
Attribute	Value	1		Resorce Grid:				
Carrier Type	DL (NR)	1	Beamforming	Numerology	Grid Size	Grid Enabled		
Cell ID Bandwidth	0 FR1_100M	÷.	Timing	µ = 0: 15kHz	270			facilitate carrier IQ
Numerology Mode	MultipleNumerologies	1					recovery from a	recording.
CP Type	Normal	2	Options	µ = 1: 30kHz				
Allocations		2		µ = 2: 60kHz	135			
Flow/eAxC ID	0001			μ = 2. ουκη2	135			
				Ref. Point A:	950.86 MHz at -49.	14 MHz from center		
Resource Allocations		Radio A	llocations					
		- 294						
Select Allocation:	DL-SCH1	100						
Attribute	Value	<u></u>						
Name of allocation	DL-SCH1							
Numerology	SCS30k	1						
Modulation	QPSK	Y **						
Slots								
First Symbol								
Last Symbol				and the second s				



To configure the overall carrier properties:

- 1 Use the "Selected Allocation" combo box to see the different numerologies.
- 2 In the "Numerology" tab, before generating IQ and Stimulus signals, make sure that you select the "Slot IDs relative to highest numerology in carrier FR" check box. The resource grids are intended to be used for IQ extraction and not for stimulus creation.

You must make sure to select the check box with respect to stimulus creation for slot numbering based on highest numerology.

## Section 3.9: Conformance to Stock Data Test Models

The Test Models feature enables the Open RAN Studio software to use predefined section mapping models. Some Radio Units only accept simple C-Plane messaging models.

A prerequisite to performing Conformance tests in the U5040A Open RAN Studio is that the Downlink and Uplink carriers must have the following attributes:

- Downlink: 30 KHz subcarrier spacing and 100 MHz Bandwidth, Test Model NR-FR1-TM1.1.
- Uplink: 30 KHz subcarrier spacing, QPSK, 100 MHz Bandwidth, Test Model G-FR1-A1-5. Note that Stock Data Test Definition D only can be applied to Uplink data.

## NOTE

While other configuration options may apply, the Beamforming methodology or approach is currently not applicable to stock data frames for conformance testing.

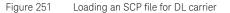
### 3.9.1: Applying Stock Data Test Definitions

For this "standard mode", O-RAN Studio software builds sections according to Channels and Users. This standard mapping model is focused on the signal performance.

To verify whether or not the carrier conforms to the Stock Data Test Definitions,

1 Load an SCP file into the Open RAN Studio software.

-Plane Builder \chi 🗈	plorer											
		-										
Component Carriers			Rad	dio Control F	Plane Da	ta						
Select Carrier:	Carrier 1 (DL)			Subframe	Slot ID	RB Start	RB Number	Sym Start	Sym Number	Channel	Beam Id	
Attribute	Value						3					
Carrier Type	DL (NR)			0		3 258	255 15	0	14	PDSCH PDSCH		
Cell ID	1			0	0	258	3		14		0	
Bandwidth	FR1_100M			0			3	2	2		0	
Numerology Mode	SingleNumerology			0			255	0	14			
CP Type	Normal			0		258	15	0	14	PDSCH	0	
Allocations										PDSCH		
Flow/eAxC ID	0001											
Resource Allocations		II	Radi	o Allocation	s							
				75								
Select Allocation:	DCI1	×		ND								
Attribute	Value			80								
Name of allocation	DCI1			20								
	SCS30k			a _								
Numerology												
Allocated Slots												



#### 2 From the main menu, click Test Models > Conformance Tests: O-RAN.WG4.CONF.O-v01.00.

3 Click either of the Stock Data Test Definitions for conformance check. You shall notice the change in the "Radio Control Plane Data" and the "Radio Allocations" for each stock data test definition you select. Optionally, you may also export the O-RAN stimulus file to load the PCAP file and view the changes in the Message Interpretation as well.

#### Selecting "Stock Data Test Definition A"

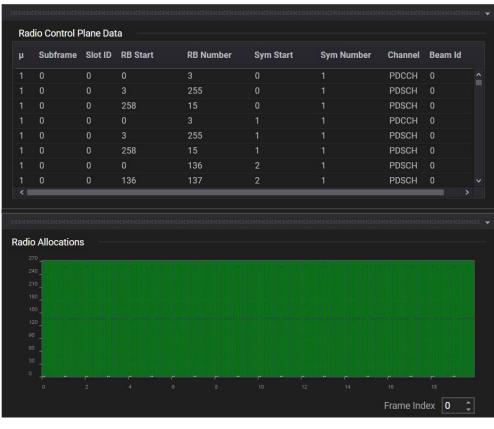
- This test frame consists of a PDCCH in the first two symbols of every slot consisting of 3 PRBs.
- All the remaining PRBs in the frame consist of Physical Downlink Shared Channel data with 1 Section per Symbol.

I	Subframe	Slot ID	RB Start	RB Number	Sym Start	Sym Number	Channel	Beam Id	
	0	0	0	3	0		PDCCH	0	
			3	255	0		PDSCH		
			258	15			PDSCH		
				3			PDCCH	0	
			3	255			PDSCH		
			258	15			PDSCH		
				273	2		PDSCH		
die	0 o Allocation:		0	273	3		PDSCH		
di( 2 2 1 1	o Allocation:								

Figure 252 Appearance after test model pattern for Stock Data A is applied

#### Selecting "Stock Data Test Definition B"

- This test frame consists of a PDCCH in the first two symbols of every slot consisting of 3 PRBs.
- All the remaining PRBs in the frame consist of Physical Downlink Shared Channel data with 2 Sections per Symbol.





#### Selecting "Stock Data Test Definition C"

- This test frame consists of a PDCCH in the first two symbols of every slot consisting of 3 PRBs.
- Symbol #6 and #7 should be defined with single section including gap. This is supported using feature non-contiguous PRB allocation. See Allocating non-contiguous PRBs on page 369 for more information. SymbolMask should be set to 00000011000000 and RBG mask to 1011111111111111111 with RBGSize 16.
- All the remaining PRBs in the frame consist of Physical Downlink Shared Channel data with 1 Sections per Symbol.

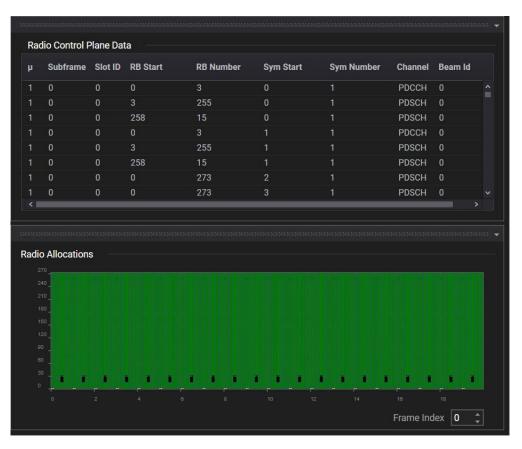


Figure 254

Appearance after test model pattern for Stock Data C is applied

# NOTE

Stock Data Frame C has dependency on the Non-contiguous PRB feature. Therefore, it enables the option "Use Extension Type 6" in the Options tab of the C/U-Plane Builder Configuration Tool.

U Plane Builder	r Configuration Tool						
Flow/eAxC	Network Layer:						
Compression	Maximum transmission unit (MTU)	9000					
Numerology	🗌 Disable VLAN Tags	VLAN ID: 0					
Beamforming	Set Sequence IDs to '0'		RB Number	Sym Start	Sym Number	Channel	Beam Id
	C-Plane Section Handling:					PDCCH	
Timing			255			PDSCH	
Options						PDSCH	
Shrione						PDCCH	
)SS	Use RB indicator					PDSCH	
	Use Extension Type 6					PDSCH	
	Use Extension Type 10 (MIMO only	0				PDSCH	
	PRACH Type 3 as Type 1 Message		273	3	1	PDSCH	0
	C-Plane Section Type 0 Messages:						
	don't generate						
	U-Plane Package:						
	Create Uplink U-Plane						
	Digital Power Scaling (IQ Data):						
	0 FS adjustment (FS_0	ffset, default 0 is no scaling)					
	Apply fixed 256QAM scaler						
	0 Additional IQ powers	scaling (default 0 dBFS is no scali	ig)				

Figure 255 Change in configuration settings after Stock Data C is applied

#### Selecting "Stock Data Test Definition D" (for DL carrier)

- This test frame consists of a PDCCH in the first two symbols of every slot consisting of 3 PRBs.
- The control plane message for symbol #3 will include PRBs number 5 through 23. This C-Plane message will have the rb bit set to 'one' for this section.
- This test uses PRBs 1 through 5. The corresponding C-Plane message will contain a section ID in a single C-Plane message describing symbol #6. The C-Plane message will have one section with the reMask set to only the odd number resource elements. The start PRB will be '1'.
- Symbols #3 and #6 should also have single PRB section.
- All the remaining PRBs in the frame consist of Physical Downlink Shared Channel data with 1 Sections per Symbol.

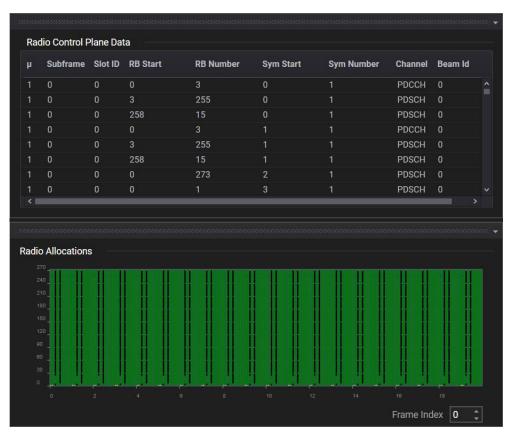


Figure 256 Appearance after test model pattern for Stock Data D is applied (DL)

# NOTE

Stock Data Frame D enables the options "Use reMask" and "Use RB indicator" in the Options tab of the C/U-Plane Builder Configuration Tool.

/U Plane Builder	Configuration Tool		<				
Flow/eAxC	Network Layer:						
Compression	Maximum transmission unit (MTU)	(pood					
	Disable VLAN Tags	VLAN ID: 0					
Numerology			RB Number	Sym Start	Sym Number	Channel	Beam Id
Beamforming	Set Sequence IDs to '0'					PDCCH	
	C-Plane Section Handling:		255			PDSCH	
Timing	Use reMask					PDSCH	
Options	Use syminc					PDCCH	
	Use RB indicator		255			PDSCH	
DSS	Use Extension Type 6		15 273	1 2		PDSCH PDSCH	0
	Use Extension Type 10 (MIMO only	A	1			PDSCH	0
	PRACH Type 3 as Type 1 Message		-		<u>.</u>	TBach	
	C-Plane Section Type 0 Messages:						
	don't generate						
			ŭ 11 11 1	1 11 11	11 11 11 11	11 11	11 1
	U-Plane Package:						1 4
	Create Uplink U-Plane				a de la sur de		
	Digital Power Scaling (IQ Data):			t i it			
		ffset, default 0 is no scal <mark>i</mark> ng)					
	ro adjustment (ro_o	naer, deladir o la no acaling)					
	Apply fixed 256QAM scaler						
	Apply lixed 2000AM scale						

Figure 257 Change in configuration settings after Stock Data D is applied

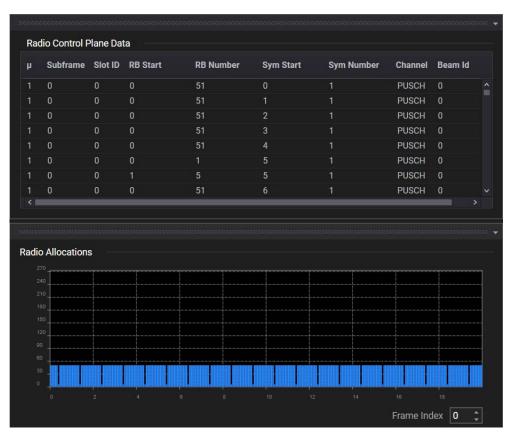
#### Selecting "Stock Data Test Definition D" (for UL carrier)

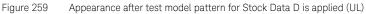
Let us now consider the following SCP file data for an Uplink carrier to see how Radio Control Plane Data and Radio Allocations appear when Stock Data Test Definition D is applied.

C-Plane Builder Explor Component Carriers Select Carrier:												
Component Carriers Select Carrier:												
			Ra	dio Control F	Plane Dat	ta						
	Carrier 1 (UL)			Subframe	Slot ID	RB Start	RB Number	Sym Start	Sym Number	Channel	Beam Id	
Attribute	Value						51		14	PUSCH		
	UL (NR)								14	PUSCH		
	0	_ I.				0	51 51	0	14	PUSCH	0	
	- FR1_100M	_ I.			0			0	14	PUSCH	0	
	SingleNumerology	_ I.				0	51	0	14	PUSCH	0	
CP Type	Normal	_ I.		3	0	0	51	0	14	PUSCH	0	
Allocations									14			
Flow/eAxC ID (w	nassigned)											
Resource Allocations		- 1		o Allocation:	\$							
Select Allocation:	UL-SCH1			то на 190								
Attribute	Value			88								
Name of allocation	UL-SCH1			20								
Numerology	SCS30k											
Modulation	QPSK			and the second se								
Slots	0:19											
	0											

Figure 258 Loading SCP file for UL carrier

- The C-Plane message for symbol #5 should have the reMask set to tell the radio to send only every odd resource element. The PRBs 1 through 5 are used in this section.
- Symbol #5 should also have a single PRB section.
- All the remaining PRBs in the frame consist of Physical Downlink Shared Channel data with 1 Sections per Symbol.

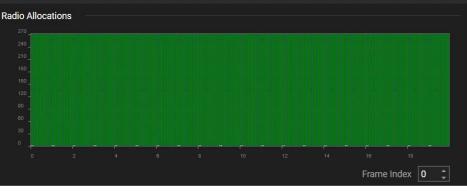




#### Selecting "Stock Data Test Definition E"

- This test frame consists of a PDCCH in the first two symbols of every slot consisting of 3 PRBs.
- Symbols #5 and #6 consist of Physical Downlink Shared Channel data with 2 Section per Symbol with SymInc bit set.
- The first section ID for symbol #6 will have the SymInc bit set informing the O-RU that the next section will begin describing symbol #6.
- The corresponding C-Plane message will contain 4 section IDs in a single C-Plane message describing Symbols #5 and #6.
- All the remaining PRBs in the frame consist of Physical Downlink Shared Channel data with 1 Section per Symbol.

1	Subframe	Slot ID	RB Start	RB Number	Sym Start	Sym Number	Channel	Beam Id	
	0	0	0	3	0		PDCCH	0	
			3	255			PDSCH		
			258	15			PDSCH		
				3			PDCCH		
			3	255			PDSCH		
			258	15			PDSCH		
				273	2		PDSCH		
				273			PDSCH		





Appearance after test model pattern for Stock Data E is applied



Stock Data Frame E enables the option "Use symInc" in the Options tab of the C/U-Plane Builder Configuration Tool.

J Plane Builder	Configuration Tool						
ow/eAxC	Network Layer:						
ompression	Maximum transmission unit (MTU)	9000					
umerology	🗌 Disable VLAN Tags	VLAN ID: 0					
amforming	Set Sequence IDs to '0'		RB Number	Sym Start	Sym Number	Channel	Beam Id
annorming						PDCCH	
ning	C-Plane Section Handling:		255			PDSCH	
						PDSCH	
tions	🕑 Use syminc					PDCCH	
s	Use RB indicator		255			PDSCH	
	Use Extension Type 6					PDSCH	
	Use Extension Type 10 (MIMO only)	10 A	273			PDSCH	0
	PRACH Type 3 as Type 1 Message		273	3	1	PDSCH	0
	C-Plane Section Type 0 Messages:		-				
	don't generate 🗸 🗸						
	U-Plane Package:						
	Create Uplink U-Plane						
	Digital Power Scaling (IQ Data):						
	o FS adjustment (FS_Of	fset, default 0 is no scaling)					
	Apply fixed 256QAM scaler						
	0 Additional IQ power s	caling (default 0 dBFS is no scaling)					

Figure 261 Change in configuration settings after Stock Data E is applied

NOTE

For some of the Stock Data Test Definitions (C, D & E), the corresponding C/U Plane Builder Configuration Tool options are enabled automatically, which cannot be manually disabled. To restore such configuration options, you must reset the current allocation by clicking **Test Models** > **Reset**.

### 3.9.2: Applying Additional Test Patterns

The "Additional Test Patterns" lets you apply custom test models on 1 C-Plane Section per entire slot and therefore, is a simplified signaling model. The Additional Test Patterns can be applied to arbitrary DL and UL SCP projects, but not on a PRACH SCP project.

1 Load an SCP file into the Open RAN Studio software.

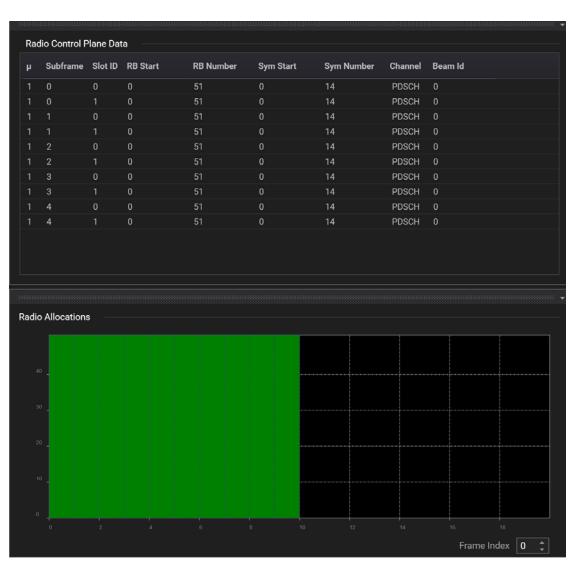
-Plane Builder Ex	plorer										
27											
Component Carriers Carrier Numerology —		Ra	dio Control F								
Camer Numerology			Subframe	Slot ID	RB Start	RB Number	Sym Start	Sym Number	Channel	Beam Id	
Select Carrier:	Carrier 1 (DL) 🗸 🗸				15	21			SS/PBCH		
									SS/PBCH		
Attribute	Value								PDSCH		
Carrier Type	DL (NR)								SS/PBCH		
Cell ID									SS/PBCH		
Bandwidth	FR1_20M								PDSCH		
Numerology Mode	SingleNumerology								PDSCH		
CP Type	Normal				0				PDSCH		
Allocations				0	0		0		PDSCH PDSCH	0	
Flow/eAxC ID	(unassigned)				0				PDSCH	0	
FION/EAG ID	(unassigned)		4	0	0		0	12	PDSCH	0	
					0				PDSCH		
Resource Allocations									1.000011		
Select Allocation:											
Select Allocation:	DL-SCH1 V	Radi	Allocation	•							
Attribute	Value	Turun I	Allocation								
Name of allocation	DL-SCH1										
Numerology	SCS30k										
Modulation	QPSK		*								
Slots	0.9										
First Symbol			°								
Last Symbol											
Number of Symbols			۰. <b>.</b>	4							
RB Offset											
RB Number			0.								
Beam IDs											
Select Beamld:	<b>Q</b>			1.			1 No.	12	14	16	11

Figure 262 Loading an SCP file for DL carrier

2 From the main menu, click **Test Models** > **Additional Test Patterns**.

3 Click either of the patterns available in the sub-menu. You shall notice the change in the "Radio Control Plane Data" and the "Radio Allocations" for each pattern you select. Optionally, you may also export the O-RAN stimulus file to load the PCAP file and view the changes in the Message Interpretation as well.

#### Selecting "1 Section description per slot; all PRBs"



 All PRBs in the frame consist of data with 1 Section description per slot. This test pattern allocates full slot in case any radio allocation is present in that slot.

Figure 263 Appearance a

Appearance after first test pattern is applied

#### Selecting "1 Section description per symbol; all PRBs"

• All PRBs in the frame consist of data with 1 Section description per symbol. This test pattern allocates full symbols in case any radio allocation is present on that symbol.

μ	Subframe	Slot ID	RB Start	RB Number	Sym Start	Sym Number	Channel	Beam Id	
1				51			PDSCH		
1				51			PDSCH		
1				51	2		PDSCH		
1				51	3		PDSCH		
1				51	4		PDSCH		
1				51			PDSCH		
1				51			PDSCH		
				51			PDSCH		
1				51	8		PDSCH		
1				51			PDSCH		
					10	1	PDSCH	0	
				51	10				
1			0	51	10		PDSCH		
				51 51	11 0		PDSCH PDSCH		
1 1 1				51 51	11 0		PDSCH PDSCH		
1 1 1				51 51	11 0		PDSCH PDSCH		
1 1 1				51 51	11 0		PDSCH PDSCH		
1 1 1	0 0 0 0 0 0 0 0 0 0 0 0			51 51	11 0		PDSCH PDSCH		
1 1 1	0 0 0 0 0 0 0 0 0 0 0 0			51 51	11 0		PDSCH PDSCH		
1 1 1	0 0 0 0 0 0 0 0 0 0 0 0			51 51	11 0		PDSCH PDSCH		
1 1 1 	0 0 0 0 0 0 0 0 0 0 0 0			51 51	11 0		PDSCH PDSCH		
1 1 1 40	0 0 0 0 0 0 0 0 0 0 0 0			51 51	11 0		PDSCH PDSCH		
1 1 1 	0 0 0 0 0 0 0 0 0 0 0 0			51 51	11 0		PDSCH PDSCH		
1 1 1 40	0 0 0 0 0 0 0 0 0 0 0 0			51 51	11 0		PDSCH PDSCH		
1 1 1 40	0 0 0 0 0 0 0 0 0 0 0 0 0			51 51	11 0		PDSCH PDSCH		
1 1 1 	0 0 0 0 0 0 0 0 0 0 0 0 0			51 51	11 0		PDSCH PDSCH		

Figure 264 Appearance after second test pattern is applied

#### Selecting "1 Section description per symbol; used PRBs and gaps"

 Similar to the second test pattern, except that the symbol only covers from minimum to maximum PRBs present in the radio allocations. Gaps in the middle are ignored. If the test pattern symbol allocation is larger than 255, the numPrbc parameter is set to zero (full height allocation).

		0 0 0		11			PDSCH	0	
				11					
		0		11			PDSCH		
				11	2		PDSCH		
				11			PDSCH		
				36	4		PDSCH		
				36			PDSCH		
				36			PDSCH		
1				36			PDSCH		
1				36	8		PDSCH		
1				36			PDSCH		
1				36	10		PDSCH		
1	0	0	0	36	11		PDSCH	0	
1	0		0	11	0	1	PDSCH	0	
dio /	Allocations	s —							

Figure 265 A

Appearance after third test pattern is applied

## Section 3.10: Applying Compression Methods

The purpose of the Compression tab in the C/U Plane Builder Configuration Tool is to assign a compression mode to each eAxC ID independently for DL and UL U-Plane IQ data.

The "Compression Method" that appears in a drop-down list under the "Compression" tab of the C/U Plane Builder Configuration Tool, for DL and UL U-Plane IQ data, are shown in Figure 266 and Figure 267, respectively.

C/U Plane Builder	Configuration Tool		
Flow/eAxC	DL U-Plane IQ Data Compression	on:	
Compression	eAxC ID	0001 ~	Apply to All DL Flows
Numerology	Static Compression (	no udCompHdr in U-Plane)	
Beamforming	Compression Method	no compression	
Timing	IQ Bitwidth	✓ no compression	
Options	UL U-Plane IQ Data Compressi		
DSS	eAxC ID	block scaling	Apply to All UL Flows
	Static Compression (     Compression Method	µ-law modulation compression	
	IQ Bitwidth	15 ~	
	whether static or dyna compression method; and The stream or spatial stre	atial stream in the downlink a amic compression should be I the I and Q bitwidth required. am is identified by the eAxC ID i nder the "Flow/eAxC" tab.	e assigned; the

Figure 266 Compression method available for DL U-Plane IQ Data

C/U Plane Builder	Configuration Tool		
Flow/eAxC	DL U-Plane IQ Data Compressio	on:	
Compression	eAxC ID	0001	Apply to All DL Flows
Numerology	Static Compression (	no udCompHdr in U-Plar	ne)
Beamforming	Compression Method	no compression	/
Timing	IQ Bitwidth	15	
Options	UL U-Plane IQ Data Compressio	on:	
DSS	eAxC ID	0001	Apply to All UL Flows
	Static Compression (	no udCompHdr in U-Plar	ne)
	Compression Method	no compression	
	IQ Bitwidth	✓ no compression	
	Compression Summary	block floating point	
	For each stream or sp whether static or dyn compression method; an	μ-law	t and uplink select be assigned; the d.
	The stream or spatial stre the flow table mappings u		

Figure 267 Compression method available for UL U-Plane IQ Data

You may select a value for the "IQ Bitwidth" from the drop-down options. Default value is '15' for each compression method, except for the 'modulation compression' method in DL U-Plane IQ data compression, where the "IQ Bitwidth" is set to '16' and cannot be modified.

By default, the compression methods are dynamic. You may select the check box for "Static Compression" to remove the 'udCompHdr' parameter in the U-Plane messages.

To understand how the various compression methods work, let us consider the following SCP project configuration shown in Figure 268 & Figure 269 and the corresponding PCAP configuration to understand how the C-Plane and U-Plane messages appear in both the Downlink and Uplink carrier when "no compression" is applied.

KEYSIGHT Open RAN Str Setup Test Models												
[• 🕸												
-Plane Builder 🔪 Exp	plorer											
		tariharan Harit 🜩										
Component Carriers			Ra	dio Control I	Plane Dat	ta						
Carrier Numerology		î		Subframe	Slot ID	RB Start	RB Number	Sym Start	Sym Number	Channel	Beam Id	
Select Carrier:	Carrier 1 (DL)	~					273			PDSCH		
							126			PDSCH		
Attribute	Value					126				SS/PBCH		
Carrier Type	DL (NR)					147	126			PDSCH		
Cell ID						0	126			PDSCH		
Bandwidth	FR1_100M			0	0	126	21 126	8	4	SS/PBCH PDSCH	0	
Numerology Mode	SingleNumerology			0	0	0	273	12	2	PDSCH	0	
CP Type	Normal			0		0	273	0		PDSCH	0	
Allocations			-		1	v	2/3	U	4	rbach		
Flow/eAxC ID	0001	-										
Resource Allocations				o Allocation	s							
Select Allocation:	DL-SCH1	~		945 115								
Attribute	Value			150								
Name of allocation	DL-SCH1											
Numerology	SCS30k											
Modulation	QPSK			10								
Slots	0:19											
First Symbol				10								
Last Symbol					1	1		10 1		10	15	
Number of Symbols	14									Frame Ind		

Figure 268 S

SCP file for the DL carrier

[+ @											
Plane Builder 🔪 Ex	plorer										
omponent Carriers		R	adio Control I	Plane Da	ta						
Carrier Numerology		^ P	Subframe	Slot ID	RB Start	RB Number	Sym Start	Sym Number	Channel	Beam Id	
Select Carrier:	Carrier 1 (UL)	1	0	0	0	273	0	14	PUSCH	0	
		1	0		0	1	10		PUCCH		
Attribute	Value	1		0	0	273	0	14		0	
Carrier Type	UL (NR)	1			0		10				
Cell ID	OL (NR)	1	2	0	0	273	0	14	PUSCH	0	
Bandwidth	6 FR1_100M	1									
Numerology Mode	SingleNumerology	1				273		14	PUSCH		
CP Type	Normal	1							PUCCH		
Allocations	2	1				273		14	PUSCH		
		1							PUCCH		
Flow/eAxC ID	0001 ~										
Resource Allocations		Rac	io Allocation	5							
Select Allocation:	UCI1		210								
Attribute	Value		100								
Name of allocation	UCI1		193	-							
Numerology	SCS30k		100	-			-				
Allocated Slots	1,3,5,7,9,11,13,15,17,19		**						6 9 <b></b> -		
First Symbol			**************************************						-	-	
Last Symbol			**************************************						-		
RB Offset			0				10		14		
RB Number											



SCP file for the UL carrier

#### 3.10.1: Selecting 'no compression'

Figure 270 & Figure 271 show the C-Plane messages in the PCAP file configuration after you export and load O-RAN stimulus files for the DL and UL carrier, respectively, with the default compression method "no compression".

Setup	p 1	est l	Mode																			- 0	
C-Plane			\$ \	Exp	plore	r \	ç		_		_												
U-Plane	e, C-F	Mane	Me	ssag	es:												U-Pla	ine:				Message Interpretation:	
Descrip	otion																	Dir	eAx		$\nabla$	ecpriMessage : 2 ecpriPayload : 20	
[PCAP]	C-PI			on Ty						e :0, S						Sti 🗠			000			<ul> <li>eCPRI Component eAxC ID (C-Plane) DuPortID : 0</li> </ul>	
[PCAP]	C-PI	ane,	Secti	on Ty	rpe: 1	, Sec	tions	s: 1, Fi	ame	e :0, S	ubfra	me: C	, Slot	0, Sy	mbol	SL						BandSectorID : 0	
																	۲.	_	-			CcID : 0 RuPortID : 1	
		Plane, Section Type: 1, Sections: 1, Frame: 0, Subframe: 0, Slot: 0, Symb Plane, Section Type: 1, Sections: 1, Frame: 0, Subframe: 0, Slot: 0, Symb Plane, Section Type: 1, Sections: 1, Frame: 0, Subframe: 0, Slot: 0, Symb Plane, Section Type: 1, Sections: 1, Frame: 0, Subframe: 0, Slot: 0, Symb Plane, Section Type: 1, Sections: 1, Frame: 0, Subframe: 0, Slot: 0, Symb Plane, Section Type: 1, Sections: 1, Frame: 0, Subframe: 0, Slot: 0, Symb Plane, Section Type: 1, Sections: 1, Frame: 0, Subframe: 0, Slot: 0, Symb Plane, Section Type: 1, Sections: 1, Frame: 0, Subframe: 0, Slot: 0, Symb Plane, Frame: 0, Subframe: 0, Slot: 0, Symbol: 0, Section: 0, PRB: 0-198								C-Pla					<ul> <li>eCPRI Sequence ID</li> <li>SequenceID : 0</li> </ul>								
																	C-PR					E:1	
		Plane, Section Type: 1, Sections: 1, Frame :0, Subframe: 0, Slot: 0, Syn Plane, Section Type: 1, Sections: 1, Frame :0, Subframe: 0, Slot: 0, Syn Plane, Section Type: 1, Sections: 1, Frame :0, Subframe: 0, Slot: 0, Syn Plane, Section Type: 1, Sections: 1, Frame :0, Subframe: 0, Slot: 0, Syn Plane, Section Type: 1, Sections: 1, Frame :0, Subframe: 0, Slot: 0, Syn Plane, Section Type: 1, Sections: 1, Frame :0, Subframe: 0, Slot: 0, Syn									Dir	eAx			SubsequenceID : 0 - C-Plane Common Header								
		Plane, Section Type: 1, Sections: 1, Frame :0, Subframe: 0, Slot: 0, Sj Plane, Section Type: 1, Sections: 1, Frame :0, Subframe: 0, Slot: 0, Sj Plane, Section Type: 1, Sections: 1, Frame :0, Subframe: 0, Slot: 0, Sj Plane, Section Type: 1, Sections: 1, Frame :0, Subframe: 0, Slot: 0, Sj Plane, Section Type: 1, Sections: 1, Frame :0, Subframe: 0, Slot: 0, Sj Plane, Section Type: 1, Sections: 1, Frame :0, Subframe: 0, Slot: 0, Sj Plane, Section Type: 1, Sections: 1, Frame :0, Subframe: 0, Slot: 0, Sj							Sti			000			DataDirection : 1								
[PCAP]	] U-PI	Plane, Section Type: 1, Sections: 1, Frame :0, Subframe: 0, Slot: 0, Sy Plane, Section Type: 1, Sections: 1, Frame :0, Subframe: 0, Slot: 0, Sy Plane, Section Type: 1, Sections: 1, Frame :0, Subframe: 0, Slot: 0, Sy Plane, Section Type: 1, Sections: 1, Frame :0, Subframe: 0, Slot: 0, Sy						8							PayloadVersion : 1 FilterIndex : 0								
																	<					Frameld : 0 Subframeld : 0	
																						Slotid : 0	
																	101000					StartSymbolid : 0 NumberOfSections : 1	
Hex Pa	iyloai	n: Di																				SectionType : 1 User Data Compression Header	
Hex	00	01	02	03	04	05	06		80	09	0A	0B	OC	0D	0E	OF						lqBitWidth : 15	
	80	09	02	03	04	05	00	00	00	00	00	00	81	00	E0	00						Compression : no compression Reserved	
					00	14	00		00				00	00								Value : 0	
32 48	FO		00		00	00	FF			00 00			00	00	00	00						<ul> <li>C-Plane Section Type 1 SectionID : 0</li> </ul>	
40	00	00	00	00	00		00	00	00	, 00	00	00										RB:0	
																						Symbolinc : 0 StartPrbc : 0	
																						NumberPrbc : 0 ReMask : 111111111111b	
																					·	NumSymbol : 4	
																						Ef : 0b Beamld : 0	
																		1				Bearing . o	

Figure 270 PC

PCAP file showing C-Plane messages (DL) with no compression applied

C-Plan	n Pu	Idor	$\overline{\mathbf{v}}$	P	plor	er -																				
		Huida			-											- 100										
J-Plan	e, C-	Plan	e Me	ssa	ges:													U-P	lane						Message Interpretation:	
Desc	riptic	n																	D	ir	eAxC	ſ	U	$\nabla$	ecpriMessage : 2 ecpriPayload : 20	
		Plar			1 Турі		Sectio								Symb		art: ( 🗠								eCPRI Component eAxC ID (C-Plane) DuPortID : 0	
[PC/	AP] C	Plan	ie, Se	ctio	тур	£ 1, 5	Sectio	ns: 1,	Fram	e :0,	Subfr	ame:	0, Slo	ot: 1, 5	Symb	ol St	art: *								BandSectorID : 0	
							Sectio																		CelD : 0 RuPortID : 1	
							Sectio																		eCPRI Sequence ID	
							Sectio Sectio											C-P	lane						SequenceID:0 E:1	
							sectio Sectio												D	ir	eAxC	t,	U		SubsequenceID : 0	
							Sectio													JL	0001				C-Plane Common Header DataDirection : 0	
																	art: ( 🗸								PayloadVersion : 1	
																									FilterIndex : 0 FrameId : 0	
																									Subframeld : 0 Slotid : 0	
																									StartSymbolid : 0	
lex Pa	ayloa	d:																						^	NumberOfSections : 1 SectionType : 1	
Her	00	01	02	03	04	05	06	07	08	09	04	0B	00	00	OF	OF	ASCI								<ul> <li>User Data Compression Header</li> </ul>	
																									IqBitWidth : 15 Compression : no compression	
					04		5 00				10		81 00		EU 01									10	Reserved	
32																									Value : 0 C-Plane Section Type 1	
48							00 0																		SectionID : 0	
																									RB : 0 Symbolinc : 0	
																									StartPrbc : 0	
																				-0.5					NumberPrbc:0 ReMask:111111111111b	
																									NumSymbol : 14	
																									Ef: Ob	

Figure 271 PCAP file showing C-Plane messages (UL) with no compression applied

Figure 272 & Figure 273 show the U-Plane messages in the PCAP file configuration after you export and load O-RAN stimulus files for the DL and UL carrier, respectively, with the default compression method "no compression".

Note that the Uplink carrier contains only C-Plane messages by default. To understand the effects of compression on U-Plane messages in the Uplink carrier, you can generate Uplink U-Plane messages using the Open RAN Studio software. See Creating U-Plane messages in Uplink Carrier on page 170 to understand how to Uplink U-Plane messages, prior to applying one of the compression methods. Figure 273 shows one such example.

-Plar	ne Builde	·V	Expl	orer																		
					10.00				-110				111	- 100	((I)) ((I))	-						
I-Plar	ne, C-Plar	e Me	ssage	<b>5</b> :												U	Plane	8				Message Interpretation:
	Protocol		Length	E	escriptio	n										4	F D	lir	eAxC	DU	$\nabla$	CcID:0 RuPortID:1
105	AE FE		60		PCAP] C	Plane	, Sec	tion	Type:	1, Sec	tion	s: 1, Fi	rame	:0, S	ubfr 🗅				0001			eCPRI Sequence ID
105					PCAPI C	Plane	e, Sec	tion	Type:	1, Sec	tion	s: 1, F	rame	:0, S	ubfr							SequenceID:0 E:1
105	AEFE				PCAP] C	Plane	e, Sec	tion	Type:	1, Sec	tion	s: 1, Fi	rame	:0, S	ubfr		_					SubsequenceID : 0
105					PCAP] C	Plane	, Sec	tion	Type:	1, Sec	tion	s: 1, Fi	rame	:0, S	ubfr							U-Plane Common Header DataDirection : 1
	AE FE				PCAP] C											C-	Plane	:				PayloadVersion : 1
	AE FE		60		PCAPJ C												D	lir	eAxC	DU	( <sup>a</sup> )	FilterIndex : 0
	AEFE		60		PCAP] C												0 0	DL	0001			Frameld : 0 Subframeld : 0
	AE FE		60		PCAP] C																	Slotid : 0
05			8991	- 2	PCAP] U	Plane	e, Fran	me :0			: 0, S	lot: 0,		ibol: C	, Se		_					Symbolid : 0 U-Plane Section
																						SectionID : 0
																						RB:0
																•					•	Symbolinc : 0 StartPrbu : 0
ex P	ayload:																					NumberPrbu : 199
Hex	00 01	02	03	04	05 06	07	08	09	0A	0B	0C	OD	0E	OF	AS							udCompHdr : 240 Reserved : 0
																						PRB 0
					05 00				00		81			00								IqSampleBlock : [5a, 82, b5,] (IgBitWidth : 15)
16 32	AE FE				09 00 82 85		00 6A	80	90	00	00 A8	00 28	00 50	00 56								(Compression : no compression)
48					85 06						28	50	56									<ul> <li>PRB 1         IqSampleBlock : [a5, 7f, 4a,]     </li> </ul>
64					FD 6A				AS		AF			D2								(IgBitWidth : 15)
80					95 FD						69			41								(Compression : no compression)
96					FA D4						5F			AS								PRB 2 IqSampleBlock : [5a, 82, b5,]
					D4 1A							BF	5A									(IqBitWidth : 15)
112																						(Compression : no compression)

Figure 272 PC

PCAP file showing U-Plane messages (DL) with no compression applied

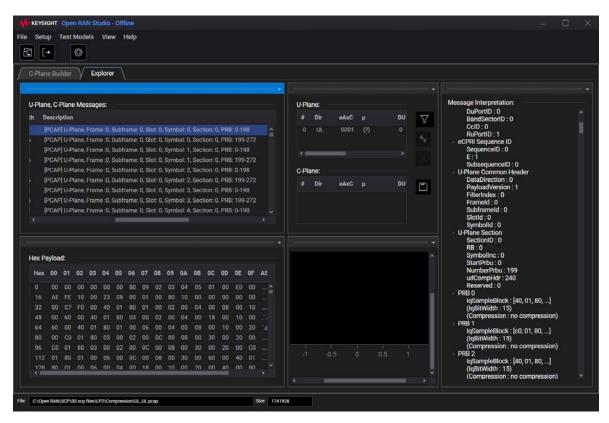


Figure 273

PCAP file showing U-Plane messages (UL) with no compression applied

3.10.2: Selecting 'block floating point'

In the 'block floating point' compression method, each I and Q sample is defined by:

- 1 bit sign
- Multiple bits mantissa = non-zero value
- Multiple bits exponent = position to place the decimal point

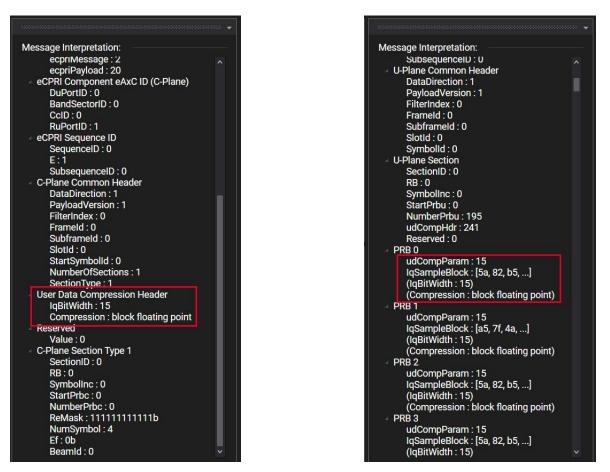


Figure 274 I and Q sample definition for block floating point compression

The 'block floating point' method reduces number of bits per PRB by assigning a common exponent to a common block of '12' I samples and '12' Q samples. This allows for reducing the amount of bits transmitted.

The common exponent is found by looking at the maximum value within the block and scaling to that value.

Figure 275 and Figure 276 show the C-Plane messages and U-Plane messages for the Downlink and Uplink carriers, respectively, after the block floating point compression method is applied.





C-Plane and U-Plane messages (DL) with block floating point method

□	
Message Interpretation:	Message Interpretation:
ecpriMessage: 2	DuPortID : 0
ecpriPayload : 20	BandSectorID: 0
<ul> <li>eCPRI Component eAxC ID (C-Plane)</li> </ul>	CcID:0
DuPortID : 0	RuPortID : 1
BandSectorID: 0	eCPRI Sequence ID
CcID:0	SequenceID: 0
RuPortID : 1	E:1
COPRI Sequence ID	SubsequenceID : 0
SequenceID : 0	U-Plane Common Header
E:1	DataDirection : 0
SubsequenceID: 0	PayloadVersion : 1
C-Plane Common Header	FilterIndex : 0
DataDirection : 0	Frameld : 0
PayloadVersion : 1	Subframeld : 0
FilterIndex : 0	SlotId : 0
Frameld : 0	Symbolid : 0
Subframeld : 0	U-Plane Section
Slotid : 0	SectionID : 0
StartSymbolid : 0	RB:0
NumberOfSections : 1	Symbolinc : 0
SectionType : 1	StartPrbu : 0
User Data Compression Header	NumberPrbu : 195
lqBitWidth : 15	udCompHdr : 241
Compression : block floating point	Reserved : 0
<ul> <li>Reserved</li> </ul>	PRB 0
Value : 0	udCompParam : 15
C-Plane Section Type 1	IqSampleBlock : [40, 01, 80,]
SectionID : 0	(IqBitWidth : 15)
RB:0	(Compression : block floating point)
Symbolinc: 0	PRB 1
StartPrbc:0	udCompParam : 15
NumberPrbc : 0	IqSampleBlock : [c0, 01, 80,]
ReMask : 11111111111b	(IqBitWidth : 15)
NumSymbol : 14 Ef : 0b	(Compression : block floating point) PRB 2
Beamld: 0	udCompParam : 15
Bearing . U	



C-Plane and U-Plane messages (UL) with block floating point method

## 3.10.3: Selecting 'block scaling'

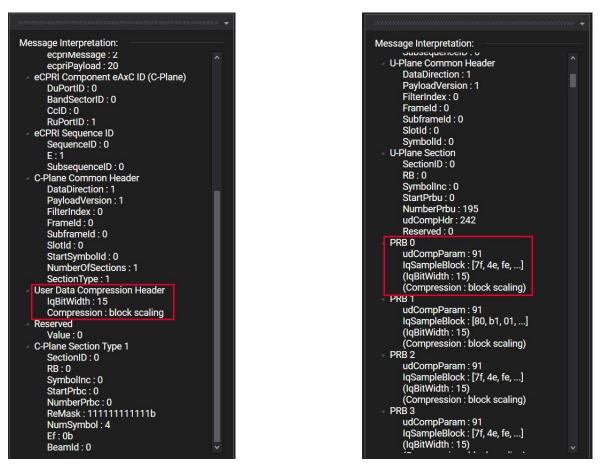
The 'block scaling' reduces number of bits per PRB by:

- Finding a common scaler for the block.
- Rescaling the samples to a lower bit width.
- Transmit the reduced PRB and the common scaler.

This allows for reducing the amount of bits transmitted.

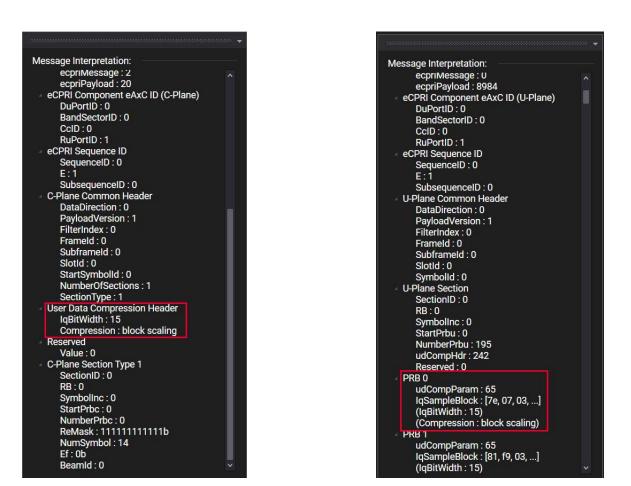
The common scaler is found by looking at the maximum value within the block and scaling to that value.

Figure 277 and Figure 278 show the C-Plane messages and U-Plane messages for the Downlink and Uplink carriers, respectively, after the block scaling compression method is applied.





C-Plane and U-Plane messages (DL) with block scaling method





e 278 C-Plane and U-Plane messages (UL) with block scaling method

#### 3.10.4: Selecting 'µ-law'

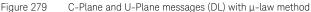
The ' $\mu$ -law' compression method reduces number of bits per I and Q sample by re-quantizing the word to a lower bit width. The  $\mu$ -law quantization is a non-linear function with finer quantization levels for small values while coarser quantization levels are for larger values.

This allows for reducing the amount of bits transmitted.

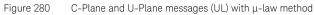
The common scaler is found by looking at the maximum value within the block and scaling to that value.

Figure 279 and Figure 280 show the C-Plane messages and U-Plane messages for the Downlink and Uplink carriers, respectively, after the  $\mu$ -law compression method is applied.





Message Interpretation:	Message Interpretation:
ecpriMessage : 2	RuPortID : 1
ecpriPayload : 20	eCPRI Sequence ID
eCPRI Component eAxC ID (C-Plane)	SequenceID : 0
DuPortID : 0	E:1
BandSectorID: 0	SubsequenceID : 0
CcID:0	U-Plane Common Header
RuPortID : 1	DataDirection : 0
eCPRI Sequence ID	PayloadVersion : 1
SequenceID : 0	FilterIndex : 0
E:1	Frameld : 0
SubsequenceID : 0	Subframeld : 0
C-Plane Common Header	SlotId : 0
DataDirection : 0	Symbolid : 0
PayloadVersion : 1	U-Plane Section
FilterIndex : 0	SectionID: 0
Frameld : 0	RB:0
Subframeld : 0	Symbolinc : 0
SlotId : 0	StartPrbu : 0
StartSymbolid : 0	NumberPrbu : 195
NumberOfSections : 1	udCompHdr : 243
SectionType : 1	Reserved : 0
User Data Compression Header	PRB 0
IqBitWidth : 15	udCompParam : 240
Compression : µ-law	IqSampleBlock : [60, 01, 40,]
Reserved	(IqBitWidth : 15)
Value : 0	(Compression : μ-law)
C-Plane Section Type 1	PRB 1
SectionID: 0	udCompParam : 240
RB:0	IqSampleBlock : [a0, 01, 40,]
Symbolinc : 0	(IqBitWidth : 15)
StartPrbc: 0	(Compression : μ-law)
NumberPrbc : 0	PRB 2
ReMask: 111111111111b	udCompParam : 240
NumSymbol : 14	IqSampleBlock : [60, 01, 40,]
Ef : Ob	(IqBitWidth : 15)
Beamld : 0	(Compression · u-law)



#### 3.10.5: Selecting 'modulation compression'

The 'modulation compression' method reduces the number of bits used to represent IQ samples (that is, 16 bits for I and 16 bits for Q for any modulation order) to just the number of bits needed to represent the constellation (that is, 2 bits for I and 2 bits for Q in 16QAM, and so on).

The whole User data is compressed but not in blocks of 12 PRBs.

There is a "shift" in the modulation, so all possible modulations can overlap, if needed. There are a couple of parameters sent via Type 4 or Type 5 C-plane messages to know about type of modulation and "shifting".

Figure 281 shows the C-Plane messages and U-Plane messages for the Downlink carrier only, after the modulation compression method is applied.

Message Interpretation:	Message Interpretation:
E:1	L:1
SubsequenceID: 0	SubsequenceID : 0
C-Plane Common Header	U-Plane Common Header
DataDirection : 1	DataDirection : 1
PayloadVersion : 1	PayloadVersion : 1
FilterIndex : 0	FilterIndex : 0
Frameld : 0	Frameld : 0
Subframeld : 0	Subframeld : 0
Slotid : 0	Slotid : 0
StartSymbolid : 0	Symbolid : 0
NumberOfSections : 1	U-Plane Section
SectionType : 1	SectionID: 0
User Data Compression Header	RB:0
IgBitWidth : 0	Symbolinc : 0
Compression : no compression	StartPrbu : 0
<ul> <li>Reserved</li> </ul>	NumberPrbu : 0
Value : 0	udCompHdr : 20
C-Plane Section Type 1	Reserved : 0
SectionID : 0	PRB 0
RB:0	IqSampleBlock : [00, 30, 45]
Symbolinc : 0	(IgBitWidth : 1)
Symboline : 0 StartPrbc : 0	(Compression : modulation compressio
NumberPrbc : 0	PRB 1
ReMask : 111111111111b	IgSampleBlock : [fa, ae, 8f]
	(IgBitWidth : 1)
NumSymbol : 4 Ef : 1b	(Compression : modulation compressio
Beamld : 0	PRB 2
Section Ext Command	IqSampleBlock : [05, 60, 42]
Ef : False	(IgBitWidth : 1)
ExtType : 4	(Compression : modulation compressio
Extrype: 4	PRB 3
Modulation Compression Ext	IqSampleBlock : [18, b9, a7]
Csf : True	(IqBitWidth : 1)
ModCompScaler : [0:2047]	(Compression : modulation compressio
(ModCompScaler Value : 0.9995117187	PRB 4
(Modeompscalervalue : 0.9993117187.	<pre>&gt; PRB 4 </pre>



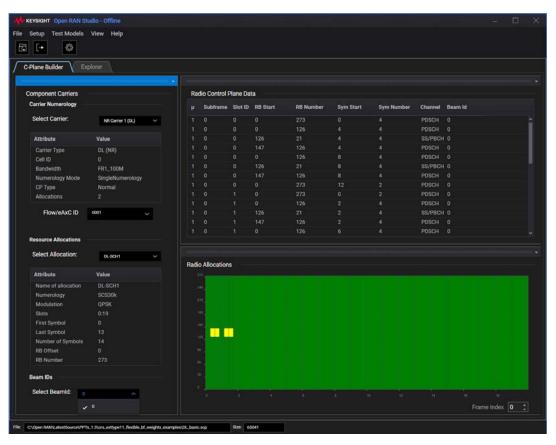
1 C-Plane and U-Plane messages (DL) with modulation compression

## Section 3.11: Understanding Configuration of Beam / Ue IDs

This section explains the appropriate ways to configure Beam / Ue IDs and assign them to the selected Radio Allocations. We shall also understand the structure of the Beamforming Weights files compatible with the U5040A Open RAN Studio software.

#### 3.11.1: Setting Beam IDs / Ue IDs for Radio Allocations

To understand Beam/Ue ID assignments, a simple DL SCP file, with PDSCH and SS/PBCH Channels, has been used for illustration.



1 Load the SCP file into the Open RAN Studio software.

Figure 282 Loading an SCP file for DL carrier with two Channels

By default, the C-Plane Builder tab displays "Beam IDs" area, where the 'Select Beamld' drop-down field shows a single value '0', which is also reflect in the last column of the Radio Control Plane Data to the right. The value '0' indicates "no beamforming" and can be manually assigned to one or more radio allocations.

C/U Plane Builder	Configuration Tool				×
Flow/eAxC	Beamforming Met	thod:			
Compression	no beamforming	)	~		
Numerology	Size of beam r	mapping table 0	+ ×		
Beamforming	Beamforming Ma	ppings:			
Timing	Beam IDs	Beam Weights	Flexible Weights	Beam Attributes	Beam Channel Information
Options	Table Index	Beam ID			
DSS					

Figure 283 Default view of the Beamforming tab

2 From the "Beamforming Method" drop-down, select the required beamforming method. Refer to Beamforming on page 77 for description of each method.

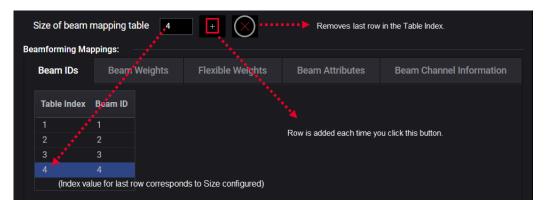
If you select the "Beamforming Method" as 'channel-information-based beamforming' and exit the C/U Plane Builder Configuration Tool, the C-Plane Builder tab displays the "Ue ID" instead of the "Beam ID", as shown in Figure 284, where the default value in the "Select Ue ID" drop-down field is 'Reset'. See Applying Channel-information-based beamforming on page 341 for more details about how this beamforming method works.

-Plane Builder Exp	plorer									
Component Carriers		Ra	dio Control I	Plane Da	ta					
Carrier Numerology		μ	Subframe			RB Number	Sym Start	Sym Number	Channel Ue Id	
Select Carrier:	NR Carrier 1 (DL)		0	0	0	273	0		PDSCH	
									PDSCH	
Attribute	Value								SS/PBCH	
Carrier Type	DL (NR)					126			PDSCH	
Cell ID						126			PDSCH	
Bandwidth	FR1_100M				126				SS/PBCH	
Numerology Mode	SingleNumerology				147				PDSCH	
CP Type	Normal								PDSCH	
Allocations									PDSCH	
Eleveration In						126			PDSCH	
Flow/eAxC ID	0001 🗸				126 147			4	SS/PBCH PDSCH	
					0	120	6	4	PDSCH	
Resource Allocations									rbach	
Select Allocation:										
Select Allocation.	DL-SCH1 Y	Padi	Allocation							
Attribute	Value	Radi	s Anocation	3						
Name of allocation	DL-SCH1		40							
Numerology	SCS30k									
Modulation	QPSK		10							
Slots			#0							
First Symbol										
Last Symbol										
Number of Symbols										
RB Offset										
RB Number	273		ē							
Ue IDs										
Select Ueld: Reset									100	
Select Deld. Reset										

Figure 284 Default view with Ue ID for channel-information-based beamforming

- 3 Increment the "Size of beam mapping table" counter to add one or more rows to the Table Index.
- 4 Click the red X button to the right to remove a row from the Table Index. The row, which is at the bottom of the Table Index, is deleted each time you click the X button.

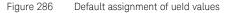
Note that deleting a Table Index row corresponding to a Beam ID simultaneously deletes the same row corresponding to the Ue ID. Deleting the last remaining Table Index row automatically resets the Beam / Ue IDs to default, as shown in Figure 282 and Figure 284.





The Table Index is added simultaneously across all tabs (irrespective of the beamforming method selected). By default, the Beam ID is assigned the same serial numbering as the Table Index starting from 1. However, the ueID under "Beam Channel Information" starts from 0.

C/U Plane Builder	Configuration Tool X
Flow/eAxC	Beamforming Method:
Compression	channel-information-based beamforming $\sim$
Numerology	Size of beam mapping table 3 + ×
Beamforming	Beamforming Mappings:
Timing	Beam IDs         Beam Weights         Flexible Weights         Beam Attributes         Beam Channel Information
Options	Table Index Regularization Factor ueld File Path Load
DSS	1 0 0 <b>Open</b>
	2 0 1 <b>Open</b>
	3 0 2 <b>Open</b>
	CI IQ Bitwidth 16  Add Ext Type 8 to Section Type 5



5 To modify the value of a Beam ID (under Beam IDs tab) or a Ue ID (under Beam Channel Information tab), double-click the entry and type a new value, as shown in Figure 287.

C/U Plane Builder	Configuration Tool				
Flow/eAxC	Beamforming Met	thod:			
Compression	predefined-bean	n beamforming	~		
Numerology	Size of beam r	mapping table	+ ×		
Beamforming	Beamforming Ma	ppings:			
Timing	Beam IDs	Beam Weights	Flexible Weights	Beam Attributes	Beam Channel Information
Options	Table Index	Beam ID			
DSS	1	45			
	2	55 65			
		00			

Figure 287 Changing values for Beam / Ue IDs

NOTE

You cannot access both Beam ID and Ue ID simultaneously for modification. However, adding / removing a Table Index row for the Beam ID simultaneously adds / removes the Table Index row for the Ue ID and vice-versa. Following images display the Beam Id / Ue ID default values in the C-Plane Builder tab after you exit the C/U Plane Builder Configuration Tool.

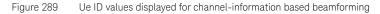
For all beamforming methods except channel-information-based beamforming

-Plane Builder 🔪 🗉	xplorer										
Component Carriers			Radio Control	Diana Da							
Carrier Numerology						100000000000000000000000000000000000000			-		
			µ Subframe			RB Number	Sym Start	Sym Number	Channel		
Select Carrier:	NR Carrier 1 (DL)										
Attribute	Value		10 10		126 147	21 126	4	4	SS/PBCH PDSCH	0	
Carrier Type	DL (NR)		1 0		0	126	8	4	PDSCH		
Cell ID	0		1 0		126	21	8	4	SS/PBCH		
Bandwidth Numerology Mode	FR1_100M SingleNumerology		1 0		147	126				0	
CP Type	Normal					273			PDSCH		
Allocations	2								PDSCH		
			1 0			126			PDSCH		
Flow/eAxC ID	0001 ~								SS/PBCH		
					147				PDSCH		
Resource Allocations						126			PDSCH		
Select Allocation:	DL-9CH1	×	adio Allocatio								
Attribute	Value	R	adio Allocatio	15							
Name of allocation	DL-SCH1		240								
Numerology	SCS30k										
Modulation	QPSK		210								
Slots			180_								
First Symbol			110	1.2							
Last Symbol	10		120								
Number of Symbo											
RB Offset			R								
RB Number			м.,								
Beam IDs			и.								
Select Beamld:											

Figure 288 Beam ID displayed for various beamforming methods

[-										
-Plane Builder Cxpl	orer									
Component Carriers		Ra	lio Control I							
Carrier Numerology			Subframe			RB Number	Sym Start	Sym Number	Channel Ue Id	
Select Carrier:	NR Carrier 1 (DL) 🗸 🗸			0	0	273 126	0	4	PDSCH PDSCH	
Attribute	Value				126			4	SS/PBCH	
Carrier Type	DL (NR)				147				PDSCH	
Cell ID	DL (NR)								PDSCH	
Bandwidth	FR1_100M								SS/PBCH	
Numerology Mode	SingleNumerology				147				PDSCH	
CP Type	Normal								PDSCH	
Allocations									PDSCH	
									PDSCH	
Flow/eAxC ID	0001 ~								SS/PBCH	
					147	126			PDSCH	
									PDSCH	
Resource Allocations					126				SS/PBCH	
Select Allocation:	DL-9CH1				147	126			PDSCH	
									PDSCH	
Attribute	Value									
Name of allocation	DL-SCH1									
Numerology	SCS30k	Radi	Allocation	s						
Modulation	QPSK									
Slots			ю_							
First Symbol			10							
Last Symbol			P.							
Number of Syl										
RB Offset o										
RB Number										
lie IDr.										
2										
Select Ueld: Reset	×			- 24	1	1	1	12	Ne.	10 10

## • For channel-information-based beamforming method only



The U5040A Open RAN Studio software returns certain warning / error prompts, in case the Beamforming data is not configured appropriately in the C/U Plane Builder Configuration Tool.

For example,

a Setting Beam Id value to '0' for an allocation is allowed in the C-Plane Builder tab, but not in the C/U Plane Builder Configuration Tool. If you attempt to set a Beam ID value to '0' for a Table Index row, a warning is prompted, as shown in Figure 290, and the Beam ID value reverts to the previous value, when you close the warning dialog box.

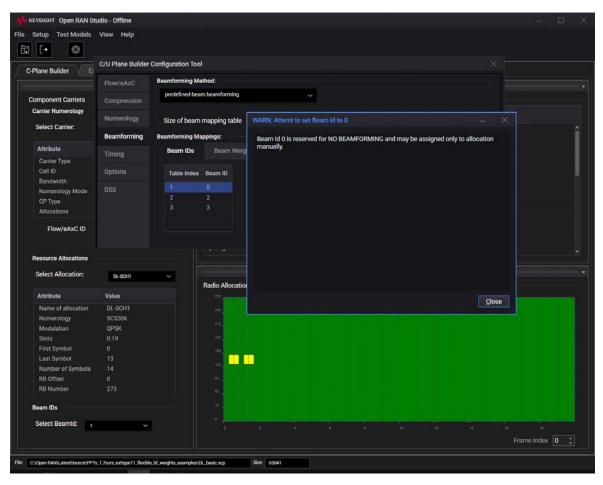
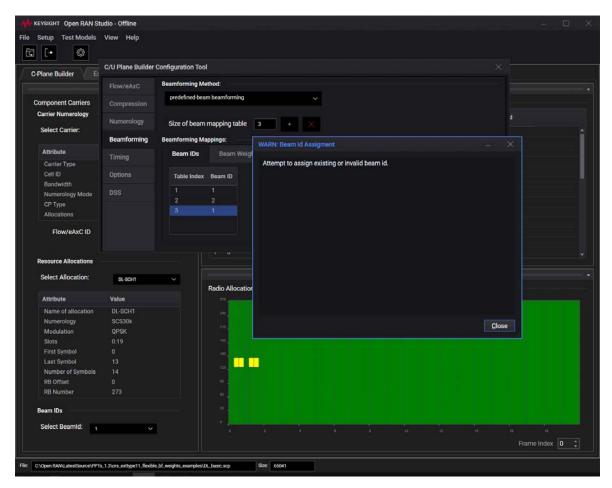


Figure 290 Warning prompt when Beam ID value is set to '0'

*b* Entering an existing Beam Id value in another row is forbidden in the C/U Plane Builder Configuration Tool. If you attempt to do so, a warning is prompted, as shown in Figure 291, and the Beam ID value reverts to the previous value, when you close the warning dialog box.





c Similarly, entering an existing Ue Id value in another row is forbidden in the C/U Plane Builder Configuration Tool. If you attempt to do so, a warning is prompted, as shown in Figure 292, and the Ue ID value reverts to the previous value, when you close the warning dialog box.

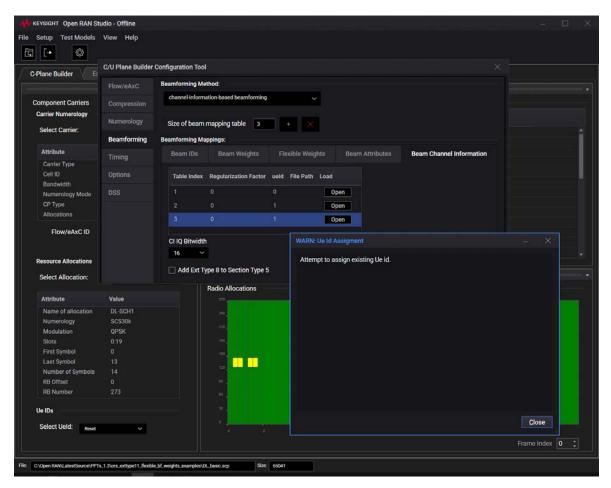


Figure 292 Warning prompt when existing Ue ID value is entered

*d* After you assign Beam ID values to specific Radio allocations, changing that value in the C/U Plane Builder Configuration Tool updates it in the Radio Control Plane Data for all allocations, as shown in Figure 293 and Figure 294.

KEYSIGHT Open RAN Studio - Offline				
lle Setup Test Models View Help				
G [• ©				
C-Plane Builder Explorer				
Component Carriers Radio Control Plane Data				
C/U Plane Builder Configuration Tool	×	Number Chann	el Beam Id	
Flow/eAxC Beamforming Method:		PDSC		
Provienaico predefined-beam beamforming		PDSC		
Compression		SS/PB		
		PDSCI		
Numerology Size of beam mapping table 3 + ×		SS/PB		
Beamforming Beamforming Mappings:		PDSC		
Timing Beam IDs Beam Weights Flexible Weights Beam Attributes Beam Channel In	nformation	PDSCI		
Timing beam tos beam weights Prexible weights Beam Attributes Beam channer in	monnation	PDSC		
Options Table Index Beam ID		PDSCI		
		SS/PB		
DSS 1 5 Beam ID value changed from 1 to 5 for the first row.		PDSCI PDSCI		
		PUSCI		
Name of allocation DL-SCH1 346 Numerology SCS30k				
Monecody Scasok 240_				
Slots 0.19 10				
First Symbol 0 to				
Last Symbol 13				
Number of Symbols 14				
RB Offset 0 🛛 👘 🔤				
RB Number 273				
Beam IDs 20				
Select Beamld:	14	12 14		
				ame Index 0 🗘

Figure 293 Changing Beam ID value already assigned to an allocation

Setup Test Models	view neip												
-Plane Builder V Exp	lorer												
Component Carriers			0	io Control I	Die								
Carrier Numerology			U	Subframe			RB Number	Sym Start	Sym Number	Channel	Beam Id		
Select Carrier:	NR Carrier 1 (DL)	v								PDSCH	5		
										PDSCH			
Attribute	Value					126				SS/PBCH			
Carrier Type	DL (NR)						126		4	PDSCH	5		
Cell ID						0	126 21	8	4	PDSCH SS/PBCH	5		
Bandwidth	FR1_100M				0	147	126	8	4	PDSCH	5		
Numerology Mode	SingleNumerology					0	273	12	2	PDSCH	5		
CP Type Allocations	Normal 2			0		0	273	0	2	PDSCH	5		
Allocations										PDSCH			
Flow/eAxC ID	0001 🗸									SS/PBCH	0		
						147				PDSCH			
Resource Allocations										PDSCH	5		
Select Allocation:	DL-SCH1	- i											
Attribute	Value		Radio	Allocation	s								
Name of allocation Numerology	DL-SCH1 SCS30k												
Modulation	QPSK												
Slots	0:19												
First Symbol													
Last Symbol													
Number of Symbols													
RB Offset													
RB Number	273												
Beam IDs													
Select Beamld: 5	~							1	a 12	14	10	-	
											Fr	ame Index 0	) ‡

Figure 294 Updated Beam ID values displayed in the Radio Control Plane Data

e Similar to Beam IDs, the Ue ID values undergo the same kind of update for the allocations, as shown in Figure 295 and Figure 296.

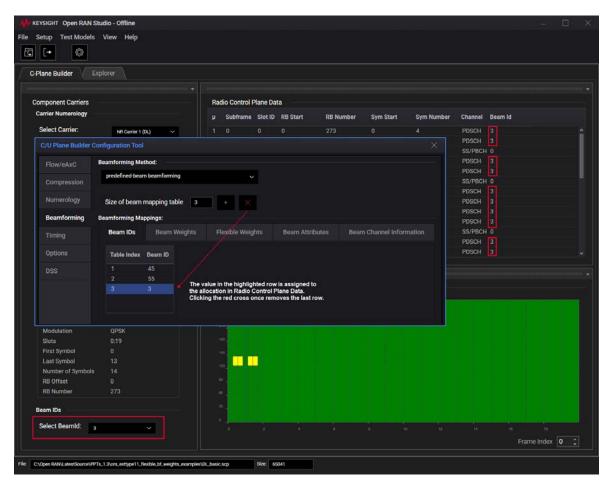
Plane Builder	Sxplorer			
omponent Carriers	Radio Control Plane Data			
Carrier Numerology	μ Subframe Slot ID RB Start RB Number Sym Start Sym Number	Channel	Ve Id	
C/U Plane Builder Co	Infiguration Tool	PDSCH		
Flow/eAxC	Beamforming Method:	SS/PBCH		
Compression	channel-information-based beamforming	PDSCH PDSCH	2	
Compression		SS/PBCH		
Numerology	Size of beam mapping table 3 + ×	PDSCH	2	
a section of		PDSCH		
Beamforming	Beamforming Mappings:	PDSCH		
Timing	Beam IDs Beam Weights Flexible Weights Beam Attributes Beam Channel Information	PDSCH		
		SS/PBCH		
Options	Table Index Regularization Factor ueld File Path Load	PDSCH	2	
DSS	1 0 0 Open	PDSCH		
	2 0 1 Open			
	3 0 4 Open			
	CI IQ Bitwidth			
	Ue ID value changed from 2 to 4 for the last row.			
	Add Ext Type 8 to Section Type 5			
Last Symbol	13			
Number of Symbols				
RB Offset	0 %			
RB Number	273			
Je IDs	*.			
Select Ueld:				

Figure 295 Changing Ue ID value already assigned to an allocation

[+											
-Plane Builder Exp											
Component Carriers		R	adio Control I	Plane Da	la						
Carrier Numerology		ų	Subframe	Slot ID	RB Start	RB Number	Sym Start	Sym Number	Channel	Ue Id	
Select Carrier:	NR Carrier 1 (DL) V								PDSCH	4	
									PDSCH	4	
Attribute	Value								SS/PBCH		
Carrier Type	DL (NR)				147	126			PDSCH		
Cell ID		1				126	8	4	PDSCH	4	
Bandwidth	FR1_100M			0	126 147	21 126	8		SS/PBCH PDSCH	4	
Numerology Mode	SingleNumerology			0	0	273			PDSCH	4	
CP Type	Normal 2		0		0	273	0		PDSCH	4	
Allocations						126			PDSCH	4	
Flow/eAxC ID	0001								SS/PBCH		
					147				PDSCH	4	
Resource Allocations									PDSCH	4	
Select Allocation:											
Select Allocation.	0L-9CH1 ~		dio Allocation	s							
Attribute	Value										
Name of allocation	DL-SCH1		340								
Numerology	SCS30k		210								
Modulation	QPSK										
Slots			100								
First Symbol			10								
Last Symbol Number of Symbols	13			_							
RB Offset	0										
RB Number	273		2								
Ue IDs											
Select Ueld: 4	<b>_</b>						1			18	

Figure 296 Updated Ue ID values displayed in the Radio Control Plane Data

f After you assign a specific Beam ID value to one or more Radio allocations, removing the Table Index row in the C/U Plane Builder Configuration Tool resets the Beam ID value to '0' (default) in the Radio Control Plane Data for the corresponding allocations, as shown in Figure 297 and Figure 298.





Plane Builder	xplorer										
omponent Carriers		- Ra	dio Control	Plane Da	ta						
Carrier Numerology		-	Subframe	Slot ID	RB Start	RB Number	Sym Start	Sym Number	Channel	Beam Id	
Select Carrier:	NR Carrier 1 (DL)			0		273		4		0	
	NR camer ( (cc)			0	0	126	4	4		0	
Attribute	Value				126				SS/PBCH		
Carrier Ture	DL (NR)				147	126			PDSCH	0	
C/U Plane Builder Co									PDSCH		
									SS/PBCH	0	
Flow/eAxC	Beamforming Method:								PDSCH	0	
	predefined-beam beamforming								PDSCH		
Compression									PDSCH		
Numerology	Size of beam mapping tab	e 2							PDSCH		
	Size of beam mapping tab	e z							SS/PBCH		
Beamforming	Beamforming Mappings:										
Timing	Beam IDs Beam W	eights Fl	exible Weig	hts	Beam Attrib	utes Beam	Channel Inform	nation	PDSCH	0	
Options	Table Index Beam ID										
DSS	1 45 2 55										
	2 33	Radio Contre	ol Plane Date	a shows r	default						
		Beam ID valu									
First Sympol			1107	-							
Last Symbol			120								
Number of Symbols RB Offset	.14 0										
RB Number	273										
KD NUNIDEI			¢0 _								
Beam IDs			편 :								

Figure 298 Default Beam ID updated in the Radio Control Plane Data

*g* Similar to Beam IDs, removing the Table Index row in the C/U Plane Builder Configuration Tool resets the Ue ID value to 'Reset' (default) in the Select Ueld drop-down field for the corresponding allocations, as shown in Figure 299 and Figure 300.

	Explorer									
Component Carriers		Radi	o Control Plane D	ata						
Carrier Numerology		μ	Subframe Slot I	D RB Start	RB Number	Sym Start	Sym Number	Channel	Ue Id	
Select Carrier:	NR Carrier 1 (DL)		0 0				4	PDSCH	64	
								PDSCH	64	
Attribute	Value	1	0 0	126	21	4	4	SS/PBCH		
C/U Plane Builde	er Configuration Tool							PDSCH	64	
7	Beamforming Method:							PDSCH SS/PBCH	64	
Flow/eAxC	channel-information-based bean	formation 1						PDSCH	64	
Compression	channel-information-based bean	norming						PDSCH	64	
1987 - 1982 1987 - 1982								PDSCH	64	
Numerology	Size of beam mapping table	3						PDSCH	64	
Beamforming	Beamforming Mappings:							SS/PBCH		
Timing	Beam IDs Beam Wel	ghts I	Texible Weights	Beam At	tributes Be	eam Channel Inf	ormation	PDSCH PDSCH	64 64	
Options	Table Index Regularization	Factor uel	d File Path Los	ıd						
DSS			1	Open						
			1	Open						
			· .	Open						
	CI IQ Bitwidth		The value in the	highlighted ro	w is assigned					
	16 🗸		to the allocation Clicking the red							
	Add Ext Type 8 to Section	n Type 5	row.							
RB Number										

Figure 299 Removing Table Index row having Ue ID value assigned to an allocation

omponent Carriers		R	dio Control F	Plane Da	ta						
Carrier Numerology			Subframe	Slot ID	RB Start	RB Number	Sym Start	Sym Number	Channel	Ue Id	
Select Carrier:	NR Carrier 1 (DL)								PDSCH		
									PDSCH		
Attribute	Value				126				SS/PBCH		
Carrier Type	DL (NR)	1	0	0	147	126	4	4	PDSCH PDSCH		
C/U Plane Builder	Configuration Tool								SS/PBCH		
Flow/eAxC	Beamforming Method:								PDSCH		
1 IOT/COND	channel-information-based beamfor	mina							PDSCH		
Compression									PDSCH		
Numerology									PDSCH		
Numerology.	Size of beam mapping table	2							SS/PBCH		
Beamforming	Beamforming Mappings:								PDSCH PDSCH		
Timing	Beam IDs Beam Weigh		Flexible We	ights	Beam Att	tributes Bea	am Channel Info	ormation			
Options	Table Index Regularization Fa	ctor u	ld File Path	1 Load							
DSS		0		0	ipen						
	2 0				pen						
	Ċ					Ue ID updated to	default value 'Re	ant'			
						after the row is rei		,			
	CI IQ Bitwidth										
	16										
			1								
NUMBER OF SWIDDIN	14										
Rumber or Symbols											
			5 - 6								
RB Offset											

Figure 300 Updated Ue ID values displayed in the Radio Control Plane Data

#### 3.11.2: Loading Beamforming Weights as File

Beginning with version 1.3 of the U5040A Open RAN Studio software, you may load Beam weights from a file. Weights file is determined separately for each Beam ID. Therefore, based on the number of Table Index rows, you must load the corresponding Weights file for each Beam ID.

# NOTE

# Channel-information-based beamforming does not require loading Beam Weights.

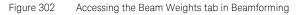
Figure 301 shows part of the structure from an Excel file containing the Beam Weights data. The format of the file containing Beam Weights data is CSV.

316228;0	948683
316228;-0	316228
948683;-0	948683
948683;-0	316228
948683;0	948683
948683;0	316228
948683;-0	948683
316228;-0	316228
948683;-0	316228
316228;-0	316228
316228;-0	316228
316228;-0	316228
948683;0	316228
	316228;-0 948683;-0 948683;0 948683;0 948683;0 948683;-0 316228;-0 948683;-0 316228;-0 316228;-0 316228;-0

Figure 301 CSV file showing structure of Beam Weights data

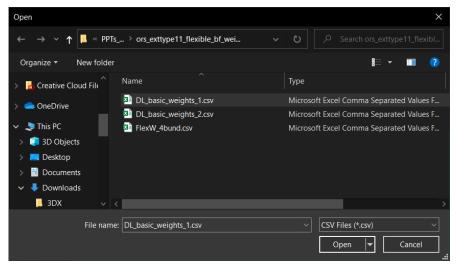
- 1 Launch the C/U Plane Builder Configuration Tool.
- 2 Click the "Beamforming" tab.
- 3 In the Beamforming Mappings area, click the "Beam Weights" tab. Notice, in Figure 302, that the "Beam Weights" column displays the value '0 0', by default, for each row. This is a read-only field that displays the data from the Beam Weights file, after it is loaded.

C/U Plane Builder	onfiguration Tool				
Flow/eAxC	Beamforming Method:				
Compression	weight-based dynamic beam	nforming v			
Numerology	Size of beam mapping ta	ble 2 + 🗙			
Beamforming	Beamforming Mappings:				
Timing	Beam IDs Beam	Weights Flexible Weights	Beam Attributes	Beam Channel Information	
Options	Table Index Beam Wei	ghts Weights File Path Load Weigh	ts Compression	Bitwidth	
DSS	1 00	Open	no compression 🗸	15 ~	
	2 0 0	Open	no compression 🗸	15 🗸	



4 Click "Open".

The 'Open' dialog box appears.





- 5 Select the Beam Weights file from your local disk and click "Open". The contents of the Beam Weights file are displayed in the "Beam Weights" column for the corresponding row. The file name is displayed in the Weights File Path field.
- 6 Repeat the previous two steps to add Beam Weights file to rest of the Table Index rows for each Beam ID.

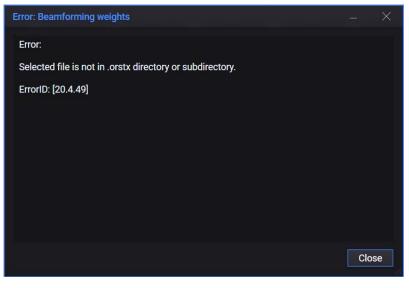
C/U Plane Builder	Configuration Tool X
Flow/eAxC	Beamforming Method:
Compression	weight-based dynamic beamforming
Numerology	Size of beam mapping table 2 + ×
Beamforming	Beamforming Mappings:
Timing	Beam IDs Beam Weights Flexible Weights Beam Attributes Beam Channel Information
Options	Table Index         Beam Weights         Weights File Path         Load Weights         Compress
DSS	1 0.316228 0.948683 -0.316228 -0.316228 DL_basic_weights_1.csv Open no com
	2 0.316228 0.948683 -0.316228 -0.316228 DL_basic_weights_2.csv Open no com
	<

Figure 304 Beam Weights data displayed after file is loaded

7 Hereafter, you may select a Compression Method and BitWidth, as required, prior to making other configuration changes.

The U5040A Open RAN Studio software returns certain error prompts, if there are issues with the Beam Weights file.

a if selected CSV file is not located in the same directory or subdirectory as the ORSTX file.





*b* if the data for weights in the file is out of range.



Figure 306 Error when loading CSV file with out of range data

*c* if the format of file or data in the file is incorrect.

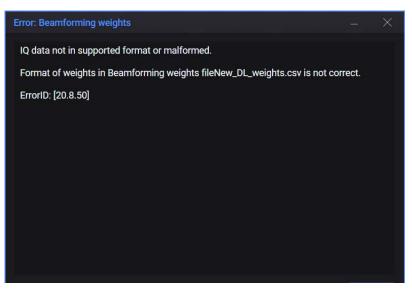


Figure 307 Error when loading CSV file that has incorrect data

d if you load an empty CSV file.

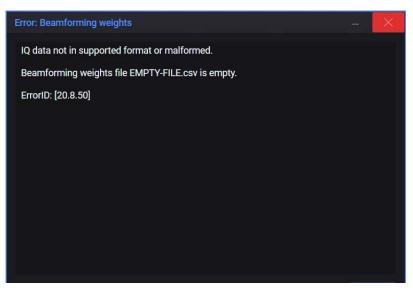


Figure 308 Error when loading CSV file that is empty

#### 3.11.3: Specifying Beam ID for SS/PBCH occurrences

The way to specify Beam / Ue IDs for SS/PBCH allocations in the U5040A Open RAN Studio is different than the rest of the allocations.

When you perform a Channel Setup in the PathWave Signal Generation Desktop 2022 software for the Downlink carrier, the SS/PBCH Channel occurrences can be specified using:

- SS block pattern
- Periodicity
- Lmax
- Active indices

S/PBCH	DCI	DL-SCH	CSI-RS	PRS	LTE-Coexistence		
SS/PB Enabled							
Numero	-					μ = 1: 30 kHz 🗡	
Periodi Half Fra	city Ime Index					Case B ✓ 10 ms ✓ 0	]
Lmax Active I	ndices					4 ¥ 0:3	

Figure 309 Specific PathWave Signal Generation settings for SS/PBCH

- 1 Load the SCP file, including the SS/PBCH Channel, into the Open RAN Studio software.
- 2 Configure one or more Beam / Ue ID values, as shown in the previous sections.
- 3 In the C-Plane Builder tab of the Open RAN Studio software, select "SS/PBCH" from the 'Select Allocation' drop-down field.

Notice how the appearance of the GUI changes, where a button displayed to "Set BeamID for SS/PBCH" (or "Set UeID for SS/PBCH" in case of channel-information-based beamforming). Also, by default, as shown in Figure 310, the Beam Id is set to '0' (or blank, in case of Ue IDs).

Setup Test Models	View Help											
Plane Builder 🔪 Exp	olorer											
Component Carriers Carrier Numerology		Ra	fio Control I Subframe			RB Number	Sym Start	Sym Number	Channel	Beam Id		
Select Carrier:	NR Carrier 1 (DL) V											
Attribute	Value				126	21			SS/PBCH			
Carrier Type	DL (NR)			0	147	126	8	4 4	PDSCH			
Cell ID					126	126 21	8	4	PDSCH SS/PBCH			
Bandwidth	FR1_100M			0	147	126	8	4	PDSCH			
Numerology Mode	SingleNumerology				0	273	12	2	PDSCH			
CP Type	Normal 2		0		0	273		2	PDSCH			
Allocations						126			PDSCH			
Flow/eAxC ID	0001				126		2		SS/PBCH			
					147							
Resource Allocations	SS/PBCH V								PDSCH			
		Radi	Allocation	s —								
Attribute	Value											
Name of allocation	SS/PBCH		40									
Numerology	SCS30k											
SS Block Pattern	CaseB		10									
Lmax			*.									
Active indices	0:3											
Set Beamld for SS/PBCH												
Set Ream	d for SS/PBCH											
									2.20			
											Frame Index 0	) ;

Figure 310 Button to Set Beam / Ue ID for SS/PBCH

4 Click the "Set BeamID for SS/PBCH" button.

A pop-up dialog box "SS/PBCH Beam/Ue Id Assignment" appears, as shown in Figure 311, with Burst Index and BeamId (or, UeId) columns, where the Burst Index corresponds to the "Active Indices" set for SS/PBCH.

-Plane Builder 🔰 🗄	ixplorer										
component Carriers		Ra	dio Control I	Plane Da	la						
Carrier Numerology			Subframe	Slot ID	R8 Start	RB Number	Sym Start	Sym Number	Channel	Beam Id	
Select Carrier:	NR Carrier 1 (DL)					273			PDSCH		
									PDSCH		
Attribute	Value				126				SS/PBCH		
Carrier Type	DL (NR)										
Cell ID											
Bandwidth	FR1_100M				126				SS/PBCH		
Numerology Mode	SingleNumerology				147						
CP Type	Normal		0 			273 273	12 0		PDSCH PDSCH		
Allocations	SS/PBCH Beam/Ue Id Assignment	×	0			126			PDSCH		
Flow/eAxC ID			0		126	21		4	SS/PBCH		
FION/EAAG ID	Burst index Beamld		0		147	126					
			0		0	126	6	4	PDSCH		
Resource Allocations											
0.1											
Select Allocation:			100.000								
Attribute	Value		Allocation	s							
Name of allocation Numerology	SS/PBCH SCS30k		10 -								
SS Block Pattern	CaseB		10								
Lmax	4		60								
Active indices	0:3		50								
Set Beamld for SS/PB			20								
Set Bear	mid for SS/PBCH		я.,								
			a _								



5 Double click the field in the "BeamId" column to modify the values.

NOTE

For the SS/PBSCH, you can set one or more of those BeamId (or, UeId) values only, which you have configured for the other Allocations. The software returns an error, if you attempt to set a value different than what has been already configured in the Beamforming tab of the C/U Plane Builder Configuration Tool.

6 Close the "SS/PBCH Beam/Ue Id Assignment" dialog box. Notice that the Beam Id (or, Ue Id) for SS/PBCH is configured in the same order as you perform the assignment.

		•									
Component Carriers Carrier Numerology			dio Control I								
			Subframe	Slot ID		RB Number	Sym Start	Sym Number	Channel Bea	im ld	
Select Carrier:	NR Carrier 1 (DL) 🗸 🗸								PDSCH 5		
									PDSCH 5		
Attribute	Value								SS/PBCH 5		
Carrier Type	DL (NR)					126			PDSCH 5		
Cell ID						126		4	PDSCH 5		
Bandwidth	FR1_100M			0	126	21 126	8	4	SS/PBCH 5 PDSCH 5		
Numerology Mode	SingleNumerology			0	0	273	12		PDSCH 5		
CP Type	Normal		0		0	273	0	2	PDSCH 5		
Allocations						126			PDSCH 5		
Flow/eAxC ID	0001				126		2		SS/PBCH 5		
					147				PDSCH 5		
									PDSCH 5		
Resource Allocations									SS/PBCH 2		
Select Allocation:					147	126			PDSCH 5		
Select Allocation.	SS/PBCH Y								PDSCH 5		
Attribute	Value										
Name of allocation	SS/PBCH										
Numerology	SCS30k	Radi	o Allocation	8							
SS Block Pattern	CaseB										
Lmax			10								
Active indices	0:3		-								
			10 <u>-</u>								
Set Beamld for SS/PBCI											
Set Beam	Id for SS/PBCH		an <mark>bhail a</mark>								
			,								

Figure 312 SS/PBCH Beam/Ue Id Assignment pop-up dialog box

## 3.11.4: Configuring Flexible Weight Based Dynamic Beamforming

The application of flexible sending of beamforming weights from the O-DU to the O-RU enables the O-DU to provide different beamforming weights for different PRBs within one section, which facilitates zero-forcing precoding. In the Open RAN studio software, this feature provides you the flexibility to configure BF weights on the granularity of individual RBs in a section.

The contents of the Weights file required for Flexible Weights based dynamic beamforming method in the example shown in Figure 313. Note that the format of this file is CSV.

numBundPrb;91 BeamID; 12	numBundPrb = number of bundled PRBs Acceptable range for numBundPrb < 256
0.1;0.1	Start of PRB bundle 0
0.1;0.1 0.1;0.1	L TRXs per bundle
BeamID; 13	<ul> <li>Start of PRB bundle 1</li> </ul>
0.2;0.2	
0.2;0.2	
0.2;0.2	
BeamID; 14	Start of last PRB bundle
0.3;0.3	
0.3;0.3	
0.3;0.3	

Figure 313 Contents of the Beam Weights file for Flexible Weights beamforming

The Weights file for Flexible Weights based dynamic beamforming method consists of the following fields:

- numBundPrb (1-255) number of bundled PRBs.
- BeamID (1-32767) bundle beam identifier. Current field indicates start of its bundle.
- Number of BeamIDs should be greater than or equal to the number of bundles, calculated using the formula:

realNumBundle = Ceiling(numPrbs in section / numBundPrb)

<bfwl>; <bfwQ> - beamforming weights values. Number of "<bfwl>;<bfwQ>" is equal to the number of TRXs.

Note that the parameters are defined using separators, which can be either colon (:) or semi-colon (;).

In case you use incorrect values as input in the file, the Open RAN Studio software may return either an error or warning prompt, as shown in Figure 314.

- The error may appear for the following unsupported / incorrect configuration:
  - Number of PRBs in section is less than the number bundled PRBs
  - Number of Bundles is greater than the number of beam IDs defined in the file
  - Splitting of PRB bundles is not supported
  - Number of bundled PRBs is greater than 255
  - Beamforming weights differ for layers when applied together with Extension Type 10
- The warning may appear for the following configuration:
  - Number of Bundles is less than the number of beam IDs defined in the file
  - Non-contiguous configuration (Extension Type 6) enabled

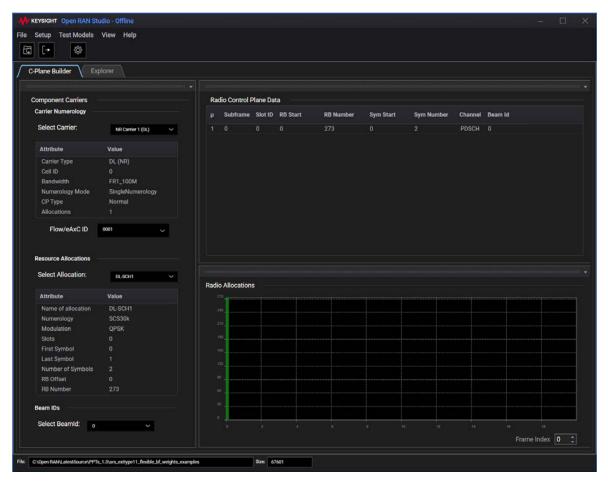
activity Progress:		
	100%	
ctivity Details:		
Fatal Error: Flex	ible beamforming weights	
Flexible weight	based beamforming configuration error	
Expected numb	er of BeamIDs 7. Defined: 3	
ErrorID: [21.42.	60]	
Ok	Cancel	
gress Dialog		
	100%	
ctivity Progress.	100%	
ctivity Progress: ctivity Details:	100% Reted successfully	
ctivity Progress: ctivity Details: Operation com WARNING: Nur	leted successfully ber of defined beam IDs are more than	PRB bundles,
	leted successfully	PPR3 bundles,
ctivity Progress: ctivity Details: Operation com WARNING: Nun	leted successfully ber of defined beam IDs are more than	PRB bundles,

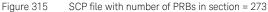


Error/Warning displayed for unsupported/incorrect configuration

To understand how to use the Flexible weight-based dynamic beamforming method,

- Load an SCP file with number of PRBs in section = 273.
   By default, no beamforming (BeamId = 0) has been set for the allocation.
- 2 Assign a Flow/eAxc ID to the carrier.

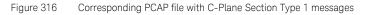




3 Export the O-RAN Stimulus file, without making any changes to the C/U Plane Builder Configuration Tool.

 Switch to the Explorer tab and load the PCAP file.
 The Message Interpretation shows that C-Plane Section Type 1 messages are included.

			<u> </u>	_					_		_									
Plane, C-P	lane Messag	es:										UH	Plane						Message Interpretation:	
ength D	escription												t D	ir	eAxC		DU Port	Band Sc	VlanTypeString : 81 00 VlanTciString : PCP(7), DEI(0)	
8991 (I 3366 (I 8991 (I	PCAP] C-Plane PCAP] U-Plane PCAP] U-Plane PCAP] U-Plane PCAP] U-Plane	, Frame , Frame , Frame	e :0, Sul e :0, Sul e :0, Sul	bfram bfram bfram	ie: 0, SI ie: 0, SI ie: 0, SI	lot: 0, lot: 0, lot: 0,	Symi Symi Symi	bol: 0, bol: 0, bol: 1,	Sect Sect Sect	ion: 0 ion: 0 ion: 0	, PI , PI , PI		0 C	DL	0001	<b>∖1</b> :	0		EtherType Value : AE FE eCPRI Common Header ecpriVersion : 1 ecpriConcatenation : 0 ecpriMessage : 2	
3300 [i	-CAPJ O-Plane	, Frame	e ;u, sui	prram	ie: u, ai	101: U,	Sym	201: 1,	2601	ion: u		C.	Plane						ecpriPayload : 20 eCPRI Component eAxC ID (C-PI DuPortID : 0	ine)
													<b>D</b> 0 C	ir	eAxC 0001		DU Port 0	Band Sc 0	BandSectorID : 0 CcID : 0 RuPortID : 1 eCPRI Sequence ID SequenceID : 0 E : 1	
		-			1											T			E : 1 SubsequenceID : 0 C-Plane Common Header DataDirection : 1 PayloadVersion : 1 FilterIndex : 0	
ex Payload	t:											R	lecove	ered IC	2	Constellati	on		Frameld : 0 Subframeld : 0 Slotid : 0	
Hex OO	01 02 03	04	05 06	07	08	09	0A	08	oc	0D	OE				elected)				StartSymbolid : 0 NumberOfSections : 1	
0 80	09 02 03	04	05 00	) 00	00		00	00	81	00			RE (N	uCm		uCmpQ		Q	SectionType : 1	
			14 00						00				nc.	uun	-the	actified		ų	User Data Compression Header IgBitWidth : 15	
	00 00 00 00 00 00								00		ot								Compression : no compressi Reserved Value : 0 C-Plane Section Type 1 SectionID: 0 RB: 0 Symbolinc : 0 StartPrbc: 0 NumberPrbc : 0 ReMask : 111111111111b	n



- 5 Launch the C/U Plane Builder Configuration Tool.
- 6 Click the 'Beamforming' tab.
- 7 From the 'Beamforming Method' drop-down options, select "flexible weight-based dynamic beamforming".

C/U Plane Builder	Configuration Tool	
Flow/eAxC	Beamforming Method:	
Compression	flexible weight-based dynamic beamforming $\sim$	
Numerology	Size of beam mapping table 1 + ×	
Beamforming	Beamforming Mappings:	
Timing	Beam IDs Beam Weights Flexible Weights Beam Attributes Beam Channel Information	
Options	Beam IDs Weights File Path Load Weights Compression Bitwidth Disable BFWs RAD	
DSS	1 Open no compression ~ 15 ~ 0 ~ 1 ~	

Figure 317 Flexible Weight based dynamic beamforming configuration option

- 8 Define the "Size of the beam mapping table".
- 9 In the Beam IDs tab, for each row that you add to the Table Index, you may optionally modify the value of the Beam ID. See Setting Beam IDs / Ue IDs for Radio Allocations on page 303 to know how to add/remove rows to Table Index and modify corresponding Beam ID values.
- 10 Click the "Flexible Weights" tab.

Note that the "Beam IDs" column under 'Flexible Weights' displays the value you set under the Beam IDs tab. Assign Beam IDs for proper allocation. For each Beam ID, the corresponding elements are displayed under each column.

- Weights File Path–Displays the file name/path of the loaded Beam Weights file.
- Load Weights—Click "Open" to navigate to the directory, where the Beam Weights file (in CSV format) is located. See Figure 318.
- Compression—Select a compression method from the drop-down options. By default, "no compression" is selected.
- Bitwidth-select a value between 1 and 16. Default is 15.
- Disable BFWs—Enable/disable BF weights. By default, '0' is selected, which indicates that Beamforming weights are enabled.

- RAD-Resets after PRB discontinuity. Applied when you select the configuration option Extension Type6 only. By default, '1' is selected indicating that this setting is enabled.
- 11 From the 'Open' dialog box, select the required file and click 'Open', as shown in Figure 318.

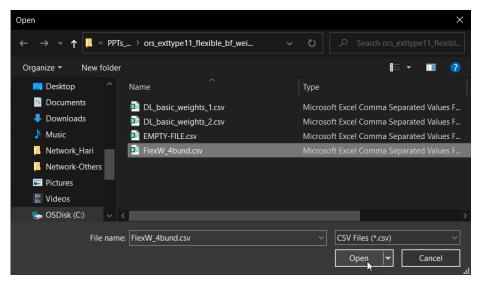


Figure 318 Opening the Weights file for the Flexible beamforming method

Notice that, in Figure 319, the *FlexW\_4bund.csv* file is displayed under the "Weights File Path", 'block scaling' is selected as the "Compression" method, rest of the columns are left as default.

C/U Plane Builder	Configuration Tool	
Flow/eAxC	Beamforming Method:	
Compression	flexible weight-based dynamic beamforming 🗸 🗸	
Numerology	Size of beam mapping table 1 + ×	
Beamforming	Beamforming Mappings:	
Timing	Beam IDs Beam Weights Flexible Weights Beam Attributes Beam Channel Information	
Options	Beam IDs Weights File Path Load Weights Compression Bitwidth Disable BFWs RAD	
DSS	1 FlexW_4bund.csv Open block scaling ~ 15 ~ 0 ~ 1 ~	
	<	

Figure 319 Configuration changes made to the Flexible Weights tab

- 12 Exit the "C/U Plane Builder Configuration Tool".
- 13 In the C-Plane Builder tab, assign Beam Id to the Radio Allocations, as shown in Figure 320.

[• 🕸	View Help										
Plane Builder 🔪 🛛 Ex	plorer										
Component Carriers		R	adio Control	Plane Da	ta						
Carrier Numerology		μ	Subframe	Slot ID	RB Start	RB Number	Sym Start	Sym Number	Channel	Beam Id	
Select Carrier:	NR Carrier 1 (DL) 🗸 🗸								PDSCH		
Attribute	Value										
Carrier Type	DL (NR)										
Cell ID											
Bandwidth Numerology Mode	FR1_100M SingleNumerology										
CP Type	Normal										
Allocations											
Flow/eAxC ID Resource Allocations	.0001 ~										
Select Allocation:	OL-SCH1 V	Ba	fio Allocation	ie							
Attribute	Value		270								
Name of allocation	DL-SCH1		240								
Numerology	SCS30k		20								
Modulation	QPSK										
Slots First Symbol											
Last Symbol			155								
Number of Symbols			41								
RB Offset			et								
RB Number											
Beam IDs											
Select Beamld:											
Select Beamld: 1											

Figure 320 Assigning BeamId to the Radio Allocations

- 14 Regenerate the O-RAN Stimulus file.
- 15 Switch to the Explorer tab and load the regenerated PCAP file.
  - The Extension to Flexible Beamforming Weights is added to the C-Plane Section Type 1 messages.

-Plane Bu	ilder	Ŋ	Ð	plor	er	Γ																		
-Plane, C-	Plan	e Me	ssa	jes:	-											U-Plan	e:							Message Interpretation:
Length	Des	cript	ion														Dir	eAx			DU Port	Band Sc	$\nabla$	SectionType : 1 User Data Compression Header
94 8991 3366 8991 3366	[P0 [P0 [P0	AP]	J-Pla J-Pla J-Pla	ine, F ine, F ine, F	ram ram ram	te :0, te :0, te :0,	Sub Sub Sub	ofram ofram ofram	ie: 0, : ie: 0, : ie: 0, :	Slot: Slot: Slot:	0, Syn 0, Syn 0, Syn	mbol: mbol: mbol:	0, Se 0, Se 1, Se	rame: ection ection ection	0, 0, 0,	•	DL	000	1 010					IqBitWidth : 15 Compression : no compression Reserved Value : 0 C-Plane Section Type 1 SectionID : 0
																C-Plan	o <sup>.</sup>						m	RB : 0 Symbolinc : 0
																	Dir	eAx	с и		DU Port	Band Sc	-	StartPrbc : 0 NumberPrbc : 0
																	DL		1 1		0	0		ReMask : 111111111111b NumSymbol : 2 Ef : 1b Beamld : 32767 Section Ext Command
																•				1				Ef : False ExtType : 11 ExtLen : 13 Flexible Beamforming Weights Ext RAD : 1
lex Payloa	d:															Reco	vere	d IQ	Cons	tellation				DisableBFWs : 0 NumBundPrb : 69 bfwCompHdr : 242
Hex OO	01	02	03	04	0	5 0	6 (	07	08	09	0A	08	oc	0D	OE									bfwlgWidth : 15
0 80	09		03	04	1 0	15 (	30	00	00	00	00	00		00				e selecte						bfwCompMeth : 2 Beam ID Bundle 1
			02	00	1 4	8 (	0				90					RE		uCmpl	uCm	ΡQ		Q		bfwCompParam : 13 BeamID : 8
																								bfwlqSampleBlock : [7e, 06, fc,]
		00											09	00 F8	71									Beam ID Bundle 2 bfwCompParam : 26
																								BeamID : 9 bfwlqSampleBlock : [7e, 06, fc,] Beam ID Bundle 3 bfwCompParam : 39
																								BeamID : 10 bfwlqSampleBlock : [7e, 06, fc,] Beam ID Bundle 4 bfwCompParam : 52
																								BeamID: 11



## 3.11.5: Applying Channel-information-based beamforming

The Open RAN Studio software now lets you apply Channel-information based beamforming on the Section Type 1 C-Plane messages.

- 1 Load an SCP file that has one or more Channel allocations, into the Open RAN Studio software.
- 2 Assign a Flow/eAxC ID to the carrier.

C-Plane Builder 🔪 🗈	plorer										
Component Carriers		e Canada Ro	dio Control I	2lana Da	to						
Carrier Numerology		μ	Subframe			RB Number	Sym Start	Sym Number	Channel	Beam Id	
Select Carrier:			0	0	0	24	0	1	PDCCH		
ochect Gamer.	Carrier 1 (DL) 🗸 🗸		0	0	0	24 21	4	4	PDCCH SS/PBCH		
Attribute	Value		0	0	126		8		SS/PBCH		
Carrier Type	DL (NR)		0		0	24	0		PDCCH		
Cell ID	0								SS/PBCH		
Bandwidth	FR1_100M				126				SS/PBCH		
Numerology Mode	SingleNumerology								CSI-RS		
CP Type	Normal								CSI-RS		
Allocations						24			PDCCH		
						255			CSI-RS		
Flow/eAxC ID	0001 ~				255				CSI-RS		
Resource Allocations		Radi	o Allocation	•							
Select Allocation:	DCI1 🗸										
Attribute	Value		HQ	-							
Name of allocation	DCI1		10								
Numerology	SCS30k										
Allocated Slots	0:4		20								
First Symbol			*								
Aggregation Level											
Beam IDs			ö								
			1000	1	1 1					1 1 1 1	1

Figure 322 Loading an SCP file for DL carrier with multiple Channels

3 Export the O-RAN Stimulus file to generate the corresponding PCAP file. See Exporting O-RAN Stimulus File on page 122 for more information.

Plane Builder / Explorer		
Plane, C-Plane Messages:	U-Plane: Message Interpreta ecpriVersion	
Description	# Dir eAxC μ DU Port B γ ecpriConcat	enation : 0
[PCAP] C-Plane, Section Type: 1, Sections: 1, Frame :0, Subframe: 0, Slot: 0, Symbol Start: 0, PR 🗖	0 DL 0001 1 0 C ecpriMessag ecpriPayload	ge:2
[PCAP] C-Plane, Section Type: 1, Sections: 1, Frame :0, Subframe: 0, Slot: 0, Symbol Start: 4, PR	eCPRI Compon	ent eAxC ID (
PCAP] C-Plane, Section Type: 1, Sections: 1, Frame :0, Subframe: 0, Slot: 0, Symbol Start: 8, PR	DuPortID:0 BandSector	
[PCAP] U-Plane, Frame :0, Subframe: 0, Slot: 0, Symbol: 0, Section: 0, PRB: 0-23 [PCAP] U-Plane, Frame :0, Subframe: 0, Slot: 0, Symbol: 4, Section: 1, PRB: 126-146	CcID : 0	0.0
[PCAP] U-Plane, Frame to, Subframe: 0, Slot: 0, Symbol: 4, Section: 1, PRB: 126-146 [PCAP] U-Plane, Frame to, Subframe: 0, Slot: 0, Symbol: 5, Section: 1, PRB: 126-146	C-Plane: RuPortID : 1	
PCAPJ U-Plane, Frame to, Subframe: 0, Slot: 0, Symbol: 5, Section: 1, PRB: 126-146 [PCAP] U-Plane, Frame to, Subframe: 0, Slot: 0, Symbol: 6, Section: 1, PRB: 126-146	# Dir eAxC µ DU Port B SequenceD SequenceD	
PCAP U-Plane, Frame :0, Subtrame: 0, Slot: 0, Symbol: 0, Section: 1, PRB: 126-146	E:1	
PCAP] U-Plane, Frame :0, Subframe: 0, Slot: 0, Symbol: 8, Section: 2, PRB: 126-146	0 DL 0001 1 0 C Subsequence C-Plane Comm	
PCAP] U-Plane, Frame :0, Subframe: 0, Slot: 0, Symbol: 9, Section: 2, PRB: 126-146	DataDirectio	n:1
	PayloadVers FilterIndex :	
	Frameld : 0	
	* Subframeld Slotid : 0	:0
	StartSymbol	
Deuteed		
x Payload:	Recovered IQ Constellation NumberOfSi SectionType	1.1
xXPayload: Hex 00 01 02 03 04 05 06 07 08 09 0A 0B 0C 0D 0E 0F ASCII	SectionType User Data Com	pression Hea
	SectionType	pression Hea 15
Hex 00 01 02 03 04 05 06 07 08 09 0A 0B OC 0D 0E OF ASCII	1.5 Section Section Section Section Type 1.5 Section	pression Hea
Hex 00 01 02 03 04 05 06 07 08 09 0A 08 0C 0D 0E 0F ASCII 0 80 09 02 03 04 05 00 00 00 00 00 00 81 00 ED 00	SectionType         SectionType           1.5         Compression           1.5         Compression           1.5         Value : 0	pression Hea 15 n : no compre
Hex         00         01         02         03         04         05         06         07         08         09         0A         0B         0C         0D         0E         0F         ASCII           0         80         09         02         03         04         05         00         0	Instruction     SectionType       1.5     User Data Complexity       1     Compression       1     Reserved       Value : 0     C-Plane Section Section D : 0	pression Hea 15 n : no compre n Type 1
Here         00         01         02         03         04         05         06         07         08         09         0A         0B         0C         0D         0E         0F         ASCII           0         80         09         02         03         04         05         00         00         00         00         00         81         00         ED         06         ASCII           0         80         09         02         03         04         05         00         00         00         00         81         00         ED         00	Iteration     SectionType       1.5     Compression       1     Compression       0.5     CPlane SectionType	pression Hea 15 n : no compre n Type 1
Here         00         01         02         03         04         05         06         07         08         09         0A         0B         0C         0D         0E         0F         ASCII           0         80         09         02         03         04         05         00         00         00         00         00         81         00         ED         06         ASCII           0         80         09         02         03         04         05         00         00         00         00         81         00         ED         00	1.5     Section Type       1 -     Compression       0.5 -     Perform Section Type       0.5 -     Section Type	pression Hea 15 n : no compre n Type 1 ) 0
Here         00         01         02         03         04         05         06         07         08         09         0A         0B         0C         0D         0E         0F         ASCII           0         80         09         02         03         04         05         00         00         00         00         00         81         00         ED         06         ASCII           0         80         09         02         03         04         05         00         00         00         00         81         00         ED         00	Network     Output       1.5     SectionType       1 -     Compression       0.5 -     Reserved       0 -     Symboline :       0 -     Symboline :	pression Hea 15 n : no compre 1 Type 1 0 0 2 : 24
Here         00         01         02         03         04         05         06         07         08         09         0A         0B         0C         0D         0E         0F         ASCII           0         80         09         02         03         04         05         00         00         00         00         00         81         00         ED         06         ASCII           0         80         09         02         03         04         05         00         00         00         00         81         00         ED         00	Network     Output       1.5     SectionType       1 -     Compression       0.5 -     Reserved       0 -     Symboline :       0 -     Symboline :	pression Hea 15 n : no compre 1 Type 1 0 0 2: 24 111111111

4 Switch to the Explorer tab and load the stimulus / recording PCAP file into O-RAN Studio.

Figure 323 PCAP file showing C-Plane Section Type 1 messages

Notice in the image above that the C-Plane messages appear as Section Type 1 messages.

If you want to include Section Type 6 messages when applying channel-information-based beamforming, you require a CI IQ sample file, which contains channel information I and Q values, related to Section Type 6 and relayed from O-DU to O-RU. Figure 324 shows the structure of this text file.

```
■ iqsample.tt - Notepad

File Edit Format View Help

Antenna: 1

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Figure 324 CI IQ Sample text file contents

- File consists of antennas along with associated numbers and IQ pairs, that is, line of antenna's number that is followed by IQ pairs.
- Each antenna should have the same number of IQ pairs.
- Each IQ pair maps to one PRB in Section Type 6.
- 5 Launch the "C/U-Plane Builder Configuration Tool" window.
- 6 In the Beamforming tab,
  - a From the 'Beamforming Method' drop-down options, select "channel-information-based beamforming".
  - *b* Set the number of 'Table Index' rows in the "Size of beam mapping table".
  - c Under 'Beamforming Mappings', click 'Beam Channel Information'. For each 'Table Index' row, configure the following parameters:
    - Regularization Factor—related to Section Type 6, supports MMSE operation within O-RU, when beamforming weights are supported. Default value is '0'. Double-click to edit the field.
    - ueld—label that supports channel information that is sent from the O-DU to the O-RU. Default first value is '0'. Double-click to edit the field.
    - File Path-displays the name of the CI IQ sample text file. If you leave this empty, the data is not sent in Section Type 6.
    - Load–Click 'Open' to select the CI IQ sample text file from the local disk.
  - *d* Set a bit width for the CI IQ data.

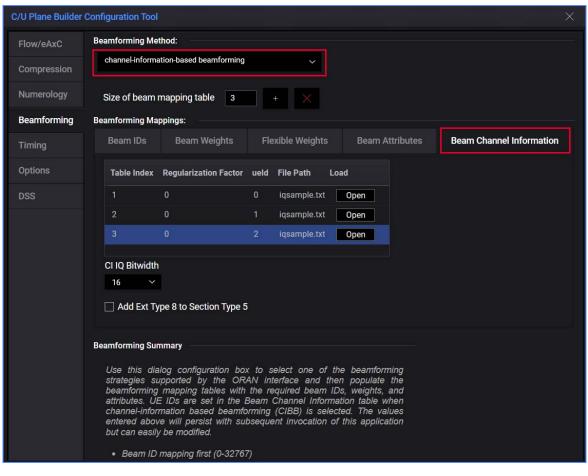


Figure 325 Appearance of tab after loading CI IQ sample file

- 7 Close the "C/U-Plane Builder Configuration Tool" window.
- 8 Export the O-RAN Stimulus file for the selected options to be applied.
- 9 In the C-Plane Builder tab, load the updated SCP file.

-Plane Builder \chi 🛛 Ex	plorer											
		-									 	
Component Carriers Carrier Numerology		Rad	lio Control F									
Carrier Numerology			Subframe	Slot ID	RB Start	RB Number	Sym Start	Sym Number	Channel	Ue Id		
Select Carrier:	Carrier 1 (DL) 🗸								PDCCH			
									SS/PBCH			
Attribute	Value								SS/PBCH			
Carrier Type	DL (NR)				0 126	24 21		1	PDCCH SS/PBCH			
Cell ID					126		6		SS/PBCH			
Bandwidth	FR1_100M SingleNumerology				0	255						
Numerology Mode CP Type	Normal								CSI-RS			
Allocations	6								PDCCH			
									CSI-RS			
Flow/eAxC ID	9901 ~				255				CSI-RS			
Resource Allocations												
Select Allocation:	SS/PBCH V		Allocation	s								
Attribute	Value		ю									
Name of allocation	SS/PBCH		10									
Numerology	SCS30k		10									
SS Block Pattern	CaseB											
Lmax												
Indice	Keysight.SignalStudio.N											
Ue IDs												

Figure 326 Updated SCP file showing Ueld instead of BeamID

Notice that upon choosing Beamforming method as "channel-information-based beamforming", BeamID is replaced with 'UeID', as highlighted in Figure 326.

10 For the Channel name you select from the "Select Allocation" drop-down options, select an Ueld from the "Select Ueld" drop-down options. The value 'Reset' indicates that no ueID has been assigned to that specific Channel.

The table in the 'Radio Control Plane Data' is updated as you set a ueID for the selected Channel.

11 Switch to the Explorer tab and load the corresponding PCAP file.

C-Plane Builder Explorer			
I-Plane, C-Plane Messages:	U-Plane:		Message Interpretation:
Description	# Dir eAxC µ DU Port	B	ecpriVersion : 1 ecpriConcatenation : 0
[PCAP] C Plane, Section Type: 5, Sections: 1, Frame 0, Subframe: 0, Slot: 0, Symbol Start: 0, Pi [PCAP] C Plane, Section Type: 5, Sections: 1, Frame: 0, Subframe: 0, Slot: 0, Symbol Start: 4, PF [PCAP] C Plane, Section Type: 6, Sections: 0, Frame: 0, Subframe: 0, Slot: 0, Symbol Start: 0, PR [PCAP] C Plane, Section Type: 5, Sections: 1, Frame 0, Subframe: 0, Slot: 0, Symbol Start: 8, PF	0 DL 0001 1 0	, <u>~</u>	ecpriNessage ; 2 ecpriPayload : 20 eCPRI Component eAxC ID (C-Plar DuPortID : 0 BandSectorID : 0
[PCAP] U-Plane, Frame :0, Subframe: 0, Slot: 0, Symbol: 0, Section: 0, PRB: 0-23			CcID:0 RuPortID:1
[PCAP] U-Plane, Frame :0, Subframe: 0, Slot: 0, Symbol: 4, Section: 1, PRB: 126-146           [PCAP] U-Plane, Frame :0, Subframe: 0, Slot: 0, Symbol: 5, Section: 1, PRB: 126-146           [PCAP] U-Plane, Frame :0, Subframe: 0, Slot: 0, Symbol: 6, Section: 1, PRB: 126-146	C-Plane: # Dir eAxC µ DU Port 0 DL 0001 1 0	в	eCPRI Sequence ID SequenceID : 0 E : 1 SubsequenceID : 0
[PCAP] U-Plane, Frame 0, Subframe: 0, Slot: 0, Symbol: 7, Section: 1, PRB: 126-146 [PCAP] U-Plane, Frame 0, Subframe: 0, Slot: 0, Symbol: 8, Section: 2, PRB: 126-146			C-Plane Common Header DataDirection : 1 PayloadVersion : 1 FilterIndex : 0
			Frameld : 0 Subframeld : 0 Stottd : 0
iex Payload:	Recovered IQ Constellation		Subframeld : 0 SlotId : 0 StartSymbolId : 0 NumberOfSections : 1
Hex Payload: Hex 00 01 02 03 04 05 06 07 08 09 0A 0B 0C 0D 0E OF ASCII	Recovered IQ Constellation		Subframeld : 0 Stottd : 0 StartSymbolid : 0 NumberOfSections : 1 SectionType : 5 User Data Compression Header
	Recovered IQ Constellation	·	Subframeld : 0 Stottd : 0 StartSymbolld : 0 NumberOfSections : 1 SectionType : 5 User Data Compression Header IqBitWidth : 15
Hex 00 01 02 03 04 05 06 07 08 09 0A 0B 0C 0D 0E OF ASCII			Subframeld: 0 Solut: 0 StartSymbolid: 0 NumberOfSections: 1 SectionType: 5 User Data Compression Header IgBIWdht: 15 Compression: no compression Reserved
Hex         00         01         02         03         04         05         06         07         08         09         04         08         0C         00         0E         DF         ASCII           0         80         09         02         03         04         05         00         00         00         00         81         00         ED         D0			Subframeld : 0 StartSymbolid : 0 NumberOfSections : 1 SectionType : 5 User Data Compression Header IgBitWidth : 15 Compression : no compression Reserved Value : 0
Hex         00         01         02         03         04         05         06         07         08         09         0A         0B         0C         0D         0E         0F         ASCII           0         80         09         02         03         04         05         00         00         00         00         01         01         00         00         00         01         00         01         00         01         00         01         00         01         00         00         00         01         01         01         01         01         01         0	1.5	•	Subframeld: 0 Subframeld: 0 StartSymbolid: 0 NumberOfSections: 1 SectionType: 5 User Data Compression Header IgBitWidth: 15 Compression: no compression Reserved Value: 0 CPPane Section Type 5 SectionID: 0
Hex         00         01         02         03         04         05         06         07         08         09         04         06         00	1.5	Î	Subframeld: 0 Subframeld: 0 StartSymbolid: 0 NumberOfSections: 1 SectionType: 5 User Data Compression Header IgBitWidth: 15 Compression: no compression Reserved Value: 0 C-Plane SectionType 5 SectionID: 0 RB: 0 Symbolinc: 0
Hex         00         01         02         03         04         05         06         07         08         09         04         06         00	1.5	Î	Subframeld : 0 StartSymbold : 0 NumberOfSections : 1 SectionType : 5 User Data Compression Header IgBIWidth : 15 Compression : no compression Reserved Value : 0 C-Plane Section : 0 SectionID : 0 StartPhbc : 0
0 80 09 02 03 04 05 00 00 00 00 00 08 100 E0 00 16 AE FE 10 02 00 14 00 01 00 80 90 00 00 00 01 05 32 F0 00 00 00 00 18 FF F1 00 05 00 00 00 00 00 00 00	1.5 1- 0.5-		Subframeld: 0 Subframeld: 0 StartSymbolid: 0 NumberOfSections: 1 SectionType: 5 User Data Compression Header IgBitWidth: 15 Compression: no compression Reserved Value: 0 C-Plane SectionType 5 SectionID: 0 RB: 0 Symbolinc: 0

Figure 327 Updated PCAP file showing Section Type 5 messages

Figure 327 shows that data is sent as C-Plane Section Type 5 messages (instead of Section Type 1) after channel-information based beamforming is applied. The O-DU sends UE scheduling information on a slot-by-slot basis. However, note that Section Type 5 does not replace Section Type 3, if the latter is sent.

Figure 328 shows that Section Type 6 C-Plane messages are included and these are sent on each slot 0, symbol 0. In this case, UE channel information is sent generally less often than every slot. As mentioned earlier, each IQ pair maps per PRB in Section Type 6, as highlighted in the Message Interpretation area. When the row in the table is setup, but ueld is not assigned to any allocation, Section Type 6 shall still send information setup in that row. If included, each Section Type 6 contains the same CI IQ data. If the CI IQ data is not sent, that is, if you do not load a CI IQ sample text file, data is not sent in Section Type 6.

CPlane Builder Explorer	ษดี : 897 nent eAxC ID (C-Plan ) HD : 0 I ce ID
Description [PCAP] C-Plane, Section Type: 5, Sections: 1, Frame :0, Slot: 0, Symbol Start: 0, PF ∧ [PCAP] C-Plane, Section Type: 5, Sections: 1, Frame :0, Slot: 0, Symbol Start: 0, PF ∧ [PCAP] C-Plane, Section Type: 5, Sections: 1, Frame :0, Slot: 0, Symbol Start: 0, PF ∧ [PCAP] C-Plane, Section Type: 5, Sections: 1, Frame :0, Slot: 0, Symbol Start: 0, PF ∧ [PCAP] L-Plane, Section Type: 5, Sections: 1, Frame :0, Slot: 0, Symbol Start: 0, PF ∧ [PCAP] L-Plane, Frame :0, Slot: 0, Symbol : 5, Section: 1, PRB: 126-146 [PCAP] L-Plane, Frame :0, Slot: 0, Symbol : 5, Section: 1, PRB: 126-146 [PCAP] L-Plane, Frame :0, Slot: 0, Symbol : 5, Section: 1, PRB: 126-146 [PCAP] L-Plane, Frame :0, Slot: 0, Symbol : 5, Section: 1, PRB: 126-146 [PCAP] L-Plane, Frame :0, Slot: 0, Symbol : 5, Section: 1, PRB: 126-146 [PCAP] L-Plane, Frame :0, Slot: 0, Symbol : 5, Section: 1, PRB: 126-146 [PCAP] L-Plane, Frame :0, Slot: 0, Symbol : 5, Section: 1, PRB: 126-146 [PCAP] L-Plane, Frame :0, Slot: 0, Symbol : 5, Section: 1, PRB: 126-146 [PCAP] L-Plane, Frame :0, Slot: 0, Symbol : 5, Section: 1, PRB: 126-146 [PCAP] L-Plane, Frame :0, Slot: 0, Symbol : 5, Section: 1, PRB: 126-146 [PCAP] L-Plane, Frame :0, Slot: 0, Symbol : 5, Section: 1, PRB: 126-146 [PCAP] L-Plane, Frame :0, Slot: 0, Symbol : 5, Section: 1, PRB: 126-146 [PCAP] L-Plane, Frame :0, Slot: 0, Symbol : 5, Section: 1, PRB: 126-146 [PCAP] L-Plane, Frame :0, Slot: 0, Symbol : 5, Section: 1, PRB: 126-146 [PCAP] L-Plane, Frame :0, Slot: 0, Symbol : 5, Section: 1, PRB: 126-146 [PCAP] L-Plane, Frame :0, Slot: 0, Symbol : 5, Section: 1, PRB: 126-146 [PCAP] L-Plane, Frame :0, Slot: 0, Symbol : 5, Section: 1, PRB: 126-146 [PCAP] L-Plane, Frame :0, Slot: 0, Symbol : 5, Section: 1, PRB: 126-146 [PCAP] L-Plane, Frame :0, Slot: 0, Symbol : 5, Section: 1, PRB: 126-146 [PCAP] L-Plane, Frame :0, Slot: 0, Symbol : 5, Section: 1, PRB: 126-146 [PCAP] L-Plane, Frame :0, Slot: 0, Symbol : 5, Section: 1, PRB: 126-146 [PCAP] L-Plane, Frame :0, Slot: 0, Symbol : 5, Section: 1, PRB:	ษดี : 897 nent eAxC ID (C-Plan ) HD : 0 I ce ID
Description Descr	ษดี : 897 nent eAxC ID (C-Plan ) HD : 0 I ce ID
Description       IPCAPI C-Plane, Section Type: 5, Sections: 1, Frame 0, Subframe: 0, Slot: 0, Symbol Start: 0, PR +       IPCAPI C-Plane, Section Type: 5, Sections: 1, Frame 0, Subframe: 0, Slot: 0, Symbol Start: 0, PR +       IPCAPI C-Plane, Section Type: 5, Sections: 1, Frame 0, Subframe: 0, Slot: 0, Symbol Start: 0, PR +       IPCAPI C-Plane, Section Type: 5, Sections: 1, Frame 0, Subframe: 0, Slot: 0, Symbol Start: 0, PR +       IPCAPI C-Plane, Section Type: 5, Sections: 1, Frame 0, Subframe: 0, Slot: 0, Symbol Start: 0, PR +       IPCAPI C-Plane, Section Type: 5, Sections: 1, Frame 0, Subframe: 0, Slot: 0, Symbol Start: 0, PR +       IPCAPI C-Plane, Section Type: 5, Sections: 1, Frame 0, Subframe: 0, Slot: 0, Symbol Start: 0, PR +       IPCAPI C-Plane, Frame 0, Subframe: 0, Slot: 0, Symbol Start: 0, PR +       IPCAPI C-Plane, Frame 0, Subframe: 0, Slot: 0, Symbol Start: 0, PR +       IPCAPI C-Plane, Frame 0, Subframe: 0, Slot: 0, Symbol Start: 0, PR +       IPCAPI C-Plane, Frame 0, Subframe: 0, Slot: 0, Symbol Start: 0, PR +       IPCAPI C-Plane, Frame 0, Subframe: 0, Slot: 0, Symbol Start: 0, PR +       IPCAPI C-Plane, Frame 0, Subframe: 0, Slot: 0, Symbol Start: 0, PR +       IPCAPI C-Plane, Frame 0, Subframe: 0, Slot: 0, Symbol Start: 0, PR +       IPCAPI C-Plane, Frame 0, Subframe: 0, Slot: 0, Symbol Start: 0, PR +       IPCAPI C-Plane, Frame 0, Subframe: 0, Slot: 0, Symbol Start: 0, PR +       IPCAPI C-Plane, Frame 0, Subframe: 0, Slot: 0, Symbol Start: 0, PR +       IPCAPI C-Plane, Frame 0, Subframe: 0, Slot: 0, Symbol Start: 0, PR +       IPCAPI C-Plane, Frame 0, Subframe: 0, Slot: 0, Symbol Start: 0, PR +       IPCAPI C-Plane, Frame 0, Subframe: 0, Slot: 0, Symbol Start: 0, PR +       IPCAPI C-Plane, Frame 0, Subframe: 0, Slot: 0, Symbol Start: 0, PR +       IPCAPI C-Plane	hent eAxC ID (C-Plan ) ID : 0 I ce ID
IPCAPI C-Plane, Section Type: 5, Sections: 1, Frame 0, Subframe: 0, Slot: 0, Symbol Start: 0, PF ^       0       DL       0001       1       0       DuPortiD 0: 0         IPCAPI C-Plane, Section Type: 5, Sections: 0, Frame 0, Subframe: 0, Slot: 0, Symbol Start: 0, PF       0       DL       0001       1       0       CP       DuPortiD 0: 0       DuPortiD	) 11D : 0 1 ce ID
[PCAP] C Plane, Section Type: 5, Sections: 1, Frame :0, Subframe: 0, Slot 0, Symbol Start: 8, PR        CPRI Sequence       [PCAP] U-Plane, Frame :0, Subframe: 0, Slot 0, Symbol: 0, Section: 0, PRB: 0:23      CPRI Sequence     SequenceDD       [PCAP] U-Plane, Frame :0, Subframe: 0, Slot 0, Symbol: 4, Section: 1, PRB: 126-146      CPRI Sequence     Subsequence       [PCAP] U-Plane, Frame :0, Subframe: 0, Slot 0, Symbol: 6, Section: 1, PRB: 126-146      Dir     eAxC     DU Port     Image: CPRI Sequence       [PCAP] U-Plane, Frame :0, Subframe: 0, Slot 0, Symbol: 6, Section: 1, PRB: 126-146      Dir     eAxC     DU Port     Image: CPRI Sequence       [PCAP] U-Plane, Frame :0, Subframe: 0, Slot 0, Symbol: 7, Section: 1, PRB: 126-146      Dir     0 DI     0 DI     0 DI       [PCAP] U-Plane, Frame :0, Subframe: 0, Slot 0, Symbol: 8, Section: 1, PRB: 126-146      Dir     eAxC     Dir     Dir     Patholitane       [PCAP] U-Plane, Frame :0, Subframe: 0, Slot 0, Symbol: 8, Section: 1, PRB: 126-146      Dir     0 DI     0 DI     0 DI     Subframe       [PCAP] U-Plane, Frame :0, Subframe: 0, Slot 0, Symbol: 8, Section: 2, PRB: 126-146       >     Subframe       [PCAP] U-Plane, Frame :0, Subframe: 0, Slot 0, Symbol: 8, Section: 2, PRB: 126-146       >     Subframe       [PCAP] U-Plane, Frame :0, Subframe: 0, Slot 0, Symbol: 8, Section: 2,	ce ID
IPCAPJ U-Plane, Frame 0, Subframe: 0, Slot: 0, Symbol: 0, Section: 0, PR8: 0-23       Sequeñci01         IPCAPJ U-Plane, Frame 0, Subframe: 0, Slot: 0, Symbol: 4, Section: 1, PR8: 126-146       E1         IPCAPJ U-Plane, Frame 0, Subframe: 0, Slot: 0, Symbol: 5, Section: 1, PR8: 126-146       DI         IPCAPJ U-Plane, Frame 0, Subframe: 0, Slot: 0, Symbol: 7, Section: 1, PR8: 126-146       DI         IPCAPJ U-Plane, Frame 0, Subframe: 0, Slot: 0, Symbol: 7, Section: 1, PR8: 126-146       DI         IPCAPJ U-Plane, Frame 0, Subframe: 0, Slot: 0, Symbol: 7, Section: 1, PR8: 126-146       DI         IPCAPJ U-Plane, Frame 0, Subframe: 0, Slot: 0, Symbol: 7, Section: 1, PR8: 126-146       DI         IPCAPJ U-Plane, Frame 0, Subframe: 0, Slot: 0, Symbol: 8, Section: 2, PR8: 126-146       DI         IPCAPJ U-Plane, Frame 0, Subframe: 0, Slot: 0, Symbol: 8, Section: 2, PR8: 126-146       DI         IPCAPJ U-Plane, Frame 0, Subframe: 0, Slot: 0, Symbol: 8, Section: 2, PR8: 126-146       Satisframed 3, Subframe 0, Slot: 0, Symbol: 7, Section: 2, PR8: 126-146	
[PCAP] U-Plane, Frame 0, Subframe 0, Slot 0, Symbol: 4, Section: 1, PRB: 126-146     © Prane:     Subfaceure     Subfaceure     Subfaceure     Subfaceure     Subfaceure     Subfaceure     Subfaceure     CPane Comm     Du Port     B     CPane Comm     DataDirection       [PCAP] U-Plane, Frame 0, Subframe: 0, Siot: 0, Symbol: 5, Section: 1, PRB: 126-146     0     DL     0001     1     0     CPane Comm     DataDirection       [PCAP] U-Plane, Frame 0, Subframe: 0, Siot: 0, Symbol: 7, Section: 1, PRB: 126-146     0     DL     0001     1     0     Subframe: 0, Siot: 0, Symbol: 8, Section: 1, PRB: 126-146       (PCAP] U-Plane, Frame 0, Subframe: 0, Siot: 0, Symbol: 8, Section: 2, PRB: 126-146     V     V     V     No     Subframe: 1     Subframe:	- 4
[PCAP] U-Plane, Frame :0, Subframe: 0, Slot: 0, Symbol: 5, Section: 1, PRB: 126-146     # Dir     eAxC     pu     DU Port     B     C-Plane Comm       [PCAP] U-Plane, Frame :0, Subframe: 0, Slot: 0, Symbol: 6, Section: 1, PRB: 126-146     0     DL     0001     1     0     C-Plane Comm       [PCAP] U-Plane, Frame :0, Subframe: 0, Slot: 0, Symbol: 7, Section: 1, PRB: 126-146     0     DL     0001     1     0     C       [PCAP] U-Plane, Frame :0, Subframe: 0, Slot: 0, Symbol: 7, Section: 1, PRB: 126-146     V     V     None Commended : 0     Subframed: 0       [PCAP] U-Plane, Frame :0, Subframe: 0, Slot: 0, Symbol: 8, Section: 2, PRB: 126-146     V     V     None Commended : 0       [PCAP] U-Plane, Frame :0, Subframe: 0, Slot: 0, Symbol: 7, Section: 2, PRB: 126-146     V     Subframed: 0     Subframed: 0	celD : 0
(PCAP) UPlane, Frame 0, Subframe: 0, Slot: 0, Symbol: 7, Section: 1, PRB: 126-146     0     DL     0001     1     0     C     PayloadVerr Filterindex: Framed: 0       (PCAP) UPlane, Frame 0, Subframe: 0, Slot: 0, Symbol: 7, Section: 1, PRB: 126-146     0     DL     0001     1     0     C     PayloadVerr Filterindex: Framed: 0       (PCAP) UPlane, Frame 0, Subframe: 0, Slot: 0, Symbol: 7, Section: 2, PRB: 126-146     0     DL     0001     1     0     C     PayloadVerr Filterindex: Framed: 0       (************************************	non Header
	: 0   : 0 blid : 0
tex Payload: Recovered IQ Constellation Number of UE Number of UE Number of UE	e:6 s
Hex 00 01 02 03 04 05 06 07 08 09 0A 0B 0C 0D 0E 0F ASCI	
0 80 09 02 03 04 05 00 00 00 00 00 81 00 E0 00	п Туре б
16 AE FE 10 02 03 81 00 01 02 80 90 00 00 00 00 06	
32 03 00 00 05 00 14 00 00 24 28 7A 79 6E 28 7A 79\$ 1-	ionFactor : 20
48 6E D7 86 D7 86 D7 86 D7 86 79 6E 86 92 79 6E 86 n	
04 92 79 0E 07 00 19 0E 07 00 00 92 79 0E 00 92 79 Jin.yii	
PRB 0, Antenna	al
96 92 D7 86 D7 86 D7 86 D7 86 79 6E D7 86 79 6E D7v	
Iqsampielik	ock : [28, 7a, 79,]
112 86 D7	



12 Launch the "C/U-Plane Builder Configuration Tool" window again.

- 13 In the Beamforming tab,
  - a With 'Beamforming Method' selected as "channel-information-based beamforming", click the 'Beam Channel Information' tab.
  - b Select the check box for "Add Ext Type 8 to Section Type 5".

C/U Plane Builder	Configuration Tool	
Flow/eAxC	Beamforming Method:	
Compression	channel-information-based beamforming ~	
Numerology	Size of beam mapping table 3 + ×	
Beamforming	Beamforming Mappings:	
Timing	Beam IDs Beam Weights Flexible Weights Beam Attributes Beam Channel Information	on
Options	Table Index Regularization Factor ueld File Path Load	
DSS	1 0 0 iqsample.txt Open	
	2 0 1 iqsample.txt Open	
	3 0 2 iqsample.txt Open	
	CI IQ Bitwidth 16 V Add Ext Type 8 to Section Type 5	

Figure 329 PCAP file showing C-Plane Section Type 1 messages

- 14 Close the "C/U-Plane Builder Configuration Tool" window.
- 15 Export the O-RAN Stimulus file for the selected options to be applied.
- 16 Load the PCAP file again to view the changes.

Plan																						
	e Buil	er y	Exp	plorer	_\																	
Dian		ane Me												•	U-Pla							Message Interpretation:
	iption		ssag	рю,												Dir	eAxC		DU Port	в	57	BandSectorID : 0
																					Y	CcID : 0 RuPortID : 1
						ns: 1, Frai ns: 1, Frai								art: 0, PR			0001				4	eCPRI Sequence ID
						ns: 1, Frai ns: 1, Frai																SequenceID : 0
						Slot: 0, S							or ata	and a provide state	2=			-				E:1 SubsequenceID:0
						Slot: 0, S							16									C-Plane Common Header
						Slot: 0, S									C-Pla	ine:						DataDirection : 1 PayloadVersion : 1
						Slot: 0, S										Dir	eAxC	U	DU Port	в		FilterIndex : 0
[PCA	PI U-P	ane, Fr	ame :0	, Subfr	ame: 0,	Slot: 0, S	ymbr	ol: 7, Se	ectio	n: 1, P	RB: 1	26-14	16		0	DL	0001					Frameld : 0 Subframeld : 0
[PCA	P] U-P	ane, Fr	ame :0	, Subfr	ame: 0,	Slot: 0, S	ymbr	al: 8, Se	ectio	n: 2, P	RB: 1	26-14	16				0001					Slotid : 0
(PCA	P] U-P	ane, Fr	ame :0	, Subfr	ame: 0,	Slot: 0, S	ymbo	al: 9, Se	ectio	n: 2, P	RB: 1	26-14	16									StartSymbolid : 0
					-										< 🗆	_	_	_				NumberOfSections : 1 SectionType : 5
																						User Data Compression Header
																						IqBitWidth : 15 Compression : no compressio
																						Reserved
															Rec	overed	IQ	Constellatio	n			Value : 0 C-Plane Section Type 5
ex Pa	yioau		1.00	04	05 06	07 08	5 0	9 0A	OB	0C	0D	0E	OF	ASCII								SectionID : 0
		01 02	- 03				0 0	0 00	00	81	00	EC	00			1.5						RB : 0 Symbolinc : 0
Hex	00			04	05 00	00 00																StartPrbc : 0
Hex 0	00 80	09 02				00 0		0 90			. 00											NumberPrbc : 24
ex Pa Hex 0 16 32	00 80 AE	09 02 FE 10	2 03			01 0	08					00										
Hex 0 16 32	00 80 AE F0	09 02 FE 10 00 00	2 03 0 02 0 00	00 00	18 00 18 FF	01 0	0 8 0 0		01			00									- 1	ReMask : 1111111111111
Hex 0 16 32	00 80 AE F0	09 02 FE 10 00 00	2 03 0 02 0 00	00 00	18 00 18 FF	01 01 F1 BI	0 8 0 0		01			00										ReMask : 11111111111111 NumSymbol : 1 Ef : 1b
Hex 0 16 32	00 80 AE F0	09 02 FE 10 00 00	2 03 0 02 0 00	00 00	18 00 18 FF	01 01 F1 BI	0 8 0 0		01			00										ReMask : 1111111111111b NumSymbol : 1 Ef : 1b Ueld : 5
Hex 0 16 32	00 80 AE F0	09 02 FE 10 00 00	2 03 0 02 0 00	00 00	18 00 18 FF	01 01 F1 BI	0 8 0 0		01			00										ReMask : 11111111111b NumSymbol : 1 Ef : 1b Ueld : 5 Section Ext Command Ef : False
Hex 0 16 32	00 80 AE F0	09 02 FE 10 00 00	2 03 0 02 0 00	00 00	18 00 18 FF	01 01 F1 BI	0 8 0 0		01			00										ReMask : 111111111111 NumSymbol : 1 Ef : 1b Ueld : 5 Section Ext Command Ef : False ExtType : 8
Hex 0 16	00 80 AE F0	09 02 FE 10 00 00	2 03 0 02 0 00	00 00	18 00 18 FF	01 01 F1 BI	0 8 0 0		01			. oc										ReMask : 11111111111b NumSymbol : 1 Ef : 1b Ueld : 5 Section Ext Command Ef : False

Figure 330 Extension Type 8 messages included with Section Type 5

Note that because of adding Extension Type 8 to Section Type 5, Section Type 6 is not sent. Also, the Message Interpretation area displays the Extension Type 8 as well as Regularization Factor is added as an extension.

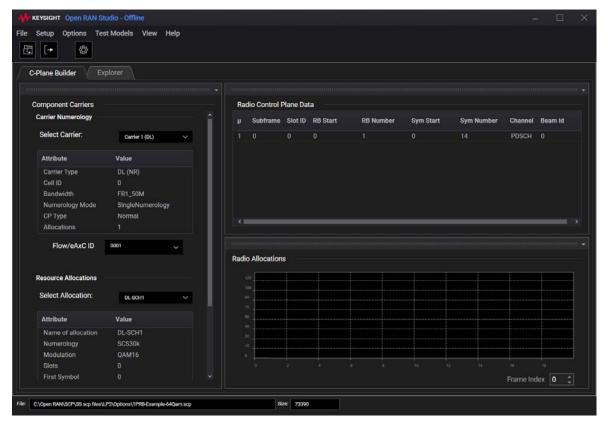
For more information about ueID, regularization factor and CI IQ data, refer to Section 5.4.5.10, 5.4.5.12 and 5.4.5.13, respectively in the O-RAN specification.

# Section 3.12: Configuring C-Plane Section Handling Options

To understand how the various options impact the C-Plane data, the reference signal comprises of a single "RF Transport Block" user data, where PDSCH allocation is 64QAM. This signal consists of 1PRB by 14 OFDM symbols, punctured with PDSCH DMRS and PT-RS reference signals (both QPSK).

## 3.12.1: Generating PCAP without compression or C-Plane options

1 Load the SCP file with the attributes described above, into the Open RAN Studio software.

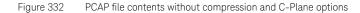


2 Assign a Flow/eAxC ID to the carrier.

Figure 331 Loading the SCP file with 64QAM PDSCH allocations

- 3 Export the O-RAN Stimulus file to generate the corresponding PCAP file without using any compression of C-Plane Section Handling options.
- 4 Load the stimulus / recording PCAP file into O-RAN Studio software.

		lder	y	Exp	lorer																
						9911D				11888			illisiin Q								
J-Plan	ie, C-	Plane	Mes	sage	<b>S</b> :									U-P	lane:						Message Interpretation:
Descri	iptior														Dir	eAx	Cμ	DU Por	E	$\nabla$	CcID:0 RuPortID:1
[PCAI														0	DL	000					eCPRI Sequence ID
[PCAR														<							SequenceID : 0 E : 1
[PCAI																					SubsequenceID : 0
[PCAI														C-P	lane:						C-Plane Common Header DataDirection : 1
IPCAR															Dir	eAx	ς μ	DU Por	: E		PayloadVersion : 1 FilterIndex : 0
(PCAR	P] U-F	lane,	Fram	e :0, s	Subfra	ime:	O, Slo	t: 0,	Symb	ol: 5	Sect	ion:	0, PI	0	DL	000					Frameld : 0
[PCAR	P] U-F	lane,	Fram	e :0, 5	Subfra	imet	0, Slo	t: 0,	Symb	ol: 6	Sect	ion:	0, PI Y	3							Subframeld : 0 SlotId : 0
																					StartSymbolid : 0 NumberOfSections : 1
																					SectionType : 1
loy D	wloa																			-	SectionType : 1 User Data Compression Header
																				-	SectionType : 1 User Data Compression Header IqBitWidth : 15 Compression : no compressio
	ayloa 02		04	05	06	07	08	09	0A	0B	oc	OD	- OE							-	SectionType : 1 User Data Compression Header IgBitWidth : 15
01 09	<b>02</b> 02	<b>03</b> 03	04	05	00	00	00	00	00	00	81	00	EO							Î	SectionType : 1 User Data Compression Header IqBitWidth : 15 Compression : no compressio Reserved Value : 0 CPIane Section Type 1
01 09 FE	02 02 10	03 03 02	04 00	05 14	00	00 01	00	00 80	00 90	00	81 00	00	E0 01							- - -	SectionType : 1 User Data Compression Header IqBitWidth : 15 Compression : no compressio Reserved Value : 0 C-Plane Section Type 1 SectionID : 0 RB : 0
01 09 FE 00	02 02 10 00	03 03 02 00	04 00 00	05 14 01	00 00 FF	00 01 FE	00 00 00	00 80 00	00 90 00	00 00 00	81	00	E0 01							^	SectionType : 1 User Data Compression Header IqBitWidth : 15 Compression : no compressio Reserved Value : 0 C P-lane Section Type 1 SectionID : 0 RB : 0 Symbolinc : 0
01 09 FE 00	02 02 10 00	03 03 02	04 00 00	05 14 01	00 00 FF	00 01 FE	00 00 00	00 80 00	00 90 00	00 00 00	81 00	00	E0 01								SectionType : 1 User Data Compression Header IqBitWidth : 15 Compression : no compressio Reserved Value : 0 C-Plane Section Type 1 SectionID : 0 RB : 0 Symboline : 0 StartPrbc : 0 NumberPrbc : 1
09 FE 00	02 02 10 00	03 03 02 00	04 00 00	05 14 01	00 00 FF	00 01 FE	00 00 00	00 80 00	00 90 00	00 00 00	81 00	00	E0 01							·	SectionType : 1 User Data Compression Header IqBitWidth : 5 Compression : no compressio Value : 0 C-Plane Section Type 1 SectionID : 0 RB : 0 Symboline : 0 StartPrbc : 0



As highlighted in Figure 332, the resulting PCAP file contains only a single C-Plane message with a single Section description.

The following sections describe the effects of applying one or more C-Plane Handling Options along with Compression.

3.12.2: Using reMask only

- 1 Launch the "C/U-Plane Builder Configuration Tool" window.
- 2 In the 'C-Plane Section Handling' area of the 'Options' tab, select the "Use reMask" check box.

[+ Ø			
/U Plane Builder	Configuration Tool ×		
Flow/eAxC	Network Layer:		
Compression	Maximum transmission unit (MTU) 9000	•	Message Interpretation:
	Disable VLAN Tags VLAN ID: 0	DU Port E 🔽	CcID: 0
Numerology	Set Sequence IDs to '0'	DU Port E	RuPortID : 1
Beamforming	- Set Sequence IDS to 0		eCPRI Sequence ID SequenceID : 0
Timing	C-Plane Section Handling:		E : 1 SubsequenceID : 0
	Use reMask		C-Plane Common Header DataDirection : 1
Options	Use symInc	DU Port E	PayloadVersion : 1
	Use RB indicator	0	FilterIndex : 0 Frameld : 0
	Use Extension Type 6		Subframeld : 0
	Use Extension Type 10 (MIMO only)		Slotid : 0 StartSymbolid : 0
	PRACH Type 3 as Type 1 Message		NumberOfSections : 1 SectionType : 1
	C-Plane Section Type 0 Messages:		User Data Compression Header
	don't generate	î î	IqBitWidth : 15 Compression : no compressi
			Reserved Value : 0
	U-Plane Package:		<ul> <li>C-Plane Section Type 1</li> </ul>
	Create Uplink U-Plane		SectionID : 0 RB : 0
	Digital Power Scaling (IQ Data):		Symbolinc : 0 StartPrbc : 0
	0 FS adjustment (FS_Offset, default 0 is no scaling)		NumberPrbc : 1
	rs adjustment (rs_onset, default of sho scaling)		ReMask : 1111111111111b NumSymbol : 14
	Apply fixed 256QAM scaler		Ef : 0b Beamld : 0
	0 Additional IQ power scaling (default 0 dBFS is no scaling)	*	Contract of Contra

Figure 333 Applying 'Use reMask' to the signal

- 3 Close the "C/U-Plane Builder Configuration Tool" window.
- 4 Export the O-RAN Stimulus file to generate the corresponding PCAP file.
- 5 Load the stimulus / recording PCAP file into O-RAN Studio software.

I-Plane, C-Plane Messages:	U-Plane:				Message Interpretation:
Description	# Dir	eAxC µ	DU Port	۴	Frameld : 0 Subframeld : 0
[PCAP] C-Plane, Section Type: 1, Sections: 2, Frame :0, Subframe: 0, Sick	0 DL	0001 1			SlotId : 0
[PCAP] C-Plane, Section Type: 1, Sections: 2, Frame :0, Subframe: 0, Sk					StartSymbolld : 0 NumberOfSections : 2
[PCAP] C-Plane, Section Type: 1, Sections: 1, Frame :0, Subframe: 0, Sk					SectionType : 1
[PCAP] C-Plane, Section Type: 1, Sections: 2, Frame :0, Subframe: 0, Sk [PCAP] C-Plane, Section Type: 1, Sections: 1, Frame :0, Subframe: 0, Sk	C-Plane:				<ul> <li>User Data Compression Header IgBitWidth : 15</li> </ul>
[PCAP] C-Plane, Section Type: 1, Sections: 1, Frame :0, Subframe: 0, Sk [PCAP] C-Plane, Section Type: 1, Sections: 2, Frame :0, Subframe: 0, Sk	# Dir	eAxC μ	DU Port	E	Compression : no compressio
(PCAP) C-Plane, Section Type: 1, Sections: 2, Frame :0, Subframe: 0, Sk	0 DL	0001 1			Reserved Value : 0
[PCAP] C-Plane, Section Type: 1, Sections: 1, Frame :0, Subframe: 0, Sit ×					C-Plane Section Type 1
· · · ·	<				SectionID : 8 RB : 0
					Symbolinc : 0 StartPrbc : 1
					NumberPrbc : 1
lex Payload:	1.5			^	ReMask : 000001000000b NumSymbol : 1
					Ef: Ob
01 02 03 04 05 06 07 08 09 0A 0B 0C 0D 0E					Beamld : 0 C-Plane Section Type 1
01 02 03 04 05 06 07 08 09 0A 08 0C 0D 0E					SectionID : 8
					RB : 0 Symbolinc : 0
09 02 03 04 05 00 00 00 00 00 81 00 E0					
09 02 03 04 05 00 00 00 00 00 00 00 81 00 E0 FE 10 02 00 1C 00 01 00 80 90 00 00 00 02					StartPrbc : 1
09 02 03 04 05 00 00 00 00 00 00 00 81 00 E0 FE 10 02 00 1C 00 01 00 80 90 00 00 00 02 00 00 80 01 01 04 01 00 00 00 88 01 01 FB					StartPrbc : 1 NumberPrbc : 1
09 02 03 04 05 00 00 00 00 00 00 00 81 00 E0 FE 10 02 00 1C 00 01 00 80 90 00 00 00 02 00 00 80 01 01 04 01 00 00 00 88 01 01 FB					StartPrbc : 1

Figure 334 PCAP file contents with reMask applied

As highlighted in Figure 334, applying reMask creates:

- 12 Section descriptions
- Section IDs 0, 2, 4 and 6 are reused twice with different masks
- 8 C-Plane messages, Section descriptions refer to different starting symbols

3.12.3: Using reMask with symInc

- 1 Launch the "C/U-Plane Builder Configuration Tool" window.
- 2 In the 'C-Plane Section Handling' area of the 'Options' tab, select the "Use reMask" (if not already selected) and "Use symInc" check boxes.

	- A				
lar (	C/U Plane Builder	Configuration Tool X	8		
iar	Flow/eAxC	Network Layer: Maximum transmission unit (MTU) 9000			
lar	Compression	Disable VLAN Tags VLAN ID: 0			Message Interpretation:
881	Numerology	Set Sequence IDs to '0'	U Port	Y	CcID:0 RuPortID:1
	Beamforming				<ul> <li>eCPRI Sequence ID</li> <li>SequenceID : 0</li> <li>E : 1</li> </ul>
	Timing	C-Plane Section Handling:			SubsequenceID : 0
	Options	Use syminc	U Port		DataDirection : 1 PayloadVersion : 1
		Use RB indicator Use Extension Type 6	þ	۵	FilterIndex : 0 Frameld : 0 Subframeld : 0
		Use Extension Type 10 (MIMO only)  PRACH Type 3 as Type 1 Message			SlotId : 0 StartSymbolId : 0 NumberOfSections : 1
		C-Plane Section Type 0 Messages:			SectionType : 1 User Data Compression Header
ex		don't generate 🗸 🗸		_	IqBitWidth : 15 Compression : no compression Reserved
		U-Plane Package:			Value : 0 C-Plane Section Type 1 SectionID : 0
5 2		Create Uplink U-Plane			RB : 0 Symbolinc : 0
8		Digital Power Scaling (IQ Data):			StartPrbc : 0 NumberPrbc : 1
		o FS adjustment (FS_Offset, default 0 is no scaling)			ReMask : 1111111111111 NumSymbol : 14
		Apply fixed 256QAM scaler			Ef : 0b Beamld : 0



- 3 Close the "C/U-Plane Builder Configuration Tool" window.
- 4 Export the O-RAN Stimulus file to generate the corresponding PCAP file.
- 5 Load the stimulus / recording PCAP file into O-RAN Studio software.

Setu			ns ②	Tes	t Mo	dels	Vi	BW	Help	)												
2-Plan			Y	Exp	olore	r \																
J-Plan	e C-	Plane	Me		95.							11000	alissiir 👻	U-PI	ane:						Message Interpretation:	
Descr				and.											Dir	eAxC	u	DU Port	į		C-Plane Section Type 1	
				_									-							Y	SectionID:0 RB:0	
													1: 0, 1 : 0, F		DL	0001					Symbolinc : 0	
													: U, F : 2, F	<							StartPrbc : 0 NumberPrbc : 1	
													3.F								ReMask : 000001000000b	
[PCA														C-PI	ane:						NumSymbol : 1 Ef : 0b	
[PCA	PU	Plane	Fran	ne :0,	Sub	frame	: 0, S	lot: 0	, Sym	bol:	4, Se	tion	: 4, F		Dir	eAxC		DU Port	E	1990	Beamld : 0	
[PCA	PU	Plane	Fran	ne :0,	Sub	frame	r: 0, S	lot: 0	, Sym	bol:	5, Sei	tion	: 4, F		DL	0001					<ul> <li>C-Plane Section Type 1</li> <li>SectionID : 0</li> </ul>	
[PCA	.P]U-	Plane	Fran	ne :0,	Sub	frame	:: 0, S	lot: 0	Sym	bol:	6, See	tion	: 5, F 🜱								RB:0	
					_																Symbolinc : 0 StartPrbc : 0	
																					NumberPrbc : 1	
																					ReMask : 111110111111b NumSymbol : 1	
lex Pa	ayloa	d:													1.5					<u>^</u>	Ef: 0b	
Hex	00	01	02	03	04	05	06	07	08	09	0A	08	oc								BeamId : 0 C-Plane Section Type 1	
0	80	09	02	03	04	05	00	00	00	00	00	00	8' ^								SectionID : 1	
		FE		02	00	90	00	01	00	80	90	00									RB:0 Symbolinc:0	
	FO	00	00	00	00		04		00	00	00	00	06								StartPrbc : 1	
48	00	00	00				04		00	00	00		0-								NumberPrbc : 1 ReMask : 000001000000b	
64	00	00	00	24	00			F1	00	00	00	34	0(		-0.5						NumSymbol : 1	
80		00	00	30	00		AA		00	00	00	44	00								Ef : 0b Beamld : 0	
96	00		00				04		00		00	50									C-Plane Section Type 1	
<		00	-	-	~	<u>.</u>		**												*	SectionID 1	
														<								

Figure 336 PCAP file contents with reMask and symInc applied

As highlighted in Figure 336, applying reMask and symInc, simultaneously, creates:

- 12 Section descriptions
- Section IDs 0, 2, 4 and 6 are reused twice with different masks
- 1 C-Plane message, Section descriptions refer to first OFDM symbol in Transport Block

3.12.4: Using Modulation Compression only

- 1 Launch the "C/U-Plane Builder Configuration Tool" window.
- 2 In the 'DL U-Plane IQ Data Compression' area of the 'Compression' tab, set 'Compression Method' as "modulation compression".

C/U Plane Bui	Ider Configuration Tool							
Flow/eAxC	DL U-Plane IQ Data Compress	on:						
Compressio	eAxC ID n	0001		Apply to All DL Flows			aaan ( 😜	
Numerology								Message Interpretation:
Beamformin	g Compression Method	modulation com	pressi 🗸		Port		Y	CcID : 0 RuPortID : 1
Timing	IQ Bitwidth							<ul> <li>eCPRI Sequence ID SequenceID : 0 E : 1</li> </ul>
Options	UL U-Plane IQ Data Compress	on:						SubsequenceID : 0 C-Plane Common Header
	eAxC ID	0001		Apply to All UL Flows	Port	E	<b>1</b>	DataDirection : 1 PayloadVersion : 1 FilterIndex : 0
	Static Compression	no udCompHdr in	n U-Plane)					Frameld : 0 Subframeld : 0
	Compression Method	no compression						SlotId : 0 StartSymbolId : 0 Number0fSections : 1
	IQ Bitwidth	15					•	SectionType : 1 User Data Compression Header IaBitWidth : 15
	Compression Summary For each stream or sp whether static or dyn compression method; an The stream or spatial str the flow table mappings i	amic compressi d the I and Q bitw aam is identified b	ion should ridth required by the eAxC I	be assigned; the				Gentreman: 15 Compression : no compress Reserved Value : 0 C-Plane Section Type 1 SectionID : 0 RB : 0 Symbolinc : 0 StartPrbc : 0 NumberPrbc : 1
				1-			•	ReMask: 11111111111111 NumSymbol: 14 Ef: 0b Beamld: 0

Figure 337 Applying 'Modulation Compression' to the signal

- 3 Clear the check boxes for the C-Plane Handling Options "use reMask" and "use symInc", if already selected in the 'Options' tab.
- 4 Close the "C/U-Plane Builder Configuration Tool" window.
- 5 Export the O-RAN Stimulus file to generate the corresponding PCAP file.
- 6 Load the stimulus / recording PCAP file into O-RAN Studio software.

n a sainte		der	y -	xplor	-																
	esti da	oii::::)		611000	alissii		i	991103 1	001160	1000	116311		en la	31 (A)							
-Plane	ie, C-F	lane	Mess	ges:											U-P	lane:					Message Interpretation:
escrip	ption															Dir	eAxC		DU	$\nabla$	StartSymbolId : 0
PCAP	C-PI	ane, S		Type:	1, Sec		Frame	:0, St	ibfran			0, Syr	mbol	k		DL	0001				NumberOfSections : 1 SectionType : 1
(PCAP)	C-PI	ane, S	ection	Type:	1, Sec	tions: 1,	Frame	:0, St	ıbfran	ie: 0,	Slot:	0, Syr	nbol								User Data Compression Header
PCAP]	C-PI	ane, S	ection	Type:	1, Sec	tions: 1,	Frame	:0, St	ibfran	ie: 0,	Slot	0, Syr	mbol								IqBitWidth : 0 Compression : no compressio
						tions: 1,									C-PI	lane:					Reserved
						tions: 1,										Dir	eAxC	U	DU		Value : 0 C-Plane Section Type 1
						tions: 1,									0			1	0	m	SectionID : 8
						tions: 1, tions: 1,										DL	0001				RB : 0 Symbolinc : 0
(PGAP) <	10-11	ane, a	scuon	Type.	n aec	uons: 1,	Fraint	.u, at	iorran	ie. 0,	alot.	u, ayı	>		< 1	_	_				StartPrbc : 1
																					NumberPrbc : 1
																					ReMask: 11111111111111
																					ReMask : 1111111111111b NumSymbol : 1
loy Do	wloa	4														1.5				-	NumSymbol : 1 Ef : 1b
lex Pa	ayloa	t: -														1.5 -				-	NumSymbol : 1 Ef : 1b Beamld : 0 Section Ext Command
lex Pa Hex			)2 O	3 04	05	06 0	7 08	09	0A	08	oc	OD	0E			1.5				-	NumSymbol : 1 Ef : 1b BearnId : 0 Section Ext Command <u>Ef : False</u>
		01	02 O			06 0 00 0			<b>0A</b> 00	<b>08</b> 00	0C 81	<b>0D</b> 00	0E E0							- Î	NumSymbol : 1 Ef : 1b Beamid : 0 Section Ext Command <u>Ef : False</u> ExtType : 5 ExtType : 5
Hex	<b>00</b> 80	01	02 0	3 04	05		0 00	00								1.5 - 1 - 0.5 -				Î	NumSymbol : 1 Ef : 1b Beamid : 0 Section Ext Command <u>Ef : False</u> ExtLen : 3 FatLen : 3 (Modulation Compression Ext
Hex 0 16 32	00 80 AE 00	01 09 FE 00	02 C 10 C	3 04 2 00 0 01	05 20 01	00 0 00 0 FF F	0 00 1 00 1 80	00 80 00	00 90 05	00 00 03	81	00	E0 01							Î	NumSymbol : 1 Ef : 1b Beamid : 0 Section Ext Command <u>Ef : False</u> <u>ExtType : 5</u> ExtLen : 3 Modulation Compression Ext McScaleReMask1 : 4031 Csf1 : True
Hex 0 16	00 80 AE 00	01 09 FE 00	02 C 10 C	3 04 2 00 0 01	05 20 01	00 0	0 00 1 00 1 80	00 80 00	00 90 05	00 00 03	81 00	00	E0 01							Ŷ	NumSymbol : 1 Ef : 1b Beamid : 0 Section Ext Command <u>Ef : False</u> ExtLen : 3 KitLen : 3 KocaleReMask1 : 4031 Csf : True McScaleRet1 : [0:1832]
Hex 0 16 32	00 80 AE 00	01 09 FE 00	02 C 10 C	3 04 2 00 0 01	05 20 01	00 0 00 0 FF F	0 00 1 00 1 80	00 80 00	00 90 05	00 00 03	81 00	00	E0 01							÷	NumSymbol : 1 Ef : 1b Beamid : 0 Section Ext Command <u>Ef : False</u> <u>ExtType : 5</u> ExtLen : 3 Modulation Compression Ext McScaleReMask1 : 4031 Csf1 : True
Hex 0 16 32	00 80 AE 00	01 09 FE 00	02 C 10 C	3 04 2 00 0 01	05 20 01	00 0 00 0 FF F	0 00 1 00 1 80	00 80 00	00 90 05	00 00 03	81 00	00	E0 01							Ŷ	NumSymbol : 1 Ef: 1b Beamid : 0 Section Ext Command <u>Ef: False</u> ExtILen : 3 Modulation Compression Ext McScaleReMask 1 : 4031 Csf1 : True McScaleOffset 1 : [0:1832] (McScaleOffset 1 : [0:1832]

Figure 338 PCAP file contents with Ext Type 5 for even-numbered Section IDs

As highlighted in Figure 338, applying modulation compression on its own creates:

- 8 Section descriptions, 8 C-Plane messages
- Section IDs 0, 2, 4 and 6 require 2 scalers; therefore, they need Extension Type 5

		lder	y	Exp	olore	r \																	
	es li ili	311155	110000	allesi	100000	iimii	antia li la	o i i i i i i	aili is	1166	alle	1000	311603)			aali ke							
I-Plar	ne, C-I	Plane	Me	ssag	es:												U-Pla	ane:					Message Interpretation:
escri	iption																	Dir	eAxC	μ	DU	$\nabla$	PayloadVersion : 1
PCAF	P] C-PI	ane, S	Secti	on Ty	pe: 1	Sec	tions:	, Fra	ime :	0, St	bfran	ne: 0	Slot:	0, Sy	mbo			DL	0001				FilterIndex : 0 Frameld : 0
PCAF	P] C-PI	ane, S	Secti	on Ty	pe: 1	, Sec	ions:	I, Fra	ime :	0, SL	bfran	1e: 0	Slot:	0, Sy	mbo								Subframeld : 0
PCAF	P] C-PI	ane, S	Secti	on Ty	pe: 1			, Fra	ime :	0, SL	bfran			0, Sy	mbo	1							Slotid : 0 StartSymbolid : 1
							lions:										C-Pla	ane:					NumberOfSections : 1
							tions:											Dir	eAxC	u	DU		SectionType : 1 User Data Compression Header
							ions:										0	DL	0001	1	0		IqBitWidth : 0
							ions:											DL	0001				Compression : no compressio Reserved
e GAR	Turri	ane, c	aecu	unny	per i I	, acc	10115.		inte :	u, at	Unan	ie. 0	3101.	U, ay	* *		< 💷	-	_				Value : 0
																							C-Plane Section Type 1 SectionID : 1
																							RB:0
																		1.5					Symbolinc : 0 StartPrbc : 0
lex P	avloa	dt																					NumberPrbc : 1
	ayloa																						
lex P Hex			02	03	04	05	06	07	08	09	0A	08	0C	OD	0E								ReMask : 1111111111111 NumSymbol : 1
	00 80	01 09	02	03	04 04	05 05			<b>08</b> 00	09 00	0A 00	<b>08</b> 00	0C 81	0D 00	OE E0			1-				1	NumSymbol : 1 Ef : 1b
Hex 0 16	00 80 AE	01 09 FE	02 10	03 02	04 00	05 18	00	00 01	00 02	00 80	00 90	00	81 00	00	E0 01							Ĩ	NumSymbol : 1
Hex 0 16 32	00 80 AE 00	01 09 FE 00	02 10 00	03 02 10	04 00 00	05 18 01	00 00 FF	00 01 F1	00 02 80	00 80 00	00 90 04	00 00 01	81	00	EO							I	NumSymbol : 1 Ef : 1b Beamld : 0 Section Ext Command 
Hex 0 16	00 80 AE 00	01 09 FE 00	02 10 00	03 02 10	04 00 00	05 18 01	00	00 01 F1	00 02 80	00 80 00	00 90 04	00 00 01	81 00	00	E0 01								NumSymbol: 1 Ef: 1b Beamld: 0 Section Ext Command Ef: False ExtType: 4
Hex 0 16 32	00 80 AE 00	01 09 FE 00	02 10 00	03 02 10	04 00 00	05 18 01	00 00 FF	00 01 F1	00 02 80	00 80 00	00 90 04	00 00 01	81 00	00	E0 01								NumSymbol : 1 Ef : 1b Beamld : 0 Section Ext Command Ef: False ExtUpe : 4 ExtLen : 1 Modulation Compression Ext
Hex 0 16 32	00 80 AE 00	01 09 FE 00	02 10 00	03 02 10	04 00 00	05 18 01	00 00 FF	00 01 F1	00 02 80	00 80 00	00 90 04	00 00 01	81 00	00	E0 01								NumSymbol : 1 Ef : 1b Beamid : 0 Section Ext Command Ef : False ExtType : 4 ExtType : 4

Figure 339 PCAP file contents with Ext Type 4 for odd-numbered Section IDs

As highlighted in Figure 339, applying modulation compression on its own creates:

- 8 Section descriptions, 8 C-Plane messages
- Section IDs 1, 3, 4 and 5 require a single scaler; therefore, only need Extension Type 4

- 3.12.5: Using reMask with Modulation Compression
  - 1 Launch the "C/U-Plane Builder Configuration Tool" window.
  - 2 In the 'C-Plane Section Handling' area of the 'Options' tab, select the "Use reMask" check box. Make sure other options are cleared.
  - 3 In the 'DL U-Plane IQ Data Compression' area of the 'Compression' tab, set 'Compression Method' as "modulation compression".

C/U Plane Builder	Configuration Tool	
Flow/eAxC	Network Layer:	
Compression	Maximum transmission unit (MTU) 9000	
Numerology	Disable VLAN Tags     VLAN ID:	
Beamforming	Set Sequence IDs to '0'	
Timing	C-Plane Section Handling:	
Options	Use reMask	
	Use RB indicator	
	Use Extension Type 6	
	Use Extension Type 10 (MIMO only)	
	PRACH Type 3 as Type 1 Message	

	-

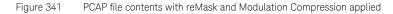
C/U Plane Builder	Configuration Tool				
Flow/eAxC	DL U-Plane IQ Data Compressio	on:			
Compression	eAxC ID	0001		Apply to All DL Flows	
Numerology		no udCompHdr in U			
Beamforming	Compression Method	modulation compre	ssi 🗸		
Timing	IQ Bitwidth				
Options	UL U-Plane IQ Data Compressio	on:			
	eAxC ID	0001		Apply to All UL Flows	
	Static Compression (	no udCompHdr in U	l-Plane)		
	Compression Method	no compression			
	IQ Bitwidth	15			

Figure 340

Applying 'Use reMask' and 'Modulation Compression' to the signal

- 4 Close the "C/U-Plane Builder Configuration Tool" window.
- 5 Export the O-RAN Stimulus file to generate the corresponding PCAP file.
- 6 Load the stimulus / recording PCAP file into O-RAN Studio software.

1000111				나사	lore	. 7																			
		81159) 8	10000	ai i interi		itali	ili	ellio		011000	silim	10000	1111111		imiis	811/8-									
-Plane	e, C-F	lane	Mes	sag	9 <b>8</b> :												U-P	lane:							Message Interpretation:
Descr	ription	i																Di	ir	eAxC	μ		DU	$\nabla$	NumberPrbc : 1
[PCA	P] C-I	lane.	Sec	tion 1	ype:	1, Se	ction	: 2, 1		:0, S	ubfra		0, Slo	t: 0, 5	symb		0		DL.	0001					ReMask : 000001000000b NumSymbol : 1
[PCA																									Ef : 1b
[PCA																									Beamld : 0 Section Ext Command
[PCA																	C-P	lane							Ef : False
[PCA																		Di	i.	eAxC	μ		DU		ExtType: 4 ExtLen: 1
[PCA																	0	D		0001	1		0		<ul> <li>Modulation Compression Ext</li> </ul>
[PCAI																			JL	0001					Csf : True ModCompScaler : [0:2047]
IPCA						1, se	etton	- 64	rame	HU, a	ubira	me:	u, sio	ic u, a	symp			_	_						(ModCompScalerValue : 0.999
			000	uon		-											<								
			000	uon		-											<pre></pre>								C-Plane Section Type 1
			6000														•								- C-Plane Section Type 1 SectionID: 8 RB: 0
			6														<							-	C-Plane Section Type 1 SectionID : 8 RB : 0 Symbolinc : 0
¢ ex Pa			60000																					-	- C-Plane Section Type 1 SectionID : 8 RB : 0 Symbolinc : 0 StartProc : 1 NumberProc : 1
c ex Pa Hex	yload	t:		03		05	06	07	08	09	0A	08	oc	OD	0E		- 10000							-	C-Plane Section Type 1 SectionID:8 RB:0 Symbolinc:0 StartPrbc:1 NumberPrbc:1 ReMask:111110111111b
	yload	t: 01				05 05	06 00	07 00	08 00	09 00	0A 00	0B 00	0C 81	<b>0D</b> 00	0E E0									*	C-Plane Section Type 1     SectionID:8     RB:0     Symboline:0     StartPrbc:1     NumberPrbc:1     ReMask:111110111111b     NumSymbol:1     Ef:1b
Hex	ayload 00 80	t: 01	02 02	03 03	04																			-	C-Plane Section Type 1 SectionID:8 RB:0 Symbolinc:0 StartPricc:1 NumberPricc:1 ReMask:111110111111b NumSymbol:1 Ef:1b Beamld:0
Hex 0	ayload 00 80 AE	l: 01 09	02 02 10	03 03 02	04 04 00	05 24	00	00	00 00	00	00	00	81	00	EO									î	C-Plane Section Type 1     SectionID : 8     RB : 0     Symbolinc : 0     StartPrbc : 1     NumSerPrbc : 1     ReMask : 11110111111b     NumSymbol : 1     Ef : 1b     Beamid : 0     Section Ext Command     Ef : False
Hex 0 16	ayload 00 80 AE 00	t: 01 09 FE	02 02 10 00	03 03 02 80	04 04 00 01	05 24 01	00 00 04	00 01 01	00 00 80	00 80 00	00 90 04	00 00 01	81 00	00	E0 02									Î	C-Plane Section Type 1     SectionID : 8     RB : 0     Symboline : 0     SiartPrbc : 1     NumberPrbc : 1     ReMask : 11110111111b     NumSymbol : 1     Ef : 1b     Beamid : 0     Section Ext Command <u>Ef : False     ExtType : 4     </u>
Hex 0 16 32	ayload 00 80 AE 00	l: 01 09 FE 00	02 02 10 00	03 03 02 80	04 04 00 01	05 24 01	00 00 04	00 01 01	00 00 80	00 80 00	00 90 04	00 00 01	81 00	00	E0 02									Ŷ	C-Plane Section Type 1 SectionID : 8 RB : 0 Symboline : 0 StartPrbc : 1 NumberPrbc : 1 ReMask : 11110111111b NumSymbol : 1 Ef : 1b Beamld : 0 Section Ext Command Ef : False ExtType : 4 ExtType : 4
Hex 0 16 32	ayload 00 80 AE 00	l: 01 09 FE 00	02 02 10 00	03 03 02 80	04 04 00 01	05 24 01	00 00 04	00 01 01	00 00 80	00 80 00	00 90 04	00 00 01	81 00	00	E0 02				-0.5			1 0.5		-	C-Plane Section Type 1     SectionID: 8     RB : 0     Symboline: 0     StartPrbc: 1     NumberPrbc: 1     ReMask: 111110111111b     NumSymbol : 1     Ef: 1b     Beamld: 0     Section Ext Command     Ef: False     Ext(Type: 4]



As highlighted in Figure 341, applying reMask and modulation compression, simultaneously, creates:

- 8 Section descriptions, 8 C-Plane messages
- Section IDs 0, 2, 4 and 6 are reused twice with different masks
- Triggers the use of Extension Type 4 only; Type 5 is made redundant due to the use of reMask

- 3.12.6: Using reMask with symInc and Modulation Compression
  - 1 Launch the "C/U-Plane Builder Configuration Tool" window.
  - 2 In the 'C-Plane Section Handling' area of the 'Options' tab, select the "Use reMask" and "Use symInc" check boxes.
  - 3 In the 'DL U-Plane IQ Data Compression' area of the 'Compression' tab, set 'Compression Method' as "modulation compression".

C/U Plane Builder	Configuration Tool
Flow/eAxC	Network Layer:
Compression	Maximum transmission unit (MTU) 9000
Numerology	Disable VLAN Tags VLAN ID: 0
Beamforming	Set Sequence IDs to '0'
Timing	C-Plane Section Handling:
Options	✓ Use reMask         ✓ Use syminc
	Use RB indicator
	Use Extension Type 6
	Use Extension Type 10 (MIMO only)
	PRACH Type 3 as Type 1 Message

+

C/U Plane Builder	Configuration Tool				
Flow/eAxC	DL U-Plane IQ Data Compressio	on:			
Compression	eAxC ID	0001		Apply to All DL Flows	
Numerology		no udCompHdr in U			
Beamforming	Compression Method	modulation compres	ssi 🗸		
Timing	IQ Bitwidth				
Options	UL U-Plane IQ Data Compressio	on:			
	eAxC ID	0001		Apply to All UL Flows	
	Static Compression (	no udCompHdr in U	-Plane)		
	Compression Method	no compression			
	IQ Bitwidth	15	~		

Figure 342 Applying 'Use reMask', 'Use symInc' and 'Modulation Compression'

4 Close the "C/U-Plane Builder Configuration Tool" window.

- 5 Export the O-RAN Stimulus file to generate the corresponding PCAP file.
- 6 Load the stimulus / recording PCAP file into O-RAN Studio software.

	ie Bui	ilder	Y	Exp	lore	$\overline{)}$																		
erisselle	991100		Haas	11661		ies li	ili	1911 (s	56115		aiii::::	10.000	1199311	ilis	elimi S									
U-Plan	ne, C-l	Plane	Me	sag	<b>!S</b> :											U-PI	ane:							Message Interpretation:
Desc	riptio	n															Dir	r i	eAxC		D	U	$\nabla$	NumberPrbc : 1
[PC/	NP] C-	Plane	, Sec	tion 1	ype:	1, Se		s: 18,		ie :0,		ame	0, Sk	ot: 0, S	ym 🗠		D		0001		0			ReMask : 111110111111b NumSymbol : 1
[PCA	AP] U	Plane	, Fran	ne :0	Sub	rame	: 0, S	lot: 0	, Sym	bol:	D, Sec	tion:	0, PR	B: 0-0,	Ser									Ef : 1b Beamld : 0
														B: 0-0		<								Beamid : 0 Section Ext Command
														B: 0-0	1	C-PI	ane:							Ef : False
														B: 0-0			Dir		PAXC	U	D			ExtType:4 ExtLen:1
														B: 0-0		0	DI		0001		0			<ul> <li>Modulation Compression Ext</li> </ul>
IPUA	APJ U	Plane	, Frai	ne :u	Sub	rame	: 0, 5	10t: U	, sym	001:	o, sec			B: 0-0				<b>-</b> (	0001					Csf : True
IDCA	DIII	Diana	Erm	0.00	Cubi	(manne	- 11 0	lot: 0	Cum	hal	5 Car	tion	5 DD	n-n-n	Carv									ModCompScaler : [0:1832]
[PC/	\P] U-	Plane	Fran	ne :0	Sub	rame	: 0, S	lot: 0	. Sym	bol:	5, Sec	tion:	5, PR	B: 0-0,	Sei Y	<	_	_						ModCompScaler : [0:1832] (ModCompScalerValue : 0.894
(PC/	\P] U-	Plane	, Fran	ne :0	Sub	'rame	: 0, S	lot: 0	, Sym	bol:	5, Sec	tion:	5, PR	B: 0-0,	Ser ¥ >	<	_	_						(ModCompScalerValue : 0.894 C-Plane Section Type 1
(PC/	\P] U-	Plane	, Fran	ne :0	Sub	irame	: 0, S	lot: 0	, Sym	bol:	5, Sec	tion:	5, PR	B: 0-0,	Sei * >	<b>K 1</b>								(ModCompScalerValue : 0.894 C-Plane Section Type 1 SectionID : 10 RB : 0
			, Fran	ne :0	Sub	'rame	: 0, S	lot: 0	, Sym	bol:	5, Sec	tion:	5, PR	B: 0-0.	Ser¥ ≯	<							-	(ModCompScalerValue : 0.894 C-Plane Section Type 1 SectionID : 10 RB : 0 Symbolinc : 1
	ayloa	ıd:												B: 0-0,	Ser ¥ >	•							-	(ModCompScalerValue: 0.894 C-Plane Section Type 1 SectionID: 10 RB: 0 Symbolinc: 1 StartPrbc: 0 NumberPrbc: 1
(PC/ « Hex Pi Hex	ayloa	ıd:									5, Sec 0A			B: 0-0,		<			-				•	(ModCompScalerValue: 0.894 C-Plane Section Type 1 SectionID: 10 RB: 0 Symbolinc: 1 StartPrbc: 0 NumberPrbc: 1 ReMask: 11111111111
< Hex Pa	ayloa	ıd:												OD									~	(ModCompScalerValue: 0.894           C-Plane Section Type 1           SectionID: 10           RB: 0           Symbolinc: 1           StartPrbc: 0           NumberPrbc: 1           ReMask: 1111111111           NumSymbol: 3           Ef: 1b
< Hex Pi Hex	ayloa 00 80	ıd: 01	02 02	03 03	04	05	<b>06</b> 00	07	08 00	09	0A 00	0B 00	0C	<b>0D</b> 00	> - 0E								~	(ModCompScalerValue: 0.894 C-Plane Section Type 1 Section ID: 10 RB: 0 Symbolinc: 1 StartPrbc: 0 NumberPrbc: 1 ReMask: 11111111111b NumSymbol: 3 Ef: 1b Beamld: 0
< Hex Pa Hex 0 16 32	ayloa 00 80 AE 00	nd: 01 09 FE 00	02 02 10 00	03 03 02	04 04 00 00	05 05 E4	06 00 00 04	<b>07</b> 00 01	08 00 00	09 00 80	0A 00	08 00 00	0C 81 00	0D 00 00 FF	> 0E E0 ^	< 11							^	(ModCompScalerValue: 0.894 C-Plane Section Type 1 SectionID: 10 RB: 0 Symbolinc: 1 StartPrbc: 0 NumberPrbc: 1 ReMask: 1111111111 NumSymbol: 3 Ef: 1b Beamid: 0 Section Ext Command <u>Ef: False</u>
<     Hex P: Hex 0     16     32     48	ayloa 00 80 AE 00 00	nd: 01 09 FE 00 01	02 02 10 00 FB	03 03 02 00 F1	04 04 00 00 80	05 05 E4 01 00	00 00 04 04	07 00 01 01 01	08 00 00 80 87	09 00 80 00 28	0A 00 90 04 00	08 00 00 01 10	0C 81 00 87 01	0D 00 00 FF 01	> 0E E0 12 00 04								Ŷ	(ModCompScalerValue: 0.894 C-Plane Section Type 1 SectionID: 10 RB: 0 Symbolinc: 1 StartPrbc: 0 NumberPrbc: 1 ReMask: 11111111111b NumSymbol: 3 Ef: 1b Beamid: 0 Section Ext Command <u>Ef: False</u> [ExtType: 4]
<     Hex Pa Hex 0 16 32 48 64	ayloa 00 80 AE 00 00 80	id: 01 09 FE 00 01 00	02 02 10 00 FB 04	03 03 02 00 F1 01	04 04 00 80 87	05 05 E4 01 00 FF	06 00 00 04 04 00	07 00 01 01 01 10	08 00 00 80 87 01	09 00 80 00 28 01	0A 00 90 04 00 FB	08 00 00 01 10 F1	0C 81 00 87 01 80	00 00 00 FF 01 00	> 0E ED 12 00 04 04								Ŷ	(ModCompScalerValue: 0.894 C-Plane Section Type 1 SectionID: 10 RB: 0 Symbolinc: 1 StartPrbc: 0 NumberPrbc: 1 ReMask: 1111111111 NumSymbol: 3 Ef: 1b Beamid: 0 Section Ext Command <u>Ef: False</u>
<     Hex P: Hex 0     16     32     48	ayloa 00 AE 00 00 80 80	nd: 01 09 FE 00 01 00 28	02 02 10 00 FB 04 00	03 03 02 00 F1 01 24	04 04 00 00 80 87 00	05 05 E4 01 00 FF	06 00 04 04 00 FF	07 00 01 01 01 10 F1	08 00 00 80 87 01 80	09 00 80 00 28 01 00	0A 00 90 04 00 FB 04	08 00 00 01 10	0C 81 00 87 01	00 00 00 FF 01 00 28	> 0E E0 12 00 04	•		- -0.5					^	(ModCompScalerValue: 0.894 C-Plane Section Type 1 SectionID: 10 RB: 0 Symboline: 1 StartPrbe: 0 NumberPrbc: 1 ReMask: 1111111111 NumSymbol: 3 Ef: 1b Beamid: 0 Section Ext Command Ef: False ExtType: 4 ExtLen: 1

Figure 343 PCAP file with reMask, symInc & Modulation Compression applied

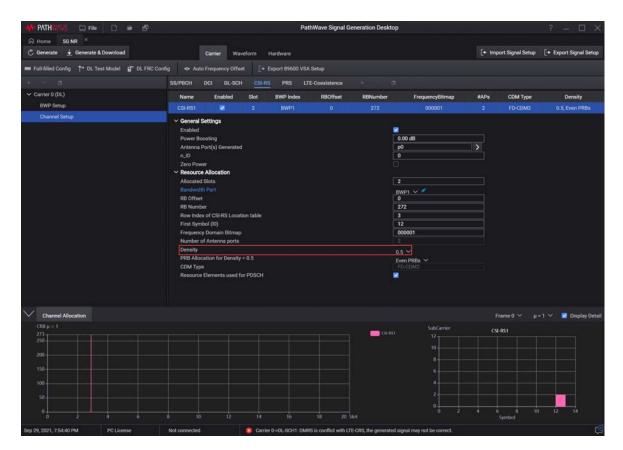
As highlighted in Figure 341, applying reMask, symInc and modulation compression, simultaneously, creates:

- · 8 Section descriptions, 1 C-Plane message
- Section IDs 0, 2, 4 and 6 are reused twice with different masks
- Triggers the use of Extension Type 4 only; Type 5 is made redundant due to the use of reMask

#### 3.12.7: Using RB Indicator

The "RB Indicator" enables only the even-numbered PRB slots in the U-Plane messages of the CSI-RS signal. Currently, the option "RB Indicator" in U5040A Open RAN Studio supports the CSI-RS format of the Downlink carrier only.

To understand how this option works, let us generate an SCP file in PathWave Signal Generation Desktop 2022 software for the DL carrier with CSI-RS format and Density as '0.5'.





- 1 Load the SCP file, with the CSI-RS format, into the Open RAN Studio software.
- 2 Assign a Flow/eAxC ID to the carrier.

Setup Options Tes	st Models View Hel	P									
	plorer										
Component Carriers				dio Control F							
Carrier Numerology			μ	Subframe	Slot ID	RB Start	RB Number	Sym Start	Sym Number	Channel	Beam Id
Select Carrier:	Carrier 1 (DL)				0	0	255 17	12 12		CSI-RS CSI-RS	0
Attribute	Value					200				Garna	
Carrier Type Cell ID Bandwidth Numerology Mode CP Type Allocations	DL (NR) 0 FR1_100M SingleNumerology Normal 1										
Flow/eAxC ID	0001		Radi	o Allocation	s						
Resource Allocations		- 11		279 540							
Select Allocation:	CSI-RS1	•		190							
Attribute	Value			190							
	CSI-RS1			10 10							
Name of allocation	SCS30k			20							
Numerology											
Numerology Allocated Slots				* <del>+</del>							
Numerology				° +						<sup>10</sup> Frame Inc	ii lex 0 🛟

Figure 345 Loading the SCP file with CSI-RS format

- 3 Export the O-RAN Stimulus file to generate the corresponding PCAP file.
- 4 Load the stimulus / recording PCAP file into O-RAN Studio software.

			y	Ex	plore	r )																			
i pi -												10000	ai (653)			all 🌩									Message Interpretation:
	ne, C-		e Me	ssag	es:												0-6	lane							Frameld : 0
	criptic																	D		eAxC			DU	$\nabla$	Frameld : 0 Subframeld : 1
									Fram								0		)L	0001					SlotId : 0
									0, Syn								<							Ξv	StartSymbolid : 12 NumberOfSections : 2
IPC	APTU	Plan	e, Fra	ime :0	, Sut	ofram	ie: 1, :	siot: (	0, Syn	nbol:	12, S	ectio	n: 0, I	PRB: 1	99-2	54									SectionType : 1
																	C-F	lane							<ul> <li>User Data Compression Header</li> <li>IgBitWidth : 15</li> </ul>
																		D	ir	eAxC	μ		DU		Compression : no compressio
																	0	C	)L	0001			0		<ul> <li>Reserved</li> <li>Value : 0</li> </ul>
																									<ul> <li>C-Plane Section Type 1</li> </ul>
						-	-			-								-	-	-					SectionID:0 RB:0
																									Symbolinc : 0
																									StartPrbc : 0 NumberPrbc : 255
	avloa	d:																						~	ReMask : 111111111111
lex P																									NumSymbol : 1
lex P			02	03	04	05	06	07	08	09	0A	08	0C	OD	0E	0									Ef : Ob Beamld : O
	00	01			04	05	00	00	00	00	00	00	81	00	EO										C-Plane Section Type 1
	<b>00</b> 80	01 09	02	03	04		00		00	80	90	00		0C										1	SectionID: 1 RB: 0
Hex 0 16	80 AE	09 FE			00				0.0	00	00	10													Symbolinc : 0
Hex 0 16 32	80 AE F0	09 FE 00	10 00	02 00	00	FF																			
Hex 0 16	80 AE	09 FE 00	10 00	02 00	00	FF			00		00	00													StartPrbc : 255
Hex 0 16 32	80 AE F0	09 FE 00	10 00	02 00	00	FF					00	00													StartPrbc : 255 NumberPrbc : 17 ReMask : 111111111111b
Hex 0 16 32	80 AE F0	09 FE 00	10 00	02 00	00	FF					00	00							-0.5			0.5			StartPrbc : 255 NumberPrbc : 17

Figure 346 Loading the PCAP file with CSI-RS format

As highlighted in Figure 346, there is 1 C-Plane message and 2 U-Plane messages from PRBs 0 to 198 and PRBs 199 to 254. The "RB:0" indicates that RB Indicator is disabled in the C-Plane messages.

- 5 Launch the "C/U-Plane Builder Configuration Tool" window.
- 6 In the 'C-Plane Section Handling' area of the 'Options' tab, select the "Use RB Indicator" check box.

	Flow/eAxC	Network Layer:				
ΡI	Compression	Maximum transmission unit (MTU) 9000				
	Numerology	Disable VLAN Tags     VLAN ID: 0				Message Interpretation:
Pl De	Beamforming	Set Sequence IDs to '0'		DU	Y	Frameld : 0
(F	Timing	C-Plane Section Handling:			-	Subframeld : 1 Slotid : 0 StartSymbolid : 12
17 (F		🔲 Use reMask				NumberOfSections : 2
"	Options	Use symInc				SectionType : 1 User Data Compression Header
		✓ Use RB indicator				IqBitWidth : 15
		Use Extension Type 6		DU	and a	Compression : no compressio Reserved
		Use Extension Type 10 (MIMO only)	1			Value : 0
		PRACH Type 3 as Type 1 Message				<ul> <li>C-Plane Section Type 1 SectionID : 0</li> </ul>
		C-Plane Section Type 0 Messages:				RB : 0 Symbolinc : 0
		don't generate	*****		•	StartPrbc : 0 NumberPrbc : 255
x		U-Plane Package:				ReMask : 1111111111111b NumSymbol : 1 Ef : 0b
)		Create Uplink U-Plane				Beamld : 0 C-Plane Section Type 1
4		Digital Power Scaling (IQ Data):			Ĩ.	SectionID : 1 RB : 0
32 48		0 FS adjustment (FS_Offset, default 0 is no scaling)				Symbolinc: 0 StartPrbc: 255
		Apply fixed 256QAM scaler				NumberPrbc : 17 ReMask : 1111111111111b
		0 Additional IQ power scaling (default 0 dBFS is no scaling)				NumSymbol : 1 Ef : 0b Beamld : 0

Figure 347 Applying 'Use RB Indicator' to the signal

- 7 Close the "C/U-Plane Builder Configuration Tool" window.
- 8 Export the O-RAN Stimulus file to generate the corresponding PCAP file.
- 9 Load the stimulus / recording PCAP file into O-RAN Studio software.

		lder	y	Exp	olore																	
Diar	ne, C-I	lon												an Hansin		-Pla						Message Interpretation:
			a me	ssag	es:																	Frameld : 0
	script															*	Dir	eAxC		DU	$\nabla$	Subframeld : 1
							iection:										DL	0001				SlotId: 0
[Pi	CAP]	J-Pla	ne, Fi	rame	0, Su	bfran	ne: 1, S	ot: 0,	Symb	ol: 12,	Secti	on: 0,	PRB:	0-254,		c 1111						StartSymbolId : 12 NumberOfSections : 2
																						SectionType : 1
															C	Pla	ne: -					User Data Compression Header
																#	Dir	eAxC		DU		Compression : no compressio
																	DL	0001				<ul> <li>Reserved</li> <li>Value : 0</li> </ul>
																						<ul> <li>C-Plane Section Type 1</li> </ul>
									_							¢ (11)		-				C-Plane Section Type 1 SectionID : 0
																< 111		-				C-Plane Section Type 1     SectionID : 0     RB : 1     Symbolinc : 0
									-							<						C-Plane Section Type 1     SectionID : 0     RB : 1     Symbolinc : 0     StartPrbc : 0
	ayloa	d:													-	<					-	C-Plane Section Type 1     Section10: 0     RB:1     Symbolinc: 0     StariPrbc: 0     NumberPrbc: 128     ReMask: 11111111111
lex P			02	03	04	05	06 0	7 08		04	08	00	00			<					-	- C-Plane Section Type 1
Hex P Hex	00	01					06 0			04				OE O		<					-	C-Plane Section Type 1     Section[D:0     R8:1     Symboline: 0     StarPrbe: 0     NumberPrbe: 128     ReMask: 11111111111     NurnSymbol: 1     Ef: 0b     Beamid: 0
lex P Hex 0	00 80	01 09	02	03	04	05	00 0	10 00	) 00	00	00	81	00	0E 0 E0 (		<					~	- C-Plane Section Type 1 
Hex P Hex 0 16	00 80 AE	01 09 FE	02 10	03 02	04 00	05 1C	00 0 00 0	io oc 11 oc	) 00 ) 80	00 90	00	81 10	00 0C	0E 0 E0 C 02 C		<					•	- C-Plane Section Type 1     Section(D): 0     R8:1     Symboline: 0     StarPrbe: 0     NumberPrbe: 128     ReMask: 11111111111     D     NumSymbol: 1     Ef: 0b     Beamid: 0     - C-Plane Section Type 1     Section(D): 1     R8:1
Hex P Hex 0 16 32	00 80 AE F0	01 09 FE 00	02 10 00	03 02 08	04 00 00	05 1C 80	00 0 00 0 FF F	io oc i1 oc i1 oc	00 00 0 80 0 00	00 90 00	00 00 19	81 10	00 0C	0E 0 E0 (		< 11					~	C-Plane Section Type 1     Section10 :0     R8:1     Symboline :0     StartPrbc :0     NumberPrbc :128     ReMask :11111111111     Ef: 0b     Beamid :0     C-Plane Section10 :1     R8:1     Symboline :0
Hex P Hex 0 16	00 80 AE F0	01 09 FE 00	02 10 00	03 02 08	04 00 00	05 1C 80	00 0 00 0	io oc i1 oc i1 oc	00 00 0 80 0 00	00 90 00	00 00 19	81 10	00 0C	0E 0 E0 C 02 C							-	- C-Plane Section Type 1     Section(D): 0     R8:1     Symboline: 0     StarPrbe: 0     NumberPrbe: 128     ReMask: 11111111111     D     NumSymbol: 1     Ef: 0b     Beamid: 0     - C-Plane Section Type 1     Section(D): 1     R8:1
Hex P Hex 0 16 32	00 80 AE F0	01 09 FE 00	02 10 00	03 02 08	04 00 00	05 1C 80	00 0 00 0 FF F	io oc i1 oc i1 oc	00 00 0 80 0 00	00 90 00	00 00 19	81 10	00 0C	0E 0 E0 C 02 C							^	C-Plane Section Type 1     Section10 : 0     R8:1     Symboline : 0     StartPrbc : 0     NumberPrbc : 128     ReMask: 11111111111     Ef : 0b     Beamid: 0     C-Plane Section12:1     R8:1     Symboline: 0     StartPrbc : 8     ReMask: 111111111111
Hex P Hex 0 16 32	00 80 AE F0	01 09 FE 00	02 10 00	03 02 08	04 00 00	05 1C 80	00 0 00 0 FF F	io oc i1 oc i1 oc	00 00 0 80 0 00	00 90 00	00 00 19	81 10	00 0C	0E 0 E0 C 02 C							^	C-Plane Section Type 1     SectionD : 0     RetionD : 0     StartPrbc : 0     NumberPrbc : 128     ReMask. 11111111111     NumSymbol : 1     Ef : 0b     Beamid : 0     C-Plane SectionD : 1     SectionD : 1     SectionD : 1     Symboline : 0     StartPrbc : 256     NumberPrbc : 8

Figure 348 C-Plane messages after RB Indicator is enabled

Notice in Figure 348 that the C-Plane messages show "RB:1", which indicates that RB Indicator has been enabled on the user payload.

C-Plar	ne Bu	lder	Y	Exp	olore	• \																	
	1911 (M		11000		100000	1166011	in an	im lie		e Has	101160	110000	116601		enimi 'e								
U-Plar	ne, C-	Plane	Me	ssag	es:											U-Pl	ane:						Message Interpretation:
ion																	Dir	eA	KC I		DU	$\nabla$	U-Plane Section
C-Plan	e, Sec	tion	Гуре:	1, Se	ction	s: 2,	Fram	e :0, S	Subfra	ame:	1, Slo	t: 0, 1	Symb	ol Sta	rt: 12, P		DL	00	01	1			SectionID: 0 RB: 1
J-Plan	e, Fra		, Sub			Slot: (	), Syn		12, S		n: O, F	RB:	0 254		ion: 1, F								Symboline : 0
																							StartPrbu : 0 NumberPrbu : 128
																C-Pla	ane:						udCompHdr : 240
																#	Dir	eA	C L	1	DU		Reserved : 0
																0	DL	00	01	1	0		IqSampleBlock : [5a, 83, 4a,
																							(IqBitWidth : 15) (Compression : no compressi
							-	-	-	-						<	-	-					PRB 2
																							IqSampleBlock : [5a, 83, 4a, (IqBitWidth : 15)
																							(Compression : no compressi PRB 4
Hex P	ayloa	d:																				^	IqSampleBlock : [a5, 7f, 4a,]
Hex	00	01	02	03	04	05	06	07	08	00	0A	08	oc	OD	OE								(IqBitWidth : 15) (Compression : no compressi
						03	00	0/	00	09		00											PRB 6
	80	09	02		04	05	00	00	00	00	00	00	81	00	EO 🏫								IqSampleBlock : [a5, 7f, 4a,] (IgBitWidth : 15)
16 32	AE 00	FE 80	10 F0	00	17 5A	FC 83	00 4A	01 FE	00 95	80 FD	90 2B	00 F0	10	00	00								(Compression : no compressi
48	00	00	00	00	5A 00	83	4A 00	00	00	00	00	00	00	00	00								PRB 8
64	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00								IqSampleBlock : [a5, 7f, 4a,] (IgBitWidth : 15)
80	00	5A	83	44	FE			D4	10	00	00	00	00	00	00								Compression : no compressi
	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00								PRB 10 IgSampleBlock : [5a, 83, 4a,
96	00																						

Figure 349 U-Plane messages after RB Indicator is enabled

Notice in Figure 349 that U-Plane messages now include only even-numbered PRBs. Also, no compression has been applied to this signal. You may configure any of the compression methods for DL U-Plane data, which is applied to the U-Plane messages along with the configured IQ bitwidth and the 'UdComParam' parameter.

#### 3.12.8: Allocating non-contiguous PRBs

The Extension Type 6 enables allocation of non-contiguous sets of PRBs (Resource Block Groups [RBGs]) in frequency and time domain, which reduces significantly the C-Plane overhead.

To understand how this Section Extension works, consider the following "Resource Allocations" configuration in the *PathWave Signal Generation Desktop 2022* interface to generate the SCP file.

- RA Type Type 0
- RBGBitmap random 0 bits included

✓ Resource Allocation	
Allocated Slots	0,2,4
First Symbol	0
Last Symbol	13
Bandwidth Part	BWP1 V
RA Туре	Туре 0 🗸
RBGSize	16 🗸
RBGBitmap	111110111101111111
VRB-to-PRB Mapping	Non-Interleaved 🗸
PRB Bundle Size	Wideband 🗸
CORESET ID For RateMatching	
RateMatchPattern(s)	0 Pattern(s) Enabled

Plane Builder 🔰 Exp	plorer										
omponent Carriers			Rac	lio Control F	Vane Dat	la					
Carrier Numerology		•	μ	Subframe			RB Number	Sym Start	Sym Number	Channel	Beam Id
Select Carrier:	Carrier 1 (DL)						80		14	PDSCH	
						96	64		14	PDSCH	
Attribute	Value					176			14	PDSCH	
Carrier Type	DL (NR)						80		14	PDSCH	
Cell ID						96	64		14	PDSCH	
Bandwidth	FR1_100M					176				PDSCH	
Numerology Mode	SingleNumerology						80		14	PDSCH	
CP Type	Normal					96	64		14	PDSCH	
Allocations						176			14	PDSCH	
Resource Allocations			Radio	Allocation	s —						
Select Allocation.	DL-SCH1 V										
Attribute	Value			10	-						
Name of allocation	DL-SCH1				1 1						
Numerology	SCS30k										
Modulation	QPSK										
Slots	0,2,4			20							
First Symbol				-							
Last Symbol					-						
Number of Symbols	14										
RB Offset RB Number	0 273										

1 Load the SCP file into the Open RAN Studio software.

Figure 350

Loading SCP file with non-contiguous PRB data

- 2 Export the O-RAN stimulus file.
- 3 Switch to Explorer tab and load the generated PCAP file.

The Message Interpretation area shows three separate 'Section Type1' C-Plane messages for each slot.

			У.	Explor	er	ć																
J-Plane	e, C-P	lane	Mes	ages:										U	Plane						Message Interpretation:	
n De:	script	ion													# D	lir	eAxC		DU Port	$\nabla$	Submarrieru , v Slotid : 0	
(P	CAP]	C-Plan	ie, Se	ction T	ype: 1	Sect	ons: 3	Fra	me :0		frame	0, SI				DL	0001			u u	StartSymbolid : 0 NumberOfSections : 3	
(Pt	CAP]	U-Plan	e, Fr	ame :0,	Subfr	ame: I	, Slot	0, 5	ymbo	: 0, 5	Section	: 0, P	RB: I								SectionType : 1	
				ame :0,																	<ul> <li>User Data Compression Header IgBitWidth : 15</li> </ul>	
				ame :0,																	Compression : no compression	
				ame :0, ame :0,										c	Plane	s –					Reserved     Value: 0	
				ame :0,											# D	lir	eAxC	Ŭ.	DU Port		<ul> <li>C-Plane Section Type 1 SectionID : 0</li> </ul>	
[P	CAPIL	U-Plar	ie, Fri	ame :0,	Subfr	ame: I	, Slot	0, 5	ymbo	1.3, 5	Section	: 0, P	RB: I		0 0	DL	0001				RB:0	
[P	CAPIL	I.Dine	e Fr	ame :0,	Subfr	ame: I	), Slot	0, 5	ymbo	: 3, 5	Section	1: 2, P	RB								Symboline : 0	
		0-r-iai																			StartPrbc:0	
	CAPI	U-Plar	ie, Fri	ame :0,																	StartPrbc : 0 NumberPrbc : 80	
	CAPI	U-Plar	ie, Fri												-	_	_	_				
	CAPI	U-Plar	ie, Fri	ame :0,											-	_	_	-			NumberPrbc : 80 ReMask : 111111111111b NumSymbol : 14 Ef : 0b	
	CAPI	U-Plar	ie, Fri	ame :0,														_			NumberPrbc : 80 ReMask: 11111111111 NumSymbol : 14 Ef : 0b Beamid : 0 - C-Plane Section Type 1	
	CAPJ	U-Plar	ie, Fri	ame :0,												ered	10	Constella	,		NumberPhbc: 80 ReMask: 11111111111b NumSymbol: 14 Ef: 0b Beamid: 0 - C-Plane Section Type 1 SectionID: 1	
	CAP) (	J-Plar 1 01 1:	ie, Fri C-	ame :0,	0.14								ъв* >		Recove	ered	IQ	Constella	> ation		NumberPrbc: 80 ReMask: 111111111111b NumSymbol: 14 Ef: 0b Bearnid: 0 - C-Plane Section Type 1 SectionID: 1 RB: 0 Symbolinc: 0	
د الم Hex Pa Hex	o A Di l ayload	U-Plar 1 Di 1: 01 (	1e, Fri C- 02 (	ame :0, ^	0	06	07	08	09	0A	08		D 0E	-	Recov		IQ selected		> ation		NumberPhDs: 80 ReMask : 1111111111b NumSymbol : 14 Ef : 0b Beamid : 0 - C-Plane Section Type 1 SectionID : 1 RB : 0	
< Hex Pa Hex 0	CAP   c+D   ayload 00 80	U-Plar 1 Di 1 1 1 1 1 0 1 0 9	ie, Fri 	ame :0,	05 05	06 00	07 00	08 00	09 00	0A 00	0B 00	DC (	10 OE 10 E	-	Recov	one s			> ation		NumberPbc: 80 ReMask:1111111111b NumSymbol:14 Ef:0b Beamid:0 - C-Plane Section Type 1 Section10:1 R8:0 Symboline:0 StartPrbc:96 NumberPbc:64 ReMask:111111111b	
د الم Hex Pa Hex	CAP) ( ayload 00 80 AE	U-Pier 1 01 1: 01 0 FE	02 02 10	ame :0, ^	0.64 05 05 024	06 00	07 01	08 00 00	09 00 80	0A 90	0B 00 00	ac ( 81	D 0E 10 0E 10 0:	-	Recovi RB: (ni	one s	selected		> ation		NumberPrbc: 80 ReMask: 111111111111 NumSymbol: 14 Ef: 0b Beamld: 0 - C-Plane Section Type 1 SectionI0: 1 R8: 0 Symboline: 0 StartPrbc: 96 NumberPrbc: 64	
< row Hex Pa Hex 0 16	CAP) ( ayload 00 80 AE F0	U-Plar 1 01 1 01 0 FE 00	02 00 00 00	ame :0, 	05 05 05 024 050	06 00 00 FF	07 00 01 FE	08 00 00 00	09 00 80 00	00A 90 00	0B 00 00 10	ac ( 81	D 0E 10 0E 10 0:	-	Recovi RB: (ni	one s	selected		ation		NumberPbc: 80 ReMask : 1111111111b NumSymbol : 14 Ef : 0b Beamd : 0 - C-Plane Section Type 1 SectionID : 1 RB : 0 Symbolinc : 0 StartPbc : 96 NumberPbc : 66 ReMask : 11111111111b NumSymbol : 14 Ef : 0b Beamd : 0	
<ul> <li>Hex Pa</li> <li>Hex</li> <li>0</li> <li>16</li> <li>32</li> </ul>	CAP) ( ayload 00 80 AE F0	U-Plar 1 01 1 01 0 FE 00	02 00 00 00	ame :0, 03 04 03 04 02 00 00 00	05 05 05 024 050	06 00 00 FF	07 00 01 FE	08 00 00 00	09 00 80 00	00A 90 00	0B 00 00 10	ac ( 81	D 0E 10 0E 10 0:	-	Recovi RB: (ni	one s	selected		ation		NumberPhDc: 80 ReMask:1111111111b NumSymbol:14 Ef:0b Beamid:0 - C-Plane Section Type 1 SectionD:1 RB:0 Symboline:0 StartPhDc:96 NumberPhDc:64 ReMask:111111111b NumSymbol:14 Ef:0b	
<ul> <li>Hex Pa</li> <li>Hex</li> <li>0</li> <li>16</li> <li>32</li> </ul>	CAP) ( ayload 00 80 AE F0	U-Plar 1 01 1 01 0 FE 00	02 00 00 00	ame :0, 03 04 03 04 02 00 00 00	05 05 05 024 050	06 00 00 FF	07 00 01 FE	08 00 00 00	09 00 80 00	00A 90 00	0B 00 00 10	ac ( 81	D 0E 10 0E 10 0:	-	Recovi RB: (ni	one s	selected		> ntion		NumberPbc: 80 ReMask: 11111111111111 NumSymbol: 14 Ef: 0b Beamd: 0 - C-Plane Section Type 1 Section0: 1 RB: 0 Symbolnc: 0 StartPbc: 96 NumberPbc: 64 ReMask: 11111111111 NumSymbol: 14 Ef: 0b Beamd: 0 - C-Plane Section Type 1 Section10: 2 RB: 0	
<ul> <li>Hex Pa</li> <li>Hex</li> <li>0</li> <li>16</li> <li>32</li> </ul>	CAP) ( ayload 00 80 AE F0	U-Plar 1 01 1 01 0 FE 00	02 00 00 00	ame :0, 03 04 03 04 02 00 00 00	05 05 05 024 050	06 00 00 FF	07 00 01 FE	08 00 00 00	09 00 80 00	00A 90 00	0B 00 00 10	ac ( 81	D 0E 10 0E 10 0:	-	Recovi RB: (ni	one s	selected		> ntion		NumberPbc: 80 ReMask: 1111111111b NumSymbol: 14 Ef: 0b Beamd: 0 - C-Plane Section Type 1 SectionID: 1 RB: 0 Symbolinc: 0 StartPbc: 96 NumberPbc: 66 ReMask: 11111111111b NumSymbol: 14 Ef: 0b Beamd: 0 - C-Plane Section Type 1 SectionID: 2	
<ul> <li>Hex Pa</li> <li>Hex</li> <li>0</li> <li>16</li> <li>32</li> </ul>	CAP) ( ayload 00 80 AE F0	U-Plar 1 01 1 01 0 FE 00	02 00 00 00	ame :0, 03 04 03 04 02 00 00 00	05 05 05 024 050	06 00 00 FF	07 00 01 FE	08 00 00 00	09 00 80 00	00A 90 00	0B 00 00 10	ac ( 81	D 0E 10 0E 10 0:	-	Recovi RB: (ni	one s	selected		> I		NumberPbc: 80 ReMask:1111111111b NumSymbol:14 Ef:0b Beamd:0 -C-Plane Section Type 1 SectionD:1 RB:0 Symboline:0 StartPrbc:96 NumberPbc:64 ReMask:111111111b NumSymbol:14 Ef:0b Beamd:0 -C-Plane Section Type 1 SectionID:2 RB:0 Symboline:0 StartPrbc:176 NumberPbc:97	
<ul> <li>Hex Pa</li> <li>Hex</li> <li>0</li> <li>16</li> <li>32</li> </ul>	CAP) ( ayload 00 80 AE F0	U-Plar 1 01 1 01 0 FE 00	02 00 00 00	ame :0, 03 04 03 04 02 00 00 00	05 05 05 024 050	06 00 00 FF	07 00 01 FE	08 00 00 00	09 00 80 00	00A 90 00	0B 00 00 10	ac ( 81	D 0E 10 0E 10 0:	-	Recovi RB: (ni	one s	selected		> I		NumberPrbc: 80 ReMask :1111111111b NumSymbol :14 Ef:0b Beamd :0 - C-Plane Section Type 1 SectionID :1 RB:0 Symbolinc:0 StartPrbc: 96 NumberPrbc: 64 ReMask :1111111111b NumSymbol :14 Ef:0b Beamd :0 - C-Plane Section Type 1 SectionID :2 RB:0 Symbolinc: 0 StartPrbc: 176	

Figure 351 Viewing PCAP file contents in Explorer tab

- 4 Open the "C/U-Plane Builder Configuration Tool" window.
- 5 In the 'Options' tab, under 'C-Plane Section Handling', select the "Use Extension Type 6" check box.

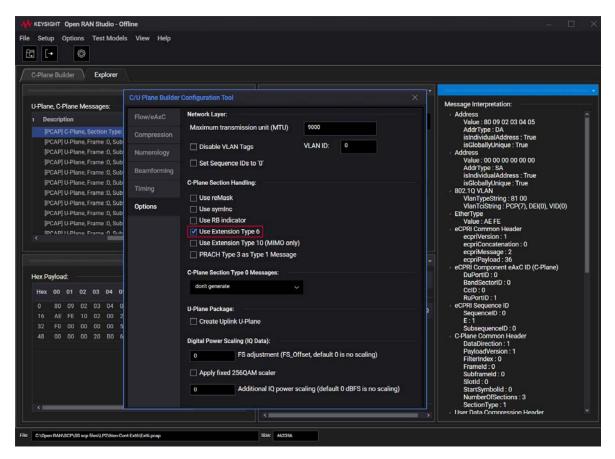


Figure 352 Applying Extension Type 6 configuration option

6 Exit the "C/U-Plane Builder Configuration Tool" window.

7 Switch to the C-Plane Builder tab to view the merged sections when Extension Type 6 is applied. Note that RB Number in the "Radio Control Plane Data" table is calculated as total number of RBs in the non-contiguous section, not including gaps.

Component Carriers			Rac	lio Control A	Plane Dat	ta					
Select Carrier:	Carrier 1 (DL)			Subframe	Slot ID	RB Start	RB Number	Sym Start	Sym Number	Channel	Beam I
Attribute	Value			0	0	0 0	241 241	0	14 14	PDSCH PDSCH	0
Carrier Type Cell ID Bandwidth Numerology Mode CP Type	DL (NR) 0 FR1_100M SingleNumerology Normal		1	2	0	0	241	0	14	PDSCH	0
Allocations											
Allocations Flow/eAxC ID		•									
		•	Radio	Allocation	s —						
Flow/eAxC ID		*	Radic	70	s —						
Flow/eAxC ID Resource Allocations	0001		Radic 21 24 21	40	5						

Figure 353 Viewing SCP file contents after Ext. Type 6 is applied

- 8 Export the O-RAN Stimulus file again.
- 9 Load the updated PCAP file into the Explorer tab.

## NOTE

Masks in the SCP and PCAP files are reversed. Mask bit order in the PCAP file follows the O-RAN CUS specification.

2-Plane	- D.	al.d.			xolo	-																		
				<u>y</u>	othic	rer																		
J-Plane	e, C	Pla	ne 1	less	ages													U-PI	ane:					Message Interpretation:
ription																			Dir	eAxC	μ	DU Pc	$\nabla$	CciD: 0
P] C-PI P] U-PI	lane	, Fra	me	0, SL	bfrar	ne: O	, Slot	0, S)	mbo	ol: 0, S	ectio	n: 0, P	R8: 0	79, S	ecti					0001				RuPortID:1 • eCPRI Sequence ID SequenceID:0 E:1
P] U-PI P] U-PI																		<	_	_				SubsequenceID : 0 - C-Plane Common Header
.P] U-PI .P] U-PI																on: 0,		C-PI	ane:				100	DataDirection : 1 PayloadVersion : 1 FilterIndex : 0
P] U-PI P] U-PI P] U-PI P] U-PI	land Iand	, Fri	me me	0, SL 0, SL	bfrar bfrar	не: О не: О	Slot:	0, S) 0, S)	mbo mbo	at: 3, S at: 3, S	ectio ectio	n: 0, P n: 0, P	RB: 0 RB: 2	-79, S 31-27	ectie 2				Dir: DL	eAxC 0001		DU Pe	۵	Frameld : 0 Subframeld : 0 Slotid : 0 StartSymbolid : 0
r] U PI																an 0,			_	_				NumberOfSections : 1 SectionType : 1 User Data Compression Header IqBIWMdth : 15 Compression : no compression
lex Pa	aylo	ad:																Re	overed	110	Constell	ation		Reserved     Value : 0     C-Plane Section Type 1
Hex	00			2 0	3 0	4 (	IS 0	6 0		18 0	9 0	A 08	3 0	: 00	) 0	εc	IF (			selected				SectionID:0 BB:0
							05 0									EO (		RI		Cmpl	uCmpQ			Symbolinc : 0 StartPrbc : 0
		0		0 1	0 0	0	1C 0 30 F 30 0	FF		80 C	10 0	6 0				91 ( 78 (								NumberPrbc:0 ReMask:1111111111b NumSymbol:14 Ef:1b
32 48																								Beanld : 0 Section Ext Command Ef : False ExtType : 6

Figure 354 Viewing updated PCAP file contents with Ext. Type 6 applied

The Message Interpretation area shows a single 'Section Type1' C-Plane message along with an additional Non-contiguous PRB Allocation Ext., which has the following elements:

- RbgSize— no. of PRBs of the resource block groups allocated by the bit mask
- RbgMask—a bit mask where each bit indicates whether a corresponding resource block group is allocated.
- SymbolMask—a bit mask where each bit indicates whether the rbgMask applies to a given symbol in the slot.

#### Interaction of reMask with Ext Type 6 on DL carrier

Setup Test Models	tudio - Offline View Help										
[+ 🕸											
-Plane Builder 🔪 Ex	plorer										
Component Carriers		Ra	dio Control I	Plane Da	ta						
Carrier Numerology			Subframe	Slot ID	RB Start	RB Number	Sym Start	Sym Number	Channel	Beam Id	
Select Carrier:	NR Carrier 1 (DL) 🧹		0	0	0 80	64 128	0 0	5 5	PDSCH PDSCH	0	
Attribute	Value				224	49			PDSCH		
Carrier Type Cell ID Bandwidth Numerology Mode CP Type Allocations	DL (NR) 0 FR1_100M SingleNumerology Normal 1										
Flow/eAxC ID											
Resource Allocations											
	DL-90H1 ~	Radi	o Allocation	s							
Resource Allocations Select Allocation: Attribute	Value		o Allocation	5							
Resource Allocations Select Allocation:				5							
Resource Allocations Select Allocation: Attribute Name of allocation Numerology Modulation Slots First Symbol Last Symbol Number of Symbols RB Offset	Value DL-SCH1 SCS30k OPSK 0 0 4 5 5 0			5							
Resource Allocations Select Allocation: Attribute Name of allocation Numerology Modulation Siots First Symbol Last Symbol Number of Symbols RB Offset RB Number	Value DL-SCH1 SCS30k QPSK 0 0 4 5		190	5							
Resource Allocations Select Allocation: Attribute Name of allocation Numerology Modulation Stots First Symbol Last Symbol Last Symbol Number of Symbols RB Offset	Value DL-SCH1 SCS30k OPSK 0 0 4 5 5 0			5							

1 Load an SCP file with Downlink carrier, which has DM-RS and PT-RS settings enabled.

Figure 355 Loading DL SCP file with DM-RS and PT-RS settings

The following illustrations describe the impact of various configuration options, as enabled / disabled in the "C/U Plane Builder Configuration Tool" window.

#### Configuration 1: Only "Use reMask" enabled

When only 'Use reMask' feature is enabled but 'Use Extension Type 6' is disabled, the C-Plane Builder tab shows that C-Plane section handling is applied with simple contiguous sections.

- DM-RS is divided into contiguous sections.
- PT-RS is divided into set of contiguous sections.

Component Carriers           Redic Contrier         Redic Contrier /Plane Data           Artribute         Value         1         0         0         1         8         0         2         PDSCH         0           Carrier Type         DL (NR)         0         0         1         3         0         2         PDSCH         0           Carrier Type         DL (NR)         0         4         0         0         1         3         0         2         PDSCH         0           Bandwidth         FR1_100M         Numerology         6         1         0         0         1         0         2         PDSCH         0           Allocations         1         0         0         1         0         0         1         0         2         PDSCH         0           1         0         0         12         1         0         2         PDSCH         0           1         0         0         13         3         0         2         PDSCH         0           1         0         0         17         3         0         2         PDSCH         0		
Carrier Numerology         Select Carrier:         NF Carrier 1 (pc)         Image: Select Carrier:         NF Carrier:	Radio Control Plane Data	
Attribute         Value         0         1         3         0         2         PDSCH         0           Cartler Type         DL (NR)		
Attribute       Value         Carrier Type       DL (NR)         Cell ID       0         Bandwidth       FR1_100M         Numerology Mode       Singlekumerology         CP Type       Normal         Allocations       1         Flow/eAXC ID       001         Coll       0         Select Allocation       0         Select Allocation       DL-SCH1         Numerology       SCS30k         Modulation       QPSK         Soldutation       QPSK         Numerology       SCS30k         Modulation       QPSK         Soldutation       QPSK         Soldutation       QPSK         Numerology       SCS30k         Modulation       QPSK         Slots       0         Last Symbol       4         Number of Symbols       5         RB Number of Zr3       5         RB Number of Zr3       0         Soldutation       QPSK         Side t       0         Numerology       SCS30k         Modulation       QPSK         Side t       0         RB Number of Symbols       5	R Carrier 1 (XL) - 1 0 0 0 1 0 2 PDSCH 0	
Carrier Type         DL (NR)           Cell ID         0           Bandwidth         FR1_100M           Numerology Mode         SingleNumerology           CP Type         Normal           Allocations         1           Flow/eAxC ID         001           0         0           7         0           8esource Allocation         1           Numerology         ScS30k           Modulation         QPSK           Sits         0           Pirst Symbol         4           Number of Symbols         5           RB Offset         0           RB Offset         0           RB Offset         0		
Cell ID       0       8       1       0       2       PDSCH       0         Bandwidth       FR1_100M       Numerology       0       9       3       0       2       PDSCH       0         Numerology Mode       SingleNumerology       0       1       0       0       9       3       0       2       PDSCH       0         Allocations       1       0       0       13       3       0       2       PDSCH       0         Allocations       1       0       0       16       1       0       2       PDSCH       0         1       0       0       16       1       0       2       PDSCH       0         1       0       0       16       1       0       2       PDSCH       0         1       0       0       21       3       0       2       PDSCH       0         1       0       0       21       3       0       2       PDSCH       0         1       0       0       24       1       0       2       PDSCH       0         1       0       0       24       1 <t< td=""><td></td><td></td></t<>		
United by Mode         SingleNumerology           Bandwidth         FR1_100M           Numerology Mode         SingleNumerology           QP Type         Normal           Allocations         1           I         0         0         12         1         0         2         PDSCH         0           Allocations         1         0         0         16         1         0         2         PDSCH         0           Flow/eAxC ID         0001         0         16         1         0         2         PDSCH         0           1         0         0         17         3         0         2         PDSCH         0           1         0         0         17         3         0         2         PDSCH         0           1         0         0         21         3         0         2         PDSCH         0           1         0         0         24         1         0         2         PDSCH         0           1         0         2         1         0         2         PDSCH         0           1         0         2         1 <td>nny a second a second</td> <td></td>	nny a second	
Darbondom       PH1_100M         Numerology Mode       SingleNumerology         CP Type       Normal         Allocations       1         Flow/eAxC ID       cool         0       0       12       1       0       2       PDSCH       0         1       0       0       13       3       0       2       PDSCH       0         1       0       0       17       3       0       2       PDSCH       0         1       0       0       17       3       0       2       PDSCH       0         1       0       0       17       3       0       2       PDSCH       0         1       0       0       20       1       0       2       PDSCH       0         1       0       0       24       1       0       2       PDSCH       0         1       0       0       24       1       0       2       PDSCH       0         1       0       0       24       1       0       2       PDSCH       0         1       0       0       24       1       0		
Normal       1       0       0       13       3       0       2       PDSCH       0         Allocations       1       0       0       13       3       0       2       PDSCH       0         Flow/eAxC ID       001       0       16       1       0       2       PDSCH       0         Resource Allocations		
Allocations       1         Allocations       1         Flow/eAxC ID       0001         Resource Allocations       0         Resource Allocations:       0         Select Allocation:       0         Name of allocation       0         Display       ScsOrt         Numerology       ScSOrk         Solotation       0         Pirst Symbol       0         Last Symbol       4         Number of Symbols       5         R8 Mumber       273	jexumerology	
How/eAxC ID       Doot         Flow/eAxC ID       Doot         Flow/eAxC ID       Doot         Resource Allocations       Display         Select Allocation:       Display         Name of allocation       Display         Name of allocation       Display         Pirst Symbol       A         Number of Symbols       5         RB Offset       O       O         B Offset       O       Carrow         Unimeer of Symbols       5       Carrow       Carrow       Carrow         B Offset       O       O       Carrow       Carrow       Carrow         Output       Carrow       Carrow       Carrow       Carrow       Carrow         Solids       O       Carrow       Carrow       Carrow       Carrow       Carrow         Solids       O       Carrow       Carrow       Carrow       Carrow       Carrow       Carrow       Carrow <td></td> <td></td>		
Attribute         Value           Name of allocation         DL-SCH1           Numerology         SCS30k           Modulation         QPSK           Slots         0           First Symbol         4           Numer of Symbols         5           RB Offset         0           RB Offset         0           RB Mumber         273		
Resource Allocation: Select Allocation: Attribute Name of allocation Slots Slots First Symbol Last Symbol B Offset RB Offset B Offset C 273 Last Symbol C	V 1 0 0 20 1 0 2 PDSCH 0	
Resource Allocations     Resource Allocations       Select Allocation:     Radio Allocations       Attribute     Value       Name of allocation     DL-SCH1       Numerology     SGS30k       Modulation     QPSK       Slots     0       Liast Symbol     4       Number of Symbols     5       RB Offset     0       RB Number     273	1 0 0 21 3 0 2 PDSCH 0	
Select Allocation:     Descrit       Attribute     Value       Name of allocation     DLSCH1       Numerology     SCS30k       Modulation     QPSK       Siots     0       Last Symbol     4       Number of Symbols     5       RB Otfset     0       RB Number     273	1 0 0 24 1 0 2 PDSCH 0	
Attribute     Value       Name of allocation     DL-SCH1       Numerology     SGS30k       Modulation     QPSK       Siots     0       First Symbol     0       Last Symbol     4       Number of Symbols     5       RB Offset     0       RB Number     273		
Attribute     Value       Name of allocation     DL-SCH1       Numerology     SCS30k       Modulation     QPSK       Siots     0       First Symbol     4       Number of Symbols     5       RB Offset     0       RB Offset     0       RB Mumber     273	Lagin v	
Name of allocation     DL-SCH1       Numerology     SCS30k       Modulation     QPSK       Slots     0       First Symbol     0       Last Symbol     4       Number of Symbols     5       RB Offset     0       RB Number     273		
Numerology     SCS30k       Modulation     QPSK       Siots     0       First Symbol     4       Number of Symbols     5       RB Offset     0       RB Number     273		
Modulation     QPSK       Siots     0       First Symbol     0       Last Symbol     4       Number of Symbols     5       R8 Offset     0       R8 Number     273	340 Store St	
Modulation     OPSK       Sids     0       First Symbol     0       Last Symbol     4       Number of Symbols     5       RB Offset     0       RB Number     273	s30k	
Slots     0       First Symbol     0       Last Symbol     4       Number of Symbols     5       RB Offsot     0       RB Number     273	sk 🔰	
Last Symbol 4		
Number of Symbols 5 RB Offset 0 RB Number 273	· · · · · · · · · · · · · · · · · · ·	
RB Offset 0 RB Number 273		
RB Number 273 00 00 00 00 00 00 00 00 00 00 00 00 00		
Beam IDs		
Select Beamid: o		

Figure 356

Usual contiguous sections used for DM-RS in SCP file

Plan	• Rui		\$ ~	Exc	olore																		
eren an	e ou	Juei	y		, or cr																		
-Plan	e, C-I	Plane	Mes	sage	es:										U-	Plane	ec —						Message Interpretation:
	Leng	h	Descr	iptio	n											# 0	Dir	eAxC		DU Port	Band Sec	$\nabla$	DuPortID : 0 BandSectorID : 0
																	DL	0001					CcID : 0 RuPortID : 1
	60										is: 1, F												<ul> <li>eCPRI Sequence ID</li> </ul>
	60										15: 2, F												SequenceID:0 E:1
	60 60										IS: 1, F												SubsequenceID : 0
	БU 60										IS: 2, F												C-Plane Common Header DataDirection : 1
	60										IS: 2, F				C-	-Plane	é –						PayloadVersion : 1
											is: 1, F				1	# D	Dir	eAxC		DU Port	Band Sec		FilterIndex : 0 FrameId : 0
			[PCA	P] C-	Plane	e, Sec	tion	Type:	1, Se	ction	15: 2, F	rame	:0, 5	u .		0 1	DL	0001					Subframeld : 0
			[PCA	P] C	Plane	e, Sec	tion	Type:	1, Se	ction	is: 1, Fi	rame	:0, S	u									SlotId : 0 StartSymbolid : 0
											is: 2, F												NumberOfSections : 2
	60		(PCA	P] C-	Plane	e, Sec	tion	Type:	1, Se	ction	is: 1, F	rame	:0, S	u v									SectionType : 1 User Data Compression Head
¢																							lqBitWidth : 15
																							Compression : no compres Reserved
																							Value : 0 C-Plane Section Type 1
lex Pa	ayloa	d:													F	lecov	rered I	Q	Constella	ition			SectionID : 243
Hex	00	01	02	03	04	05	06	07	80	09	0A	0B	0C	OD	D	DD+ (e		elected)					RB : 0 Symbolinc : 0
	80	09	02	03	04	05	00	00	00	00	00	00	81	00		RE (II	uCi		uCmpQ		Q		StartPrbc : 272
	AE	FE			00				00	80	90	00	00	00		RE	uci	npi	ucmpų		ų		NumberPrbc : 1 ReMask : 000000000001b
32		00																					NumSymbol : 2
48	00	00		00	00	00	00		00	00	00	00											Ef : Ob Beamld : O
																							C-Plane Section Type 1
																							SectionID : 243 RB : 0
																							Symbolinc : 0
																							StartPrbc : 272 NumberPrbc : 1
																							ReMask:11111111110b
																							NumSymbol : 2 Ef : 0b
																							Beamld : 0

The Message Interpretation area shows reversed masks in the generated PCAP file.

Figure 357 Masks are reversed when reMask only is used

#### Configuration 2: Both "Use reMask" and "Use Extension Type 6" enabled

When both 'Use reMask' feature and 'Use Extension Type 6' are enabled, the C-Plane Builder tab shows that C-Plane section handling is applied with non-contiguous sections for PDSCH and DM-RS parts.

• PT-RS is still divided into set of contiguous sections.

Plane Builder 🔪 Ex	plorer											
omponent Carriers			Ra	dio Control I	Plane Da	ta						
Carrier Numerology				Subframe	Slot ID	RB Start	RB Number	Sym Start	Sym Number	Channel	Beam Id	
Select Carrier:	NR Carrier 1 (DL)	×		0	0 0	265 268		0	2	PDSCH PDSCH	0	
Attribute	Value					269				PDSCH		
Carrier Type	DL (NR)									PDSCH		
Cell ID												
Bandwidth	FR1_100M									PDSCH		
Numerology Mode	SingleNumerology									PDSCH		
CP Type	Normal									PDSCH		
Allocations										PDSCH		
Flow/eAxC ID	0001			0	0	8		4		PDSCH PDSCH	0	
FIOW/EAKG ID		<b>^</b>		0		12		4		PDSCH	0	
				0		13		4		PDSCH		
Resource Allocations												
Select Allocation:												
Select Allocation.	DL-SCH1		Radi	o Allocation	s							
Attribute	Value			771 <b></b>								
Name of allocation	DL-SCH1			iii .								
Numerology	SCS30k			110								
Modulation	QPSK											
Slots				100								
First Symbol				197								
Last Symbol				w								
Number of Symbols RB Offset	5 0			10 S								
RB Number	u 273											
No Nulliver	275											
Beam IDs												

Figure 358 Non-contiguous sections are used for DM-RS and PDSCH in SCP file

The Message Interpretation area shows DM-RS section as two non-contiguous sections with same position and non-contiguous parameters, but with reversed ReMask bitmaps.

	o Test Ma	AN Studio - Offline Idels View Help						
C-Plane	Builder	Explorer						
J-Plane,	, C-Plane N	lessages:		U-Plane:			Message Int	
locol	Length	Description		# Dir	AxC µ	DU P		Symbolid : 2 berOfSections : 2
FE	60	[PCAP] C-Plane, Section Type: 1,	Sections: 2. Frame :0. Subfra A	0 DL	0001 1		Section	onType:1
ΈE	9009	[PCAP] U-Plane, Frame :0, Subfra					User Dat	ta Compression Header Width : 15
	2628	[PCAP] U-Plane, Frame :0, Subfra						pression : no compression
	9009	[PCAP] U-Plane, Frame :0, Subfra	me: 0, Slot: 0, Symbol: 1, Sec				Reserved	d and a second
	2628	[PCAP] U-Plane, Frame :0, Subfra					Value C-Plane	s: 0 Section Type 1
Æ		[PCAP] C-Plane, Section Type: 1,	Sections: 2, Frame :0, Subfra	C-Plane:			Section	onID:1
	9003	[PCAP] U-Plane, Frame :0, Subfra						) polinc : 0
	1926	[PCAP] U-Plane, Frame :0, Subfra			AxC µ	DU P	Start	Prbc:0
	9003	[PCAP] U-Plane, Frame :0, Subfra			0001 1			berPrbc : 0 ask : 010101010101b
ΈE ΈE	1926	[PCAP] U-Plane, Frame :0, Subfra					Num	Symbol : 2
FE	60 60	[PCAP] C-Plane, Section Type: 1, [PCAP] C-Plane, Section Type: 1,					Ef: 1	b nld:0
		(PCAP) C-Plane, Section Type: 1,3	Sections: 1, Frame :0, Subtra					Ext Command
							Ef : Fi	
							Extly	/pe:6 :n:2
							Non-con	tiguous PRB Allocation Ext
lex Pay	yload:			Recovered IQ	Constell	ation		ize : 16 PRBs Aask : 0000000000111101111111101111 RBI
Hex	00 01 0	2 03 04 05 06 07 08 0	9 0A 0B 0C 0D 0E (				Symb	olMask : 00000000001100 symbols
	80 00 0	2 03 04 05 00 00 00 0	0 00 00 81 00 E0	PRB: (none sele	cted)			Section Type 1 onID : 1
		2 03 04 05 00 00 00 0		RE uCmp	uCmpQ		RB : C	)
		0 10 00 00 55 52 80 0						polinc : 0 Prbc : 0
		0 10 00 00 AA A2 80 0					Num	berPrbc : 0
	00 0C							ask : 101010101010b
							Ef: 1	Symbol : 2 b
							Beam	nld:0
							Section I Ef : Fi	Ext Command alse
							ExtTy	/pe:6
							ExtLe	en : 2 Itiguous PRB Allocation Ext
							RbgS	ize : 16 PRBs
								/lask : 00000000001111011111111101111 RB/ polMask : 00000000001100 symbols
				<		1	Symu	undsk. dobbooot roo symbols

#### Figure 359 Non-contiguous DM-RS sections with reversed masks

#### Interaction of Ext Type 6 with DM-RS outside of allocation

1 Load an SCP file with Downlink carrier, which has DM-RS settings enabled, but has been placed outside of allocation. For example, the DM-RS could be configured on symbol 2 and the starting symbol of PDSCH allocation could be set to 5.

-Plane Builder V Ex	plorer										
Component Carriers		Radio Cont	ol Plane D	ata							
Carrier Numerology		u Subfra	me Slot IC	RB Start	RB Number	Sym Start	Sym Number	Channel	Beam Id		
Select Carrier.	NR Carrier 1 (DL)	1 0 1 0	0 0	0 255	127 1	2	1	PDSCH PDSCH	0		
Attribute	Value							PDSCH			
Carrier Type Cell ID Bandwidth Numerology Mode CP Type	DL (NR) 0 FR1_100M MultipleNumerologies Normal							PDSCH			
Allocations Flow/eAxC ID	Normai 1 0001										
Allocations		adio Alloca	ions								
Allocations Flow/eAxC ID Resource Allocations	1	adio Alloca	ions								
Allocations Flow/eAxC ID Resource Allocations Select Allocation:	1 0001 ~	279 240 - 1 210	ions								
Allocations Flow/eAxC ID Resource Allocations Select Allocation: Attribute Name of allocation Numerology Modulation Slots	1 Contraction of the second se	277 240 243 243 140	ions								
Allocations Flow/eAxC ID Resource Allocations Select Allocation Attribute Name of allocation Numerology Modulation Silota First Symbol	1 0001 0L-SCH1 SCS30k QPSK 0 5	279 246 210 100 110	ions								
Allocations Flow/eAxC ID Resource Allocations Select Allocation: Attribute Name of allocation Numerology Modulation Slots	1 Contraction of the second se		ions								
Allocations Flow/eAxC ID Resource Allocations Select Allocation: Attribute Name of allocation Numerology Modulation Siota First Symbol Last Symbol Last Symbol Rubber of Symbols RB Offset	1 0001 0L-SCH1 SCS30k 0 5 13 9 0	279 246 210 100 110	ions								
Allocations Flow/eAxC ID Resource Allocations Select Allocation: Attribute Name of allocation Womerology Modulation Slots First Symbol Last Symbol Number of Symbols	1 0001 0L-9CH1 DL-SCH1 SC530k 0 SC530k 0 5 13 9		ions								
Allocations Flow/eAxC ID Resource Allocations Select Allocation: Attribute Name of allocation Numerology Modulation Siota First Symbol Last Symbol Last Symbol Rubber of Symbols RB Offset	1 0001 0L-SCH1 SCS30k 0 5 13 9 0		ions								

#### Figure 360 Loading DL SCP file with DM-RS settings outside of allocation

The following illustration shows that if the you enable the "Use Extension Type 6", the Message Interpretation area of the regenerated PCAP file contains new allocation, which is merged into similar non-contiguous section. Therefore, by enabling Extension Type 6 for this DM-RS allocation, non-contiguous section is used for the added section and new SymbolMask is generated during PCAP creation, as shown in Figure 361.

Flan		ilder	\$ 	Fri	plore	- )																		
	e ou	inves	7		phone		-	-		-				-										
Plan	e C-	Plan	e Me	ssao	es:											_	U-P	lane:						Message Interpretation:
			script															Dir		AxC	μ	DU P	$\nabla$	PayloadVersion : 1
60					na Si	ection	i Tyn	a: 3 !	Sectio	ne 1	Erar	ne 10	Subf	rame	r: 0, 5 4					0001			Y	FilterIndex : 0 Frameld : 0
60			CAPI																	0001				Subframeld : 0
581	4		CAPI																					Slotid : 0 StartSymbolid : 2
			CAPI																					NumberOfSections : 1
															r: 0, 5			2						SectionType : 3 Frame Timing
581		(P	CAP]	U-Pla	ne, Fr	ame	:0, Su	bfra	ne: 0	Slot	0, Sy	mbol	: 5, S	ectio	n: 1,		1000						100	TimeOffset : 0
581		(P	CAP]	U-Pla	ne, Fr	ame	:0, Su	ibfrai	ne: 0	Slot	0, S)	mbol	: 6, 5	ectio	n: 1,		C-P	fane:						(time_offset : 0) FrameStructure : 193
581		(P	CAP	U-Pla	ne, Fr	ame	:0, Su	bfra	ne: 0	Slot	0, S)	mbol	: 7, S	ectio	n: 1,			Dir	r 0	AxC		DU P		(fft_size: 4096)
581		[P	CAPJ	U-Pla	ne, Fr	ame	:0, Su	bfra	ne: O	Slot	0, 5)	mbol	: 8, S	ectio	n: 1,			DL		0001				(scs_delta_f : 30 kHz)
581															n: 1,									(N_slot_subframe : 2) (slot_length : 500 µs)
581			CAP]																					CpLength: 0
581	4	(P	CAP]	U-Pla	ne, Fr	ame	:0, Su	ubfra	ne: 0	Slot	: 0, Sy	mbol	: 11, :	Secti	on: 1 ,									(CP_length : 0) User Data Compression Header
																								IgBitWidth: 15
																								Compression : no compression
																								<ul> <li>C-Plane Section Type 3 SectionID : 0</li> </ul>
ex Pa	iyloa	d:															Re	cover	red IQ		Constel	lation		RB:0
Hex	00			03								08			OE				- and					Symbolinc : 0 StartPrbc : 0
10X	00	01	02	03	04	05	06	07	08	09.	UA	UB	UC	00	UE		PRE	B: (nor	ne sele	cted)				NumberPrbc : 255
																	R	Æ	uCmpl		uCmpQ			ReMask : 11111111111b NumSymbol : 1
16			10										00											Ef:1b
32													80	00										Beamld : 0 Frequency Offset
48	34	00	06	02		00	C6	OF	00	04	00	00												Frequency Offset FreqOffset : -3276
																								(frequency_offset : -49140000)
																								Reserved Value : 0
																								<ul> <li>Section Ext Command</li> </ul>
																								Ef : False ExtType : 6
																								Extlen: 2
																								Non-contiguous PRB Allocation Ext     Decline + 16 PDP-
																								RbgSize : 16 PRBs RbgMask : 000000000001100011000001111 RBG
e 💷			_						_															SymbolMask : 0000000000100 symbols



#### Interaction of reMask with Ext Type 6 on UL carrier

	slorer										
Component Carriers		Ra	dio Control	Plane Da	ta						
Carrier Numerology			Subframe	Slot ID	RB Start	RB Number	Sym Start	Sym Number	Channel	Beam Id	
Select Carrier:	NR Carrier 1 (UL) 🗸 🗸							14	PUSCH		
(analas)	11102				64	64		14	PUSCH		
Attribute	Value						0	14	PUSCH		
Carrier Type	UL (NR)				64	52 64		14	PUSCH	0	
Cell ID	0				176	97			PUSCH		
Bandwidth	FR1_100M			0		32			PUSCH		
Numerology Mode CP Type	SingleNumerology Normal					64			PUSCH		
Allocations	1								PUSCH		
dawa wa in	0001										
Flow/eAxC ID	0001										
Resource Allocations											
Select Allocation:											
Select Allocation:	ul-schi ~	Rad	o Allocation	าร							
Select Allocation:	ul-schi ~	Rad	o Allocation	15							
Attribute	Value		in .	15							
Attribute Name of allocation			27 14	15							
Attribute	Value UL-SCH1		in .	15							
Attribute Name of allocation Numerology	Value UL-SCH1 SCS30k		27 14	15							
Attribute Name of allocation Numerology Modulation	Value UL-SCH1 SCS30k QPSK		279 248 210	15							
Attribute Name of allocation Numerology Modulation Siots	Value UL-SCH1 SCS30k QPSK 0:2		679 940 940 940 940	15							
Attribute Name of allocation Numerology Modulation Slots First Symbol	Value UL-SCH1 SCS30k QPSK 0-2 0		270 240 400	ns l							
Attribute Name of allocation Numerology Modulation Slots First Symbol Last Symbol	Value UL-SCH1 SCS30k QPSK 0-2 0 13		679 940 940 940 940	ns							
Attribute Name of allocation Numerology Modulation Slots First Symbol Last Symbol Number of Symbols	Vatue UL-SCH1 SCS30k QP3K 0:2 0 13 13		279 245 _ 246 _ 246 _ 246 _	15							
Attribute Name of allocation Numerology Modulation Slota First Symbol Last Symbol Number of Symbols RB Offset	Value UL-SCH1 SCS30k OPSK 0:2 0 13 14 0		279 245 _ 246 _ 246 _ 246 _	15							

1 Load an SCP file with Uplink carrier, which has DM-RS and PT-RS settings enabled.

Figure 362 Loading UL SCP file with DM-RS and PT-RS settings

When both 'Use reMask' feature and 'Use Extension Type 6' are enabled, the C-Plane Builder tab shows that C-Plane section handling is applied with non-contiguous sections for PUSCH and DM-RS parts.

• PT-RS is still divided into set of contiguous sections.

-Plane Builder V Exp	lorer											
Component Carriers			Ra	dio Control F	Plane Dat	la .						
Carrier Numerology			p.	Subframe			RB Number	Sym Start	Sym Number	Channel	Beam Id	
Select Carrier:	NR Carrier 1 (UL)	v				265				PUSCH		
-	24.00			0	0	268 269				PUSCH PUSCH		
Attribute	Value					269				PUSCH		
Carrier Type	UL (NR)			0	0		193			PUSCH	0	
Cell ID Bandwidth	0 FR1_100M					0	193			PUSCH		
Numerology Mode	SingleNumerology		1	0	0	0	193	3	31	PUSCH	0	
CP Type	Normal									PUSCH		
Allocations										PUSCH		
										PUSCH		
Flow/eAxC ID	0001									PUSCH		
										PUSCH		
Resource Allocations										PUSCH		
Select Allocation:	UL-SCH1			o Allocation:								
Attribute	Value		Rau		5							
Name of allocation	UL-SCH1			42								
Numerology	SCS30k											
Modulation	QPSK											
Slots				*								
First Symbol												
Last Symbol				20	EERFICIES							
Number of Symbols RB Offset												
RB Offset RB Number	U 273											
ND Humber												
Beam IDs												
Select Beamld: 0												

Figure 363 Non-contiguous sections are used for DM-RS and PUSCH in SCP file

The Message Interpretation area shows DM-RS section as two non-contiguous sections with same position and non-contiguous parameters, but with reversed ReMask bitmaps.

	Open RAN : Test Models																
>Plane Buil	lder \ E	xplorer															
J-Plane, C-P	Plane Messa	ides:									U-Plane						Message Interpretation:
Length	Description											e.	eAxC	н	DU P	$\nabla$	StartSymbolid : 2
60	[PCAP] C-F		ntion Tu		ations	- 2 54	ma :0	Cubi		- 0.14						Y	NumberOfSections : 2 SectionType : 1
60	[PCAP] C-F															A.,	<ul> <li>User Data Compression Header</li> </ul>
60	[PCAP] C-F																IqBitWidth : 15 Compression : no compression
	[PCAP] C-																Reserved
	[PCAP] C-F																Value : 0 C-Plane Section Type 1
	(PCAP) C-F	lane, Se	ction Typ	e: 1, Se	ctions	c 1, Fra	me :0	, Subf	rame							res.	SectionID : 2
	[PCAP] C-F										C-Plane						RB : 0 Sumbolize : 0
60	[PCAP] C-I										# 0	ir	eAxC		DU P		Symbolinc : 0 StartPrbc : 0
																	NumberPrbc : 0
	[PCAP] C-F																ReMask : 010101010101b NumSymbol : 1
	[PCAP] C-F																Ef:1b
	[PCAP] C-F	nane, se	ction Typ	50: 1, Se	ctions	c 1, Fra	me :u	, Subr	rame	: U, : ,							BeamId : 0 Section Ext Command
																	Ef : False
																	ExtType:6 ExtLen:2
																	Non-contiguous PRB Allocation Ext
ex Payload	d:										Recov	ered	10	Constell	ation		RbgSize : 16 PRBs RbgMask : 000000000111111100011110011 RBGs
Hex 00	01 02 0	3 04	058 06	07 0	8 05	0A	08	00	0D	0E							SymbolMask: 0000000000100 symbols
											PRB: (n	one s	elected)				C-Plane Section Type 1 SectionID : 2
	09 02 0		05 00				00		00	EO	RE	uC	mpl	uCmpQ			RB:0
	FE 10 0				2 8		00	00 70	02	02 F8							Symboline : 0
	00 00 2																StartPrbc : 0 NumberPrbc : 0
64 00					n (1987)												ReMask: 101010101010b
																	NumSymbol : 1 Ef : 1b
																	Beamld : 0
																	<ul> <li>Section Ext Command</li> <li>Ef : False</li> </ul>
																	ExtType: 6
																	ExtLen : 2 Non-contiguous PRB Allocation Ext
																	RbgSize : 16 PRBs
<																	RbgMask : 0000000000111111100011110011 RBGs SymbolMask : 00000000000100 symbols
											<						Symbolimask. 0000000000 rob symbols

Figure 364 Non-contiguous PRB Allocation Extensions in DM-RS sections

As shown above, both DMRS sections have Non-contiguous PRB Allocation Extension with the respective parameters.

For more information about Extension Type 6, refer to *Section 5.4.7.6* in the O-RAN specification.

#### 3.12.9: Group configuration of multiple ports

The Open RAN Studio allows group configuration of section extension on Multi-Input-Multi-Output (MIMO) files, which have one carrier with at least two antennas. For the purpose of understanding, an SCP file for the DL carrier with four antennas has been used in this example.

1 Load the MIMO SCP file into O-RAN Studio software.

1 Carrier 1 (DL), Anteren	Rad	lio Control I	Mane Dat						
t Garrier 1 (DL), Antenni 🗸				ld l					
Carrier 1 (DL), Antenn 🗸		Subframe	Slot ID	RB Start	RB Number	Sym Start	Sym Number	Channel	Beam Id
					273			PDSCH	
								PDSCH	
								SS/PBCH	
NR)				147				PDSCH	
100M									
leNumerology									
nal									
Hea)									0
									0
					120			Posen	
80H1 Y									
	Radio	Allocation	s						
		e j							
		0							
		70							
	100M leNumerology ned) v	1 100M 1 1 1 1 1 1 1 1 1 1 1 1 1	1     0       1 <td>xvvv     1     0     0       1     0     0     1     0       1     0     0     1     0       1     0     0     1     0       1     0     1     0     1       1     0     1     0     1       1     0     1     0     1       1     0     1     1     1       1     0     1     1     1       1     0     1     1     1       1     0     1     1     1       1     0     1     1     1       1     0     1     1     1       1     0     1     1     1       1     0     1     1     1       1     0     1     1     1       1     0     1     1     1       1     0     1     1     1       1     0     1     1     1       1     0     1     1     1       1     0     1     1     1       1     0     1     1     1       1     0     1     1</td> <td>xxxy       1       0       0         1       0       0       126         1       0       0       147         1       0       0       1         xxd)       1       0       147         1       0       1       0         1       0       1       0         1       1       1       0         1       1       1       1         xxdin       1       1       1       0         xxdin       1       1       1       0       0         xxdin       1</td> <td>NNN         1       0       0       126         1       0       0       126         1       0       0       126         1       0       0       126         1       0       0       126         1       0       0       126         1       0       147       126         1       0       1       0       273         1       0       1       0       126         1       0       1       0       126         1       0       1       126       21         1       0       1       126       21         1       0       1       147       126         1       0       1       147       126         1       0       1       126       1         0       1       0       1       26         1       0       1       0       126         1       1       1       1       1         1       1       1       1       1         1       1       1       1       1</td> <td>NNY       1       0       0       0       126       8         1       0       0       126       21       8         1       0       0       147       126       8         1       0       0       147       126       8         1       0       0       147       126       8         1       0       0       273       12         1       0       1       0       273       0         1       0       1       0       126       2         1       0       1       0       126       2         1       0       1       126       2       1         1       0       1       147       126       2         1       0       1       126       2       1         1       0       1       126       6       1         Radio Allocations         1       1       1       1       1       1         1       1       1       1       1       1       1         1       1       1       1       1</td> <td>Net       1       0       0       0       126       8       4         1       0       0       126       21       8       4         1       0       0       126       21       8       4         1       0       0       126       21       8       4         1       0       0       127       0       2         1       0       1       0       273       0       2         1       0       1       126       2       4         1       0       1       126       2       4         1       0       1       126       2       4         1       0       1       147       126       2       4         1       0       1       147       126       2       4         1       0       1       147       126       2       4         1       0       1       147       126       2       4         1       0       1       147       126       2       4         1       0       1       147       126       2&lt;</td> <td>NNY       1       0       0       0       126       8       4       PDSCH         1:00M       10       126       8       4       SS/PBCH         1:0       0       147       126       8       4       SS/PBCH         1:0       0       147       126       8       4       PDSCH         1:0       0       147       126       8       4       PDSCH         1:0       0       147       126       8       4       PDSCH         1:0       1       0       273       0       2       PDSCH         1:0       1       0       126       2       4       PDSCH         1:0       1       126       2       4       PDSCH         1:0       1       147       126       2       4       PDSCH         1:0       1       147       126       4       PDSCH         1:0       1       126       -       4       PDSCH         1:0       1       126       -       4       PDSCH         1:0       1       1       1       1       1       PDSCH         1:0<!--</td--></td>	xvvv     1     0     0       1     0     0     1     0       1     0     0     1     0       1     0     0     1     0       1     0     1     0     1       1     0     1     0     1       1     0     1     0     1       1     0     1     1     1       1     0     1     1     1       1     0     1     1     1       1     0     1     1     1       1     0     1     1     1       1     0     1     1     1       1     0     1     1     1       1     0     1     1     1       1     0     1     1     1       1     0     1     1     1       1     0     1     1     1       1     0     1     1     1       1     0     1     1     1       1     0     1     1     1       1     0     1     1     1       1     0     1     1	xxxy       1       0       0         1       0       0       126         1       0       0       147         1       0       0       1         xxd)       1       0       147         1       0       1       0         1       0       1       0         1       1       1       0         1       1       1       1         xxdin       1       1       1       0         xxdin       1       1       1       0       0         xxdin       1	NNN         1       0       0       126         1       0       0       126         1       0       0       126         1       0       0       126         1       0       0       126         1       0       0       126         1       0       147       126         1       0       1       0       273         1       0       1       0       126         1       0       1       0       126         1       0       1       126       21         1       0       1       126       21         1       0       1       147       126         1       0       1       147       126         1       0       1       126       1         0       1       0       1       26         1       0       1       0       126         1       1       1       1       1         1       1       1       1       1         1       1       1       1       1	NNY       1       0       0       0       126       8         1       0       0       126       21       8         1       0       0       147       126       8         1       0       0       147       126       8         1       0       0       147       126       8         1       0       0       273       12         1       0       1       0       273       0         1       0       1       0       126       2         1       0       1       0       126       2         1       0       1       126       2       1         1       0       1       147       126       2         1       0       1       126       2       1         1       0       1       126       6       1         Radio Allocations         1       1       1       1       1       1         1       1       1       1       1       1       1         1       1       1       1       1	Net       1       0       0       0       126       8       4         1       0       0       126       21       8       4         1       0       0       126       21       8       4         1       0       0       126       21       8       4         1       0       0       127       0       2         1       0       1       0       273       0       2         1       0       1       126       2       4         1       0       1       126       2       4         1       0       1       126       2       4         1       0       1       147       126       2       4         1       0       1       147       126       2       4         1       0       1       147       126       2       4         1       0       1       147       126       2       4         1       0       1       147       126       2       4         1       0       1       147       126       2<	NNY       1       0       0       0       126       8       4       PDSCH         1:00M       10       126       8       4       SS/PBCH         1:0       0       147       126       8       4       SS/PBCH         1:0       0       147       126       8       4       PDSCH         1:0       0       147       126       8       4       PDSCH         1:0       0       147       126       8       4       PDSCH         1:0       1       0       273       0       2       PDSCH         1:0       1       0       126       2       4       PDSCH         1:0       1       126       2       4       PDSCH         1:0       1       147       126       2       4       PDSCH         1:0       1       147       126       4       PDSCH         1:0       1       126       -       4       PDSCH         1:0       1       126       -       4       PDSCH         1:0       1       1       1       1       1       PDSCH         1:0 </td



Loading MIMO SCP file

2 If you see only one entry in the Flow/eAxC ID drop-down under the C-Plane Builder tab, open "C/U-Plane Builder Configuration Tool" window to add more Flow/eAxC IDs to the respective carrier.

Component Carrie				idio Control F	D							
Carrier Numerolo			Ka	Subframe			RB Number	Pum Plant	Ours Mussher	Channel	Ream Id	
Select Carrier:			4					Sym Start	Sym Number			
Select Gamer.	NR Carrier 1 (	(DL), Antenn 🗸		0	0	0 0	273 126	0	4	PDSCH PDSCH	0	
Attribute	Value						21			SS/PBCH		
Carrier Type	DL (NR)					147				PDSCH		
Cell ID	0									PDSCH		
Bandwidth	FR1_100M									SS/PBCH		
Numerology M	lode SingleNumer	ology								PDSCH		
ODT	Nermel		1	0	0	0	273	12	2	PDSCH		
U Plane Builder	Configuration Tool									PDSCH		
Flow/eAxC	Flow Fields Allocation									PDSCH		
		1								SSIDBCH		
ion/caxo			444			(ac	olied to all eAxC	IDs)		SS/PBCH PDSCH		
Compression	eAxC ID fields bitwi					× (ap	plied to all eAxC	IDs)		SS/PBCH PDSCH PDSCH		
			A.A.A			× (ap	plied to all eAxC	IDs)		PDSCH		
Compression	eAxC ID fields bitwi	dth patterns 4		∽ nent Carrier II	+ ) RU Po			$\sim$		PDSCH		
Compression Numerology Beamforming	eAxC ID fields bitwi Flows DL eAxC ID DU Port II 0001 0	idth patterns 4 D Band Sector IC 0	) Compoi 0	~ nent Carrier II				$\sim$		PDSCH		
Compression Numerology	eAxC ID fields bitwi Flows DL eAxC ID DU Port II 0001 0 0002 0	dth patterns 4 D Band Sector IC 0 0	) Compoi O O	∽ nent Carrier II				$\sim$		PDSCH		
Compression Numerology Beamforming	eAxC ID fields bitwi Flows DL eAxC ID DU Port II 0001 0 0002 0 0003 0	dth patterns 4 D Band Sector IC 0 0 0	) Compoi 0 0 0	~ nent Carrier II				$\sim$		PDSCH		
Compression Numerology Beamforming Timing	eAxC ID fields bitwi Flows DL eAxC ID DU Port II 0001 0 0002 0	dth patterns 4 D Band Sector IC 0 0	) Compoi O O	∽ nent Carrier II				$\sim$	×	PDSCH		
Compression Numerology Beamforming Timing Options	eAxC ID fields bitwi Flows DL eAxC ID DU Port II 0001 0 0002 0 0003 0	dth patterns 4 D Band Sector IC 0 0 0	) Compoi 0 0 0	v				$\sim$	×	PDSCH		
Compression Numerology Beamforming Timing Options	eAxC ID fields bitwi Flows DL eAxC ID DU Port II 0001 0 0002 0 0003 0 0004 0	dth patterns 4	) Compoi 0 0 0			rt ID Group	Number of DL	flows +	×	PDSCH		
Compression Numerology Beamforming Timing Options	eAxC ID fields bitwi Flows DL eAxC ID DU Port II 0001 0 0002 0 0003 0 0004 0 Flows UL	dth patterns 4	) Compoi 0 0 0			rt ID Group	Number of DL	flows +	×	PDSCH		
Compression Numerology Beamforming Timing Options	eAxC ID fields bitwi Flows DL eAxC ID DU Port II 0001 0 0002 0 0003 0 0004 0 Flows UL eAxC ID DU Port II	dth patterns 4	) Compos 0 0 0 0 0		1 2 3 4	rt ID Group	Number of DL	flows +	×	PDSCH		
Compression Numerology Beamforming Timing Options	eAxC ID fields bitwi Flows DL eAxC ID DU Port II 0001 0 0002 0 0003 0 0004 0 Flows UL eAxC ID DU Port II	dth patterns 4	) Compos 0 0 0 0 0		1 2 3 4	rt ID Group	Number of DL	flows +	×	PDSCH		



3 At this stage, if you exit the "C/U Plane Builder Configuration Tool" and generate the Stimulus file, the PCAP file contents loaded in the Explorer tab are displayed in Figure 367.

	lane Messages:		50000110001111000111. 🗣	3011000						
				U-Pla	ine: -					 Message Interpretation:
	escription				Dir	eAxC		DU Port	Band Sector	Value : AE FE eCPRI Common Header
	PCAPI C-Plane, Section	Type: 1, Sections: 1, Frame :	0. Subframe	0	DL	0003		0	0	ecpriVersion : 1
		Type: 1, Sections: 1, Frame :	CORRECT COLORS							ecpriConcatenation : 0 ecpriMessage : 2
60 [I	PCAP] C-Plane, Section	Type: 1, Sections: 1, Frame :	0, Subframe			0001				ecpriPayload : 20
60 [1	PCAP] C-Plane, Section	Type: 1, Sections: 1, Frame :	0, Subframe	< 11	100	an a th				<ul> <li>eCPRI Component eAxC I DuPortID : 0</li> </ul>
8991 [	PCAP] U-Plane, Frame :	0, Subframe: 0, Slot: 0, Symb	ol: 0, Section:							BandSectorID: 0
3366 [	PCAP] U-Plane, Frame	0, Subframe: 0, Slot: 0, Symb	ol: 0, Section	C-Pla	ine:					 CcID:0 RuPortID:4
8991 [	PCAP] U-Plane, Frame :	0, Subframe: 0, Slot: 0, Symb	ol: 0, Section		Dir	eAxC		DU Port	Band Sector	RuPortID : 4
3366 [	(PCAP) U-Plane, Frame :	0, Subframe: 0, Slot: 0, Symb	ol: 0, Section			0003				SequenceID : 0 E : 1
		0, Subframe: 0, Slot: 0, Symb				0002				SubsequenceID : 0
		0, Subframe: 0, Slot: 0, Symb				0001				- C-Plane Common Header
• • • • • • • • • • • • • • • • • • •	DPADI ILDiana Erama	A Quinferran A Clart A Cumh	nl: IL Continue	<	_			_		DataDirection : 1 PayloadVersion : 1
										FilterIndex : 0
										Frameld : 0
										SlotId : 0
ex Payload:				Rec	overed	IQ 0	Constella	tion		StartSymbolid : 0 NumberOfSections : 1
Hex 00 0	01 02 03 04 05	06 07 08 09 0A 08	B OC OD OE	PDD-	(none )	selected)				SectionType : 1
0 80	09 02 03 04 05	00 00 00 00 00 0	0 81 00 E							<ul> <li>User Data Compression F IgBitWidth : 15</li> </ul>
	FE 10 02 00 14			RE	u (	Cmpl	uCmpQ			Compression : no corr
		FF F4 00 00 00 0								Reserved Value : 0
	00 00 00 00 00	00 00 00 00 00 0								C-Plane Section Type 1
										SectionID:0 RB:0
										Symbolinc: 0
										StartPrbc : 0
										NumberPrbc : 0 ReMask : 1111111111



In this stimulus:

- the U-Plane, C-Plane Messages area displays the C-Plane messages for each antenna
- the C Plane area displays the Flow/eAxC assigned to each antenna
- the Message Interpretation area displays the C-Plane Secton Type 1 for the highlighted C-Plane message only.

To understand the effect of adding Extension Type 10 and Beamforming methodology to the MIMO configuration, follow the steps described further.

4 In the 'Options' tab, under 'C-Plane Section Handling', select the "Use Extension Type 10 (MIMO only)" check box, so that Section Extension Type 10 is added to all sections in the C-Plane message.

lane Builder	V Explorer					
mponent Carr	iers Radio Control Plane Data					
arrier Numerol	ροgy μ Subframe Slot ID RB Start	RB Number	Sym Start	Sym Number	Channel	Beam Id
I Plane Builder	r Configuration Tool					
	Network Layer:				PDSCH SS/PBCH	
low/eAxC						
ompression	Maximum transmission unit (MTU) 9000				PDSCH	
	Disable VLAN Tags VLAN ID: 0				SS/PBCH	
umerology					PDSCH	
eamforming	Set Sequence IDs to '0'				PDSCH	
carniorining	C-Plane Section Handling:					
iming	C-Plane Section Handling.					
	🗌 Use reMask				SS/PBCH PDSCH	
ptions	🗌 Use syminc				PDSCH	
	Use RB indicator				PUSCH	
	Use Extension Type 6					
	Use Extension Type 10 (MIMO only)					
	PRACH Type 3 as Type 1 Message					
	C-Plane Section Type 0 Messages:					
	don't generate					
	U-Plane Package:					
	Create Uplink U-Plane					
	Digital Power Scaling (IQ Data):					
	0 FS adjustment (FS_Offset, default 0 is no scaling)					
	Apply fixed 256QAM scaler					

Figure 368 Enabling the Extension Type 10 configuration option

Note that enabling Extension Type 10 in the Configuration Tool facilitates the feature to group Flow/eAxC IDs, such that the first selected eAxC ID becomes the "representative eAxC ID" for the group.

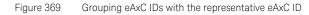
After you enable the "Use Extension Type 10 (MIMO Only)" in the Options tab, you shall notice that a button "Group" appears in the Flow/eAxC tab.

5 Select an eAxC ID.

Notice that the "Group" button is activated, as shown in Figure 369. In this example, '0003' is selected as the "representative eAxC ID" for the group.

6 Press CTRL key and select other eAxC IDs you wish to group.

omp													
	onent Carriers				Radio Contr	ol Plane Dat	a						
Carri	er Numerology				μ Subfrar	me Slot ID	RB Start	RB Number	Sym Start	Sym Number	Channel	Beam Id	
Sel	ect Carrier:	NR Carti	er 1 (DL), Antenr	×				273			PDSCH		
								126			PDSCH		
Att	tribute	Value			1 0	0	126	21	4	4	SS/PBCH	0	
	C/U Plane Builder	Configuration	n Tool										
	Flow/eAxC	Flow Fields	Allocation								SS/PBCH		
	Flow/eAxC			- 	444			(applied to al			PDSCH		
Н	Compression	eatc ib i	ields bitwidtl	n patterns				(applied to al	i eac ibs)				
	Numerology	Flows DL										0 0	
Н											SS/PBCH		
Н	Beamforming					it Carrier ID	RU Port ID Grou	p Number	of DL flows	+ ×	PDSCH		
	Timing	0001	0	0	0		1				PDSCH		
te	Options									Group			
\$													
		Flows UL						lines as	-610 8				
		Flows UL	DI Port ID	Rand Sector II	Componer	et Carrier ID	PH Port ID Grou						
1		eAxC ID				nt Carrier ID	RU Port ID Grou	p Number	of UL nows	· ·			
			DU Port ID 0	Band Sector II	Componer 0	nt Carrier ID	RU Port ID Grou	p Number	of OL nows	Group			
		eAxC ID				nt Carrier ID		p Number	of UL nows	Group			
		eAxC ID				nt Carrier ID		p Number	of up nows	Group			
		eAxC ID				nt Carrier ID		p Number	OF UL HOWS	Group			
		eAxC ID				nt Carrier ID		p Number	of UL Hows	Group			
36		eAxC ID 0001 Flow Summ	0 nary					p Number	of UL Hows	Group			



7 Click "Group".

Notice that all the eAxC IDs selected after the "representative eAxC ID" are displayed under the 'Group' column of the table, as shown in Figure 370.

Plan	e Builder 🖉 🗗	plorer												
Carri	onent Carriers er Numerology				Rac	dio Control F Subframe	Slot ID	RB Start	RB Numb		Sym Number		Beam Id	
Sele	ect Carrier:	NR Carri	ier 1 (DL), Antenn						273 126	4	4	PDSCH PDSCH		
Att	ribute	Value										SS/PBCH		
	C/U Plane Builder Flow/eAxC	Flow Fields	s Allocation									SS/PBCH		
	Compression Numerology	eAxC ID f	fields bitwidt	h patterns	4,4,4	4			(applied	to all eAxC IDs)		PDSCH PDSCH PDSCH		
	Beamforming	eAxC ID	DU Port ID	Band Secto	r ID (	Component C	arrier ID	RU Port ID	Group Num	nber of DL flows		SS/PBCH PDSCH		
Re	Timing	0001 0002	0	0		0		1 2				All the second		
5	Options													
												-		
		Flows UL												
		eAxC ID	DU Port ID	Band Secto	r ID (	Component C	arrier ID	RU Port ID	Group Nun	ber of UL flows				
		0001			ļ	0								
		Flow Sumr	nary											
3e			presents the											

Figure 370 Grouping eAxC IDs with the representative eAxC ID

- If there is a need to change the group or remove one or more eAxC IDs from a group, you must first 'ungroup' the representative eAxC ID.
  - i To remove grouping of eAxC IDs, select the row with the "representative eAxC ID" only.

-Plar	e Builder 🖉 🗗												
Comp	onent Carriers				Radio Control I	Plane Dat	ta						
Carri	er Numerology				µ Subframe	Slot ID	RB Start	RB Number	Sym Start	Sym Number	Channel	Beam Id	
Se	ect Carrier:	NR Carr	ier 1 (DL), Antenr	~				273			PDSCH		
											PDSCH		
	tribute	Value			1 0	0	126	21	4	4	SS/PBCH PDSCH		
	C/U Plane Builder	Configuratio	n Tool								PDSCH		
	Flow/eAxC	Flow Field	s Allocation								SS/PBCH		
	Compression	eAxC ID	fields bitwidt	h patterns 4	4,4,4			(applied to a	all eAxC IDs)		PDSCH PDSCH		
	Compression										PDSCH		
	Numerology	Flows DL									PDSCH		
	Beamforming	eAxC ID	DU Port ID	Band Sector ID	Component (	arrier ID	RU Port ID	Group Numbe	r of DL flows		SS/PBCH		
	Timing	0001									PDSCH PDSCH		
Re		0002	0	0	0		2			Ungroup			
s	Options	0003	0	0	0		3						
		0004											
		Flows UL											
			DLI Port ID	Band Sector ID	Component (	arrier ID	RU Port ID	Group Numbe	r of UL flows				
		0001	0		0								
		0001											
		Flow Sum	nary										
Be				e number of s values entere									

Notice that the "Group" button is replaced with "Ungroup", as shown in Figure 371.

Figure 371 Ungroup eAxC IDs from the representative eAxC ID

- ii Click "Ungroup" to remove grouping of eAxC IDs.
- iii Repeat steps 4 to 6 to perform grouping of eAxC IDs in the desired manner.

# NOTE

### Starting with ver. 1.3 of the U5040A Open RAN Studio software, Beam/Ue ID must be assigned individually to each antenna in a MIMO configuration.

- 8 Click the "Beamforming" tab in the "C/U Plane Builder Configuration Tool".
  - a To set Beam ID for each antenna,
    - i Set the 'Beamforming Method' to "predefined-beam beamforming".
    - ii Set the 'Size of the beam mapping table' to correspond to the number of antennas in the MIMO configuration.
    - By default, the Beam ID has a 1-to-1 mapping with the Table Index, which can be seen in the Beam IDs tab under "Beamforming Mappings". However, you may optionally double click to manually change the Beam ID values.

Component Carriers	•	Pa	dio Control P	Nana Da							
Carrier Numerology			Subframe			RB Number	Sym Start	Sym Number	Channel	Baam Id	
Select Carrier:	NR Carrier 1 (DL), Antenr 🗸	-	0	0	0	273	0	4	PDSCH		
	HICODINE TOO, MILEN V					126					
Attribute	Value								SS/PBCH	10	
C/U Plane Builde	r Configuration Tool								PDSCH		
									PDSCH SS/PBCH		
Flow/eAxC	Beamforming Method:			-1					PDSCH		
Compression	predefined-beam beamforming			~					PDSCH		
									PDSCH		
Numerology	Size of beam mapping table	4							PDSCH		
Beamforming	Beamforming Mappings:								SS/PBCH PDSCH		
Timing	Beam IDs Beam Weig		Flexible W	leights	Beam A	ttributes B4	eam Channel In	formation	PDSCH		
Options											
	Table Index Beam ID								_		
DSS											
DSS											
DSS											
DSS											
DSS											



b To set Ue ID for each antenna,

- i Set the 'Beamforming Method' to "channel-information-based beamforming".
- ii Set the 'Size of the beam mapping table' to correspond to the number of antennas in the MIMO configuration.
- iii By default, the Ue ID is assigned default values, starting from 0, for each value of Table Index, which can be seen in the Beam Channel Information tab under "Beamforming Mappings".

However, you may optionally double click to manually change the ueld values.

iv Optionally, open the CI IQ sample file to include Section Type 6 messages. Also, if required, set the value for "CI IQ Bitwidth" and select the "Add Ext Type 8 to Section Type 5" check box to include the corresponding extension.

omponent Carrie	ers		- Rad	io Control	l Plane Dat	a					
Carrier Numerolo						R6 Start	RB Number	Sym Start	Sym Number	Channel	Ue Id
Select Carrier:	NR Cal	rier 1 (DL), Antenn 🗸								PDSCH	
Attribute	Value					0				PDSCH SS/PBCH	
		Configuration Tool				120	- 41			X	
Cell ID	Flow/eAxC	Beamforming Method									
Bandwidth Numerology CP Type	Compression	channel-information	based beamfo	orming							
Allocations	Numerology	Size of beam map	ping table	4							
Flow/eA	Beamforming	Beamforming Mappin	gs:								
	Timing	Beam IDs	Beam Weigl		Flexible W	/eights E	eam Attributes	Beam Ct	nannel Informatio	n	
tesource Alloca	Options	Table Index Re	ularization F	actor ue	ld File Pa	ith Load					
Select Alloca					iqsam	ple.txt Ope	n î				
Select Alloca						ple.txt Ope					
Select Alloca Attribute					iqsam	pie.ux					
Attribute Name of allo				2		ple.txt Ope					
Attribute Name of alio Numerology Modulation						ANNO 10 LANGE					
Attribute Name of allo Numerology		3 0 4 0				ANNO 10 LANGE					
Attribute Name of allo Numerology Modulation Slots First Symbol Last Symbol Number of S		3 0 4 0 CI IQ Bitwidth	to Section			ANNO 10 LANGE					
Attribute Name of allo Numerology Modulation Slots First Symbol Last Symbol		3 0 4 0 Cl IQ Bitwidth 16 ~	to Section 1			ANNO 10 LANGE					
Attribute Name of allo Numerology Modulation Slots First Symbol Last Symbol Number of S RB Offset		3 0 4 0 Cl IQ Bitwidth 16 ~				ANNO 10 LANGE					



9 Exit the "C/U Plane Builder Configuration Tool".

10 In the C-Plane Builder tab, assign a Flow/eAxC ID to each antenna.



Assign a Flow/eAxC ID to each antenna.

Figure 374 Assigning Flow/eAxC ID to each antenna

- 11 For each Resource allocation, assign the same or different Beam ID / Ue ID individually to each antenna.
  - *a* From the 'Select Carrier' drop-down, select an antenna entry.
  - *b* From the 'Select Beamld' drop-down, assign the corresponding Beam ID value. You may set the same Beam ID for more than one antennas.

NOTE

# Beam Id 0 is reserved for NO BEAMFORMING and may be assigned only to allocation manually.



Assign the same or different Beam ID to each antenna



c Repeat the steps above to assign the corresponding Ue ID value, if the Beamforming Method is channel-information-based beamforming. Note that selecting "Reset" performs a reset of the Ue ID for the selected allocation.

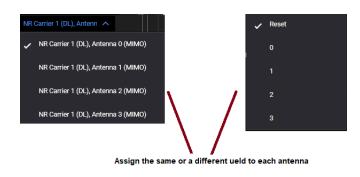


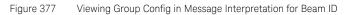
Figure 376 Assigning Ue ID to each antenna

Also, note that if the selected allocation is "SS/PBCH", you will see a button to set the Beam/Ue Id, instead of a drop-down field. See.

12 Export the O-RAN stimulus file with the modified configuration options.

13 Switch to Explorer tab and load the MIMO PCAP file. *a* For Beam ID

	up	Test Mode	ls View	Help									
-Pla	ne Bi	ilder V	Explorer	ſ					-				
-Pla	ne, C	-Plane Mes	sages:							Recovered	d IQ	Message Interpretation:	
Len	gth	Description										<ul> <li>eCPRI Component eAxC ID (C-Plane)</li> </ul>	
		[PCAP] C-F							0-272	PRB: (none	eselected	DuPortID : 0 BandSectorID : 0	
60		[PCAP] C-F	Nane, Sect	ion Type: 1, Sect	ions: 1, Frame :0,	Subframe	: 0, Slot: 0, Symb	ool Start: 0, PRB:	0-272	RE u	uCmpl	CcID:0	
899					0, Slot: 0, Symbol							RuPortID : 3	
336					0, Slot: 0, Symbol							SequenceID : 0	
899					0, Slot: 0, Symbol							E : 1 SubsequenceID : 0	
336					0, Slot: 0, Symbol			12				C-Plane Common Header	
899 336					0, Slot: 0, Symbol 0, Slot: 0, Symbol			22				DataDirection : 1 PayloadVersion : 1	
330					0, Slot: 0, Symbol 0, Slot: 0, Symbol							FilterIndex : 0	
336					0, Slot: 0, Symbol			12				Frameld : 0 Subframeld : 0	
899					0, Slot: 0, Symbol							Slotid : 0	
336	i6	[PCAP] UH	Plane, Fran	ne :0, Subframe:	0, Slot: 0, Symbol	1, Section	n: 0, PRB: 199-2					StartSymbolid : 0 NumberOfSections : 1	
												SectionType : 1	
												User Data Compression Header     IgBitWidth: 15	
												Compression : no compression	
												Reserved Value: 0	
Pla												C-Plane Section Type 1	
•	Dir	eAxC		DU Port	Band Sector	cc	RU Port		$\nabla$			SectionID:0 RB:0	
		0003										Symbolinc : 0	
		0002										StartPrbc : 0 NumberPrbc : 0	
	DL	0001				0						ReMask:11111111111b	
	DL	0004										NumSymbol: 4 Ef: 1b	
Pla	ne:											Beamid : 3	
	Dir	eAxC		DU Port	Band Sector		RU Port	Group				<ul> <li>Section Ext Command Ef : False</li> </ul>	
								Group				ExtType: 10	
	DL	0001				0		2.4				ExtLen : 3 - Group Configuration of Multiple Ports Ext	
		0003										Beamidueid2 : 2 Beamidueid2 : 4	
										<		BeamldUeld4 : 0	



-Pla	ine Bu	iilder V	Explorer	<u>]</u>								
Pla	ine, C-	Plane Me	sages;							Recov	ered IQ	Message Interpretation:
Len	igth	Descriptio	n									<ul> <li>eCPRI Component eAxC ID (C-Plane)</li> <li>DuPortID : 0</li> </ul>
	14	[PCAP] C	Plane, Sect	ion Type: 6, Sect	ions: 0, Frame :0,	Subframe	: 0, Slot: 0, Symb	ol Start: 0, PRB:	0-35, PRE ^		ione selected	BandSectorID: 0
					ions: 0, Frame :0,					RE	uCmpl	ColD:0
												RuPortID : 3 eCPRI Sequence ID
					ions: 0, Frame :0,							SequenceID : 1
					ions: 0, Frame :0,							E : 1 SubsequenceID : 0
60					ions: 1, Frame :0,			ol Start: 0, PRB: (	9-272			C-Plane Common Header
89					0, Slot: 0, Symbol							DataDirection : 1 PayloadVersion : 1
33 89					0, Slot: 0, Symbol 0, Slot: 0, Symbol							FilterIndex : 0
33												Frameld : 0
89												Subframeld : 0 Slotid : 0
		[PCAP] U-Plane, Frame :0, Subframe: 0, Slot: 0, Symbol: 0, Section: 0, PRB: 199-272 [PCAP] U-Plane, Frame :0, Subframe: 0, Slot: 0, Symbol: 0, Section: 0, PRB: 0-198										
33	66											StartSymbolid : 0
33				ne :0, Subframe:	0, Slot: 0, Symbol	0, Section	n: 0, PRB: 199-27					StartSymbolid : 0 NumberOfSections : 1
				ne :0, Subframe:	0, Slot: 0, Symbol	0, Section	n: 0, PRB: 199-27					StartSymbolid : 0
				ne :0, Subframe:	0, Slot: 0, Symbol	0, Section	n: 0, PRB: 199-27					Startsymbolid : 0 NumberOfSections : 1 SectionType : 5 - User Data Compression Header IqBIWidth : 15
				ne :0, Subframe:	0, Slot: 0, Symbol	0, Section	n: 0, PRB: 199-27					StartSymbolid : 0 NumberOfSections : 1 SectionType : 5 - User Data Compression Header
				ne :0, Subframe:	0, Slot: 0, Symbol	0, Section	n: 0, PRB: 199-27					StartSymbolid : 0 NumberOfSections : 1 SectionType : 5 User Data Compression Header IqBRWidth : 15 Compression : no compression · Reserved Value : 0
Pla			Plane, Fran 	ne :0, Subframe:	0, Slot: 0, Symbol	0, Section	n: 0, PRB: 199-27		, ,			StartSymbolid : 0 NumberOfSections : 1 SectionType : 5 · User Data Compression Header IqBitWidth : 15 Compression : no compression · Reserved
Pla	 ine:	[PCAP] U	Plane, Fran	ne 10, Subframe:	0, Slot: 0, Symbol	: 0, Section	n: 0, PRB: 199-27		, * • •			StartSymbolid : 0 NumberOfSections : 1 SectionType : 5 · User Data Compression Header I alatWidth : 15 Compression : no compression · Reserved Value : 0 · CPIane Section Type 5 SectionID : 0 RB : 0
Pla	 ine: Dir	(PCAP) U	Plane, Fran	ne 10, Subframe:	0, Slot: 0, Symbol Band Sector	cc	n: 0, PRB: 199-27		•			StartSymbolid : 0 NumberOfSections : 1 SectionType : 5 User Data Compression Header IqBitWidth : 15 Compression : no compression Reserved Value : 0 - C-Plane Section Type 5 Section ID : 0
	++ ine: Dir DL	(PCAP) U	Plane, Fran → – Plane, Fran 1	ne :0, Subframe:  DU Port 0	0, Slot: 0, Symbol Band Sector 0	0, Section 	n: 0, PRB: 199-27					StartSymbolid : 0 NumberOfSections : 1 SectionType : 5 User Data Compression Header IqBitWidth : 15 Compression : no compression Reserved Value : 0 C-Plane Section Type 5 SectionID : 0 RB : 0 Symbolinc : 0 StartPrbc : 0 NumberPbc : 0
<b>Pla</b> 0 1 2	ne: Dir DL DL	[PCAP] U	Plane, Fran 	DU Port 0	0, Slot: 0, Symbol Band Sector 0 0	0, Section cc 0 0	n: 0, PRB: 199-21  RU Port 3 2					StartSymbolid : 0 NumberOfSections : 1 SectionType : 5 · User Data Compression Header IqBitWidth : 15 Compression : no compression · Reserved Value : 0 · C-Plane Section Type 5 SectionID : 0 RB : 0 Symbolinc : 0 StartPrbc : 0 NumberPrbc : 0 NumberPrbc : 4
Pla 0 1 2 3	Dir Dir DL DL DL DL	(PCAP) U- eAxC 0003 0002 0001	Plane, Fran 	DU Port 0 0	0, Slot: 0, Symbol Band Sector 0 0 0	0, Section 	RU Port 3 2 1					StartSymbolid : 0 NumberOfSections : 1 SectionType : 5 · User Data Compression Header IqaRiWidth : 15 Compression : no compression · Reserved Value : 0 · C-Plane Section Type 5 SectionID : 0 · RB : 0 · StartPrbc : 0 NumberPrbc : 0 NumberPrbc : 0 ReMask : 1111111111b NumSymbol : 4 Ef : 1b Ueld : 2
Pla 0 1 2 3 Pla	ne: Dir DL DL DL	(PCAP) U- eAxC 0003 0002 0001	Plane, Fran 	DU Port 0 0	0, Slot: 0, Symbol Band Sector 0 0 0	0 0 0 0	RU Port 3 2 1	Croup				StartSymbolid : 0 NumberOfSections : 1 SectionType : 5 · User Data Compression Header IgBitWidth: 15 · Compression : no compression · Reserved Value : 0 · CPlane Section Type 5 · SectionID : 0 · RB : 0 · StartPrbc : 0 NumberPrbc : 0 NumberPrbc : 0 ReMask : 1111111111b NumSymbol : 4 · Ef : 1b
Pla 0 1 2 3 Pla	ne: Dir DL DL DL DL DL DL	(PCAP) U eAxC 0003 0002 0001 0004 eAxC	Plane, Fran	DU Port 0 0 0 0	Band Sector 0 0 0 0 0	0 0 0 0	RU Port 3 2 1 4	Group				StartSymbolid : 0 NumberOfSections : 1 SectionType : 5 · User Data Compression Header IgRitWidth : 15 · Cerepression : no compression · Reserved · Value: 0 · CPIane Section Type 5 · SectionID : 0 · Rate Composed in the section of the section · Rate Composed in the section of the section · Rate Composed in the section of the section · StartPrbc : 0 · NumberPrbc : 0 · NumberPrbc : 0 · ReMask : 1111111111b · NumSymbol : 4 · E' : 1b · Ueld : 2 · Section Ext Command E' Fraise · ExtType : 10
Pla 0 1 2 3 Pla	ne: Dir DL DL DL DL	(PCAP) U eAxC 0003 0002 0001 0004	Plane, Fran 	DU Port 0 0 0 0 DU Port	0, Slot: 0, Symbol Band Sector 0 0 0 0 8 Band Sector	CC 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	RU Port 3 2 1 4 RU Port					StartSymbolid : 0 NumberOfSections : 1 SectionType : 5 · User Data Compression Header IqaRtWidth : 15 Compression : no compression · Reserved Value : 0 · CPIane Section Type 5 · SectionID : 0 · RB : 0 · Symboline : 0 · StartPrbc : 0 NumberPrbc : 0 NumberPrbc : 0 · NumberPrbc : 0 · Redusk : 11111111111 · NumSymbol : 4 · Ef : 1b · Evetion Ext Command · Ef : False ExtType : 10 · ExtLen : 3
Pla 0 1 2 3 Pla 0 1	nne: Dir DL DL DL DL DL DI DI Dir	eAxC 0003 0002 0001 0004 eAxC 0003	Plane, Fran 	DU Port 0 0 0 0 0 0 0 0 0 0 0 0 0 0	Band Sector 0 0 0 0 Band Sector 0 0	CC 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	RU Port 3 2 1 8 8 0 Port 3	Group				StartSymbolid : 0 NumberOfSections : 1 SectionType : 5 · User Data Compression Header IqBitWidth : 15 Compression : no compression · Reserved Value : 0 • CPlane Section Type 5 SectionID : 0 • RB : 0 • Symbolin: 0 • StartPrbc : 0 NumberPrbc : 0 NumberPrbc : 0 NumberPrbc : 0 • ReMask : 1111111111b NumSymbol : 4 • E : 19 • Ueid : 2 • Section Ext Command eE : Fate ExtType : 10 ExtLen : 3 • Group Configuration of Multiple Ports Ext BeamGroupType : 2
Pla 0 1 2 3 Pla 0 1 2	ne: Dir DL DL DL DL DL DI DI DI DI DI DI	(PCAP) U eAxC 0003 0002 0001 0004 eAxC 0003 0002	Plane, Fran 	DU Port 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	Band Sector 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	0, Section CC 0 0 0 0 0 0 0 0 0 0 0 0 0	RU Port 3 2 1 4 RU Port 3 2 2 1 3 2 2 1 4	Group				StartSymbolid : 0 NumberOfSections : 1 SectionType : 5 User Data Compression Header IgBitWidth : 15 Compression : no compression Reserved Value : 0 C-Plane Section Type 5 SectionID : 0 R 8: 0 StartPbc : 0 NumberPrbc : 0 NumberPrbc : 0 NumberPrbc : 0 NumberPrbc : 0 ReMask : 111111111b NumSymbol : 4 Ef : 1b Ueld : 2 Section Ext Command Ef : False ExtType : 10 ExtLen : 3 Group Configuration of Multiple Ports Ext BeamGroupType : 2
- <b>Pla</b> 0 1 2 3	nne: Dir DL DL DL DL DL DL DL DL DL DL	(PCAP) U eAxC 0003 0002 0001 0004 eAxC 0003 0004 0004	Plane, Fran 	DU Port 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	Band Sector 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	0, Section CC 0 0 0 0 0 0 0 0 0 0 0 0 0	RU Port 3 2 1 4 8 1 2 1 3 2 1 3 2 1 3 2 1 3 2 1	Group				StartSymbolid : 0 NumberOfSections : 1 SectionType : 5 · User Data Compression Header IqBitWidth : 15 Compression : no compression · Reserved Value : 0 • CPlane Section Type 5 SectionID : 0 • RB : 0 • Symbolin: 0 • StartPrbc : 0 NumberPrbc : 0 NumberPrbc : 0 NumberPrbc : 0 • ReMask : 1111111111b NumSymbol : 4 • E : 19 • Ueid : 2 • Section Ext Command eE : Fate ExtType : 10 ExtLen : 3 • Group Configuration of Multiple Ports Ext BeamGroupType : 2

## *b* For Ue ID (without adding Ext Type 8 to Section Type 5)

Figure 378 Viewing Group Config in Message Interpretation for Ue ID

>Pla	ane Buil	der V	Explorer	<u> </u>								
)-Pla	ane, C-P	lane Mes:	sages:							Recov	ered IQ	Message Interpretation:
Ì	Length	Descript	ion									SequenceID : 0
		[PCAP]	C-Plane, Sect	ion Type: 5, Se	ections: 1, Frame :	0. Subfrar	ne: 0, Slot: 0, Sy	mbol Start: 0, PR	8: 0-272	PRB: (n	one selected;	E:1 SubsequenceID:0
	60				ctions: 1, Frame :				COMPANY CONTRACTOR	RE	uCmpl	C-Plane Common Header
	8991	(PCAP)	J-Plane, Fram	ne :0, Subfram	e: 0, Slot: 0, Symb	ol: 0, Sect	ion: 0, PRB: 0-19	78				DataDirection : 1 PayloadVersion : 1
	3366	(PCAP)	J-Plane, Fran	ne :0, Subfram	e: 0, Slot: 0, Symb	ol: 0, Sect	ion: 0, PRB: 199					FilterIndex : 0
	8991	[PCAP]	J-Plane, Fran	ne :0, Subfram	e: 0, Slot: 0, Symb	ol: 0, Sect	ion: 0, PRB: 0-19				Frameld : 0	
	3366				e: 0, Slot: 0, Symb							Subframeld : 0 Slotid : 0
	8991				e: 0, Slot: 0, Symb							StartSymbolid : 0
	3366				e: 0, Slot: 0, Symb							NumberOfSections : 1 SectionType : 5
	8991				e: 0, Slot: 0, Symb							<ul> <li>User Data Compression Header</li> </ul>
	3366 8991				e: 0, Slot: 0, Symb e: 0, Slot: 0, Symb							IqBitWidth : 15 Compression : no compression
	3366						ION; U, PRD; U-19	10				Compression no compression
					at 0 Slat 0 Sumb	all 1 Cant	Inet 0 000-100					Reserved
		(Fearing a	J-Plane, Fram	ie:0, Subfram	e: 0, Slot: 0, Symb							Value : 0
		10-0-1-1-	J-Plane, Fran	ie 0, Subfram								Value : 0 C-Plane Section Type 5
			J-Plane, Fran	ne :0, Subfram								Value : 0 C-Plane Section Type 5 SectionID : 0 RB : 0
		(F GAP ) 1	J-Plane, Fran	ie 0, Subfram								Value : 0 C-Plane Section Type 5 Section ID : 0 RB : 0 Symboline : 0
< J-Pla	ane:		J-Plane, Fran	ie:0, Subfram								Value : 0 - C-Plane Section Type 5 Section(D: 0 R8 : 0 Symbolinc : 0 StartPrbc : 0 NumberPrbc : 0
< J-Pla #	ane: Dir	eAxC		DU Port					,` 			Value : 0 - C-Plane Section Type 5 SectionID : 0 R8 : 0 Symbolinc : 0 StartPrbc : 0 NumberPrbc : 0 ReMask : 1111111111b NumSymbol : 4
	Dir DL	eAxC 0003		DU Port 0	Band Sector 0	cc 0	RU Port					Value : 0 - C-Plane Section Type 5 SectionID : 0 R8 : 0 Symbolinc : 0 StartPrbc : 0 NumberPrbc : 0 ReMask : 111111111b
	Dir DL DL	eAxC 0003 0002		DU Port 0	Band Sector 0 0	CC 0 0	RU Port 3 2		, `			Value : 0 · C-Plane Section Type 5 SectionID : 0 R8 : 0 Symboline : 0 StartPrbc : 0 NumberPrbc : 0 ReMask : 1111111111b NumSymbol : 4 Ef : 1b Ueld : 2 · Section Ext Command
	Dir DL DL DL	eAxC 0003 0002 0001		DU Port 0 0	Band Sector 0 0 0	cc 0 0 0	RU Port 3 2 1					Value : 0 • CPtane Section Type 5 SectionID : 0 R8 : 0 Symbolinc : 0 StartPhc : 0 NumberPhc : 0 ReMask : 1111111111 NumSymbol : 4 Ef : 1b Ueid : 2 • Section Ext Command Ef : True
	Dir DL DL	eAxC 0003 0002		DU Port 0	Band Sector 0 0	CC 0 0	RU Port 3 2					Value : 0 • CPlane Section Type 5 SectionID : 0 R8 : 0 Symboline : 0 StartPhe : 0 NumberPhe : 0 ReMask : 1111111111 NumSymbol : 4 Ef : 1b Ueid : Command Ef : True ExtType : 8 ExtType : 8
	Dir DL DL DL DL	eAxC 0003 0002 0001		DU Port 0 0	Band Sector 0 0 0	cc 0 0 0	RU Port 3 2 1					Value : 0 · C-Plane Section Type 5 Section(D: 0 R8 : 0 Symbolinc : 0 StartPrbc : 0 NumberPrbc : 0 ReMask : 1111111111 NumSymbol : 4 Ef: 1b Ueid : 2 · Section Ext Command Ef: True ExtLen : 1 · Regularization Factor Ext
	Dir DL DL DL DL	eAxC 0003 0002 0001 0004		DU Port 0 0 0	Band Sector 0 0 0	<b>cc</b> 0 0 0	RU Port. 3 2 1 4					Value : 0 - C-Plane Section Type 5 SectionID : 0 R8 : 0 Symboline : 0 StartPrbc : 0 NumberPrbc : 0 ReMask : 1111111111 NumSymbol : 4 Ef : 1b Ueid : 2 - Section Ext Command Ef : Tue ExtLen : 1 - Regularization Factor Ext Regularization Factor : 0 - Section Ext Command
	Dir DL DL DL DL	eAxC 0003 0002 0001		DU Port 0 0	Band Sector 0 0 0	cc 0 0 0	RU Port 3 2 1	Group				Value: 0 C-Plane Section Type 5 SectionID: 0 PB: 0 Symboline: 0 Symboline: 0 StartPbc: 0 NumberPbc: 0 ReMask: 1111111111 NumSymbol: 4 Ef: 1b Ueid: 2 Section Ext Command Ef: Thue ExtType: 8 ExtLen: 1 RegularizationFactor: 0 Section Ext Command Ef: False
0 1 2 3	Dir DL DL DL DL	eAxC 0003 0002 0001 0004 eAxC		DU Port 0 0 0	Band Sector 0 0 0	<b>cc</b> 0 0 0	RU Port. 3 2 1 4					Value : 0 - C-Plane Section Type 5 SectionID : 0 R8 : 0 Symboline : 0 StartPrbc : 0 NumberPrbc : 0 ReMask : 1111111111 NumSymbol : 4 Ef : 1b Ueid : 2 - Section Ext Command Ef : Tue ExtLen : 1 - Regularization Factor Ext Regularization Factor : 0 - Section Ext Command
# 0 1 2 3 <b>Pla</b>	Dir DL DL DL DL DL DL DL	eAxC 0003 0002 0001 0004 eAxC		0 0 0 0 0 0 0 0 0 0 0 0 0 0	Band Sector 0 0 0 0 Band Sector	cc 0 0 0 0 0 0	RU Port 3 2 1 4 RU Port					Value : 0 - C-Plane Section Type 5 SectionID : 0 R8 : 0 Symbolinc : 0 StartPrbc : 0 NumberPrbc : 0 ReMask : 111111111b NumSymbol : 4 Ef : 1b Ueid : 2 Section Ext Command Ef : True ExtType : 8 ExtLen : 1 - RegularizationFactor : 0 Section Ext Command Ef : False ExtType : 10 ExtLen : 3 - Group Configuration of Multiple Ports Ext
0 1 2 3 2 Pla 0	Dir DL DL DL DL ane: Dir DL	eAxC 0003 0002 0001 0004 eAxC 0001		DU Port 0 0 0 0 0 0 0 0 0 0 0	Band Sector 0 0 0 Band Sector 0	CC 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	RU Port 3 2 1 4 RU Port 1	Group				Value: 0 C-Plane Section Type 5 SectionID: 0 BB: 0 StartPhe: 0 NumberPhe: 0 NumberPhe: 0 NumberPhe: 0 ReMask: 1111111111b NumSymbol: 4 Ef: 1b Ued: 2 Section Ext Command Ef: The 8 ExtLype: 8 ExtLype: 8 ExtLen: 1 RegularizationFactor : 0 Section Ext Command Ef: False ExtType: 10 ExtType: 10 ExtLype: 3
0 1 2 3 2 Pla 0	Dir DL DL DL DL ane: Dir DL	eAxC 0003 0002 0001 0004 eAxC 0001		DU Port 0 0 0 0 0 0 0 0 0 0 0	Band Sector 0 0 0 Band Sector 0	CC 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	RU Port 3 2 1 4 RU Port 1	Group				Value: 0 C-Plane Section Type 5 SectionID: 0 PB: 0 SurtPhote: 0 NumberPhote: 0 NumberPhote: 0 NumberPhote: 0 NumberPhote: 0 ReMask: 1111111111b NumSymbol: 4 Ef: 1b Ued: 2 Section Ext Command Ef: The ExtType: 8 ExtLen: 1 Regularization Factor Ext Regularization Factor 0 Section Ext Command Ef: False ExtType: 10 ExtLen: 3 Group Configuration of Multiple Ports Ext BeamGroupType: 2

#### c For Ue ID (after adding Ext Type 8 to Section Type 5)



In the modified stimulus file,

 BeamGroupType is determined automatically by the software based on how Beam/Ue IDs have been assigned to the antennas. The following table helps you understand the various BeamGroupTypes and the value determined by the software.

#### Table 11 Understanding BeamGroupTypes

BeamGroupType in Software	Corresponding specification value	Condition
0	00b	When all antennas in a carrier are assigned equal Beam IDs. For example, BeamID '1' is assigned to all four antennas in the illustration above.
1	01b	When all antennas in a carrier are assigned consecutive Beam IDs. For example, BeamID '1, 2, 3, 4' is assigned to all four antennas in the illustration above.
2	10b	When all antennas in a carrier are assigned arbitrary Beam IDs.
2	10b	When all antennas in a carrier are assigned Ue IDs.

the U-Plane, C-Plane Messages area displays one C-Plane message (combined) for all antennas

- the C-Plane area displays the "Representative eAxC ID", which is used for Extension Type 10
- the Message Interpretation area displays the Section Extension, which is added to all sections in the C-Plane message

For more information about Extension Type 10, refer to Section 5.4.7.10 *ExtType=10: Section description for group configuration of multiple ports* in the O-RAN specification.

#### 3.12.10: Recovering IQ from MIMO files

The process of recovering IQ data from Multi-Input-Multi-Output (MIMO) files is slightly different from that of other signals with DL / UL carrier. In this case, you must select the U-Plane flow in a serial order for proper recovery of IQ data.

For the purpose of understanding, an SCP file for the DL carrier with two antennas has been used in this example.

1 Load the MIMO SCP file into O-RAN Studio software.

Setup Test Models	View Help										
[-• 🕸											
-Plane Builder Ex	plorer										
Component Carriers			Radio Control R	Plane Da	ta						
Select Carrier:	Carrier 1 (DL), Antenna 0 🗸		u Subframe	Slot ID	RB Start	RB Number	Sym Start	Sym Number	Channel	Beam Id	
Attribute	Value		1 0			273		14	PDSCH		
Carrier Type	DL (NR)		1 0			273		14	PDSCH		
Cell ID	0		1 1			273		14	PDSCH		
Bandwidth	FR1_100M		1 1			273		14	PDSCH		
Numerology Mode	SingleNumerology		12						PDSCH		
CP Type	Normal		12						PDSCH		
Allocations	1		1 3					14	PDSCH		
									PDSCH		
Flow/eAxC ID	(unassigned)										
	I	R	adio Allocation	5							
Resource Allocations											
Select Allocation:	DL-SCH1 V		245								
Attribute	Value		100								
Name of allocation	DL-SCH1		125								
Numerology	SCS30k		197 _								
Modulation	QPSK		49 - 30								
Slots	0:19										
First Symbol	0										
8									Fran	ne Index 🛛 0	:
									T Turi	Television 18	

Figure 380 Loading MIMO SCP file

2 From the Select Carrier drop-down options, check the number of antennas configured in the Carrier.

Component Carriers Select Carrier:	Carrier 1 (DL), Antenna 0 🔨
Attribute	<ul> <li>Carrier 1 (DL), Antenna 0 (MIMO)</li> </ul>
Carrier Type	Carrier 1 (DL), Antenna 1 (MIMO)
Cell ID	0
Bandwidth	FR1_100M
Numerology Mode	SingleNumerology
СР Туре	Normal
Allocations	
Flow/eAxC ID	(unassigned) ~

Figure 381 Checking number of antennas in MIMO file

3 Open the "C/U-Plane Builder Configuration Tool" window to add more Flow/eAxC IDs to the respective carrier in the **Flow/eAxC** tab, to match the number of antennas checked in the previous step.

C/U Plane Builder	Configuratio	n Tool				×
Flow/eAxC		Allocation				
Compression	eAxC ID f	ields bitwidt	h patterns 4,4	,4,4 ~		(applied to all eAxC IDs)
Numerology	Flows DL					
Beamforming	eAxC ID	DU Port ID	Band Sector ID	Component Carrier ID	RU Port ID	Number of DL flows +
	0001	0	0	0		
Timing	0002		0	0	2	
Options						
DSS						
	Flows UL					
	eAxC ID	DU Port ID	Band Sector ID	Component Carrier ID	RU Port ID	Number of UL flows +
	0001	0	0	0	1	

Figure 382 Adding Frame/eAxC IDs to match with no. of antennas

- 4 Exit the "C/U-Plane Builder Configuration Tool" window.
- 5 Assign a Flow/eAxC ID to each antenna.

C	omponent Carriers Select Carrier:	Carrier 1 (DL), a	Antenna 1 🗸 🐴
	Attribute	Value	
	Carrier Type	DL (NR)	
	Cell ID		
	Bandwidth	FR1_100M	
	Numerology Mode	SingleNumero	ology
	СР Туре	Normal	
	Allocations		
	Flow/eAxC ID	0002	~



- 6 Export the O-RAN stimulus file.
- 7 Switch to Explorer tab and load the MIMO PCAP file.

Notice that In the U-Plane area, there are two flows, as shown in Figure 384, according to the number of Flow/eAxC IDs assigned earlier.

8 Click the first flow in order, that is, 0001. Then, press and hold the CTRL key to select the next in order, which is 0002. See Figure 384.

Let us consider a scenario where you have four eAxC IDs that are mapped to four layers of MIMO, which appear in the U-Plane in the following order in the 'eAxC' column:

0004

0002

0003

0001

For the proper recovery of IQ data, it is imperative that you select the flow in the following sequence:

- Select 0001
- Press and hold the CTRL key and select 0002
- With the CTRL key pressed down, select 0003
- With the CTRL key pressed down, select 0004

Plane	Builder Explorer		_									
Plane	, C-Plane Messages:		U-Pla	ane:			811333111119-0108	1100-1100110011-				Message Interpretation
#	Time	Source		Dir	eAxC	μ	DU Port	Band Sector	cc	RU Port	V	
	00:00:00.009995000	00 00 00 00 00 00 00 ^			0002							
	00:00:00.009995000	00 00 00 00 00 00										
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	00:00:00.009998000	00 00 00 00 00 00	C-Pla	ane:								
5 6	00:00:00.009998000	00 00 00 00 00 00 00 00 00 00 00 00 00		Dir	eAxC		DU Port	Band Sector	cc	RU Port		
	00:00:00.010033714	00 00 00 00 00 00 00			0002						Ľ	
4	00.00.00.010000714				0001							
ex Pay	yload.		Rec	overed	IQ	Constellatio						
			PRB	(none :	selected)							
			RE	i uC	mpl	uCmpQ						

Figure 384 Selecting U-Plane eAxC flow in serial order with CTRL key

## NOTE

Selecting the flow in serial order in a MIMO PCAP file's U-Plane is imperative because the Open RAN Studio software constructs the ORB file with the data according to the number of flows you select and filter (as channels) and in the correct order.

If you do not select all flows, the 89600 VSA software prompts an error. See Figure 389.

If you select all flows but in the wrong order, the 89600 VSA software will not prompt any error but will not demodulate.

KEYSIGHT Open RAN Studi	io - Offline			– 🗆 X
File Setup Test Models Vi	iew Help			
G [• Ø				
C-Plane Builder Explo	rer			
U-Plane, C-Plane Messages:		U-Plane;		Message Interpretation:
# Time	Source	Progress Dialog		
1 00:00:00.0099956	000 00 00 00 00 00			
2 00:00:00.0099956		Activity Progress:	- · · · ·	
3 00:00:00.0099980		24%		
4 00:00:00.0099980 5 00:00:00.0099980				
6 00:00:00:0099980		Activity Details:		
7 00:00:00.010033		Filtered item:286		
U. Durland				
Hex Payload:				
		Ok Cancel		
		не истрі истру і у		
		ve nouth nouths 1 d		
4				
File: C:\Open RAN\SCP\MIMO.pcap		Size: 6961504		
File: C:\Open RAN\SCP\MIMO.pcap		Size: 6961504		

9 Click the icons for **Filter on Selected Flow** followed by **Recover IQ Waveform**. The Progress Dialog is displayed.

Figure 385 Progress dialog indicating extraction of files with IQ data

- 10 Launch the 89600 VSA software.
- 11 From the main menu, click File > Recall > Recall Setup....
- 12 On the Recall Setup window that appears, navigate to the folder where the SETX file, corresponding to the PCAP file captured by the O-RU device, is located.

	ault 🔹 📒 🗖	🖩 🏁 , i 🔺 88* 📲 ,		II M	🗶 Ш 👗			
Spectrum •								×
0 Looki	x Compression	•	🗈 💣 💷 🔻		Contained Me	asurements:		
9	Name	Date	modified T	ype	Name	Meas Type / Analyzer	Chan Config	Shared
Quick access	DL.Carrier_1_DL.setx	1/29/	2021 1:56 PM S	ETX File	Meas01	NewRadio Analyzer2	1 User	
Desktop Desktop Rr Libraries Rr This PC k St Network								
	<			>	4			



- 13 Select the SETX file and click Open.
- 14 From the main menu, click File > Recall > Recall Recording....
- 15 On the Recall Recording window that appears, all stimulus files are displayed, which are associated with the SETX file loaded in the previous step. Select the ORB file.
- 16 On the right pane, under "Padding Selection", select 'Repetition'.
- 17 Modify "Factor" field to '3'.

	ntrol Source		etup Trace Markers		)    <b>   </b> .	50 %		
Rr 🏧	Recall Record	ing	• × 10	JFUM Detected Allocations Time			narv	×
1.5	Look in:	Compression				Preview file inform	ation	
Const 300 m /div -1.5 -2. Ré h1 Spec 20 Rr 20	Duick access Desktop Libraries This PC	Name DL1_mu1_ai DLCarrier_1 DLorstx DLpcap ULscp ULCarrier_1 ULCarrier_1 ULCarrier_1 ULCarrier_1 ULcristx ULpcap ULscp ULscp ULscp	DLsetx	Date modified 1/29/2021 1:58 PM 1/29/2021 1:56 PM 1/29/2021 3:07 PM 1/29/2021 3:07 PM 1/29/2021 9:18 AM 1/28/2021 9:18 AM 1/28/2021 9:18 AM 1/28/2021 9:18 AM 1/28/2021 6:58 PM 1/28/2021 6:58 PM 1/28/2021 6:58 PM	Type ORB File SETX File ORSTX File PCAP File Text Docun SETX File ORSTX File PCAP File Text Docun PCAP File			4
gMag 10 dB /div -80 dBm		< File name: Files of type:	DL1_mu1_ant1.iqt.orb All Files (*.*)	×	> Open Cancel	Padding Selection: No Action Zero Padding Cyclic Padding Repetition	Factor: 3	41

Figure 387 Loading ORB file to extract IQ data in the 89600 VSA software

18 Click Open.

The IQ data is recovered and the constellation diagram is plotted accurately, as shown in Figure 388, from MIMO.

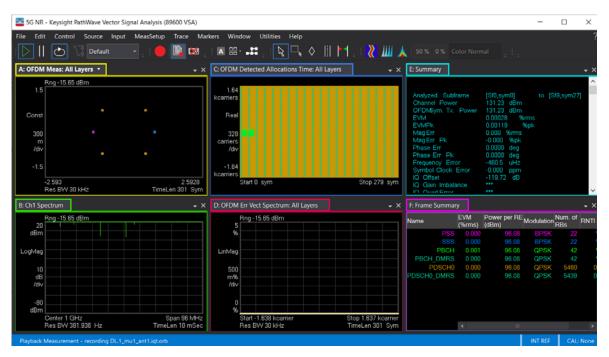


Figure 388 Recovered IQ data and Constellation for MIMO in 89600 VSA

5G NR - Keysight PathWave Vector Sig e Edit Control Source Input		ers Window Utilities Help	- 0
Default			🛄 🗼 50 % 0 % Color Normal 💡 💱
: OFDM Meas	<b>.</b> ×	C: OFDM Detected Allocations Time	x E: Summary
1.5 Const	NO DATA	1.84 NO DATA	<b>A</b>
300 m /div		320 carriers	NO DA
-1.5		eysight 89600 VSA : Error	EVM Power per RE Modulation Num. of (%rms) (dBm) RBs RNTI E
-2.593 Res BW 30 kHz	2.5928 TimeLen 1 Sym	(R) The recording does not contain data for all input char	
Ch1 Spectrum	- ×	The recording does not contain data for all input char	nneis. r
8ng - 15.85 dBm 20 dBm	NO DATA	OK	DATA?
ogMag		LinMag	G: MIMO Info *
10 dB /div		500 m%	Name Meas. Anterna Despread EVM/Power TAE F Channel Port (%rms) (dBm) (sec) (I
-80	Span 96 MHz	0 % Start - 1.638 kcarrier Stop 1.837 kcarrie	er DATA?

Figure 389 Error when flow is not selected in ORAN Studio software

# Section 3.13: Missing Configuration for eAxC ID's

While loading a (recorded) ".pcap" file into Explorer, if the results in message lines are displayed in pink, this indicates that those messages have non-configured eAxC IDs. To fix this, correct eAxC's must be configured in ORAN Studio by use of "Configuration Tool". This can be fixed by either loading an Open RAN Studio settings (.orstx) file, or manually configuring the settings.

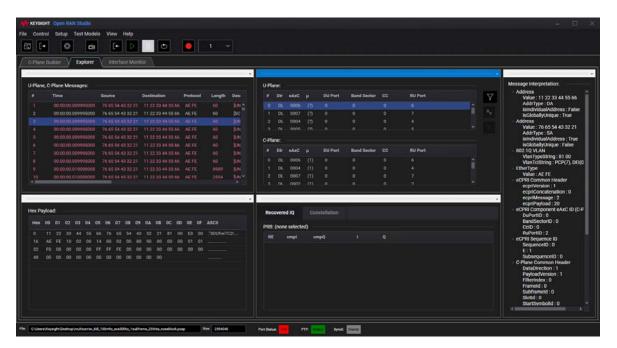


Figure 390 Missing configuration for eAxC IDs

Keysight U5040A Open RAN Studio

User Guide

4.

Using PathWave Signal Generator for Waveform and Channel Setup

Using PathWave Signal Generator for Waveform Setup / 412 Using PathWave Signal Generator for Channel Setup / 413 Using PathWave Signal Generator for Mixed Numerology Carrier Setup / 420



## Section 4.1: Using PathWave Signal Generator for Waveform Setup

Perform the following steps for a waveform setup using the PathWave Signal Generation Desktop 2022 software:

1 Launch the PathWave Signal Generation Desktop 2022 software.

🚸 PATHWAVE 🗀 File	0 = #			PathWave Signal Generation Desktop		? – 🗆 🗙
G Home 5G NR ×						
🖒 Generate 🛓 Generate & Do	ownload	Carrier	Waveform	Hardware	- Import Signal Setup	[+ Export Signal Setup
+ Export 89600 VSA Setup						
<ul> <li>Basic</li> <li>Phyback License Mode</li> <li>Waveform Comment</li> <li>3GPP Version</li> <li>User Defined Sample Rate</li> <li>Sample Rate</li> <li>Time Scale Factor</li> <li>Number of Radio Frames</li> <li>Subframe Offset</li> <li>Number of Subframes</li> <li>Sito Offset in Subframe</li> <li>Total Sample Points</li> <li>Waveform Length</li> <li>Mirror Spectrum</li> <li>Phase Compensation</li> <li>Radio Fraquency</li> <li>Total Number of Antennas</li> <li>Marker 1 Source</li> <li>Marker 2 Source</li> </ul>				PC License ~ /		
0 IQ 0 Spectrum ( CCC	DF) 🔽 Reference	Acquire Reference Wave	form 🕑			
100% - 10% - 1% - 0.1% - 0.01% -						CCDF Gensian
Sep 29, 2021, 8:11:30 PM	PC License	Not connected				Q



- 2 Select "Waveform Setup" branch in the tree.
- 3 Add/delete carriers from the editing toolbox.
- 4 View the potential waveform by:
  - Clicking "Waveform Generation" button.
  - Looking at the information in "CCDF" and "Waveform" tabs.

# Section 4.2: Using PathWave Signal Generator for Channel Setup

Perform the following steps for a Channel setup using the PathWave Signal Generation Desktop 2022 software.

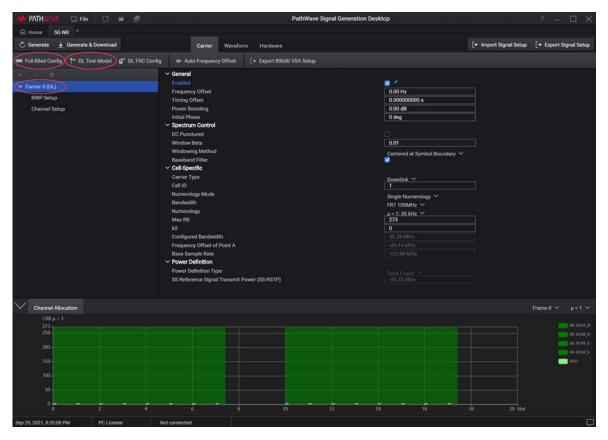


Figure 392 Channel Setup process in PathWave Signal Generation Desktop 2022

- 1 On the PathWave Signal Generation Desktop 2022 application, select "Carrier x (DL)" branch in the tree.
- 2 Click "Full-filled Config" button to quickly create fully filled channels at different numerologies and modulations schemes.

Fullfil	lled Preset Config			$\times$
	Bandwidth	FR2 50MHz	~	
	Numerology	μ = 2: 60 kHz Extended CP	~	
>	Duplex Type	FDD		
	Modulation	QPSK	<	
		OK Cano	cel	

Figure 393 Full-filled Configuration window

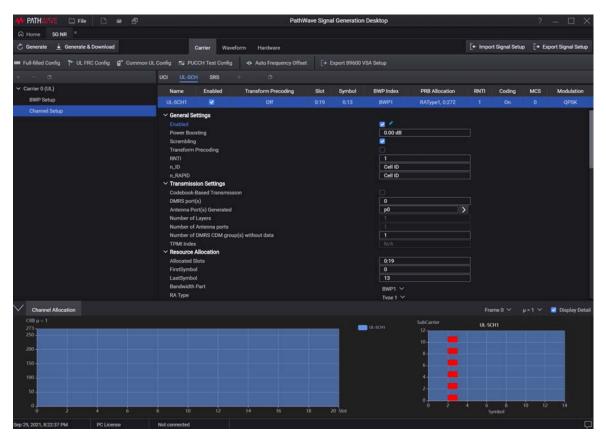
3 Click "DL Test Model" button to quickly create 3GPP antenna conformance test patterns for different numerologies.

Downlink Test Model (Base Station	Tx Test based on 38.141	v16.4.0)		$\times$
Bandwidth Duplex Type BC3 CS16/17 (TS 37.141)	FR1 100MHz TDD	>	NR-FR1-TM1.1 • BS output power • Transmit ON/OFF power • TAE • Unwanted emissions • Occupied bandwidth • ACLR • Operating band unwanted emissions • Transmitter spurious emissions	
Numerology Test Model	μ = 1: 30 kHz NR-FR1-TM1.1	~ ~	<ul> <li>Transmitter intermodulation</li> <li>Receiver spurious emissions</li> </ul>	
Number of Layers	1			
Phase Compensation	Auto	~		
DCI/DLSCH Payload Data	PN23	~		
			OK Cancel	

Figure 394 Viewing Downlink Test Model window

- 4 Click the "Waveform" tab if you wish to see the generated waveform.
- 5 When ready, click the "Export Signal Setup" button. This will open a dialog that allows you to save the RF design to use with Open RAN Studio. The file will be saved in (.SCP) format.

The steps described above pertain to Channel Setup for the Downlink carrier. Similarly, you may perform Channel Setup for the Uplink and PRACH carrier, respectively.



#### Channel Setup interface for Uplink Carrier

Figure 395 Cha

Channel Setup for Uplink carrier

#### Channel Setup interface for PRACH Carrier

N PATHWAVE 🗅 File 🗅 🖨 🗗		PathWave Signal Generation Desl	ktop		? – 🗆 🗙
A Home 5G NR ×					
🖒 Generate 🛓 Generate & Download	Carrier Waveform Hardware			+ Import Signal Setup	[+ Export Signal Setup
▲ PRACH Test Preambles Config    Auto Frequency Offs	iet [+ Export 89600 VSA Setup				
+ - 0	PRACH Time-domain Resource				
<ul> <li>Carrier 0 (PRACH)</li> </ul>	Configuration Table		FR1 - Paired Spectrum/Supplement	tary uplink 🗸	
<ul> <li>Channel Setup</li> </ul>	Configuration Index		16		
	PRACH Format Frame Period				
PRACH Burst	Frame Offset				
	Slot Index				
	Number of PRACH slots within a subframe				
	Number of time-domain PRACH occasions within	a PRACH slot			
	PRACH duration				
	Symbol Start				
22	PRACH Frequency-domain Resource				
	Subcarrier Spacing for PRACH				
0	✓ Active Uplink BWP				
	Numerology		0 = 1:00.04r ×		
	RB Offset (N_BWP_start)		273		
	RB Number (N_BWP_size) Msg1 Frequency Start (n_RA_start)		0		
	Msg1 FDM				
	<ul> <li>PRACH Sequence Generation</li> </ul>				
	PRACH Root Sequence Index		0		
	Restricted Set Config		Unrestricted set V		
	Zero Correlation Zone Config		0		
	L,RA				
	N_CS				
Channel Allocation					Frame 0 🗸 🛛 μ = 1 🗸
Frequency (MHz)					100000
60					PRACH
40					
20					
0					
-20					
-40					
60				9 10 Ms	
Sep 29, 2021, 8:27:25 PM PC License Ne	ot connected				Ģ

Figure 396 Channel Setup for PRACH carrier

4.2.1: Channel Setup for LTE Support

The Open RAN Studio LTE TDD Support application requires an SCP file generated using the N7625C Signal Studio for LTE and LTE-Advanced TDD software (version 2.2.0.0). Similarly, the Open RAN Studio LTE FDD Support application requires an SCP file generated using the N7624C Signal Studio for LTE and LTE-Advanced FDD software (version 2.2.0.0). While the functionality is the same as that explained in these sections, the appearance of the Signal Studio interface is slightly different.

#### Appearance of the N7625C Signal Studio for LTE and LTE-Advanced TDD software

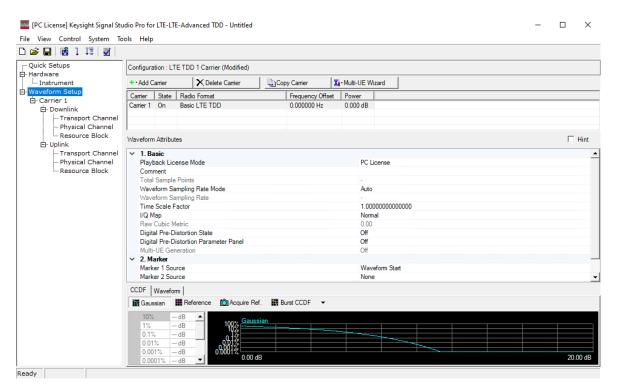


Figure 397 Channel Setup for LTE TDD carrier

#### Appearance of the N7624C Signal Studio for LTE and LTE-Advanced FDD software

Quick Setups            - Hardware             - Instrument             - Carrier 1             - Downlink             - Transport Channel             - Physical Channel             - Physical Channel             - Physical Channel             - Vaveform Satup             - Transport Channel             - Physical Channel             - Vaveform Satup             - Transport Channel             - Vaveform Satup             - Valide             - Resource Block             - Intime Scale Factor             - Uig Stale Peoints             - Waveform Satue             - Ot	×
Hardware       Complete Control         Instrument       * Add Camer         Waveform Setup       Carrier 1         G- Carrier 1       Basic LTE FDD Downlink         Physical Channel       Physical Channel         Resource Block       Vaveform Attributes         Vaveform Setup       Vaveform Attributes         Vaveform Sampling Rate       -         Vaveform Sate       Off         Digital Pre-Distortion State       Off         Digital Pre-Distortion Parameter Panel       Off         Marker 1 Source       None         Marker 2 Source       None </td <td></td>	
How we form Satupe     How we form Attributes     How we form Attributes     How we form Attributes     Hayback License Mode     Comment     Teasport Channel     Hayback License Mode     Comment     Total Sample Points     Wave form Satupe Points     Wave form Satupe Points     Wave form Satupe Points     Wave form Satupe Points     Hayback License Mode     Comment     Total Sample Points     Wave form Satupe     Wave form     Wave form     Wave form	
Carrier 1     On Basic LTE FDD Downlink     Control of Carrier 1     On Basic LTE FDD Downlink     O.000000 Hz     O.000 dB     Vaveform Attributes     Vaveform Attributes     Vaveform Sampling Rate Node     Comment     Total Sample Points     Vaveform Sampling Rate Node     Vaveform Sampling Rate Node     Vaveform Sampling Rate     Vaveform Sampling Rate     Comment     Total Sample Points     Vaveform Sampling Rate Node     Vaveform Sampling Rate     Vaveform Sampling Rate     Comment     Total Sample Points     Vaveform Sampling Rate     On     Vaveform Sampling Rate     On     Digital Pre-Distortion State     Off     Digital Pre-Distortion State     Off     Digital Pre-Distortion Parameter Panel     Off     Vateform Stat     Marker 1 Source     None     Marker 2 Source     None     Marker 4 Source     None     Marker 4 Source     None	
Carrier 1 On Basic LTE FDD Downlink 0.00000 Hz 0.000 dB     Carrier 1 On Basic LTE FDD Downlink 0.000000 Hz 0.000 dB     Vareform Attributes     Vareform Attributes	
Transport Channel       Physical Channel         Physical Channel       Waveform Attributes         Image: Comment       PC License         Total Sample Points       -         Total Sample Points       -         Waveform Sampling Rate       -         Waveform Sampling Rate       -         Waveform Sampling Rate       -         Time Scale Factor       1.000000000000         I/Q Map       Normal         Raw Cubic Metric       0.00         Digital Pre-Distortion State       Off         Digital Pre-Distortion Parameter Panel       Off         Multi-UE Generation       Off         Marker 1 Source       Waveform Statt         Marker 2 Source       None         Marker 4 Source       None         CCDF       Waveform	
Physical Channel       Waveform Attributes         Resource Block <ul> <li>Y</li> <li>1.Basic</li> <li>Playback License Mode</li> <li>Comment</li> <li>Total Sample Points</li> <li>Waveform Sampling Rate Mode</li> <li>Auto</li> </ul> Waveform Sampling Rate Mode       Auto         Waveform Sampling Rate       -         Time Scale Factor       1.000000000000000000000000000000000000	
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Comment     -       Total Sample Points     -       Waveform Sampling Rate Mode     Auto       Waveform Sampling Rate     -       Time Scale Factor     1.00000000000       I/Q Map     Normal       Raw Cubic Metric     0.00       Digital Pre-Distortion State     Off       Digital Pre-Distortion Parameter Panel     Off       Multi-UE Generation     Off       Vulti-VE Generation     Off       Multi-US Generation     Off       Marker 1 Source     None       Marker 4 Source     None       Marker 4 Source     None       CCDF     Waveform	
Waveform Sampling Rate Mode     Auto       Waveform Sampling Rate     -       Time Scale Factor     1.00000000000       I/Q Map     Normal       Raw Cubic Metric     0.00       Digital Pre-Distortion State     Off       Digital Pre-Distortion Parameter Panel     Off       Multi-UE Generation     Off       Waveform Starter     Waveform Start       Marker 1 Source     Waveform Start       Marker 2 Source     None       Marker 4 Source     None       CCDF     Waveform	
Waveform Sampling Rate       -         Time Scale Factor       1.00000000000         VQ Map       Normal         Raw Cubic Metric       0.00         Digital Pre-Distortion State       Off         Digital Pre-Distortion Parameter Panel       Off         Multi-UE Generation       Off         Wulti-UE Generation       Off         Marker 1 Source       Waveform Stat         Marker 2 Source       None         Marker 4 Source       None         Warker 4 Source       None	
Time Scale Factor       1.00000000000         I/Q Map       Normal         Raw Cubic Metric       0.00         Digital Pre-Distortion State       Off         Digital Pre-Distortion Parameter Panel       Off         Multi-UE Generation       Off         V       2. Marker         Marker 1 Source       Waveform Start         Marker 2 Source       None         Marker 4 Source       None         Marker 4 Source       None         Marker 4 Source       None	
VQ Map     Normal       Raw Cubic Metric     0.00       Digital Pre-Distortion State     Off       Digital Pre-Distortion Parameter Panel     Off       Multi-UE Generation     Off       * 2. Marker     Marker 1 Source       Marker 1 Source     None       Marker 3 Source     None       Marker 4 Source     None       CCDF     Waveform	
Raw Cubic Metric     0.00       Digital Pre-Distortion State     Off       Digital Pre-Distortion Parameter Panel     Off       Wilth-UE Generation     Off       V     2. Marker       Marker 1 Source     Waveform Start       Marker 2 Source     None       Marker 4 Source     None       CCDF     Waveform	
Digital Pre-Distortion State     Off       Digital Pre-Distortion Parameter Panel     Off       Multi-UE Generation     Off       V     2. Marker       Marker 1 Source     Waveform Start       Marker 2 Source     None       Marker 4 Source     None       Marker 4 Source     None	
Digital Pre-Distortion Parameter Panel     Off       Multi-UE Generation     Off       V     2. Marker       Marker 1 Source     Waveform Start       Marker 2 Source     None       Marker 3 Source     None       Marker 4 Source     None       CCDF     Waveform	
Multi-UE Generation     Off       V     2. Marker       Marker 1 Source     Waveform Start       Marker 2 Source     None       Marker 3 Source     None       Marker 4 Source     None       CCDF     Waveform	
V     2. Marker       Marker 1 Source     Waveform Start       Marker 2 Source     None       Marker 4 Source     None       CCDF     Waveform	
Marker 1 Source     Waveform Start       Marker 2 Source     None       Marker 3 Source     None       Marker 4 Source     None	
Marker 2 Source None Marker 3 Source None Marker 4 Source None CCDF Waveform	
Marker 4 Source None CCDF   Waveform	
CCDF   Waveform	
🗱 Gaussian 🗱 Reference 🙆 Acquire Ref. 🗱 Burst CCDF 👻	
10%         − dB         Gaussian           1%         − dB         0.1%         − dB           0.01%         − dB         0.001%         − dB           0.001%         − dB         0.00 dB         20	20.00 dB

Figure 398

Channel Setup for LTE FDD carrier

# Section 4.3: Using PathWave Signal Generator for Mixed Numerology Carrier Setup

Perform the following steps for mixed numerology carrier setup using the PathWave Signal Generation Desktop 2022 software.

- 1 On the PathWave Signal Generation Desktop 2020 application, select "Carrier x (DL)" branch in the tree.
- 2 Create a carrier as normal, but set the "Numerology Mode" to "Multiple Numerologies".

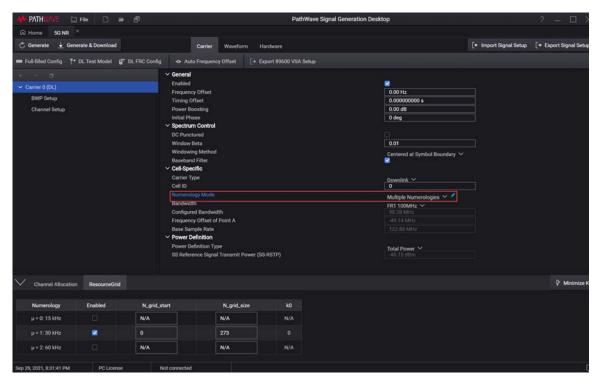


Figure 399 Mixed Numerology Carrier Setup

3 Select "BWP Setup" branch in the tree. Create bandwidth parts for the different numerologies and enable the active grids.

🕩 PATHWAVE 🛛 🗀 FI	le 🗋 🗃			PathWave	Signal Generation Desk	top		? - 🗆
ය Home 5G NR ×								
🖑 Generate 🛓 Generat	te & Download		Carrier Waveform	Hardware			+ Import Signal Setup	[+ Export Signal Se
Full-filled Config T+ DL	. Test Model	DL FRC Config	> Auto Frequency Offset	<ul> <li>Export 89600 VSA Setup</li> </ul>				
		+ Add	BWP - Remove BWP	Copy BWP				
<ul> <li>Carrier 0 (DL)</li> </ul>		ID	Name	Numerology	Bandwidth	#CORESET		
BWP Setup		0	Initial BWP	µ = 1:30 kHz	126	24	8.64 MHz	
Channel Setup		1	BWP1	μ = 1: 30 kHz	0	273	98.28 MHz	1
		R8 R8 ✓ <b>C0</b> Nu ✓ C0	merology Offset (N. 20WP_start) Number (N. 20WP_size) ntrol Resource Sets messer (JD = 1) CORESET (JD = 1) C			µ = 1: 30 MHz ✓ 0 273 1 NICORESET 1 2 Not Configured 1000000000000000000000000000000000000		
Channel Allocation	ResourceGrid							🖗 Minimiz
Numerology	Enabled	N_grid_start	N_grid_size	kO				
μ = 0: 15 kHz		138	270					
			273					
µ = 1:30 kHz								

Figure 400 Configuring information for BWP Setup

4 Select "Channel Setup" branch in the tree. Create channels and assign to bandwidth parts.

🚧 PATHWAVE 🗀 File 🗋 🖨 🗗		PathWave Signal	Seneration De	sktop					
G Home 5G NR ×									
🖒 Generate 👌 Generate & Download	Carrier Wave	form Hardware				[+ Impor	Signal Setup	[+ Exp	ort Signal Setu
Full-filled Config 👎 DL Test Model g DL FRC Conf	fig 🔷 Auto Frequency Offset	-+ Export 89600 VSA Setup							
	SS/PBCH DCI DL-SCH	CSI-RS PRS LTE-Coexistence							
- Carrier 0 (DL)	Name Enabled	Slot	Symbol	8WP Index	PRB Allocation	RNTI	Coding	MCS	Modulation
BWP Setup	DL-SCH1	0.1.2.3.4.5.6.10.11.12.13.14.15.16	0:13	BWP1	RAType1, 3:272				QPSK
Channel Setup	Number of DMRS CDM group		W.142	1	in the second		ų		NT-UR
	Number of Codewords	a minor cara							
	~ Resource Allocation								
	Allocated Slots			0,1,2,3,4,5,6,1	0,11,12,13,14,15,16				
	First Symbol			0					
	Last Symbol			13					
	Bandwidth Part			BWP1 ~					
	RA Type			Type 1 V					
	RB Offset			3					
	RB Number			270					
	VRB-to-PRB Mapping PRB Bundle Size			Non-Interleave					
	CORESET ID For RateMatchi	<u>40</u>		Wideband $\sim$					
	RateMatchPattern(s)	ag .		0 Pattern(s) E	Enabled				
	<ul> <li>Modulation and Coding</li> </ul>			o Patternija) i	inauleu /				
	Channel Coding								
	MCS Table				1 (64QAM) 🗸				
	MCS			0	r (pagaan) . •				
	TB Scaling Factor			1.0 ~					
	wheekand								
Channel Allocation ResourceGrid CR8 µ = 1						Fran	ne0 ∽ µ		🗹 Display De
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200-					8				
100 -					4				
50 -					2				
ő.					0 2	4 6	8 10	0 12	14
p 29, 2021, 8:42:07 PM PC License	Not connected								

Figure 401

Configuring information for Channel Setup

Keysight U5040A Open RAN Studio

User Guide

# 5. Playback and Capture

Overview / 424 Playback and Capture Toolbar / 425 Play Continuous / 426 Play Single Sweep / 427 Capture Number of Radio frames / 428 Capture and Load a File / 429



## Section 5.1: Overview

The Open RAN Studio Player software and the Integrated Hardware Appliance will playback Open RAN Studio Builder generated stimulus files to an O-RU Radio Unit over an Ethernet based interface. The Open RAN Studio Player emulates and is seen by the DUT (O-RU) as an O-DU. The Keysight Open RAN Studio Player application is provided for use on the Integrated Hardware Appliance.

To ensure compliant frame synchronization, the Open RAN Studio Player can also act as a PTP master and ensure that O-RAN messages are played honoring specified timestamps – enabling positive and negative testing of required timing windows.

The player also generates frames using the System Frame Number (SFN) algorithm in *Section 9.7.2* of the O-RAN specification.

For further details on its application and key features, refer to the product datasheet available on www.keysight.com.

The Open RAN Studio provide a set of toolbar buttons, which controls the playback and capture handled by the connected DU Emulator (Player). If these buttons are dimmed it indicates that no O-DU Emulator is found running. (Configuration and availability test of O-DU Emulator is done via the "Configuration Tool").



# Section 5.2: Playback and Capture Toolbar

The tool bar provides the following convenient functions:

Table 12 Player toolbar

Elements	Name	Function
[+	Load Stimulus	This button loads a stimulus PCAP file for playout on the Open RAN O-DU Emulator.
	Play Stimulus	This button starts playout of a previously loaded "stimulus" file on the Open RAN O-DU Emulator.
11	Pause Stimulus	This button toggles the O-DU Emulator state between stopped and running.
Ð	Single / Continuous Sweep	This is a toggle button that controls single or continuous "stimulus" playout mode on O-DU Emulator. In single mode, the stimulus file is played "once" per click of the Play (or Pause) Stimulus button.
	Record	This button starts/stops recording on the Open RAN O-DU Emulator of traffic between the O-DU Emulator and the O-RU DUT. Note that this feature interleaves downlink and uplink traffic into a single ".pcap" recording.
1 ×	Recording Length	This button controls the maximum number of RF frames recorded by the O-DU Emulator. You can chose a number of frames from the pull down menu or enter a value like "100" RF frames. Value "0" will be captured continuously.

## Section 5.3: Play Continuous

Perform the steps below to play the stimulus file continuously in an Open RAN O-DU Emulator:

- 1 Set the "Sweep" button ♂ or 🕶 to "Continuous" mode ♂.
- 2 When you click the "Play" button 🗾, its background changes to gray

in color | > , implying that the O-DU Emulator is on and "playing".

Simultaneously, the "Pause" button II changes to black indicating the O-DU Emulator is running.

- 3 The "Sweep" button 🕑 or 🕑 is set to "Continuous" mode; thus, the play action continues until paused by clicking the "Pause" button
- 4 When you click the "Pause" button while the O-DU Emulator is playing (indicated by the "Play" button being gray), the O-DU Emulator will stop playing.
- 5 You can resume playing by either clicking the "Pause" 🔢 or the

"Play" button 🖻

#### Section 5.4: Play Single Sweep

Perform the steps below to play stimulus file single sweep in an Open RAN O-DU Emulator:

- 1 Set the "Sweep" button 🖒 or 🕶 to "Single" mode 🕶 .
- 2 When you click the "Play" button **1**, its background changes to gray

in color | > , implying that the O-DU Emulator is on and "playing".

Simultaneously, the "Pause" button III changes to black indicating the O-DU Emulator is running. These indications last only as long as it takes to play a single sweep (that is, to play the stimulus file once).

- 3 The "Sweep" button 🕐 or 🕶 is set to "Single" mode 🕶; thus, the play action will just play the stimulus file once.
- 4 After playing the stimulus file, once the O-DU Emulator stops automatically, it is indicated by the "Play" button's background turning

black 🗋 and the "Pause" button's background turning gray

5 You may trigger a new sweep by either clicking the "Pause" or the "Play" button .

## Section 5.5: Capture Number of Radio frames

Perform the following steps to use the O-RAN studio to capture a number of radio frames:

- 1 The "Record" button together with the associated combo-box controls the O-DU Emulator capture function.
- 2 When the **[11]** "Record" button is clicked, a Stop icon is displayed and

the button's background changes to gray in color <a>
 </a>

 , implying that the O-DU Emulator is on and "capturing". The O-DU captures a number of radio frames as specified in the combo-box. The captured data contains both DL (played by "player") and UL traffic (received from DUT). The file is formatted as a ".pcap" file.

NOTE	This mode should capture at least the specified number of radio frames based on the size of the input stimulus. In most cases, it will capture at least one additional radio frame to guarantee that a full frame is captured.

- 3 As a special case, the recording length can be specified to "Until Full". This implies that recording is running infinitely – or until the file is full. In this mode, no DL traffic is captured and the recorder works as a sniffer, simply capturing everything received.
- 4 The recording does not automatically stop. The recording continues until the radio frame count specified in the combo-box has been reached, or until the Stop button is clicked.

### Section 5.6: Capture and Load a File

Perform the following steps to capture a file and open in the O-RAN Studio Explorer:

1 When the recording is completed by clicking the Stop button, a dialog box pops up as the captured file is being stored. The captured file, named *captured <year-month-day-hour-min-sec>.pcap*, is stored on the file system in the same folder as the stimulus that was loaded (or in the user's "Documents" folder if no stimulus was loaded).

The destination of the saved captured file is shown in the "Progress Dialog" window when file transfer is completed.

Progress Dialog			×
Activity Progres	s:		
		100%	
Activity Details:			
	mpleted successfully saved to: C:\Users\Keysig	ht\Documents\Keysight\Open RAN Studio\captured 2020-08-22–14-17-	-39.pcap
Ok	Cancel	Open captured file in Explorer	

Figure 402 Progress Dialog displaying status of file capturing activity

2 When the file transfer is completed, the captured file can automatically be opened in Explorer by selecting "Open captured file in Explorer" check box before you click "OK".

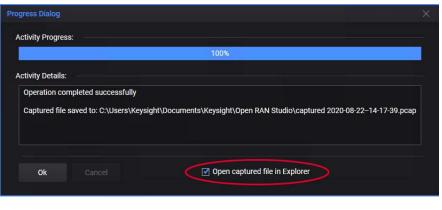


Figure 403 Progress Dialog option to open file in Explorer

"Progress Dialog" window is closed after you click "OK" and the captured file opens in the Explorer.

The file name is shown in the Status bar as highlighted below:

Same Builder ) Explorer ( seterface Montar															
U-Plane, C-Plane Messages:							U-Ph	ane:							Message Interpretation:
	Time.	Source	Destination	Protocol	Length	Description			eAxC		DU Port	Band Sector	RU Port	V	
	20:20:39.579995143					Iscrit c-Pite 2									
	20:20:39.579998432					(SCP) U-PIA									
	20:20:39.580034179		02 04 05 08 0A 0C			[SCP] U-Plai									
	20:20:39.589995136					(SCP] C-Pla									
	20.20.39.589998425					(SCP) U-Pla (SCP) U-Pla	CPI	ane:							
	20:20:39.590034172 20:20:39.599995166				64 64	(SCP) C-Plai			eAst		DU Port	Band Sector	RU Port		
	20:20:39.599998455				64	ISCPI U-Plan			0001						
	20:20:39.600034140				64	ISCPI U-Pla									
	20/20:39 609995172					Incel c-Ptw *									
'ayı	oad:						Rec	covere	ed liQ	Cor	atellation				
0	0 01 02 03 04 0	05 06 07 08 01	0A 08 0C 00		ASCI		000	- (000	e selecti	-0					
							RE		cambi		nþQ				

Figure 404 Captured file location displayed on Status bar

# Appendix I: IQ Scaling Flow

Signal Studio I/Q  $\Rightarrow$  Scale within dBFS Circle  $\Rightarrow$  Scale with Additional IQ Power Scaling AND\* FS Adjustment  $\Rightarrow$  Scale to Configured IQ Width

Modulation Type	Signal Studio I/Q (Value_0)	Scale within dBFS Circle Single Constellation OR 256 QAM Scaling (Value_1)		Scale with Additional IQ Power Scaling AND* FS Adjustment (Value_2) *In practice you'd probably only use one of them.		Scale to Configured IQ Width (Value_3)		
		Single** Constellation Scaling ** carrier can have multiple kinds of modulations. In this case we apply the "largest"	With 256 QAM Scaling	Additional IQ Power Scaling by -X dBFS	FS Adjustment by Y FS_Offset	No Compression OR Block Scaling Re(fPRB) / Im(fPRB)	Block Floating Point Re(fPRB) / Im(fPRB)	μ-Law Compression prbl / prbQ
4QAM	Value_0 e.g. $1/\sqrt{2} = 0.707$ 4QAM • • • • • • • • • • • • • • • • • • •	(Value_0 / 1) e.g. 0.707/1=0.707	(Value_0 / 1.62715) e.g. 0.707/1.62715=0.4345	(Value_1/10^(X/20)) e.g. Single Constellation Scaling & -6 dBFS Additional Power Scaling I/Q= (0.707/10^(6/20)) e.g. 256 QAM Constellation Scaling & No Additional Power Scaling I/Q = 0.4345	(Value_1/sqrt(1/2^-Y)) e.g. Single Constellation Scaling & FS Adjustment by 2 FS_Offset I/Q= (0.707/sqrt(1/2^-2)) e.g. 256 QAM Constellation Scaling & No FS Adjustment I/Q = 0.4345	(Value_2 * 2^(IQWidth -1)) e.g. Single Constellation Scaling & 16-bit IQ Width I/Q=0.707*2^15=23166 Single Constellation Scaling & -6 dBFS Additional Power Scaling & 16-bit IQ Width I/Q= (0.707/10^(6/20))*2^15 = 11610 Single Constellation Scaling & FS Adjustment by 2 FS_Offset & 16-bit IQ Width I/Q= (0.707/sqrt(1/2^-2))*2^15 = 11583	(Value_2 *(2^(mantissaBW-1)) * (2^(2^exponentBW)-1)) mantissaBW : Mantissa bitwidth is user configured bitwidth exponentBW : 4 bits for Exponent e.g. Single Constellation Scaling & Block Floating Point (IQ Width 16) I/Q = (0.707 *(2^15) * (2^(2^4)-1)) = 759135469	(Value_2 * 2^15) <i>IQ Width fixed to</i> 16
16QAM	Value_0 e.g. $3/\sqrt{10} = 0.94$ 16QAM $3/\sqrt{10} = 0.94$	(Value_0 / 1.329561528) e.g. 0.94/1.329561528=0.707	(Value_0 /1.62715) e.g. 0.94/1.62715=0.577	Same as above	Same as above	Same as above	Same as above	Same as above
64QAM	Value_0 e.g. $7/\sqrt{42} = 1.08012$ $_{640AM}$	(Value_0 / 1.527751061) e.g. 1.0802/1.527751061=0.707	(Value_0 / 1.62715) e.g. 1.0802/1.62715=0.66	Same as above	Same as above	Same as above	Same as above	Same as above
256QAM	Value_0 e.g. $15/\sqrt{170} = 1.1504$ 256 QAM	(Value_0 / 1.62715) e.g. 1.1504/1.62715=0.707	(Value_0 / 1.62715) e.g. 1.1504/1.62715=0.707	Same as above	Same as above	Same as above	Same as above	Same as above



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