Keysight U5040A Open RAN Studio

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

Getting Started
Guide

KEYSIGHT
TECHNOLOGIES

Notices

Manual Part Number

U5040-91000

Edition

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Keysight Technologies, 1900 Garden of the Gods Rd, Colorado Springs, CO 80907, United States

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Safety Notices

CAUTION

A CAUTION notice denotes a hazard. It calls attention to an operating procedure, practice, or the like that, if not correctly performed or adhered to, could result in damage to the product or loss of important data. Do not proceed beyond a CAUTION notice until the indicated conditions are fully understood and met.

WARNING

A WARNING notice denotes a hazard. It calls attention to an operating procedure, practice, or the like that, if not correctly performed or adhered to, could result in personal injury or death. Do not proceed beyond a WARNING notice until the indicated conditions are fully understood and met.

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.
	Standby supply. Unit is not completely disconnected from AC mains when switch is off.
	The CE mark is a registered trademark of the European Community.
	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
	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.
	The recycling symbol indicates the general ease with which the instrument can be recycled.
	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

Table 1   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.

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.

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1 Getting Started

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About this Document

This guide is intended to help users get started quickly with the U5040A Open RAN Studio.

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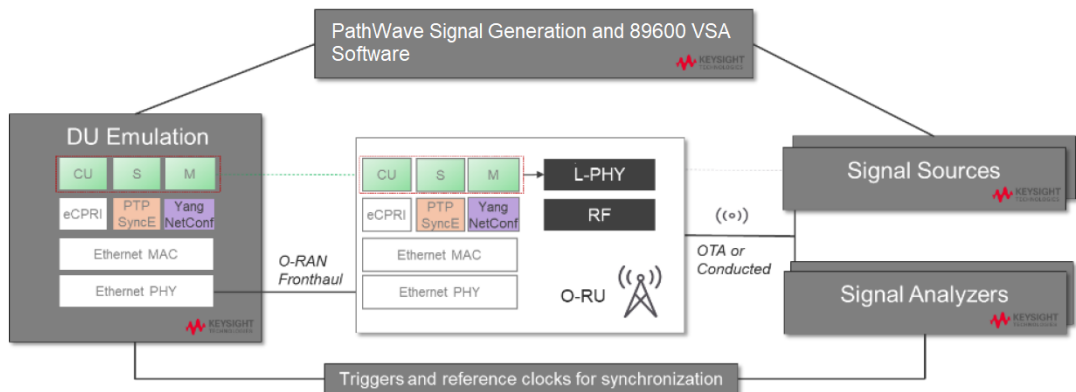
Designed for LTE and 5G O-RAN Radio Unit (O-RU) testing, Keysight Open RAN Studio provides powerful, yet easy to use, capabilities to:

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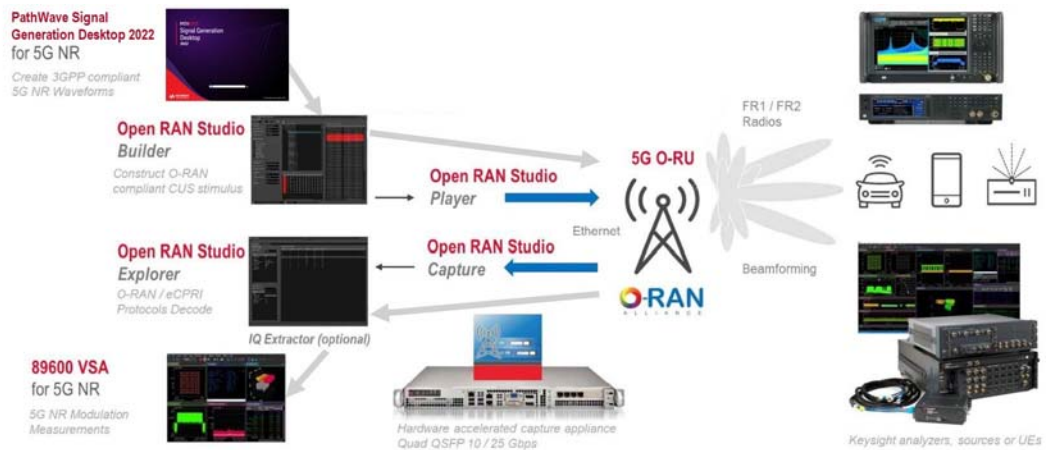
Figure 1   Integrated Open RAN Studio solution for comprehensive O-RU testing

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

1   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 front-haul Interface.

  a 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.

Prerequisites

The following are the prerequisites for installing Keysight U5040A O-RAN software:

System Prerequisites

- Windows 10 64-bit
- Minimum 8 GBytes RAM
- Microsoft .NET 3.5 (installed with OS or updated from Internet)

Software Prerequisites

- Keysight IO Libraries, version 18.0 or later
- Keysight License Manager 5 (2. Downloading and Installing Keysight License Manager 5)
- IVI Shared components 64-bit 2.6.1 or later
- PathWave Signal Generation Desktop 2022 (for 5G NR)
- Signal Studio Software
  - N7624C Signal Studio for LTE/LTE-Advanced FDD – software version 2.2.0.0
  - N7625C Signal Studio for LTE/LTE-Advanced TDD – software version 2.2.0.0

Licenses

This section covers the license information required by the following application.

Table 2   O-RAN Studio Software and corresponding license options

Setup Mode	Software	License options
Complete	U5040A Open RAN Studio	• U5040BSCA - Base Software license • U5040IQEA - IQ Extraction license • U5040MDLA[1] - Manufacturing Downlink Test license • U5040MULA[2] - Manufacturing Uplink Test license
	PathWave Signal Generation	• N7631ORNC - PathWave Signal Generation license (for 5G NR)
Custom	U5040A Open RAN Studio	• U5040BSCA - Base Software license • U5040IQEA - IQ Extraction license • U5040MDLA - Pre-defined Downlink Test license
	U5040A Open RAN Studio: LTE FDD Support	• U5040BSCA - Base Software license
	U5040A Open RAN Studio: LTE TDD Support	• U5040BSCA - Base Software license
	N7624C Signal Studio for LTE/LTE-Advanced FDD	• N7624ORNC - Signal Studio LTE FDD license
	N7625C Signal Studio for LTE/LTE-Advanced TDD	• N7625ORNC - Signal Studio LTE TDD license

1. The U5040MDLA license allows you to play pre-defined Downlink PCAP files through the BittWare HW using the REST API. You will not be able to launch the Open RAN Studio GUI and actions pertaining to ORAN testing can be performed using saved files only. This license is targeted for manufacturers, so facilitate lower costs for testing RUs on the manufacturing line.

2. The U5040MULA license allows you to play pre-defined Uplink PCAP files through the BittWare HW using the REST API. This license also supports an application required for BER/BLER measurement on the captured data. Refer to Measuring BER / BLER using ORAN Studio Solution (v1.2) Reference Guide for more information.

> **NOTE**
>
> Use Keysight License Manager 5 to install 'fixed' licenses; whereas, to install 'floating licenses, use Keysight License Manager 6. To know about how to redeem a license in the latter, refer to the Help file, which can be found at: *C:/Program Files/Common Files/Keysight/License Manager 6/bin/help/Content/KLMHelp.htm*.

Installation

Software Download

Download the latest version of the software from "Drivers, Firmware & Software" tab of the U5040BSCA Open RAN Studio for O-RAN Radio Unit (O-RU) Testing and Validation Technical Support page.

Installation Options

The Setup wizard for the U5040A Open RAN Studio software provides you two options in the Setup mode, to determine the software components that must be installed.

- **Complete** – Proceeds with automatically installing the "Open RAN Studio Base Software" and "Open RAN Studio Hardware Support" software components only. These components are displayed as the offline version and the full version of the U5040A Open RAN Studio Software, which supports the BittWare Hardware and BittWare XUPP3R-0121 PCIe card, connected to the PC.
- **Custom** – Lets you choose one or more software components to install on your machine.
    - Open RAN Studio Base Software
    - Open RAN Studio Hardware Support
    - Open RAN Studio LTE TDD Support
    - Open RAN Studio LTE FDD Support
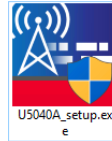   - M-Plane Toolkit

See for more information on the installation options.

Installation Steps

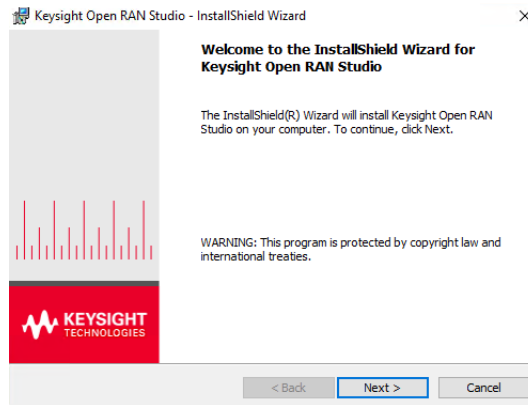This section contains detailed steps for installing the software.

Step 1 - Launching the Installer

After you download the software, double click the setup icon to launch the installshield wizard:

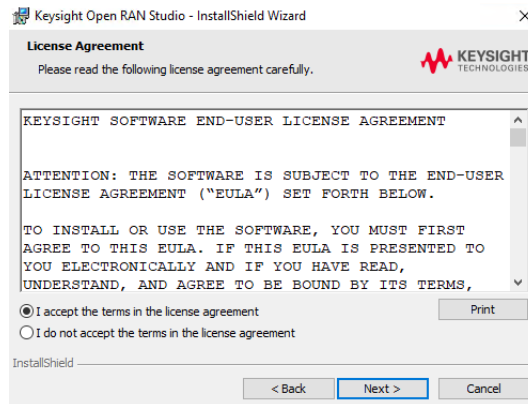Click **Yes** on the "User Account Control" prompt to proceed with installation.

Step 2 - Welcome Screen

Click **Next**.

Step 3 - Accepting the License Agreement

You must carefully read and accept the **End User License Agreement** (EULA) in order to install or use the software.

If you agree to the license agreement, select "**I accept the terms in the license agreement**" and click **Next**.

Step 4 - Customer Information

In the **Customer Information** dialog, enter your name and company/organization name.
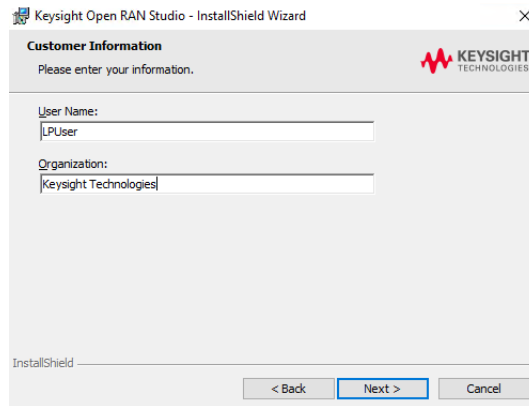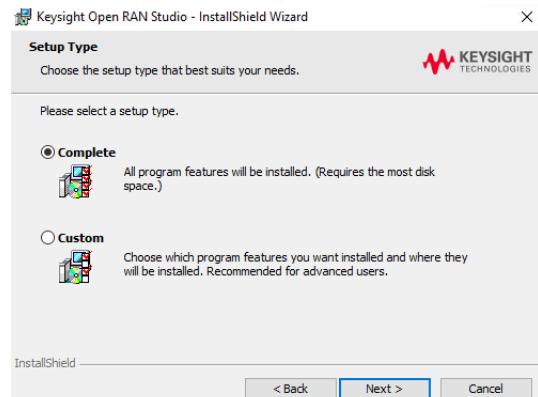

Click **Next**.

Step 5 - Setup Type

Select the appropriate option either for automatic or manual selection of one or more Open RAN Studio software components that must be installed:

· "Complete" setup
· "Custom" setup

"Complete" setup

Select **Complete** so that the "Open RAN Studio Base Software" and "Open RAN Studio Hardware Support" software components only are automatically installed.
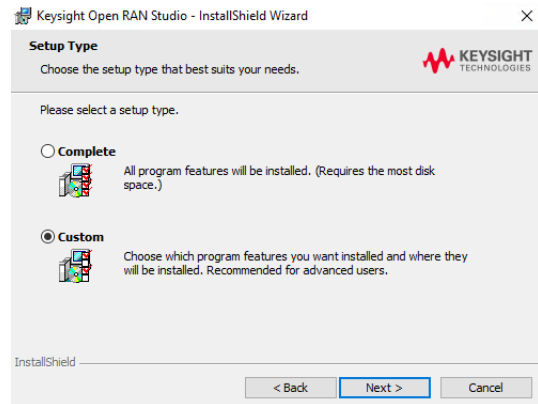

Click **Next** and proceed to

"Custom" setup

Select **Custom** to view the Open RAN Studio software components that you may choose to select or remove for installation.

| NOTE | By selecting the Setup Type as 'Custom', you may choose not to install the Open RAN Studio Drivers, which are required only when installing on BittWare Hardware. |

Click **Next**.

On the following window, the software components appear with default setup options, which are given below. Note that the first two components in the list below are set to be installed automatically when the **Setup Type** is selected as "Complete".
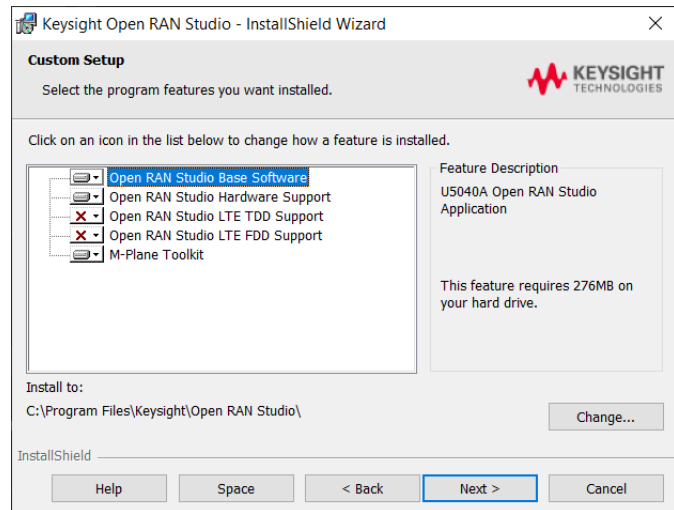

As mentioned earlier, the "Open RAN Studio LTE TDD Support" and "Open RAN Studio LTE FDD Support" applications are not part of the default "Complete" installation. You must manually indicate in the installer whether to install either one or both components on the local drive of your machine.

To toggle between the setup options, click the drop-down arrow.

To install the "Open RAN Studio LTE TDD Support" application, select the option "This feature will be installed on local hard drive".
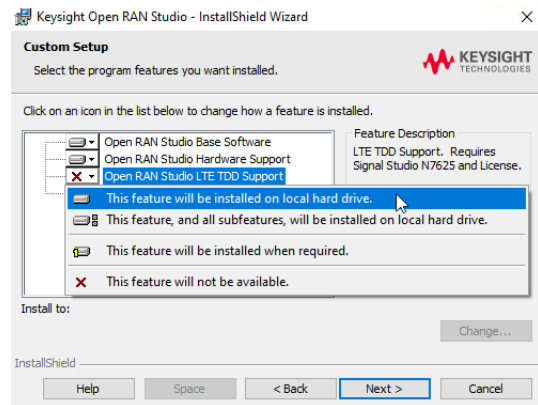
Similarly, to install the "Open RAN Studio LTE FDD Support" application, select the option "This feature will be installed on local hard drive".
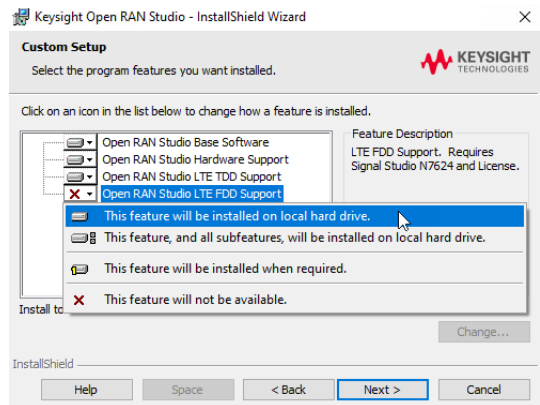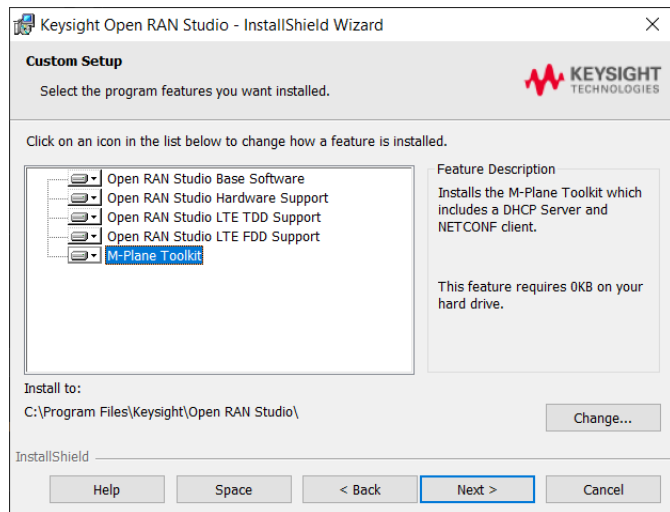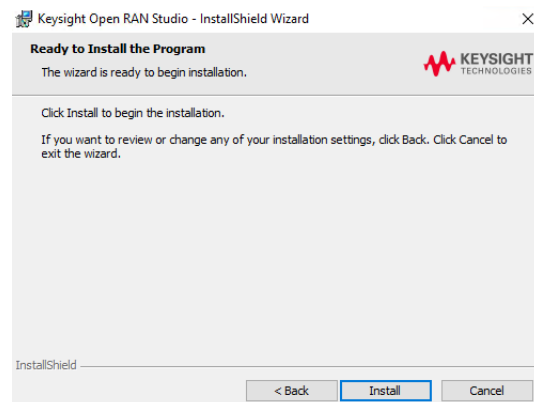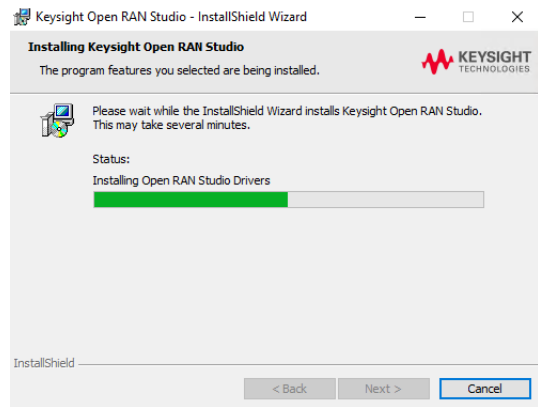
Click **Next**.

Step 6 - Ready to Install

After you select the **Setup Type** (and the required software components), click **Install** to begin the installation.

A progress bar is displayed during the installation process.

Step 7 - Installation Completion

Click **Finish**. This completes the installation process.
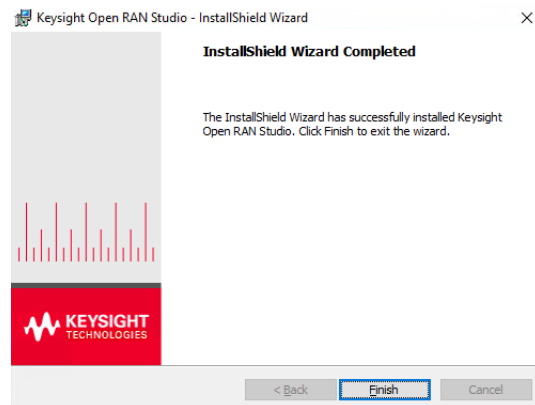
You may also be required to reboot the computer.

Launching the Application

You may launch the following components from the **Start** menu of your machine.

- U5040A Open RAN Studio
- U5040A Open RAN Studio - Offline
- U5040A Open RAN Studio LTE TDD Support (appears after 'Custom' installation only)
- U5040A Open RAN Studio LTE FDD Support (appears after 'Custom' installation only)

The detailed information launching and using O-RAN application user interface elements is available in *Open RAN Studio Online Help*, which can be found in *C:\Program Files\Keysight\Open RAN Studio\Help.*

Firmware Updates

Firmware Update Process

If a firmware update is required, you will see a dialog like the following:

<table>
<tr><td colspan="2">Firmware Update</td><td>×</td></tr>
</table>

Firmware Details:
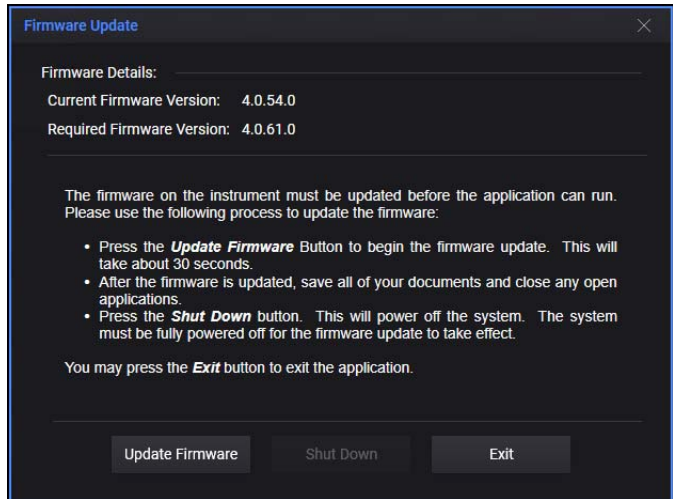Current Firmware Version: 4.0.54.0
Required Firmware Version: 4.0.61.0

The firmware on the instrument must be updated before the application can run. Please use the following process to update the firmware:

- Press the **Update Firmware** Button to begin the firmware update. This will take about 30 seconds.
- After the firmware is updated, save all of your documents and close any open applications.
- Press the **Shut Down** button. This will power off the system. The system must be fully powered off for the firmware update to take effect.

You may press the **Exit** button to exit the application.

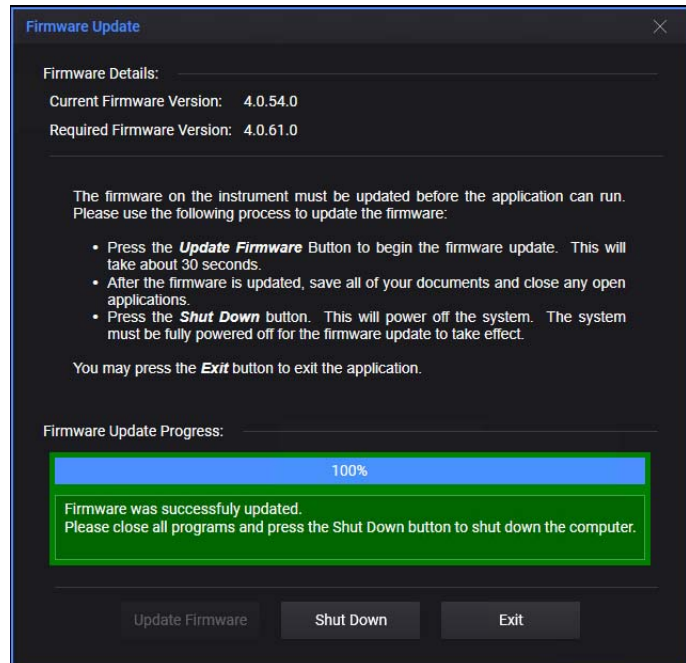[Update Firmware]   [Shut Down]   [Exit]

NOTE	Your computer should not be shutdown or lose power during a firmware update. This may corrupt the firmware on the card, requiring a special process to recover the firmware.

At this point, click the **Update Firmware** button to start the firmware update process.

This process takes 10-20 seconds to complete. On successful completion, you will see the following window:

If the progress / status area turns red, please refer to the next section on *Firmware Update Errors*.

After a successful firmware update, close all open application and click **Shut Down**. If you cannot shutdown immediately, click the **Exit** button.

NOTE	The updated firmware will not be loaded into the card until the computer has been shut down to a complete power off state.

Firmware Update Errors

If an error occurs during firmware update, you may see a dialog like the following:
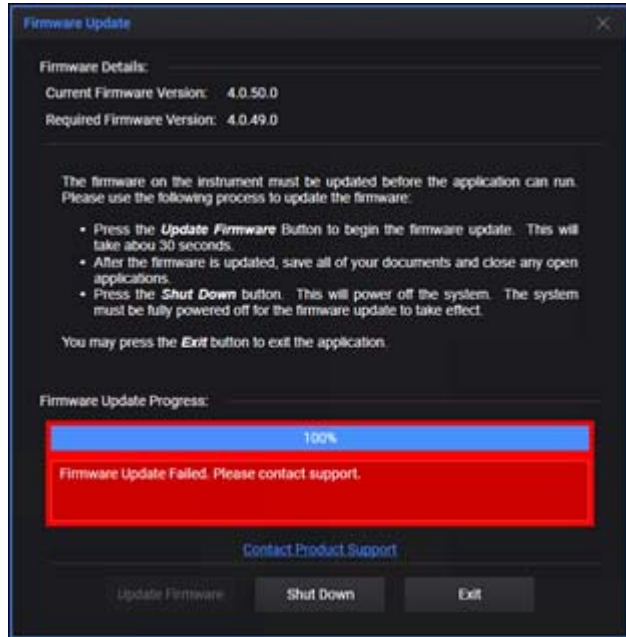
If this happens, please exit the application and try updating the firmware again. If this does not work, please contact product support. See Troubleshooting Installation on page 29.

Troubleshooting Installation

- If installing the complete/hardware install and the installer is stalling for long periods or failing installing Keysight IO Libraries, try downloading and installing Keysight IO Libraries directly from:
  - http://www.keysight/com/find/iolibs
  - Please select the 2019 U1 version (Build 18.1.24715.0)
- For logging information, run the installer from the command line with the following options:
  - "U5040A_setup.exe" /debuglog"C:\tmp\isdebug.log" /v"ISDEBUGLOG=C:\tmp\prereq.log"
- For Keysight support for help with tools and documentation or to connect with a technical expert for product and service support, see http://www.keysight.com/find/support.

1   Getting Started

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U5040-91000

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