

Keysight U5040B Open RAN Studio Software

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

Startup Guide

Notices

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Manual Part Number

9921-01567.EN

Edition

Edition 1.2, June 2026

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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

This product has been designed and tested in accordance with accepted industry standards, and has been supplied in a safe condition. The documentation contains information and warnings that must be followed by the user to ensure safe operation and to maintain the product in a safe condition.

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.

Safety symbols & 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
	This mark denotes compliance with the essential requirements of the following applicable UK regulations: <ul style="list-style-type: none">- Electromagnetic Compatibility Regulations 2016 No. 1091 (as amended)- Electrical Equipment (Safety) Regulations 2016 No. 1101 (as amended)- The Restriction of the Use of Certain Hazardous Substances in electrical & Electronic Equipment Regulations 2012 No. 3032 (as amended)
	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.

Instrument Marking	Description
	Attach ESD protective wrist strap to avoid damage by direct contact with the equipment.
	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.
	Hot surface. The metallic panels may get warm after powering on the equipment.
	Caution, risk of electric shock. After disconnection from mains allow internal capacitors to fully discharge.
	Symbol 7, the frame or chassis terminal.

NOTE The QSFP communication cables (or any other with potential laser energy) are not sold as part of the equipment and as such the unit has no laser safety classification. The QSFP communication cables used must be compliant with the requirements of the authorities having jurisdiction where the equipment is used.

Compliance and Environmental Information

Table 1 Compliance and Environmental Information

Safety Symbol	Description
	<p>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.</p> <p>Please refer to http://www.keysight.com/go/takeback to understand your Trade in options with Keysight in addition to product takeback instructions.</p>

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.

S5040A ORAN Studio Player and Capture Appliance – At a Glance

Designed for LTE and 5G O-RAN Radio Unit (O-RU) testing, Keysight S5040A Open RAN Studio Player and Capture Appliance is a Windows® 11 Pro Workstation based operating system 1RU server and FPGA hardware accelerated Ethernet acquisition, timing, and triggering hardware, which 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.

The S5040A Appliance 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 of the U5040B Open RAN Studio software 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.

Some of the highlights of the S5040A Appliance are:

- High-capacity removable solid state hard drive for fast boot-up, storing setups, and saving measurement results.
- USB 3.0 and LAN ports make printing, saving, and sharing data easy.
- VGA and DisplayPort ports on the motherboard I/O panel for displaying the screen on a different monitor.
- 64-bit Windows operating system and graphical user interface with easy-to-use menus, toolbars, and features. Ability to install other Windows applications other than the pre-installed Signal Studio and vector signal analysis (VSA) software.

References to other documents

- Keysight S5040A Open RAN Studio Player and Capture Appliance User's Guide
- Keysight U5040B Open RAN Studio Software User Guide

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Getting Started

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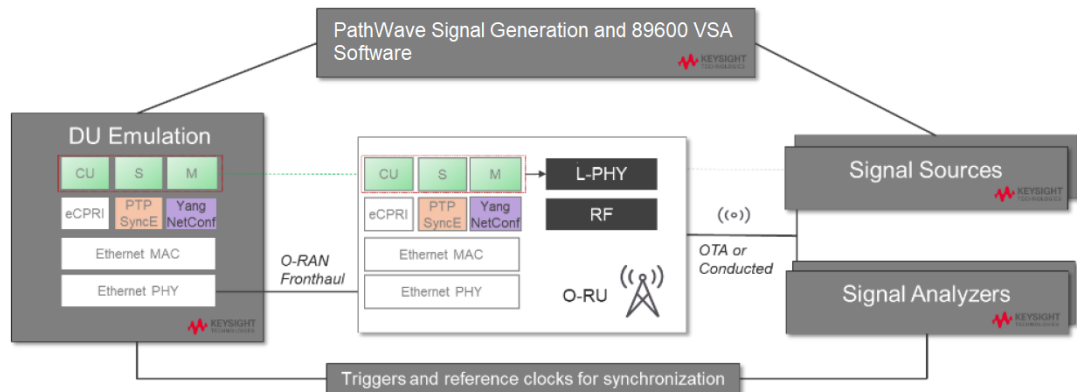
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About this Document

This guide is intended to help users get started quickly with the U5040B Open RAN Studio software.

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.

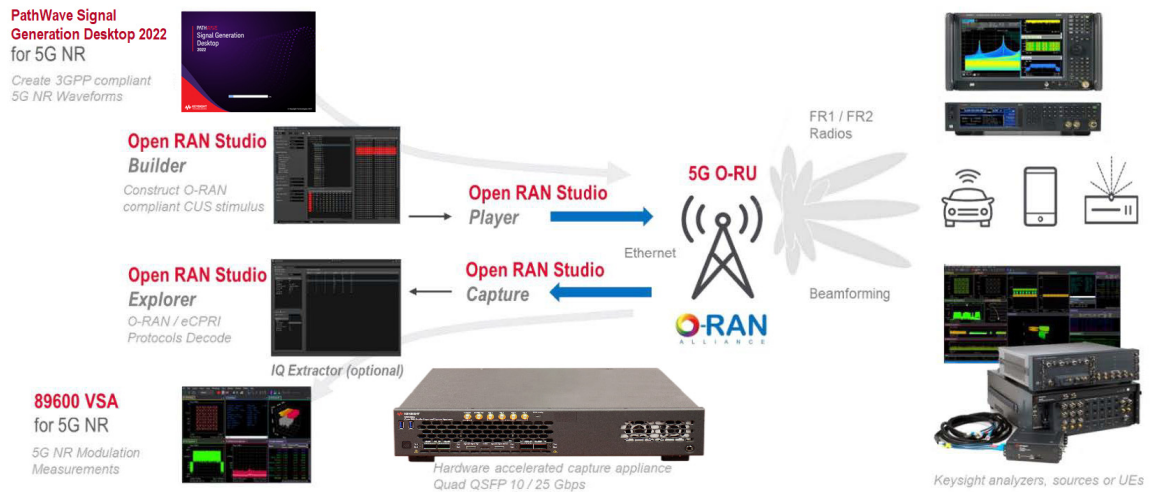


Figure 1 Integrated Open RAN Studio solution for comprehensive O-RU testing

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 compliant 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 compliant 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 U5040B Open RAN Studio software for the S5040A Open RAN Studio Player and Capture Appliance.

System Prerequisites

- Windows 11 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
- PathWave License Manager
- 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

NOTE

The U5040B Open RAN Studio software is designed to run on the S5040A Open RAN Studio Player and Capture Appliance, whereas the U5040A Open RAN Studio software is designed to run on the BittWare hardware only.

Licenses

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

Table 2 O-RAN Studio Software and corresponding license options

Setup Mode	Software	License options
Complete	U5040B Open RAN Studio	<ul style="list-style-type: none"> ▪ U5040BSCB - Base Software license ▪ U5040IQEB - IQ Extraction license ▪ U5040MDLB - Manufacturing Downlink Test license ▪ U5040MULB - Manufacturing Uplink Test license ▪ U5040ORAB - ORAN Protocol Analytics License
	PathWave Signal Generation	<ul style="list-style-type: none"> ▪ N7631ORNC - PathWave Signal Generation license (for 5G NR)
Custom	U5040B Open RAN Studio	<ul style="list-style-type: none"> ▪ U5040BSCB - Base Software license ▪ U5040IQEB - IQ Extraction license ▪ U5040MDLB - Manufacturing Downlink Test license ▪ U5040MULB - Manufacturing Uplink Test license ▪ U5040ORAB - ORAN Protocol Analytics License
	U5040B Open RAN Studio: LTE FDD Support	<ul style="list-style-type: none"> ▪ U5040BSCB - Base Software license
	U5040B Open RAN Studio: LTE TDD Support	<ul style="list-style-type: none"> ▪ U5040BSCB - Base Software license
	N7624C Signal Studio for LTE/LTE-Advanced FDD	<ul style="list-style-type: none"> ▪ N7624ORNC - Signal Studio LTE FDD license
	N7625C Signal Studio for LTE/LTE-Advanced TDD	<ul style="list-style-type: none"> ▪ N7625ORNC - Signal Studio LTE TDD license

Using PathWave License Manager

You use the PathWave License Manager to install 'fixed' and 'floating' licenses. When you install the U5040B Open RAN Studio software, the PathWave License Manager is also installed along with it.

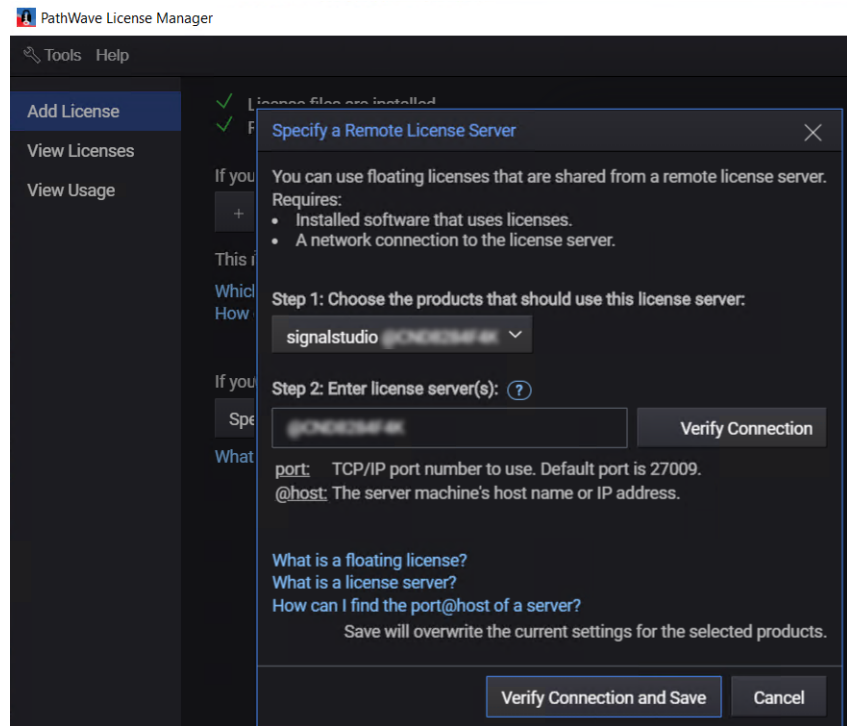
NOTE

The U5040B software supports and recognizes licenses installed using PathWave License Manager only, whereas the U5040A software uses Keysight License Manager 5 for "fixed" licenses and Keysight License Manager 6 for "floating" licenses.

To configure Signal Studio in the PathWave License Manager

If you want to use floating licenses for Signal Studio, you need to ensure that Signal Studio is configured as the product that uses the license server on which your floating licenses reside.

- 1 In the **Add License** page of PathWave License Manager, click **Specify a Remote License Server**.
- 2 In the **Specify a Remote License Server** dialog box, click the **Choose Products** drop-down listbox and then select the **signalstudio** checkbox.
- 3 Type the `<port_number@host_Name>` of the license server.
- 4 Click **Verify Connection and Save**.



For more information about how to add and manage licenses, refer to the **Help > Help Contents** from the main menu of the PathWave License Manager.

Installation

Software Download

Download the latest version of the software from “Drivers, Firmware & Software” tab. Go to <http://www.keysight.com/find/U5040B>.

NOTE

The U5040A Open RAN Studio software and U5040B Open RAN Studio software cannot be installed on the same machine. In case U5040A software is installed already, installing U5040B software on the same machine removes the U5040A software. To install U5040A software on a machine that has U5040B software installed, you must remove the latter.

Also, the U5040B software is designed for S5040A Appliance only whereas the U5040A software can be run on BittWare hardware only. You must ensure that the correct hardware is being used with the corresponding software.

Installation Options

The Setup wizard for the U5040B 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 all the software components only. These components are displayed as the offline version and the full version of the U5040B Open RAN Studio Software, which supports the S5040A Open RAN Studio Player and Capture Appliance, connected to the PC.
- **Custom** – Lets you choose one or more software components to install or to remove from being installed on your machine.
 - Open RAN Studio Base Software
 - Open RAN Studio LTE TDD Support
 - Open RAN Studio LTE FDD Support
 - M-Plane Toolkit

See [Step 5 - Setup Type](#) on page 21 for more information on the installation options.

Installation Steps

This section contains detailed steps for installing the software.

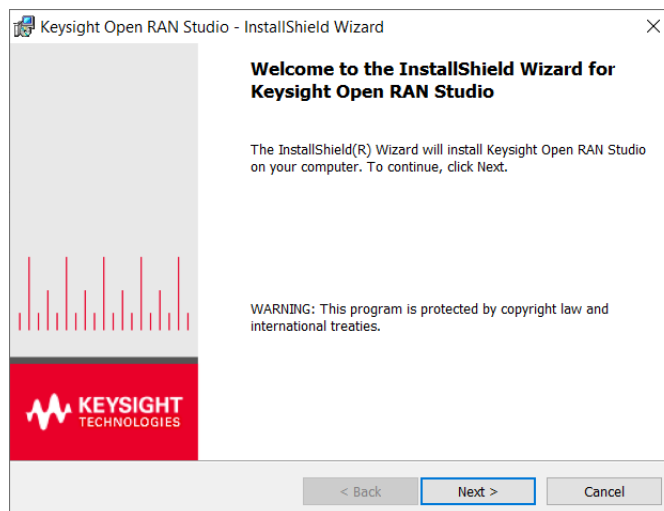
Step 1 - Launching the Installer

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.

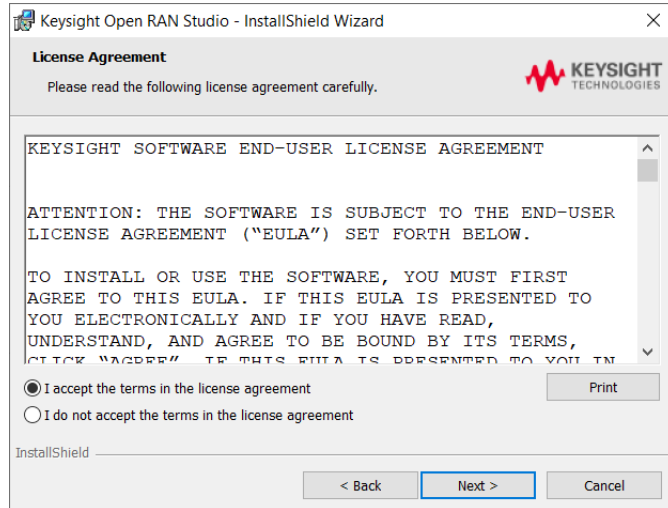
Step 2 - Welcome Screen



Click **Next**.

Step 3 - Accepting the License Agreement

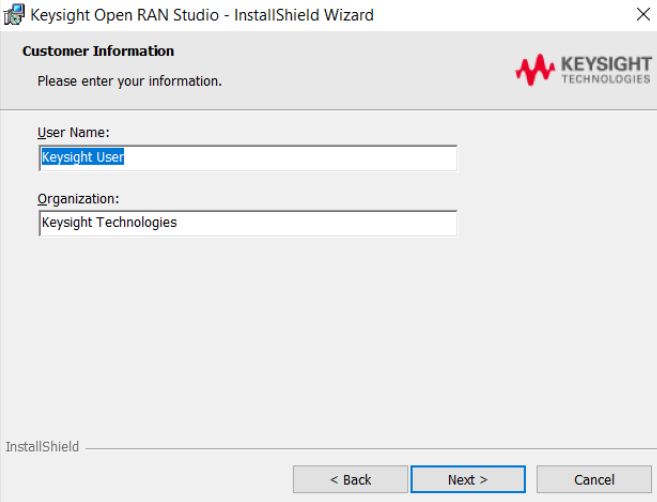
You must carefully read and accept the **End User License Agreement (EULA)** in order to install or use the software.



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.



The screenshot shows a dialog box titled "Keysight Open RAN Studio - InstallShield Wizard". The dialog has a "Customer Information" header with the instruction "Please enter your information." and the Keysight Technologies logo. Below the header, there are two text input fields: "User Name:" with the text "Keysight User" and "Organization:" with the text "Keysight Technologies". At the bottom of the dialog, there are three buttons: "< Back", "Next >" (which is highlighted with a blue border), and "Cancel". The text "InstallShield" is visible in the bottom left corner of the dialog.

Click **Next**.

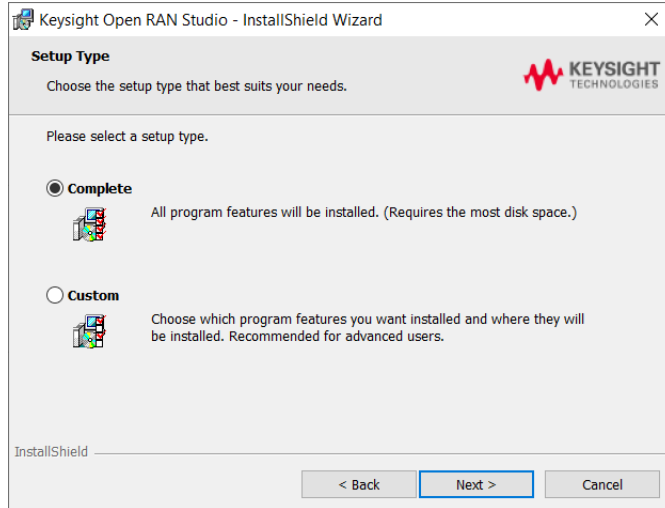
Step 5 - Setup Type

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

- **“Complete” setup**
- **“Custom” setup**

“Complete” setup

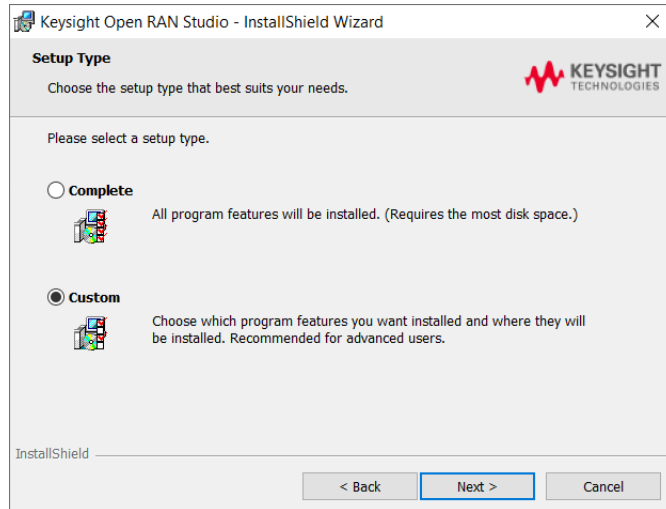
Select **Complete** to proceed with installing all software components automatically.



Click **Next** and proceed to **Step 6 - Ready to Install** on page 25.

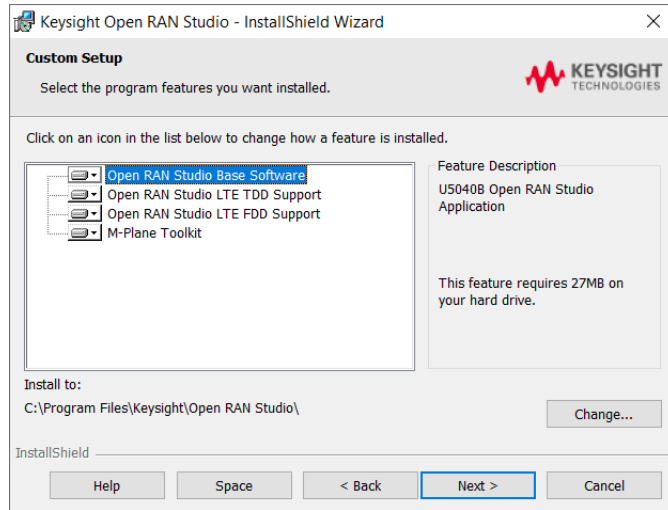
“Custom” setup

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



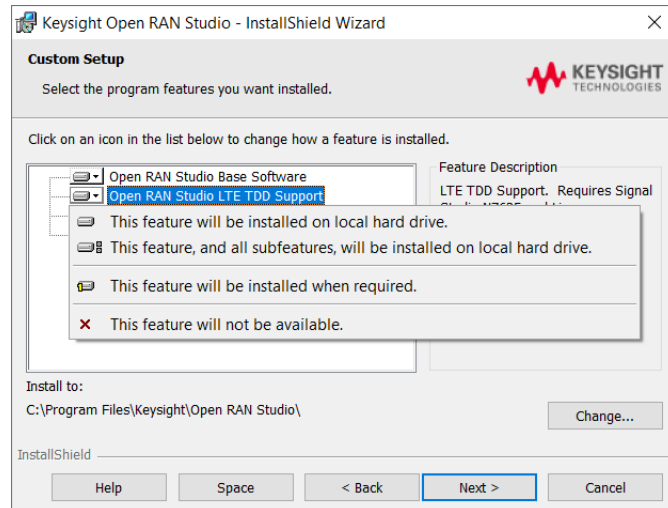
Click **Next**.

On the following window, all components in the list are set to be installed automatically by default when the **Setup Type** is selected as “Complete”.



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

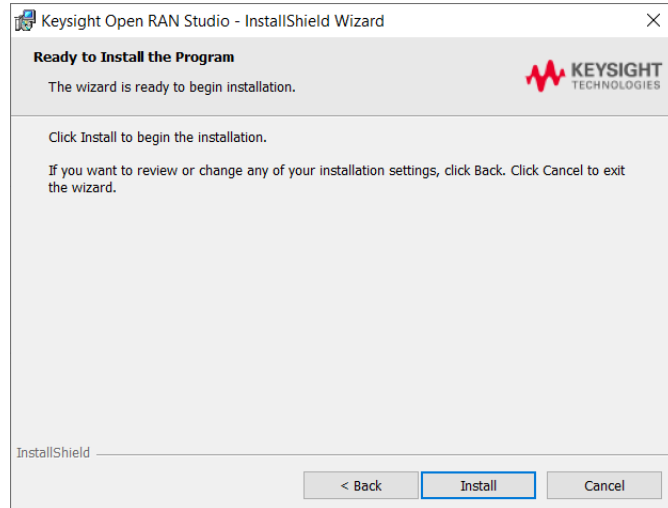
To remove a software component from being installed, select the option “This feature will not be available”.



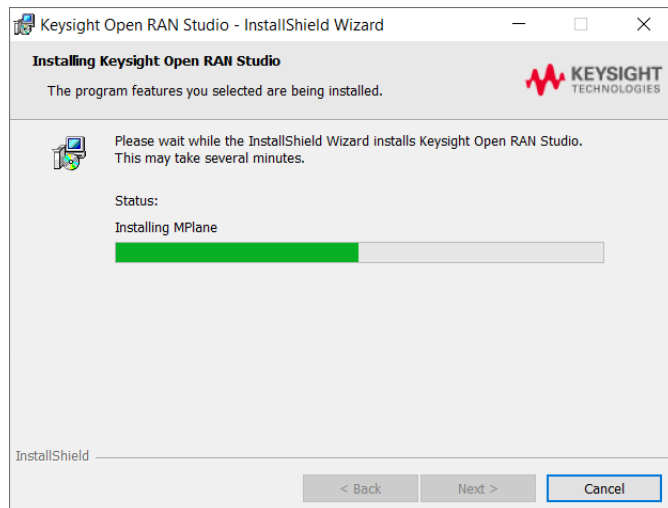
Click **Next**.

Step 6 - Ready to Install

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

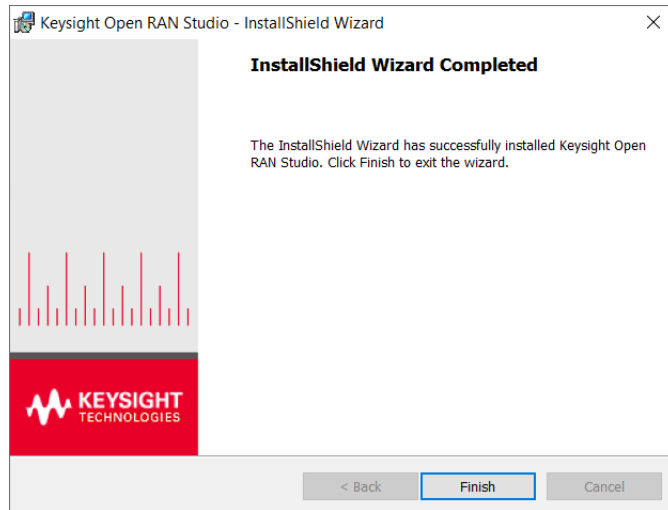


A progress bar is displayed during the installation process.



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.

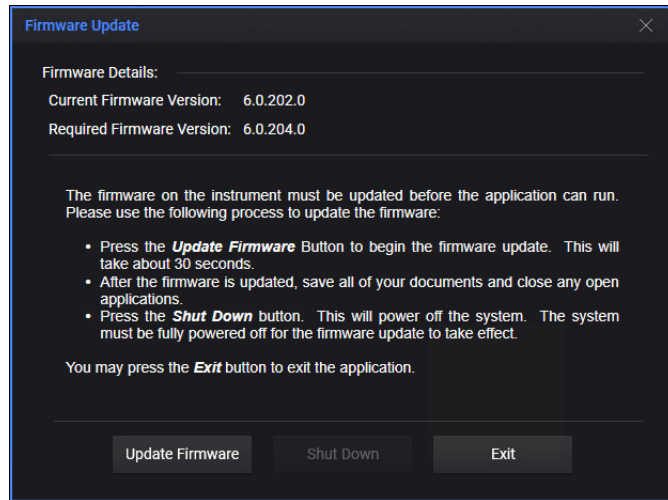
- U5040B Open RAN Studio
- U5040B Open RAN Studio - Offline
- U5040B Open RAN Studio LTE TDD Support (appears after 'Custom' installation only)
- U5040B Open RAN Studio LTE FDD Support (appears after 'Custom' installation only)

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:

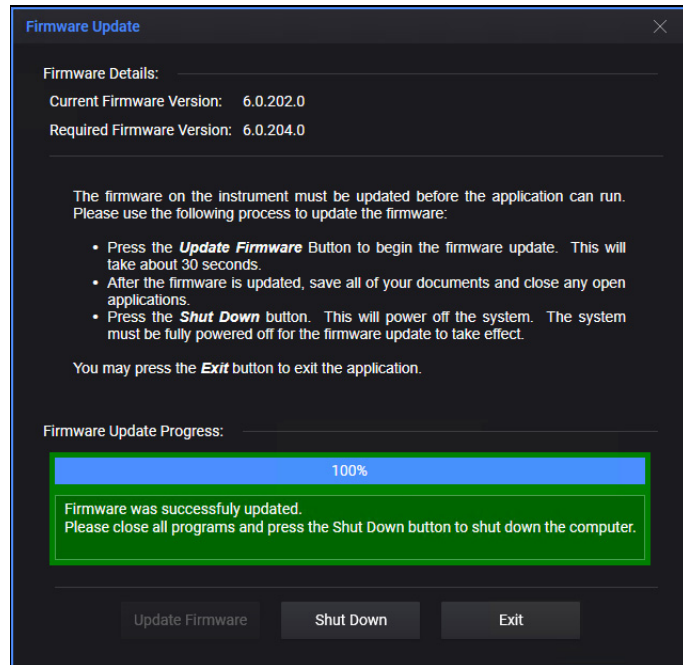


NOTE

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*.

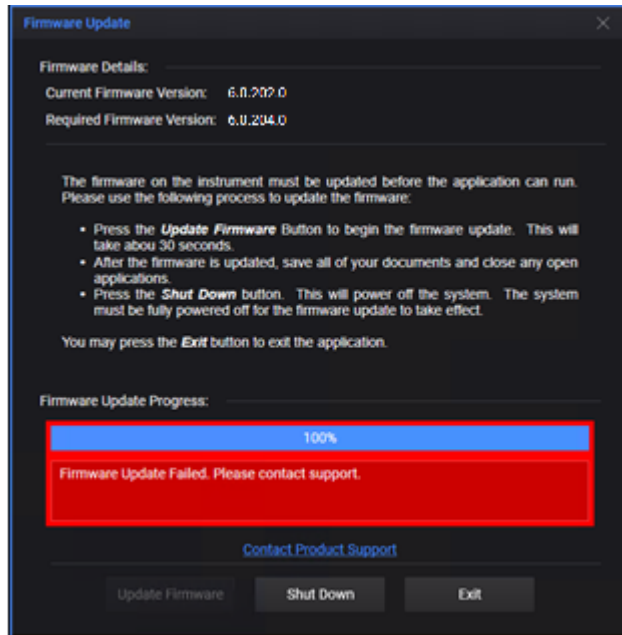
After a successful firmware update, close all open application and click **Shut Down**. If you cannot shutdown immediately, click the **Exit** button.

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, exit the application and try updating the firmware again. If this does not work, contact Keysight support.

See [Software errors during / after installation](#) on page 31.

Software errors during / after installation

Errors with U5040B software

Errors during or after installation

If you encounter errors during or after installation / upgradation of the U5040B Open RAN Studio software,

- 1 Check “Uninstall a program” feature in the Control Panel to completely remove the existing software version.
- 2 Check logs by running the installer from the command line with the following syntax:
“U5040B_setup_full_<version>.exe” /debuglog“C:\tmp\isdebug.log”/v“ISDEBUGLOG=C:\tmp\prereq.log”
- 3 Download the latest version of installer from <https://www.keysight.com/find/U5040B>.
- 4 Run the installer.
- 5 If prompted, restart the S5040A Appliance to complete the installation.

Errors during software usage

If you encounter any unexpected errors while using the U5040B Open RAN Studio software,

- 1 Check logs in the *OpenRANStudio.log* file, which can be found in C:\Users\<user-profile>\Documents\Keysight\Open RAN Studio.
- 2 For information regarding software usage and various measurements, refer to the *U5040B Open RAN Studio User's Guide*.
- 3 For further support, contact a technical support executive at Keysight. See <https://www.keysight.com/find/support>.

Errors with supporting software

If you encounter errors during or after installation / upgradation of other pre-installed software; Keysight PathWave 89600 VSA 2020 U1, or even encounter any unexpected errors during usage,

- 1 Check “Uninstall a program” feature in the Control Panel to completely remove the existing software version.
- 2 Download the latest version of installer for the software. For example, for Keysight PathWave 89600 VSA 2020 U1 software from <https://www.keysight.com/find/89600>.
- 3 Run the installer.
- 4 If prompted, restart the S5040A Appliance to complete the installation.

For further support, contact a technical support executive at Keysight. See <https://www.keysight.com/find/support>.

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9921-01567 . EN

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