
USB Type-C Connectivity Solution

N7015A / 6A / 7A / 8A / 9A Type-C Test Fixtures

Notices

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1 Type-C Connectivity Solution Overview

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This chapter introduces the Keysight Type-C connectivity test fixtures and describes how these function together to allow you to perform integrated testing for various interfaces supported over Type-C. The details of each of these test fixtures and the hardware and software setup information are included in the subsequent chapters.

Introduction to the Type-C Test Fixtures

The N7015A, N7016A, N7017A, N7018A, and N7019A Type-C test fixtures provide a comprehensive and complete testing solution for automated compliance testing, characterization, validation, and debugging of your Type-C host/device including various Type-C interfaces such as USB, DisplayPort, and Thunderbolt™. The following picture highlights the broad role that each of these Type-C test fixtures play in the Type-C testing.

NOTE

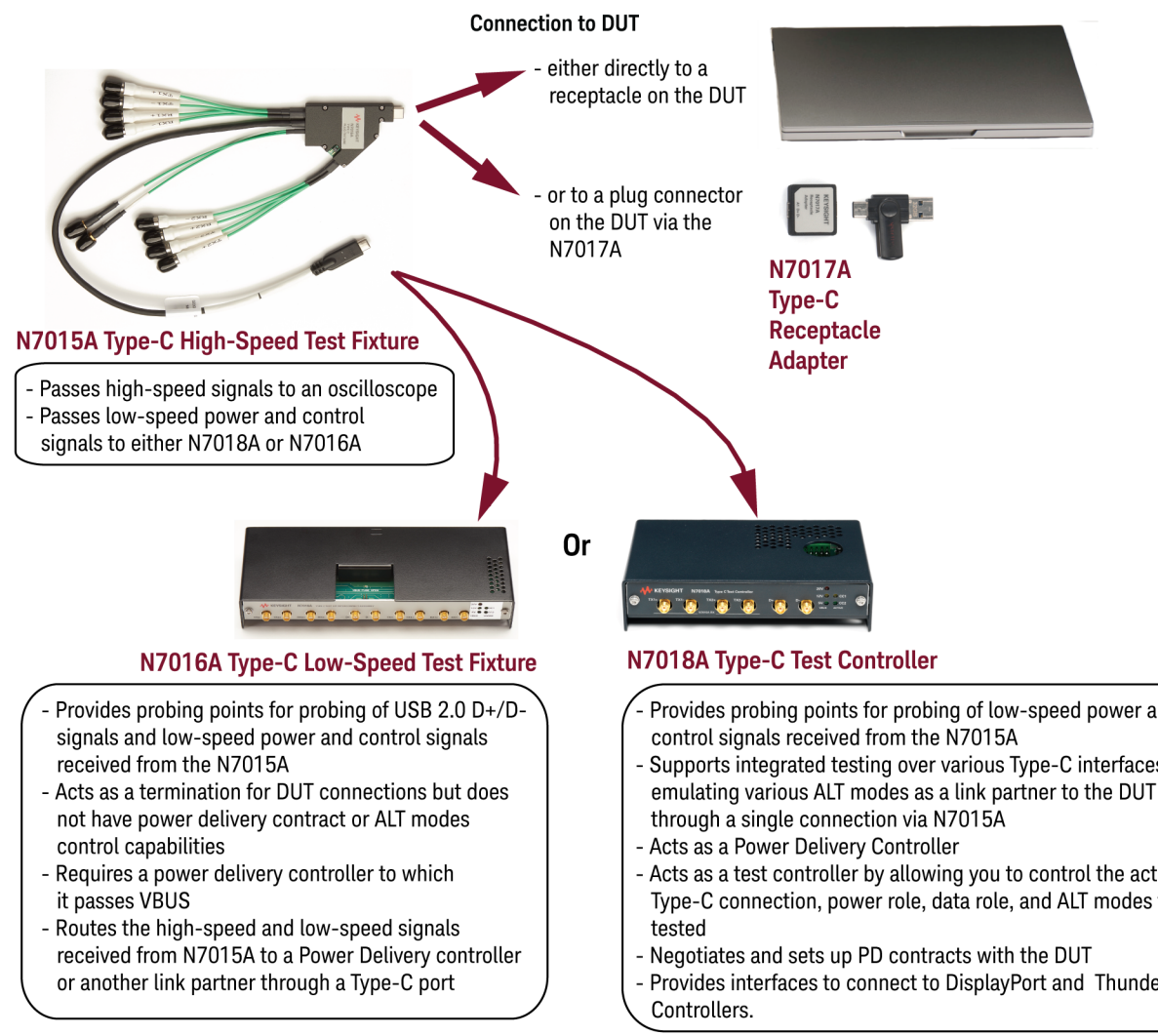
The N7018A is a superset of most of the features of the N7016A and additionally provides power delivery controller capabilities and integrated testing over Type-C interfaces through a single connection. This makes the N7018A a replacement of the N7016A which has been discontinued.

Debugging a host/device on an active Type-C link



- N7019A Type-C Active Link Test Fixture**
- Provides access to all Type-C signals on an active link
 - Connects to a variety of Keysight probes to pass these signals to a Keysight oscilloscope
 - Helps debugging at the packet level using the Protocol Decoders available in the Infiniium software GUI

Signals Verification and Compliance testing



Usage Scenarios for the Type-C Test Fixtures

You can use the Type-C test fixtures described in this guide in the following scenarios.

For N7015A, N7016A, N7017A, and N7018A

- USB 2.0 Tx and Rx testing
- USB4, USB4 Version 2.0, USB 3.x Gen 1 (5Gbs) and Gen 2 (10Gbs) Tx and Rx testing
- Thunderbolt 2/3/4 over Type-C Tx and Rx testing
- DisplayPort 1.4/2.0/2.1 over Type-C testing including:
 - 2+2 mode: Two DisplayPort differential lanes + two simultaneous USB 4/3.x differential lanes
 - Four DisplayPort differential lanes
- DisplayPort AUX Channel testing
- USB-Power Delivery over Type-C (Provider and Consumer and ALT Modes Control testing)

Sample setups and specific notes for these scenarios are included in the chapter [“Sample Setups for Compliance Testing using N7015A/6A/7A/8A”](#) on page 69.

For N7019A

- Debug and test designs that include:
 - USB-PD
 - USB 2.0
 - USB 3.0
 - USB 3.1 (Gen 1 or 2)
 - USB 3.2 (Gen 1 or 2)
 - USB4
 - Thunderbolt 3 over Type-C
 - DisplayPort over Type-C

Sample setups for N7019A are included in the chapter [“Sample Setups for Debugging on an Active Link using N7019A”](#) on page 66.

How the Type-C Test Fixtures Work Together



A high level overview of how these Type-C test fixtures work together is provided below. For details, refer to the individual chapters in this guide dedicated to these fixtures.

The N7015A test fixture connects to a DUT and a compatible oscilloscope to break out four differential lanes of Type-C high-speed signals from the DUT to the oscilloscope. These high-speed signals can be monitored and analyzed using the Keysight Infiniium software installed on the oscilloscope.

For low-speed power and control signals access, the N7015A test fixture connects to the N7018A test controller or the N7016A test fixture and passes the Vbus, SBU, and CC lines to the N7018A / N7016A via a USB Type-C (plug style) cable. There are probe points for Vbus, SBU, and CC lines on the N7018A or N7016A to allow you to probe these low-speed signals at these fixtures.

The USB Type-C cable that connects the N7015A to the N7018A also serves as the connection mechanism between the N7018A and DUT with the N7015A test fixture in between. Using this cable, the N7018A establishes a Type-C connection and a standard 5V PD contract with DUT and advertises the user-selected mode of operation (ALT Mode) and power delivery role to the DUT.

Once the connection is established, the N7018A can negotiate a new PD contract with the DUT on the selected CC line using the USB PD protocol. This PD contract is as per the settings that you configured for the N7018A.

When USB PD negotiations are complete, the N7018A enables the appropriate power path and negotiates and enters the user-selected ALT Mode. It enables, discovers, configures, and enters/exits the selected Alt Mode with the DUT via a USB PD protocol handshake.

All these configurations and control of the N7018A test controller including connection, power role, ALT modes, and power delivery contract settings are done using the N7018A software (see [page 88](#)).

To provide power to the N7016A / N7018A test fixtures and control and configure these fixtures using their software, you connect these to an oscilloscope or a host computer via the supplied USB cable. An external power supply is needed if the N7018A / N7016A is acting as a power delivery provider to DUT.

If you are using the N7016A, a power delivery controller is also needed. If you are using the N7018A, then you do not need a power delivery controller as the N7018A acts as a power delivery controller as well.

The N7018A / N7016A test fixtures are also integrated with a number of Keysight compliance applications software to allow you to do automated compliance testing when using these test fixtures.

NOTE

If you want to test and debug the power up of your device on an active Type-C link and perform pre-test verifications, then the N7019A is the appropriate choice. This active link test fixture gives you access to all Type-C signals exchanged between your product under test and link partner on the active Type-C link.

Type-C Connectivity Test Kits

The Type-C test fixtures documented in this guide are available as Keysight Type-C connectivity test kits. These kits include the test fixture(s) as well as other components needed for operating these test fixtures. These kits contain standard components as well as optional components that you can choose to buy when ordering the kit.

The following Type-C test kits are available.

N7015A Type-C High Speed Test Fixture Kit

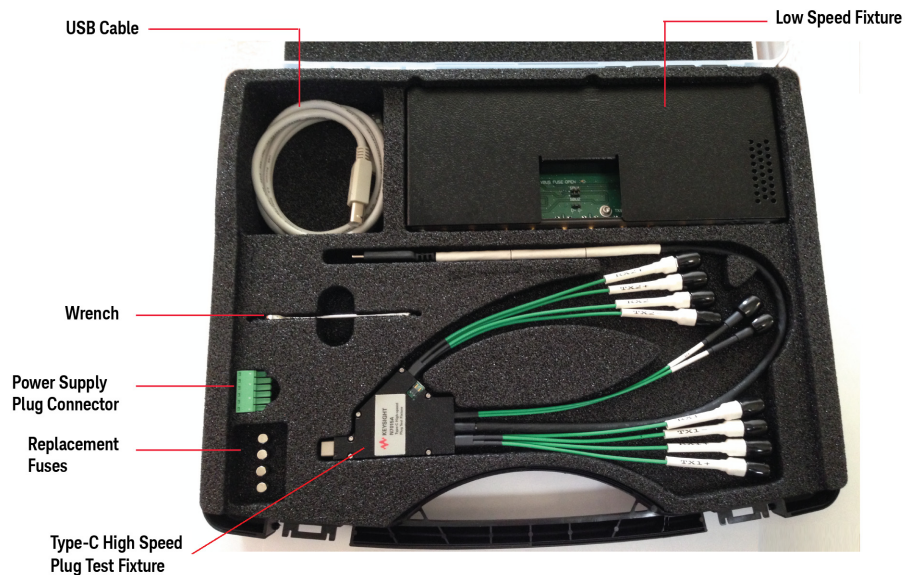


Figure 1 N7015A Type-C Test Kit with N7015A-016 Product Option

You can order this test kit with the following product options:

Item	Part Number	Quantity
N7015A Type-C High Speed Test Fixture <i>(standard component of the test kit)</i>		
Type-C High Speed Test Fixture	N7015A	1
Wrench	8710-2803	1
N7016A Type-C Low Speed Signal Access and Control Fixture (Discontinued) <i>(optional component of the test kit. Can be ordered with the test kit as the N7015A-016 option or separately as a standalone product (model number N7016A)</i>		
Low Speed Fixture	N7016A	1
Power Supply Connector Plug	0360-2693	1
USB Cable	8121-1242	1

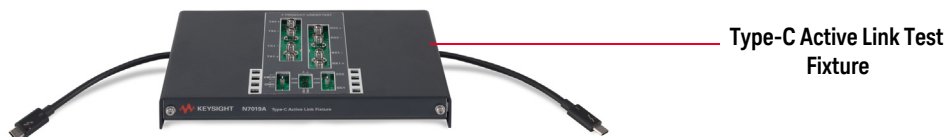
Item	Part Number	Quantity
Replacement Fuses	2110-0623	4
N7017A Type-C Receptacle Adapter (Discontinued) <i>(optional component of the test kit. Can be ordered with the test kit as the N7015A-017 option or separately as a standalone product (model number N7017A))</i>		
Receptacle Adapter	N7017A	1

N7018A Type-C Test Controller Kit



Item	Part Number	Quantity
<i>Standard component of the test kit</i>		
Type-C Test Controller	N7018A	1
Power Supply Connector Plug	0360-2693	1
USB Cable	8121-1242	1

N7019A Type-C Active Link Fixture Kit



Item	Part Number	Quantity
<i>Standard component of the test kit</i>		
Type-C Active Link Fixture	N7019A	1

ZA0200 Type-C Core Connectivity Kit

This kit includes Type-C test fixtures as well as the equipment and accessories that are recommended for use with these test fixtures.

The following table lists the kit contents.

Item	Part Number	Quantity
Type-C High-speed Test Fixture	N7015A	1
Type-C Test Controller	N7018A	1
Type-C Receptacle Adapter (Discontinued)	N7017A	1
1m Phase Matched Cables	N2823A	2
Connector Savers	5061-5311	10
Blocking Capacitors	N9398C	4
4-slots Low-Profile Modular Power System Mainframe	N6701C	1
Source/Measure Unit (power supply/load module)	N6786A	1

Compatibility with Oscilloscopes

The Type-C test fixtures included in this guide are compatible with the following Keysight oscilloscopes:

NOTE

For the compatibility list applicable to the N7019A test fixture, refer to the topic [“Recommended Oscilloscopes”](#) on page 55.

Compatible Oscilloscopes

- Infiniium 9000A Series Oscilloscopes
- Infiniium Z-Series Oscilloscopes
- Infiniium V-Series Oscilloscopes

Compatible Oscilloscope Software

Infiniium baseline software version 6.10 or higher

Is Your Oscilloscope Software Up-to-Date?

Keysight periodically releases software updates to support your probe, fix known defects, and incorporate product enhancements. To download the latest firmware, go to www.keysight.com and search for your oscilloscope's series. Then click on the “Drivers, Firmware & Software” tab.

For More Information...

You can find application notes, videos, data sheets, guides, methods of Implementation documents as well as general information about various products that Keysight offers for USB Type-C Interface testing at www.keysight.com.

- [How to Correlate USB Type-C Simulation and Measurement - Application Note \(5992-1391EN\)](#)
- [How to Address USB Type-C Transmitter and Receiver Test Challenges - Application Note \(5992-1392EN\)](#)
- [How to Test USB Type-C™ Alt Mode and the Standards Running Across It - Application Note \(5992-1393EN\)](#)
- [How to Test USB Power Delivery \(PD\) Over Type-C - Application Note \(5992-1394EN\)](#)
- [How to Test USB Type-C Interconnects Compliance Test for Cables and Connector](#)
- [How to Ensure Interoperability and Compliance of USB Type-C Cables and Connectors - Application Note \(5992-1390\)](#)

2 N7015A Type-C High Speed Test Fixture

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N7015A Insertion Loss Plot / 22

Cleaning the N7015A Test Fixture / 23

The N7015A Type-C high speed test fixture comes with a plug style Type-C connector mated to the receptacle on the USB host/device to enable you to verify and debug USB 4/3.x designs, and designs using other high-speed signal standards that support the Type-C connector. It can also connect to a USB device with a plug connector using the N7017A Type-C receptacle adapter.

It breaks the signals into four differential lanes of high speed Tx and Rx signals and USB 2.0 D+/D- signals to an oscilloscope input. It can also work with either N7018A or N7016A test fixtures to pass low-speed power and control signals to either of these for probing and analysis.

Using the N7015A, you can obtain the most accurate measurements with the best signal integrity by supporting bandwidth up to 30 GHz with low noise levels.

By providing a Type-C connection with the DUT, it allows the N7018A test controller to establish Power Delivery (PD) contracts and enter/exit various ALT modes with the DUT.

Components

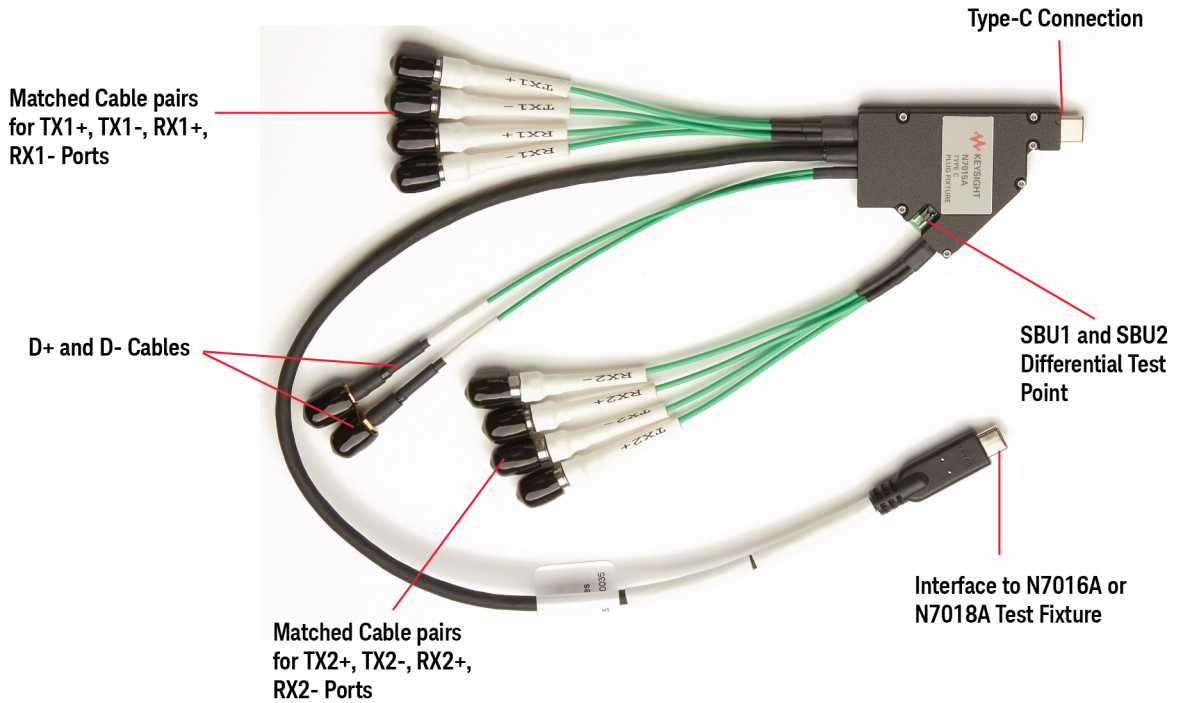


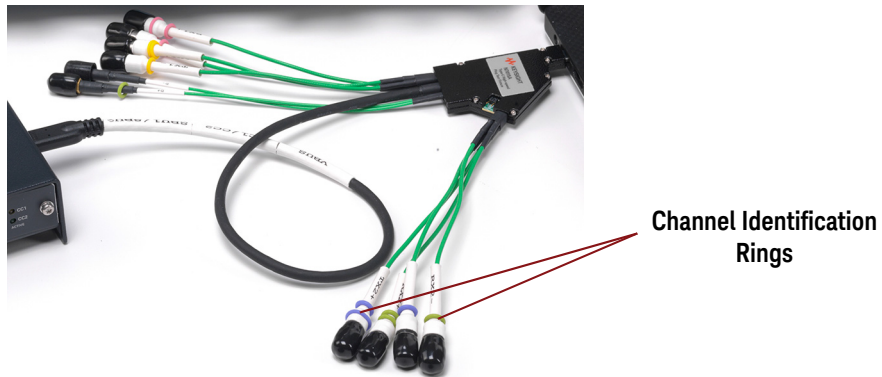
Figure 2 N7015A Type-C High Speed Test Fixture

Component	Description
Type-C Connection	The Type-C connector that connects the N7015A: <ul style="list-style-type: none"> either to a receptacle connector on the DUT or to a receptacle adapter (such as the N7017A) during a Type-C port extension or a receiver test calibration
Matched Cable Pairs for High-speed data lanes	The Type-C connection of N7015A breaks out the following high-speed data differential data lanes: <ul style="list-style-type: none"> four data lanes across eight pins, (TX1±, RX1±, TX2±, RX2±). These lanes are capable of carrying USB 4/3.x, DisplayPort, or Thunderbolt signals available for use during Alt mode transmissions.
D± Cables	D± lanes are used for USB 2.0 data transmissions.
SBU1 / SBU2 Differential Test Point	The test point to differentially probe the SBU1/SBU2 signals directly at the N7015A. This is particularly useful for DisplayPort AUX channel signal evaluation. For details, see page 81 .
Interface to N7016A or N7018A test fixtures	The USB Type-C (plug style) cable that connects the N7015A to the N7018A or N7016A test fixture. Through this cable connection, the N7015A passes low-speed power and control signals to these test fixtures. This cable connection also serves as the connection mechanism between the N7018A and DUT with the N7015A test fixture in between.

N7015A Channels Identification Rings

The high-speed Tx and Rx cables and the USB 2.0 cables of the N7015A test fixture have channel identification rings. These rings allow you to color-code each differential lane of Type-C high-speed signals and USB 2.0 signals and thereby easily identify these signals ensuring an error-free connection of the cables to the oscilloscope.

You can either use the default assignment in which these rings are assigned to cables or you can change this default assignment to define your own color coding.



In the default assignment:

- The cable with a single ring represents a minus (-) high-speed signal and the cable with a set of two rings represents a plus (+) high-speed signal.
- For USB 2.0 signals, the cable with a single ring represents a plus (+) signal and the cable with no rings indicates a minus (-) signal.

N7015A Insertion Loss Plot

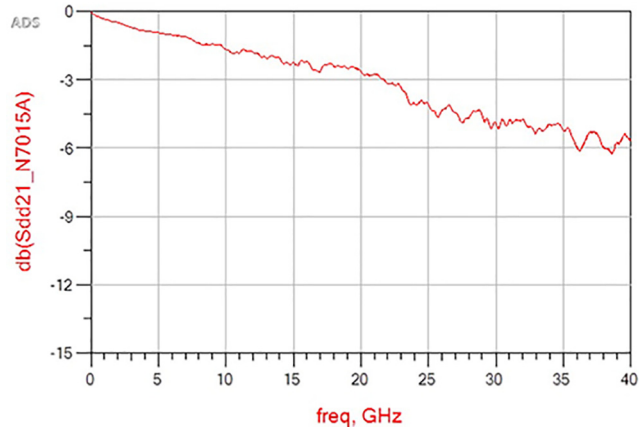


Figure 3 N7015A Fixture Insertion Loss Plot

For the insertion loss plot of the N7015A test fixture when used with the N7017A receptacle adapter, refer to the topic "[Insertion Loss Plot for N7015A with N7017A](#)" on page 51.

Cleaning the N7015A Test Fixture

The presence of foreign particles on the contacts can degrade the N7015A Type-C connector performance. Therefore, it is recommended that you clean the N7015A Type-C Connector in case there is a suspicion of contamination.

To clean the Type-C connector

- 1 Disconnect the N7015A from the oscilloscope, any test fixtures, and DUT.
- 2 Gently clean the Type-C connector by applying an electrical contact cleaner.
- 3 Connect and disconnect the Type-C connector a few times to dislodge any contaminants stuck on the connector.
- 4 If needed, apply additional contact cleaner to remove any remaining contaminants.

CAUTION

Carefully read and follow the directions for use and disposal provided on your electrical contact cleaner label.

- 5 Make sure the connector is completely dry before reconnecting it for use by:
 - either using forced air to remove excess contact cleaner.
 - or allowing the connector to dry.

CAUTION

Do not try to clean the test fixture using Isopropyl alcohol as it may leave a residue.

3 N7018A Type-C Test Controller

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- Features / 30
- Powering the N7018A and DUT / 32
- Pre-use Warnings and Connectivity Precautions / 35
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The N7018A Type-C Test Controller emulates a power delivery link partner to help you validate, characterize, or debug various Type-C host and devices. As a power delivery link partner, it allows you to control the interface and validate ALT modes entry/exits over Type-C.

By supporting various operating modes as a link partner to the DUT through a single connection, it allows you to perform an integrated, unattended testing of various Type-C interfaces.

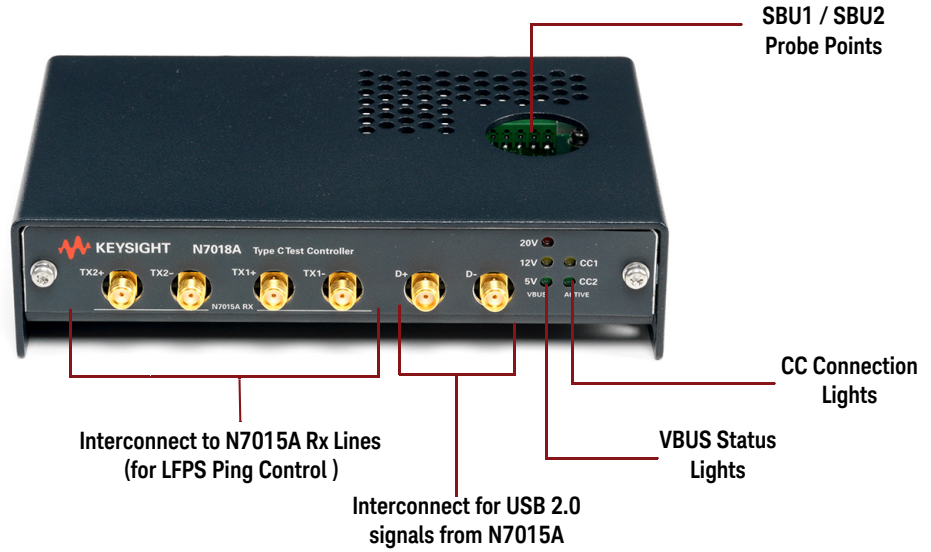
Besides emulating a link partner and supporting various ALT modes, the N7018A also provides access to various low-speed Type-C signals for observation and measurement.

For automated testing of interfaces such as DisplayPort and Thunderbolt, it supports connectivity to appropriate industry standard controllers for alt mode operation so that you can not only monitor but also control the applicable Type-C interface.

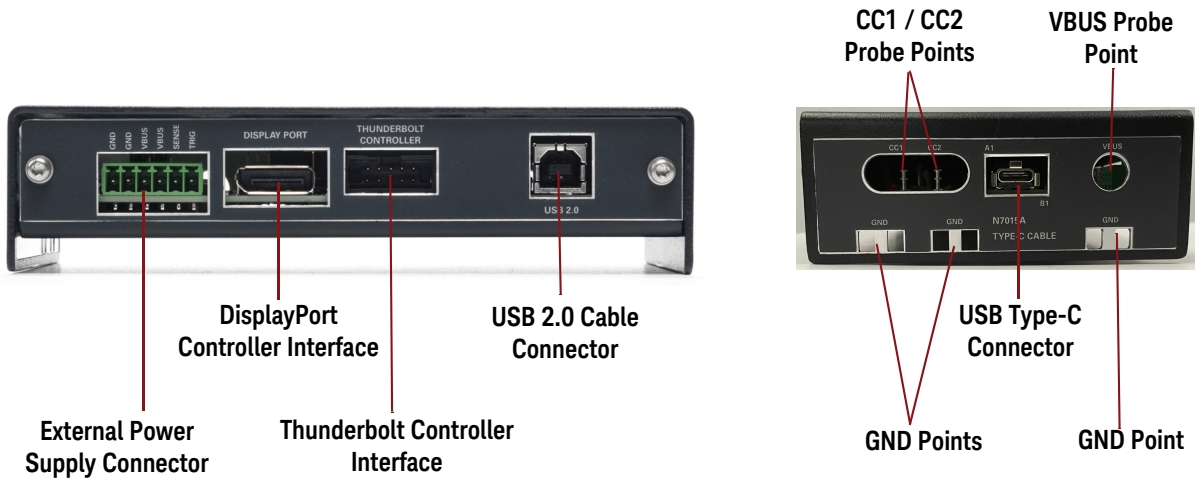
NOTE

The N7018A is a superset of most of the features of the N7016A and additionally provides power delivery controller capabilities and integrated testing over Type-C interfaces through a single connection. This makes the N7018A a full replacement of the N7016A.

Components





Front View



Back View

Side View

The following table describes these N7018A components.

Component	Description
SBU1/SBU2 Probe Points	<p>The points to probe the DUT's SBU1/SBU2 signals that the N7015A passes to the N7018A through the USB Type-C cable connection. Using these points, you can probe SBU signals single-ended or differentially. See page 81 to know more.</p> <p>WARNING SBU1 and SBU2 probe points may have sharp edges. Exercise caution when using these probe points to avoid personal injury.</p>
Interconnect to N7015A Rx Lines (for LFPS Ping Control)	<p>The four (Tx1+, Tx1-, Tx2+, and Tx2-) SMA ports on the N7018A can be used when testing USB 4/3.x to provide LFPS signals to the DUT via the N7015A. You connect the high-speed Rx cables of the N7015A to these SMA ports for LFPS signaling.</p> <p> Each of these SMA connectors can accept a maximum of 5V.</p>
Interconnect for USB 2.0 signals from N7015A	<p>These D+ / D- SMA ports on the N7018A are used to maintain an optional USB2.0 connection in ALT modes. You connect the D+ / D- cables of the N7015A to these SMA ports. These ports can be used for probing USB 2.0 signals only if another adapter board is used.</p> <p> Each of these SMA connectors can accept a maximum of 5V.</p>
VBUS Status Lights	<p>The N7018A passively detects the VBUS level. If VBUS is present, the appropriate LED glows.</p> <ul style="list-style-type: none"> 5V 12V 20V
CC Connection Lights	<p>Based on whether you select the Normal (CC1) or Flipped (CC2) option as the N7018A Type-C connector orientation in the N7018A software GUI, the applicable LED glows.</p> <ul style="list-style-type: none"> CC1 - Indicates that the CC1 (CC line on the top of the N7018A USB Type-C connector) will be used as the communication channel for the N7018A connection to DUT. This represents the Normal connector orientation (right-side up) of the N7018A. CC2 - Indicates that the CC2 (CC line on the bottom of the N7018A USB Type-C connector) will be used as the communication channel for the N7018A connection to DUT. This represents the Flipped connector orientation (upside down) of the N7018A. <p>See page 91 for more information on connector orientation.</p>
External Power Supply Connector	<p>The connector to connect the N7018A to an external power supply (Keysight N6700-series Low Profile Modular Power System Mainframe such as N6701C or N6702C with at least one N6786A Source/Measure Unit). A 6-pin power supply connector plug is provided with the N7018A for this connector. See page 32 to know more.</p>
DisplayPort Controller Interface	<p>The interface to connect the N7018A to a DisplayPort AUX controller such as the Unigraf DPR-100 AUX Controller or Unigraf DPT-200 DisplayPort AUX Controller. Using this interface, the DUT's SBU signals (AUX+ and AUX-) received from the N7015A can be routed to the connected DisplayPort Controller to not only monitor but also control the DUT's DisplayPort state. See page 71 for a sample hardware setup for DisplayPort testing.</p>
Thunderbolt Controller Interface	<p>The interface to connect the N7018A to a Thunderbolt controller such as Wilder controller. Using this interface, the DUT's SBU signals (LFTX and LFRX) received from the N7015A can be routed to the connected Thunderbolt Controller to control the Thunderbolt connection. See page 73 for a sample hardware setup for Thunderbolt 2/3/4 testing.</p>
USB 2.0 Cable Connector	<p>The connector to establish connectivity between the N7018A and oscilloscope / host computer via the supplied USB 2.0 cable. This connection is needed to:</p> <ul style="list-style-type: none"> power the N7018A hardware control and configure the N7018A hardware using the N7018A software GUI installed on the oscilloscope / host computer.
CC1 / CC2 Probe Points	<p>The points to probe the DUT's CC1 and CC2 signals that the N7015A passes to the N7018A through the USB Type-C cable connection. See page 79 to know more.</p>

Component	Description
GND Points	GND connection points provided below the CC1, CC2, and VBUS probe points to allow you to clip the probe grounds to these points.
USB Type-C Connector	<p>The USB Type-C connector to connect the N7018A to the N7015A via the USB Type-C plug style cable of the N7015A.</p> <p>Using this connection, the N7015A passes the DUT's low-speed signals ((VBUS, CC1/2, SBU1/2, GND) to the N7018A for monitoring and full control of the Type-C interface.</p> <p>This connection also serves as the connection between the N7018A and DUT with the N7015A test fixture in between.</p>
VBUS Probe Point	<p>The point to probe the DUT's VBUS supply that the N7015A passes to the N7018A through the USB Type-C cable connection.</p> <p>See page 79 to know more.</p>

Supported ALT Modes

The N7018A is capable of operating at and supporting the following ALT modes of the Type-C specifications:

- DisplayPort - The following signal configurations are supported.
 - a two-lane DisplayPort and a two-lane USB 4/3.x configuration for simultaneous data and video transfer
 - a four-lane DisplayPort configuration
- USB 4/3.x Host and Device
- Thunderbolt 2/3/4

Features

The table below lists some of the key features of the N7018A in the context of various emulation roles and functions that it can perform.

NOTE

For the ALT modes supported, the N7018A can support and maintain a USB2.0 and a USB Power Delivery connection.

As a Power Delivery Provider, the N7018A:

- advertises an initial 5V/3A PDO which is used to establish a basic 5V PD contract between the N7018A and consumer DUT. After the initial 5V PD contract is established, the N7018A can provide for any advertised consumer PDO ranging from 5-20V and up to 5A (@ 20V) using the N6701A external power supply.
- advertises a maximum current limit that it guarantees to be able to supply to the DUT.
- displays the sink PDOs that the DUT advertised for its power operating requirements.
- allows you to select a sink PDO from the DUT's advertised PDOs to set up a new PD contract with the DUT.
- allows you to configure its source PDO (fixed only) to advertise its power delivery capabilities to the consumer DUT.
- negotiates and sets up new PD contracts with the DUT,

As a Power Delivery Consumer, the N7018A:

- advertises an initial 5V/1A PDO request which is used to establish a basic 5V PD contract between the N7018A and provider DUT. After the initial 5V PD contract is established, the N7018A can operate at any provider PDOs advertised by the DUT ranging from 5-20V.
- advertises a maximum current limit that the provider DUT has to guarantee to be able to supply.
- displays the source PDOs that the DUT advertised for its power providing capabilities.
- allows you to select a source PDO from the DUT's advertised PDOs to set up a new PD contract with the DUT.
- allows you to configure its sink PDO (fixed only) to advertise its power requirements to the provider DUT.
- negotiates and sets up new PD contracts with the DUT,
- can sink up to 5A in the consumer role when connected to the N6701A external power supply (set to Sink mode).

For these PD negotiations, the N7018A uses the USB Type-C CC line that you selected as the communication channel and manages the connection to the link partner DUT via the Type-C cable connection to the N7015A test fixture.

See Also

["Power Delivery Contract Setup - Flow of Steps"](#) on page 94

As a Power Delivery Controller, the N7018A:

- supports USB PD negotiations and ALT modes.
- control the active Type-C connection (Normal or Flipped).
- control the power role (as a provider or a consumer)
- control (swap) the data role. As a DFP, it can control the entry and exit of the modes in the sink DUT.
- control the ALT modes to be tested.
- control the power delivery (as a Power Delivery Controller)

As a UFP / DFP, the N7018A:

- can handle either of the two data roles - Upstream Facing Port (UFP) or Downstream Facing Port (DFP).
- can accept a default data role based on the power role that you configured for the N7018A.
- can accept a data role swap when initiated by the DUT.
- can initiate a data role swap itself when configured by the user to do so.

As a USB 4/3.x LFPS generator, the N7018A:

- can transmit LFPS and SCD/LBPM signals (LFPS Ping, LFPS Warm Reset, or LFPS Polling patterns)
 - can encode the LBPM signal as SuperSpeed (5Gbps) or SuperspeedPlus (10Gbps).
-

For DisplayPort DUT control, the N7018A:

- supports reconfiguration of pins on the USB Type-C connector for the selected DisplayPort mode.
 - supports the following two modes of operation in DisplayPort emulation.
 - Four DisplayPort lanes to transport DisplayPort streams on these four lanes.
 - Two DisplayPort lanes + two simultaneous USB 4/3.x lanes (Tx and one Rx lanes) to support the simultaneous use of USB data and DisplayPort Audio/Video streams over Type-C connector
 - allows DisplayPort AUX channel testing by probing and routing the SBU1/SBU2 (reconfigured as AUX+ /AUX-) signals received from the DUT via N7015A. These signals can be routed to a DisplayPort Controller via the DisplayPort controller interface on the N7018A.
-

For Thunderbolt 2/3/4 DUT control, the N7018A:

- supports probing and routing of the SBU1/SBU2 signals (LFRX and LFTX) received from the DUT via N7015A. These signals can be routed to a Thunderbolt Controller via the Thunderbolt interface on the N7018A.
-

Powering the N7018A and DUT

Powering the N7018A

You can power the N7018A by connecting it to the oscilloscope or the host computer using the supplied USB 2.0 cable.



Powering the DUT as a Provider or a Consumer

The N7018A can power the DUT when acting as a PD provider or a PD consumer.

You can connect the N7018A to an external power supply to power the DUT. Connecting to an external power supply is mandatory when the N7018A is emulating the role of a Power Delivery Provider. The N7018A has an external power supply port to make this connection. This is particularly useful when testing a DUT under “No Power” or “Dead Battery” or “DUTs with no self powering” situations.

Using an External Power Supply

When connected to an external power supply, the N7018A can accept an input voltage ranging from 0V to 20V in its PD provider role and sink up to 5A in its PD consumer role. The actual input voltage that it uses from the external power supply as a provider depends on the PDO that you selected when setting up the PD contract between the N7018A and DUT (see [page 94](#)).

The Keysight N6700-series Low Profile Modular Power System Mainframe such as N6701C or N6702C with at least one Keysight N6786A Source/Measure Unit (module) can act as an external power supply to the N7018A. One N6786A module can provide the maximum voltage at up to 20V with the maximum current at upto 4A. If required, you can use an additional N6786A power module in the mainframe to support the maximum voltage at up to 20V with the maximum current at up to 5A.

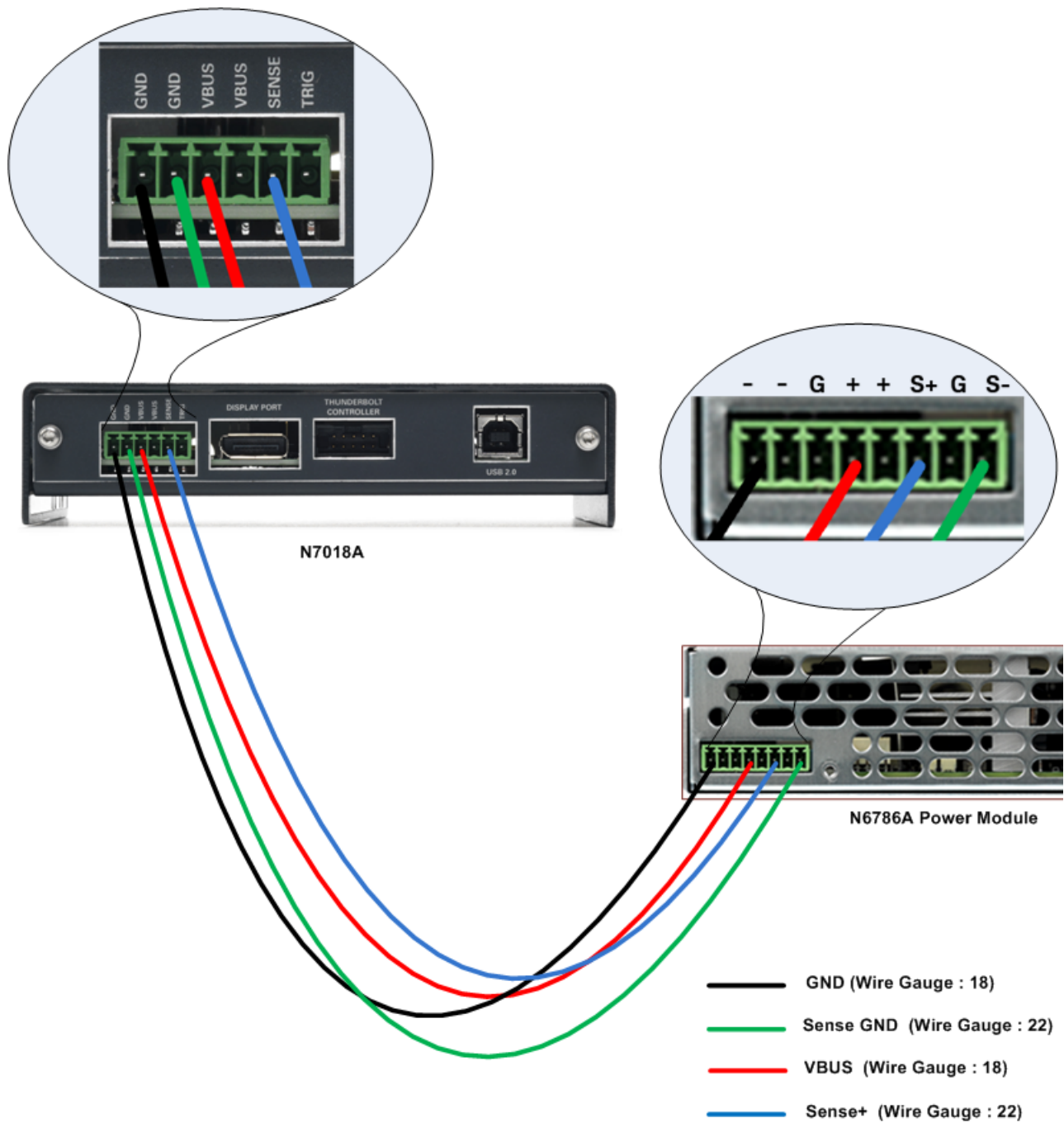
N6701C 4-slots Low-Profile Modular Power System Mainframe



N6786A Source/Measure Unit (module)

Setting up the Wire Harness for the External Power Supply

- 1 Make the wires connection between the N6786A module's SMU connector and N7018A's external power supply connector as illustrated in the following picture.



Wire Harness for 4 Amps External Power Supply Configuration

NOTE

While making these wires connection:

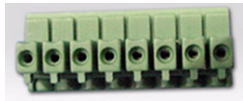
- ensure that the signal labels on the N7018A and N6786A are matched correctly as illustrated in the picture on the previous page.
 - ensure that the wires used conform to the wire gauge indicated in the picture on the previous page.
-

- 2 Securely fasten all wires by tightening the screw terminals.

NOTE

To make these wire connections, you need a small and flat blade screwdriver such as the Phoenix Contact SZS, 0.4 x 2.5 x 80 mm VDE screwdriver.

- 3 Use the following connector plugs to secure the wire harness.



8-pin output connector plug for the N6786A module's SMU connector. This plug is provided with the N6786A.



6-pin power supply connector plug (part number 0360-2693) for the N7018A external power supply connector. This plug is provided with the N7018A.

Pre-use Warnings and Connectivity Precautions

With USB Type-C connectors and cables involved in an N7018A and N7015A test setup, it is essential that proper procedures are followed for connecting and disconnecting these Type-C cables from the device/host and N7015A/N7018A test fixtures during testing. For instance, you may experience problems when the system is disconnected with the power supply on and greater than 5V voltage present on the VBUS.

This topic provides guidelines and precautions that you must take while connecting/disconnecting Type-C cables. Failure to comply to these guidelines and precautions can result in damage to system components.

CAUTION

The USB Type-C connector is a 24-pin fine pitch connector that can have up to 20V on the VBUS pins, and up to 5A supplied to DUTs during testing. Therefore, you must break the Type-C connection between the N7018A and DUT prior to disconnecting or reconnecting any Type-C cable used in the setup. This ensures that the VBUS is at V_{safe0V} before the disconnection/reconnection.

You use the **Break Connection** button in the N7018A software GUI to break the connection. See [page 90](#) for more details on connection.

CAUTION

The N7018A uses an external power supply when configured as a Power Delivery Provider to the DUT. Therefore, in such test configurations, you must set up all physical connections before the power supply is turned on during testing. By doing so, you can ensure that the PD contract that allows currents to flow between the power supply and DUT is set up only after the physical connections have been made. This will ensure protection against damage from disconnecting/reconnecting components with power supply on and at high voltages.

CAUTION

The CC1/CC2 and SBU1/SBU2 lines are limited to 5V swings. These are located next to the VBUS lines in the Type-C connector and the voltage on the VBUS pins can range from 0-20V. This may cause damage to CC/SBU lines if the Type-C cable is connected/disconnected while voltages are present on the VBUS.

To prevent this damage, you must connect all physical connections and cables between the N7018A/N7015A and DUT before any PD contracts are made while running tests.

When disconnecting a Type-C cable while running tests, the PD contract must be broken before disconnecting. This can be done by breaking the Type-C connection using the N7018A software GUI.

Cleaning the N7018A Test Controller

Do not try to clean the probe using Isopropyl alcohol as it may leave a residue.

To clean the N7018A

- 1 Disconnect the N7018A from all external devices such as an oscilloscope, any test fixtures, or controllers.
- 2 Clean the outside of the N7018A with a soft, lint free, slightly dampened cloth.

CAUTION

Do not use detergent or chemical solvents.

- 3 After cleaning, allow any residual moisture to dissipate prior to connection with any external devices.

4 N7016A Type-C Low Speed Test Fixture (Discontinued)

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N7016A Block Diagrams / 40
Powering the N7016A / 45
Replacing the N7016A Fuse / 47

This chapter provides details on the N7016A test fixture.

Introduction

The N7016A Type-C low-speed test fixture is used along with the N7015A High-speed test fixture to allow monitoring and limited control of the Type-C low-speed signals that it receives from the N7015A.

The N7016A supports termination requirements of the DUT as well as a connection to a power delivery controller. It also provides a Type-C port to connect to a Type-C device (can be a link partner to the DUT). Using this port, it allows you to merge and route DUT's high-speed and low-speed signals received via the N7015A to the Type-C device connected to this port.

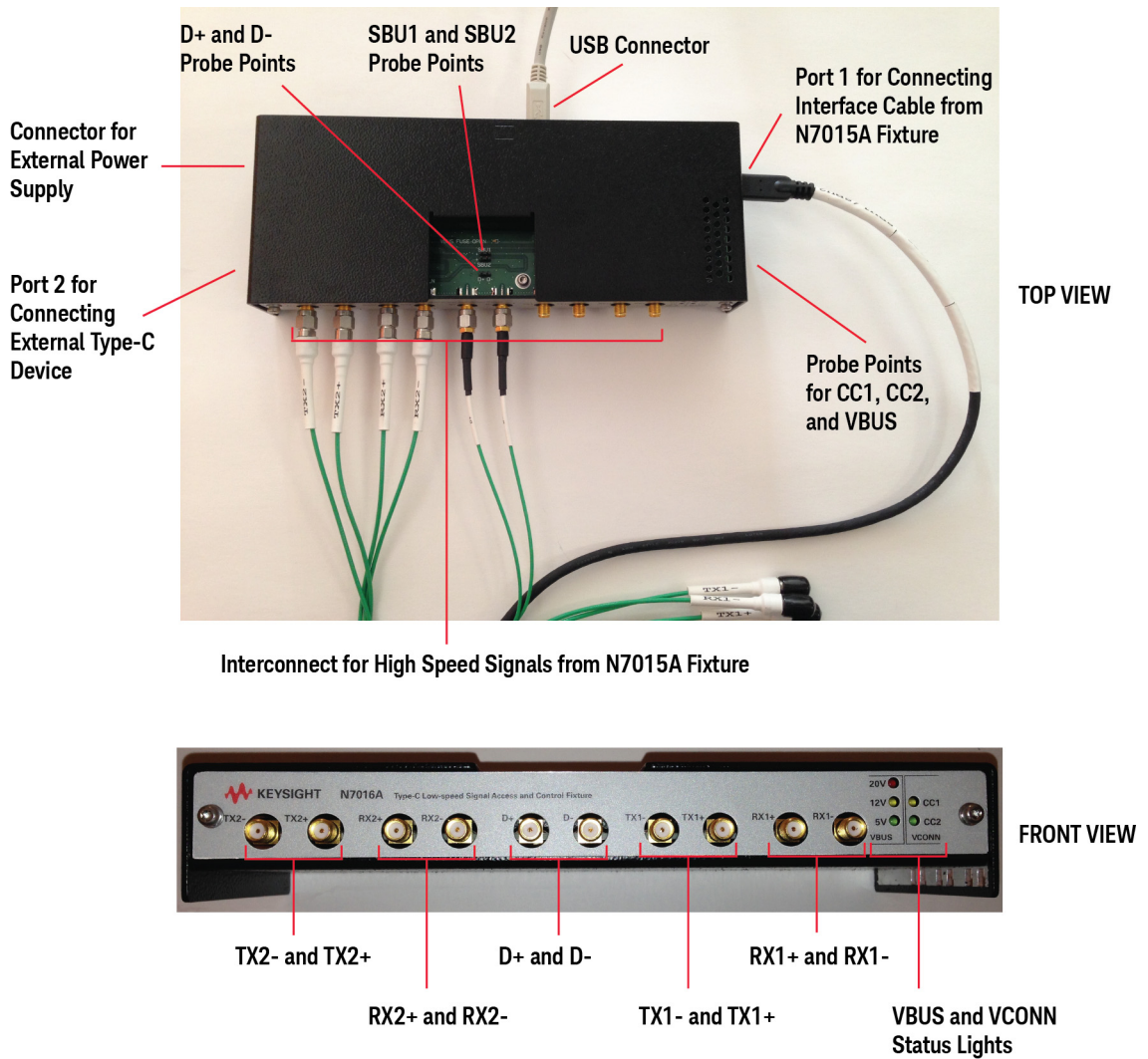


Figure 4 N7016A Low Speed Test Fixture

NOTE

When connecting the N7015A's TX and RX SMA cables to the N7016A TX and RX SMA ports, ensure that the labels on these SMA cables and SMA ports match. For instance, connect the TX1+ cable from N7015A to TX1+ SMA port on N7016A.

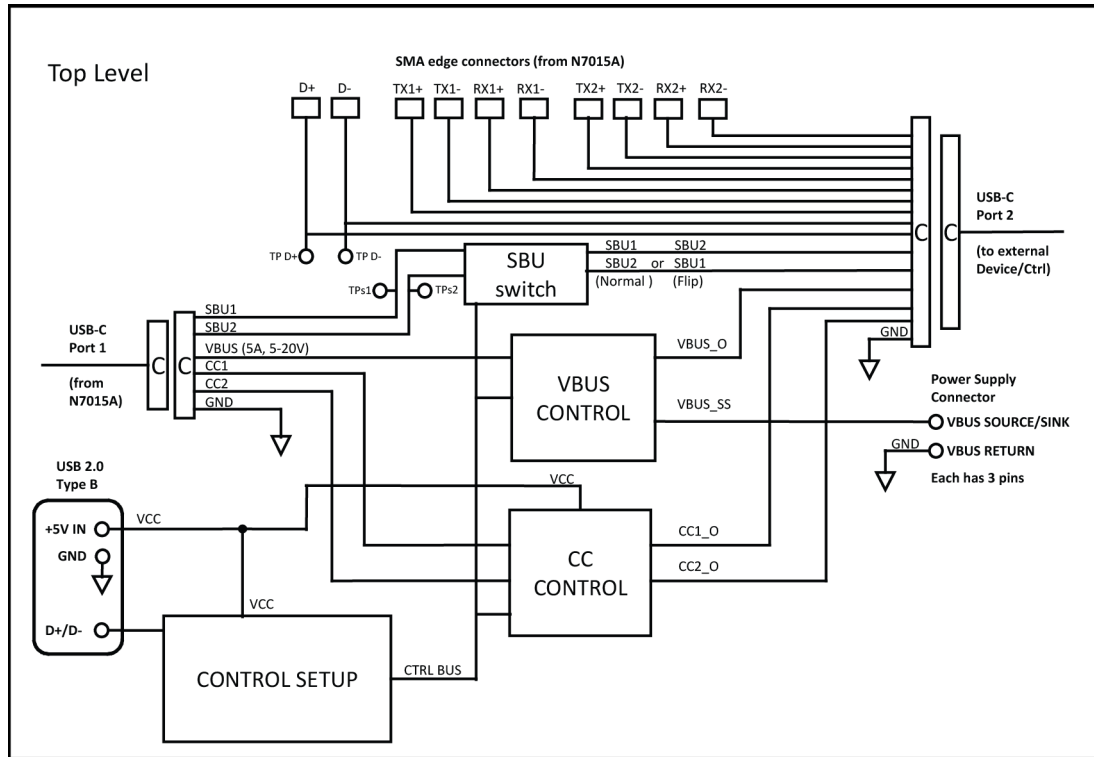
Features

Following are some of the key features of the N7016A.

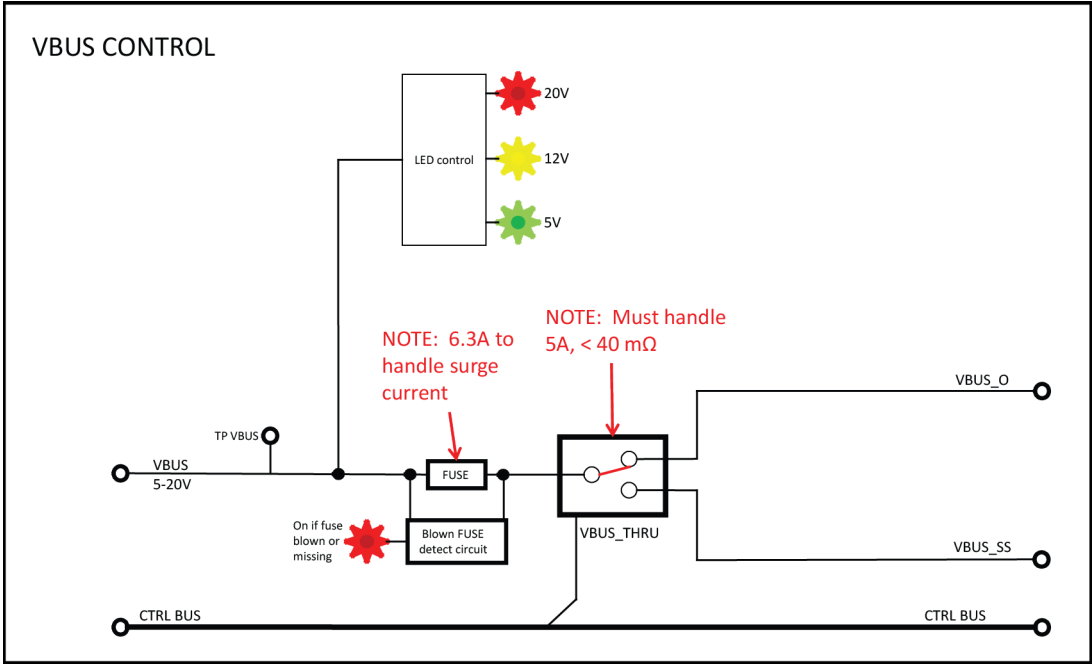
- Can turn on a Type-C DUT using the N7016A low speed fixture termination control options. These options are the R_p , R_d and R_a resistances (See "[Significance and Values of \$R_p\$, \$R_d\$, and \$R_a\$ Termination Resistors in the USB Type-C Connector:](#)" on page 43 for more details).
- Can probe the CC lines for power delivery protocol and power delivery physical layer testing.
- Can probe the SBU1/SBU2 lines for AUX channel testing.
- Can probe the VBUS and D+/D- signals.
- Can load the VCONN according to both the DisplayPort and USB specifications. VCONN is the CC line which is not used for link communication and can be controlled using the N7016A low speed fixture control software.
- Can simulate a flip of the CC lines without removing the Type-C cable.
- Can enable the use of an external power supply to support two quadrant operation. An optional Keysight power supply can supply and load VBUS and report the value of the current.
- Can pass the VBUS and N7015A high speed lanes to its Port 2 to be used by a power delivery controller or other link partner.
- Can be controlled and configured using the N7016A Type-C Low Speed Signal access and Control Fixture software.

N7016A Block Diagrams

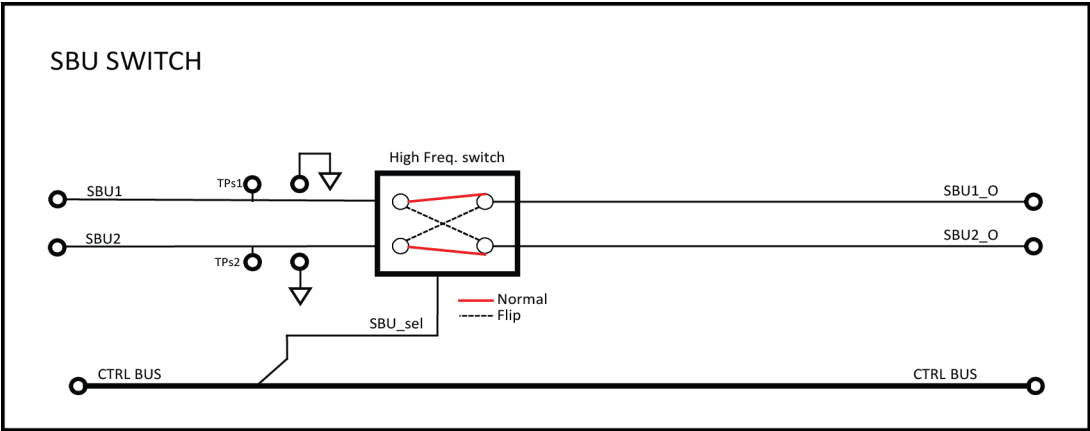
Connection Block Diagram



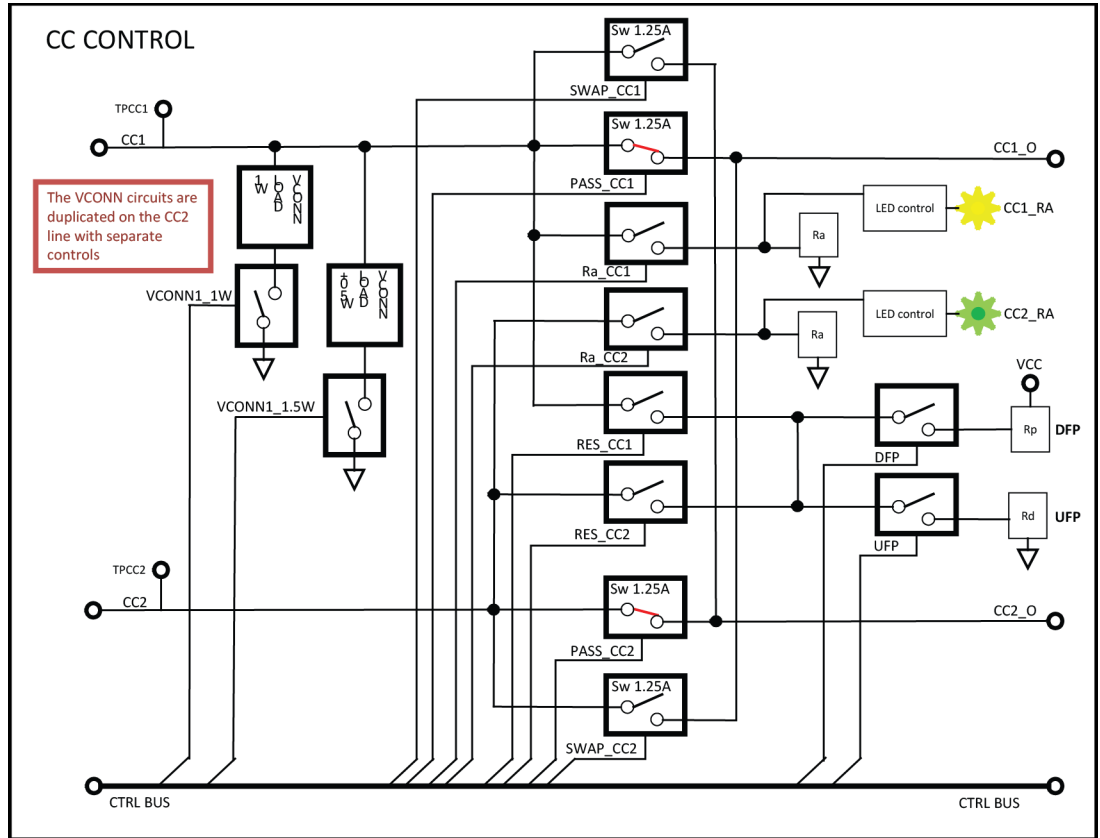
VBUS Control Block Diagram



SBU Switch Block Diagram

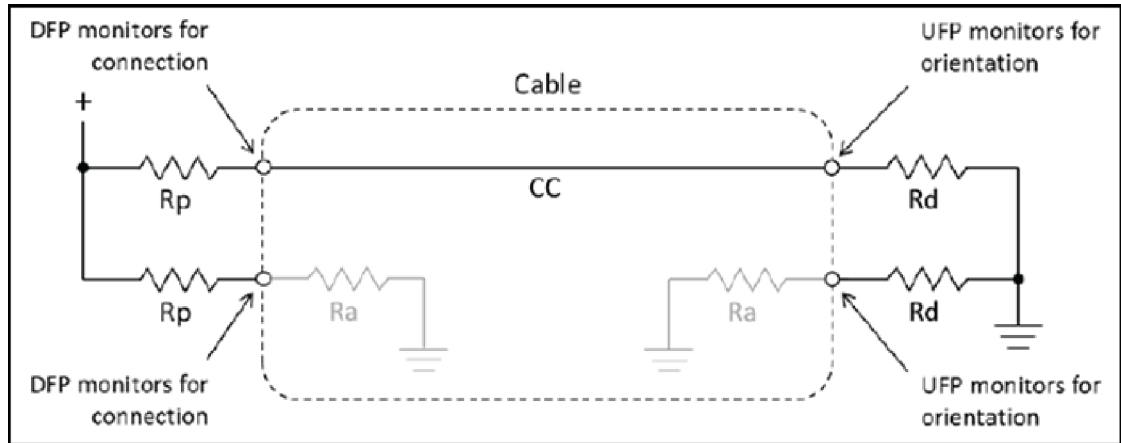


CC Control Block Diagram



Significance and Values of Rp, Rd, and Ra Termination Resistors in the USB Type-C Connector:

A downstream facing port (DFP), such as a host computer, exposes pull-up terminations, Rp, on its CC pins (CC1 and CC2). An upstream facing port (UFP), such as a peripheral, exposes pull-down terminations, Rd, on its CC pins. The purpose of Rp and Rd terminations on CC pins is to identify the DFP to UFP connection and the CC pin that will be used for communication. To do this, the DFP monitors both CC pins for a voltage lower than its unterminated voltage.



The N7016A low speed fixture has a fixed Rd value of 5.1 kΩ for the UFP connection and a fixed Rp value of 56 kΩ for the DFP connection. For simulating the VCONN connection, the Ra value is fixed at 1 kΩ.

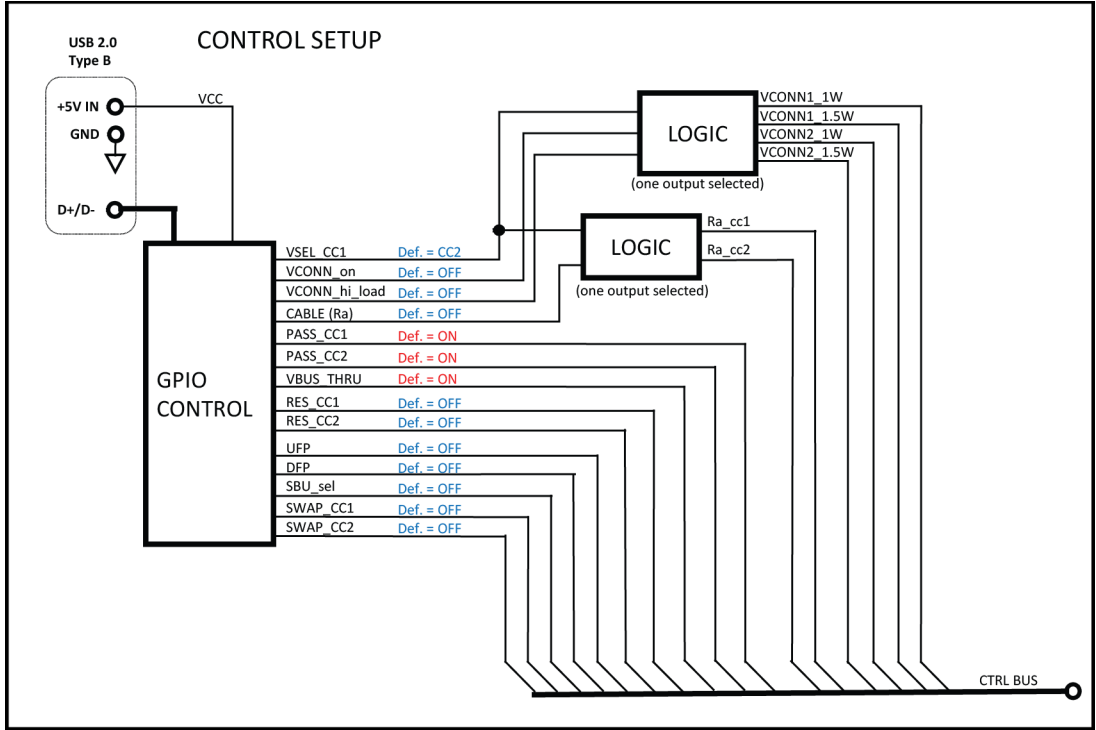
The following table provides the values used for the DFP's Rp based on the current sourcing capability of the type-C port and the voltage that is connected to the Rp.

DFP Advertisement	Resistor Pull-up to 4.75 V - 5.5 V	Resistor Pull-up to 3.3 V ± 5%
Default USB power	56 kΩ ± 20%	36 kΩ ± 20%
1.5A at 5 V	22 kΩ ± 5%	12 kΩ ± 5%
3.0A at 5 V	10 kΩ ± 5%	4.7 kΩ ± 5%

The type-C cable needs to expose a pull-down termination, Ra, on its VCONN pin to signal to the DFP that it needs power. The DFP must be able to differentiate between the presence of Rd and Ra to know whether there is a UFP attached and where to apply VCONN. The DFP is not required to source VCONN unless Ra is detected.

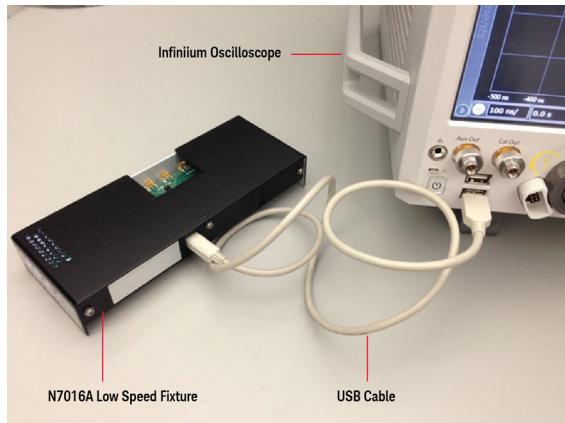
	Minimum Impedance	Maximum Impedance
Ra	800 Ω	1.2 kΩ

Control Setup Block Diagram



Powering the N7016A

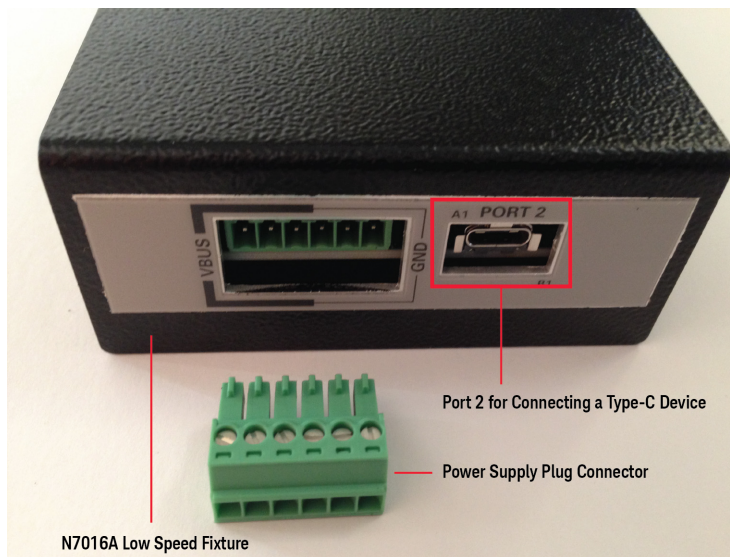
You can power on the N7016A by connecting it to an oscilloscope or a personal computer using the supplied USB cable.



Using an External Power Supply

In order to comply with the USB Type-C specifications, the N7016A supports the Keysight N6701A Low-Profile Modular Power System Mainframe and Module that acts as an external power supply. The external power supply port of the N7016A is also a power sink port.

A power supply connector plug is included in the N7015A/16A Type-C Test Kit for convenience.



NOTE

Port 2 of the N7016A low speed fixture can be used to connect a Type-C device such as a power delivery controller, a monitor, or a USB-C power supply which acts as an external power supply to this low speed fixture.

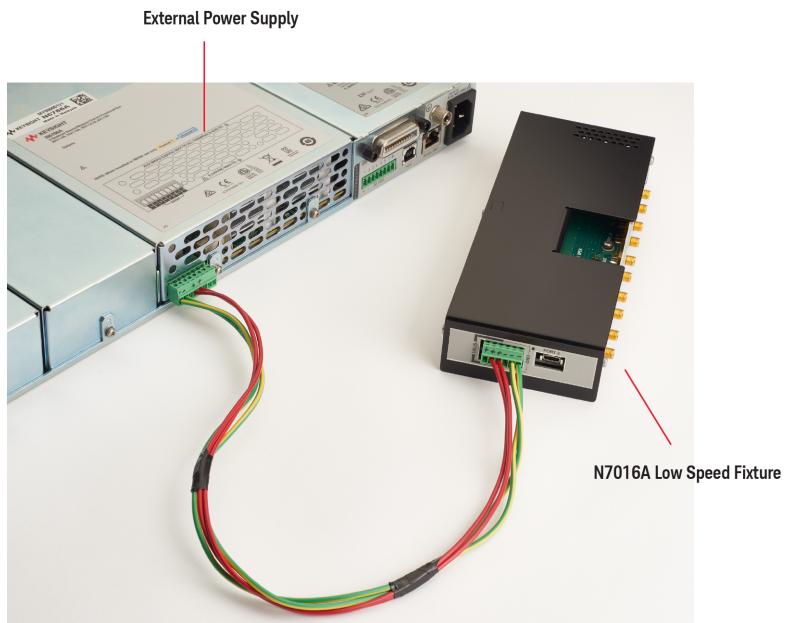


Figure 5 External Power Supply for Low Speed Fixture

Replacing the N7016A Fuse

When using an external power supply for supplying power to the N7016A, the 6.3A slow blow fuse protects the DUT from a VBUS to GND short at the external power supply connector.

In case this fuse blows, you can replace this fuse with a fuse (P/N: 2110-0623) provided in the N7015A/16A Type-C Test Kit.

To replace this fuse, perform the following procedure.

- 1 Remove the power source and connecting cables from the N7016A.

WARNING

Do not remove power from the N7016A before disconnecting the connected devices from Port 1 and Port 2 of this fixture.

- 2 Remove the three screws on the back side and the two screws on the front side of the N7016A cover using a Torx size 10 driver.

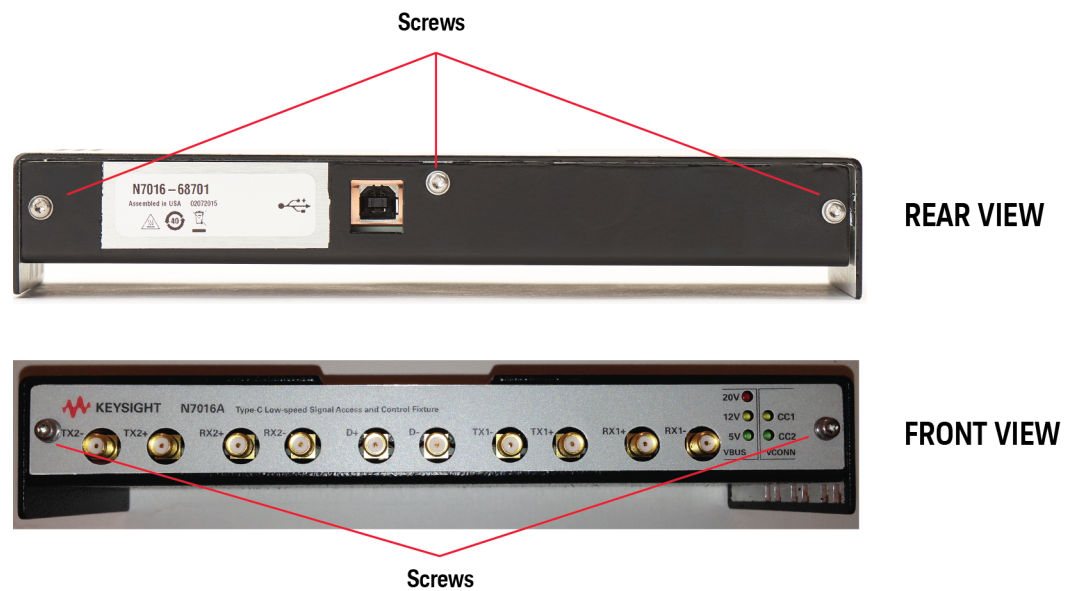


Figure 6 Cover Screws

- 3 Pull the cover off the N7016A.
- 4 Pull the fuse out carefully and replace this fuse with one of the fuses provided in the N7015A/16A Type-C Test Kit.

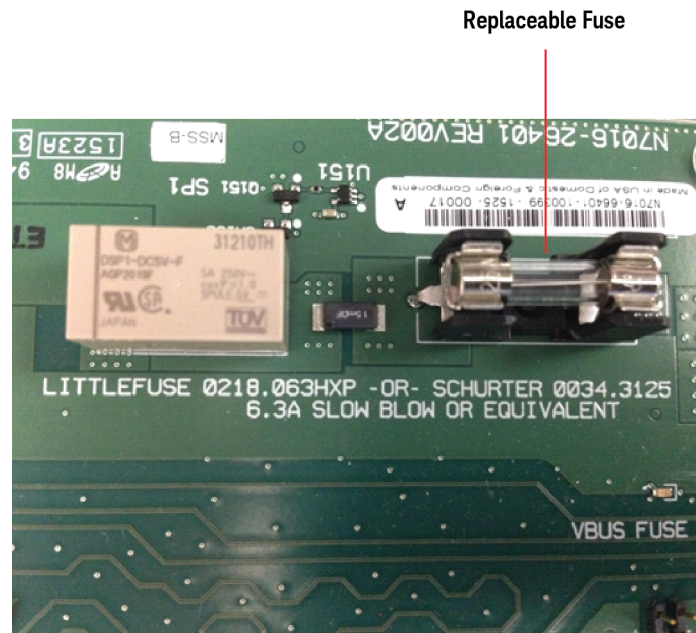


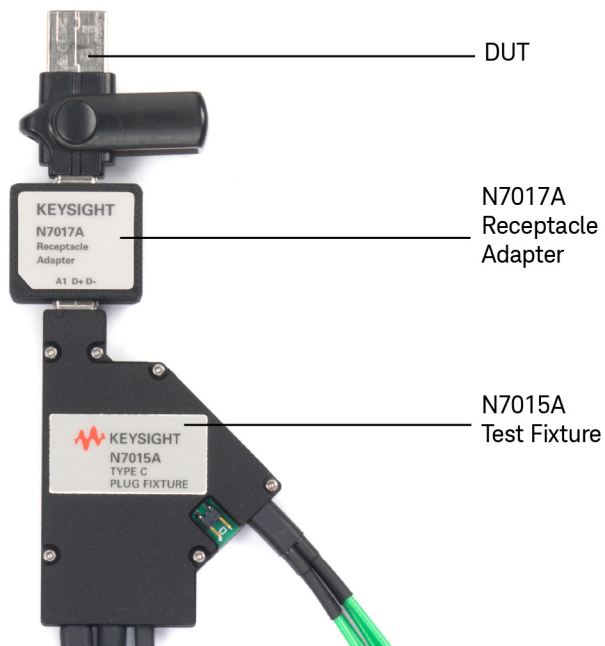
Figure 7 Fuse Location

- 5 After replacing the fuse, carefully fit the cover back on the N7016A and tighten the three screws on the back side and the two screws on the front side of the N7016A cover (See [Figure 6](#) on page 47).

5 N7017A Type-C Receptacle Adapter (Discontinued)

The N7017A Type-C receptacle adapter allows the N7015A test fixture to act as a receptacle fixture as well.

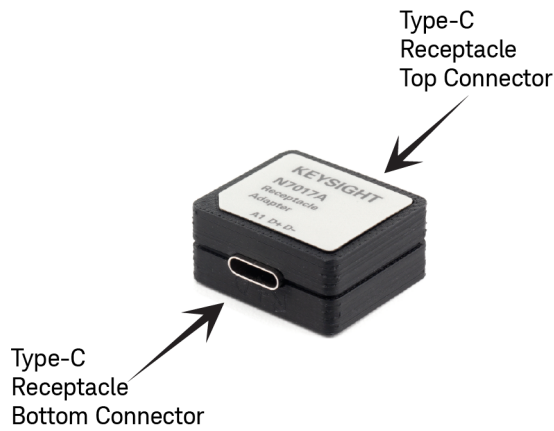
The N7015A comes with a plug Type-C connector allowing it to connect only to a USB host/device with a receptacle connector. But with the usage of the N7017A receptacle adapter, the N7015A can also connect to a USB device with a plug connector such as a thumb drive.



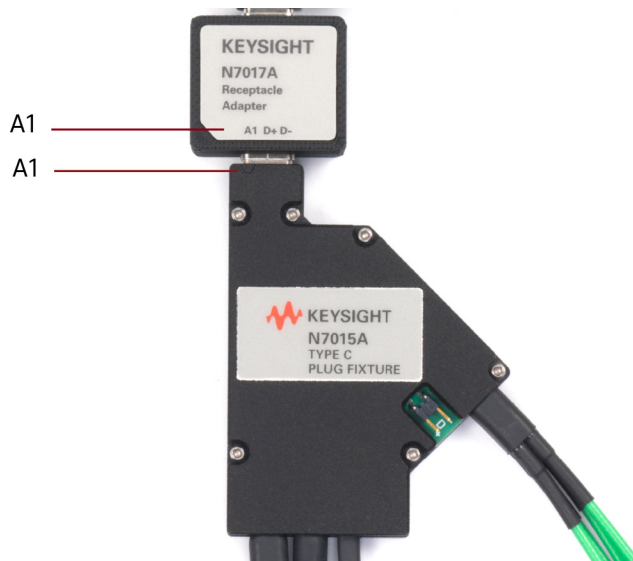
The N7017A receptacle adapter is required in the following situations:

- Testing tethered devices such as thumb drives
- Enabling Rx signal validation and calibration when testing receptacle devices

The N7017A receptacle adapter provides two receptacle connectors. You can use any of these two connectors to connect to the N7015A test fixture's plug and the other to connect to a USB device's plug.



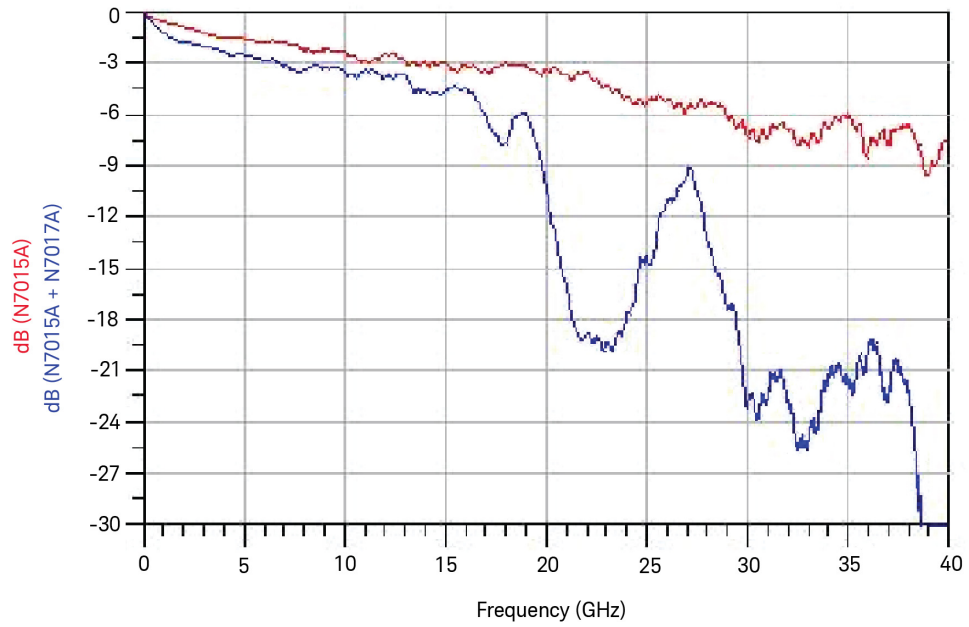
While making these connections, ensure that the A1 pin marking displayed on the receptacle adapter is aligned to the A1 pin on the N7015A test fixture as shown in the figure below.



To learn more about the pinout of the N7017A's receptacle connectors, refer to the topic "[N7017A Receptacle Adapter Pinout](#)" on page 121.

To know about the signal path when using the N7017A receptacle adapter with the N7015A test fixture, refer to the topic "[Signal Routing when using the N7017A Receptacle Adapter](#)" on page 122. This topic illustrates how these signals are routed from the DUT to the N7017A receptacle adapter and then to the N7015A test fixture.

Insertion Loss Plot for N7015A with N7017A



6 N7019A Type-C Active Link Test Fixture

Introduction /	54
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Recommended Probes and Cables /	55
Protocol Decodes Supported /	56
Trigger, Decode, and Search Acquired Signals /	56
Tx and Rx when using N7019A /	57
N7019A Components /	58
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Introduction

The *N7019A Type-C Active Link Test fixture* provides you access to individual low speed as well as high speed Type-C signals on an active link between Type-C link partners. You can access the following Type-C signals using the N7019A fixture.

Type-C Signals
High Speed Tx and Rx Signals (TX1+/-, RX1+/-, TX2+/-, RX2+/-)
USB 2.0 (D+/D-)
CC1/CC2
SideBand Use Signals (SBU1/SBU2)
VBUS
GND

The signals that you access using the N7019A can be captured on a compatible Keysight oscilloscope using appropriate Keysight probes and cables. This signal acquisition can then be decoded and analyzed as packets using the protocol decoders available in the Keysight Infiniium software GUI. The packet-level protocol decode allows you to troubleshoot and debug quickly and perform power-up and pre-test verifications. In addition, the time-correlated views in the decoders also allow you to quickly find the timing or signal integrity root cause. You can also set a trigger on packets or patterns in this protocol-based data.

NOTE

Protocol decoders are licensed software applications for Keysight Infiniium software GUI. Contact Keysight Technologies for a subscription to these decoders.



Figure 8 N7019A

The N7019A fixture establishes an active Type-C connection between your Product Under Test and link partner via the Thunderbolt 3 cables attached to it. The fixture has various probe points and ports to let you access signals individually. Based on the signal that you want to access, you connect a compatible Keysight probe / cable to the appropriate probe point /port on the N7019A.

Refer to the topic ["Sample Setups for Debugging on an Active Link using N7019A"](#) on page 66 to get more information on the hardware setups recommended for N7019A as per probing scenarios.

Recommended Oscilloscopes

The following table lists the Keysight oscilloscopes that you can use with the N7019A fixture as per your specific testing scenario.

Compatible Oscilloscopes	Required Infiniium Software Version
For High Speed Signals Capture and Analysis	
Infiniium V-Series	Infiniium 6.55 or higher
Infiniium Z-Series	Infiniium 6.55 or higher
Infiniium UXR-Series	Infiniium 10.25 or higher
For Low Speed Signals Capture and Analysis	
Infiniium S-Series	Infiniium 6.55 or higher

NOTE

The low bandwidth oscilloscopes (suitable for low speed signals capture and analysis) support the hardware based triggering feature for certain protocols. This feature allows you to specify protocol-level trigger conditions to trigger when the condition is met. (Refer to your oscilloscope's *Infiniium online help > Protocol Decode, Search, Trigger* section to get details on the triggering capabilities of your oscilloscope.)

Software based triggering (search on protocol data) is available on all recommended oscilloscopes and for all supported protocols decodes.

Based on the type of signals being accessed, you can select Analog or Digital channels of the oscilloscope for acquisition.

USB 2.0 (Low speed, Full speed, and High speed D+/D-)	Analog or Digital channels (MSO)
USB4 High speed signals	Analog channels
Low speed power and control signals	Analog or Digital channels (MSO)

Recommended Probes and Cables

The following table lists the Keysight probes and cables recommended for use with the N7019A fixture as per your specific probing needs.

Signal to be Probed	Probing Type Supported	Recommended Keysight Probes and Cables
High Speed Tx and Rx Signals (TX1+/-, RX1+/-, TX2+/-, RX2+/-)	Differential or Single-Ended	Direct Coaxial Cables N2823A (1 m) Phase-matched Cable Pair or N5448B (25 cm) Phase-matched Cable Pair
USB 2.0 (D+/D-)	Differential or Single-Ended	Differential Probe Head with an InfiniiMax Probe Example - E2678B Differential Socketed Probe Head
CC1/CC2	Single-Ended	Passive Probe Example - N2871A Passive Probe

Signal to be Probed	Probing Type Supported	Recommended Keysight Probes and Cables
SideBand Use Signals (SBU1/SBU2)	Differential or Single-Ended	Differential Probe Head with an InfiniiMax Probe Example - E2678B Differential Socketed Probe Head
VBUS	Single-ended	Passive Probe Example - N2871A Passive Probe Power Rail Probe Example - N7020A or N7024A Power Rail Probe with N7023A Power Rail Browser

See [Chapter 7](#), "Recommended Accessories" to know more about these probes and cables.

For more information on probing signals, refer to [Chapter 9](#), "Accessing Type-C Signals".

Protocol Decodes Supported

The N7019A is capable of supporting the following protocol decodes.

- USB-PD [300kbps]
- USB2 [480Mbps]
- USB 3.0 [5 Gbps]
- USB 3.1 (Gen 1 or 2) [5, 10 Gbps]
- USB 3.2 (Gen 1 or 2) [5, 10, 20 Gbps]
- USB4 [20Gbps]

Trigger, Decode, and Search Acquired Signals

The signals that are accessed using the N7019A can be further decoded on the oscilloscope using a variety of Keysight Protocol Decoder applications. Some key features of these applications that you can use for debugging with N7019A are:

- Packet-level protocol decode such as:
 - Dual lane and multi-lane decode
 - Forward Error Correction (FEC) analysis
 - LFPS decoding
 - Ordered sets decode
 - Tunneled protocol traffic (PCIe, DisplayPort) decode
- Hardware-based triggering for selected protocols such as USB 2.0 and USB PD on an oscilloscope that supports the hardware trigger feature such as the S-series oscilloscope. This feature includes configurable protocol-level trigger conditions such as:
 - Trigger on ordered sets, link commands, header packets, link management header packets, transaction header packets, data packet payloads, symbol sequences, or errors etc.
- Search on the acquired protocol data based on a specific packet or pattern. You can also use this search as a software-based trigger.

See "[An Overview to the Protocol Decoder Software Applications](#)" on page 109.

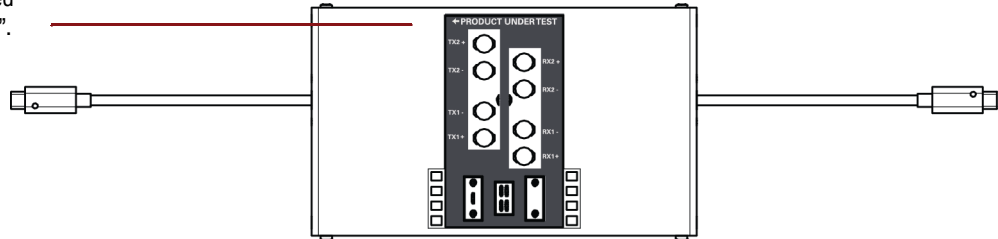
For detailed information on Protocol Decoders, refer to the Online help included with these applications in the Infiniium GUI. You can also refer to the data sheet available for these applications on www.keysight.com.

See Also

"[Troubleshooting Closed Eyes for USB4 \(Gen2/Gen3 Signals\)](#)" on page 110

Tx and Rx when using N7019A

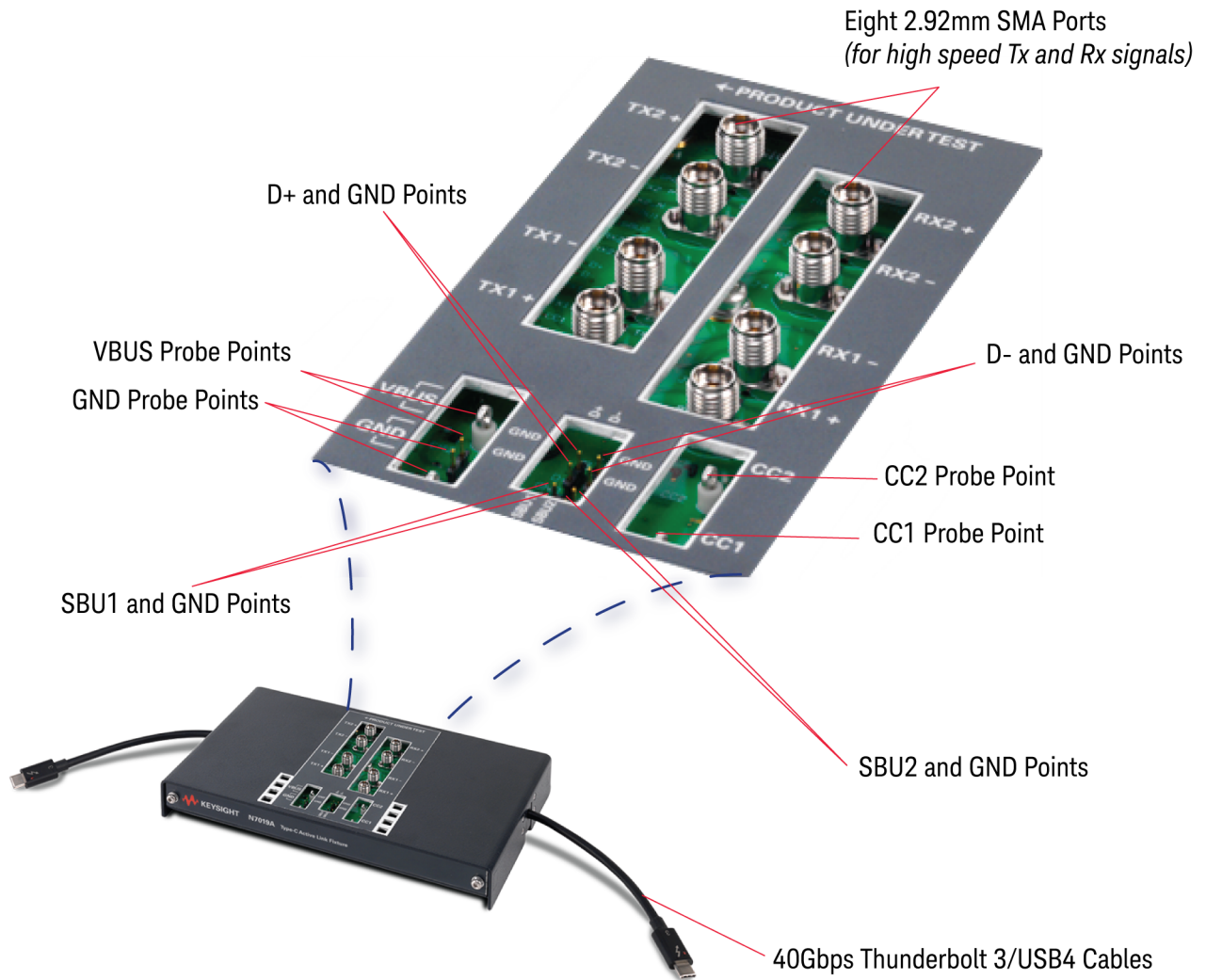
The product that you connect to this side of N7019A is considered "Product Under Test".



When acquiring signals using N7019A:

- The signals that the "Product under Test" transmits to the link partner are considered Tx signals.
- The signals that this "Product under Test" receives from the link partner are considered Rx signals.

N7019A Components



The following table describes these N7019A components.

Component	Description
40Gbps Thunderbolt 3/USB4 cables	The cables to connect N7019A to the Product Under Test and link partner.
	CAUTION Care should be taken while handling these cables. These cables are designed to be flexible, but are not designed to be bent sharply. Do not twist, pull, or tightly bend these cables at 90° to ensure signal integrity. Do not put any force onto these cables.

Component	Description
Tx ports	The four Tx ports on N7019A are used to acquire the signals transmitted from the Product Under Test to the link partner. Note: Here, Product Under Test refers to the product connected to that side of N7019A that the Product Under Test label points to.
Rx ports	The four Rx ports on N7019A are used to acquire the signals that the Product Under Test receives from the link partner. Note: Here, Product Under Test refers to the product connected to that side of N7019A that the Product Under Test label points to.
SBU1/SBU2 Probe Points	Using these points, you can probe SBU1/SBU2 signals. See page 83 to know more.
CC1 / CC2 Probe Points	See page 80 to know more.
GND Points	GND connection points are provided with the SBU1, SBU2, D+, D-, and VBUS probe points.
VBUS Probe Point	See page 80 to know more.
D+ / D- Probe Points	Using these points, you can probe D+/D- signals single-ended or differentially. See page 85 to know more.

Cleaning the N7019A Test Fixture

Do not try to clean the test fixture using Isopropyl alcohol as it may leave a residue.

To clean the N7019A

- 1 Disconnect the N7019A from all external devices such as an oscilloscope, any test fixtures, or controllers.
- 2 Clean the outside of the N7019A with a soft, lint free, slightly dampened cloth.

CAUTION

Do not use detergent or chemical solvents.

- 3 After cleaning, allow any residual moisture to dissipate prior to connection with any external devices.

7 Recommended Accessories

N2787A 3D Probe Positioner / 61
N2823A or N5448B Coaxial Phase Matched Cable Pair / 61
InfiniiMax 1130B Series Probe Amplifier / 64
E2678B Socketed Head for InfiniiMax Probe / 64
Passive Probe / 64

This chapter lists the accessories that are recommended for use with the Type-C test fixtures described in this guide. These accessories provide support, convenience, flexibility, or probing access in your Type-C test setups. You can order these accessories either with the test fixture(s) or separately later as individual products.

NOTE

You may want to order the Keysight Type-C Connectivity Core Kit (part number ZA0200) that includes a number of the recommended accessories and equipment needed for Type-C testing. See [page 15](#) to know more.

N2787A 3D Probe Positioner

The N2787A 3D Probe Positioner can be quickly positioned in a wide variety of configurations to support the N7015A and DUT. This support is intended to mitigate accidentally disconnecting the DUT.



N2823A or N5448B Coaxial Phase Matched Cable Pair

For extending the cable length of the N7015A and to add convenience and flexibility to the probing setup, use the N2823A 39 inches (1 m) long coaxial phase matched cable pair. This coaxial cable has 2.92 mm male connectors on both ends.



Figure 9 N2823A Coaxial Cable Pair

NOTE

In situations where a shorter extension of a cable's length is needed, you can use the N5448B (25 cm long) coaxial phase matched cable pair.



Figure 10 N5448B Coaxial Cable Pair

The figure below shows the N5448B cables attached to the 2.92 mm high speed signal connectors of the N7015A test fixture and channels 1 and 3 of the Infiniium oscilloscope.

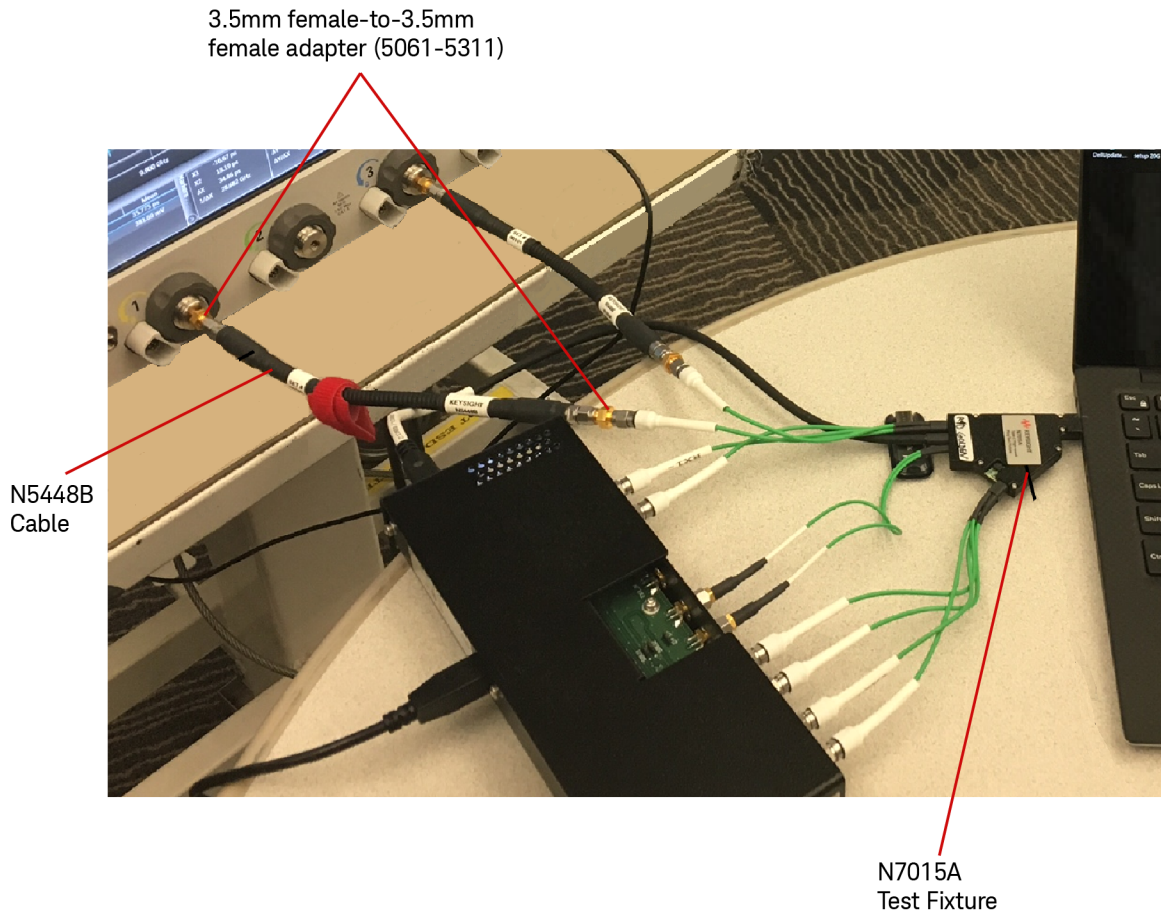


Figure 11 N5448B Cable Pair Attached to N7015A and Infiniium Oscilloscope

The N2823A (or the shorter N5448B) cables provide excellent signal integrity to support high speed digital signals. These are, therefore, optimum for use with the matched cables for differential high speed lines of the N7015A Type-C High Speed Test Fixture's connectivity with the Infiniium Oscilloscope channels.

Besides this usage, you can also use the N2823A (or the shorter N5448B) cables in other scenarios such as extending the length of matched cables that connect the high speed signals from the N7015A to the N7016A or N7018A SMA ports.

NOTE

To adapt the 2.92mm male connector of the N2823A (or N5448B) cable and the N7015A test fixture, use the Keysight 3.5mm female-to-3.5mm female adapter (part number 5061-5311).



This adapter is also recommended to connect the 2.92mm male connector of these cables to the input of Infiniium V Series, Z Series or 90000X oscilloscope.

CAUTION

The minimum bend radius for the N2823A and N5448B coaxial cable pair is 30 mm. Bending these cables at too tight a radius or twisting the cables can cause damage, reduce performance, and impact the precision of these cables.

Also, ensure that the plastic caps that are provided with these cables are installed when the cables are not in use.

For details on the N2823A and N5448B cables, refer to its guide available in the Document Library tab of this product's page on www.keysight.com.

InfiniiMax 1130B Series Probe Amplifier

This InfiniiMax probe amplifier is used for probing USB 2.0 D+/D- or SBU1/SBU2 signals at the N7016A or N7018A test fixture.

E2678B Socketed Head for InfiniiMax Probe

This socketed head is attached to the 1130B series InfiniiMax probe amplifier for probing USB 2.0 D+/D- or SBU1/SBU2 signals at the N7016A or N7018A test fixture.

Passive Probe

For probing CC1, CC2, and VBUS signals at the N7016A or N7018A test fixture, use either Keysight N2871A 200MHz or 10074C 150MHz passive probe.

8 Sample Setups for Type-C Active Link Debugging and Compliance Testing

Sample Setups for Debugging on an Active Link using N7019A ...	66
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Sample Setups for Compliance Testing using N7015A/6A/7A/8A ...	69
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Testing a DisplayPort (2+2) Source (Tx and AUX Channel Testing) ...	71
Testing a DisplayPort (4 lanes) Source (Tx and AUX Channel Testing) ...	72
Testing a Thunderbolt 2/3/4 Host (Tx) ...	73
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Testing a USB Power Delivery Provider with N7018A set to Sink Current ...	75
Testing a USB Power Delivery Provider over Type-C Interface ...	76

This chapter illustrates a few sample setups that utilize the Keysight Type-C connectivity fixtures for various Type-C interfaces pre-test verifications, compliance testing, and debugging scenarios.

CAUTION

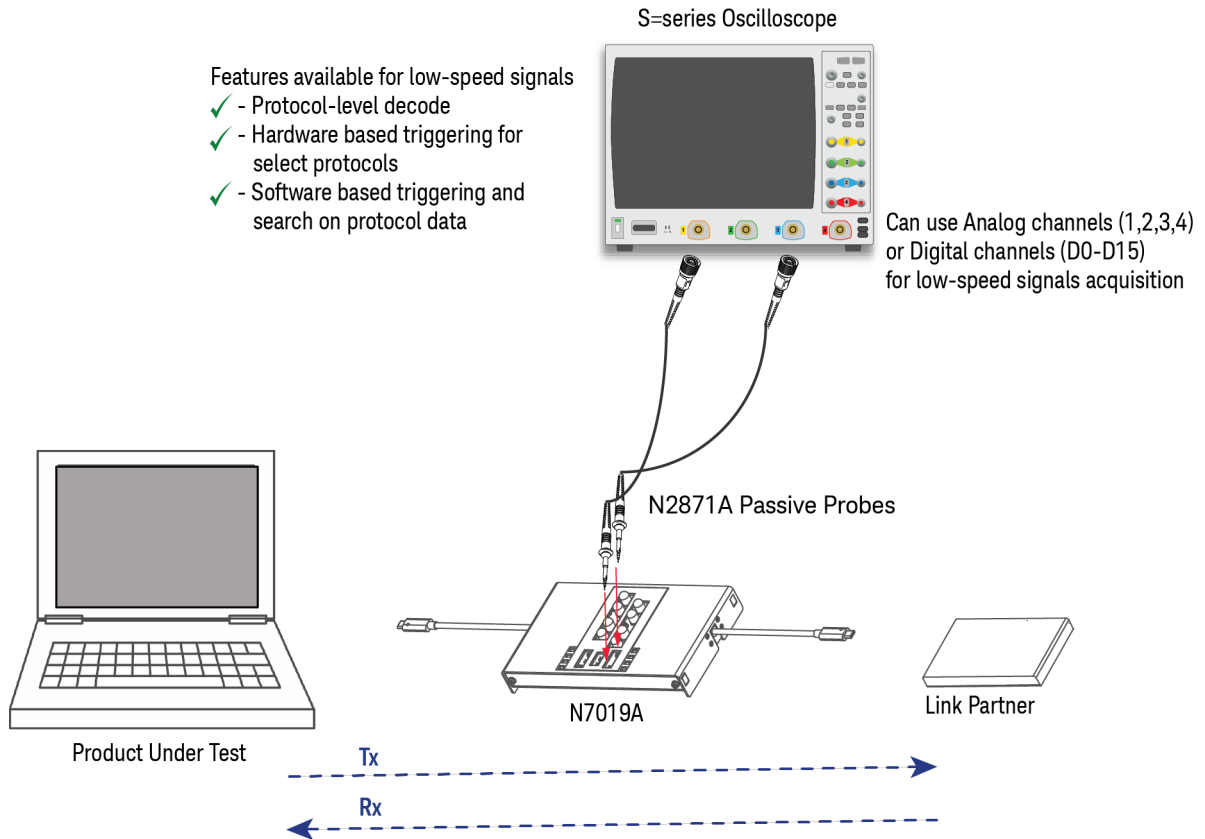
Ensure that you follow the guidelines and precautions mentioned in the topic **"Pre-use Warnings and Connectivity Precautions"** on page 35 while connecting/disconnecting components used in the test setup.

Sample Setups for Debugging on an Active Link using N7019A

Low Speed Signals Decode and Analysis

In situations such as monitoring and debugging the Power Delivery line (CC1/CC2) and decoding to troubleshoot power up and PD or monitoring the data transmission over USB 2.0 D+/D- signals, you can use a low bandwidth Keysight oscilloscope in the setup.

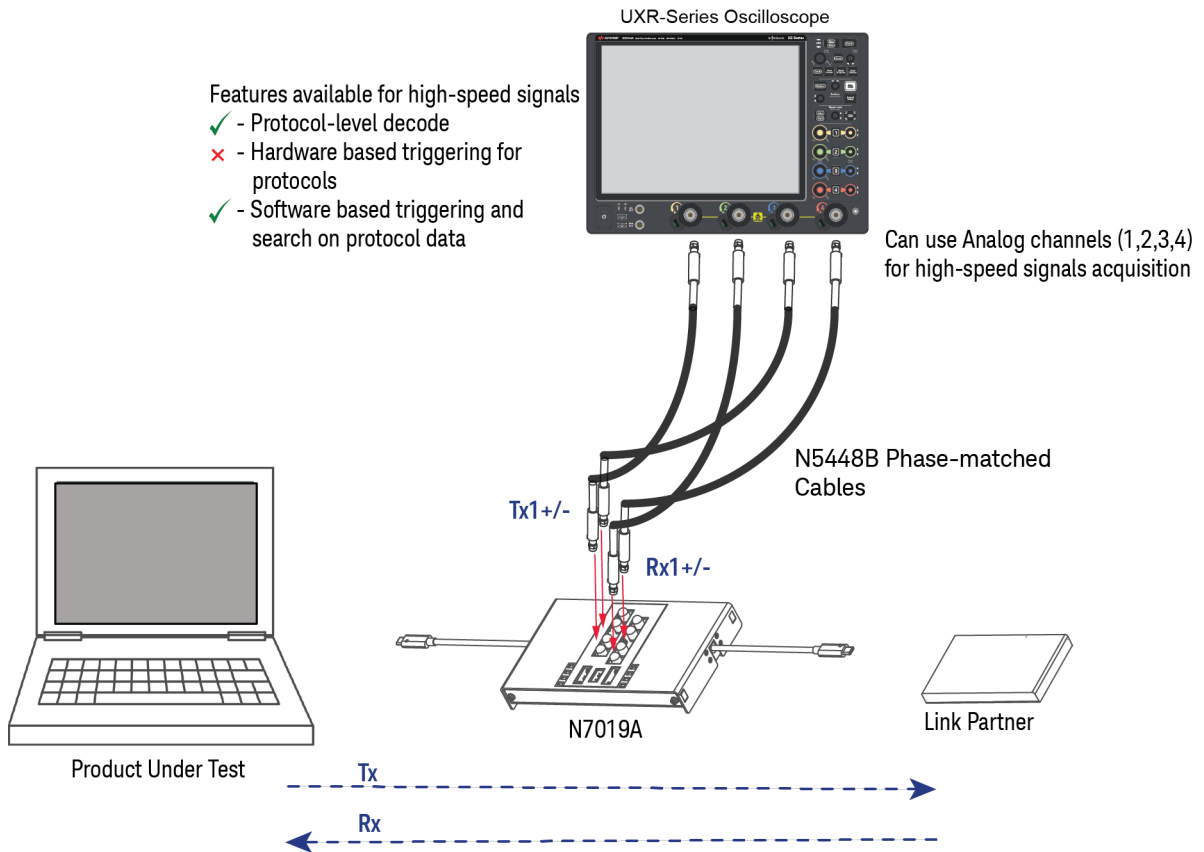
The figure below illustrates a sample setup for the acquisition and decoding of CC1 and CC2 signals.



High Speed Signals Decode and Analysis

In situations such as monitoring and debugging the high speed data transmission (on Tx and Rx lanes) between your Product and Test and link partner, you need a high-bandwidth Keysight oscilloscope in the setup.

The figure below illustrates a sample setup for the acquisition and decoding of USB4 high speed Tx1 and Rx1 signals differentially.



See Also

["Troubleshooting Closed Eyes for USB4 \(Gen2/Gen3 Signals\)"](#) on page 110

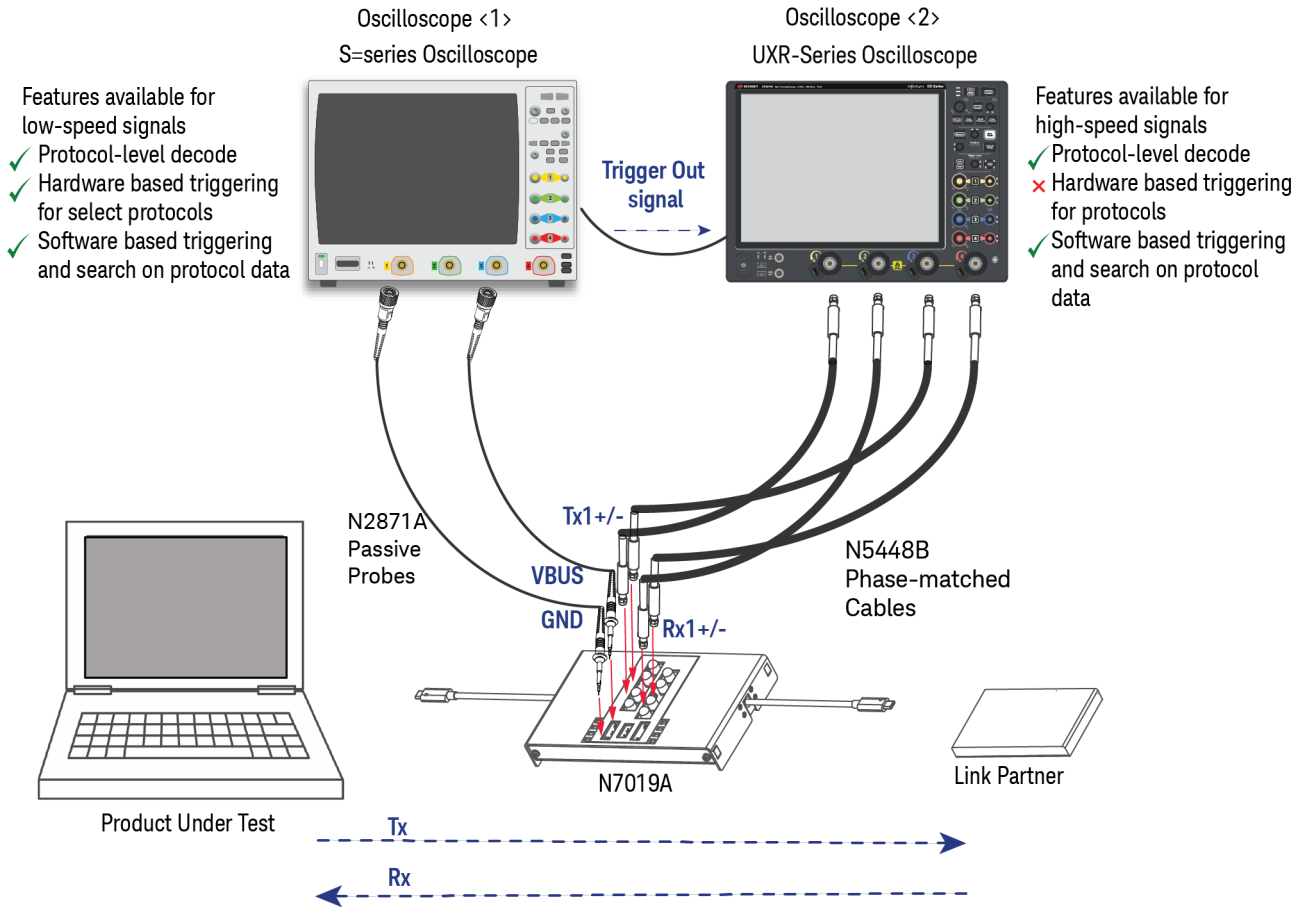
Combined Setup for High Speed and Low Speed Decode and Analysis (*applicable to USB4*)

In situations when you want to use N7019A to acquire and analyze both low speed as well as high speed signals on the active link, you need two oscilloscopes in your setup.

- Oscilloscope <1> is used to acquire and decode USB4 low speed transactions.
 - This oscilloscope can be a low bandwidth oscilloscope.
 - You can utilize the hardware based triggering feature of this oscilloscope to configure a trigger on a low speed transaction event.
- Oscilloscope <2> is used to acquire and decode USB4 high speed data.
 - This oscilloscope must be a high bandwidth oscilloscope.

You can configure Oscilloscope <1> to send a Trigger Out signal to Oscilloscope <2> to trigger it to start the high speed data capture.

The following figure illustrates a sample setup for acquiring and decoding USB4 low speed and high speed signals.



- Features available for low-speed signals
- ✓ Protocol-level decode
 - ✓ Hardware based triggering for select protocols
 - ✓ Software based triggering and search on protocol data

- Features available for high-speed signals
- ✓ Protocol-level decode
 - ✗ Hardware based triggering for protocols
 - ✓ Software based triggering and search on protocol data

See Also

[“Troubleshooting Closed Eyes for USB4 \(Gen2/Gen3 Signals\)”](#) on page 110

Sample Setups for Compliance Testing using N7015A/6A/7A/8A

NOTE

The sample setups included in this section are basic setups applicable to a specific testing scenario.

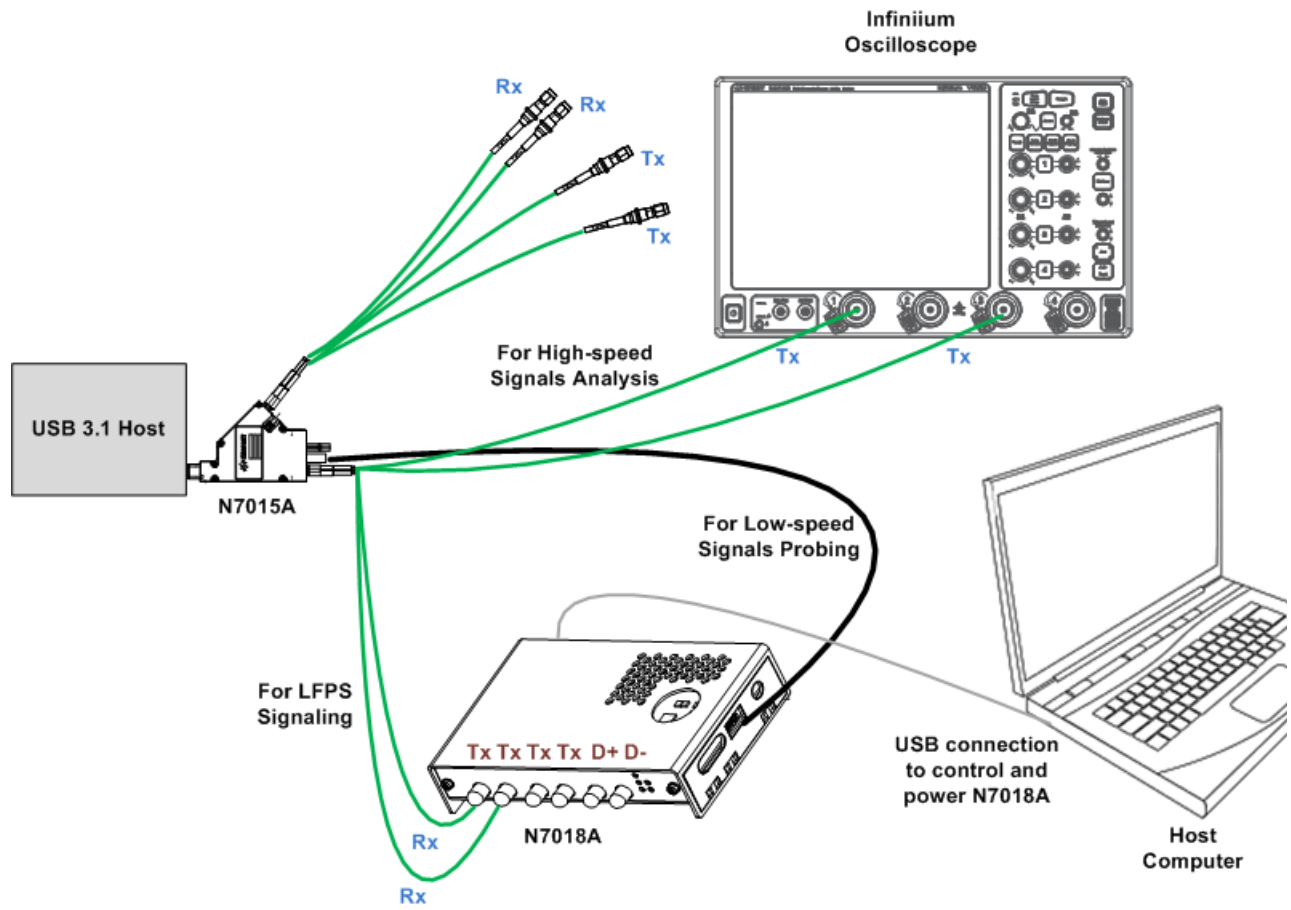
If you are performing compliance testing such as USB 3.1 or DisplayPort source or sink tests, then you should also refer to the *Method of Implementation (MOI)* document for the Keysight compliance software being used to know about the specific setup and equipment requirements for that compliance testing. The MOI can be downloaded from the webpage of the compliance software on www.keysight.com.

In addition, the *Connect* tab of the compliance application software displays the specific setup requirements for the compliance tests that you want to run. Please follow the instructions given in this tab.

NOTE

As the N7018A is a superset of most of the features provided by the discontinued product N7016A, the sample setups illustrated for compliance testing in this section utilize the N7018A.

Testing a USB 4/3.x Host (Tx)

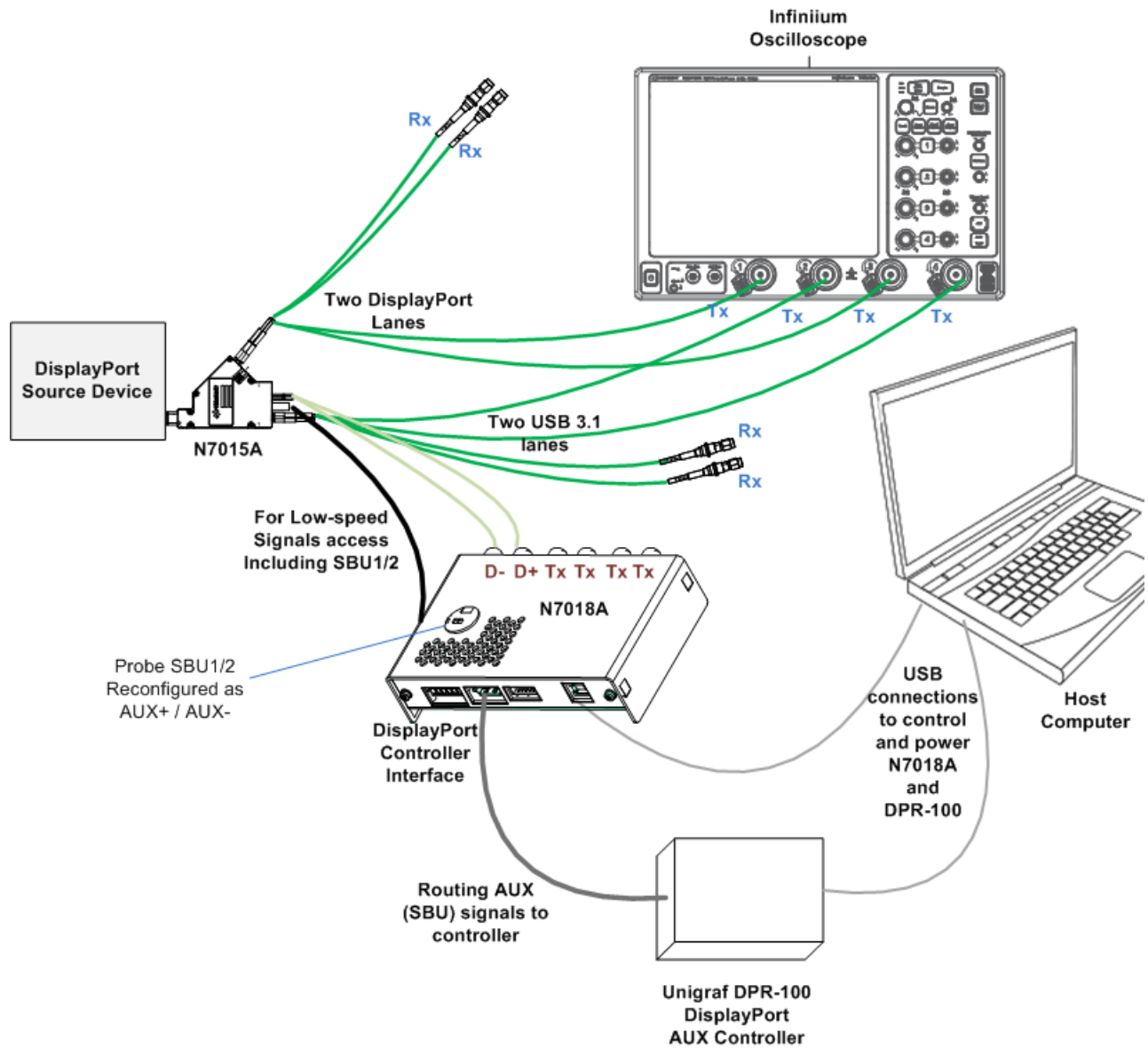


Notes for USB 4/3.x Testing Setup

The Rx SMA cables of N7015A connect to the Tx SMA ports of N7018A only in USB 4/3.x setups for LFPS signaling.

The TX1/RX1± pair is available for USB 4/3.x data transmission if the Type-C connector orientation is selected as Normal (CC1).
 The TX2/RX2± pair is available for USB 4/3.x data transmission if the Type-C connector orientation is selected as Flipped (CC2).
 See [page 91](#) for details.

Testing a DisplayPort (2+2) Source (Tx and AUX Channel Testing)



Notes for DisplayPort 2+2 Lanes Testing Setup

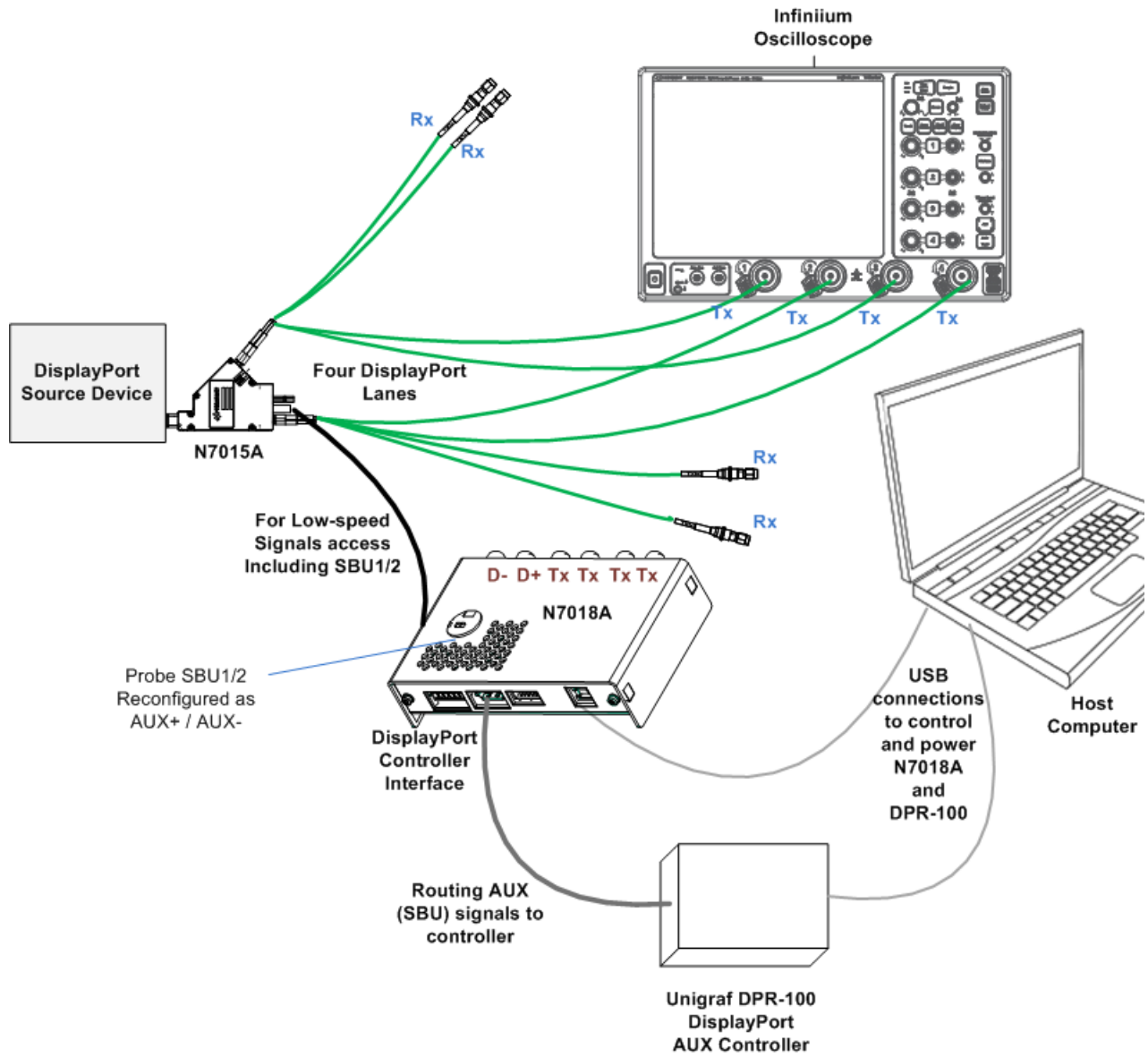
A DisplayPort Controller such as Unigraf DPR-100 is mandatory in this setup.

The TX1/RX1± pair is available for USB 4/3.x data transmission and TX2/RX2± pair is available for DisplayPort transmission if the Type-C connector orientation is selected as Normal (CC1).

The TX2/RX2± pair is available for USB 4/3.x data transmission and TX1/RX1± pair is available for DisplayPort transmission if the Type-C connector orientation is selected as Flipped (CC2).

See [page 91](#) for details.

Testing a DisplayPort (4 lanes) Source (Tx and AUX Channel Testing)

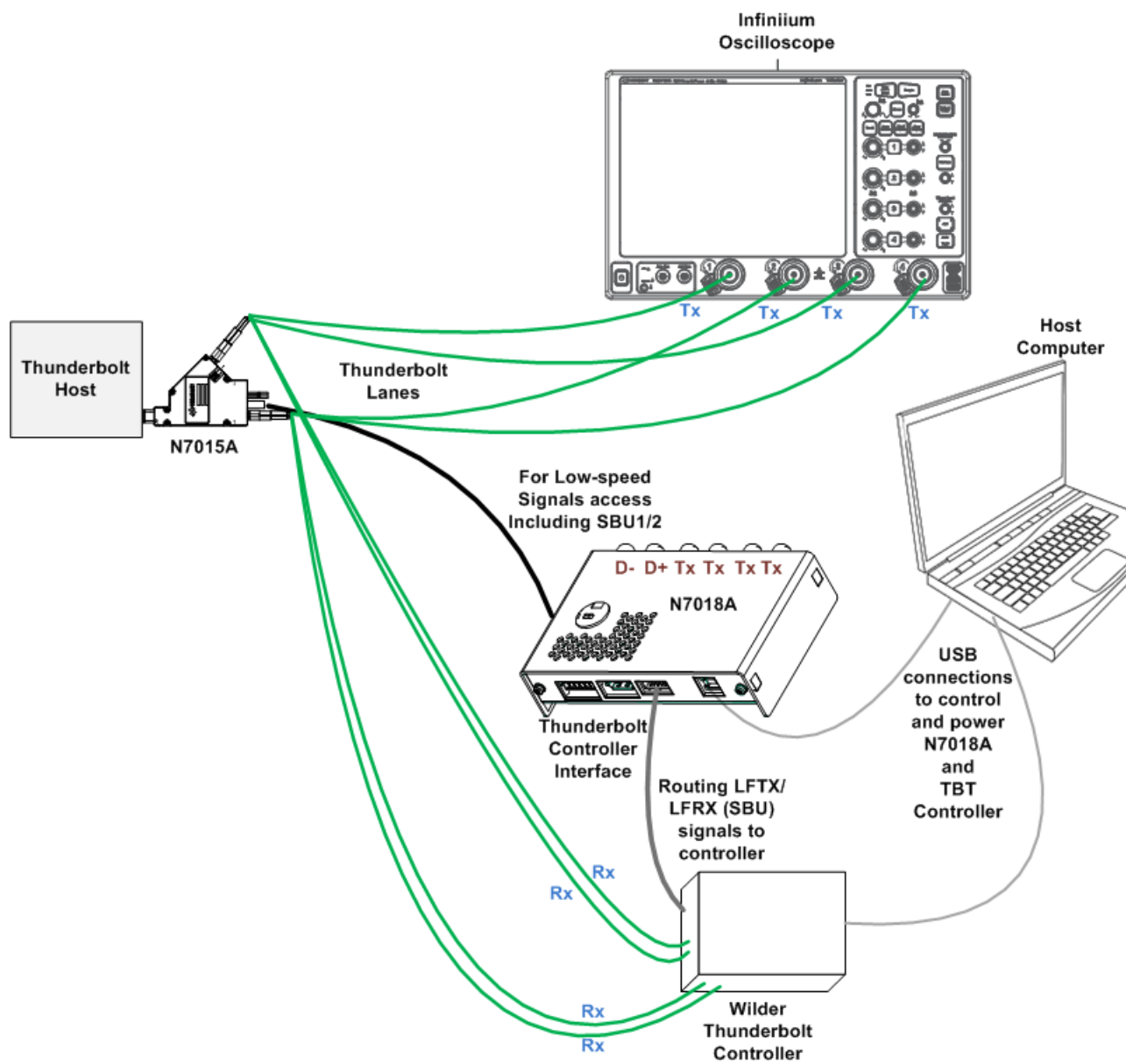


Notes for DisplayPort 4 Lanes Testing Setup

A DisplayPort Controller such as Unigraf DPR-100 is mandatory in this setup.

Both TX1/RX1± pair and TX2/RX2± pair are available as DisplayPort lanes irrespective of the Type-C connector orientation.

Testing a Thunderbolt 2/3/4 Host (Tx)

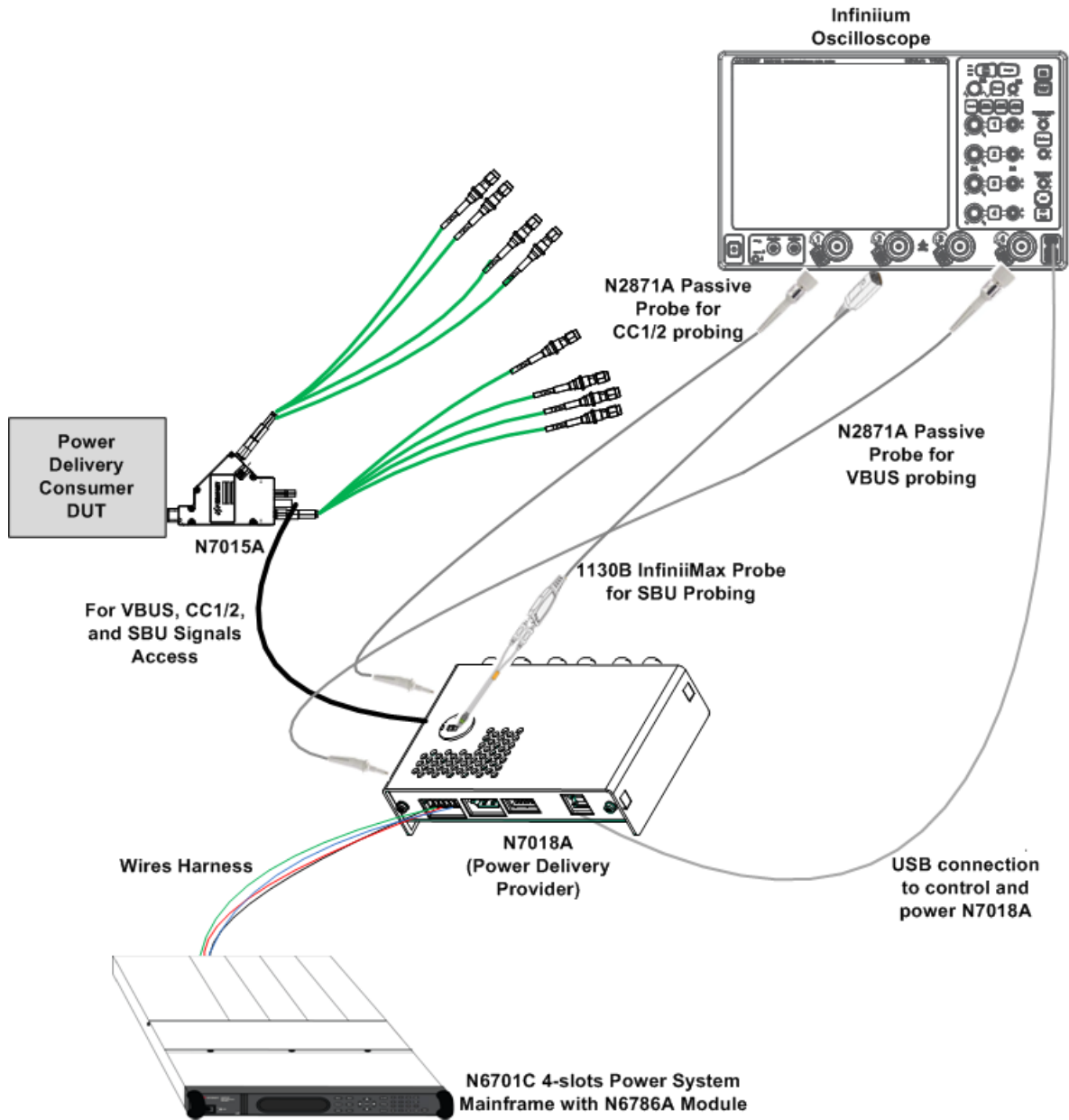


Notes for Thunderbolt 2/3/4 Testing Setup

A Thunderbolt Controller is mandatory in this setup.

Both TX1/RX1± pair and TX2/RX2± pair are available as Thunderbolt lanes irrespective of the Type-C connector orientation.

Testing a USB Power Delivery Consumer over Type-C Interface



Notes for Power Delivery Consumer Testing Setup

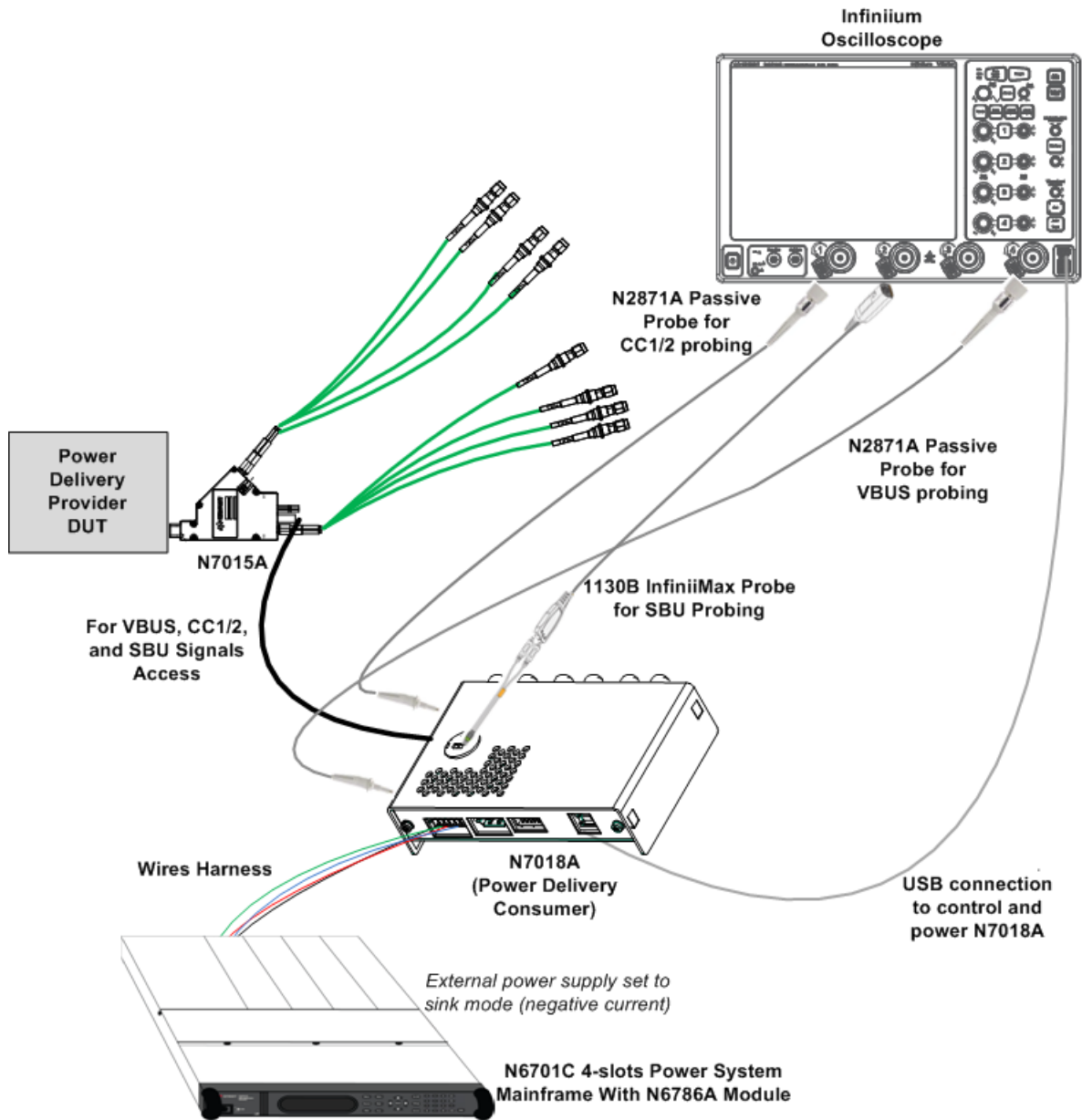
To allow the N7018A to act as a PD provider, you must connect the N7018A's external power source port to an external power supply so that it can meet the power requirements of the DUT and support high-voltage contracts.

The external power supply wires harness should be set up as per the instructions on [page 33](#).

You must ensure that the external power supply of N7018A is set up and turned on before a Type-C connection is established with the N7018A acting as a Provider.

By default, the N7018A plays the role of a DFP when configured as a PD Provider. However, you can change this role by configuring the N7018A to initiate data role swap. See [page 92](#) to know more.

Testing a USB Power Delivery Provider with N7018A set to Sink Current

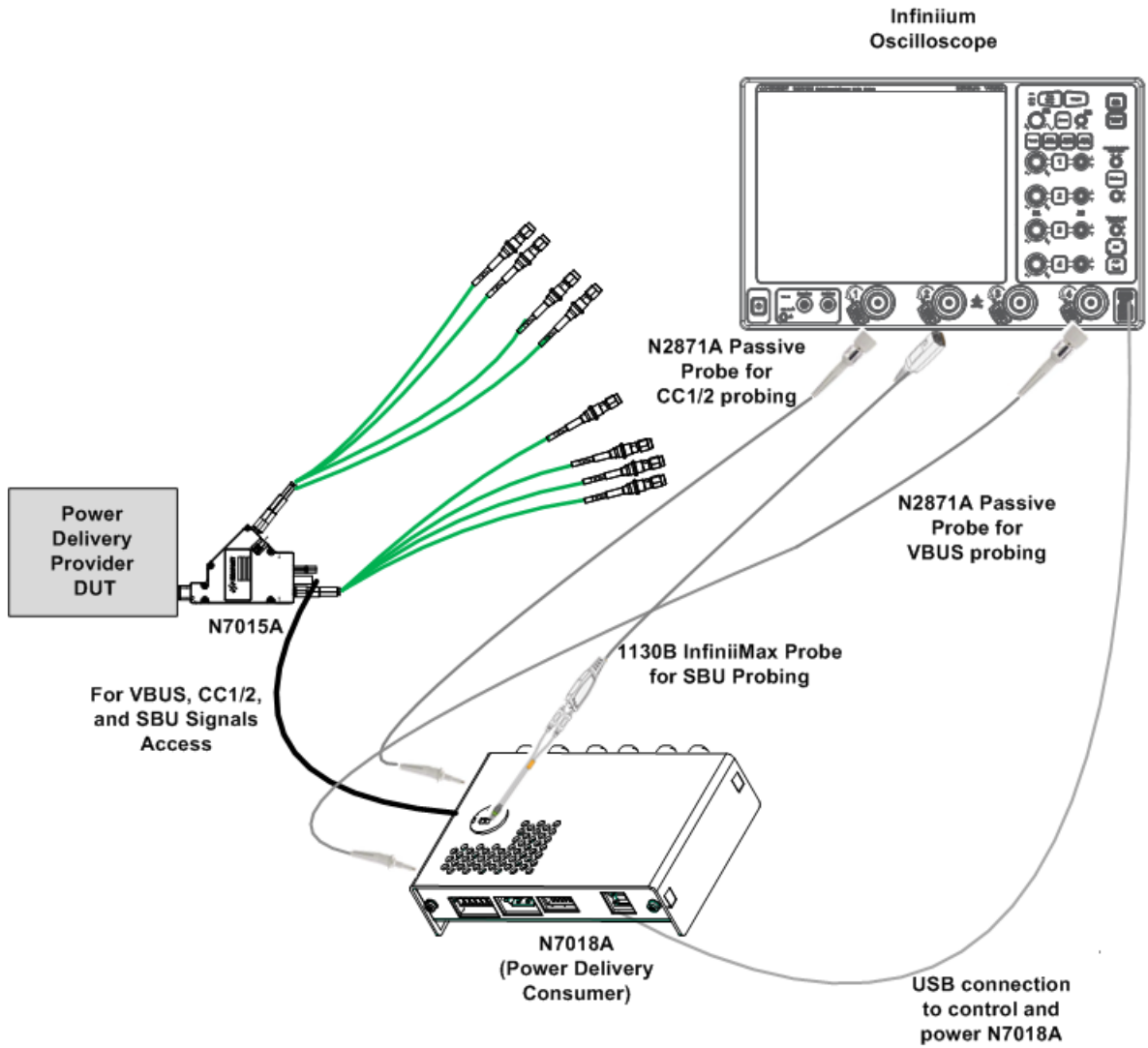


Notes for Power Delivery Provider Testing Setup (with N7018A set to sink current)

To allow the N7018A to act as a PD consumer and sink current, you must connect the N7018A's external power source port to an external power supply. The external power supply must be set to sink mode (negative current) so that it can sink current during the testing of the DUT. The external power supply wires harness should be set up as per the instructions on [page 33](#). You must ensure that the external power supply of N7018A is set up but disabled before a Type-C connection is established with the N7018A acting as a Consumer.

By default, the N7018A plays the role of a UFP when configured as a PD Consumer. However, you can change this role by configuring the N7018A to initiate data role swap. See [page 92](#) to know more.

Testing a USB Power Delivery Provider over Type-C Interface



Notes for Power Delivery Provider Testing Setup

By default, the N7018A plays the role of a UFP when configured as a PD Consumer. However, you can change this role by configuring the N7018A to initiate data role swap. See [page 92](#) to know more.

You must ensure that the power supply of N7018A is disabled and the currents are not drawn before a Type-C connection is established with the N7018A acting as a Consumer.

9 Accessing Type-C Signals

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Probing the SBU1 and SBU2 Signals at the N7016A or N7018A / 81

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Probing D+ and D- Signals / 84

Using the D+ and D- Pins on the N7016A Low Speed Fixture / 84

Using the D+ and D- SMA Ports on the N7015A Test Fixture / 84

Using the D+ and D- Pins on the N7019A Test Fixture / 85

This chapter describes how to access and probe various Type-C high-speed and low-speed signals when using the Keysight Type-C test fixtures described in this guide.

Overview

Signal	Access through...			
	N7015A	N7016A (Discontinued))	N7018A	N7019A
High-speed Tx and Rx signals	High-speed coax cables of N7015A connected to an oscilloscope	High-speed coax cables of N7015A connected to the N7016A SMA ports for routing to another DUT connected to N7016A's Port2	-	2.92 mm SMA ports on the N7019A for connection to an oscilloscope via High-speed coax cables
Low-speed signals				
CC1 / CC2 Signals	-	CC1 and CC2 probe points on N7016A	CC1 and CC2 probe points on N7018A	CC1 and CC2 probe points on N7019A
VBUS Signals	-	VBUS probe point on N7016A	VBUS probe point on N7018A	VBUS and GND probe points on N7019A
SBU1 and SBU2 (Secondary Bus) Signals	SBU1 and SBU2 test points on the N7015A	SBU1 and SBU2 probe points on top of the N7016A	SBU1 and SBU2 probe points on top of the N7018A	SBU1 and SBU2 probe points on the N7019A
USB 2.0 D+ and D- Signals	USB 2.0 D+ and D- cables of N7015A connected to an oscilloscope	USB 2.0 D+ and D- probe points on top of the N7016A	-	USB 2.0 D+ and D- probe points on the N7019A

The probing procedure for these signals is described in the following sections.

Probing CC1, CC2, and VBUS Signals

With N7016A / N7018A

You can probe the CC1, CC2, and VBUS signals either at the N7016A or at the N7018A.

You need Keysight passive probes such as N2871A-3A or 10073D/74D general-purpose high impedance passive probe with 10:1 attenuation ratio to probe these signals.

Connect the passive probe to the CC1, CC2 and/or VBUS probe points of the N7016A or N7018A as shown in [Figure 2](#) on page 79.

NOTE

The GND probe connection points below the CC1, CC2, and VBUS probe points can be used to clip the probe grounds to the N7016A / N7018A test fixture.



Figure 1 Probing the CC2 signal at the N7018A with the probe ground connected to the GND connection point

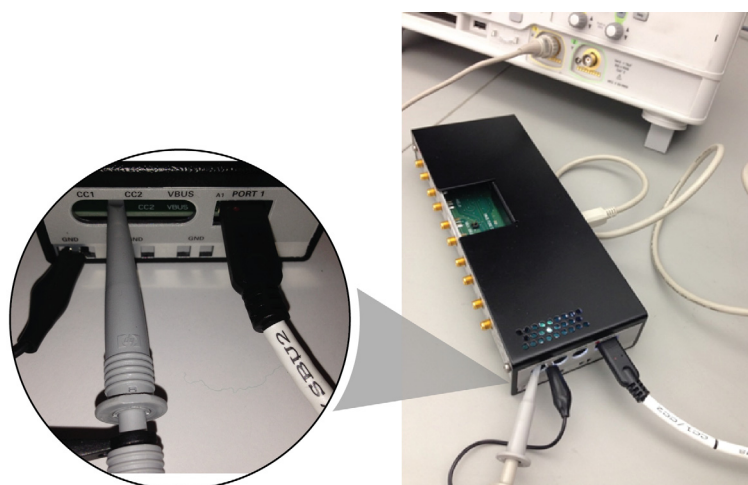


Figure 2 Probing the CC1 signal at the N7016A



Figure 3 Probing the VBUS at the N7018A

With N7019A

If you want to access CC1, CC2, or VBUS signals on an active link, you can use the probe points available on the N7019A Type-C Active Link Test fixture.

For VBUS and GND signals, you can either use:

- a Keysight passive probe
- a Keysight Power Rail probe

For CC1/CC2 signals, you can use a Keysight passive probe.

Probing SBU1 and SBU2 Signals

You can probe the USB Type-C SBU1 and SBU2 signals:

- either at the N7015A Type-C test fixture.
- or at the N7016A / N7018A.
- or on an active link via the N7019A test fixture.

Probing SBU1 and SBU2 Signals at the N7015A Test Fixture

You can probe the SBU1 and SBU2 signals at the N7015A using the E2678B InfiniiMax differential socket probe head connected to an InfiniiMax probe.

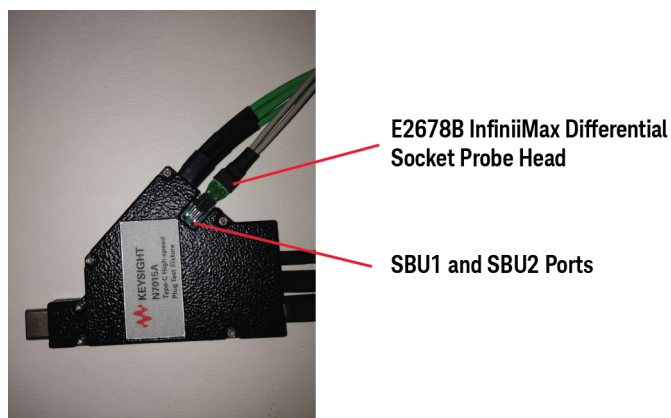


Figure 4 Probe connected to the N7015A SBU1/SBU2 differential test point

Probing the SBU1 and SBU2 Signals at the N7016A or N7018A

There are SBU1 and SBU2 probe points available at the top of the N7018A as well as the N7016A. Using these probe points, you can probe SBU1 and SBU2 signals at the N7016A or N7018A either individually or together.

NOTE

The N7018A or N7016A test fixture must be connected to the N7015A via its Type-C cable for the SBU1/SBU2 signals to be present at these probe points.

Probing SBU1 and SBU2 Signals individually

For probing the SBU1 or SBU2 signals individually, connect the E2678B InfiniiMax differential socket probe head and an InfiniiMax probe across either the SBU1 or SBU2 pins of the N7018A or the N7016A test fixture at the probe pins labeled SBU1 or SBU2.

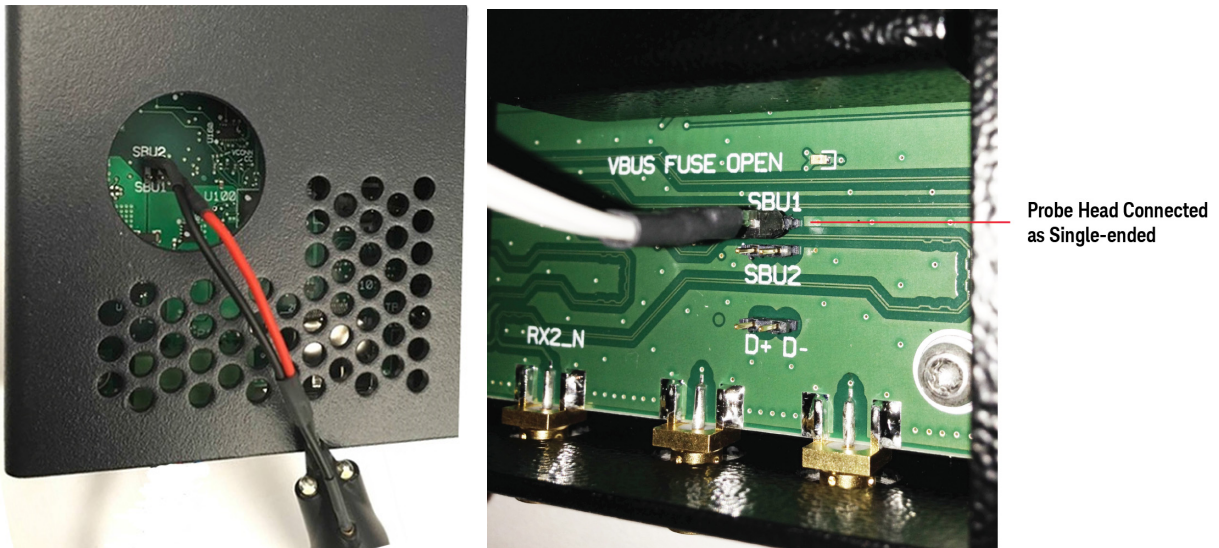


Figure 5 Top Views of the N7018A and N7016A test fixtures showing the Probe Head connected to the SBU2 and SBU1 Pins Respectively

Probing the SBU1 and SBU2 Signals Together

For probing the SBU1 and SBU2 signals together, connect the E2678B InfiniiMax differential socket probe head and an InfiniiMax probe across both SBU1 and SBU2 probe pins labeled with the “+” indicators at the top of the N7018A / N7016A test fixture.

Probe Head Connected Differentially

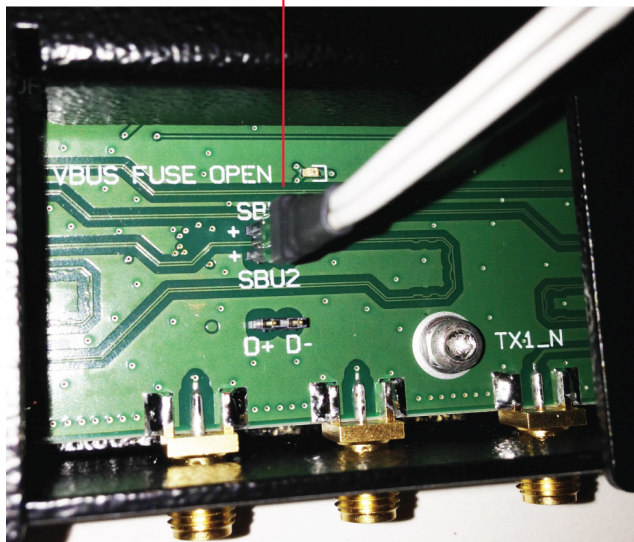


Figure 6 Top view of the N7016A showing the probe head connected to the SBU1 and SBU2 pins together

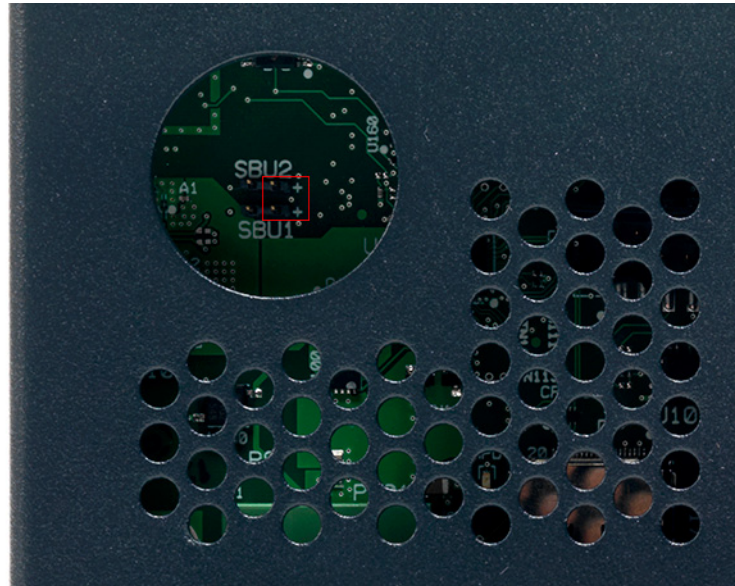


Figure 7 Top view of the N7018A highlighting the SBU1 and SBU2 probe pins and the + indicators for probing together

Probing SBU1 and SBU2 Signals on an Active Link using N7019A

There are SBU1 and SBU2 probe points available at the top of the N7019A test fixture. Using these probe points, you can probe SBU1 and SBU2 signals individually.

For probing the SBU1 or SBU2 signals single-ended, connect the E2678B InfiniiMax differential socket probe head and an InfiniiMax probe across either the SBU1 or SBU2 pins of the N7019A test fixture at the probe pins labeled SBU1 or SBU2.

Probing D+ and D- Signals

You can probe D+ and D- signals:

- either using the D+ and D- pins on the N7016A low speed fixture.
- or using the D+ and D- SMA ports on the N7015A test fixture.
- or on an active link via the N7019A test fixture.

Using the D+ and D- Pins on the N7016A Low Speed Fixture

- 1 Connect the E2678B InfiniiMax differential socket probe head and an InfiniiMax probe across both the D+ and D- pins on the top side of the N7016A low speed fixture.
- 2 Connect the D+/D- SMA cables of the N7015A to the D+/D- SMA ports on the front of the N7016A.

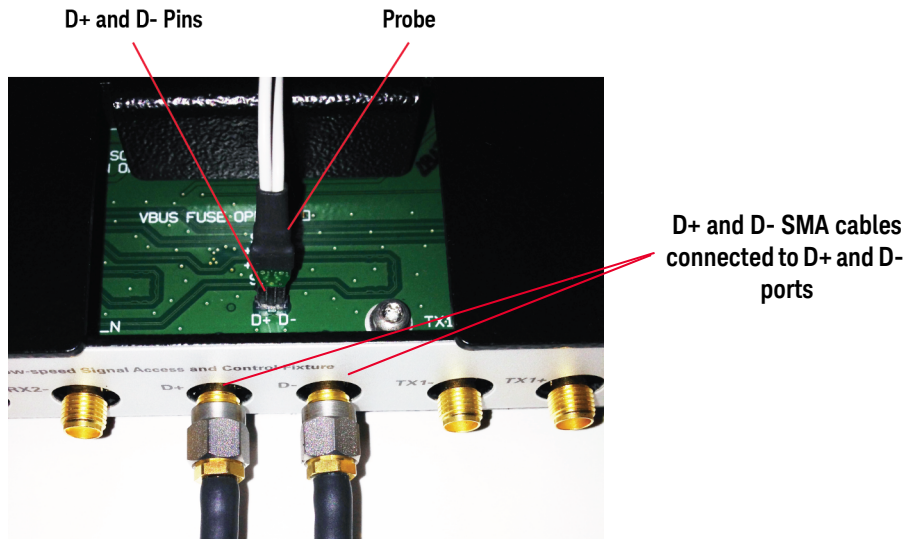


Figure 8 Top View of N7016A showing D+ and D- pins and D+/D- SMA cables connected to the D+/D- SMA ports

NOTE

The N7016A low speed fixture must be connected to the N7015A via both the Port 1 cable and the D+/D- SMA cables for the D+/D- signals to be present at the N7016A.

Using the D+ and D- SMA Ports on the N7015A Test Fixture

There are D+/D- SMA ports on the front of the N7018A to allow the N7018A to do USB 2.0 data transmission to the DUT via the N7015A. However, the N7018A does not provide D+/D- probe pins for probing these signals at the N7018A. Therefore, if you are using the N7018A and want to monitor D+/D- signals, then you can do so by connecting the D+/D- SMA cables of the N7015A to an oscilloscope.

Using the D+ and D- Pins on the N7019A Test Fixture

There are D+ and D- probe pins available at the top of the N7019A test fixture. Using these probe pins, you can probe D+ and D- signals either Differentially or Single-ended.

Probing the D+ and D- Signals Single-ended

For probing these signals single-ended, connect the E2678B InfiniiMax differential socket probe head and an InfiniiMax probe across either D+ or D- pins of the N7019A test fixture at the probe pins labeled D+ or D-.



Figure 9 Top view of the N7019A highlighting the probe pins for probing D+ signal single-ended

Probing the D+ and D- Signals Differentially

For probing the D+ and D- signals differentially, connect the E2678B InfiniiMax differential socket probe head and an InfiniiMax probe across both D+ and D- probe pins located at the top of the N7019A test fixture.



Figure 10 Top view of the N7019A highlighting the probe pins for probing D+ and D- signals differentially

10 Installing and Configuring Software Components for Type-C Testing

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Installing the N7018A Type-C Test Controller Software / 88

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Setting up the N7018A Emulation Role and ALT Mode and Establishing Connection with DUT / 91

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Configuring LFPS Settings (applicable to USB 4/3.x testing only) / 98

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If you are Using N7016A / 103

Installing the Appropriate Keysight Compliance Application Software / 108

If you are using N7019A / 109

This chapter describes how to install and configure the software components required for controlling and configuring the N7018A and N7016A test fixtures described in this guide. Based on whether you are using N7018A or N7016A in your testing, follow the steps in the relevant topics in this chapter.

This chapter also provides a brief overview to the protocol decoder software applications that you need to decode and analyze the protocol data acquired using N7019A on an active link.

If you are Using N7018A

If you are using N7018A in your test setup, you need the following software component to configure and control the N7018A:

N7018A Type-C Test Controller Software

Installing the N7018A Type-C Test Controller Software

Prerequisite

- Before installing the N7018A software, make sure that the Microsoft .NET 4.5.2 software is installed on your Infiniium Oscilloscope or the host computer used in the test setup.
- If not already installed, download and install the Microsoft .NET 4.5.2 software for free from <https://www.microsoft.com/en-us/download/details.aspx?id=42642>. This software requires a few minutes to install on your Infiniium Oscilloscope or host computer.

Then you can download and install the latest N7018A software from:

<http://www.keysight.com/find/N7018A>

Follow the on-screen prompts of the Installation wizard to complete the installation. Once the installation completes, restart the system.

The N7018A software is installed at the following location:

- On a 32-bit system: *C:\Program Files (x86)\Keysight\Infiniium\Apps\USB C-Connector\Type-C Test Controller*
- On a 64-bit system: *C:\Program Files\Keysight\Infiniium\Apps\USB C-Connector\Type-C Test Controller*

Launching the N7018A Software GUI

- You can launch the N7018A software GUI by navigating to **Start > All Programs > Keysight Infiniium Applications > Type-C Test Controller**.
- Alternatively, you can click **Start > Type-C Test Controller**.

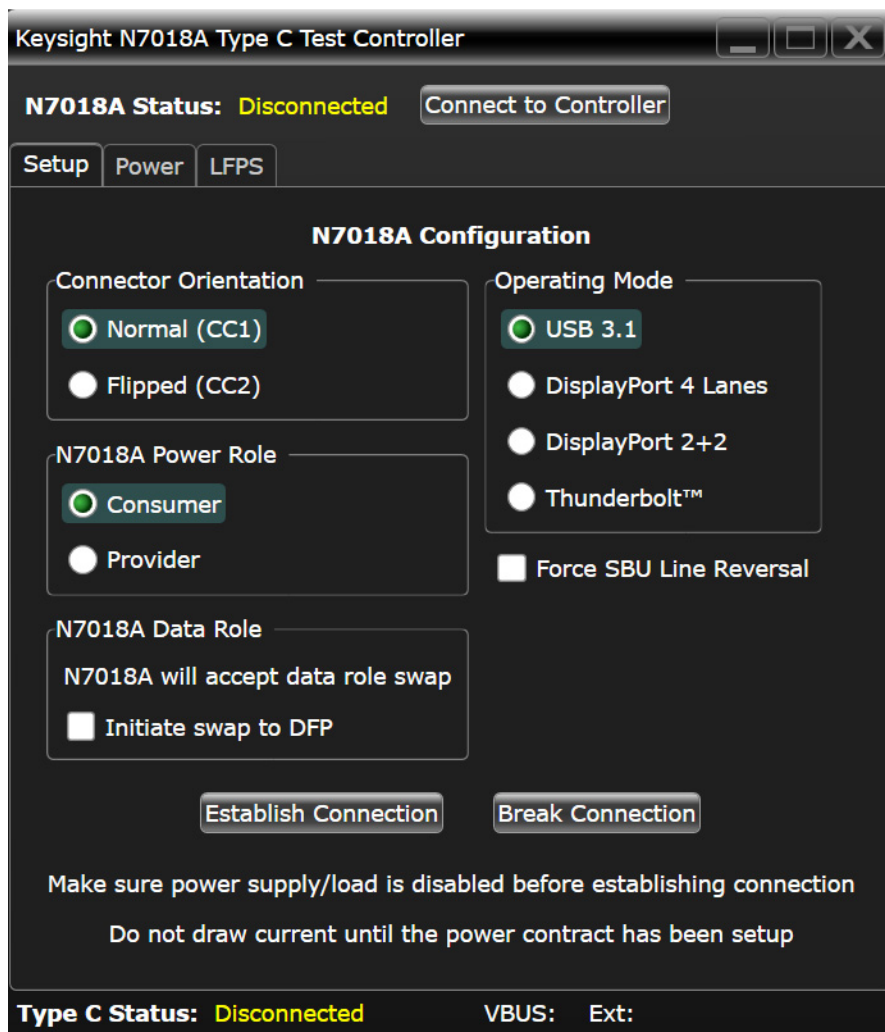
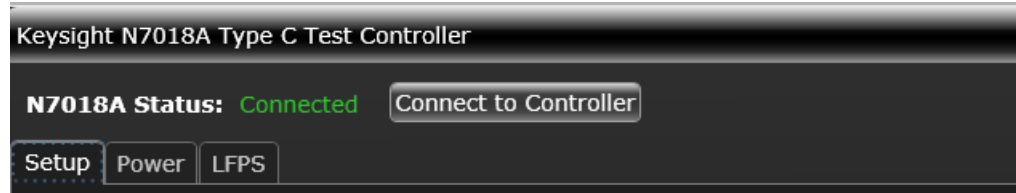


Figure 11 Startup screen of N7018A Software GUI

Establishing Connectivity between the N7018A Hardware and Software GUI

As a first step in configuring the N7018A settings through its software GUI, you connect the software GUI to the N7018A hardware. This allows you to control and configure the hardware through this software GUI.

- 1 In the **Setup** tab of the GUI, click the **Connect to Controller** button on the top. The **Status** should then be displayed as **Connected** indicating that a connection has been established between the N7018A hardware and its software GUI.

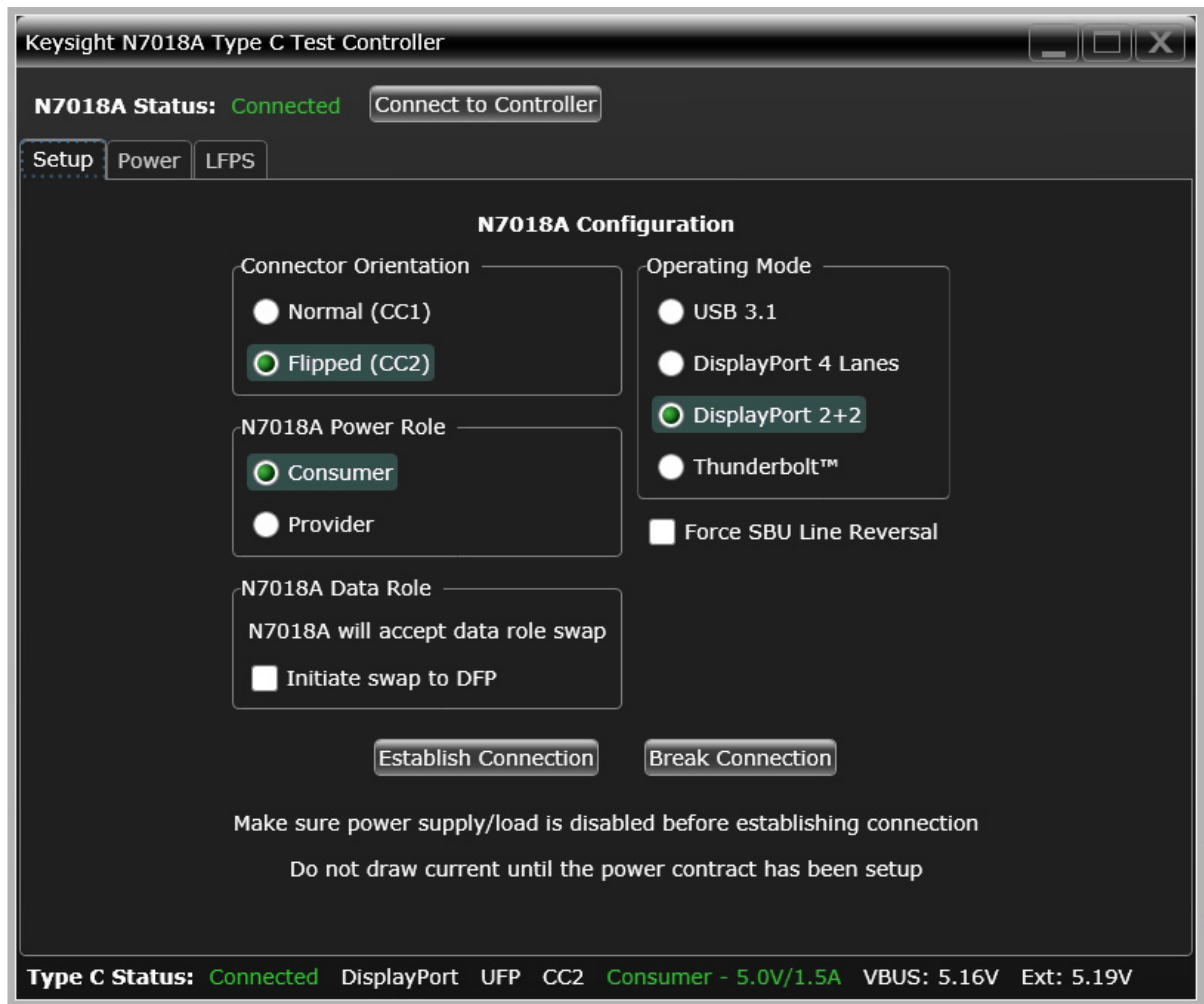
**NOTE**

If you have not connected the N7018A to the oscilloscope or personal computer on which the N7018A GUI is installed, then the connection cannot be established and the N7018A status at the top of the GUI is displayed as "Disconnected".

Setting up the N7018A Emulation Role and ALT Mode and Establishing Connection with DUT

You use the **Setup** tab in the N7018A software GUI:

- to configure the settings for the emulation role that you want the N7018A to perform in the Type-C testing.
- and then to establish N7018A's Type-C connectivity via N7015A with the link partner under test.



NOTE

The configuration settings that were last applied to the N7018A hardware are displayed with their backgrounds highlighted with green in this tab.

When you change these settings and the changes are applied to the N7018A hardware by clicking **Establish Connection**, the background highlighting automatically reflects the changed settings.

- 1 Select the N7018A Type-C **Connector Orientation** that you want to use in this test configuration. This represents the side of the Type-C connector that will be active at the N7015A test fixture.
 - **Normal (CC1)** - Indicates that the CC1 (CC line on the top of the N7018A USB Type-C connector) will be used as the communication channel.

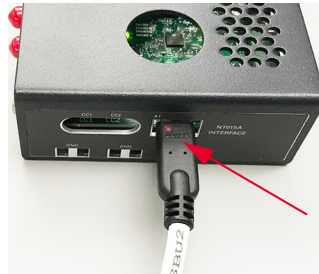
- **Flipped (CC2)** - Indicates that the CC2 (CC line on the bottom of the N7018A USB Type-C connector) will be used as the communication channel.

When testing a USB 4/3.x host/device, the selected connector orientation determines whether USB 4/3.x data transmission will be on TX1/RX1+/- pair or TX2 /RX2+/- pair. If CC1 is selected, then TX1/RX1+/- pair is used for USB 4/3.x. If CC2 is selected, then TX2/RX2+/- pair is used for USB 4/3.x.

NOTE

As the N7015A Type-C interface cable is reversible, the top side of this cable connector is provided with a red dot to indicate correct insertion of the cable into the Type-C port of the N7018A. Inserting this cable with the red dot facing up allows the N7018A to do proper signal identification and transmission by matching the lines from the DUT.

For instance, for the “Normal” connector orientation, the N7015A test fixture should be oriented with the Keysight label facing up and the red dot on the cable facing up. This means that the upper side of the N7015A Type-C cable connects to A1 of the N7018A Type-C port.



- 2 From the **N7018A Power Role** section, select the role that you want the N7018A to perform in the Power Delivery scenario. At a time, the N7018A can act:
 - either as a Power Delivery Source (Provider) to a consumer DUT
 - or as a Power Delivery Sink (Consumer) for a provider DUT.

NOTE

If you configure N7018A as a Power Delivery Provider:

Ensure that the external power supply is able to provide the 5V voltage for the basic 5V PD contract to be established initially between the N7018A and DUT once the Type-C connection is established.

NOTE

If you configure N7018A as a Power Delivery Consumer:

Ensure that the power supply is disabled before establishing connection between the N7018A and DUT. Do not draw current until the power delivery contract is established.

- 3 By default, the N7018A accepts an upstream-facing port (UFP) or a downstream-facing port (DFP) role based on the power role configured for the N7018A, that is, UFP role when configured as a Consumer and DFP role when configured as a Provider. This default data role can be changed when:

- the DUT initiates a data role swap. (The N7018A always accepts a data role swap initiated by DUT.)
- you configure the N7018A to initiate a data role swap itself. To do this, you select the **Initiate swap to DFP / UFP** checkbox from the **N7018A Data Role** section.

NOTE

There may be situations when the N7018A is not able to complete the user-configured data role swap successfully. For instance, the DUT may not support a data role or may not accept the data role swap.

In such situations, you can use the Status bar at the bottom of the GUI to view the current data role of the N7018A and ascertain whether or not the data role swap has been successful.

- 4 From the **Operating Mode** section, choose the ALT mode that you want to test using the N7018A. The selected mode then becomes the ALT mode to which the N7018A is configured to enter during testing. By setting different ALT modes from this section, you can achieve integrated Type-C interfaces testing through a single N7018A connection.
 - **USB 3.1**
 - **DisplayPort 4 lanes** - Four DisplayPort lanes
 - **DisplayPort 2+2** - Two DisplayPort lanes + two simultaneous USB 4/3.x lanes

Based on whether you select 4 lanes or 2+2, there is a change in the supported pin assignment capabilities of N7018A during the alt-mode discovery process over the Type-C configuration channel.
 - **Thunderbolt 3**
- 5 Select the **Force SBU Line Reversal** checkbox to force a reversal of the standard SBU line routing when establishing a connection with the DUT. In certain hardware setup configurations, the SBU lines may be in the wrong orientation for reasons such as the use of a receptacle adapter with the N7015A and N7018A test setup. In such configurations, this checkbox allows you to bring the SBU lines in the correct orientation by forcing a reversal.
- 6 Once you configure the N7018A settings, click the **Establish Connection** button to establish a Type-C connection between the N7018A and DUT using the selected CC line. If a connection already exists, it is disconnected and a new connection is established with the new settings in the tab.

CAUTION

Prior to changing any power supply settings, DUT configurations, or disconnecting/connecting a Type-C cable used in the test setup, you must break the connection established between the N7018A and DUT. This acts as a safety measure against any damage to the system components that may occur due to connection/disconnection with the Type- connection and power supply ON.

You use the **Break Connection** button to do this.

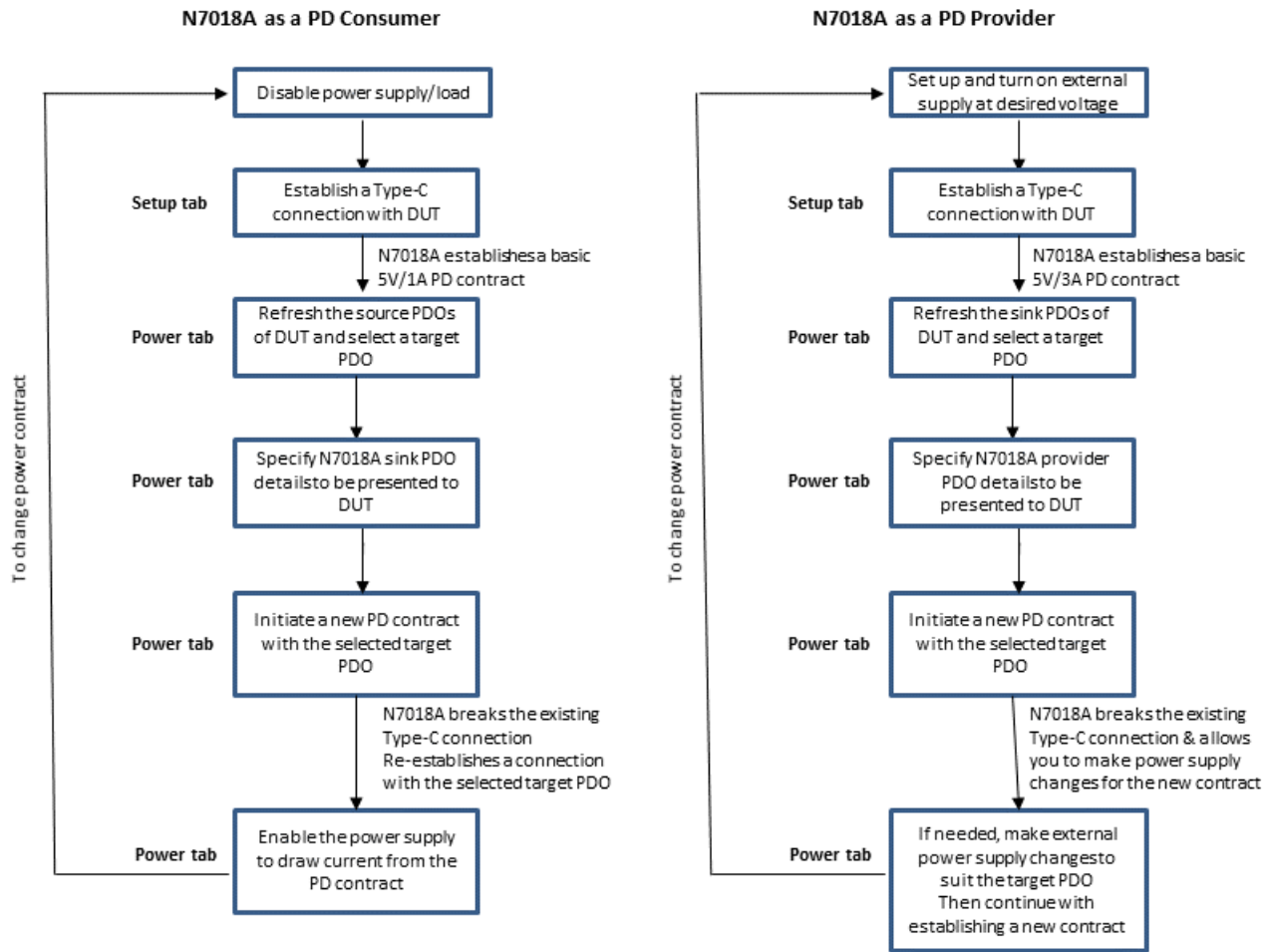
The Status bar displays whether or not the connection with the DUT is established. In addition, it also displays if the settings that you configured in the tab are applied to the N7018A hardware.

Setting up and Establishing a Power Delivery Contract with DUT

You use the **Power** tab in the N7018A GUI to:

- select a Power Data Object (PDO) from the list of DUT’s advertised PDOs.
- negotiate and establish a Power Delivery contract between the N7018A and DUT.

Power Delivery Contract Setup - Flow of Steps

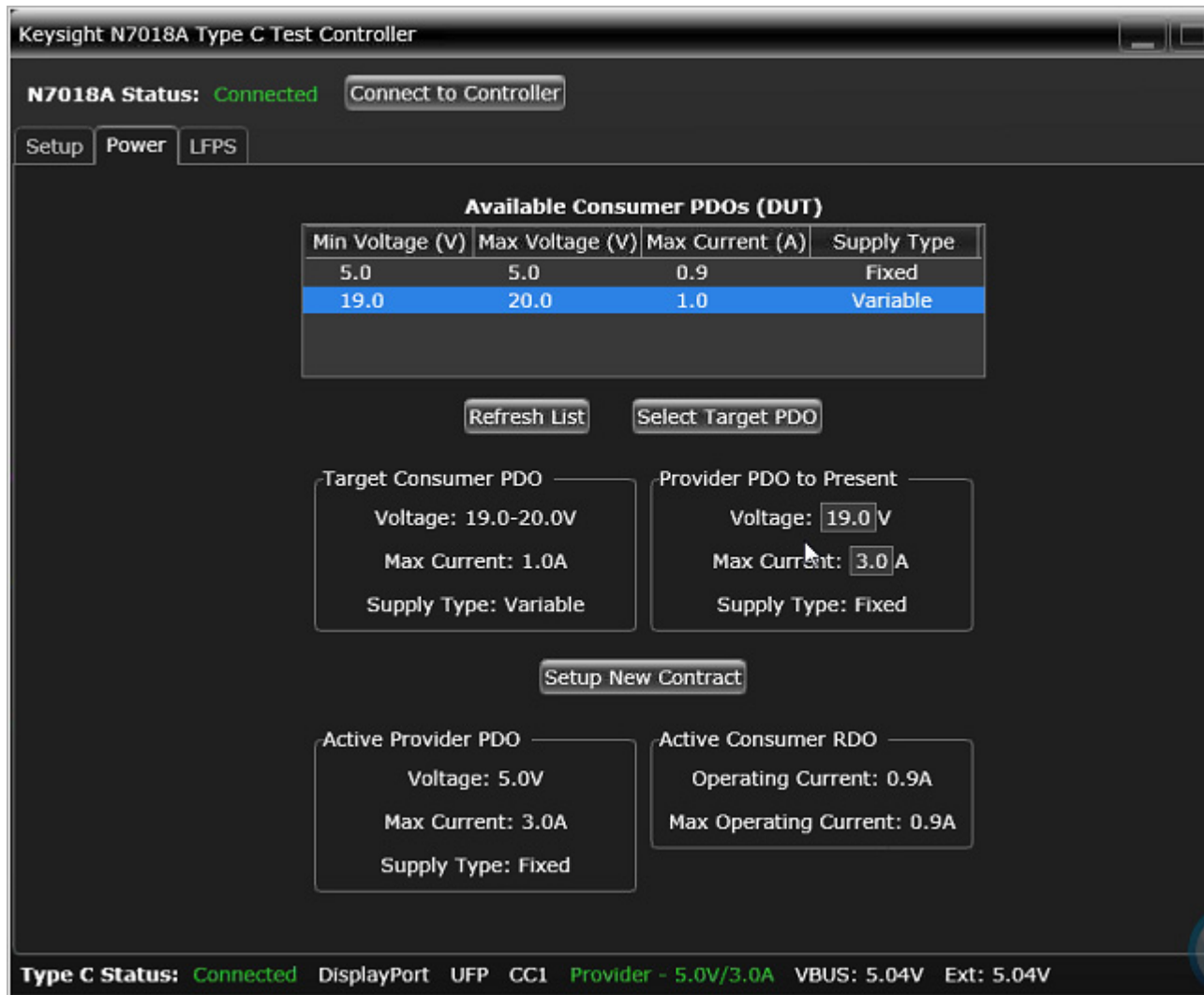


CAUTION

All physical connections must be set up before turning on the power supply to avoid damage that may result from connecting/disconnecting components with power supply on.

CAUTION

Make sure the Type-C connection and PD contract is broken before connecting /disconnecting a Type-C cable between the N7018A/N7015A and DUT.



The section below describes the fields available in the Power tab.

Available Consumer PDOs (DUT) / Available Provider PDOs (DUT)

Based on the currently set power role of the N7018A, either **Available Consumer PDOs (DUT)** or **Available Provider PDOs (DUT)** section is displayed.

The Available Consumer PDOs (DUT) section displays the list of sink PDOs that the power delivery consumer (DUT) advertised as its power requirements. These represent the power levels at which the sink (DUT) is able to operate.

The Available Provider PDOs (DUT) section displays the list of source PDOs that the power delivery provider (DUT) advertised as its power capabilities. These represent the power levels which the source (DUT) is able to provide.

In these sections, the following values are displayed for each PDO advertised by DUT:

- **Min Voltage** - The minimum voltage required by the Consumer DUT or provided by the Provider DUT for a Fixed Supply Type PDO.
- **Max Voltage** - The maximum voltage required by the Consumer DUT or provided by the Provider DUT for a Variable or a Battery Supply Type PDO.

- **Max Current** - If DUT is the consumer, then the maximum current the DUT may need at the given voltage range. If DUT is the provider, then the maximum current the DUT can guarantee to supply at the given voltage range.
- **Supply Type** - Indicates the type of PDO based on the power supply it exposes. Can be Fixed, Variable, or Battery.

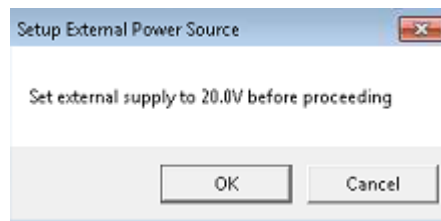
To set up a PD contract

A basic 5V PD contract is automatically established between the N7018A and DUT when you establish the Type-C connection. After the initial 5V basic PD contract is established, you can select a PDO from the DUT's advertised list in the Available PDOs section and set up a new PD contract with DUT.

- 1 Click the **Refresh List** button to refresh the list of available PDOs advertised by the DUT. This allows you to fetch an updated list when you want to set up a new contract.
- 2 Select the PDO that you want to use by clicking it in the **Available PDOs** listbox. Click the **Select Target PDO** button to choose the currently selected PDO from the Available PDOs list as the requested PDO with which the N7018A will make PD negotiations with the DUT.
The details of the selected target PDO are then displayed in the **Target PDO** section.
- 3 Based on the current power role of the N7018A, either the **Consumer PDO to Present** or **Provider PDO to Present** section is displayed. In this section, specify the details of the N7018A PDO to be presented to the DUT for PD negotiations. The type of this PDO is always Fixed. When the N7018A is configured as a Consumer, the voltage that you can specify for this PDO must be within the voltage range of the target provider PDO.
- 4 Click the **Setup New Contract** button to set up a new Power Delivery contract between the N7018A and DUT.

NOTE

If N7018A is configured as a Power Delivery Provider, the following popup is displayed to allow you to verify that the external power supply is set to provide the voltage indicated in the provider PDO to be used for PD negotiations.



When you click OK on the popup, the existing Type-C connection is disconnected and a new connection is established first with a minimal 5V contract and then moved to the new PD contract.

NOTE

If N7018A is configured as a Power Delivery Consumer, then the existing Type-C connection is disconnected and a new connection is established first with the 5V contract and then moved to the new PD contract.

For the consumer DUT, do not draw current prior to the PD contract set up.

Once the PD contract is set up, the **Active Provider PDO** and the **Active Consumer RDO** sections are auto-populated with the latest details. These sections are auto-refreshed to display the latest details.

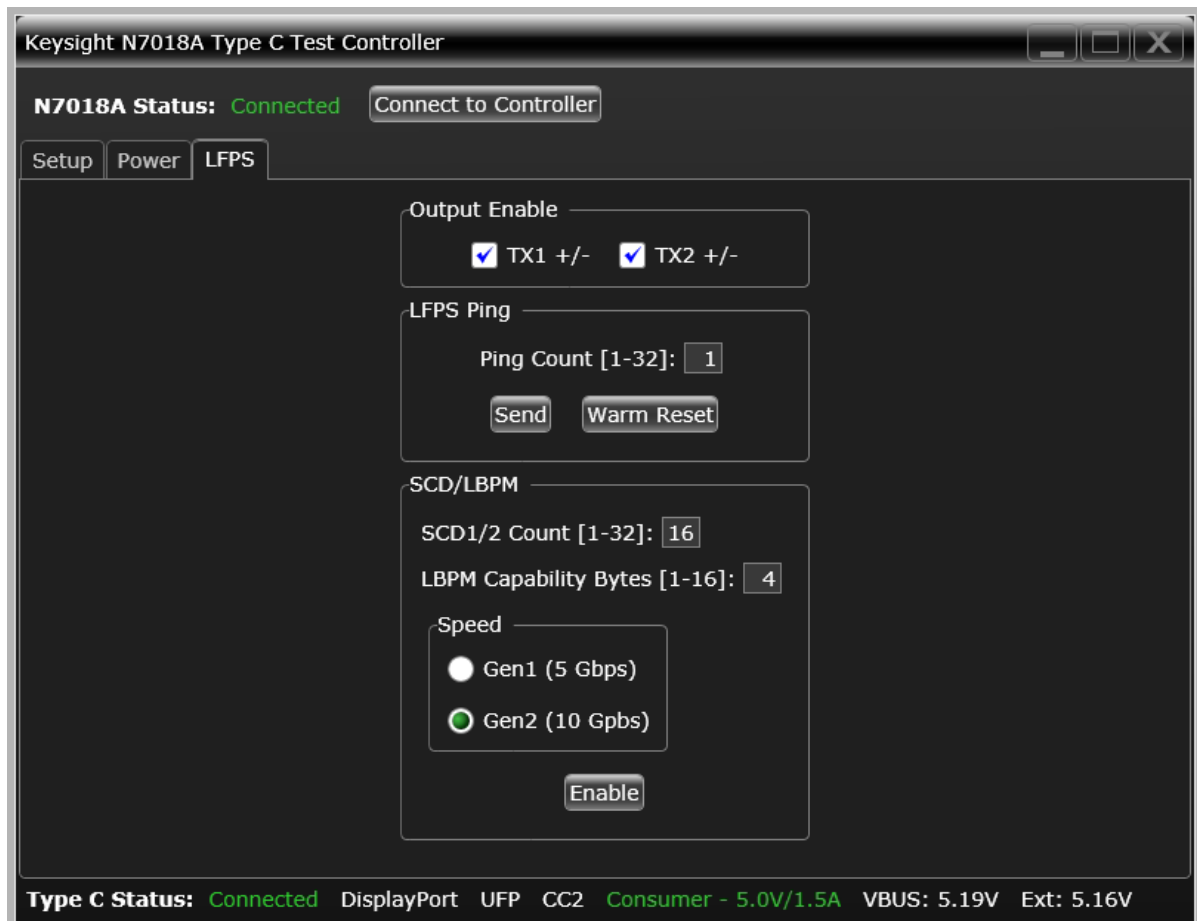
- **Active Provider PDO** - This section displays the PDO that the consumer requested from the advertised provider PDOs.
- **Active Consumer RDO** - This section displays the Response Data Object (RDO) that the provider accepted from the advertised consumer PDOs.
 - **Operating Current** - The amount of current the consumer will need to operate.
 - **Max Operating Current** - The maximum current that the provider should be able to guarantee to provide.

Configuring LFPS Settings (applicable to USB 4/3.x testing only)

You use the **LFPS** tab to configure the Low Frequency Periodic Signaling (LFPS) settings for N7018A.

NOTE

You can use the N7018A instead of an external signal pattern generator such as the Keysight 81134 Pattern Generator to send LFPS signals pattern to DUT.



- 1 From the **Output Enable** section, select the N7018A transmission line(s) that you want to enable for LFPS signaling (LFPS Ping, LFPS Warm Reset, or LFPS Polling patterns). By default, none of the transmission lines are enabled.
(Ensure that the Rx high-speed cables of N7015A test fixture are connected to the N7018A Tx line(s) that you enabled in this step.)
- 2 Use the **LFPS Ping** section to configure and send LFPS Ping bursts to DUT (that is, the transmission of continuous LFPS signal over a period of defined time).

NOTE

- N7018A sends out 3 cycles of LFPS with 40ns time period of each cycle.
- N7018A sends an LFPS burst for the total burst time of 120ns.
- N7018A can send an LFPS burst repeatedly (1-32) times depending on your selection.
- The time between LFPS bursts is set to 200ms.

- i In the **LFPS Ping** section, set the **Ping Count**. This is the number of times you want the N7018A to repeat the transmission of the LFPS burst to DUT. Each LFPS ping should advance the test pattern of the DUT by one CP pattern. With a Gen1 DUT, the patterns range from CP0-8, and with a Gen2 DUT, the patterns range from CP0-16. The count of 32 allows you to advance from any CP pattern to any other with a single press of the Send button'
- ii Click **Send** to start the transmission of the LFPS ping burst(s) from N7018A to DUT for the number of times specified in **Ping Count**.
- iii Click the **Warm Reset** button to send a continuous burst of LFPS pings for the generation of a warm reset. A Warm Reset makes a compliant USB3.1 device reset to CP0. It is not used for a host and will either be ignored or will advance the CP pattern by one count.

NOTE

For the Warm Reset:

- N7018A sends out a 100ms burst of LFPS.Ping with 40ns time period of each cycle.
- The tReset is set in the middle of the USB specification to be 100ms of the Ping.LFPS signal.

- 3 Use the **SCD/LBPM** section to configure and send SuperSpeedPlus Capability Declaration (SCD) and SuperSpeedPlus LFPS Based PWM Message (LBPM) patterns associated with LFPS Polling state to DUT.

NOTE

The N7018A sends SuperSpeedPlus specific patterns in SCD1 and SCD2 as follows:

- The SCD1 pattern is fixed at 0010 (LSB is sent first) and can be repeated 1-32 times in a burst depending on the count that you set.
- The SCD2 pattern is fixed at 1101 (LSB is sent first) and can be repeated 1-32 times in a burst depending on the count that you set.

- i In the **SCD/LBPM** section, set the **SCD1/2 Count**. This is the number of times you want the N7018A to repeat the transmission of the SCD1 and SCD2 patterns in a burst to DUT.
- ii In the **LBPM Capability Bytes** field, set the number of times you want the N7018A to repeat the transmission of the LBPM Capability Byte in a burst to DUT.
- iii In the **Speed** section, select the USB speed capability that you want the N7018A to present in its LBPM Capability Byte. Based on whether you want the N7018A to emulate a

a SuperSpeed design (capable of operating at 5Gbps) or a SuperspeedPlus design (capable of operating at 10Gbps), select the appropriate Gen1 or Gen2 radio button.

- iv Click the **Enable** button to send SCD1/2/LBPM patterns to the DUT. The N7018A continues to send these patterns until you send an LFPS Ping or Warm Reset or click the Disable button. (The Enable button changes to Disable after it is clicked).

NOTE

The transmission of LFPS signals as well as SCD1/2/LBPM signals is done using the same N7018A transmission lines that you enabled in the LFPS tab. Therefore, at a time, either LFPS signals or SCD1/2/LBPM signals are enabled for transmission.

Viewing the Status of the N7018A Connection with the DUT

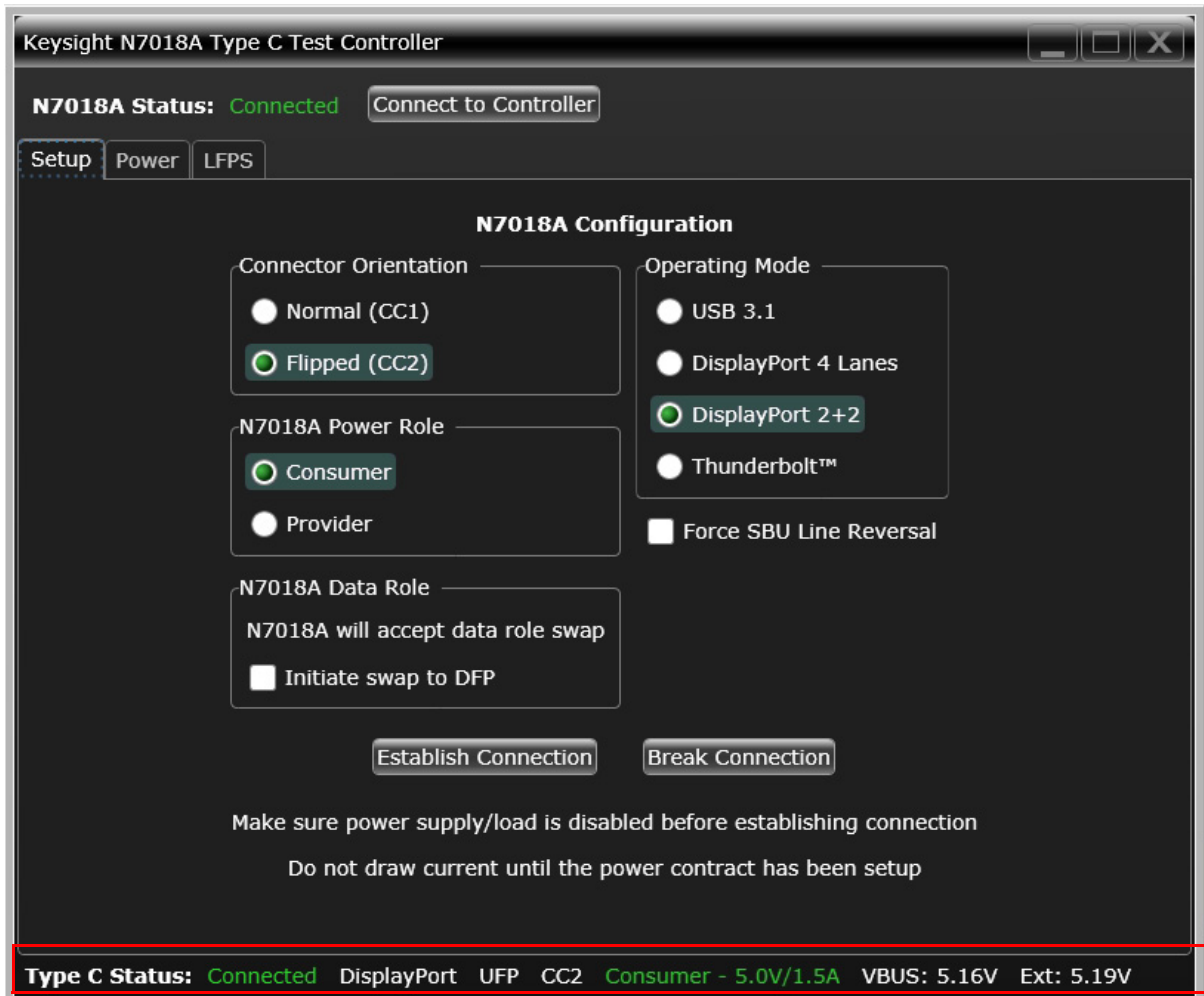
The **Status** bar at the bottom of the N7018A displays the current status of the N7018A connection with the DUT.

NOTE

The information in the Status bar is auto-refreshed at the time interval of one and a half seconds.

It displays:

- the current connection status between the N7018A and DUT.
- the ALT mode and data role (DFP/UFP) set for the N7018A in the current connection.
- the CC line used for the connection.
- the power role (provider or consumer) that the N7018A is emulating with DUT.
- the Active PDO (V/A), that is, the PDO selected on the Provider side for the PD contract. Irrespective of whether the N7018A is emulating a Provider or a Consumer, this PDO always represents the PDO selected on the Provider side.
- the VBUS: n.nnV and Ext: n.nnV represent the actual voltages of VBUS at the N7018A's USB Type-C connector and External Power Supply connector respectively.



If you are Using N7016A

Installing the N7016A Type-C Low Speed Signal Access and Control Fixture Software

Before you Start

Make sure that the Microsoft .NET 4.5.2 software is installed on your Infiniium Oscilloscope or personal computer before installing the N7016A USB Type-C Low Speed Signal Access and Control Fixture software.

If not already installed, download and install the Microsoft .NET 4.5.2 software for free from <https://www.microsoft.com/en-us/download/details.aspx?id=42642>. This software requires a few minutes to install on your Infiniium Oscilloscope or personal computer.

NOTE

In case you have not received the installation package of the N7016A USB Type-C Low Speed Signal Access and Control Fixture software driver, contact your Keysight representative.

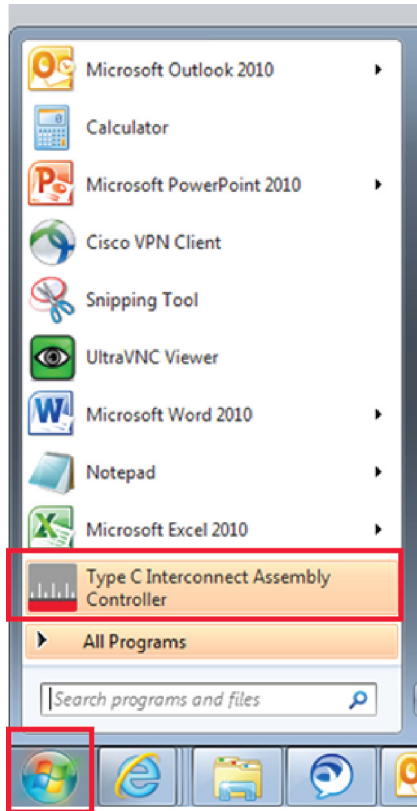
You can also download this software from <http://www.keysight.com/main/software.jsp?ckey=2674876&lc=eng&c=US&nid=-33524.1140138&id=2674876>.

Install the N7016A USB Type-C Low Speed Signal Access and Control Fixture software by following the on-screen prompts.

To complete the installation of this software driver on your Infiniium Oscilloscope or personal computer, restart the system.

Launching the N7016A USB Type-C Low Speed Signal Access and Control Fixture Software

- You can launch this N7016A driver software by navigating to **Start > All Programs > Keysight Infiniium Applications > USB C-Connector > Type-C Interconnect Assembly Controller** on your desktop.
- To launch this software for the first time after installation, you can navigate to **Start > Type-C Interconnect Assembly Controller** on your desktop.



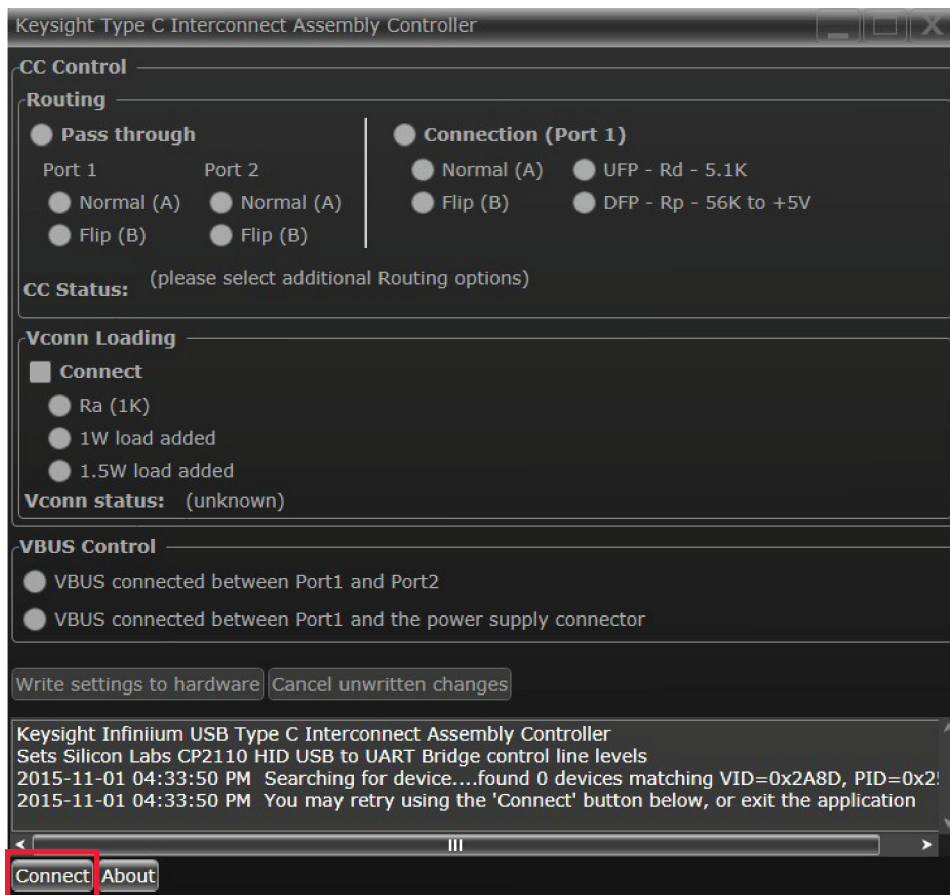
Using the N7016A USB Type-C Low Speed Signal Access and Control Fixture Software

The N7016A USB Type-C Low Speed Signal Access and Control Fixture software is used to configure the hardware settings of the low speed fixture. To use this software, perform the following procedure.

- 1 In the Keysight Type C Interconnect Assembly Controller dialog box, click **Connect** to connect the N7016A low speed fixture to your Infiniium Oscilloscope or personal computer.

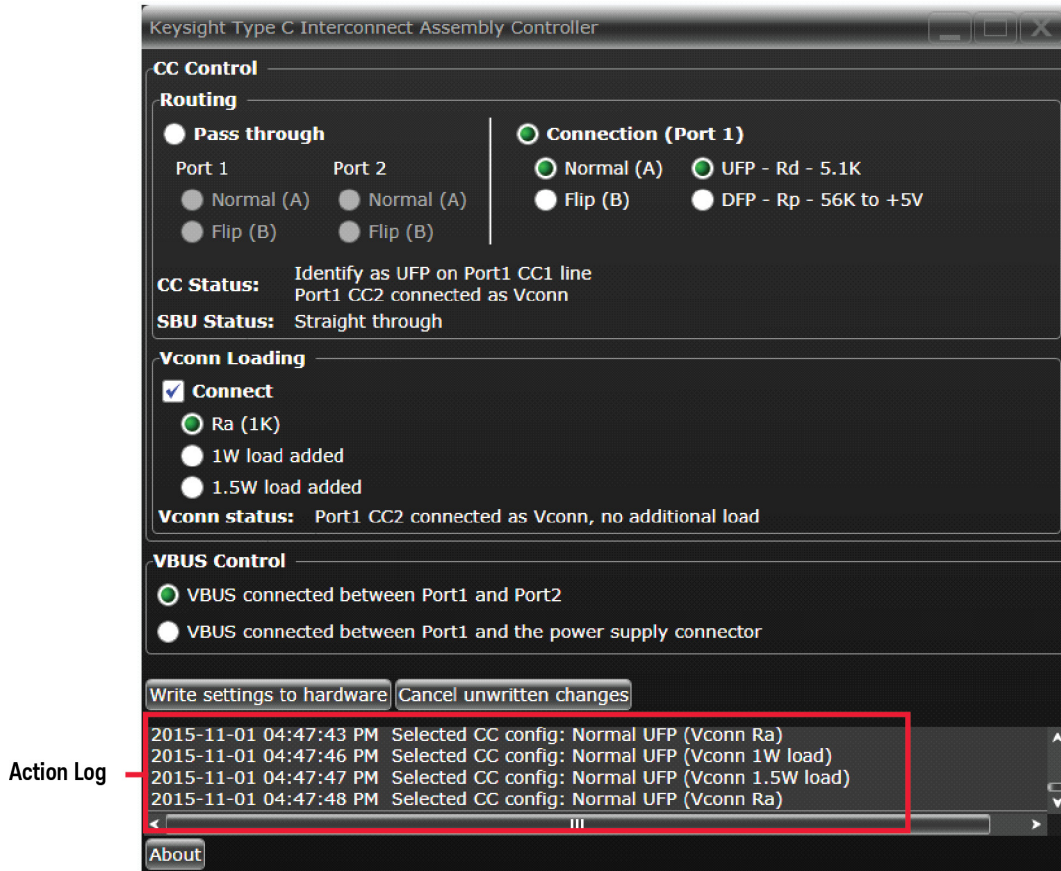
NOTE

If you have already connected the N7016A low speed fixture hardware to your Infiniium Oscilloscope or personal computer, this driver software automatically connects the low speed fixture to the oscilloscope / computer at the driver software launch.

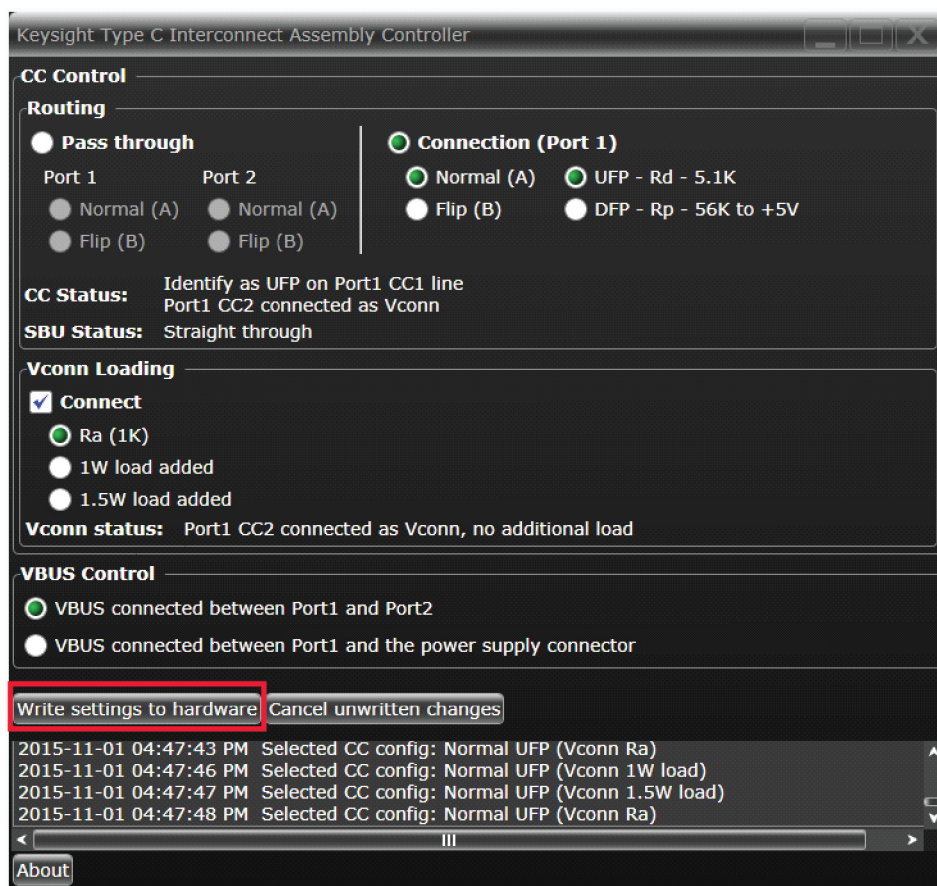


Click to Connect the N7016A Low Speed Fixture to the Infiniium Oscilloscope

- 2 Select the appropriate hardware configuration option in the Keysight Type C Interconnect Assembly Controller dialog box to configure the N7016A low speed fixture settings. As you configure these hardware settings, the subsequent actions are logged and displayed in the bottom section of the software driver dialog box.



- 3 Click **Write settings to hardware** to allow the configured hardware settings to take effect.



Installing the Appropriate Keysight Compliance Application Software

For compliance testing, you need to install the appropriate Keysight compliance application software in addition to the N7018A / N7016A controller software.

These applications are integrated with the N7016A as well as N7018A software. Therefore, irrespective of whether you are using N7016A or N7018A, the compliance applications can be easily used.

The description of these compliance software GUIs is outside the scope of this guide. You can find the compliance application software at www.keysight.com. You can download its Methods of Implementation (MOI) document to get a description of all the compliance tests, how to configure and run these tests, and how to analyze the results obtained.

If you are using N7019A

If you are using N7019A for debugging on an active Type-C link, you can use the following set of software applications to perform decode, trigger, and search on the acquired signals.

Protocol Decode Software Applications for Infiniium Oscilloscopes

An Overview to the Protocol Decoder Software Applications

These decoder applications run on Infiniium software GUI.

You can download and install the required protocol decoder software from:

<http://www.keysight.com>

NOTE

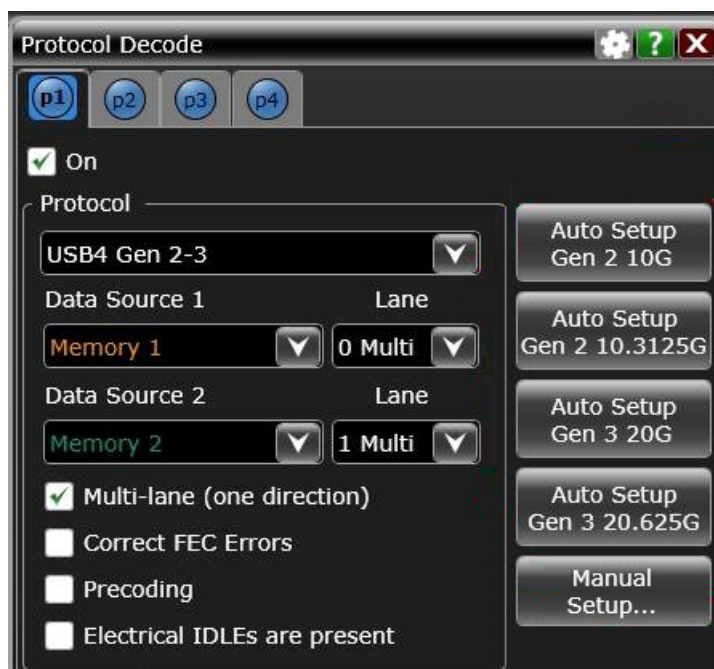
These software applications require the relevant Protocol Decode software to be licensed on your oscilloscope.

Detailed information on each of these decoders is available in:

- the Infiniium online help for your oscilloscope
- the data sheet (accessible from the Document Library tab of the protocol decoder software page on www.keysight.com)

Launching the Protocol Decoder Software GUI

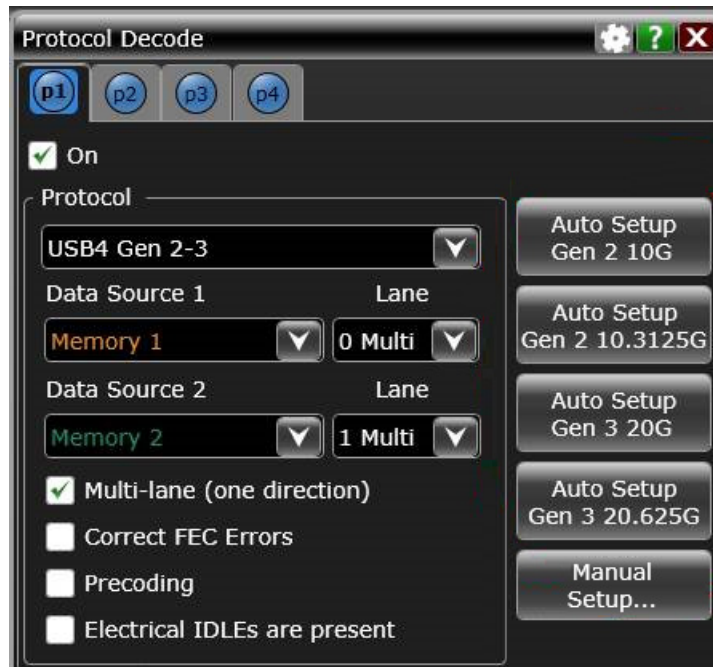
- You can launch the decoder software by opening the Protocol Decode dialog box (**Setup > Protocol Decode...**) in the Infiniium GUI.



Troubleshooting Closed Eyes for USB4 (Gen2/Gen3 Signals)

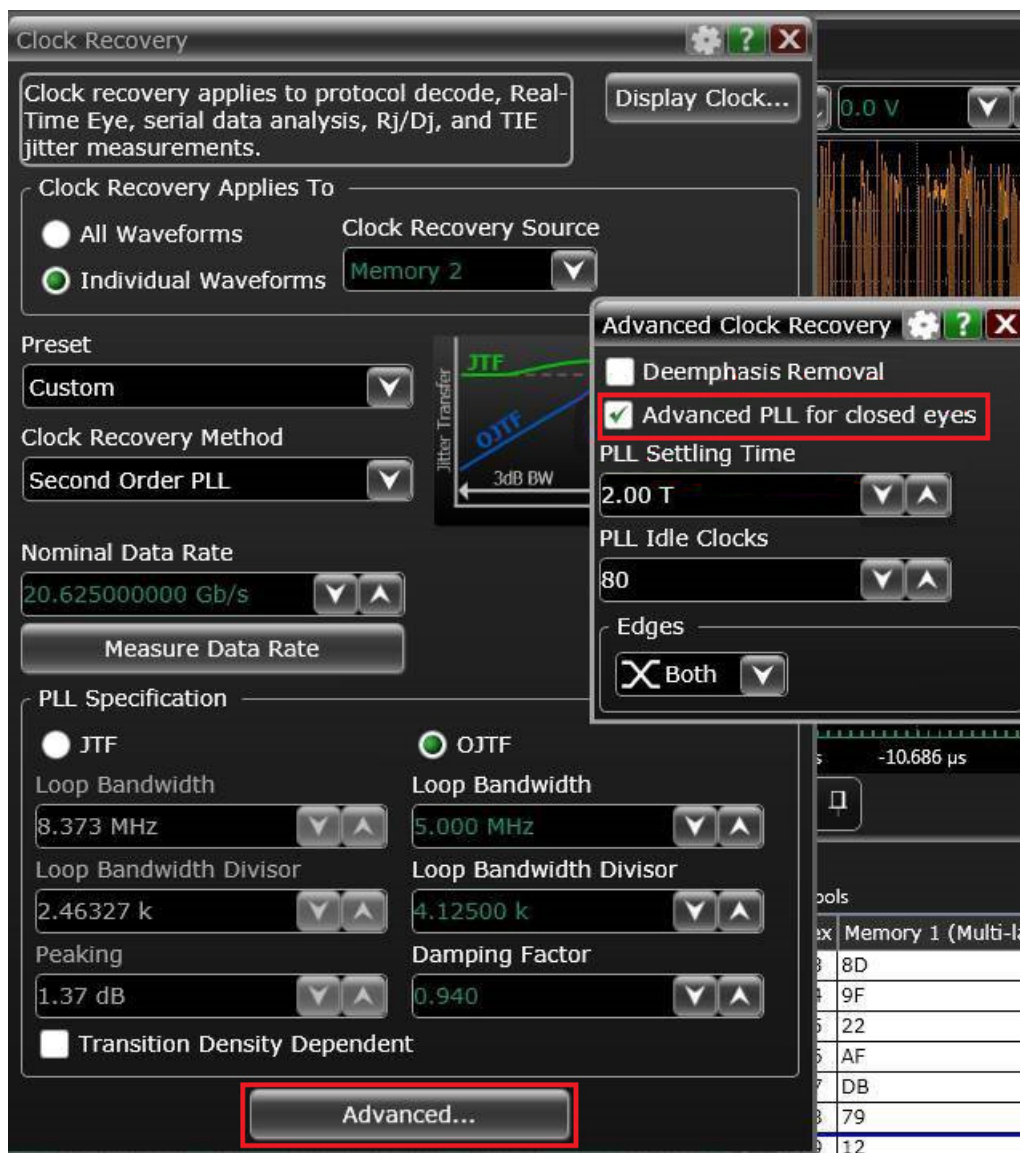
When decoding USB4 (Gen2 or Gen3) signals accessed using the N7019A test fixture, you may encounter the situation when the eye is not large enough to decode. To resolve the closed eyes problem, follow these steps:

- 1 In the **Protocol Decode** dialog box, click the appropriate **Auto Setup** button matching the USB4 data rate applicable to your testing scenario. Using the correct Auto Setup button is crucial in this step. The Auto Setup then automatically sets the appropriate option to resolve closed eyes.



If you are doing a manual setup, then perform the following steps to resolve closed eyes:

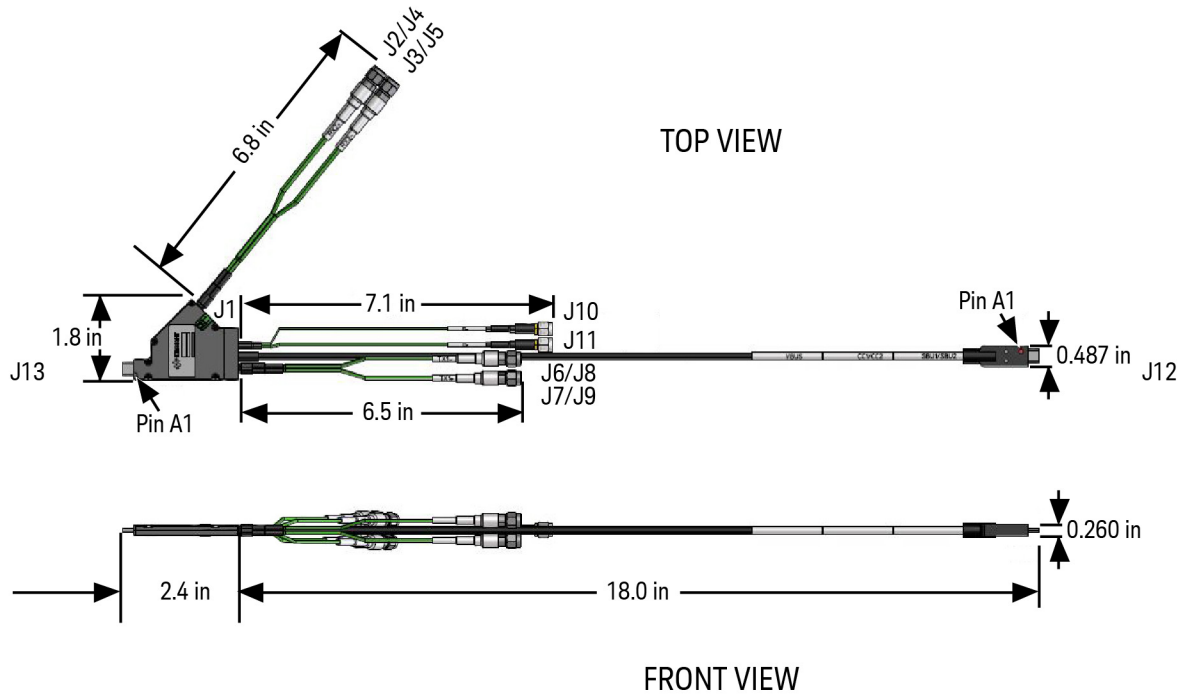
- 1 Click the **Manual Setup...** button in the Protocol Decode dialog box.
- 2 The Protocol Manual Setup dialog box is displayed. From this dialog box, access the **Clock Recovery** dialog box
- 3 Click the **Advanced** button at the bottom of the **Clock Recovery** dialog box.
- 4 In the **Advanced Clock Recovery** dialog box, ensure that the **Advanced PLL for closed eyes** checkbox is selected as displayed in the figure on the next page.



11 Schematic Diagrams and Pinouts

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N7015A Dimensions



N7015A Pinout

The tables that follow provide the pinouts for the connectors of the N7015A test fixture.

Pin Details

Connector	Name
J1	SBU1
	SBU2

Top Coax/Bottom Coax	
Connector	Name
J2	RX2+
J3	RX2-
J4	TX2+
J5	TX2-

Top Coax/Bottom Coax	
Connector	Name
J6	TX1-
J7	TX1+
J8	RX1-
J9	RX1+

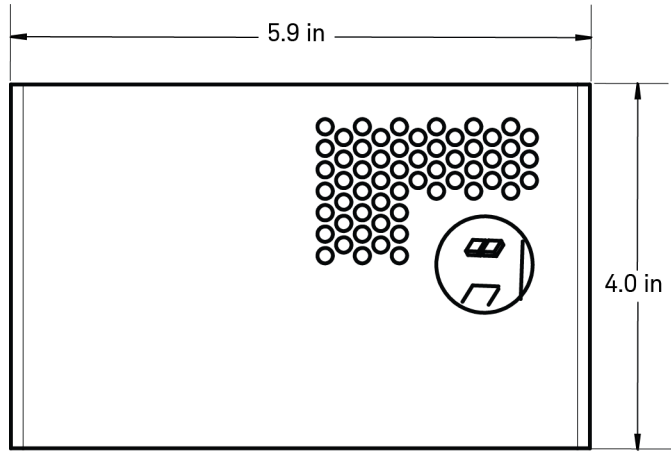
Connector	Name
J10	D-
J11	D+

J12 (Looking into the Connector)			
Pin No.	Name	Name	Pin No.
A1	GND	GND	B12
A2	NC	NC	B11
A3	NC	NC	B10
A4	VBUS	VBUS	B9
A5	CC1	SBU2	B8
A6	NC	NC	B7

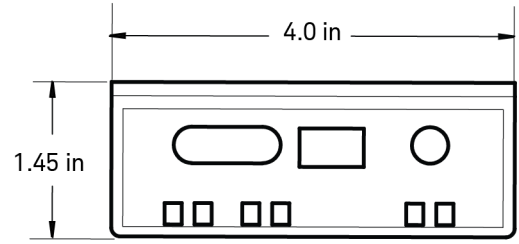
J12 (Looking into the Connector)			
Pin No.	Name	Name	Pin No.
A7	NC	NC	B6
A8	SBU1	CC2	B5
A9	VBUS	VBUS	B4
A10	NC	NC	B3
A11	NC	NC	B2
A12	GND	GND	B1

J13 (Looking into the Connector)			
Pin No.	Name	Name	Pin No.
B1	GND	GND	A12
B2	TX2+	RX2+	A11
B3	TX2-	RX2-	A10
B4	VBUS	VBUS	A9
B5	CC2	SBU1	A8
B6		D-	A7
B7		D+	A6
B8	SBU2	CC1	A5
B9	VBUS	VBUS	A4
B10	RX1-	TX1-	A3
B11	RX1+	TX1+	A2
B12	GND	GND	A1

N7018A Dimensions

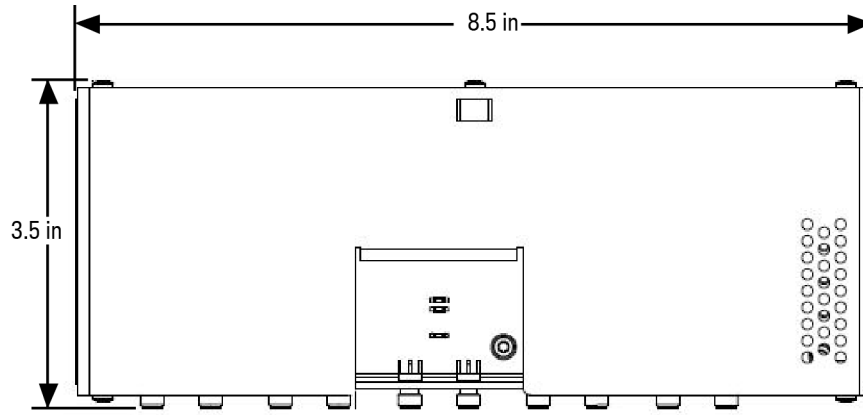


TOP VIEW

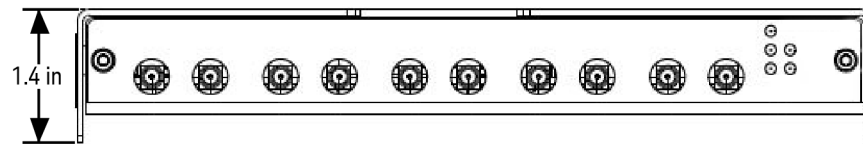


SIDE VIEW

N7016A Dimensions



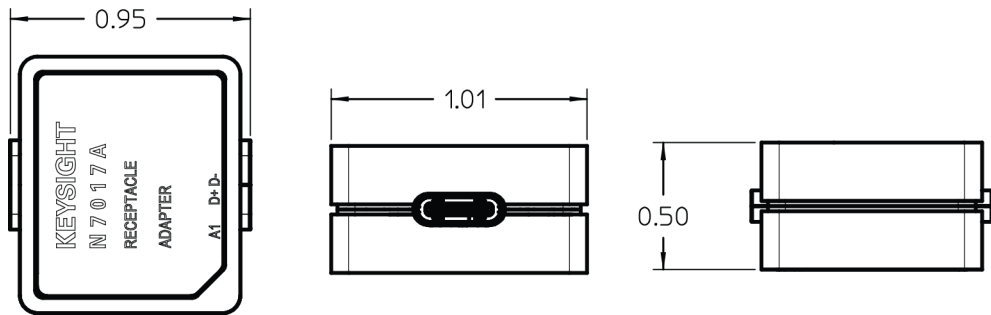
TOP VIEW



FRONT VIEW

N7017A Receptacle Adapter Dimensions

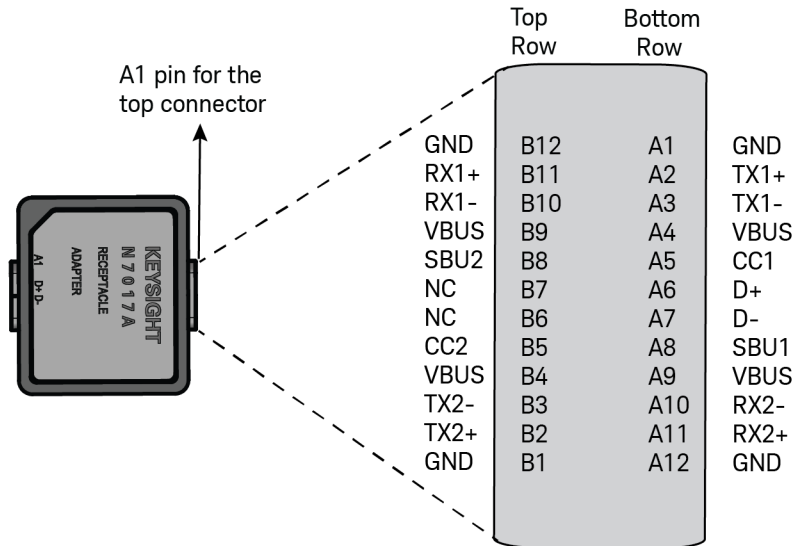
All dimensions are in Inches.



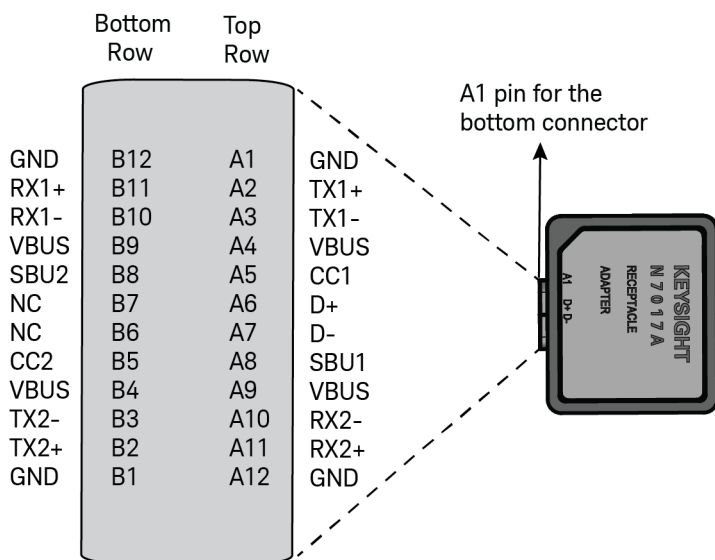
N7017A Receptacle Adapter Pinout

The following figures illustrate the pinouts for the receptacle connectors on the top and bottom of the N7017A receptacle adapter.

Pinout for the Top Connector of N7017A
(Looking into the connector with the Keysight label on top)



Pinout for the Bottom Connector of N7017A
(Looking into the bottom connector with the Keysight label on top)

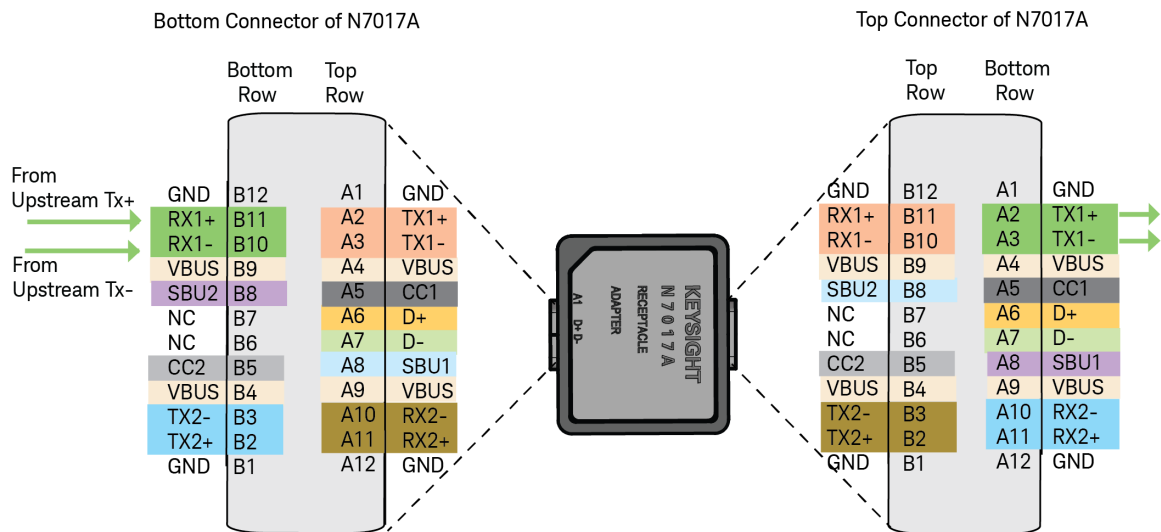


Signal Routing when using the N7017A Receptacle Adapter

The following illustration shows how a signal is routed from a DUT to the N7015A test fixture when using the N7017A receptacle adapter to connect the DUT and N7015A test fixture.

Color codes are used in the illustration below to indicate the signal path.

For instance, the N7017A adapter receives the Tx+ and Tx- signals from the host as Rx1+ and Rx1- on its bottom connector's B11 and B10 pins. These Rx1+ and Rx1- signals are routed as Tx1+ and Tx1- signals to the N7015A test fixture. The green color has been used to indicate these signals' path.



12 Downloading the S-parameter File

The N7015A has four high speed differential paths from its 2.92 mm connectors to its Type-C plug. To correct for the signal loss of the N7015A test fixture, the N7017A receptacle adapter, and the N2823A coaxial phase-matched cable pair in the de-embedding software such as InfiniiSim, download the S-parameter files from the below-mentioned product pages. On these product pages, click the **Technical Support** link and then click the **Drivers, Firmware, & Software** tab.

Product	S-parameter file location
N7015A	www.keysight.com/find/N7015A
N7017A	www.keysight.com/find/N7017A
N2823A	www.keysight.com/find/N2823A

13 Characteristics and Specifications

Product	Weight
N7015A Type-C High Speed Test Fixture	110 grams
N7016A Type-C Low Speed Test Fixture	320 grams
N7017A Type-C Receptacle Adapter	5 grams
N7018A Type-C Test Controller	257 grams

Environmental Characteristics

Characteristic	Value
Temperature	Operating: 0 °C to +55 °C
	Non-operating: -40 °C to +70 °C
Humidity	Operating: Up to 95% RH at or below +40 °C Up to 80% RH at or below +55 °C
	Non-operating: Up to 90% RH at or below 65 °C
Altitude	Operating: Up to 4600 m (15000 ft)
	Non-operating: 4600 m

Specifications

Specification	N7015A, N7016A, N7017A, N7018A	N7019A
Maximum non-destructive input voltage	20V (mains isolated) *	20V (mains isolated) *
Maximum non-destructive input current	3A	5A

* Mains isolated is for measurements performed on circuits not directly connected to a mains supply.

14 Safety and Regulatory Information

The products described in this guide have been designed and tested in accordance with accepted industry standards, and have 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 products in a safe condition.

Only Keysight approved accessories shall be used.

WARNING

If these products are not used as specified, the protection provided by these could be impaired.

WARNING

These products are NOT intended for measurements on mains circuits (CATII, CAT III, and CAT IV).

WARNING

No operator serviceable parts inside. Do not install substitute parts or perform any unauthorized modification to these products. Do not attempt internal service or adjustment. Service should be carried out by a Keysight Technologies authorized service personnel. For any service/repair needs, contact Keysight Technologies. To prevent electrical shock, do not remove outer cover of the product.

WARNING

Indoor Use Only. Do not operate in wet / damp environments. Keep product surfaces dry and clean. Do not operate in an explosive environment.






WARNING

Periodically inspect the probe and probe wires to check for any damage. Do Not Operate With Visible or Suspected Failures. If you suspect there is damage, have it inspected by a Keysight authorized service personnel.

CAUTION

Cables are a sensitive part of these products and, therefore, you should be careful not to damage these cables through excessive bending or pulling. Avoid any mechanical shocks to the products to guarantee accurate performance and protection.

Instrument Markings

Marking	Description
	<p>The CE mark is a registered trademark of the European Community. ISM GRP 1-A denotes the instrument is an Industrial Scientific and Medical Group 1 Class A product. ICES/NMB-001 indicates product compliance with the Canadian Interference-Causing Equipment Standard.</p>
	<p>Notice for the European Community: This product complies with the WEEE Directive (2002/96/EC) marking requirements. The affixed label indicates that you must not discard this electrical/electronic product in domestic household waste. Product Category: With reference to the requirement types in the WEEE Directive Annex I, this product is classed as a "Monitoring and Control Instrumentation" product. Do not dispose in domestic household waste. To return unwanted products, contact your local Keysight office.</p>
	<p>KC certification mark to demonstrate compliance with the South Korean EMC requirements. South Korean Class A EMC declaration This equipment is Class A suitable for professional use and is for use in electromagnetic environments outside of the home.</p>
	<p>This symbol indicates the Environmental Protection Use Period (EPUP) for the product's toxic substances for the China RoHS requirements.</p>
	<p>The product is marked with this symbol when it is necessary for the user to refer to the instructions in the documentation.</p>

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