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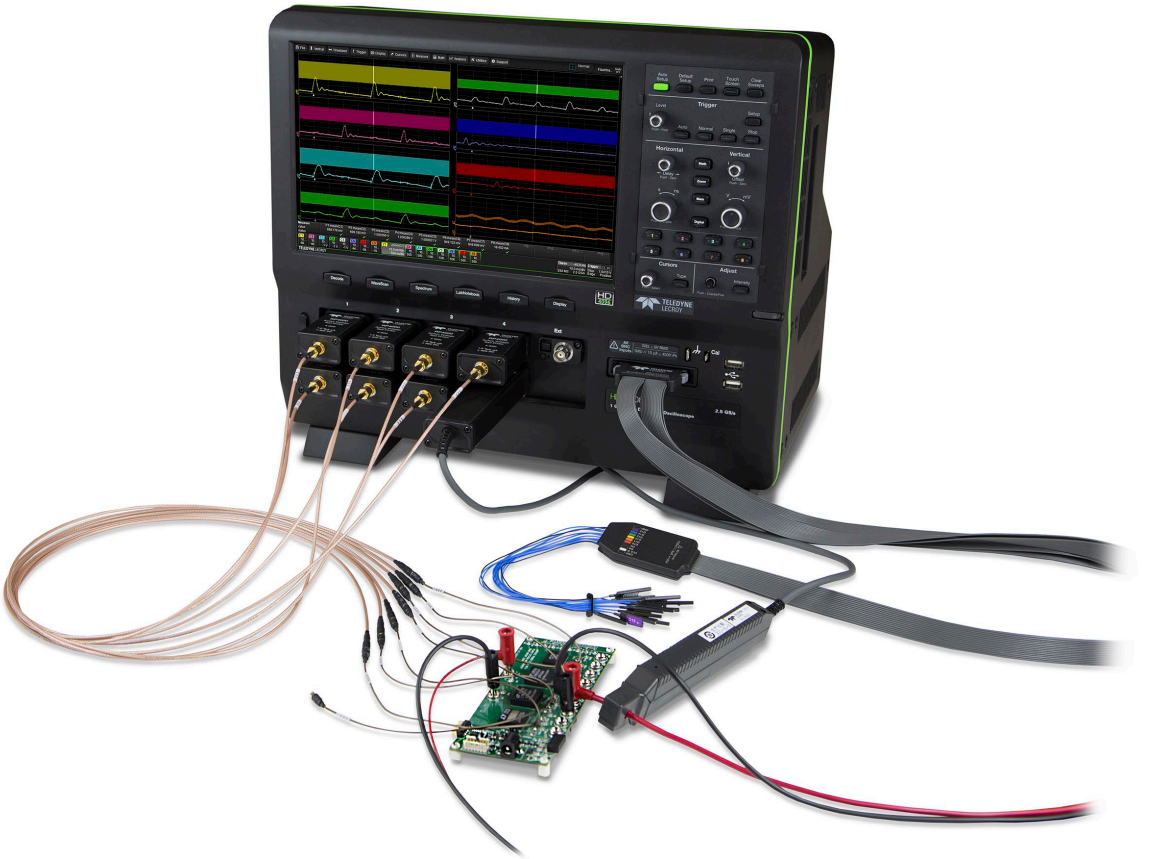

User Manual

RP4030
Power Rail Probe

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May, 2021

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Contents

Safety Instructions

Follow these instructions to keep the probe operating in a correct and safe condition. Observe generally accepted safety procedures in addition to the precautions specified here.

The overall safety of any system incorporating this accessory is the responsibility of the assembler of the system.

Symbols

These symbols appear on the probe body or in documentation to alert you to important safety considerations.

	CAUTION, possibility of electric shock.
	CAUTION of damage to probe or instrument, or WARNING of hazard to health. Refer to the manual to protect against personal injury or damage. Do not proceed until conditions are fully understood and met.
	Equipment protected by double insulation or reinforced insulation.
	ESD CAUTION. Risk of Electrostatic Discharge (ESD) that can damage the probe or instrument if anti-static measures are not taken.

Precautions

Comply with the following safety precautions to avoid personal injury or damage to your equipment:

Use only as specified. The probe is intended to be used only with compatible Teledyne LeCroy instruments. Using the probe and/or the equipment it is connected to in a manner other than specified may impair the protection mechanisms.

Do not use the probe for measurements on Mains circuits.

Do not overload; observe all ratings. To avoid electric shock or fire, do not connect the current probe to any wire that carries voltages or currents that exceed the ratings of the probe.

Connect and disconnect properly. Connect the probe to the measurement instrument before connecting to the circuit being measured. Avoid damaging the cable through excessive bending.

Use only indoors and within the operational environment listed. Do not use in wet or explosive atmospheres.

Do not remove the probe's casing. Touching exposed connections may result in electric shock.

Keep product surfaces clean and dry.

Handle with care. Probe tips are sharp and may cause injury if not handled properly.

Comply with the maximum input voltage vs. frequency derating when measuring voltage that includes a high frequency component.

Do not operate with suspected failures. Before each use, inspect the probe and accessories for damage such as tears or other defects in the probe body, cable jacket, accessories, etc. If any part is damaged, cease operation immediately and sequester the probe from inadvertent use.

Introduction

The Teledyne LeCroy RP4030 Power Rail Probe meets the specific requirements of those who need to acquire a low-voltage DC signal as part of testing:

- Digital power management components such as power management IC (PMIC); voltage regulator module (VMR); point-of-load (POL) switching regulator; or low-dropout regulator
- Complete embedded systems containing digital power management components

The RP4030 will acquire a low-impedance, low-voltage DC power/voltage rail signal without loading the device under test (DUT). It provides high offset—allowing DC power/voltage rail signal to be display in the vertical center of the oscilloscope—and high sensitivity (gain) with low noise.

Key Features

- High offset capability (+/-30 V) to permit the DC signal to be displayed in the vertical center of the oscilloscope grid regardless of the gain/sensitivity setting
- Low attenuation (nominally 1.2:1) for operation with very low additive noise levels of 50 µVrms probe noise, referenced to the input of the probe. When used with an HDO 12-bit oscilloscope at 1 GHz bandwidth, this equates to 140 µVrms system noise at 1 mV/div or 210 µVrms system noise at 5 mV/div, an approximately 5% increase in oscilloscope only noise.
- 50 Ω DC coupled to the oscilloscope with high DC input impedance (50 kΩ) to minimize loading on the DUT
- High dynamic range (+/-800 mV)
- 4 GHz of bandwidth—ideal for use with a 4 GHz 10-bit HDO9404
- ProBus interface with wide variety of leads for different probing needs

Low- and High-Frequency Measurements at High Bandwidths

The RP4030 is a superior solution to commonly used alternative methods.

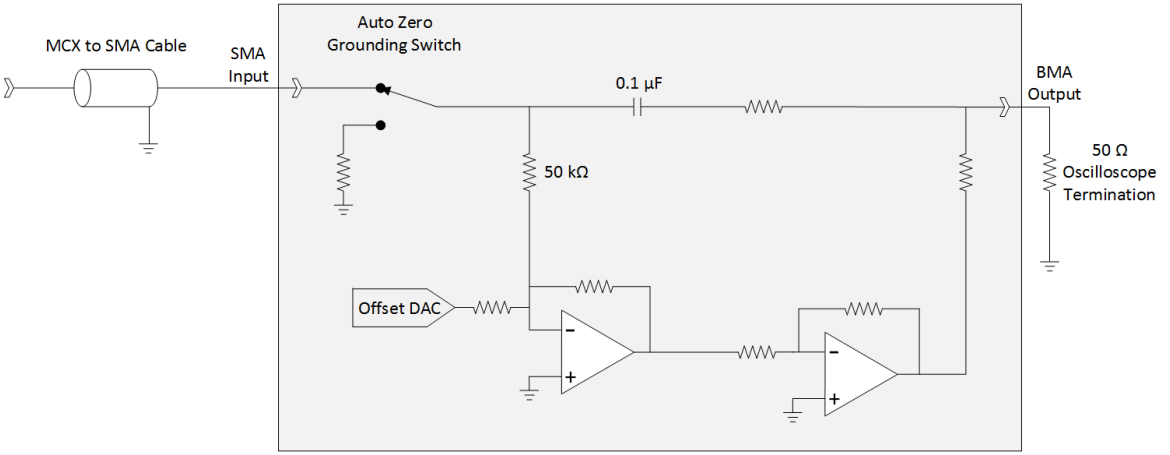
One commonly used method is to terminate a 50 Ω transmission line into 1 MΩ coupling at the oscilloscope. While this will provide acceptable bandwidth performance for some, the loading impedance of a 50 Ω cable terminated to a 1 MΩ input will depend upon the length of the 50 Ω cable and will have null values when frequency is proportional to the length of the cable. A damping resistor could be used to mitigate this impact, but the 1 MΩ input to the oscilloscope is typically limited to 500 MHz, and the oscilloscope must inherently have high offset-adjust

capability equivalent to the DC rail voltage at the most sensitive gain settings. This is rarely the case, although Teledyne LeCroy HDO oscilloscopes are a notable exception.

To avoid the need for high offset in the oscilloscope input channel, engineers may use a DC block between their cable connection and the oscilloscope input, or AC coupling of the oscilloscope input. A DC block has a non-ideal low-frequency response (typically blocking DC to 100 kHz or DC to 10 MHz), which eliminates low-frequency signal content that would normally be seen during typical oscilloscope acquisition times (100 ns to 10 ms). This approach might show the signal with a misunderstood non-zero DC offset, or might introduce a “droop” or “sag” in the waveform at a step voltage change due to the loss of low-frequency content. The frequency response of an oscilloscope when AC input coupled usually reaches closer to DC (~10 Hz low-pass cutoff), but is still not ideal.

The RP4030 eliminates the above tradeoffs and permits more accurate and more convenient DC power/voltage rail probing at very high bandwidths.

In the simplified circuit diagram below, the RP4030 portion is highlighted in gray. The input is through a high bandwidth SMA connector, terminated to ground with a 50 kΩ resistor in parallel with a 0.1 µF capacitor. This termination provides high input impedance near DC and low input impedance at high frequencies—highly desirable for low impedance DC power rail probing. A two-stage offset DAC provides 16-bit offset resolution over a 30 V range. This permits the offset value to be set with high precision (~1mV) and accuracy (0.1% ± 3 mV). The output is through a BMA connection to the Teledyne LeCroy ProBus interface into a 50 Ω oscilloscope termination. An Auto Zero grounding switch permits Auto Zero of the DC value at any time without disconnecting the probe from the device under test (DUT).



Variety of Leads

An assortment of solder-in leads and MCX or U.FL (compatible with IPX or MMCX) PCB mount receptacles are supplied for connection to the power rails. Multiple solder-in leads or PCB mount receptacles can be left in place, while the probe MCX cable is moved from one lead/receptacle to another as test needs change. The compact (3mm x 3mm) U.FL PCB mount receptacles permit installation of many PCB mount receptacles on a compact, power dense mobile/handheld PCB. A separate browser tip accessory (the RP4000-BROWSER) is available at additional cost.

If desired, the cable and lead connection components may be used separately from the RP4030 probe. This is useful for power sequencing tests where the dynamic range of the DC power/voltage rail exceeds the +/-800 mV rating of the probe. See Connecting to the Circuit.

ProBus Interface

The RP4030 uses the ProBus interface to connect to Teledyne LeCroy oscilloscopes. With the ProBus interface, the probe becomes an integral part of the measuring instrument. Power is provided to the probe through the interface, so there is no need for a separate power supply or batteries, and attenuation is automatically identified. All compatible Teledyne LeCroy oscilloscopes will support the connection of an RP4030 on every input channel, if required.

Compatibility

The Teledyne LeCroy RP4030 is compatible with a wide range of Teledyne LeCroy oscilloscopes:

- For 64-bit MAUI oscilloscopes, proper functioning of the RP4030 requires MAUI (XStreamDSO) firmware version 8.2.1.1 or higher.
- For 32-bit MAUI oscilloscopes, proper functioning of the RP4030 requires MAUI (XStreamDSO) firmware version 8.1.2.0 or higher.

Note: RP4030 is not compatible with WaveSurfer Xs oscilloscopes, which only run up to 32-bit XstreamDSO 7.2.0.5. Contact Service for available oscilloscope upgrades.

See our website for a full list of compatible models.

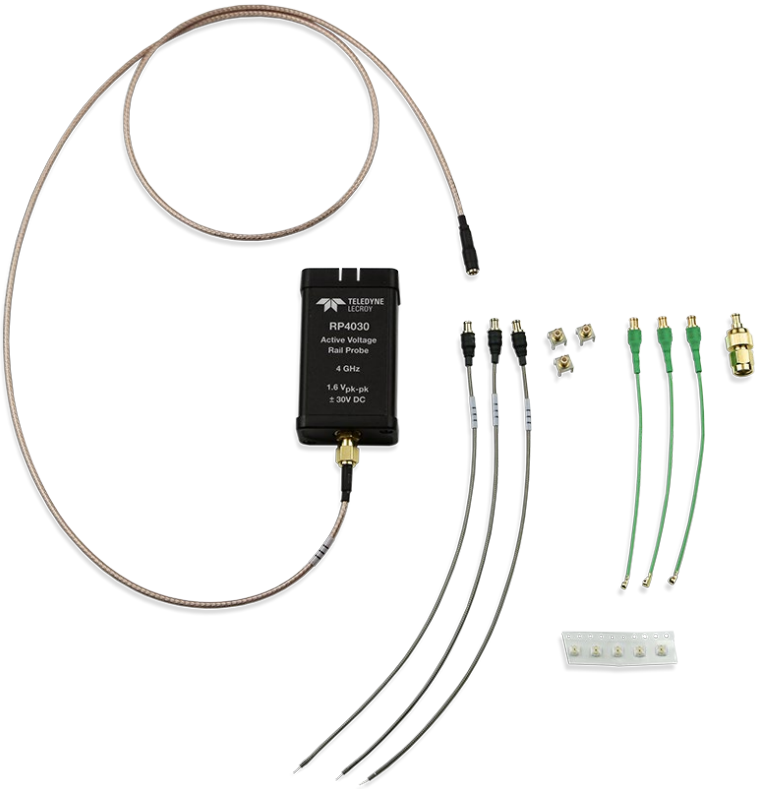
For power integrity testing, digital power management, and system power management testing on one or more DC power/voltage rails, Teledyne LeCroy HDO oscilloscopes are recommended due to their high resolution, high bandwidth, high inherent offset capability, and the availability of more than four channels.

For power integrity testing, it may be desirable to use a high-resolution oscilloscope with over 1 GHz bandwidth.

Probe Kit

The following items are shipped with the RP4030 probe. Additional quantities of some parts may be purchased separately using the part number shown in the table.

Item	Description	Part Number	QTY
Extension Cable	SMA-to-MCX extension cable, 0.9 meters	42A0000007349	1
Solder-in Leads	MCX solder-in lead, 18cm long, 4 GHz	RP4000-MCX-LEAD-SI	3
MCX PCB Mounts	MCX 6mm x 6mm PCB mounts	See accessory list below	3
Coaxial Cables	MCX to U.FL ultra-miniature coaxial cable, 8cm long, 3 GHz	RP4000-MCX-CABLE-UFL	3
U.FL PCB Mounts	U.FL 3mm x 3mm PCB mounts	See accessory list below	5
Adapter	SMA-to-MCX adapter	42A0000007475	1
Case	Soft storage case with foam insert	N/A	1
User Manual	Printed user manual	N/A	1



RP4000-BROWSER Accessory

The RP4000-BROWSER tip accessory is a ÷1 high-frequency transmission line browser tip. It connects to one end of the supplied standard SMA-to-SMA extension cable, while the other end of this cable terminates at the RP4030 probe, which then terminates at the oscilloscope with 50 Ω coupling with high input impedance. The spring-loaded, hinged ground pin contributes to contact stability while making it easier to reach into dense circuitry.

Additional resistors are supplied so that the browser can be operated as a ÷10 or a ÷20 attenuation conventional high-frequency transmission line probe with direct connection to an oscilloscope SMA input (or BNC input using the included SMA to BNC adapter). In this case, the included 450 Ω (÷10) or 950 Ω (÷20) probe resistors must be installed in the tip.

CAUTION: When using the RP4030 probe and browser tip together, install the 0 Ω resistor in the browser. Only install the 450 Ω or 950 Ω resistors when using the browser tip as a conventional transmission line probe.

Item	Description	Part Number	QTY
Probe Body	Probe body browser tip	PACC-PB001	1
Cable	SMA to SMA probe cable	PACC-CB001	1
Resistor	÷1 attenuating resistor (0 Ω, pre-installed)	927419-00	1
Resistor	÷10 attenuating resistor (450 Ω)	PACC-X1001	1
Resistor	÷20 attenuating resistor (950 Ω)	PACC-X2001	1
Housing	Plastic nose housing, black	PACC-NH001	1
Adapter	SMA to BNC adapter (Standard)	PACC-AD001	1

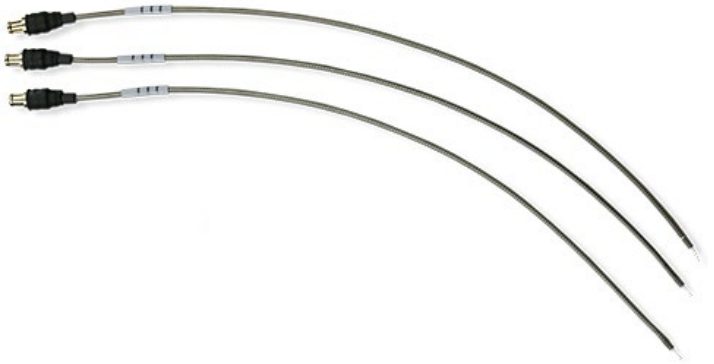
Other RP4030 Accessories

Additional quantities of the following accessories may be purchased with the RP4030 or separately. If ordered with the RP4030, they are shipped inside the RP4030 soft carrying case.

Item	Description	Part Number	QTY
Solder-in Leads	MCX solder-in lead, 18cm long, 4 GHz	RP4000-MCX-LEAD-SI	3
MCX PCB Mounts	MCX 6mm x 6mm PCB mounts	RP4000-MCX-PCBMOUNT	10
Coaxial Cables	MCX to U.FL ultra-miniature coaxial, 8 cm long, 3 GHz	RP4000-MCX-CABLE-UFL	3
U.FL PCB Mounts	U.FL 3mm x 3mm PCB mounts	RP4000-UFL-PCBMOUNT	10

MCX to Solder-in Leads

Three are supplied with the RP4030, and more may be purchased as accessory or replacement items using part number RP4000-MCX-LEAD-SI.



MCX 6mm x 6mm PCB Mount Receptacles

Three are supplied with the RP4030, and more may be purchased as accessory or replacement items using part number RP4000-MCX-PCBMOUNT. The supplied SMA-to-MCX cable connects directly to these PCB mounts for optimum signal fidelity.

Ultra-miniature U.FL Coaxial Cables

Three are supplied with the RP4030, and more may be purchased as accessory or replacement items using part number RP4000-MCX-CABLE-UFL. U.FL is a Hirose Electric ultra-miniature connector that is ideal for use in very dense or compact circuits, and is functionally equivalent to IPX and UMCC connectors. The corresponding U.FL PCB mount is one fourth the size of the MCX (3mm x 3mm). This coaxial cable assembly utilizes an IPX connector that was qualified with the U.FL PCB mount receptacles described below.

NOTE: While there are a variety of ultra-miniature PCB mounts and cables available from other manufacturers that are compatible with U.FL, Teledyne LeCroy recommends using the supplied coaxial cable and U.FL PCB mount receptacles as a system (cable connector and PCB mount together), as this is how the frequency response has been validated.

U.FL 3mm x 3mm PCB Mounts

Five are supplied with the RP4030, and more may be purchased as accessory or replacement items using part number RP4000-UFL-PCBMOUNT. The MCX to U.FL cables connect between the SMA-to-MCX cable and the U.FL PCB mounts.

Specifications

For the most current specifications, see the product datasheet at teledynelecroy.com. Specifications are subject to change without notice.

NOTE: The components supplied as part of the RP4030 probe are tested as a system. The performance presented in this manual represents the probe when used with these components. If components are lost or damaged, replace them with factory-certified components to maintain the stated performance.

Nominal Characteristics

Nominal characteristics describe parameters and attributes that are guaranteed by design, but do not have associated tolerances.

Offset Range	±30 V
Attenuation	1.2x
DC Input Impedance	50 kΩ
Input Dynamic Range	±800 mV (single-ended)
Maximum Non-Destruct Input Voltage	50 V (DC + Peak AC)
Output Termination	50 Ω at oscilloscope input

Warranted Characteristics

Warranted characteristics are parameters with guaranteed performance. Unless otherwise noted, tests are provided in the Performance Verification Procedure for all warranted specifications.

Bandwidth	4 GHz using SMA-to-MCX cable with PCB mount
Attenuation Accuracy	1% into 50 Ω
Offset Accuracy	±0.1% ±3 mV

Typical Characteristics

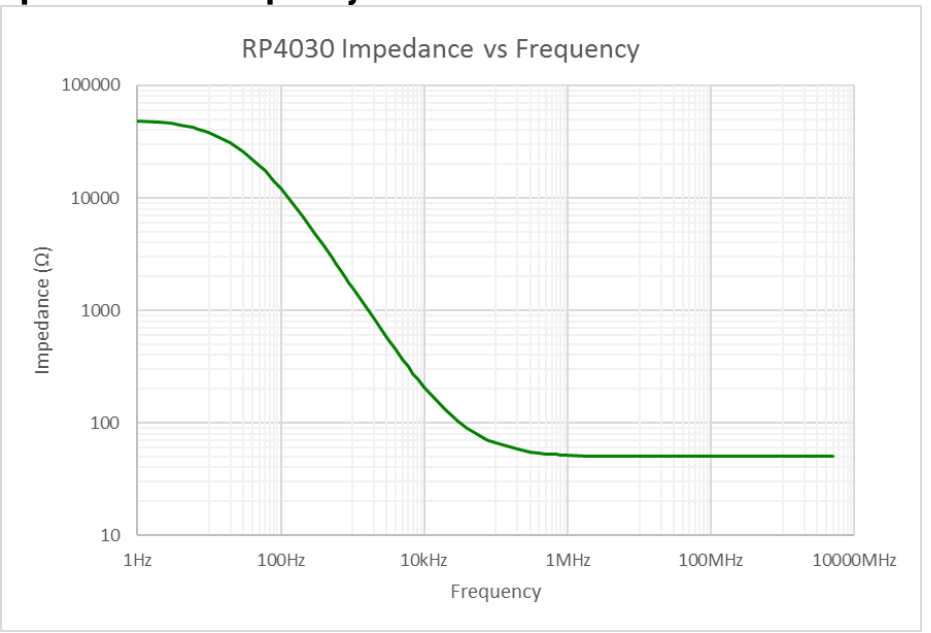
Typical characteristics are parameters with no guaranteed performance. Tests for typical characteristics are not provided in the Performance Verification Procedure.

Bandwidth	4 GHz using MCX solder-in lead 3 GHz using U.FL ultra-miniature cable with PCB mount 350 MHz using browser
Rise Time (10-90%)	110 ps

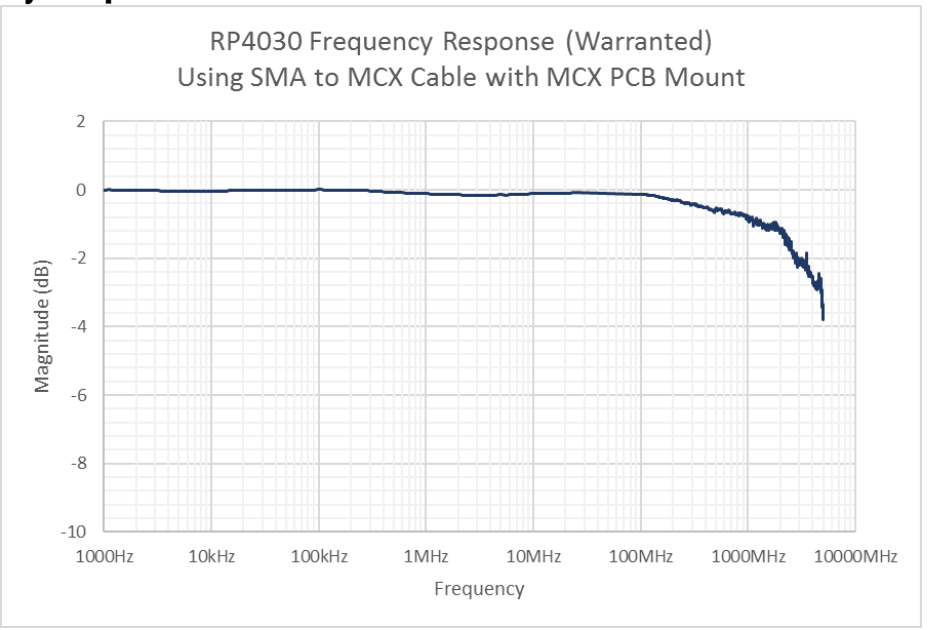
Physical Characteristics

RP4030 Weight (with all accessories and carrying case)	620 grams (1.37 lb.) net of packaging material
RP4030 Dimensions	Probe: 38.1 mm W x 15.9 mm H x 73 mm L (1 1/2″ x 5/8″ x 2 7/8″) SMA-to-MCX Cable: 914 mm L (36″) MCX to Solder-in Lead: 191 mm (7 1/2″) usable length MCX to U.FL Plug Coaxial Cable: 102 mm (4″) usable length
RP4000-BROWSER Dimensions	11.9 mm W x 9.5 mm H x 38 mm L (15/32″ x 3/8″ x 1 1/2″) SMA to SMA Cable: 1 m (39 3/8″) usable length

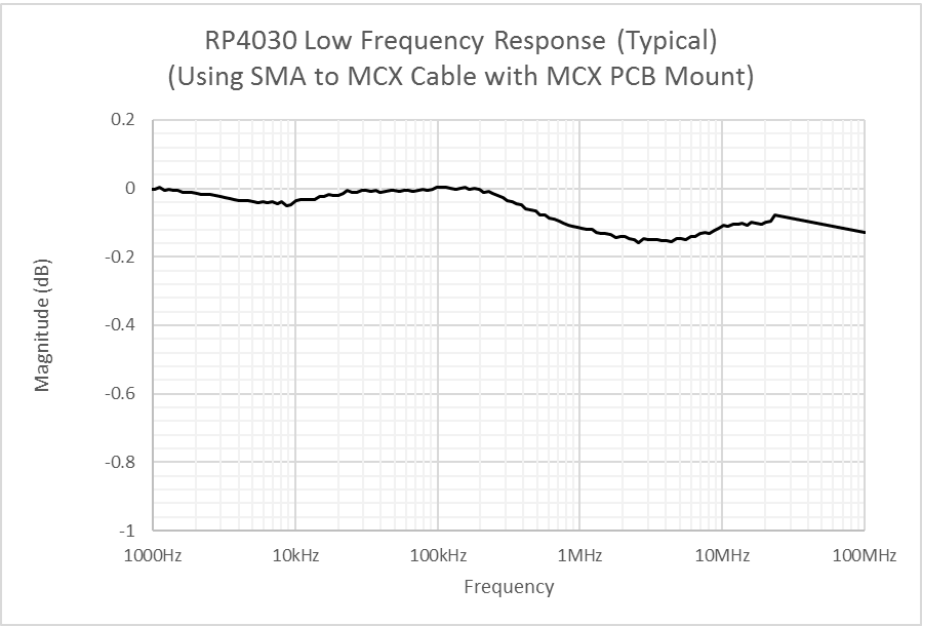
Probe Impedence vs. Frequency

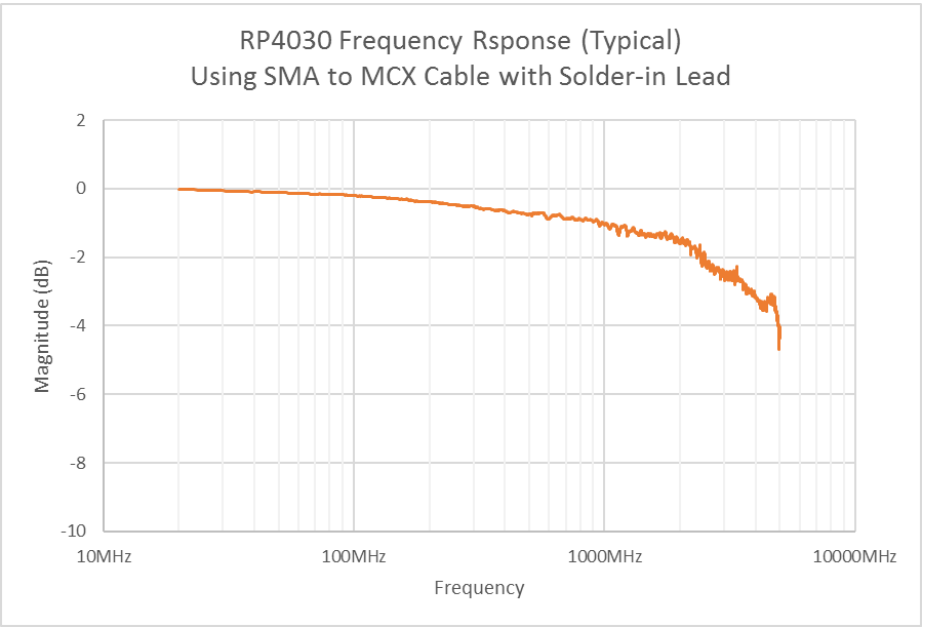


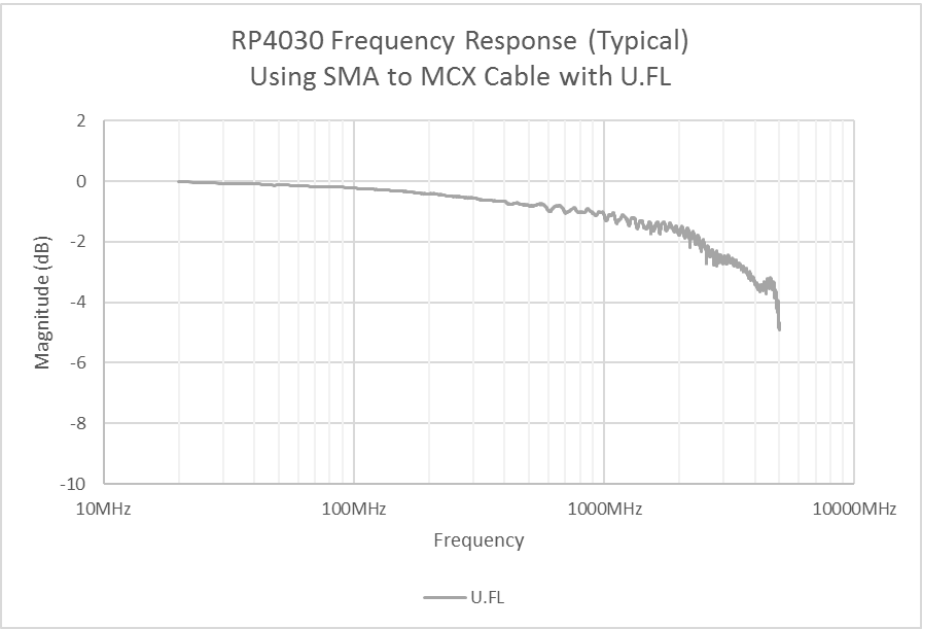
Frequency Response

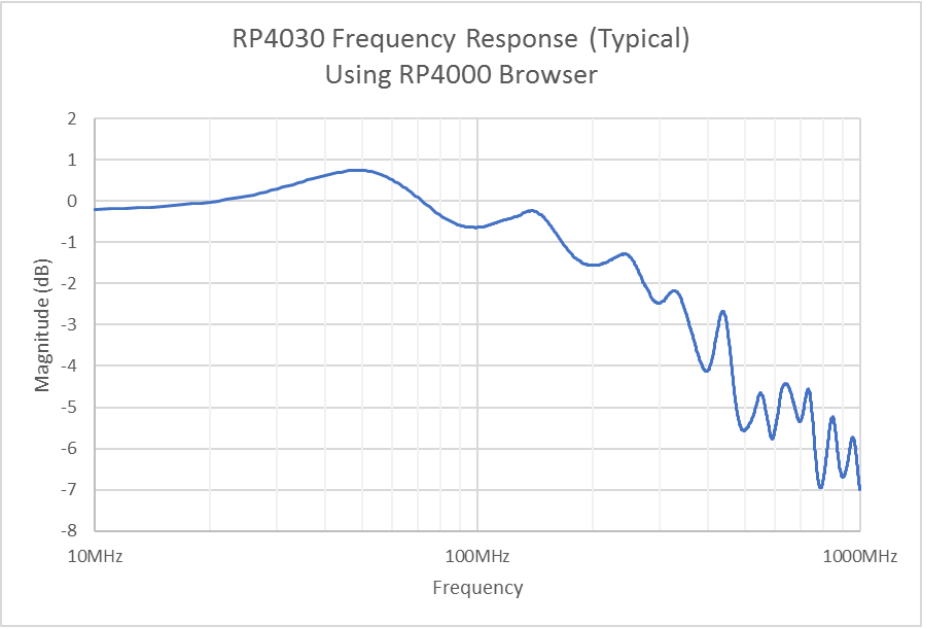


Following is the same data presented with a different magnitude and frequency scale.




RP4030 Frequency Rsponse (Typical)
Using SMA to MCX Cable with Solder-in Lead
2
0
-2
-4
-6
-8
-10
Magnitude (dB)
10MHz
100MHz
1000MHz
10000MHz
Frequency


RP4030 Frequency Response (Typical)
Using SMA to MCX Cable with U.FL
2
0
-2
-4
-6
-8
-10
Magnitude (dB)
10MHz
100MHz
1000MHz
10000MHz
Frequency
U.FL


RP4030 Frequency Response (Typical)
Using RP4000 Browser
2
1
0
-1
-2
-3
-4
-5
-6
-7
-8
Magnitude (dB)
10MHz
100MHz
1000MHz
Frequency

Operation

NOTE: Operation of the probe as described requires the correct version of the MAUI (XStreamDSO) firmware (see p.5). To confirm the version installed, choose Utilities > Utilities Setup from the oscilloscope menu bar, then open the Status dialog.

Handling the Probe

The RP4030 probe is a precision test instrument. Exercise care when handling and storing the probe. Always handle the probe by the probe body or compensation box. Avoid putting excessive strain on or exposing the probe cable to sharp bends.

ESD Sensitive: The probe tips are sensitive to Electrostatic Discharge (ESD). Avoid damaging the probe by always following anti-static procedures (wear wrist strap, etc.) when using or handling the probe.

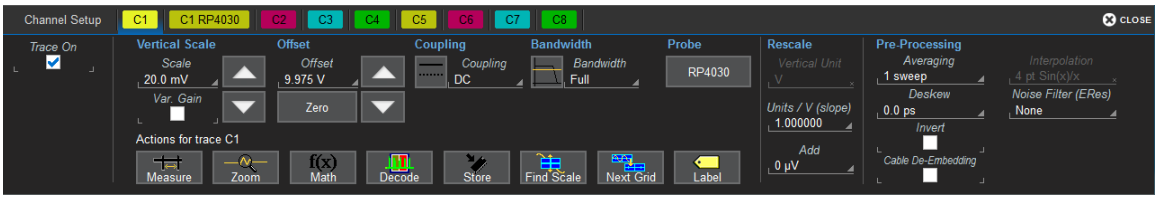
Operating from the Oscilloscope

The RP4030 probe has been designed for use with Teledyne LeCroy oscilloscopes equipped with the ProBus interface. When the probe output connector is attached to the oscilloscope's input connector, the instrument will:

- Recognize the probe
- Set the oscilloscope input termination to DC50Ω
- Set the probe attenuation to 1.2x
- Activate the probe control functions on the oscilloscope user interface.

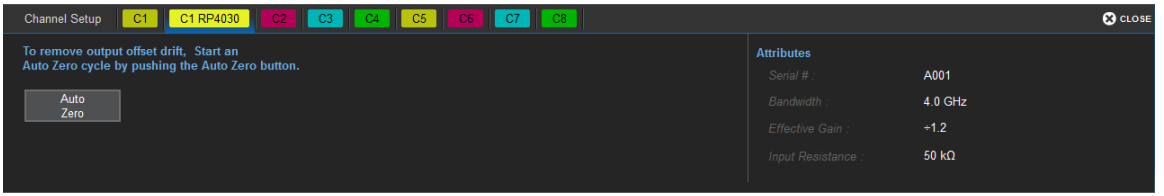
For accurate measurements, allow the probe to warm up for at least 20 minutes after being connected to the oscilloscope.

Vertical Scale (V/div), Coupling, Bandwidth (BWL), and Attenuation are controlled from the Channel setup dialog (C*n*).



Channel setup dialog (Cn) with Probe dialog (Cn RP4030) behind it.

The probe's attributes are shown on the RP4030 Probe dialog, which appears behind the C*n* dialog when a probe is detected. The Probe dialog also contains controls for Auto Zero.



RP4030 Probe dialog.

Vertical Scale (Volts/div)

The oscilloscope automatically factors in the nominal 1.2x attenuation and adjusts the Vertical Scale gain readout to reflect the attenuation value. No further scaling adjustment is needed.

NOTE: The maximum input dynamic range of the RP4030 is +/-800 mV. The maximum oscilloscope gain setting with the RP4030 connected is +/-200 mV/div. Most DC rail voltage exceeds 800 mV, so some applied offset is required to display the signal on the oscilloscope.

Offset

The RP4030 has built-in offset capability of ±30 V using a 16-bit offset DAC for high offset accuracy and resolution. This allows you to remove a DC bias voltage from the input signal while maintaining DC coupling. By using probe offset, the full dynamic range of the probe can be centered around the vertical center of the oscilloscope grid so as to permit high sensitivity gain settings to be used on a DC-biased signal.

Probe offset is controlled using the front panel Vertical OFFSET knob. The amount of offset applied is displayed on the channel descriptor box.

NOTE: On Teledyne LeCroy oscilloscopes, the input offset displayed is the amount of offset required to zero the applied voltage (e.g., a -1 V offset is required to vertically center a 1 V DC rail on the grid).

Coupling

When the RP4030 is connected to the oscilloscope, input coupling is automatically set to DC50Ω and cannot be changed. If using the browser tip as a transmission-line probe directly connected to the oscilloscope, manually set Coupling to DC50Ω.

Bandwidth Limit

The bandwidth of the RP4030 ranges up to 4 GHz (depending on the lead attachment). If it is desired to limit bandwidth to less than the rating, make a selection from the C*n* dialog Bandwidth control.

Attenuation

When the RP4030 is connected to the oscilloscope, attenuation is automatically set to 1.2x and cannot be changed.

However, if the ÷10 or ÷20 attenuation resistors are installed in the browser tip accessory and it is connected directly to the oscilloscope (not through the RP4030) as a transmission line probe, Attenuation must be manually set to the appropriate value on the C*n* setup dialog.

Auto Zero

After 20 minutes of warm-up, or when the probe is exposed to a large shift in ambient temperature, some DC offset drift may occur. The Probe dialog incorporates an Auto Zero function to remove any DC offset drift.

To invoke Auto Zero, open the C*n* RP4030 dialog and touch Auto Zero. The probe contains an internal relay to disconnect the input from the probe amplifier while Auto Zero is performed, so the probe does not need to be disconnected from the DUT prior to invoking Auto Zero.

NOTE: If the probe is open-circuited, a slight non-zero offset value may be observed on the probe following Auto Zero. This is normal and represents the small amount of input offset current from the probe amplifier into the 50 KΩ input impedance. When the probe is connected to a DUT, this offset is not observed because the current will flow through the low DUT impedance.

Connecting to the Circuit

The RP4030 provides a high degree of flexibility in connecting to the circuit. For measuring AC fluctuation of a DC rail, you may make any of the following connections:

- Direct MCX connection using a user-installed MCX PCB mount (4 GHz bandwidth, 36 mm2 PCB mount receptacle footprint).
- Direct U.FL connection using the MCX-to-U.FL ultra-miniature coaxial cable and a user-installed U.FL PCB mount (3 GHz of bandwidth, 7.7 mm2 PCB mount receptacle footprint)
- Solder-in connection using the SMA-to-MCX extension cable and the MCX solder-in lead (4 GHz of bandwidth)
- Browser connection (350 MHz of bandwidth)

To measure the full DC rail voltage (beyond the +/-800 mV input dynamic range rating of the RP4030), use the RP4030 components to connect directly to the oscilloscope as follows:

1. Connect the SMA-to-MCX extender cable to one of the solder-in leads, MCX PCB mounts, or U.FL ultra-miniature coaxial cables described above.
2. Connect an SMA-to-BNC converter to the SMA end of the cable, then connect it to the BNC input on the oscilloscope channel.
3. Set the oscilloscope channel Coupling to DC1MΩ.

This is an easy way to utilize the same connections to the power rail for power integrity or transient rail voltage testing as for DC rail power startup/shutdown timing measurements.

Avoiding Damage

In all cases, use caution when connecting to the DUT. Low voltage DC power rails carry large amounts of current and if they are shorted to ground, the low attenuation of the probe will permit large currents to flow, potentially damaging the probe or the DUT. To prevent this:

- Inspect solder-in and PCB mount connections carefully before powering up the DUT to ensure that there is no inadvertent connection between the power rail and ground.
- Use insulating tapes or other materials around the connection points (especially when using the solder-in lead, which has an exposed cable ground).
- Tape the solder-in lead and coaxial cables to the DUT to avoid stress on the connection point and/or accidental disconnection that could lead to short circuiting of the rail voltage or other damage to the circuit.
- Use extreme caution when using the browser accessory to avoid inadvertent contact between the ground pin and the conductive browser tip and tip assembly, or from the browser ground pin to the DC rail.

Avoiding Parasitic Inductance

All ground connections provided with the RP4030 are very short (browser) or coaxial in nature. This is to ensure any parasitic inductance added to the circuit when the probe connection is made remains low. If the browser ground lead is increased in length, or if long ground leads are attached to the coaxial solder-ins, then the parasitic loop inductance of the probe will greatly increase and the signal fidelity performance will deteriorate. This is seen on the signal as a “ringing” or a slowing rise time of fast signals. Additionally, large loop areas will pick up any radiated electromagnetic field which passes through the loop and may induce noise into the probe input. Verify that no ground loop is present by connecting the ground and tip to the DUT ground, and validating that a low noise 0 Vdc signal is measured.

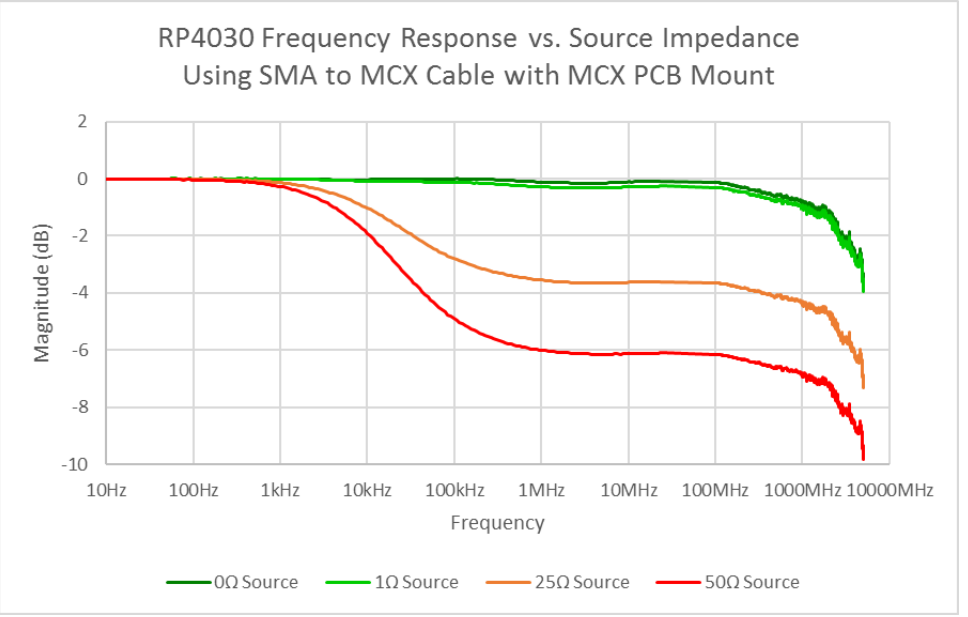
TIP: When using the browser tip, keep the browser body perpendicular to the circuit under test. This will minimize the parasitic capacitance and maintain high performance.

Connecting to High Impedance Sources

The RP4030 is intended to probe low-impedance DC voltage and power rails. The probe's input impedance is optimized to provide a flat frequency response from DC to rated bandwidth when the source impedance is very low. However, the probe input impedance declines from 50 kΩ at DC to 50 Ω at ~1 MHz. If the source impedance is high, then the decline in probe input impedance at higher frequencies will have two effects:

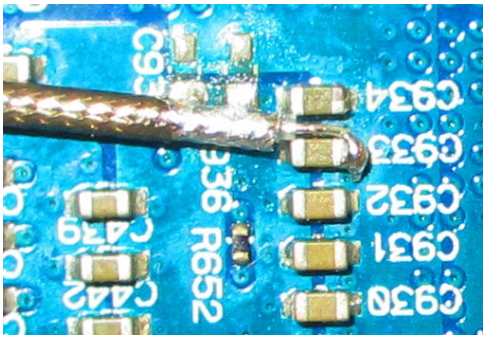
- It will reduce the bandwidth rating of the probe
- It may unacceptably load the source

The frequency response and impedance vs. frequency of the probe is described elsewhere, and those plots describe probe performance with a 0 Ω load. If the source impedance is non-zero, then the frequency response will degrade, as shown in the plot below:



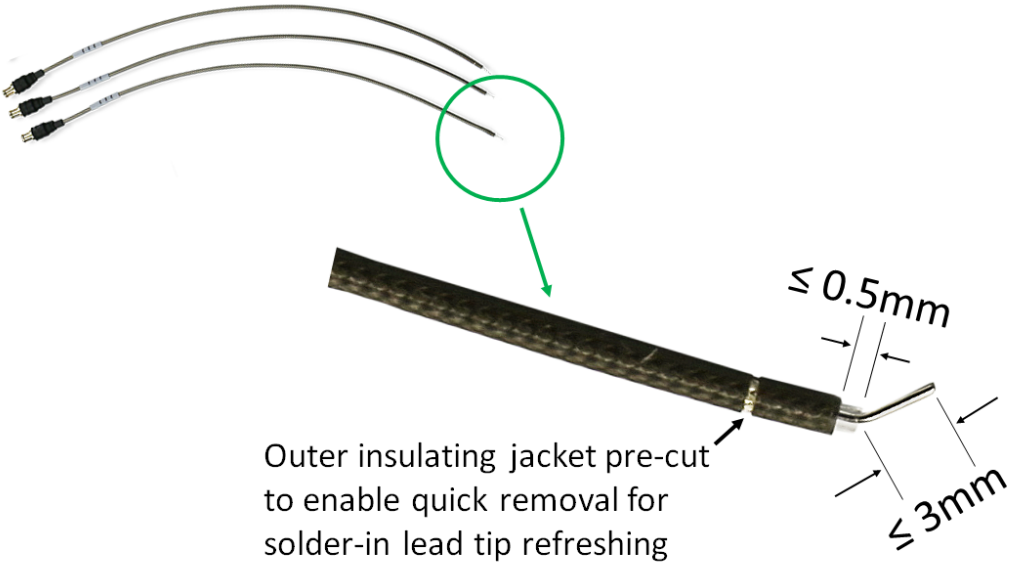
NOTE: Near-zero source impedance values (~1 Ω, light green) have little impact on probe performance, while source impedance values approaching 50 Ω have high impact on probe performance. This is to be expected based on the probe topology.

Using the Solder-in Lead



The MCX cable to solder-in connection is a great solution for probing DC rails on a crowded board. The exposed ~3 mm inner conductor connected to the DC rail and the exposed ~0.5 mm outer conductor is connected to ground, ideally with as short a ground lead as possible. The image at left shows the solder-in lead center conductor soldered to the back side of a capacitor (where the DC power rail is applied) and the outer conductor (ground) soldered to the ground pad behind it. In this example, additional outer conductor was exposed so as to make connection to ground easier.

The solder-in lead may be re-used multiple times. If, after a few solder-in connections, it is difficult to solder down the cable, trim back the coaxial cable and expose the center conductor to a short a length as practical (<3 mm will provide the rated frequency response) and expose enough of the shield to solder to ground. These trimming operations may be performed multiple times; the shorter length of the cable does not materially affect the frequency response, so this is not a concern.



Using the MCX PCB Mounts (Receptacles)

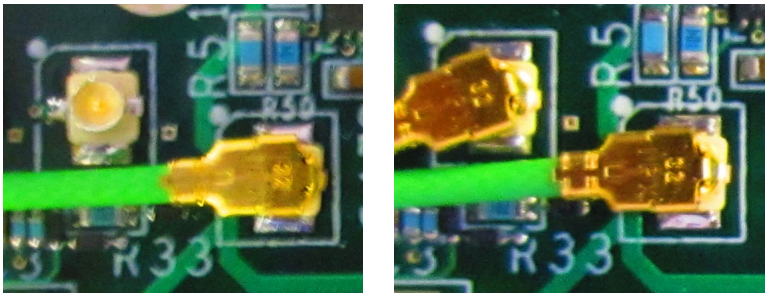
The MCX PCB mount receptacle manufacturer is TE Connectivity and the part number is 1061015-1. This part is exceptionally durable and provides the highest bandwidth connection, but it has a larger footprint than other solutions. The center pin is soldered to the signal and one or more of the four posts are soldered to ground. Avoid excessive lateral or vertical force on the receptacle once it has been installed. For more detail and full instructions, refer to the original instructions from the manufacturer.

Using the U.FL PCB Mounts (Receptacles)

The U.FL PCB mount receptacle is manufactured by Hirose (P/N U.FL-R-SMT-1, with various suffixes to indicate the quantity). For more information, refer to the manufacturer's instructions.

For manual soldering, maximum temperature is 350 °C for five minutes. More specific instructions are provided by the manufacturer for reflow soldering.

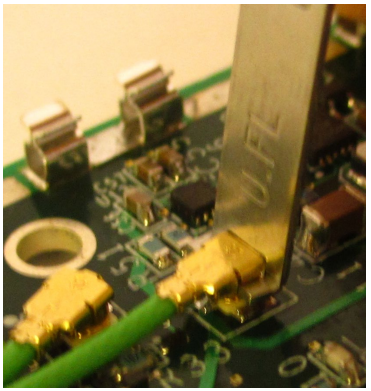
The U.FL PCB mount receptacles are used with the RP4000-MCX-CABLE-UFL cable. To mate the cable to the receptacle, ensure that the connectors are aligned (avoid any type of extreme angle) and press the cable plug into the receptacle. A "click" will confirm proper mating. The images below show two connectors, one unmated with the other mated to an MCX to U.FL coaxial cable (left) and both mated (right).



Unmated (top left) and mated (right) U.FL PCB mount receptacles.

After the connectors are mated, do not apply a load to the cable in excess of 2 Newtons in a direction parallel to the mating axis, or in excess of 4 Newtons in a direction perpendicular to the mating axis. Do not forcefully twist or deform the wires.

To unmate the connectors, insert an edge under the cable plug connector flange, and lift it off vertically in the direction of the connector mating axis.

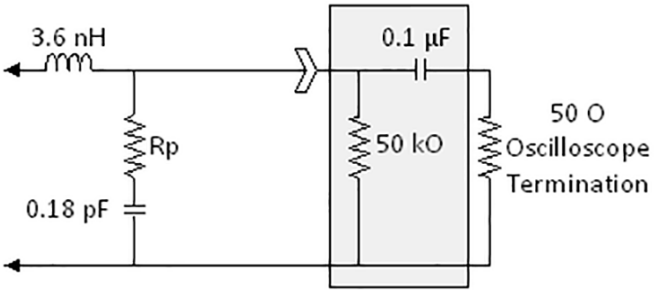


Hirose makes a tool to assist in the unmating of the plug and the receptacle (left), Hirose part number U.FL-LP-N-2, Plug Extraction Tool. This tool is widely available from distributors around the world. It fits between the U.FL plug and receptacle to "pop" the plug out of the receptacle using lever action.

Using the RP4000-BROWSER

The browser is shipped with a pass-through 0 Ω resistor installed for use with the RP4030. To maintain the high performance capability of the probe in measurement applications, care must be exercised in connecting the probe to the test circuit. Increasing the parasitic capacitance or inductance in the input paths may deteriorate the performance by introducing a "ring" or slowing the rise time of fast signals. To obtain the highest performance, keep the body of the probe perpendicular to the circuit under test. Insulate areas around the browser with tape to avoid inadvertent browser ground or DC rail voltages to other components/areas.

A simplified schematic for the RP4000-BROWSER when connected to the RP4030 probe is shown below, with the simplified RP4030 probe circuit highlighted in gray:



The value of Rp is ~50 Ω.

Using the RP4000-BROWSER as a Transmission Line Probe

The RP4000-BROWSER accessory is the same as a PP066 Transmission Line Probe, except with a "pass-through" 0 Ω resistor pre-installed at shipment to provide 1x attenuation when used with the RP4030. The only resistor that should be installed when the RP4000-BROWSER is used with the RP4030 is the 0 Ω resistor.

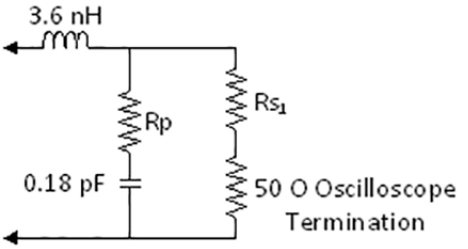
To use the RP4000-BROWSER tip as a transmission line probe, install the supplied 450 Ω (÷10) or 950 Ω (÷20) probe resistors inside the browser body in place of the 0 Ω resistor:

1. Remove the nose housing by rotating it counter clockwise and pulling it away from the probe body, taking care not to bend or twist the resistor inside the housing.
2. Pull the resistor straight out of the probe body without twisting or bending the resistor.
3. Gently insert one end of the alternate resistor into the probe body.

   NOTE: The 450 Ω (÷10) resistor is directional. Place the dotted end of the resistor towards the probe side. The 950 Ω (÷20) resistor is not directional.
4. Re-install the nose housing by carefully sliding it over the resistor and screwing it onto the probe body. Additional nose housings have been supplied to indicate the probe's attenuation: a black one for the 450 Ω resistor and a blue one for the 950 Ω resistor.
5. Select the proper Attenuation on the input Channel (C*n*) setup dialog.

   NOTE: The RP4030 will not work properly when a resistor other than 0 Ω is installed in the RP4000-BROWSER. If the resistor is changed and is not reverted to 0 Ω prior to using the browser with the RP4030, the voltages displayed on the oscilloscope will be incorrect. When the RP4000-BROWSER is operated as a conventional transmission line probe, it connects directly to the oscilloscope input, and Attenuation and Coupling must be set manually on the input Channel (C*n*) dialog.

Below is a simplified schematic for the RP4000 Browser when used as a conventional transmission line probe. Rs1 is the 450 Ω (10x operation) or 950 Ω (20x operation) accessory resistor, and Rp is ~60 Ω (10x) or 45 Ω (20x).



Performance Verification

This procedure can be used to verify the warranted characteristics of an RP4030 probe. It tests LF Attenuation Accuracy and Offset Accuracy.

The recommended calibration interval for the RP4030 is one year. Perform the complete performance verification procedure as the first step of annual calibration. The procedure can be done without removing the probe covers or exposing the user to hazardous voltages. Test results can be recorded on a photocopy of the RP4000 Test Record provided in this manual.

Required Test Equipment

The following table lists the test equipment and accessories (or their equivalents) required for performance verification of an RP4030 Power Rail probe. Because input and output connector types may vary on different equipment, additional adapters or cables may be required.

Description	Minimum Requirements	Example Equipment
Oscilloscope	ProBus interface equipped	Teledyne LeCroy HDO6000, WaveRunner 6 Zi, WaveRunner 8000
Digital Multimeter (2 required)	DC: 0.1% accuracy AC: 0.1% accuracy 5.5 digit resolution	Keysight Technologies 34401A Fluke 8842A-09
Function Generator	Sine Wave output amplitude adjustable to 14.14 Vp-p (5 Vrms) into 1 MΩ at 70 Hz	Teledyne LeCroy WaveStation 3082 Keysight Technologies 33120A Stanford Research Model DS340
BNC Coaxial Cable	Male to Male, 50 Ω, 36"	Pomona 2249-C-36 Pomona 5697-36
BNC Tee Connector	Male to Dual Female	Pomona 3285
Banana Plug Adapter	Female BNC to Dual Banana Plug	Pomona 1269
SMA(f) to BNC(m) adapter		Pomona 4289
Calibration Fixture	Probus Extender	LeCroy Probus-CF01
Precision BNC(f) to Dual Banana Plug 50 Ω Termination	50 Ω ±0.05%	LeCroy Term-CF01

NOTE: Some test equipment used may have environmental limitations required to meet the accuracy needed. Make sure that the ambient conditions meet the requirements of all the test instruments used in this procedure.

Functional Check

The functional check will verify the basic operation of the probe functions. It is recommended to perform the functional check prior to the performance verification procedure.

1. Connect the RP4030 probe to the oscilloscope C1 input.
2. Verify that the C1 RP4030 dialog tab appears behind the C1 setup dialog. This confirms the probe is sensed.
3. Open the C1 RP4030 dialog and touch Auto Zero then OK to Auto Zero the probe.
4. Confirm that the message "Performing Auto Zero on RP4030...." is displayed on the message bar and that no error messages appear.

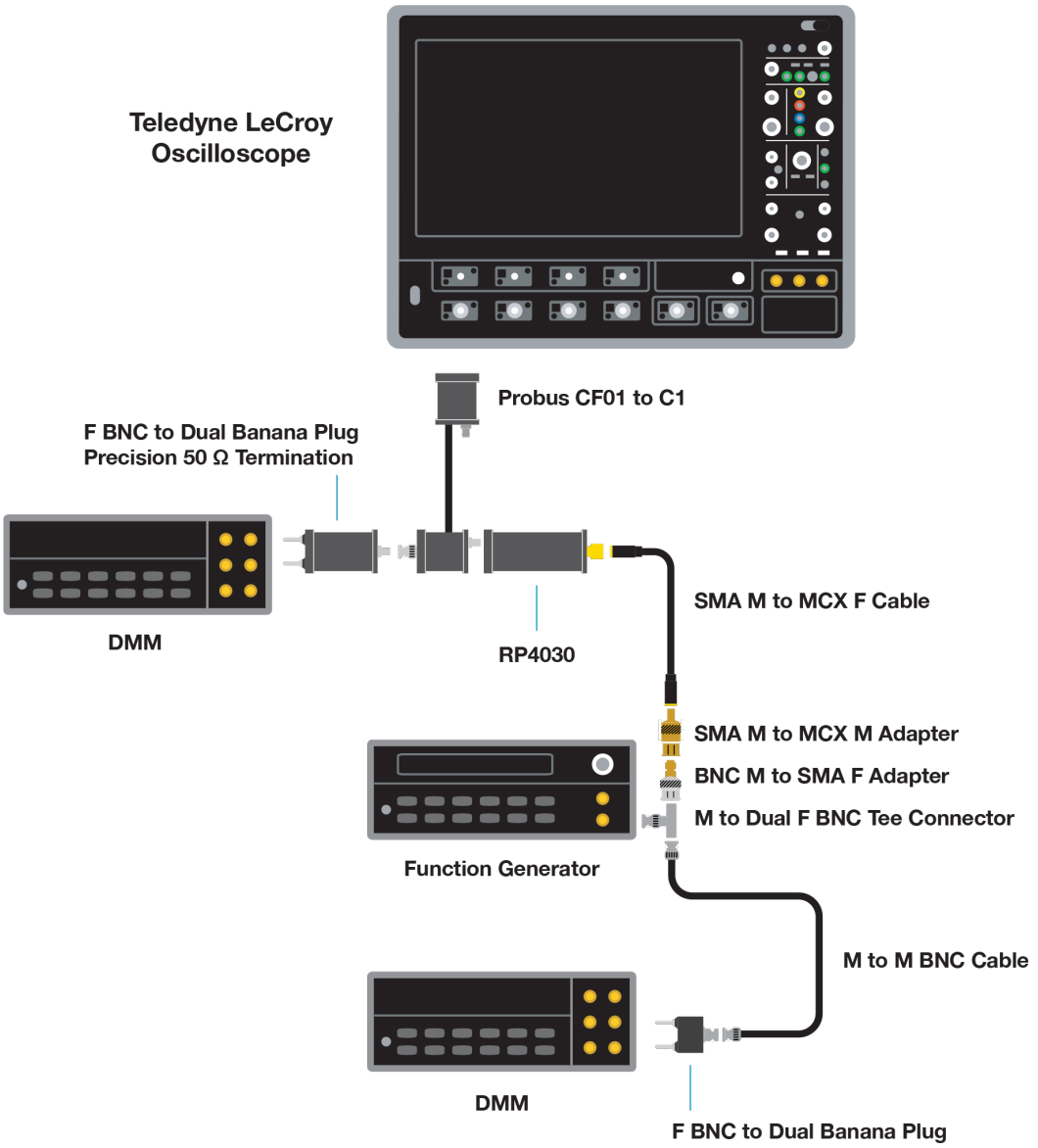
Performance Verification Test

Before You Begin

1. Set up the RP4030 and test equipment as shown in the diagram on page 26.
2. Connect the Probus-CF01 to the oscilloscope C1 input.

   NOTE: All instructions will refer to C1 as the assumed connection for the Probus-CF01.
3. Turn on the oscilloscope and allow at least 30 minutes warm-up time for the probe before performing the verification procedure.
4. Turn on the other test equipment and allow these to warm up for the time recommended by the manufacturer.
5. While the instruments are reaching operating temperature, make a photocopy of the Performance Verification Test Record, fill in the necessary data, and repeat step 2 of the “Functional Check” procedure to ensure the Probus-CF01 is working properly.

Performance Verification Test Setup



Check LF Attenuation Accuracy

1. Connect the RP4030 and test equipment as shown in the diagram on page 26.
2. Set both DMMs to measure Vac.
3. Set the function generator to output a sine wave of 50 Hz, amplitude 200 mVrms, at HiZ.
4. Record the voltage measured on the DMM in "Generator Output Voltage" on the Test Record (~200 mVAC).
5. Multiply the probe output voltage measured on the DMM by 1.2354 and record the result in “RP4030 Measured Voltage” on the Test Record.

   NOTE: Probe output voltage is shown rounded to 1.2 in the Effective Gain attribute on the oscilloscope C1 RP4030 dialog.

6. Calculate the attenuation accuracy (%) using the equation:

$$\frac{(Step\ 5\ value - Step\ 4\ value)}{Step\ 4\ value} . 100$$

7. Record the LF attenuation accuracy “Gain Error” on the test record.

Check Offset Accuracy

1. Connect the RP4030 and test equipment as shown in the diagram on page 26.
2. Set both DMMs to measure DC Volts.
3. Set the function generator to output DC Volts.
4. Open the oscilloscope C1 setup dialog (not the C1 RP4030 dialog) and set Coupling to ground (GND). Ensure that there is 0.00 mV Offset on C1.
5. Multiply the probe output voltage measured on the DMM by 1.2354 and record the result on the test record in “RP4030 Offset Voltage”.
6. On the C1 setup dialog, reset Coupling to DC.
7. Set the function generator to output +10 Vdc at HiZ.
8. Record the “Generator Output Voltage” measured on the DMM on the test record.
9. Set the C1 Offset to the negative of the generator output value measured on the DMM.
10. Multiply the probe output voltage measured on the DMM by 1.2354 and record the result on the test record in “RP4030 Measured Voltage”.

11. Calculate the offset accuracy (%) using the equation:

$$\frac{(Step\ 10\ value - Step\ 5\ value)}{Step\ 8\ value}.100$$

NOTE: Make sure all values are converted to Volts before calculating.

Record the result in Step 11 “Offset Error” on the test record.

12. Set the function generator to output -10 Vdc at HiZ.
13. Record the “Generator Output Voltage” measured on the DMM on the test record.
14. Set the C1 Offset to the negative of the generator output value measured on the DMM.
15. Multiply the probe output voltage measured on the DMM by 1.2354 and record the result on the test record in “RP4030 Measured Voltage”.
16. Calculate the offset accuracy (%) using the equation:

$$\frac{(Step\ 15\ value - Step\ 5\ value)}{Step\ 13\ value}.100$$

NOTE: Make sure all values are converted to Volts before calculating.

Record the result in Step 16 “Offset Error” on the test record.

This completes the Performance Verification of the RP4030. Complete and file the Test Record as required to support your internal calibration procedure.

Permission is granted to photocopy the following page and record the results of the performance verification procedure on the copy. File the completed record as required by applicable internal quality procedures.

Results recorded under "Test Result" are the actual specification limit check. The test limits are included in all these steps. Record other measurements and intermediate calculations that support the limit check under "Intermediate Data".

RP4030 Test Record

Serial Number: _____

Asset/Tracking Number: _____

Date: _____

Technician: _____

Equipment	Model	Serial Number	Calibration Due Date
Digital Multimeter 1			
Digital Multimeter 2			
Oscilloscope			
Function Generator			N/A*

* The function generator is used for making relative measurements. The output of the generator is measured with a DMM or oscilloscope. Thus, it is not required to calibrate the generator.

LF Attenuation Accuracy

Step	Description	Intermediate Data	Test Result
4	Generator Output Voltage	mVrms	
5	RP4030 Measured Voltage	mVrms	
6	Gain Error (< ±1.00%)		%

Offset Accuracy

Step	Description	Intermediate Data	Test Result
5	RP4030 Offset Voltage	mVdc	
8	Generator Output Voltage	Vdc	
10	RP4030 Measured Voltage	mVdc	
11	Offset Error (< ±0.10%)*		%
13	Generator Output Voltage	Vdc	
15	RP4030 Measured Voltage	mVdc	
16	Offset Error (< ±0.10%)*		%

*The actual offset error specification is **±0.1% ±3 mV**

Care and Maintenance

Cleaning

Clean the exterior of the probe and cable using only a soft cloth moistened with water or isopropyl alcohol. The use of abrasive agents, strong detergents or other solvents may damage the probe.

CAUTION: The probe case is not sealed and should never be immersed in any fluid.

Calibration Interval

The recommended calibration interval is one year. Adjustment should only be performed by qualified personnel. (A Performance Verification procedure is included in this manual.)

Service Strategy

The RP4030 probe utilizes fine pitch surface mount devices, making it impractical to repair in the field. Defective probes must be returned to a Teledyne LeCroy service facility for diagnosis and exchange. A defective probe under warranty will be replaced with a factory refurbished probe. A probe that is not under warranty can be exchanged for a factory refurbished probe. A modest fee is charged for this service.

Troubleshooting

If the probe is not operating properly the problem may be the way in which it is used. Before assuming the probe is defective, verify each of the following:

- The oscilloscope is running the required version of XStreamDSO firmware (see p.5).
- The channel to which the RP4030 is connected displays a probe dialog for the RP4030, indicating the probe is sensed.
- One of the leads/tips is connected to the MCX termination of the SMA-to-MCX extension cable and properly connected to the DUT.
- A suitable offset has been applied to the input so that the signal appears on the oscilloscope grid. On Teledyne LeCroy oscilloscopes, the input offset displayed on the oscilloscope is the amount of offset required to zero the applied voltage (e.g., a -1 V offset is required to vertically center a 1VDC rail on the oscilloscope grid).

Returning a Product for Service

Contact your local Teledyne LeCroy service center for calibration or other service. If the product cannot be serviced on location, the service center will give you a Return Material Authorization (RMA) code and instruct you where to ship the product. All products returned to the factory must have an RMA.

Return shipments must be prepaid. Teledyne LeCroy cannot accept COD or Collect shipments. We recommend air freighting. Insure the item you're returning for at least the replacement cost.

1. Remove all accessories from the probe.
2. Pack the probe in its case. If possible, include all tips. Do not include the manual.
3. Pack the case in its original shipping box, or an equivalent carton with adequate padding to avoid damage in transit.
4. Mark the outside of the box with the shipping address given to you by Teledyne LeCroy. Be sure to add the following:

   ATTN:<RMA code assigned by Teledyne LeCroy>

   FRAGILE
5. If returning a probe to a different country: contact Teledyne LeCroy Service for instructions on completing your import/export documents.

Extended warranty, calibration and upgrade plans are available for purchase. Contact your Teledyne LeCroy sales representative to purchase a service plan.

Technical Support

For a complete list of offices by country, including our sales & distribution partners, visit:
teledynelecroy.com/support/contact

Teledyne LeCroy
700 Chestnut Ridge Road
Chestnut Ridge, NY, 10977, USA

US Service and Support:
Ph: 800-553-2769 / 845-425-2000
FAX: 845-578-5985
customersupport@teledynelecroy.com

Warranty

THE WARRANTY BELOW REPLACES ALL OTHER WARRANTIES, EXPRESSED OR IMPLIED, INCLUDING BUT NOT LIMITED TO ANY IMPLIED WARRANTY OF MERCHANTABILITY, FITNESS, OR ADEQUACY FOR ANY PARTICULAR PURPOSE OR USE. TELEDYNE LECROY SHALL NOT BE LIABLE FOR ANY SPECIAL, INCIDENTAL, OR CONSEQUENTIAL DAMAGES, WHETHER IN CONTRACT OR OTHERWISE. THE CUSTOMER IS RESPONSIBLE FOR THE TRANSPORTATION AND INSURANCE CHARGES FOR THE RETURN OF PRODUCTS TO THE SERVICE FACILITY. TELEDYNE LECROY WILL RETURN ALL PRODUCTS UNDER WARRANTY WITH TRANSPORT PREPAID.

The product is warranted for normal use and operation, within specifications, for a period of one year from shipment. Teledyne LeCroy will either repair or, at our option, replace any product returned to one of our authorized service centers within this period. However, in order to do this we must first examine the product and find that it is defective due to workmanship or materials and not due to misuse, neglect, accident, or abnormal conditions or operation.

Teledyne LeCroy shall not be responsible for any defect, damage, or failure caused by any of the following: a) attempted repairs or installations by personnel other than Teledyne LeCroy representatives, or b) improper connection to incompatible equipment, or c) for any damage or malfunction caused by the use of non-Teledyne LeCroy supplies. Furthermore, Teledyne LeCroy shall not be obligated to service a product that has been modified or integrated where the modification or integration increases the task duration or difficulty of servicing the oscilloscope. Spare and replacement parts, and repairs, all have a 90-day warranty.

Products not made by Teledyne LeCroy are covered solely by the warranty of the original equipment manufacturer.

Certifications

For the full list of current certifications, see the EC Declaration of Conformity shipped with your product.

The probe is marked with this symbol to indicate that it complies with the applicable European Union requirements to Directives 2012/19/EU on Waste Electrical and Electronic Equipment (WEEE).

For more information about proper disposal and recycling of your Teledyne LeCroy product, visit teledynelecroy.com/recycle.

Unless otherwise specified, all materials and processes are compliant with RoHS Directive 2011/65/EU in its entirety, inclusive of any further amendments or modifications of said Directive.

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