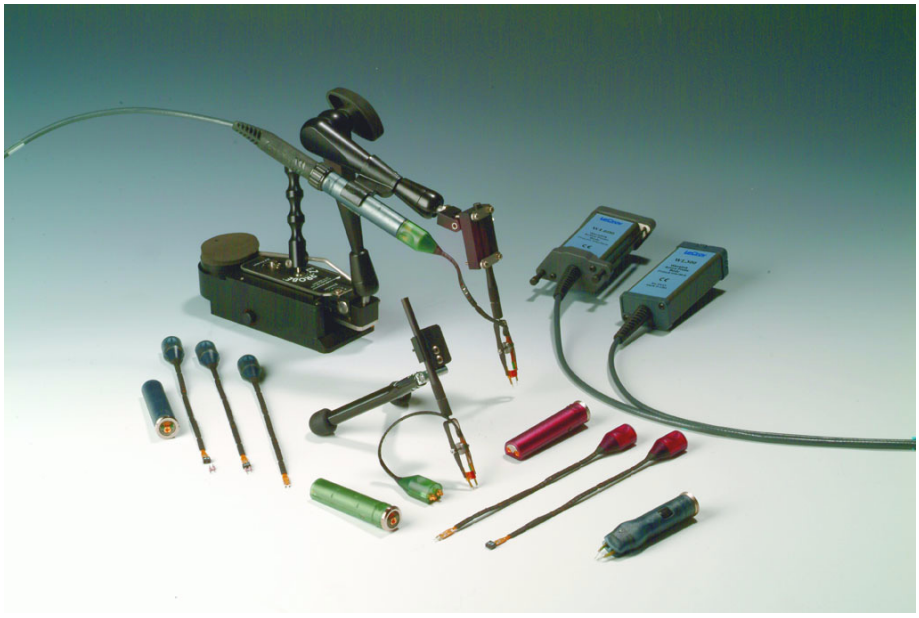


Instruction Manual

LeCroy WaveLink Series

Differential Probes

Revision D – November 2006

LeCroy Corporation
700 Chestnut Ridge Road
Chestnut Ridge, NY 10977-6499
Tel: (845) 578-6020, Fax: (845) 578-5985

Internet: www.lecroy.com

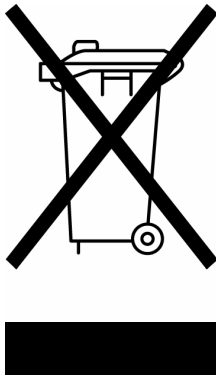
Warranty

LeCroy warrants this oscilloscope accessory for normal use and operation within specification for a period of one year from the date of shipment. Spare parts, replacement parts and repairs are warranted for 90 days.

In exercising its warranty, LeCroy, at its option, will either repair or replace any assembly returned within its warranty period to the Customer Service Department or an authorized service center. However, this will be done only if the product is determined by LeCroy's examination to be defective due to workmanship or materials, and the defect is not caused by misuse, neglect, accident, abnormal conditions of operation, or damage resulting from attempted repair or modifications by a non-authorized service facility.

The customer will be responsible for the transportation and insurance charges for the return of products to the service facility. LeCroy will return all products under warranty with transportation charges prepaid

This warranty replaces all other warranties, expressed or implied, including but not limited to any implied warranty of merchantability, fitness or adequacy for any particular purposes or use. LeCroy shall not be liable for any special, incidental, or consequential damages, whether in contract or otherwise.

Manufactured under an ISO 9000 Registered Quality Management System Visit www.lecroy.com to view the certificate.		This electronic product is subject to disposal and recycling regulations that vary by country and region. Many countries prohibit the disposal of waste electronic equipment in standard waste receptacles. For more information about proper disposal and recycling of your LeCroy product, please visit www.lecroy.com/recycle.

WL-OM-E Rev D

914672-00 Rev A

DECLARATION OF CONFORMITY

according to ISO/IEC Guide 22 and EN 45014:1998

Manufacturer's Name: LeCroy Corporation

Manufacturer's Address: 700 Chestnut Ridge Road
Chestnut Ridge, NY
10977
USA

herewith declare that

Product(s) Name: Differential Probe

Model Number(s): WL600, D600ST, D600A-AT, D500PT, D350ST, WL300, D300A-AT

including all their options are in conformity with the provisions of the following EC directive(s), including the latest amendments, and with national legislation implementing these directives:

73/23/EEC Low Voltage Directive
89/336/EEC EMC Directive

and that conformity with Council Directive 73/23/EEC is based on

EN 61010-031: 2002 — Safety requirements for electrical equipment for measurement, control, and laboratory use -
Part 031: Safety requirements for hand-held probe assemblies for electrical measurement and test

and that conformity with Council Directive 89/336/EEC is based on

EN 61326-1: 1997 +A1:1998 +A2:2001 — EMC requirements for electrical equipment for measurement control and laboratory use

Emissions	EN 55011:1998+A1:1999	Radiated Emissions
Immunity	EN 61000-4-2:1995+A2:2002	Electrostatic Discharge
	EN 61000-4-3:2002	RF Radiated Electromagnetic Field

By: David C. Graef
Vice President & Chief Technology Officer

Place: LeCroy Corporation
700 Chestnut Ridge Road
Chestnut Ridge, NY 10977
USA

Date: December 18, 2007

European Contact:
Your local LeCroy Sales Office or

LeCroy Europe GmbH
Waldhofer Str 104
D-69123 Heidelberg
Germany

Tel: (49) 6221 82700
Fax: (49) 6221 834655

Warning: This is a Class A product. In a domestic environment this product may cause radio interference, in which case the user may be required to take adequate measures.

BLANK PAGE

Table of Contents

BLANK PAGE

Safety Information

SAFETY SYMBOLS

The following symbols appear on the WaveLink Differential Probe or in this manual and alert the customer to important safety considerations.

Refer to the accompanying information or document to protect against personal injury or damage to the instrument.

The CAUTION sign indicates a potential hazard. It calls attention to a procedure, practice or condition, which, if not followed, could possibly cause damage to the equipment. If a CAUTION is indicated, do not proceed until its conditions are fully understood and met.

The WARNING sign indicates a potential hazard. It calls attention to a procedure, practice or condition which, if not followed, could possibly cause bodily injury or death. If a WARNING is indicated, do not proceed until its conditions are fully understood and met.

The ESD sign indicates a potential hazard. It calls attention to the susceptibility of the equipment to Electrostatic Discharge (ESD) induced damage if anti-static measures are not taken.

OPERATOR SAFETY

To avoid personal injury and to prevent damage to the probe or any products connected to it, review the following safety precautions. To avoid potential hazards, use the probe only as specified.

To avoid damage to the probe or personal injury, comply with the following:


CAUTION

ESD Sensitive: The probe tips of the WaveLink probe are sensitive to Electrostatic Discharge (ESD). To avoid causing damage to the probe, always follow anti-static procedures (wear wrist strap, etc.) when using or handling the probe.


CAUTION

Connect probe to the measurement instrument before connecting the probe test leads to a circuit/signal being tested.


CAUTION

Using the probe and/or the oscilloscope it is connected to in a manner other than that specified may impair their protection mechanisms.


WARNING

Do not apply a voltage to any input that exceeds the maximum rating of that input. (Section 9, Specifications).


WARNING

Handle the probe with care as it has sharp tips that may cause bodily injury if not handled properly.


WARNING

Do not use the probe in wet or explosive atmospheres.


CAUTION

Do not use the probe if any part is damaged. All maintenance should be referred to qualified service personnel.

OPERATING ENVIRONMENT

The WaveLink Differential Probe is intended for indoor use and should be operated in a clean, dry environment.

The design of the differential probe has been verified to conform to EN 61010-031 safety standard per the following limits:

- Installation (Overvoltage) Category I: Refers to signal level which is applicable for equipment measuring terminals that are connected to source circuits in which measures are taken to limit transient voltages to an appropriate low level.
- Pollution Degree 2: Refers to an operating environment where normally only dry non-conductive pollution occurs. Occasionally a temporary conductivity caused by condensation must be expected.

###

BLANK PAGE

Overview

DESCRIPTION

The WaveLink Differential Probe series is a very high bandwidth active differential probe. The probes feature low noise, very low input capacitance and high common mode rejection, and is ideally suited for signal integrity measurements in high-speed digital systems.

The dynamic range, system attenuation, and input impedance were designed to optimize performance for use with these types of signals.

The series is modular in concept, accepting several interchangeable Probe Tip Modules to allow for flexibility in physical interconnect, and optimizes bandwidth and electrical performance.

The WaveLink probe consists of
(Refer to Figures 2-1and 2-2 for visual description of available probes):

Probe Tip Modules

The Probe Tip Modules contain the active amplifier circuitry. Different modules have different electrical and physical interconnect characteristics, allowing the user to select the module appropriate for the application.

a. Small Tip Module – The differential Small Tip Module D600ST and D350ST connects to any WaveLink probe body and accepts differential Probe Tip Modules to provide the user with flexibility in connecting the probe to the circuit under test without degrading the electrical performance. Three interconnect lead assemblies, which are interchangeable between the probe bodies, are provided:

   - SI – Solder-In interconnect lead assembly provides the highest level of electrical performance. It uses two small damping resistors in the input with flexible leads, allowing connection to a wide range of test point spacings. The leads are soldered directly into the connection points of the circuit under test, providing a reliable, intermittence-free connection. The SI interconnect lead assembly provides the highest possible performance at the expense of non-movable installation.

- QC – Quick Connect interconnect lead assembly allows the probe to be moved quickly between different test points of the circuit. A pair of small damping resistors (supplied with the probe) are soldered to the circuit's test points, and the ends of the damping resistors plug into the small connector at the probe tip for a reliable quick connection. A set of 20 resistors are shipped with the probe.
  The QC interconnect lead assembly is available for the D600ST only.
- SP – Square Pin interconnect lead assembly can be used on boards where standard 0.025" square pins are used for interconnect. The highly flexible, 145 mm (5.7") long Square Pin Interconnect lead connects directly with a pair of square pins mounted on standard 0.100" (2.54 mm) centers. Because of the parasitic inductance of the square pin to which the probe is connected, the system will not support maximum bandwidth or the minimum risetime when used with a 6 GHz oscilloscope. The added inductance of the square pins limits the measurements to signals of 4 GHz bandwidth. A low cost alternative is to provide vias in the circuit to be tested, and to insert the flexible tips of the very low loading Adjustable Tip module into these vias.

b. The Positioner Mounted Module, D500PT, with the Positioner Mounted Tip, D500PT-TIP, can be used as a browser for use in a positioner such as Easy Probe positioner. Because of its thin form factor and spring-loaded tips, it is ideally suited for use with multiple probes in tight areas such as the back side of boards with ball-grid array packaged ICs.

c. Differential Adjustable Tip Modules, D600A–AT and D300A-AT, with adjustable pin spacing are suitable for probing traces and components on circuit boards. The Adjustable Tip Module connects directly to the WaveLink probe body.

Note

The D600xx and D500PT probe tip modules can be used with a WL300 probe body. However they will not deliver full system bandwidth with 5 or 6 GHz oscilloscopes.

Probe Body

The probe body contains common circuitry such as power supply, communication and control and AutoColor ID. The series consists of:

- WL600 probe body for ProLink instruments
- WL300 probe body for ProBus instruments

The WaveLink series probes utilize digital filtering to improve the system frequency response. The response is corrected through the use of digital filters, which are specifically tailored through calibration to optimize the frequency flatness of each individual probe. This, combined with the exceptional probe loading characteristics, provides the highest fidelity in eye pattern measurement.

Note

For maximum performance, X-Stream software version 4.0.0 or later is required for operation with the WaveLink probes.

The D600ST, D600A–AT and D500PT, when used with a WL600 probe body, are powered directly from a LeCroy 8000 series WaveMaster oscilloscope, Serial Data Analyzer (SDA), or Disk Drive Analyzer (DDA) through the ProLink interface.
This probe tip module will support full bandwidth at the probe tip with oscilloscopes up to 6 GHz (5 GHz for the D500PT).

All Probe Tip modules are interchangeable with probe bodies, meaning the D300A-AT and D350ST can also be operated with a WL600 probe body for use with oscilloscopes equipped with ProLink interface with reduction in overall bandwidth.

The D600xx series and D500PT can be used with the WL300 probe body for use with LeCroy WavePro 7000 & WaveRunner 6000 series oscilloscope and DDA3000.

In the configuration, the probe provides full bandwidth at the probe tip with 3 GHz oscilloscopes.

Both the ProLink and ProBus interfaces also allows for local control of the probe through the oscilloscope user interface.

This manual covers body models WL600, WL300 and all interchangeable probe tip modules.

A Certificate of Calibration is supplied with each probe indicating that the system will meet the specifications with those components listed in the Certificate.

ESD Sensitive: The probe tips of the WaveLink probe are sensitive to Electrostatic Discharge (ESD). To avoid causing damage to the probe, always follow anti-static procedures (wear wrist strap, etc.) when using or handling the probe.

ADVANTAGE OF MODULARITY

Any time wires are attached to a probe's input to make probing of the circuit under test easier to perform, additional inductance and/or capacitance is added to the input, lowering the resonance frequency of a series resonance circuit, which may cause oscillations with frequencies within the passband of the probe. These effects, or excessive ringing, will degrade the performance of the probe, resulting in incorrect presentation of the input signal, reduced bandwidth, and changes in loading impedance.

To eliminate the necessity of adding external wires or accessories, the WaveLink series differential probe has been designed as a modular system with different probe tip Modules, each with its own buffer amplifier. When using these modules, no interconnects are needed in the high-impedance path of the input signal, assuring proper transmission of the signals as it passes through the probe.

Using these Probe Tip Modules will guarantee the specified performance and input characteristics of the probe.

APPLICATIONS

The WaveLink Probe series is ideally suited for acquiring differential signals such as are found in disk drive read channels and applications with fine pitch ICs and high lead count where high speed, minimal loading, and accurate jitter measurement are required.

- System Designers:

  Design systems using standard and ASIC components
  Use simulators and correlate with lab measurements
- IC Designers:

  Characterize new chip design
- Manufacturers of servers, PC Motherboards, Data routers, Disk drives

STANDARD ACCESSORIES

D600A-AT and D300A-AT Adjustable Tip modules include:

- Ground lead and clip
- Protective storage case
- WaveLink Series Instruction Manual
- Quick Start Guide
- Calibration certificate

D600ST and D350ST Small Tip Module includes:

- Solder-In interconnect lead set with replacement resistors (10)
- Quick Connect interconnect lead set with additional damping resistors (20). (D600ST only)
- Square Pin interconnect lead set
- Ground lead and clip
- Probe tip mounting kit
- WaveLink Series Instruction Manual
- Quick Start Guide
- Calibration certificate

Continued on page 2-8

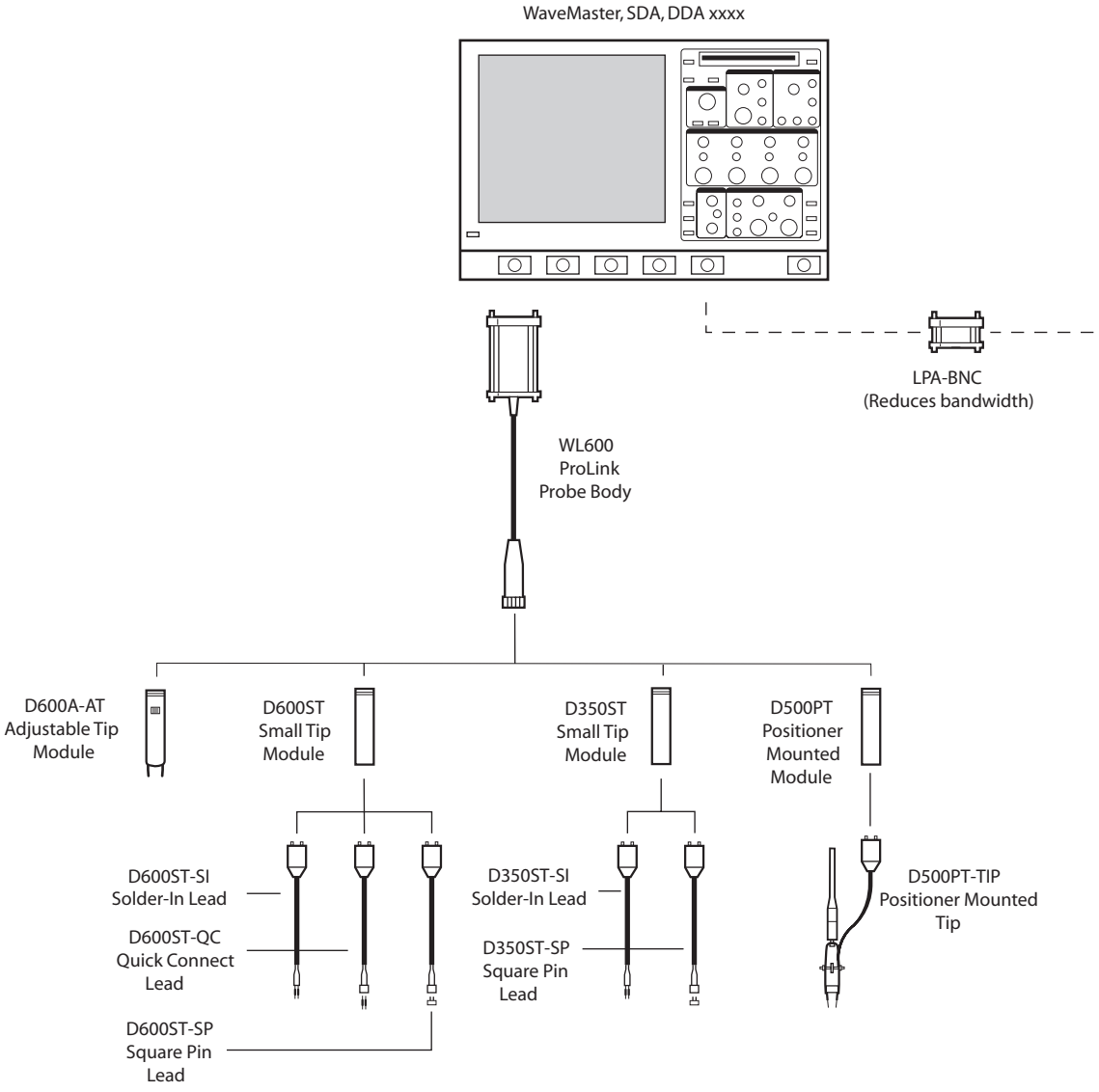


Figure 2-1. WL600 Probe Family

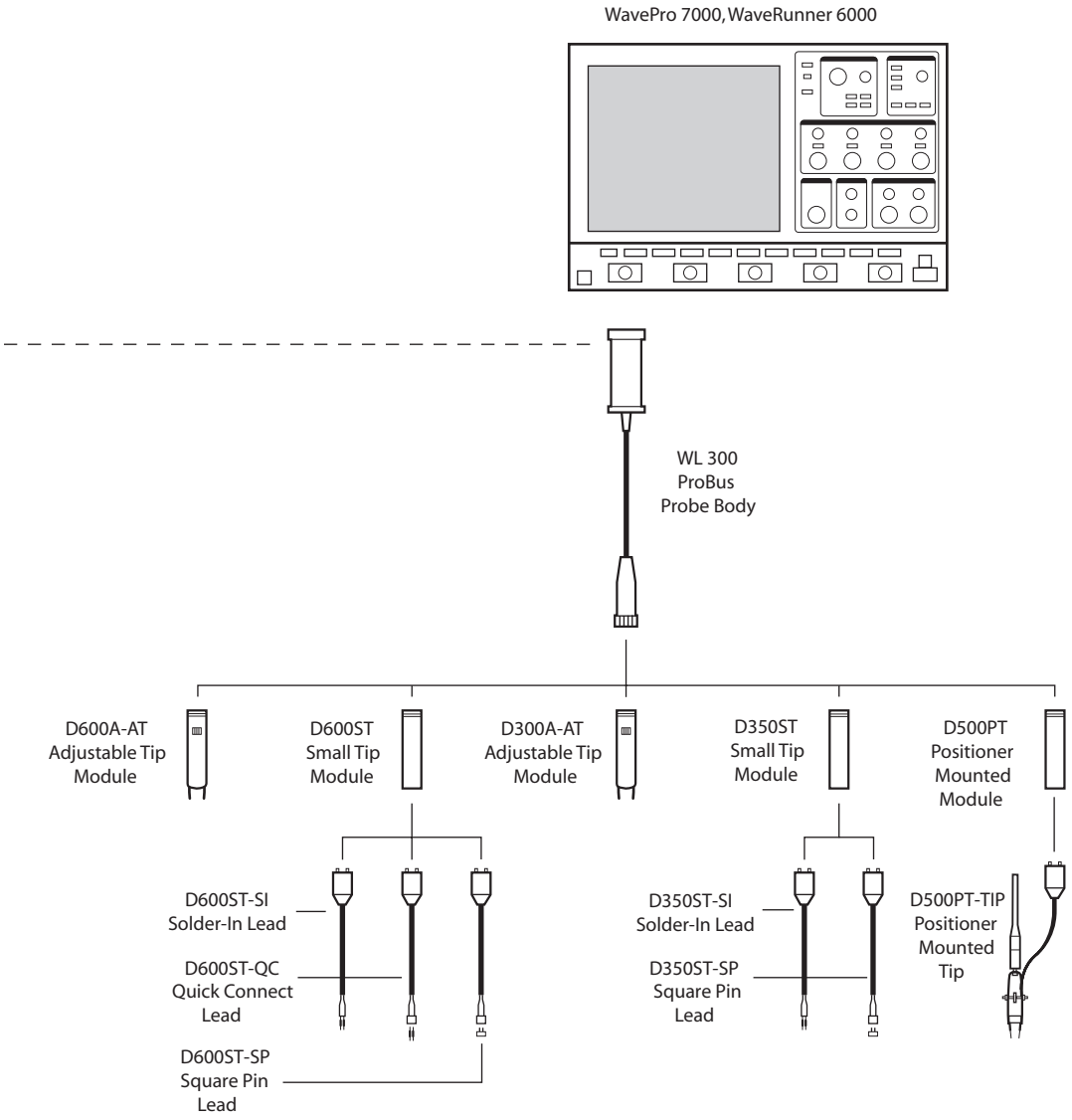


Figure 2-2. WL300 Probe family

Continued from page 2-5

D500PT Positioner Mounted Tip includes:

- Positioned tip assembly
- Probe tip module
- Module mounting clamp
- Ground lead and clip
- WaveLink Series Instruction Manual
- Quick Start Guide
- Calibration certificate
- FreeHand probe stand
- Tip repair tool
- Replacement tips (2)

WL600 and WL300 Probe Bodies include:

- Soft accessory case with WaveLink series insert
- Probe characterization fixture
- Probe body mounting clip
- Probe cable clamp (2)
- Small accessory case

D600A-AT, D300A-AT, D600ST, D500PT and D350ST tip modules, when ordered with WL600 or WL300 also substitute:

- Certificate of NIST traceable calibration in place of calibration certificate

OPTIONAL ACCESSORY

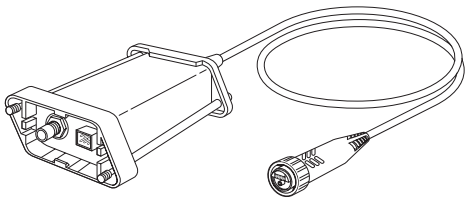
- EZ Probe positioner

###

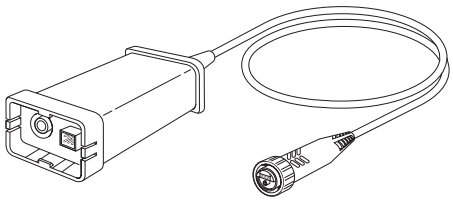
Features and Accessories

FEATURES

Probe



WL600



WL300

The small, low mass WaveLink Differential Probe series is designed for ease of use and high frequency performance, and is supplied in two different configurations:

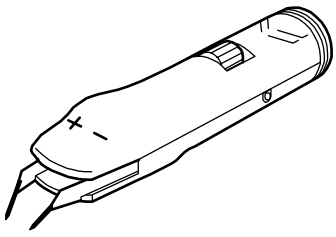
1. WL600 for use with ProLink interface

2. WL300 for use with ProBus interface

Each probe is made up of two different components:

Probe Body and Probe Tip Module (See below for a description of each component).

Adjustable Tip Module



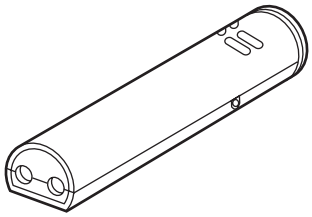
The Adjustable Tip Module, D600A-AT and D300A-AT, with two highly flexible NiTiNOL alloy tips, allow for easy probing of very dense circuitry.

By rotating the thumb wheel on top of the module you can change the spacing of the tips to accommodate any test point spacing from < 0.1 mm (0.004”) to 3 mm (0.12”).

The AT tip can be used in hand-held applications for rapid browsing of test points.

WaveLink Differential Probe

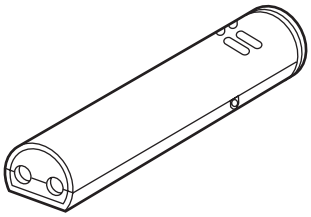
Small Tip Module



The Small Tip Module, D600ST and D350ST, extend the measuring capabilities of the AT Module which have physical interconnect constraints not addressable with the AT Module.

The ST Module allows three types of new interconnect leads (Solder-In, Quick Connect, and Square Pin) to connect to circuit elements not previously accessible.

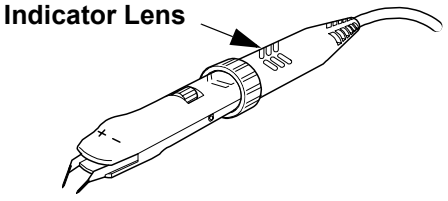
Positioner Mounted Module



The Positioner Mounted Module, D500PT, will accept the D500PT-TIP, designed specially to facilitate browsing in areas where many test points are located in a small area.

The module is calibrated to be used with the D500PT-TIP tip only.

AutoColor ID and Power Control Indicators



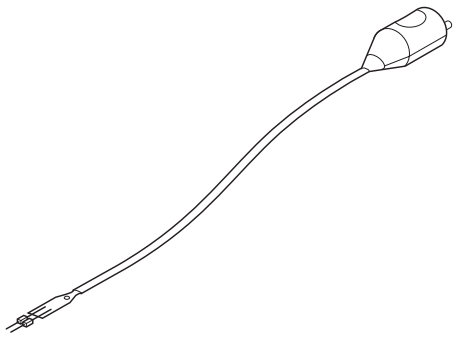
AutoColor ID LED, located in the probe body, illuminates in the default color of the channel to which the probe is connected.

It also is used for warnings.

The WaveLink series probe is provided with several standard and optional accessories to make probing and connecting to different test points easier than ever.

STANDARD ACCESSORIES

Solder-In Interconnect Lead



The Solder-In Interconnect Leads (D600ST-SI and D350ST-SI) are supplied with two pre-installed damping resistors. The user solders the free end of the damping resistors directly to the pads or runs on in the circuit under test.

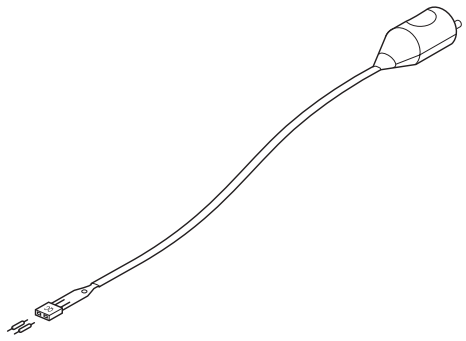
Because the resistors and lead lengths are small, this type of Interconnect Lead will give the maximum signal fidelity at the highest frequencies.

10 Replacement damping resistors are supplied with the Interconnect Lead.

The D600ST-SI and the D350ST-SI are of different designs and not interchangeable.

Refer to section 5, Care and Maintenance, for replacing of the damping resistors.

Quick Connect Interconnect Lead

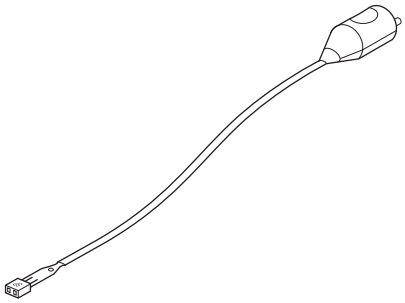


The Quick Connect Interconnect Lead (D600ST-QC) is ideally suited for applications where the probe needs to be moved frequently between different test points.

The user solders somewhat larger damping resistors to the points in the circuit that need to be probed. The free end of the damping resistors plug into a special connector mounted directly on the probe input board.

20 Solder-In resistors are supplied with the Quick Connect Interconnect Lead.

Square Pin Interconnect Lead



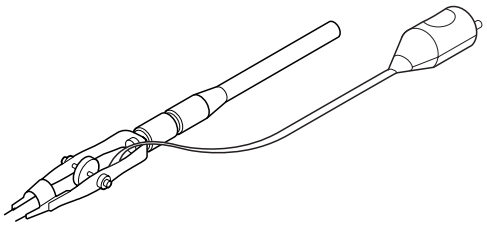
The Square Pin Interconnect Leads (D600ST-SP and D350ST-SP) allow the probe to connect directly to the standard 0.025” square pins mounted on 0.100” centers.

The system bandwidth and rise time are limited when a Square Pin interconnect lead is used, due to the inherent inductance of the square pins themselves.

The practical BW limit is approximately 4 GHz.

The D600ST-SP and the D350ST-SP are of different designs and not interchangeable.

Positioner Mounted Tip



The Positioner Mounted Tip (D500PT-TIP), with its adjustable tip spacing and spring loaded tips, is ideally suited for browsing many test points in small areas, i.e., connecting multiple PM Tips to the back side of boards with ball grid arrays.

Because of the telescoping tips, the probe can be angled while still making good contact with the test points.

The adjustable tip section is ball mounted in the holder for easy adjustment

Note

All Interconnect leads are colored to distinguish between D600ST (Grey), D500PT (Green) and D350ST (Red).

The interconnect Leads for the D500PT, D600ST, and the D350SI will mechanically mate with any module, but are not compatible. No damage will result, but performance may be reduced and the response will be uncalibrated when switching tips between modules.

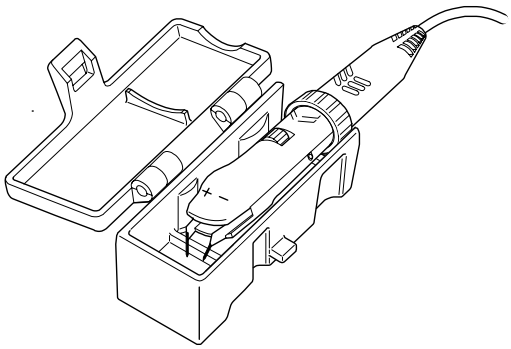
Note

Do not confuse the Square Pin lead with the Quick Connect lead. The Quick Connect tip has been designed to accept only the wire diameter of the small damping resistors, not the 0.025' thickness of the square pin.

Inserting square pins into the connector of the Quick Connect Lead could cause damage to the wire receptacle of the QC Lead.

To avoid confusion, the receptacles are printed with 'QC' or 'SP' for identification.

Protective Cover

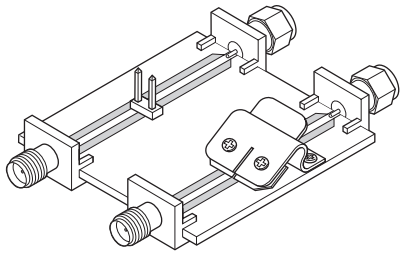


The protective cover is supplied as a standard accessory to prevent damage to the Adjustable Tip module. The flexible NiTiNOL-alloy tips of the module are very durable, but can be damaged when enough stress is applied resulting in erroneous measurements.

The Protective Cover is supplied as a standard accessory to the D600AT series probes.

To prevent damage to the tips, always attach the cover to the module when the module is not being used.

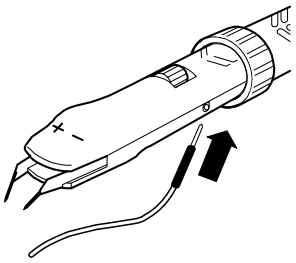
Characterization Fixture



The Characterization Fixture (PCF200) will allow you to determine the effect of input loading of the probe on the circuit under test, and the probe response to the signal being measured, using the AT module, ST module with SI, or QC or SP Interconnect Leads

The Characterization Fixture is supplied as a standard accessory to the WaveLink series probes.

Ground Lead and Clip



This Ground Lead (PACC-LD005) and the Ground Clip (PK006-4) can be used to connect the probe to ground of the circuit under test. The plug of the ground lead connects to the receptacle located on the side of the probe body.

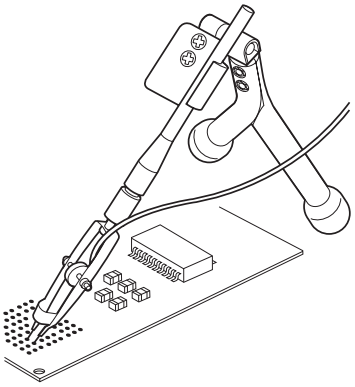
The Ground Lead and Clip is supplied as a standard accessory to the WaveLink series probes.

The ground lead is not intended to be used with high-frequency measurements, but to ground floating test circuits to keep the common mode within the maximum specified range.

RELATED PRODUCTS AND REPLACEMENT COMPONENTS

Positioning Aids and Retaining Devices

FreeHand Probe Holder

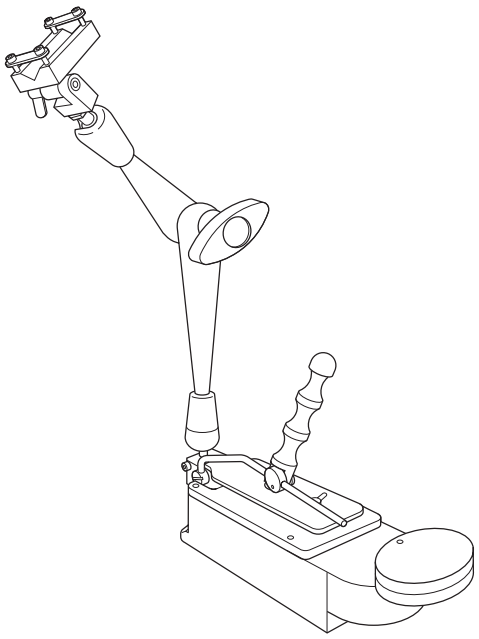


The FreeHand Probe Holder (PACC-MS001) is a quick, stable, easy-to-set-up probe positioner, allowing the user to concentrate on the measurement without having to hold the probe.

The FreeHand probe holder is designed to keep most of the weight on the probe tip to prevent loss of contact with the circuit under test.

The FreeHand probe holder is supplied as a standard accessory with the D500PT Probe Tip Module.

EZ Probe Positioner



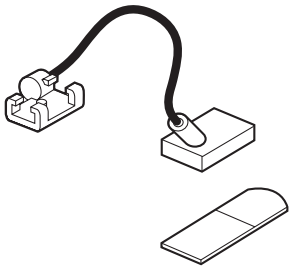
The EZ Probe Positioner provides stable, accurate positioning in the X-Y-Z axes. The unique 3:1 motion reduction joystick allows simple, precise positioning of the attached probe in both the horizontal and vertical measuring plane. The probe has a fully articulating arm, providing 30 cm (12 inch) reach in virtually any direction.

The XYZ joystick has separate friction controls that allow you to move in the X-Y plane or the Z-axis independently, and is especially useful for use with the PT module.

The EZ-Probe Positioner comes with a vacuum mounted base to keep the probe in place in any test environment. However, the solid base is heavy enough so that the Positioner can be used without vacuum.

The EZ Probe Positioner is available as an optional accessory

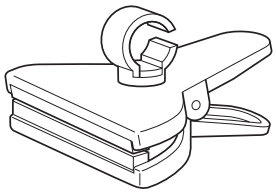
Tip Retaining Clip



The Tip Retaining Clip (PK600ST-3) is an aid to allow the SI and QC Interconnect Leads to be held in place while making measurements or when soldering the damping resistors to the test points of the board under test.

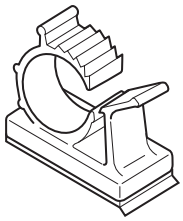
The Clip is supplied as a standard accessory with the D600ST and D350ST and comes with a package of 20 adhesive pads for mounting the clip to the board.

Probe Body Clamp Set



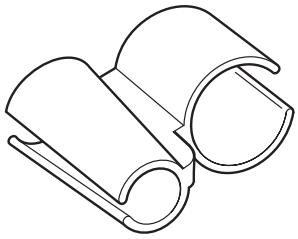
The Probe Body Clamp Set (PK600ST-4) can be used to give support to the probe and Interconnect Lead when the test points are located close to the edge of the board under test.

The PK600ST-4 includes one Board Edge Clip and four Adhesive Backed Probe Body Clamps.



The Adhesive Backed Probe Body Clamp can be used to give support to the probe body and Interconnect Lead anywhere on the board under test.

Module Mounting Clamp



The Probe Module Clip should be used to attach the D500PT to the arm of the EZ Probe Positioner.

See Figure 4-15 and 4-16 for attachment instructions.

###

Operation

HANDLING THE PROBE

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


CAUTION

ESD Sensitive: The probe tips of the WaveLink probe are sensitive to Electrostatic Discharge (ESD). To avoid causing damage to the probe, always follow anti-static procedures (wear wrist strap, etc.) when using or handling the probe.

CAUTION


CAUTION

To prevent damage to the flexible tips, always attach the Protective Cover to the Adjustable Tip module when not in use.

CONNECTING A MODULE TO THE PROBE BODY

To attach an Adjustable Tip, Small Tip or Positioner Tip Module to the probe body, align the connectors of the module with the receptacles in the probe body and press the two together. Finger tighten the assembly by rotating the threaded collar onto the module.

Do not use pliers to tighten collar. Figure 4-1.

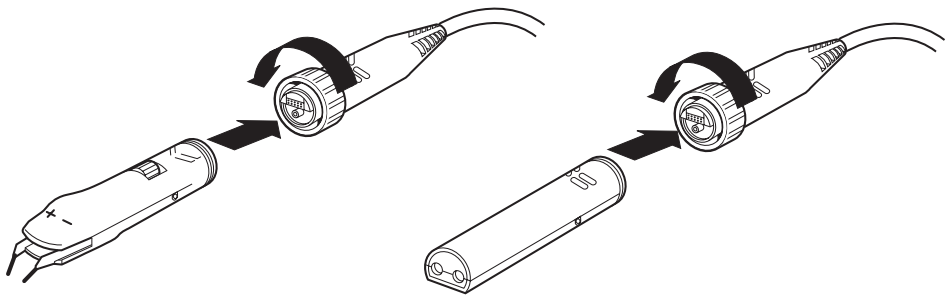


Figure 4-1. Attaching Adjustable Tip or Small Tip Module

To remove the Probe Tip Module, loosen the threaded collar from the module and pull the two assemblies apart.

By design, the PT, AT, and ST modules can be interchanged with any Probe Body; and any Interconnect Lead will fit into the ST module.

CONNECTING THE SI, QC, SP, OR TIP TO MODULE

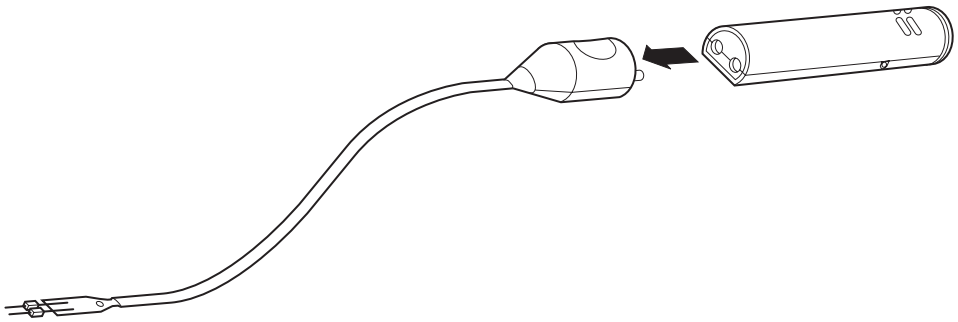


Figure 4-2. Attaching an Interconnect Lead

Align the flat side of the Interconnect Lead Module with the flat side of the Small Tip Module and press together. Figure 4-2.

Note

The interconnect Leads for the D600ST, D500PT, and the D350SI will mechanically mate with any module, but are not compatible. No damage will result, but performance may be reduced when switching tips between modules, and the response will be uncalibrated.

To prevent accidental interchanging, the interconnect lead connector housing is color coded to match the corresponding probe tip module.

INTERCHANGEABILITY AND CALIBRATION

By design, the D600A-AT, D300A-AT, D660ST, D500PT, and D350ST Amplifier Modules and Interconnect Leads will deliver

the specified performance when interchanged on a WL300 or WL600 probe body.

Each configured probe is shipped with a Certificate of Calibration indicating that the system performance was validated and found to meet or exceed the warranted specifications with those models and accessories listed in the Certificate.

As only this configuration was validated, the certificate is only valid for the configuration indicated.

Note

For maximum performance, X-Stream software version 4.0.0 or later is required for operation with the WL600 or WL300 probe.

COMPATIBILITY

Several probe tip modules and probe bodies are available; however, not all of them may be compatible with one another.

Over time, LeCroy may offer additional modules that will mechanically mate with the probe body. However, not all modules will be electrically compatible with all probe bodies. Connecting a non-compatible module to a probe body will not damage either the probe body or the module. This incompatibility, however, will be detected by the probe body, and a warning will be issued by the AutoColor ID LED.

Table 4-1 shows the compatibility of Probe Body vs. Probe Tip Module.

Table 4-1. Probe Body – Probe Tip Compatibility

Probe Body	Probe Tip Module	
	D300A-AT D350ST	D600A-AT, D600ST D500PT
WL300	Allowed	Reduced BW
WL600	Allowed	Allowed

Note

The D350ST can be used with the WL600 to get a 5.0 V input.

CONNECTING THE PROBE TO A LECROY OSCILLOSCOPE

The WL600 probe has been designed for use with the ProLink interface of the LeCroy's WaveMaster, SDA, and DDA 5000 oscilloscopes; and the WL300 for use with the ProBus interface of the WavePro, WaveRunner, and DDA 3000 oscilloscopes.

To attach the probe to the test instrument, align the interface connector with the input connector and push the interface toward the instrument.

On the WL600 probe body, a click will be heard when the probe's interface latches to the test instrument. This probe also uses thumbscrews to secure the interface to the instrument. **Do not overtighten the thumbscrews.**

Thumbscrews are not provided on the ProBus interface system.

To remove the WL600 probe from the instrument, unscrew the thumbscrews, move the interface up and down while pulling gently till a click is heard indicating that the probe is unlatched from the instrument.

For the WL300 probe, just pull the interface box from the oscilloscope.

AUTOCOLOR ID

The AutoColor ID LED, built into the Probe Body, is designed to indicate three functions of the probe or probe/oscilloscope combinations:

1. **AutoColor ID**

   When the probe is connected to a LeCroy X-Stream oscilloscope, the LED will illuminate in the default color of the channel to which the probe is connected.

2. **Probe Body Compatibility**

   - When the probe tip module is compatible with the probe body to which it is connected, the green LED will be illuminated for about one second after the probe is connected to the oscilloscope.

- A solid red light will indicate that the probe is not compatible with the probe body to which it is connected.

3. **Over-Temperature**

   A flashing red light indicates over-temperature of the probe. Power to the probe will be shut down automatically when the light is flashing. The LED is OFF when probe power is OFF, unless the shut-down is caused by over-temperature.

AUTOZERO

The WaveLink probes incorporate an AutoZero function to remove any DC offset from the probe. This function is available when the probe is used with LeCroy's X-Stream oscilloscopes, and must be invoked by the user.

After several minutes of warm-up, or when the probe is exposed to a large shift in ambient temperature, some DC offset may occur, and an AutoZero cycle should be initiated.

To start an AutoZero cycle, remove the probe from the circuit under test and touch the on-screen **AutoZero** button to remove output offset drift.

POWER CONTROL

Power Control allows intermittent operation of the probe during testing at elevated ambient temperatures to prevent overheating of the probe; as, for example, testing the operation of test circuits in temperature chambers.

The intent of this feature is to keep the probe tip power OFF during the time the chamber temperature is changing between tests. When the chamber temperature has stabilized and measurements are ready to be taken, the probe is powered ON to facilitate measurements. The probe is then powered down while the chamber temperature is changing for the next test.

The time the probe can be operated at these elevated temperatures is a function of airflow, thermal conductivity of the probe in that environment, etc. For a starting estimate on time vs. temperature refer to table 4-2.

Note

The D600ST, D500PT, and D350ST will operate from +40 °C to +85 °C and will not shut down.

However, no probe should be operated with power ON for

more than 2 hours at any temperature that exceeds the value given in the environmental specifications.

When the probe operates at an elevated ambient temperature, the wave shape will be correct, but because it is outside the specified temperature range the amplitude may be uncalibrated.

Table 4-2. Approximate Operating Time versus Temperature for the D300A-AT and D600A-AT

Temperature °C	Time
Up to 40	Continuous
40 to 55	40 minutes
55 to 65	18 minutes
65 to 75	30 seconds
75 to 85	15 seconds

Power Control is not supported on older non-X-Stream oscilloscopes.

When used with a LeCroy X-Stream oscilloscope, and over-temperature does occur, the probe will automatically turn off the power applied to the probe and the AutoColor ID in the probe body will flash in red. In addition a warning message will appear on the oscilloscope's screen. When cooled down, the user must reset the power to the probe again.

OPERATION WITH A LECROY OSCILLOSCOPE

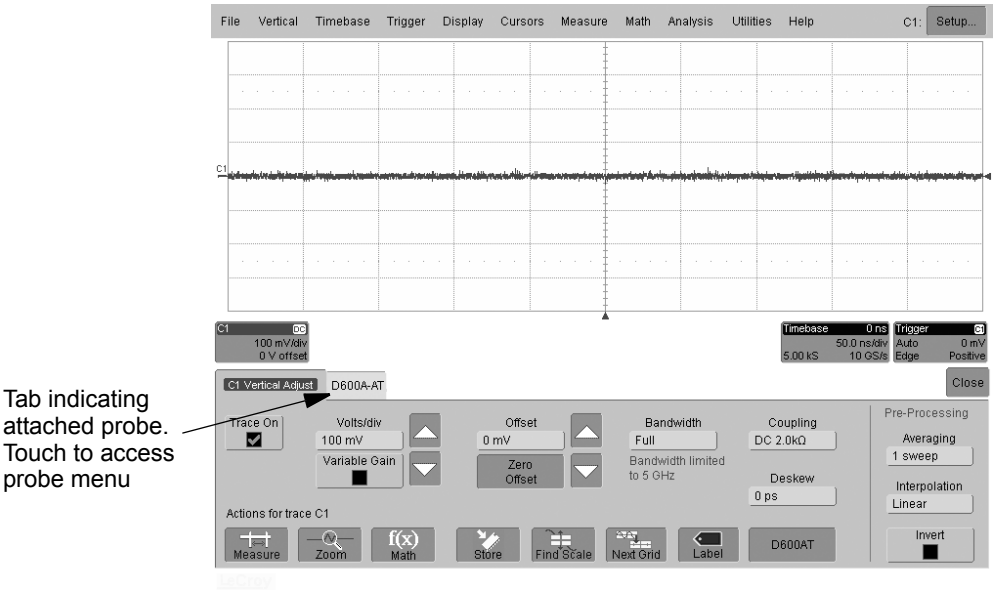


Figure 4-3. Vertical Menu

When the probe's output connector is attached to an X-Stream oscilloscope's input connector, the oscilloscope will recognize the probe and activate the vertical channel functions in the user interface. Figure 4-3. Refer to your oscilloscope's instruction manual for oscilloscope operation.

Control through the oscilloscope's interface can be found in the screen menu of the channel to which the probe is connected.

Touching the tab indicating the attached probe (in this case D600ST) will activate the probe menu screen. Figure 4-4.

The probe information frame shows the characteristics of the probe only.

Touching the **Power On** checkbox will turn the probe power ON or OFF.

In some applications it may be desirable to turn the probe's Auto-Color ID OFF or ON by touching the **LED On** checkbox.

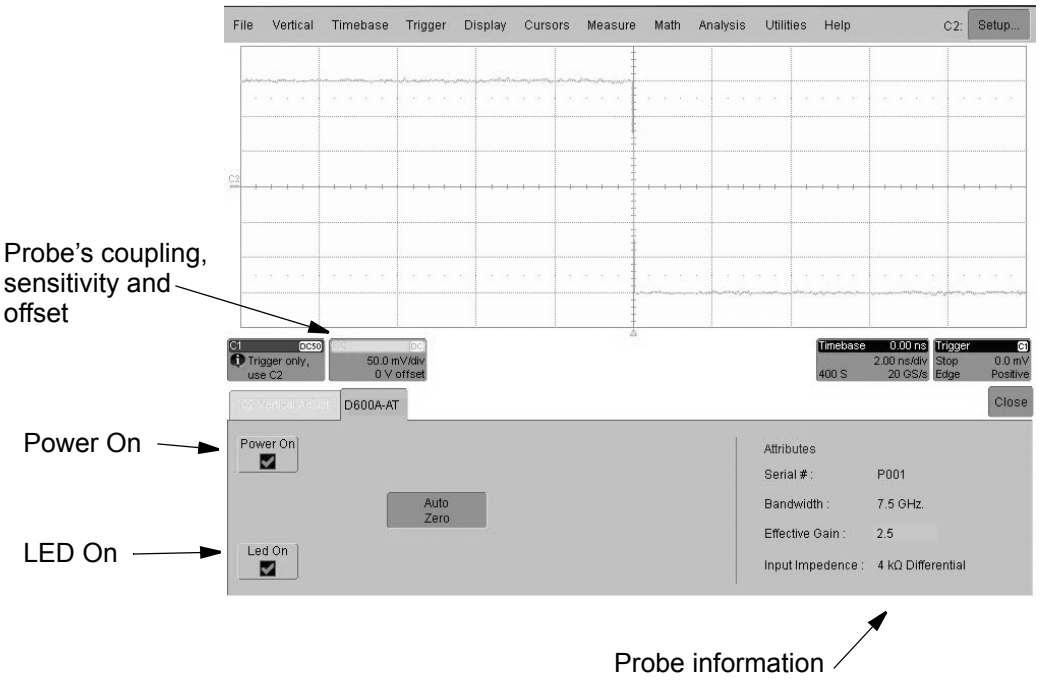


Figure 4-4. Probe menu

CONNECTING THE PROBE TO THE TEST CIRCUIT

For all modules and interconnect leads, positive voltages applied to the + input relative to the – input will deflect the oscilloscope trace towards the top of the screen.

To maintain the high frequency 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 path may introduce a ring, or slow the rise time of fast rising signals. Any extension of the signal path with extra wire leads, etc. will adversely affect the performance of the probe.

Generally a ground connection is not required. Refer to section on Probe Grounding later in this chapter.

Adjustable Tip Module

The WL600 and WL300 probes with their small profile, low mass head and the D600A-AT or D300A-AT Adjustable Tip Module are ideally suited for hand-held browsing applications in dense circuitry.

The highly flexible tips of the Adjustable Tip Module are made out of nickel-titanium alloy and are permanently attached to the module.

The spacing of the tips can be adjusted by rotating the knurled thumbscrew on the top of the module to accommodate different test point spacing from less than 0.1 mm to > 3 mm (Figure 4-5).

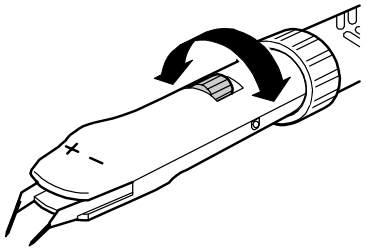


Figure 4-5. Adjusting the Tips

For accurate measurements, both the + and – inputs must always be connected to the test circuit.

Note

When making differential measurements, both tips need to make good contact. The best way to accomplish this is to place one tip on one test point, apply a little pressure and by rotating the probe body slightly, place the other tip on the other test point. To assure good contact keep applying some pressure to allow the tips to bend a little.

Excessive bending of these tips may damage the module beyond repair. However, the tips are flexible enough to allow both tips to make good contact with the circuit under test even when the probe is slightly rotated with respect to the circuit under test.

As indicated on the module, the left tip, looking from the top of the module, is connected to the – input and the right pin is connected to the + input of the differential probe.

Note

Always support the probe to prevent putting too much stress on the pins of the Adjustable Pin Module.

Positioner Mounted Tip

The Positioner Mounted Tip, with its small form factor and low mass, is specifically designed to be used in areas with a high concentration of test points; for example, testing ball grid arrays on the back side of an etched circuit board.

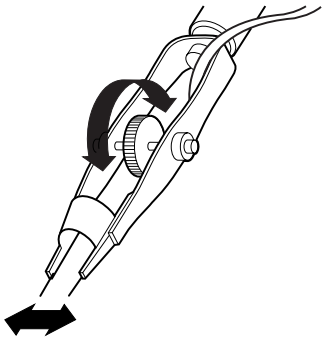


Figure 4-6. Adjusting the spacing of the TIP

To accommodate different test point distances, the spacing of the tips can be adjusted from 0.5 mm to 4 mm by rotating the knurled knob of the assembly (Figure 4-6).

In addition, the tip assembly is ball mounted to the holder for increased flexibility in mounting the probe tips.
To adjust the tip assembly without moving the whole probe assembly, loosen the nut, move the tip assembly to the desired location, and tighten the nut (Figure 4-7).

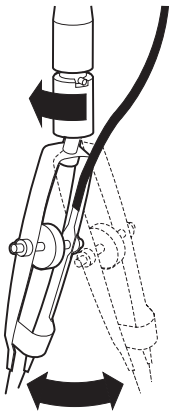


Figure 4-7. Ball Mounted Probe Tip

To give a certain amount of Z-axis compliance, the tips of the assembly are spring mounted. This will aid in applications where additional tips are required to make measurements and the tips need to be mounted at an angle to the board under test.

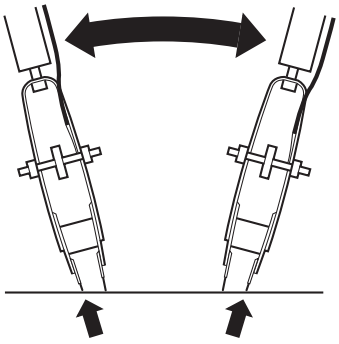


Figure 4-8. Z-axis compliance

Because of its small size, more than one positioner-mounted tip can be used in tight areas for testing several test points at the same time. The tips are easily positioned on the test points through the use of an EZ positioner, its ball joint mounting of the probe tips, and the adjustable spacing of the probe tips (Figures 4-6, 4-7, 4-8, and 4-9).

Note

As in all testing with a differential probe, to obtain accurate measurements, both the + and – inputs must be connected to the test points. On all interconnect leads and tips the positive input is marked with a '+' sign.

Note

To obtain maximum response, compress the PT tips between half and full amount. The probe performs well with less compression, except for optimum flatness in the transient response.

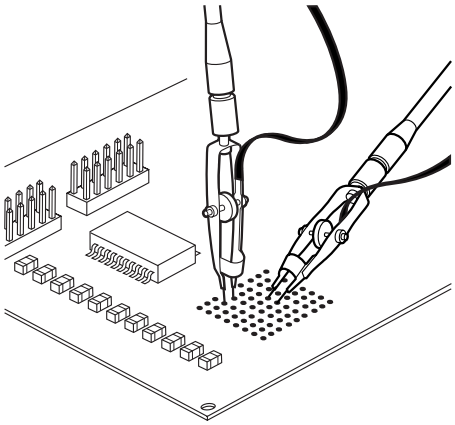


Figure 4-9. Measuring with Dual Positioner Mounted Tip

The Positioner Mounted Tip is designed to be used with the EZ Positioner for ease of measurement and to prevent excessive stress on the test points.

Solder-In Lead

The Solder-In Lead for the ST module is supplied with two pre-installed resistors, which are intended to be soldered to the runs or pad test points on the board under test. Because the resistors and the leads are small, this interconnect lead provides the maximum signal fidelity at the highest frequency response (Figure 4-10).

Using a small soldering iron, attach the free wires of the resistors to the appropriate test points.

Note

The primary function of the Probe Tip Retaining Clip is to position the resistor leads when soldering the resistors to the test points.

Caution

CAUTION

Because resistors are small to maintain high-frequency performance, they are not sturdy enough to support the weight of the probe module. The module should be supported by other means

A positioning tool, such as the Board Clip, the Probe Tip Retaining Clip, or EZ Probe positioner can be used to support the probe.

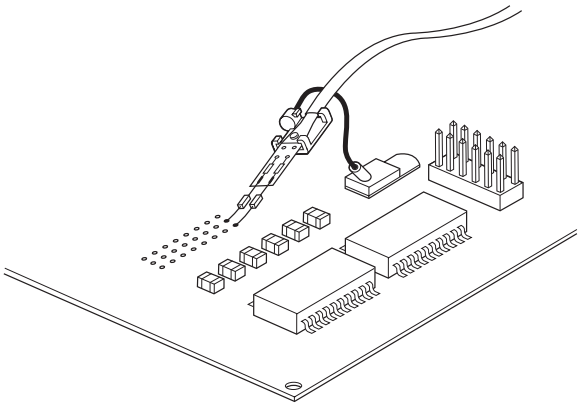


Figure 4-10. Measuring with SI Interconnect Lead

Quick Connect Lead
(D600ST only)

The Quick Connect lead can be used in applications where the user has to move the probe between multiple test points.

The user solders one end of the supplied damping resistors to the points to be tested, while the other end plugs directly into the special connector mounted on the probe input board.

To accurately position the resistors for soldering, first insert the resistor leads into the QC receptacle, then position the tip and solder the resistors in place. Repeat this process to install resistors in other test points.

A positioning tool like the Probe Tip Retaining Clip can be used to aid in holding the QC module and the resistor in place for soldering.

Note

To maintain maximum performance, do not extend the resistor wires or use different resistors.

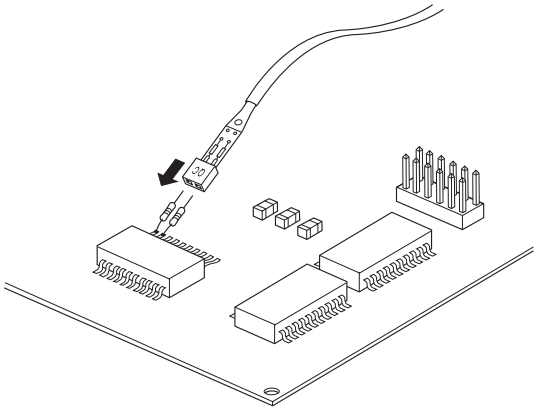


Figure 4-11. Measuring with the QC Interconnect Lead

Caution

CAUTION

Inserting square pins or other wires besides the wire of the supplied QC damping resistors into the connector of the Quick Connect Lead could cause damage to the wire receptacle of the QC Lead.

Square Pin Lead

The Square Pin lead allows the probe to be connected directly to standard 0.025” square pins mounted on 0.100” centers (Figures 4-12, 4-13 and 4-14).

The system bandwidth and rise time are limited by the Square Pin lead because of the inherent inductance of the square pins themselves. The practical bandwidth is approximately 4 GHz.

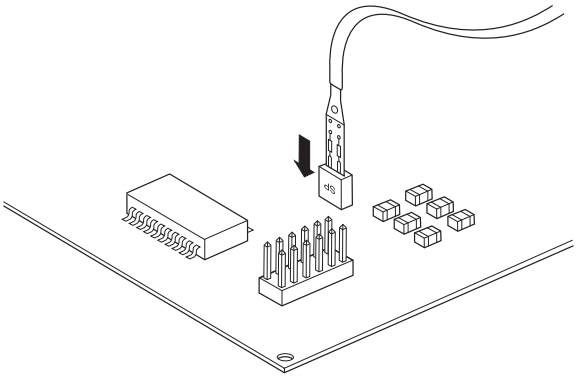


Figure 4-12. Measuring with the SP Interconnect Lead

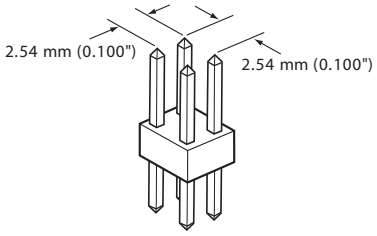


Figure 4-13. Square Pin Header Dimensions

To keep the highest possible performance by keeping the parasitic inductance under control and to make good electrical connection, do not use any square pins longer than 2.79 mm (0.110”) or shorter than 2.54 mm (0.100”). See Figure 4-12.

A square pin that meets these dimensional requirements is available from Samtec (www.samtec.com) in the TLW-1xx-06 series.

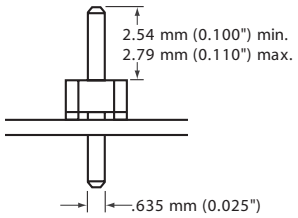


Figure 4-14. Square Pin length

CAUTION

CAUTION

Do not confuse the Square Pin lead with the Quick Connect lead. The Quick Connect tip has been designed to accept only the wire diameter of the small damping resistors, not the 0.025" thickness of the square pin.

Inserting square pins into the connector of the Quick Connect Lead could cause damage to the wire receptacle of the QC Lead.

To help identify the module, the initials SP are printed on the Square Pin receptacle housing.

POSITIONING OF THE INPUT LEADS

Normally the performance of the Solder In and Quick Connect modules is not affected by the position of the modules. They can be mounted straight up or under an angle. However when it is necessary to mount the module parallel to the board, the maximum performance is obtained when the '+' sign, printed near the positive input of the module, is facing up and the ground plane on the opposite side of the module's input is facing the board. The flexible cable connecting the input tip to the module is insensitive to placement.

POSITIONING TOOLS

To support the probe and module and to reduce the risk of damaging runs or pads on the board, always use a positioning tool as a probe support.

EZ Probe Positioner

The EZ Positioner will provide stable, accurate positioning in the X-Y-Z axes. It is ideally suited for use with the D500TP-TIP, D600A-AT, and D300A-AT browsing tips. The vacuum-mount base keeps the EZ Positioner in place in any test environment. The solid brass base is heavy enough that it can be used without vacuum. The 3:1 motion reduction joystick pivots in the X-Y direction and moves up and down for Z-axis positioning

D500PT

To connect the probe to the EZ Positioner, slide the large opening of the tapered section of the Module Mouting Clamp on the narrow section of the positioner's arm, and slide the clamp towards the positioner while pushing down on the clamp (Figures 4-15).

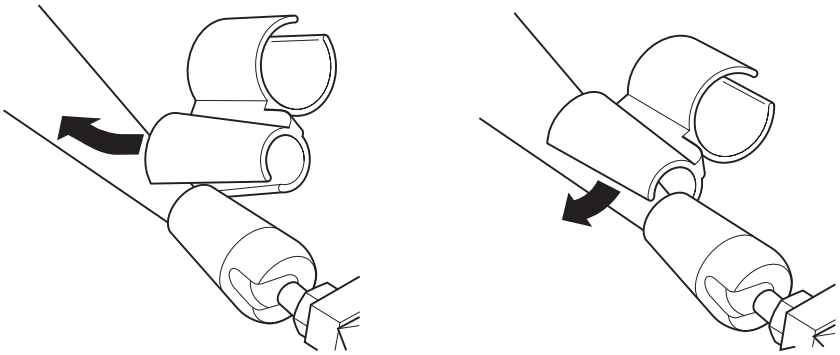


Figure 4-15. Attaching the Clamp to the EZ Positioner

Slide the probe cable through the slot on the other section of the clamp and slide the probe into the clamp until it hits the locking nut (Figure 4-16).

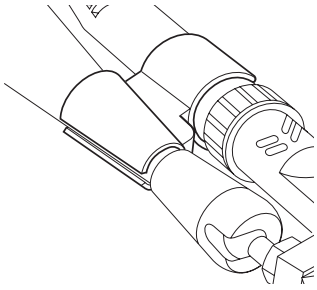


Figure 4-16. Module Mounting Clamp

Loosen the screws of the V-shaped probe holder, slide the shaft of the probe tip module into the positioner's probe holder, and tighten the screws (Figure 4-17).

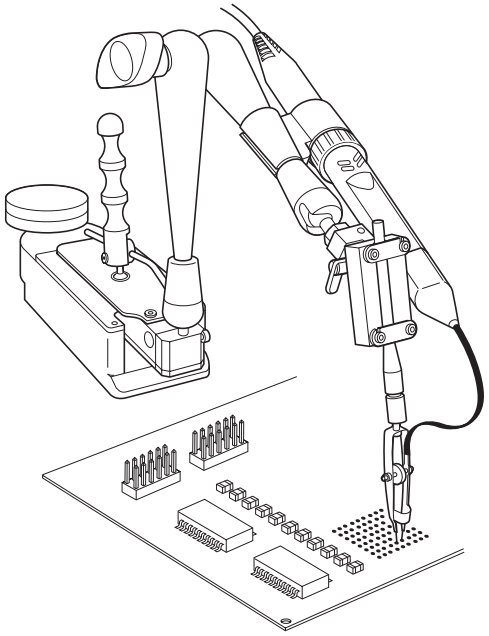


Figure 4-17. PT Probe mounting to EZ Positioner

The connection to the test points will be greatly simplified through the use of the joystick, ball joint of the positioner, the ball joint of the probe, and the spring mounted probe tips.

Optional Accessory Clamp

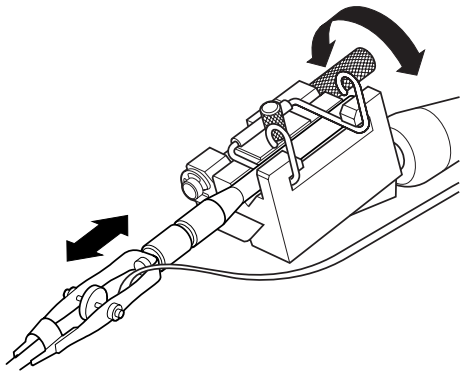


Figure 4-18. Optional Accessory Clamp with Z-axis adjustment

The optional accessory clamp will replace the probe clamp provided with the EZ positioner and will allow easy Z-axis adjustment of the probe. The Z-axis can be adjusted by rotating the knurled knob located on top of the clamp (Figure 4-18).

Dx00A-AT

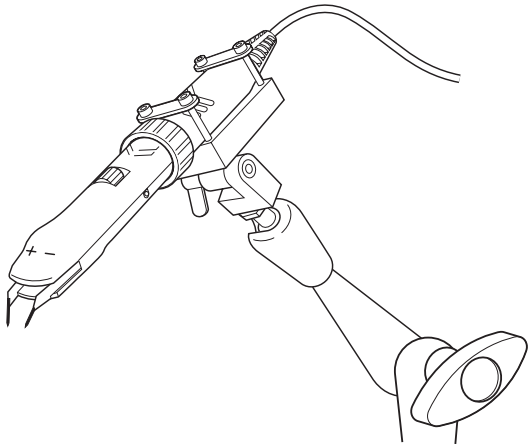


Figure 4-19. AT Probe mounted to EZ Positioner

To attach the probe, remove the screws holding the top plate to the V-shaped probe holder. Rest the probe body, not the AT or ST module, in the V-shaped groove, and fasten the top plate to the holder, using the removed screws (Figure 4-19).

Do not over-tighten the screws.

Once the probe has been attached, loosen the knob on the EZ Positioner arm and position the probe close to the test point. Tighten the knob and use the joystick to fine position the probe.

Tip Retaining Clip

The Probe Tip Retaining Clip has been designed to give support to the probe when soldering the resistors of the Solder-In module to test points.

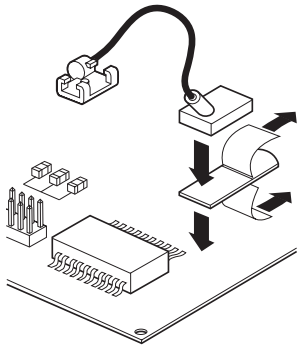


Figure 4-20. Connecting the SI Module Using the Tip Retaining Clip

To fasten the clip to the board, remove the small piece of protection paper from one side of the adhesive pad and mount the pad to the underside of the clip. If necessary clean the section of the board where the clip will be mounted with alcohol to remove any grease or flux residue.

Remove the protective paper from the other side of the adhesive pad and mount the clip to the desired location on the board. Apply pressure to the clip for at least several seconds to assure proper adhesion (Figure 4-20).

The adhesive pad with the tab will still be visible and stays attached to the adhesive pad. The tab will be used to remove the clip from the board.

Note

Maximum strength of the adhesive pad is obtained after about 30 minutes.

If you have to bend the arms to move the probe adapter part of the clip for positioning or attaching the probe before the adhesive has cured properly, always apply pressure to the pad to prevent the pad from shifting. Figure 4-21.

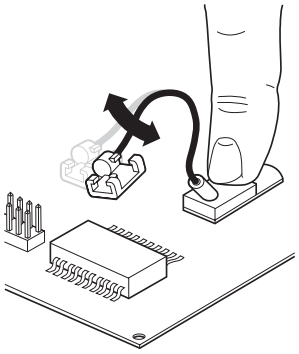


Figure 4-21. Applying pressure when adjusting the probe holder

Attaching the Probe

To attach the probe, position the cable of the module on top of the clip and slide the input board of the module into the grooves. While moving the probe into position for measurement, apply pressure to the mounting pad to prevent the adhesive pad from moving and losing its adhesion. Figure 4-22.

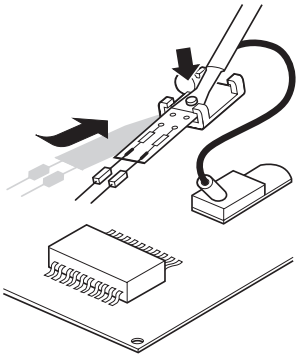


Figure 4-22. Attaching the Probe

Tip Retaining Clip Removal

To remove the Retaining Clip from the board, pull on the tab of the adhesive pad. The clip can now be removed easily without leaving any adhesive residue and can be used in another application using a new adhesive pad (Figure 4-23).

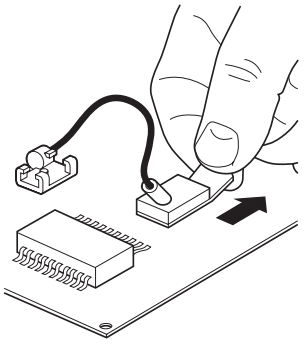


Figure 4-23. Removing the Retaining Clip

Probe Body Location Clip

The Probe Body Location Clip can be used to give support to the probe and Interconnect Lead when the test points are located close to the edge of the board under test. Slide the probe cable into the clamp opening and move the probe so that the probe's strain relief is located in the opening. Close the clamp (Figures 4-24 and 4-25).

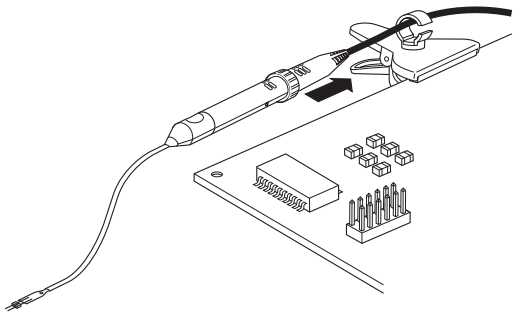


Figure 4-24. Slide Probe into Board Clip

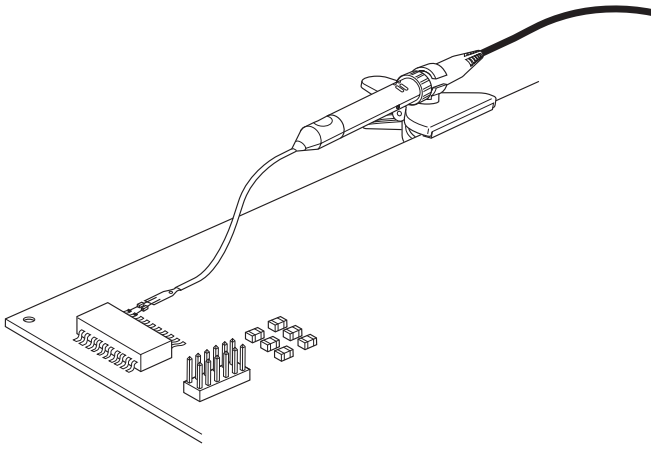


Figure 4-25. Probe Body Location Clip

PROBE GROUNDING

In most cases, when the common mode portion of the signal consists mainly of lower frequencies, the probe does not need to be connected to ground of the circuit under test. This will minimize the effects of ground loop currents. Any signal corruption caused by not having the probe connected to ground of the signal under test will be common to both inputs and will be rejected by the differential operation of the probe.

However, in an environment with high RF ambient noise, it may be better to connect the probe ground lead to a good RF ground near the point where the signal is being measured. To find out if a ground lead is necessary, make a measurement with and without a ground lead and use the one that gives the least signal corruption.

Capacitive coupling from AC mains may cause truly floating devices, like battery operated devices, to exceed the common mode range. In such cases it is recommended to connect the probe ground to the device under test.

Caution

Always use a ground lead when testing floating circuits.

Floating circuitry may exceed the common mode input voltage causing damage to the probe.

Example: Circuits powered from laboratory bench power supplies which normally have floating outputs.

OFFSET

Offset for the WaveLink Series probe is provided by LeCroy's X-Stream based oscilloscopes. This allows you to remove a DC bias voltage from the input signal while maintaining DC coupling. To prevent displaying a clipped waveform from overdriving the probe, the available offset changes as a function of the V/Div setting of the oscilloscope.

The following equation determines the available offset as a function of oscilloscope sensitivity:

$$MaximumOffset = \pm|V - 4x\ V/div|$$

where

V is the maximum range of the probe, and

V/div is the selected scale factor

V= 2.4 for the D600A-AT, D500PT, D600ST or D300A-AT

V= 5 for the D350ST

As can be seen the maximum offset for the probe with either the D600A-AT or D300A-AT is 2.4 V, while the minimum offset is 0 Volt at a scale factor of 0.6 V/div. (0.6 V/div is the minimum sensitivity available when using the D600A-AT or D300A-AT adjustable tip.

When the WaveLink series probe is used with a LeCroy WaveMaster oscilloscope equipped with ProLink interface, or with a WavePro oscilloscope with ProBus interface, the probe offset is controlled with the channel **OFFSET** knob.

Sometimes it may be desirable to display a waveform as a reference signal where a large displayed amplitude may not be necessary.; i.e., as in a timing reference when amplitude details are not needed. In such a case the oscilloscope's zoom function can be used to reduce the displayed height of the reference signal. (Refer to your oscilloscope's on-line Help for operation of the zoom function.)

PROBE CHARACTERIZING

For any measurement, it is important to know how the input impedance of the probe affects the signal to be measured and how well the output signal of the probe represents the input signal.

With their transmission line topology, the WaveLink probes provide relatively high impedance over the entire frequency range.

It may be desirable to accurately characterize the probe loading when correlating oscilloscope measurements to simulation results.

This test can be performed using the Characterization Fixture, shown in Figure 4-26. This fixture has two 50 Ω microstrip transmission lines, one for testing the SP lead and one for testing the SI and QC lead. The AT module can be tested with either microstrip.

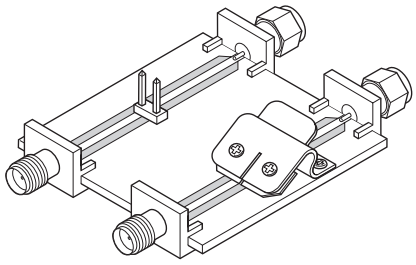


Figure 4-26. Characterization Fixture

In addition a LeCroy X-Stream oscilloscope and a signal source, such as a sine wave generator or a pulse generator with fast step output signal, will be needed. Using this fixture, you can measure this signal with and without the probe attached to detect any change in shape or timing due to probe loading.

To perform the test, connect one end of the Characterization fixture (via a 50 Ω SMA cable) to the fast rising (50 Ω) output of a pulse generator and the output end of the fixture to an input of the oscilloscope. Verify that the input impedance of the oscilloscope channel is set to 50 Ω.

The output of the probe is connected to another 50 Ω input, and the probe's input pins are adjusted to make contact with the run and ground plane of the 50 Ω Characterization Fixture.

Figures 4-27 through 4-30 show the correct way of connecting the modules to the characterization fixture.

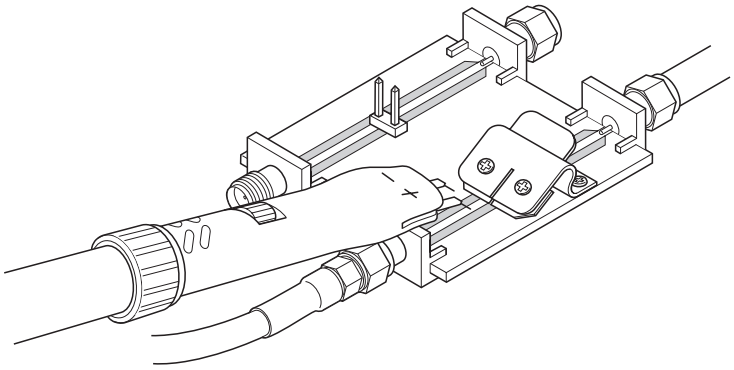


Figure 4-27. Measuring Response using the AT module

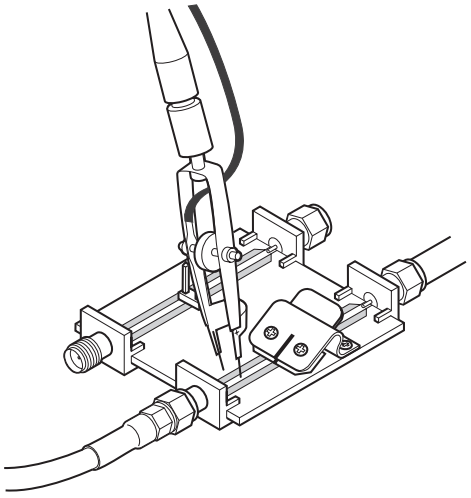


Figure 4-28. Characterization Fixture with PT module

To use the SI Interconnect Lead with Characterization Fixture, press on the black plastic tab to open the clamp. Place the resistor leads under the clamp, assuring that the '+' lead is under the section making contact with the center microstrip and that the '–' lead is under the other section making contact with the ground plane. Release the clamp so that the clamp will hold the wires securely in place (Figure 4-29).

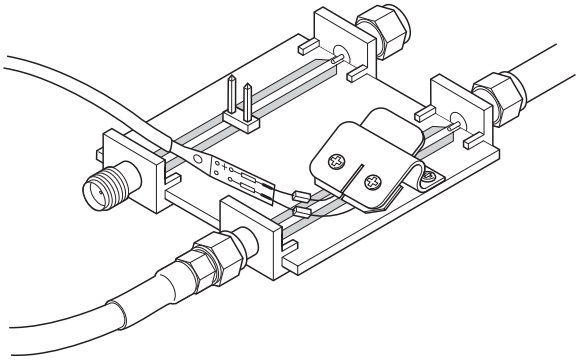


Figure 4-29. Characterization Fixture with SI Lead

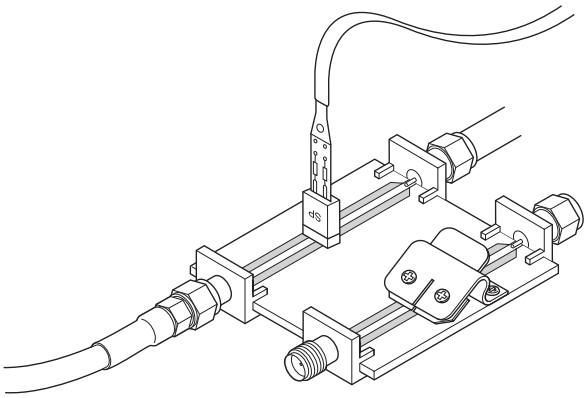


Figure 4-30. Characterization Fixture with SP Lead

Note

It is important to verify that the positive input of the modules is connected to the positive signal on the center microstrip. All modules show the positive input with a '+' sign.

To determine the effect of delay due to loading, you must trigger the oscilloscope on an independent signal so that the trigger point will not shift when the probe is connected to the 50 Ω strip line.

First, to obtain a reference, display and store the waveform of the pulse through the fixture without the probe touching the microstrip or ground plane around the strip.

Next, touch the + input of the probe tip to the center trace, and the – input to ground on either side of the microstrip. The output of the fixture represents the loading effect that the probe has on a signal in a 50 Ω transmission line environment.

Finally, to view the signal passing through the probe, turn ON the channel to which the probe's output is connected. (It may be necessary to deskew to remove the propagation delay of the probe).

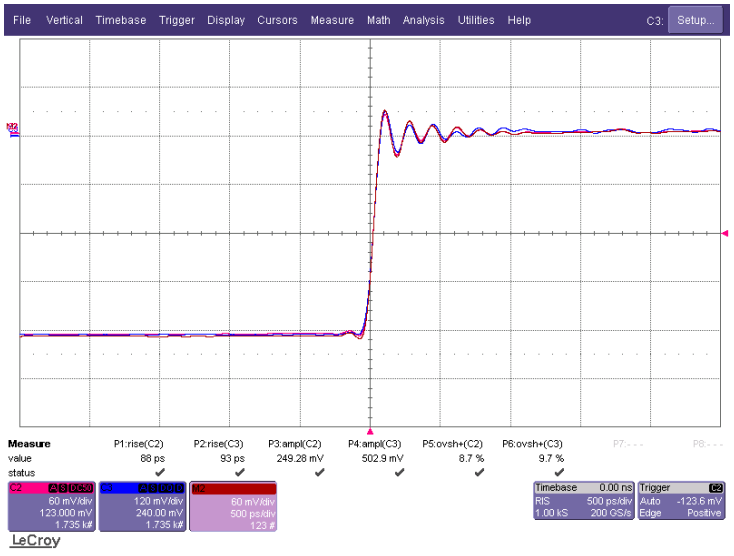


Figure 4-31. Responses of probe input loading and probe output

Figure 4-31 shows the output of the Characterization Fixture with and without probe loading, and the probe output response, using a 35 ps, –0.25 to 0 V pulse.

As can be seen on the top part of the traces, the probe loading effect on the input signal is negligible. The small voltage difference between the responses prior to the fast rise step is due to the resistive loading of the probe.

DYNAMIC RANGE

The WaveLink probe has no gain or attenuation control. The system attenuation is fixed at ÷2.5 when using either an AT, PT, or D600ST module; or ÷5 for the D350ST.

The WaveLink series probes are always DC coupled (no AC coupling is provided). Thus, care must be exercised to avoid exceeding the common mode range. Because the common mode signal is rejected by the probe and is not displayed, changes in the amplitude of the common mode component are not apparent to the user. Exceeding the common mode range may introduce distortion to the probe's output signal.

The maximum range for the Differential Mode with either an AT, PT, or ST module is ± 2.4 V.

The Common Mode range for the D600ST, D500PT, and Dx00A-AT is ± 2.4 Volt.

The Common Mode and Differential Mode for the D350ST is ±5 V.

###

BLANK PAGE

Care and Maintenance

USER SERVICES

Replacing Damping resistors

A set of 10 replacement damping resistors have been supplied with the Solder-In Interconnect Lead to replace any damaged ones.

Note

Do not confuse the replacement damping resistors for the SI module with the resistors supplied with the Quick Connect lead. The replacement damping resistors are smaller than the Quick Connect resistors.

Resistors used in the D600ST have different values from those used in the D350ST.

Because of the small mass of the SI Lead input board, be sure to support the unit using the Probe Tip Retaining Clip when removing the old resistors and adding the new ones. Refer to section 4, “Operation,” for information about using the Retaining Clip.

With an appropriate soldering iron for these low mass resistors, remove the damaged resistor from the SI input board. Since the length of each wire is identical, align the wire of one end of the new resistor with the end of the pad on the input board and solder in place.

To assure highest performance (by providing the correct parasitic inductance of the wire), be sure to use the supplied damping resistors, and that the end of the resistor lead coincides with the end of the pad (Figure 5-1).

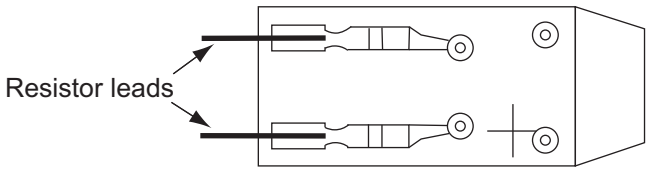


Figure 5-1. Placement of Resistor Leads

Replacing Spring Loaded Tips

If the spring-loaded tip fails to perform properly, the tips can be replaced. A special Spring Holder Tool is provided to hold the spring-loaded tip during the replacement process.

Caution

CAUTION

To prevent damaging the flex circuit, always use a small, low-temperature soldering iron when replacing the spring-loaded tips.

To replace a tip, position the movable tip of the spring-loaded tip in the hole of the Spring Holder Tool (Figure 5-2). Mount the Positioner Mounted Tip in a clamp to prevent applying too much strain on the flex circuit. Apply heat and remove the spring-loaded tip.

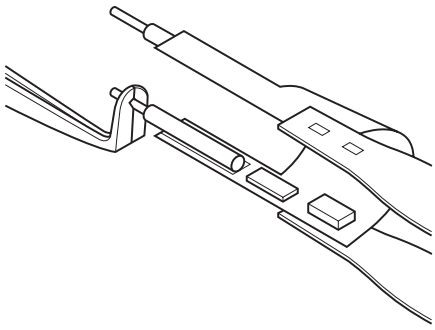


Figure 5-2. Removing a Spring Loaded Tip

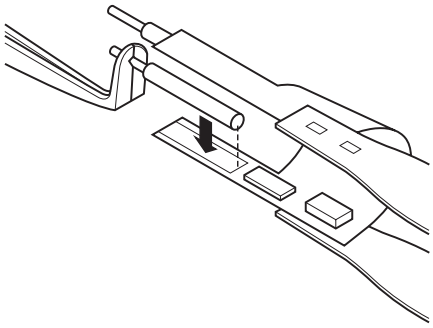


Figure 5-3. Replacing a Spring Loaded Tip

To add a new tip, position the new tip in the hole of the Spring Holder Tool and position the new tip on the flex circuit of the Positioner Mounted Tip so that the end of the new tip aligns with the end of the pad on the Positioner Mounted Tip (Figure 5-3).

To avoid damaging the flex circuit, do not apply too much heat or solder to the spring-loaded tip.

CLEANING

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

CAUTION

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

SERVICE STRATEGY

Defective probes or probe tip modules must be returned to a LeCroy service facility for diagnosis and repair or replacement. A defective product under warranty will be repaired or replaced.

RETURNING A PROBE FOR CALIBRATION OR SERVICE

The procedure for returning a product for calibration or service:

Contact your local LeCroy sales representative to find out where to return the product. All returned products should be identified by model number and serial number. Provide your name and contact number, and, if possible, describe the defect or failure. In case of products returned to the factory, a Return Authorization Number (RAN) should be used. The RAN can be established by contacting your nearest LeCroy sales office, representative, or the North America Customer Care Center.

Return shipment should be prepaid. LeCroy cannot accept COD or Collect Return shipments. We recommend air-freighting.

Note

It is important that the RAN be clearly shown on the outside of the shipping package for prompt redirection to the appropriate department.

1. Contact your local LeCroy sales or service representative to obtain a Return Authorization Number.
2. Remove all accessories from the probe. Do not include the manual. If you need to return a D600ST or D350ST module, do include all Interconnect Leads.
3. Pack the probe in its case, surrounded by the original packing material (or equivalent) and box.
4. Label the case with a tag containing:
   - The RAN
   - Name and address of the owner
   - Product model and serial number
   - Description of failure
5. Package the probe case in a cardboard shipping box with adequate padding to avoid damage in transit.
6. Mark the outside of the box with the shipping address given to you by the LeCroy representative; be sure to add the following:
   - ATTN: <RAN assigned by the LeCroy representative>
   - FRAGILE
7. Insure the item for the replacement cost of the product.
8. Ship the package to the appropriate address.

RETURNING A PROBE TO A DIFFERENT COUNTRY

In order to avoid customs duty for purchase price of a new probe or accessory when your probe is returned for service, please use the following procedure.

In addition to the items mentioned above in ‘Returning a probe for calibration or service’, you’ll need to mark shipments returned for service as a ‘Return of US manufactured goods for warranty repair/recalibration’. If there is a cost involved in the service, put the cost of the service in the value column and the original value of the product at time of purchase in the body of the invoice marked ‘For insurance purposes only’. Be very specific as to the reason for shipment. Duties may have to be paid on the value of the service.

REPLACEMENT PARTS

The probe accessories and other common parts can be ordered through the regional customer care centers. Refer to table 5-1 for LeCroy part numbers.

Table 5-1. Replaceable Parts List

Item	LeCroy P/N	Replacement Quantity
D600 Adjustable Tip Module	D600A-AT	1
D300 Adjustable Tip Module	D300A-AT	1
D600 Small Tip Module	D600ST	1
D500 Positioner Tip Module	D500PT	1
D350 Small Tip Module	D350ST	1
ProLink Probe Body	WL600	1
ProBus Probe Body	WL300	1
Ground Lead	PACC-LD005	1
Ground Clip	PK006-4	1
FreeHand Probe Holder	PACC-MS001	1
Characterization Fixture	PCF200	1
Soft Case	SAC-01	1
Solder In Lead Set for D600ST	D600ST-SI	1
Quick Connect Lead Set for D600 ST	D600ST-QC	1
Square Pin Lead Set for D600ST	D600ST-SP	1
Resistor kit for D600ST-SI	PK600ST-1	10
Resistor kit for D600ST-QC	PK600ST-2	40
Probe Tip holder kit	PK600ST-3	1 (incl. 20 pads)
Probe Body mounting kit	PK600ST-4	Includes: 1Board Edge Clip and 4 Adhesive Backed Probe Body Clamps

Item	LeCroy P/N	Replacement Quantity
Positioner Mounted Tip	D500PT-TIP	1
Replacement tips for D500PT	PK500PT-1	2
Solder In Lead Set for D350ST	D350ST-SI	1
Square Pin Lead Set for D350ST	D350ST-SP	1
Resistor kit for D350ST-SI	PK350ST-1	40
Instruction Manual	WL-OM-E	1

Table 5-2. Optional Accessories Parts List

EZ Probe positioner	EZ Probe	1

###

Reference Information

PROBE INPUT LOADING

Attaching any probe to a test circuit will add some loading to the circuit under test. In most applications the high impedance of the probe, compared to the impedance of the circuit under test, will impart an insignificant load to the test circuit. However at very high frequencies the capacitive reactance of the Probe Tip Module or Interconnect Lead may load the circuit enough to affect the measurement. These probes are designed to minimize these effects at high frequencies. See Figures 6-1, 6-3, 6-5, and 6-7 for equivalent input circuit.

These circuits represent the aggregate load placed on the test circuit, but not the actual input circuit of the probe. For critical applications, you can enter the information of your module or lead into SPICE to accurately represent the probe loading.

Note

To avoid degrading the high frequency performance of the probe, ***do not*** *extend the input pins on the module.*

As an aide in determining the loading of the probe, loading impedance plots for the different modules and leads are shown in Figures 6-2 through 6-12. For more information on probe loading, see also the “Probe Characterization” section in Section 4.

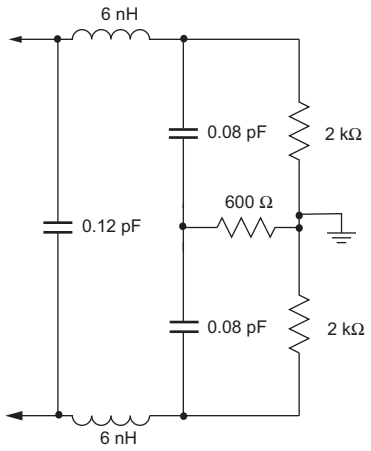


Figure 6-1. D600A-AT/D300A-AT Equivalent Input Circuit

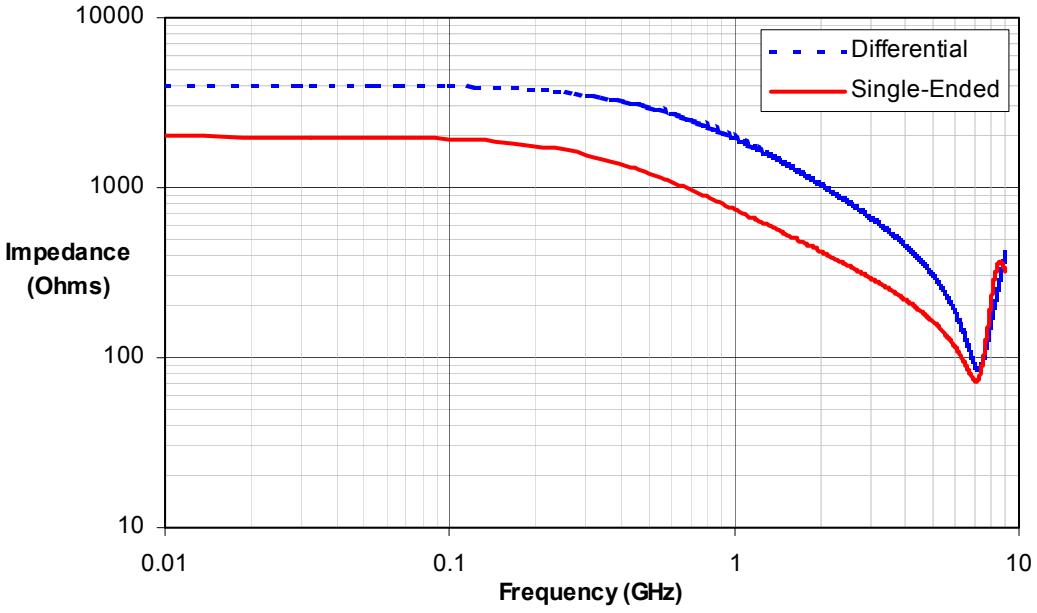


Figure 6-2. D600A-AT / D300A-AT Loading Impedance

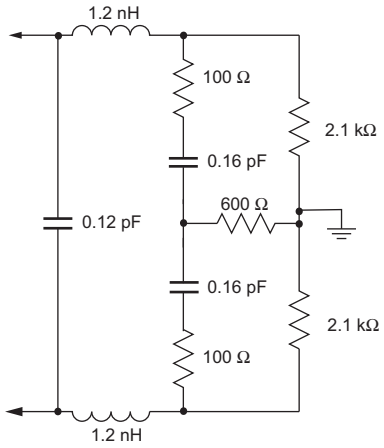


Figure 6-3. D600ST-SI Equivalent Input Circuit

(With 2.54 mm (0.100”) square pins)

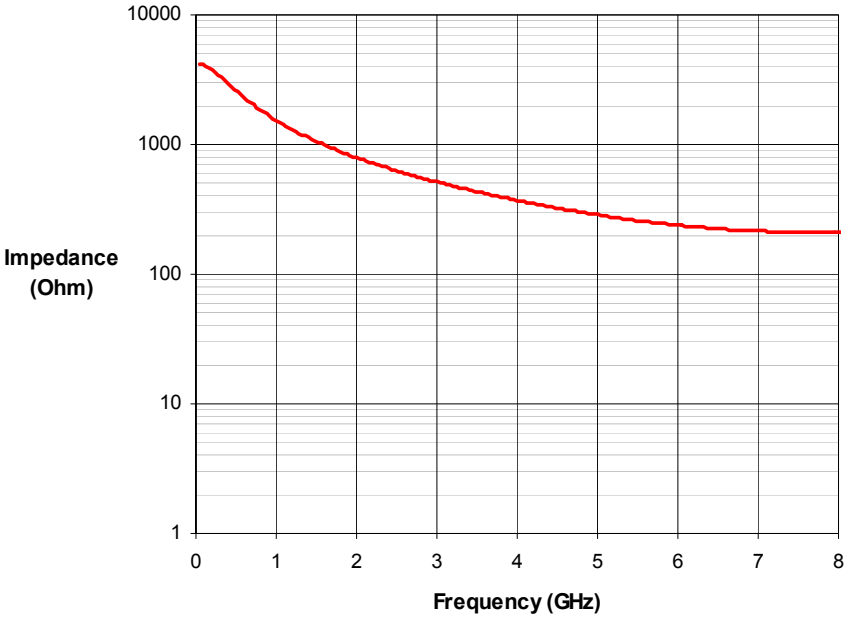


Figure 6-4. D600ST-SI Differential Loading Impedance

(With 2.54 mm (0.100”) square pins)

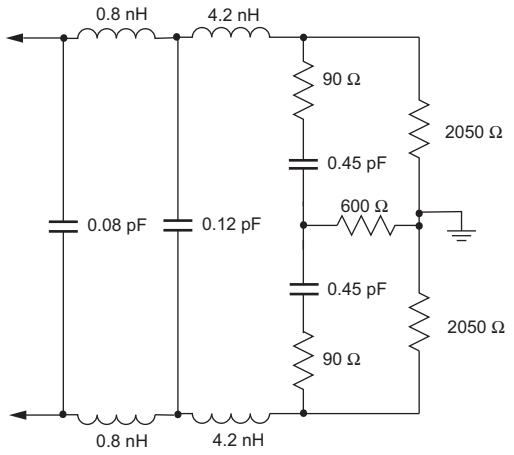


Figure 6-5. D600ST-QC Equivalent Input Circuit

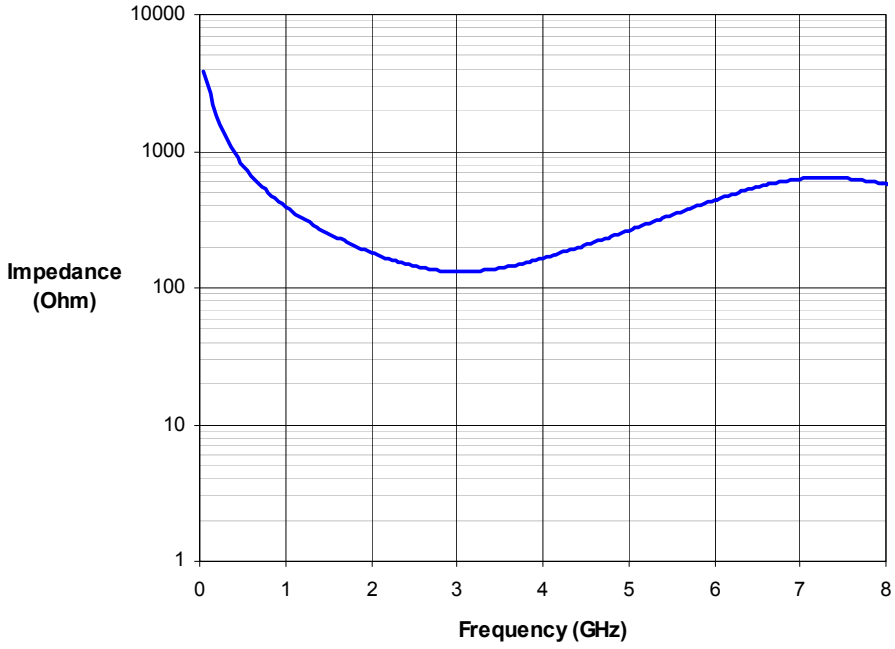


Figure 6-6. D600ST-QC Differential Loading Impedance

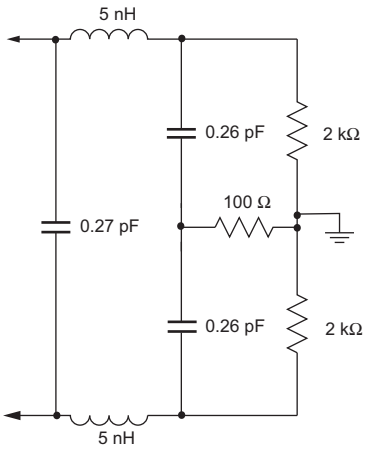


Figure 6-7. D600ST-SP Equivalent Input Circuit

(With 2.54 mm (0.100”) long square pins)

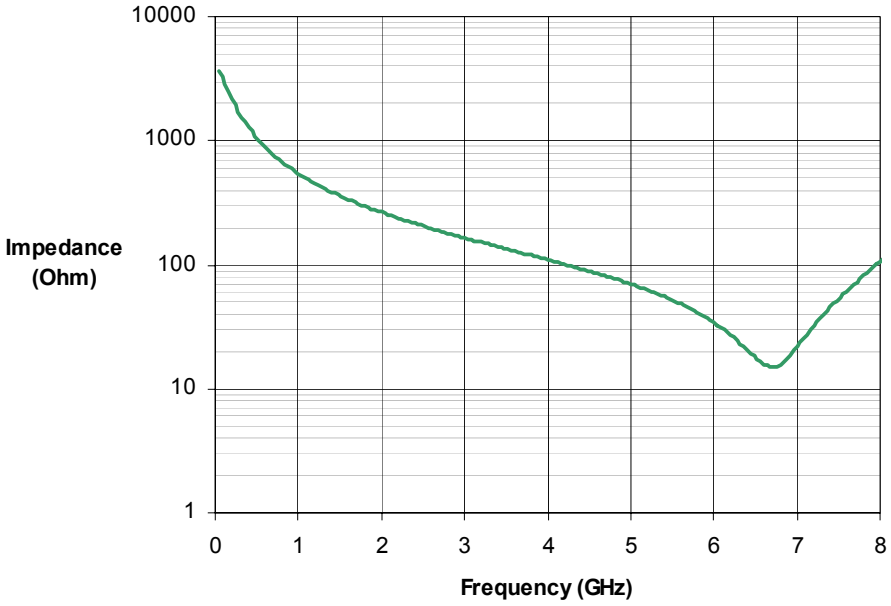


Figure 6-8. D600ST-SP Differential Loading Impedance

(With 2.54 mm (0.100”) long square pins)

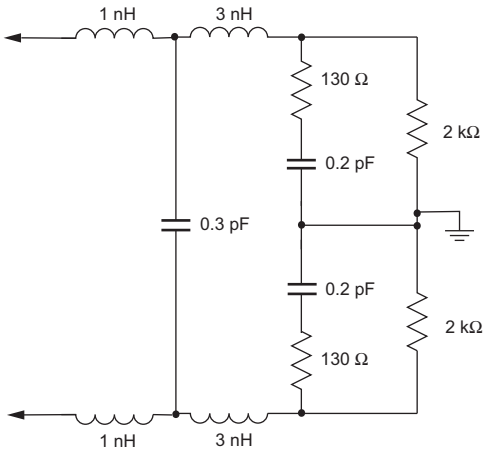


Figure 6-9. D500PT Equivalent Input Circuit

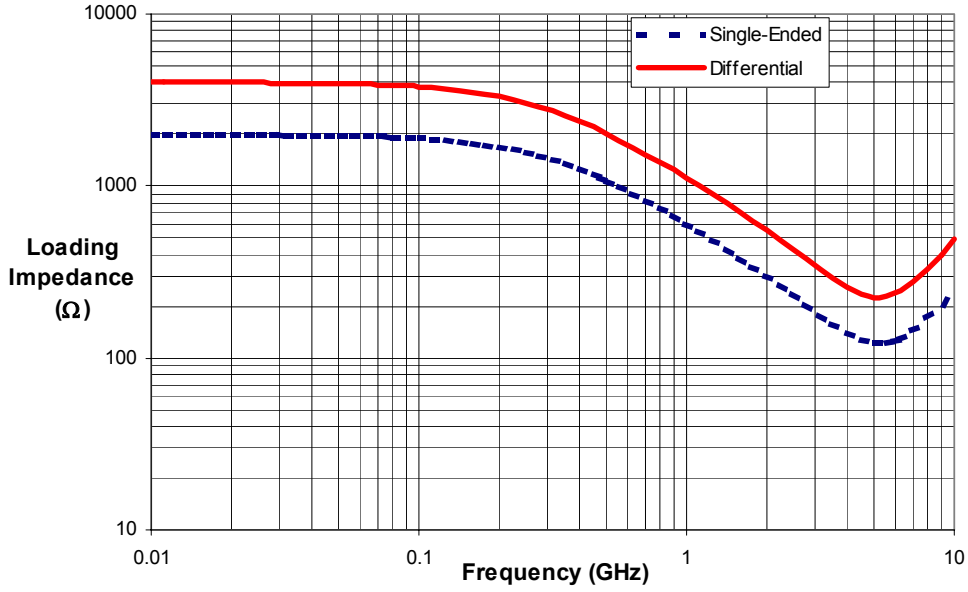


Figure 6-10. D500PT Loading Impedance

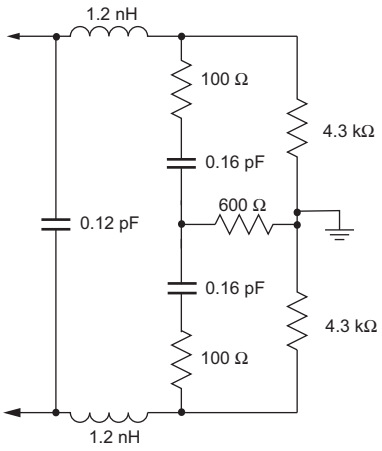


Figure 6-11. D350ST-SI Equivalent Input Circuit

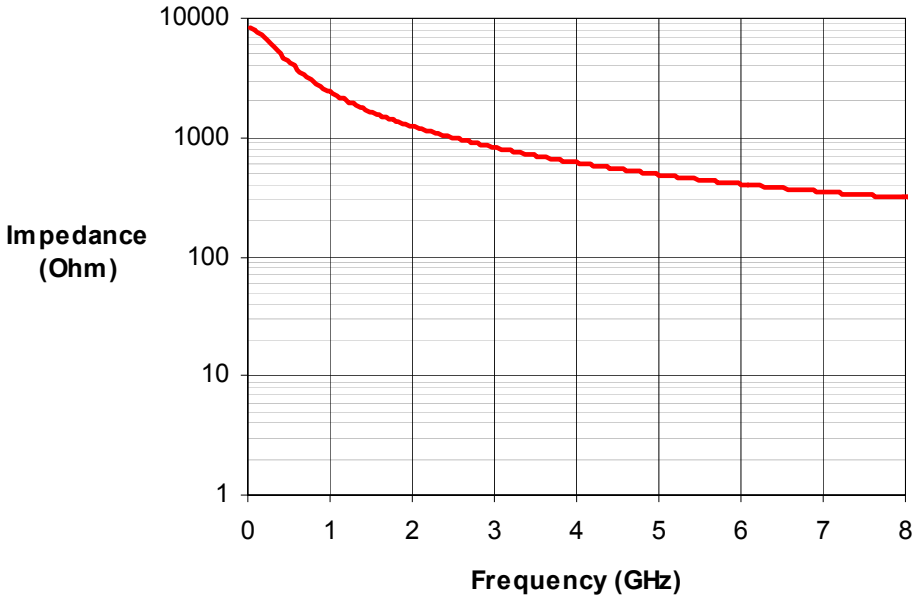


Figure 6-12. D350ST-SI Differential Loading Impedance

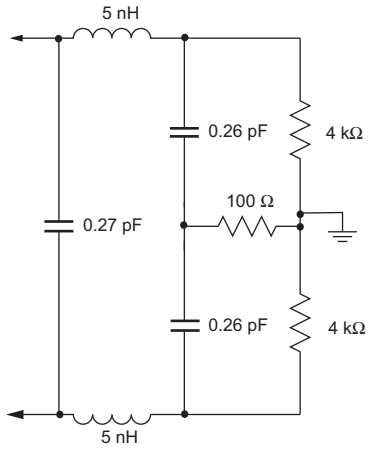


Figure 6-13. D350ST-SP Equivalent Input Circuit

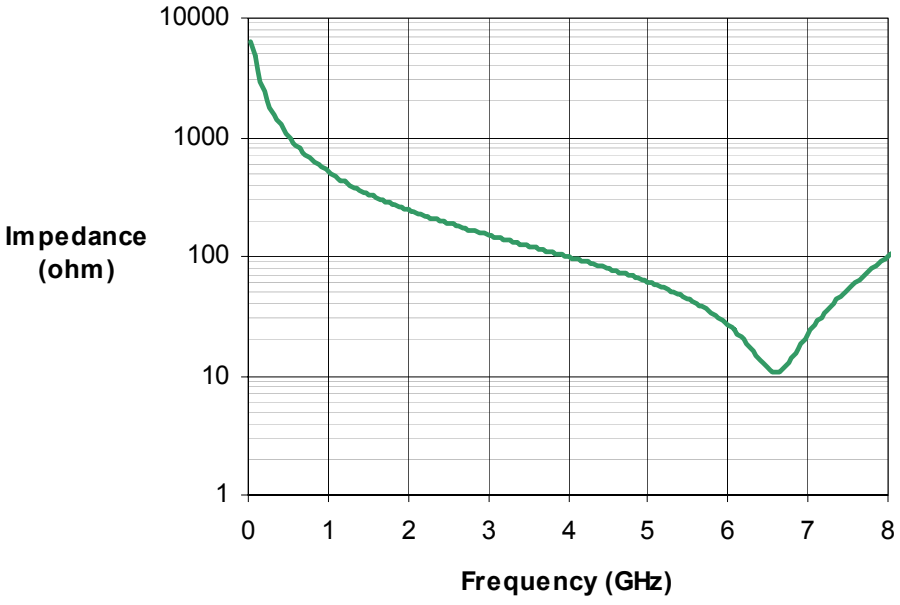


Figure 6-14. D350ST-SP Differential Loading Impedance

DIFFERENTIAL MODE AND COMMON MODE

Differential probes sense the voltage difference which appears between the + input and – input. This voltage is referred to as the Differential Mode or Normal Mode voltage. The voltage component which is referenced to earth and is identical on both inputs is rejected by the amplifier. This voltage is referred to as the Common Mode voltage and can be expressed as:

$$V_{CM} = \frac{V_{+input} + V_{-input}}{2}$$

DIFFERENTIAL MODE RANGE AND COMMON MODE RANGE

Differential Mode range is the maximum signal that can be applied between the + and - inputs without overloading the amplifier/amplifier, which otherwise would result in clipping or distorting of the waveform measured by the oscilloscope.

The Common Mode Range is the maximum voltage with respect to earth ground that can be applied to either input. Exceeding the common mode range can result in unpredictable measurements. Because the Common Mode signal is normally rejected, and not displayed on the oscilloscope, the user needs to be careful to avoid accidentally exceeding the common mode range.

Because the input signal of a differential amplifier is not referenced to ground, the concept of "V_{peak}" versus "$V_{peak\text{-}peak}$" may be confusing.

With a ground referenced signal, V_{peak} is the maximum instantaneous voltage amplitude the signal will have with respect to ground. In a differential system, there is no ground reference. Therefore the Differential Mode Range refers to the maximum instantaneous amplitude of the signal difference between the positive input and the negative input. Since most amplifiers have symmetrical bipolar inputs, the value is generally expressed as an absolute value, and can have either polarity.

For example, an amplifier with a differential mode rating of ±1 V can have a maximum voltage difference appearing at any instant in time of 1 V between the inputs. The polarity could be either positive or negative. This does not imply that the number can be

doubled to 2 volts, however. For clarity, consider the following table of absolute voltages applied to the inputs of a differential amplifier that has a differential mode range or ±1 V and a common mode range of ±5 V:

Voltage on + input to ground	Voltage on - input to ground	Difference	Comment
+1.5 V	+0.8 V	+0.7 V	OK: within ±1 V range
-1.5 V	-0.8 V	-0.7 V	OK: within ±1 V range
+0.8 V	-0.1V	+0.9 V	OK: within ±1 V range
+1.0 V	-1.0 V	+2.0 V	Out of range: exceeds ±1 V
+6.5 V	+6.0 V	0.5 V	Exceeds ±5 V common mode range
1.5 V_{pk-pk} sine	Ground	0.75 Vpeak	OK: within ±1 V range

Some amplitudes are specified as "peak to peak." The differential amplifier peak-to-peak range will be twice the peak differential mode range specification as, at any instant in time, the maximum voltage amplitude signal would be one-half of the peak-to-peak value.

In a balanced differential system, the signal on each output will be an inverted copy of the other input. For example, an LVDS system may have a pair of outputs, each of which has a voltage swing of 0 to +370 mV. A logic 1 would be represented when the + output is at +370 mV, while the - output is at 0 V. A logic zero would be the opposite polarity: the + output at 0 V and the - output at +370 mV. Note that even though both outputs swing 370 mV, the maximum difference voltage between them at any instant is still within ±370 mV. So this signal could be measured with a differential amplifier that has a differential mode range of ±400 mV.

COMMON MODE REJECTION RATIO

The ideal differential probe/amplifier would sense and amplify only the differential mode voltage component and reject all of the common mode voltage component. Real differential amplifiers are not perfect, and a small portion of the common mode voltage component appears at the output. Common Mode Rejection Ratio (CMRR) is the measure of how much the amplifier rejects the common mode voltage component. CMRR is equal to the differential mode gain (or normal gain) divided by the common mode gain. Common mode gain is equal to the output voltage divided by the input voltage when both inputs are driven by only the common mode signal. CMRR can be expressed as a ratio (e.g., 10,000:1) or implicitly in dB (e.g., 80 dB). Higher numbers indicate greater rejection (better performance).

The first order term that determines the CMRR is the relative gain matching between the + and – input paths. To obtain high CMRR values, the input attenuators in a differential amplifier are precisely matched to each other. The matching includes the DC attenuation as well as the capacitance that determines the AC attenuation. As the frequency of the common mode component increases, the effects of stray parasitic capacitance and inductance in determining the AC component become more pronounced. The CMRR becomes smaller as the frequency increases. Hence, the CMRR is usually specified in a graph of CMRR versus common mode frequency.

The common mode frequency in these graphs is assumed to be sinusoidal. In real life applications, the common mode signal is seldom a pure sine wave. Signals with pulse wave shapes contain frequency components much higher than the repetition rate may suggests. As such, it is very difficult to predict actual performance in the application for CMRR-versus-frequency graphs. The practical application of these graphs is to compare the relative common mode rejection performance between different probes and amplifiers.

###

BLANK PAGE

Functional Test

INTRODUCTION

The functional test can be used to verify the basic operation of the WaveLink Differential Probe functions, using a LeCroy X-Stream oscilloscope. Refer to the oscilloscope's on-line Help for proper use of the touch screen and controls.

TEST

To perform the basic setup tests:

1. Connect the probe (for example, a WL600 with a D600A-AT) to channel 1 of the oscilloscope. The instant the probe is connected to the oscilloscope, the AutoColor ID LEDs should illuminate GREEN for less than 1 second to indicate that the probe is compatible with the oscilloscope.
2. After the green LED indication, the Probe's AutoColor ID indicators will illuminate in the color of the channel to which the probe is connected. Disconnect the probe and reconnect to the other channels to verify that the probe's AutoColor ID in each case indicates the proper channel. Reconnect the probe to Channel 1.

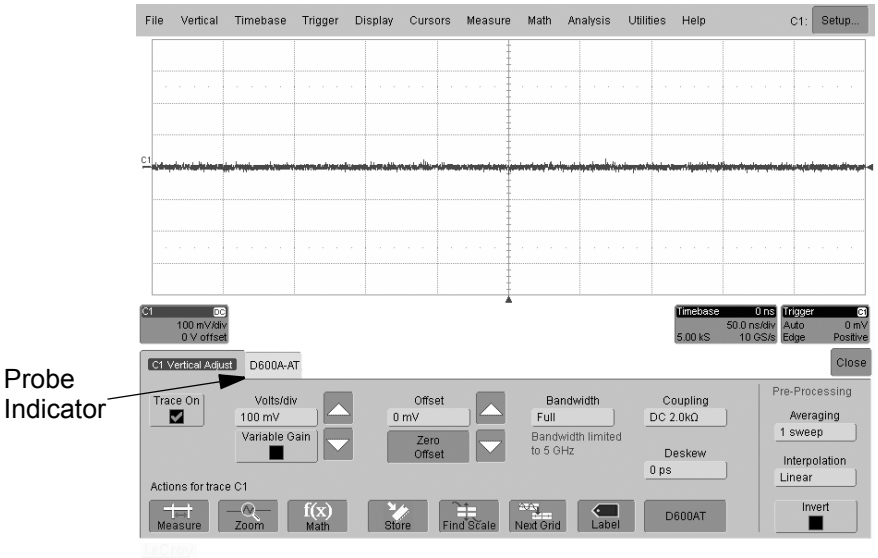


Figure 7-1. Vertical Channel setup

3. Turn on the channel to which the probe is connected.
4. Touch the channel trace label to which the probe is connected to open the Cx Vertical Adjust dialog. Verify that probe model, in this case ‘D600A-AT’, is displayed (Figure 7-1).
5. Touch D600A-AT frame to bring up the D600A-AT probe menu (Figure 7-2).

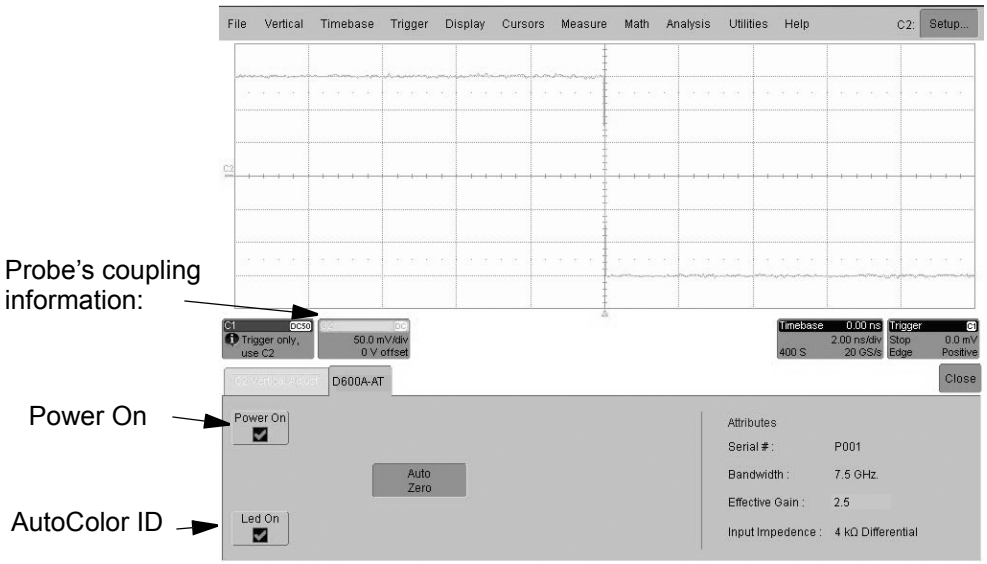


Figure 7-2. D600ST probe menu

6. Touch the **Power On** checkbox to verify that the AutoColor ID LEDs on the probe are OFF (probe power is OFF). Turn power ON again.
7. Touch the **Led On** checkbox to verify that the probe’s AutoColor ID LEDs turn off (probe power is still ON). Turn LEDs back ON.
8. To perform the functional tests, the Calibrator needs to be set up first. From the menu bar, select **Utilities**, then **Utilities Setup...** from the drop-down menu.
9. Touch the **Aux Output** tab (See figure 7-3).
10. Touch the **Square** button to obtain a square wave output signal.

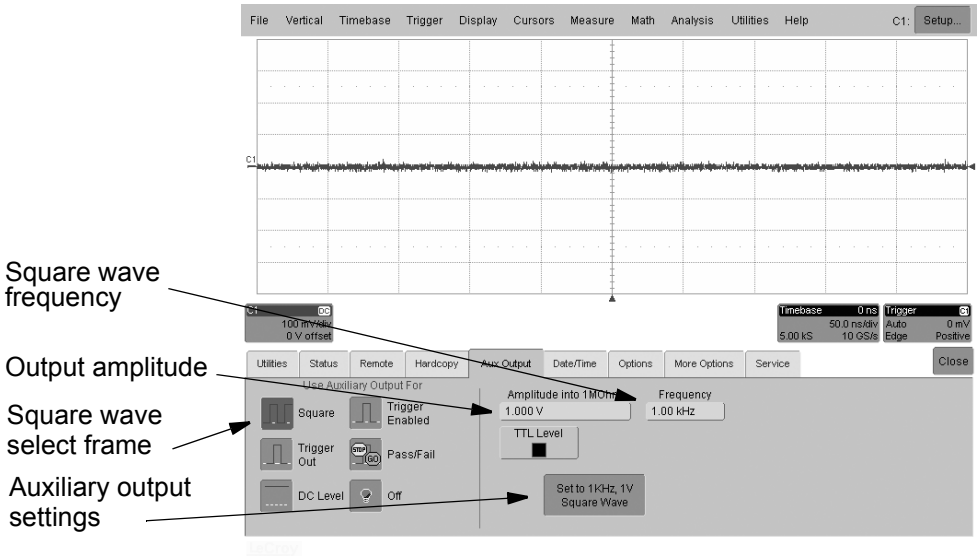


Figure 7-3. Auxiliary output set up

11. Set the amplitude to 1 Volt, Frequency to 1.00 kHz, Offset to 0 V.
12. Verify that the screen indicates the proper settings in the Aux Output fields.
13. Set the probe's sensitivity to 200 mV/div.
14. Connect the + tip of the Adjustable Tip module to the center connector of the calibrator output signal, and the – pin to the shell (ground) of the connector. Readjust tip spacing if necessary.
15. Verify that the screen shows a square wave centered around the center graticule line. Refer to Figure 7-4. If no square wave is shown, the + channel of the probe may be faulty.

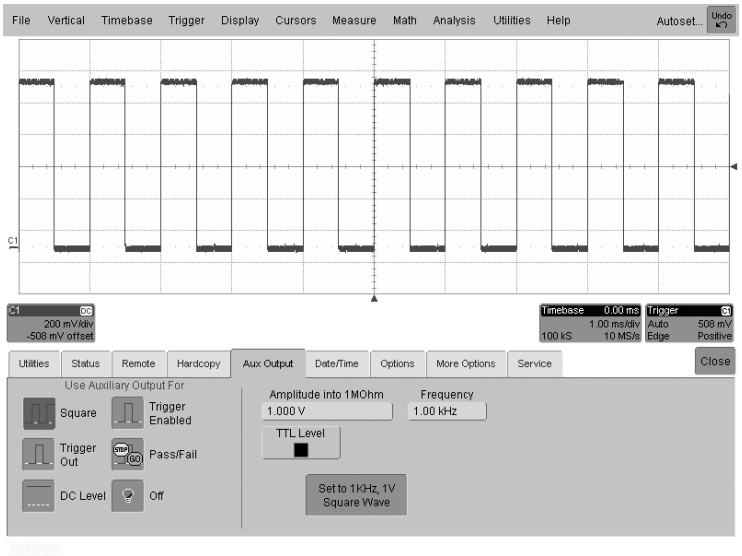


Figure 7-4. Square wave output signal

16. To obtain a stable display press AUTO SETUP on the oscilloscope's front panel.
17. Adjust the adjustable tips so both tips touch or almost touch.
18. Connect both tips to the calibrator output signal.
19. Verify that a straight line is shown, centered on screen. There should be no vertical deflection, to indicate good CMRR.
20. One of the channels may be at fault if a square wave or part of a square wave is shown.

This concludes the functional tests of the WaveLink Differential Probe.

###

Performance Verification

INTRODUCTION

This procedure can be used to verify the warranted characteristics of the WaveLink Differential Probe.

The recommended calibration interval for this differential probe is one year. Test results can be recorded on a photocopy of the Test Record provided in Appendix A.

Performance Verification can be completed without removing the probe covers or exposing the user to hazardous voltages. No adjustments are provided.

In the unlikely event that a probe should fail the performance verification, it can be sent back to the local service center or the factory. For information on returning the probe, refer to Section 5, Care and Maintenance.

This procedure tests the WL600 with a D600A-AT, D600ST-SI, D500PT; and the WL300 with a D300A-AT and D350ST-SP for the following warranted specifications:

- Output Zero
- Low frequency attenuation accuracy at low and high voltage range
- Rise time

The rise time specification has dependency on characteristics of the probe body. Therefore, traceable calibration requires verification with a specific probe body, denoted by serial number. The rise time and attenuation accuracy parameters of probe tip modules that utilize detachable tips have similar dependency on the individual tip, which is serialized. The probe tip modules that this applies to are the D600ST, D350ST, and D500PT.

The rise time specification for the D600A-AT, D600ST, and D500PT are only valid with a WL600 probe body. Rise time for the D300A-AT and D350ST can be measured with a WL300 probe body. Output zero and LF attenuation accuracy can be measured with any probe body.

If the probe package includes more than one probe tip module, e.g., a D600ST and a D600A-AT, the entire procedure will need to be completed for each probe tip module. If more than one module

is being verified, copy and fill out a separate test record for each probe, probe tip module, and interconnect lead.

Note

It is recommended that the Functional Check be performed prior to the Performance Verification Procedure to assure that all other non-warranted functions perform as specified. For the Functional Check refer to Section 7, Functional Test.

TEST EQUIPMENT REQUIRED

Table 8-1 lists the test equipment and accessories, or their equivalents, that are required for performance verification of the WaveLink Differential Probe series.

This procedure has been developed to minimize the number of parameters required to be calibrated in the test instrumentation.

Only the parameters listed in **boldface** in the “Minimum Requirements” column must be calibrated to the accuracy indicated.

Because the input and output connector types may vary on different brands and models of test instruments, additional adapters or cables may be required.

Table 8-1. List of Required Equipment

Description	Minimum Requirements	Test Equipment Examples
Oscilloscope, High BW [1]	BW ≥ 6 GHz	LeCroy: WaveMaster 8600A
Oscilloscope, High BW [2]	BW ≥ 3 GHz	LeCroy: Wavemaster 8300A or WavePro 7300
Oscilloscope, High Impedance	200 mV/div - 2 V/div scale factor 1 MΩ input impedance ProBus interface	LeCroy: WavePro 7300 or WaveRunner 6200
Digital Multimeter	**AC: 0.2% accuracy** to measure 200 mV and 2 V_{rms} @ 1 kHz 6½ digit resolution	Agilent Technologies: 34401A, or Fluke: 8842A-09, or Keithley: 2001

Description	Minimum Requirements	Test Equipment Examples
Oscillator/Function Generator	Sine Wave output, adjustable from 500 mV to 4 Vp-p (357 mV to 2.83 V_{rms}) at 70 Hz	Stanford Research: Model DS340,or Agilent Technologies: 33120A, or Leader: LAG-120B
Pulse Generator	12 ps, -5 V_{out}, 2.4 mm output	Picosecond Pulse Labs: 4015D-215
Calibration Fixture [3]	See Preliminary Procedure	LeCroy: ProLink-CF01
Calibration Fixture [4]	See Preliminary Procedure	LeCroy: ProBus-CF01
Terminator, Precision, BNC	50 Ω ± 0.05%	LeCroy: TERM-CF01
Characterization Fixture [5]		LeCroy: PCF-200
SMA to BNC Adapter	Female SMA to male BNC	Pomona Electronics: 4289 Pasternack Enterprises: PE9073
SMA to BNC adapter	Male SMA to female BNC	Pomona Electronics: 4290 Pasternack Enterprises: PE9074
SMA to BNC Adapter	Female SMA to female BNC	Pomona Electronics: 4291 Pasternack Enterprises: PE9075
SMA to SMA Adapter [6]	Female SMA to female SMA	Pomona Electronics: 4284 Pasternack Enterprises: PE9070
Terminator, SMA	Female SMA, 50 Ω, ½ W	Pomona Electronics: 4287 Pasternack Enterprises: PE6003
Attenuator	Male 2.4 mm to male SMA, 50 Ω, 10 dB,12 GHz	Pasternack Enterprises: PE7045-10
BNC coaxial cable, (3 ea)	Male-male BNC, 50 Ω, 36”	Pomona Electronics: 2249-C-36 Pasternack Enterprises: PE3067-36
SMA coaxial cable, (2 ea) [6]	Male-male SMA, 50 Ω, 36”	Pomona Electronics: 4846-K-24 Pasternack Enterprises: PE3369-36
SMA coaxial cable, (1 ea) [5]	Male SMA to female SMA, 50 Ω, 36”	Pomona Electronics: 4528-K-24 Pasternack Enterprises: PE3078-36
BNC Tee connector, (2ea)	Male to dual female, BNC	Pomona Electronics: 3285 Pasternack Enterprises: PE9001
Banana Plug adapter	Female BNC to dual banana plug	Pomona Electronics: 1269 Pasternack Enterprises: PE9008
ProBus to ProLink adapter [7]		LeCroy: LPA-BNC

Description	Minimum Requirements	Test Equipment Examples
Adapter	Female 2.4 mm to female SMA	Pasternack Enterprises: PE9656
1 MΩ adapter [3]		LeCroy AP-1M
Torque Wrench	for SMA connectors	

Notes:

[1] Only required for verification of the D600A-AT, D600ST-SI, or D500PT rise time

[2] Only required for verification of the D300A-AT or D350ST rise time

[3] Required for WL600 verification

[4] Required for WL300 verification

[5] Standard accessory included with probe

[6] Instead of using a male-to-male SMA cable with a SMA-to-SMA adapter to connect to the male end of the characterization fixture, you can use a male SMA-to-female SMA cable.

[7] Only needed when testing a WL300 probe for rise time with a WaveMaster oscilloscope. Not needed when using a WavePro oscilloscope. (Adapter supplied as a standard accessory with WaveMaster oscilloscopes.)

PRELIMINARY PROCEDURE

For this procedure a different oscilloscope is required when testing a WL600 or a WL300 probe body. When testing a WL300 any X-Stream oscilloscope with an input impedance of 1 MΩ can be used. A WL600 requires a WaveMaster oscilloscope with an AP-1M Hi-Z adapter to convert the 50 Ω input impedance into 1 MΩ. No external power supply is required; the ProLink-CF01 or the ProBus-CF01 are used to power the probe.

1. Connect the WL600 to the input of ProLink-CF01 Calibration Fixture. When testing the WL300 connect the probe to the ProBus-CF01 Calibration Fixture (Figure 8-1).

   Remove the captive screws from the ProLink-CF01 to allow the WL600 to connect to the Calibration Fixture.

2. Connect the output of the ProLink-CF01 Calibration Fixture to a free channel of the WaveMaster oscilloscope; or, when testing a WL300, connect the ProBus-CF01 to a free Channel of the 1 MΩ oscilloscope.

3. Allow at least 20 minutes warm-up time for the WaveLink probe and test equipment 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 (located in Appendix A), and fill in the necessary data.

Most of the warranted characteristics of the WaveLink Differential Probe are valid at any temperature within the Environmental Characteristics listed in Section 9. However, some of the other test equipment used to verify the performance may have environmental limitations required to meet the accuracy requirements needed for the procedure. Be sure that the ambient conditions meet the requirements of all the test instruments used in the procedure.

As specified, the low frequency attenuation accuracy is valid at a reduced temperature range from 20 to 30 °C; verification, therefore, must be done at an ambient temperature within that range.

VERIFICATION PROCEDURE

This verification procedure describes the tests, using a probe with an AT module. The procedure for testing a PT module or a ST module with either a SI, QC, or SP interconnect lead is identical to testing an AT module. However, the connection to the Characterization Fixture may be different.

The setup and procedure for testing Output Zero and Attenuation Accuracy is the same for WL600 as for WL300, except for a different oscilloscope.

1. Output Zero

a. Connect the appropriate calibration fixture to the output of the probe to be tested (Figure 8-1).

Note

The output zero is not affected by the input leads, so any D600ST or D350ST interconnect lead may be used for this test.

b. To provide power to the probe, connect the ProLink-CF01 to any input of a WaveMaster oscilloscope or the ProBus-CF01 to any input of the WavePro oscilloscope.

   No signal input connection to the oscilloscope will be required for the Output Zero test.

c. For the WL600, connect a BNC-to-SMA adapter to the SMA output connector of the ProLink-CF01 Calibration Fixture, and the BNC end to a BNC Tee (Figure 8-1).
   No adapter is needed for connecting the WL300 ProBus-CF01 to a BNC TEE.

d. Connect the Precision 50 Ω Terminator, using another BNC cable, to the free end of the BNC Tee.

e. Set the DMM to DC volts.

f. Connect the Precision 50 Ω Terminator to the DMM input.

g. After a warm-up time of at least 20 minutes, measure the output voltage and record the result as ‘Output Voltage’ in the Test Record.

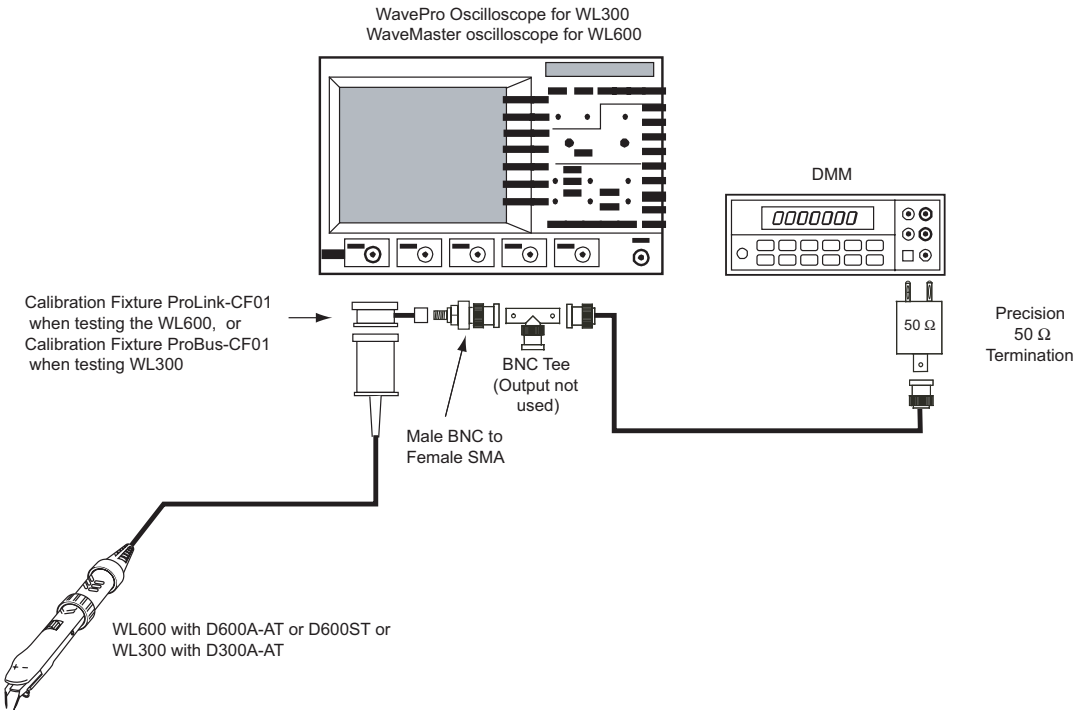


Figure 8-1. Output Zero Voltage

h. Initiate an AutoZero.

i. Wait an additional 15 minutes, then record the DMM reading to 1 mV resolution in the Test Record as ‘Output Voltage after AutoZero’.

j. Take the difference of the two readings recorded in 1-g and 1-i and multiply by 2.5 when testing with a D600A-AT, D600ST, D500PT or D300A-AT. Multiply the result by 5 for a D350ST module.

k. Record the result as ‘Output Zero’ in the Test Record.

l. Check that the absolute value of Output Zero is less than 10 mV. For D350ST Output Zero should be < 20 mV.

2. Low Voltage Low Range Attenuation Accuracy

Note

When verifying an ST module, the low-frequency attenuation accuracy at low and high voltage needs to be verified with each interconnect lead.

Because each PT and ST interconnect lead has its own serial number, it should be recorded with the serial number of the probe tip module on the Test Record.

Note

A WaveMaster oscilloscope is required for testing a WL600 and a WavePro for testing a WL300.

a. Connect the male end of a BNC Tee to the Sine Wave Generator output. Refer to Figure 8-2 for setup. Set the generator's output voltage to 0 Volt.

b. Connect one end of a BNC cable to the BNC Tee and the other end to a Female BNC-to-Male SMA adapter.

c. Connect the male side of the BNC-to-SMA adapter to a female end of the Characterization Fixture. Refer to Figures 8-3, 8-4, and 8-5 to determine which side of the Characterization Fixture to use for the probe tip module and interconnect lead to be tested.

d. Connect another BNC cable to the free end of the BNC Tee and the other end of the cable to the Female BNC-to-Dual Banana Plug Adapter.

e. Connect the Banana Plug Adapter to the DMM input, verifying that the ground side of the adapter is connected to the low side of the DMM.

f. Attach a ProLink-CF01 Calibration Fixture to the WL600, or a ProBus-CF01 to the WL300 probe.

   Remove the captive screws from the ProLink-CF01 to allow the WL600 to connect to the Calibration Fixture.

g. Connect the Calibration Fixture to Channel 1 of the oscilloscope.

h. For the WL600 connect a BNC-to-SMA adapter to the SMA output connector of the ProLink-CF01 Calibration Fixture, and the BNC end to a BNC Tee (Figure 8-2).

No adapter is needed when connecting the WL300 ProBus-CF01 to the BNC TEE.

i. For a WL600, to obtain 1 MΩ input impedance, connect the male side of the BNC Tee to an AP-1M Hi-Z adapter, and the adapter to a free channel of a WaveMaster oscilloscope.

For a WL300, connect the male side of the BNC Tee to a free channel of the WavePro oscilloscope.

This input will be used to observe the probe's output signal to verify if good contact is made to the Characterization Fixture.

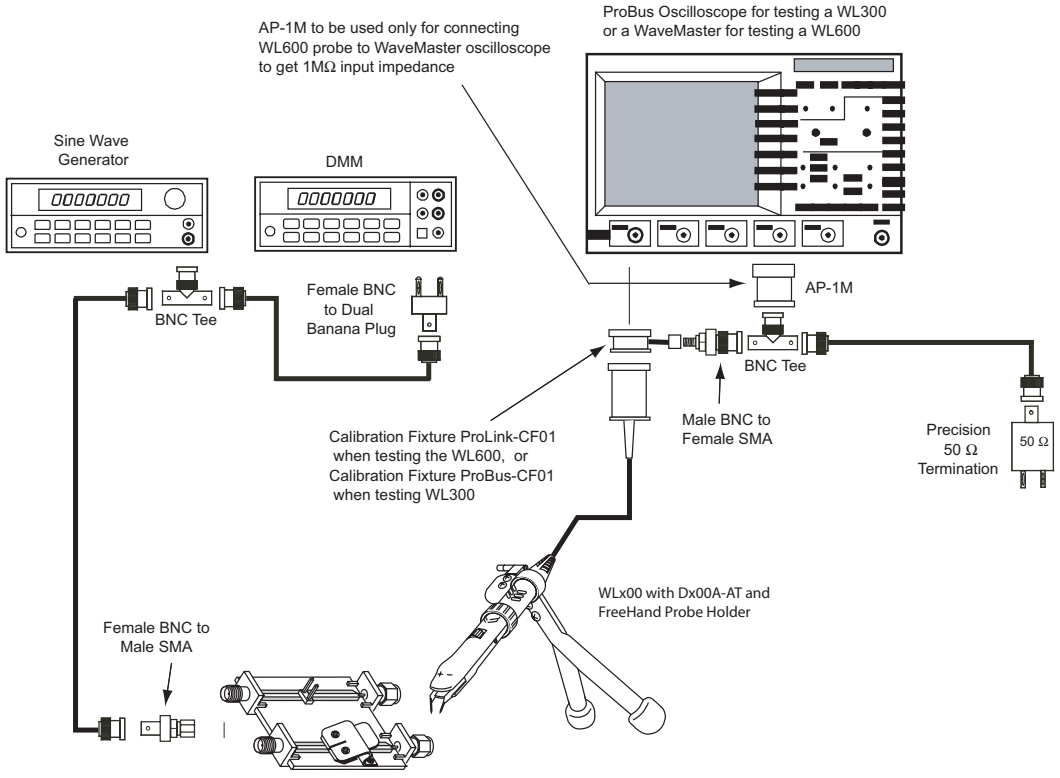


Figure 8-2. WLx00 with a Dx00A-AT Measuring Input Voltage

j. Connect the Precision 50 Ω Terminator via another BNC cable to the free end of the BNC Tee.

k. Leave the unused end of the Precision Terminator floating for the time being.

l. Select the channel to which the BNC tee is connected and set the channel's sensitivity to 0.1 V/DIV. Verify that the input coupling is set to **DC** and the input resistance to **1 MΩ**.
Do not terminate the BNC Tee adapter into 50 Ω.

Figures 8-3 through 8-6 show how to connect the different modules to the characterization fixture.

m. Connect the AT module to the fixture. Refer to Figure 8-3 to see which side to use.

When testing the probe with an Adjustable Tip module, use the FreeHand Probe Holder for stability and easy measuring. Adjust the tips so that one tip makes contact with the center strip of the Characterization Fixture, and the other tip with one of the side ground strips.

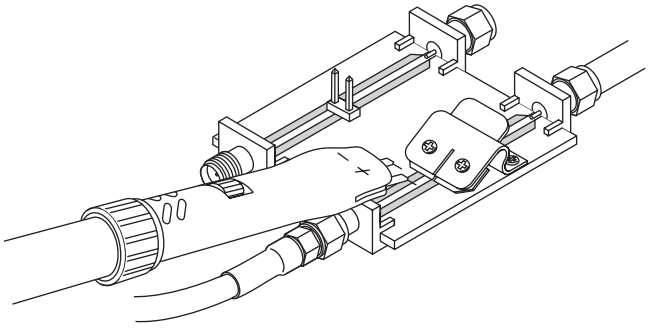


Figure 8-3. Dx00A-AT to Characterization Fixture Connection

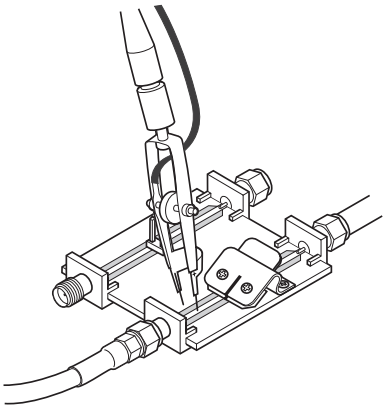


Figure 8-4. D500PT-TIP to Characterization Fixture Connection

n. Connecting the SI, QC and SP modules to the fixture:

The ST and QC leads should be connected with the ends of the damping resistors placed under the clip. Refer to Figure 8-5. (Press down on the plastic tab to lift the clip and slide the wires under the clip, verifying that the + side is located over the center strip and the – side over the ground plane on either side of the center strip. Release the tab.)

The SP lead should plug onto the square pins located on the fixture (Figure 8-6).

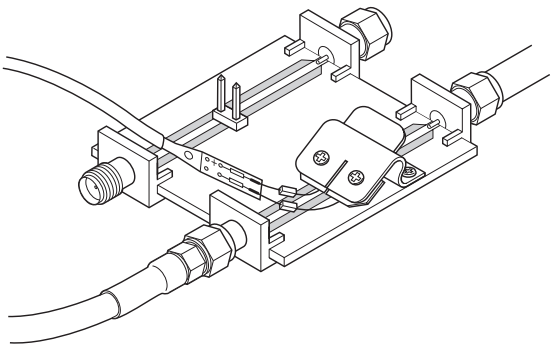


Figure 8-5. SI and QC to Characterization Fixture Connection

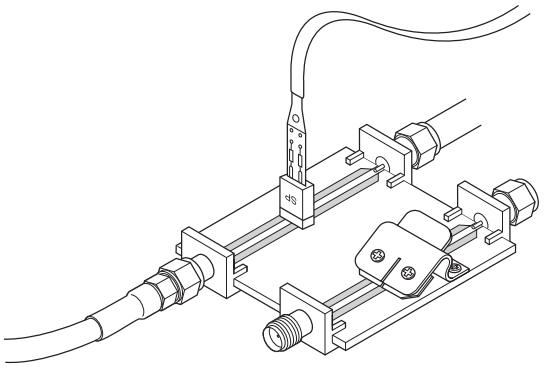


Figure 8-6. SP to Characterization Fixture Connection

o. Set the DMM to read AC.

p. Set the sine wave generator to about 70 Hz and the output when testing the D600A-AT, D600ST, D500PT, and D300A-AT to 1.0 V_{p-p} (0.353 V_{rms}) and for the D350ST to 2.0 V_{p-p} (0.707 V_{rms}) as indicated on the DMM.

q. If necessary, move the AT module so the tips make good contact to get the proper amplitude (about 4 divisions) on the oscilloscope.

r. When satisfied that good probe tip contacts are made, record the DMM reading to 1 mV resolution in the Test Record as ‘Probe Low Range Input Voltage’.

s. Unplug the BNC to Banana Plug Adapter from the DMM and connect the Precision 50 Ω Terminator to the DMM input (Figure 8-7).

t. After the DMM has stabilized, record the reading to 1 mV resolution in the Test Record as ‘Probe Low Range Output Voltage’.

u. To take the probe’s attenuation into account, multiply the reading recorded in step 2-s for the D600A-AT, D600ST, D500PT, or D300A-AT modules by 2.5; and for the D350ST module, by 5. Record the result as ‘Corrected Low Range Output Voltage’ in the test record.

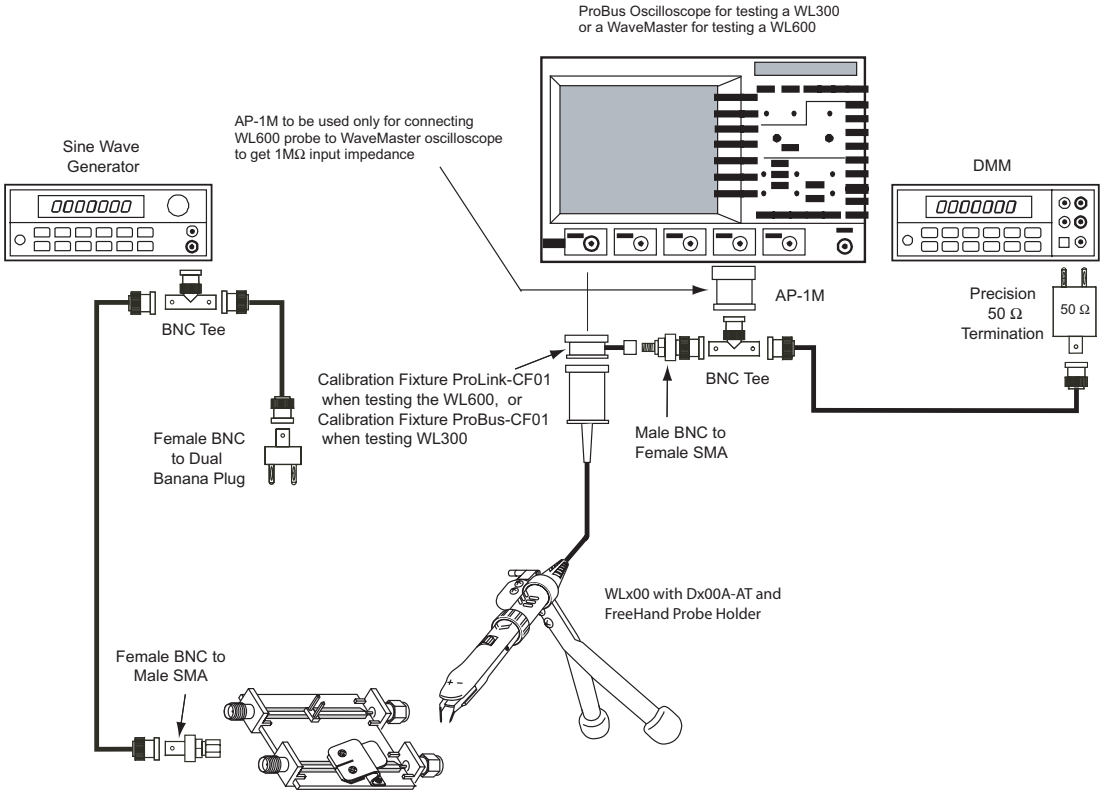


Figure 8-7. WLx00 with a Dx00A-AT measuring Output Voltage.

v. Divide the output voltage obtained in step 2-t by the input voltage obtained in step 2-q. Subtract the ratio from 1.0 and multiply the result by 100% to get the error in percent.

$$Error = \left(1 - \frac{Corrected\ Probe\ Output\ Voltage}{Probe\ Input\ Voltage}\right) x100\%$$

w. Record the result to two decimal places (±0.xx %) as 'Low Range Attenuation Error' in the Test Record.

x. Check that the calculated Low Voltage Attenuation Error is less than ±2%.

y. When testing an ST module, repeat these steps for the other two interconnect leads. Use a new test record sheet for each probe.

z. Leave the setup as is for the next step.

3. High Range Attenuation Accuracy

These steps, like in the low range attenuation accuracy, need to be performed with all three interconnect leads.

a. Unplug the Precision 50 Ω Terminator and BNC cable from the DMM, and reconnect the BNC cable with the BNC-to-Banana Plug Adapter to the DMM input (Figure 8-2).

b. Set the oscilloscope scale factor to 0.2 V/DIV. Verify that the Coupling is set to **1 MΩ** and **DC**.

c. Set the output voltage of the sine wave generator when testing the D600A-AT, D600ST, D500PT, and D300A-AT to 4.0 V_{p-p} (1.414 V_{rms}) and for the D350ST to 8.0 V_{p-p} (2.828 V_{rms}) as indicated on the DMM. Leave the frequency at 70 Hz.

d. Observe the oscilloscope's display and verify that the probe tips are making good contact with the Characterization Fixture.

e. Record the DMM reading to 1 mV resolution as 'Probe High Range Input Voltage' in the Test Record.

f. Disconnect the BNC-to-Banana Plug Adapter from the DMM and reconnect the Precision 50 Ω Terminator to the DMM input. See Figure 8-6.

g. After the DMM has stabilized, record the reading to 1 mV resolution in the Test Record as 'Probe High Range Output Voltage'.

h. Multiply the reading recorded in step 3-g for the D600ST, D600A-AT, D500PT, or D300A-AT modules by 2.5; and for

the D350ST module, by 5. Record the result as 'Corrected High Range Output Voltage' in the Test record.

i. Divide the calculated output voltage obtained in step 3-h by the input voltage obtained in step 3-e. Subtract the ratio from 1.0 and multiply the result by 100% to get the error in percent.

$$Error = \left(1 - \frac{Corrected\ Probe\ Output\ Voltage}{Probe\ Input\ Voltage}\right) x100\%$$

j. Record the result to two decimal places (±0.xx %) as 'High Range Attenuation Error' in the Test Record.

k. Check that the calculated High Voltage Attenuation Error is less than ±5%.

4. Rise (Fall) Time (10% to 90%)

Measuring the probe's rise time cannot be done directly; it has to be done in an indirect way. First you have to measure the rise time of the total system (i.e., rise time of the pulse generator, characterization fixture with probe connected, and the oscilloscope). Second, measure the rise time of the probe's output. The rise time of the probe alone can then be determined from these two measurements.

When testing the WL600 probe for rise time, you have to use the very high bandwidth WaveMaster oscilloscope. However, when testing a WL300, you can use either a WaveMaster or a WavePro 7300 oscilloscope. When using a WaveMaster oscilloscope with the WL300, you need to use the LPA-BNC ProBus-to-ProLink adapter to connect the WL300 probe to the WaveMaster oscilloscope.

This section tests the rise times for:

D600A-AT (70 ps), D600ST-SI (65 psec) and D500PT (100 ps) using a WaveMaster 8600A oscilloscope.

D350ST-SP (90 ps) and D300A-AT (95 ps) using a WaveMaster 8300A or WavePro 7300 oscilloscope.

Note

Of the three interconnect leads, only the D600ST-SI and D350ST-SP have a warranted rise time. Therefore, only these leads will need to be verified in this procedure.

Refer to Figures 8-3 and 8-5 for connection of the Dx00A-AT, D600ST-SI, D500PT-TIP, or D350ST-SP to the Characterization Fixture.

a. Connect a female 2.4 mm-to-female SMA adapter to the output of the pulse generator's pulse head; and one side of a male SMA-to-male SMA cable to the adapter and the other side to a 10 dB attenuator.

Note

When fastening a SMA connector, always use the SMA Torque Wench to tighten the connector to 8 in-lbs.

b. Connect the male side of the attenuator to one of the female sides of the Characterization Fixture (Figure 8-8).

c. Set the oscilloscope vertical to Channel 1, the input coupling to DC 50 Ω, the scale factor when testing a D600A-AT, D600ST-SI, D500PT-TIP, or D300A-AT to 0.2 V/div. When testing the D350ST-SP, set the scale factor to 0.1 V/div.

d. Select INVERT in the vertical menu.

e. Connect another SMA cable via a female-to-female SMA connector to the male output of the Fixture and the other end of the cable to an LPA-to-SMA adapter when connecting a WL600 to a ProLink oscilloscope, or to a SMA-to-BNC adapter when connecting a WL300 probe to a ProBus oscilloscope. Connect either adapter to Channel 1 of the oscilloscope.

   A female-to-male SMA cable, if available, can be used instead of a male-to-male SMA cable with a female-to-female SMA adapter to connect the Fixture to the oscilloscope.

f. Connect the probe tip to the Characterization Fixture, as shown in Figures 8-3 and 8-4.

g. When testing the probe with an adjustable tip module, use the FreeHand Probe Holder for stability and easy measuring. Adjust the tips of the Adjustable Tip Module so that one tip makes contact with the center strip of the Characterization Fixture and the other tip with one of the side ground strips.

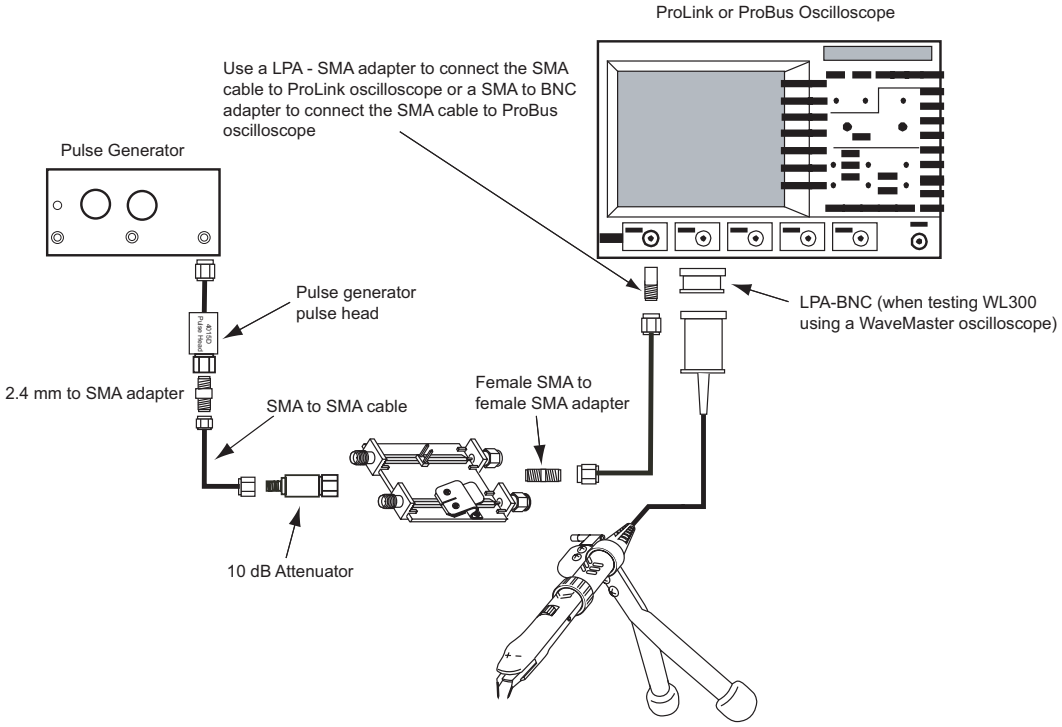


Figure 8-8. Measuring System Rise Time

h. To verify that good contact is made between the adjustable tip and the Characterization Fixture, connect the output of the probe to Channel 2 of the appropriate oscilloscope. Verify that the vertical input is set to Channel 2, the input coupling to DC 50 Ω, the scale factor to 0.2 V/div; except for the D350ST-SP where the scale factor should be set to 0.1 V/div. The displayed signal should be a negative going pulse about 3 divisions high.

When testing a WL300 using a WaveMaster instead of a WavePro oscilloscope, connect the LPA-BNC to the WL300 before connecting the probe to the oscilloscope.

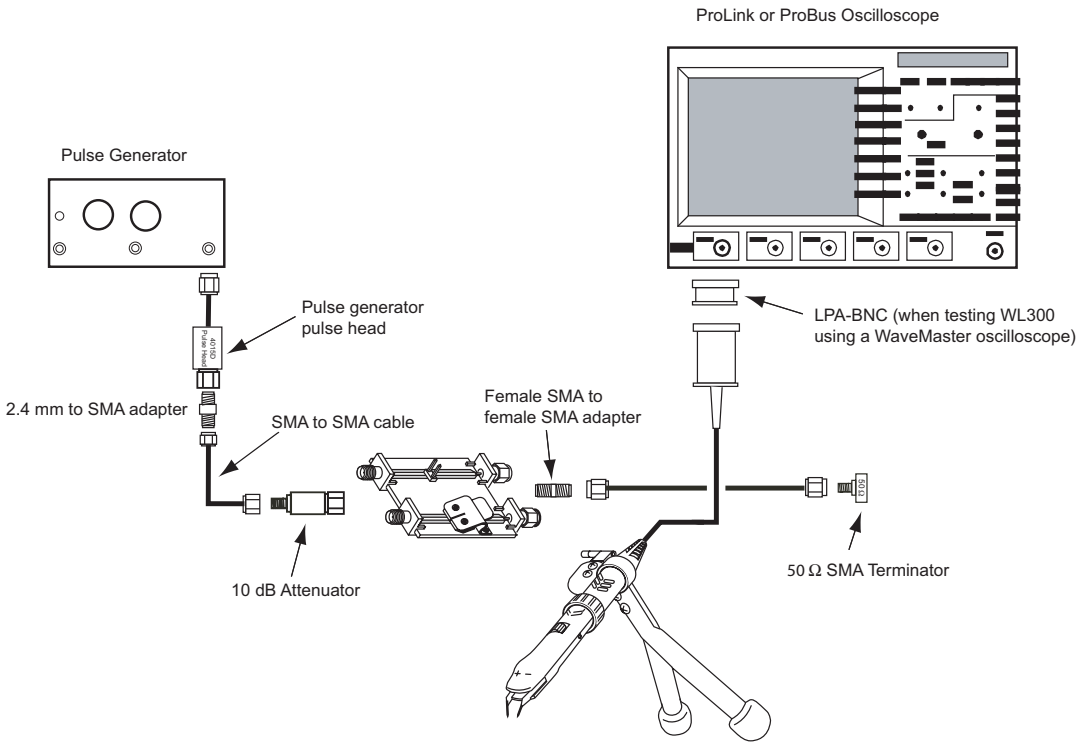


Figure 8-9. Measuring System Rise Time with Probe

i. To measure the system rise time, set the oscilloscope to Channel 1, adjust the variable scale factor to obtain a pulse height of 6 divisions. Adjust the OFFSET to center the displayed pulse around the center graticule line.

j. Set the oscilloscope bandwidth to FULL, triggering from Channel 1, select the RIS method, set the timebase to 20 ps/div and adjust the trigger for a stable display.

k. Record the measured 10% to 90% rise time as 'System rise time' (t_{sys}) in the Test Record.

l. To measure the probe's rise time, disconnect the SMA cable from either the LPA-to-BNC adapter or the SMA-to-BNC adapter, and connect it to the female SMA 50 Ω terminator (Figure 8-8).

m. Remove the LPA-to-SMA or the SMA-to-BNC adapter from Channel 1. Set the Channel 1 scale factor to 0.1 V/div, the input coupling to DC 50 Ω and triggering from Channel 1.

n. Disconnect the probe output from Channel 2 and connect to Channel 1, taking care not to disturb the Adjustable Tip module setup with the Characterization Fixture.

o. Use the variable scale factor to obtain a pulse height of about 6 divisions. Adjust the OFFSET to center the displayed pulse around the center graticule line.

p. Measure the 10% to 90% rise time and record the measurement as 'Rise time with probe' (t_2) in the Test Record.

q. Calculate the probe's rise time by taking the square root of the difference of $(t_{sys})^2$ and $(t_2)^2$.

$$Probe\ Rise\ Time\ =\ \sqrt{(t_2)^2 - (t_{sys})^2}$$

r. Record the calculated rise time as 'Probe Rise Time' in the Test Record.

s. Check that the calculated rise time for the WLx00 is:

WL600 with D600A-AT: < 70 ps

WL600 with D600ST-SI: < 65 ps

WL300 with D350ST-SP: < 165 ps

WL300 with D300A-AT: < 95 ps

This concludes the Performance Verification Procedure.

###

BLANK PAGE

Specifications

The specifications are valid for probes when the following conditions have been met:

- The probe has been operating for at least 30 minutes in an environment that is within the operating environmental specifications.
- The probe has been calibrated within the last 12 months. Calibration was performed in a controlled environment of 25 °C ±5 °C.
- D600A-AT, D600ST or D500PT operated with WL600 probe body.
- D300A-AT or D350ST-SP operated with either a WL300 or WL600 probe body.

NOMINAL CHARACTERISTICS

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

General

Input Configuration	True differential + and – Inputs with auxiliary ground connection.
Input Connectors	
AT	Sharp probe tip; user adjustable spacing of the flexible tips to ensure contact on uneven surface.
PT	Small format probe with sharp probe tip; user adjustable spacing is spring loaded to assure contact on uneven surface.
SI	Solder-In; damping resistor leads can be soldered directly onto any test point on the board.
QC	Quick Connect; connector at the end of the QC lead will connect to damping resistors soldered to circuit's test points.

SP	Square Pin; connects to standard square pins test points.
Maximum Non-Destruct Input Voltage, continuous	Withstand up to ±18 V_p (±40 V_p for D350ST only)
Probe Attenuation	
D600A-AT, D600ST, D500PT and D300A-AT	÷2.5
D350ST	÷5
Input Resistance	
D600A-AT, D600ST, D500PT and D300A-AT	4 kΩ Differential, 2 kΩ each input to ground
D350ST	8 kΩ Differential, 4 kΩ each input to ground
Output Interface	
WL600	ProLink
WL300	ProBus

Dynamic Ranges

Maximum Differential Linear Input	
D600A-AT, D600ST, D500PT and D300A-AT	±2.4 V
D350ST	±5.0 V
Maximum Common Mode Input	
D600A-AT, D600ST, D500PT and D300A-AT	±2.4 V
D350ST	±5.0 V

WARRANTED CHARACTERISTICS

Warranted characteristics describe parameters that have guaranteed performance. Unless otherwise noted, tests are provided in Section 8, “Performance Verification,” for all warranted specifications.

LF Attenuation Accuracy	
(Probe only at +20 °C to +30 °C with 0 V common mode)	
D600A-AT, D600ST,	2% (V_{in}: | 0 to 1.2 V |)
D500PT and D300A-AT	5% (V_{in}: | 1.2 V to 2.4 V |)

D350ST	2% (V_{in}: | 0 to 2.4 V |) 5% (V_{in}: | 2.4 V to 5.0 V |)

Output Zero
(Referred to the input. For at least 15 minutes after AutoZero)

D600A-AT, D600ST, D500PT and D300A-AT	<10 mV
D350ST	< 20 mV

Rise Time (probe only) (10% - 90%)

D600A-AT[1]	< 70 ps
D600ST-SI[1]	< 65 ps
D500PT[2]	< 100 ps
D350ST-SP[3]	< 90 ps
D300A-AT[3]	< 95 ps

TYPICAL CHARACTERISTICS

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

Bandwidth (System)

D600A-AT	6 GHz[1]
D600ST-SI	6 GHz[1]
D600ST-QC	4 GHz[1]
D600ST-SP	3 GHz[1]
D500PT	5 GHz[2]
D350ST	4 GHz[3]
D300A-AT	3 GHz[3]

Rise Time (System) (10% - 90%)

D600A-AT	89 ps[1]
D600ST-SI	93 ps[1]
D600ST-QC	87 ps[1]
D600ST-SP	117 ps[1]
D500PT	120 ps[2]
D350ST	180 ps[3]
D300A-AT	183 ps[3]

Noise (Referred to input, System)

D600A-AT, D600ST	5.8 mV_{rms}[1]

D500PT	5.8 mV_{rms} [1]
D350ST	9.5 mV_{rms} [3]
D300A-AT	5.0 mV_{rms} [3]

Notes:

[1] Measured with 6 GHz instrument bandwidth

[2] Measured with 5 GHz instrument bandwidth

[3] Measured with 3 GHz instrument bandwidth

CMRR	See figures 9-1 through 9-4
D600A-AT:	
DC to 1 GHz	> 40 dB
1 GHz to 3 GHz	> 30 dB
3 GHz to 7 GHz	> 20 dB
D600ST	
DC to 1 GHz	> 30 dB
1 GHz to 3 GHz	> 25 dB
3 GHz to 7 GHz	> 20 dB
D500PT	
DC to 1 GHz	> 25 dB
1 GHz to 3 GHz	> 19 dB
3 GHz to 5 GHz	> 16 dB
D350ST	
DC to 1 GHz	> 30 dB
1 GHz to 3 GHz	> 25 dB
D300A-AT	
Dc to 1 GHz	> 40 dB
1 GHz to 3 GHz	> 30 dB
Propagation Delay	7 ns
Total Harmonic Distortion	
D600A-AT, D600ST, D500PT, D300A-AT	1.10% at 1 GHz, 0.8 V_{p-p} input
D350ST	0.66% at 1 GHz, 2 V_{p-p} input
2nd Order Intercept (Input)	
D600A-AT, D300A-AT	43 dBm
D600ST, D500PT	48 dBm
D350ST	54 dBm

3rd Order Intercept (Input)	
D600A-AT, D300A-AT	33 dBm
D600ST, D500PT	30 dBm
D350ST	36 dBm
Gain / Temperature Coefficient	
D600ST, D500PT, D350ST	0.08%/°C

ENVIRONMENTAL CHARACTERISTICS

The Environmental Characteristics are tested to specification MIL-PRF-28800F Class 4

Temperature (Operating)	0 °C to 40 °C (Probe module can be operated intermittently at higher temperatures using the Power Control function)
Temperature (Non-Operating)	-40 °C to 71 °C
Humidity (Operating)	5% to 80% RH* (Non-Condensing) *50% RH above 30 °C
Humidity (Non-Operating)	5% to 95% RH* (Non-Condensing) *75% RH above 30 °C and 45% RH above 40 °C

Note 1: Measured with 6 GHz instrument bandwidth
Note 2: Measured with 3 GHz instrument bandwidth

PHYSICAL CHARACTERISTICS

Adjustable Tip spacing	0 to 3.0 mm (0 to 0.12”)
Adjustable Tip point diameter	75 µm
Positioner Mounted Tip spacing	0.5 to 4 mm
Positioner Mounted Tip diameter	0.2 mm (0.008”)
Z-axis compliance	2 mm
SI & QC Resistor Tip Spread at circuit connection	0 to 11 mm (0 to 0.43 in.)
SP Insertion Depth	2.54 mm (0.100 in.) min. to 2.79 mm (0.110 in.) max.

Cable Length	1.3 m (4 ft. 3 in.)

Weight:

Probe only

(Includes probe body with WL300)

D600A-AT, D300A-AT	146 g (5.1 oz.)
D600ST, D350ST	152 g (5.3 oz.)
D500PT	170 g (6.0 oz.)

(Includes probe body with WL600)

D600A-AT, D300A-AT	171 g (6.0 oz.)
D600ST, D350ST	177 g (6.2 oz.)
D500PT	197 g (6.9 oz.)

Shipping

D600A-AT, D300A-AT	0.45 kg (1 lb.)
D600ST, D350ST	0.57 kg (1 lb. 4 oz.)
WL600, WL300	1.3 kg (2 lbs. 14 oz.)

COMPLIANCE AND CERTIFICATIONS

CE Compliant

CE Declaration of Conformity

The Dx00 Differential Probe meets the intent of the European Council Directive 73/23/EEC for Product Safety and 89/336/EEC for Electromagnetic Compatibility. This declaration is based upon compliance of the product to the following standards:

Low Voltage Directive:	EN 61010-031:2002 Safety requirements for electrical equipment for measurement, control and laboratory use. Part 031: Safety requirements for hand-held probe assemblies for electrical measurements and test.
EMC Directive:	EN 61326-1:1997+Amd1:1998+Amd2:2001 EMC requirements for electrical equipment for measurement, control and laboratory use.
	EN 55011:1998+Amd1:1999 Radiated Emissions (Class A)
	EN 61000-4-2:1995+Amd2:2001* Electrostatic Discharge Immunity (±4 kV contact discharge, ±8 kV air discharge)
	EN 61000-4-3:2002* RF Radiated Electromagnetic Field Immunity (3 V/m, 30 MHz to 1 GHz, 80% amplitude modulated with 1 kHz sinewave)

* Meets Performance Criteria “B” limits – temporary, self-recoverable degradation or loss of performance is allowed, but no change of actual operating state or loss of stored data is allowed.

Warning

This is a Class A product. In a domestic environment this product may cause radio interference, in which case the user may be required to take appropriate measures.

CMRR GRAPHS

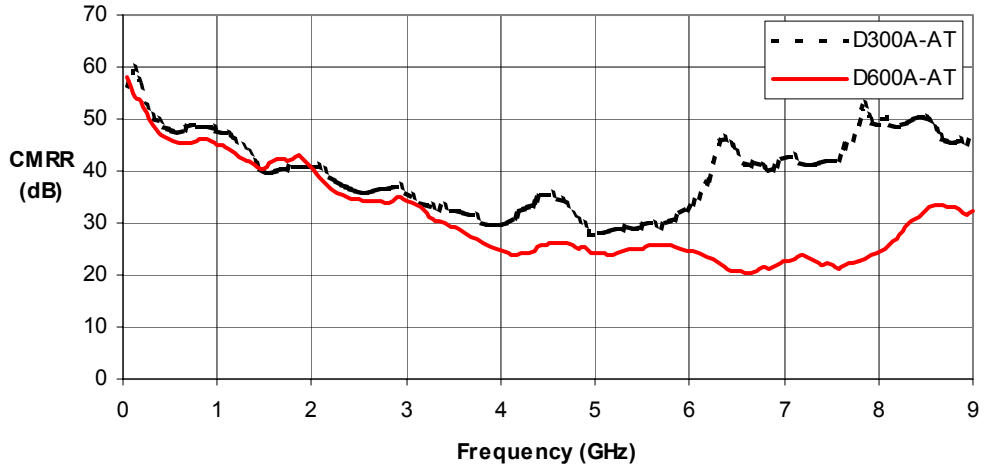


Figure 9-1. Typical D600A-AT / D300A-AT CMRR

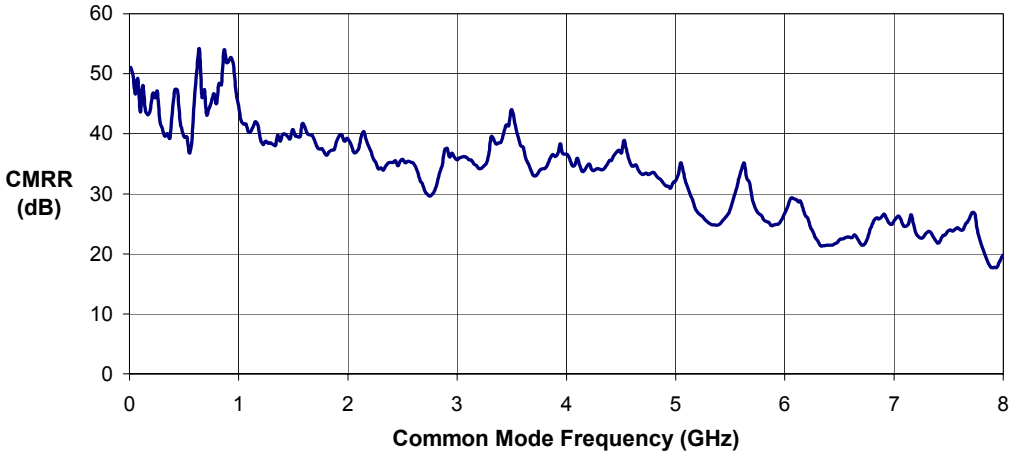


Figure 9-2. Typical D600ST CMRR

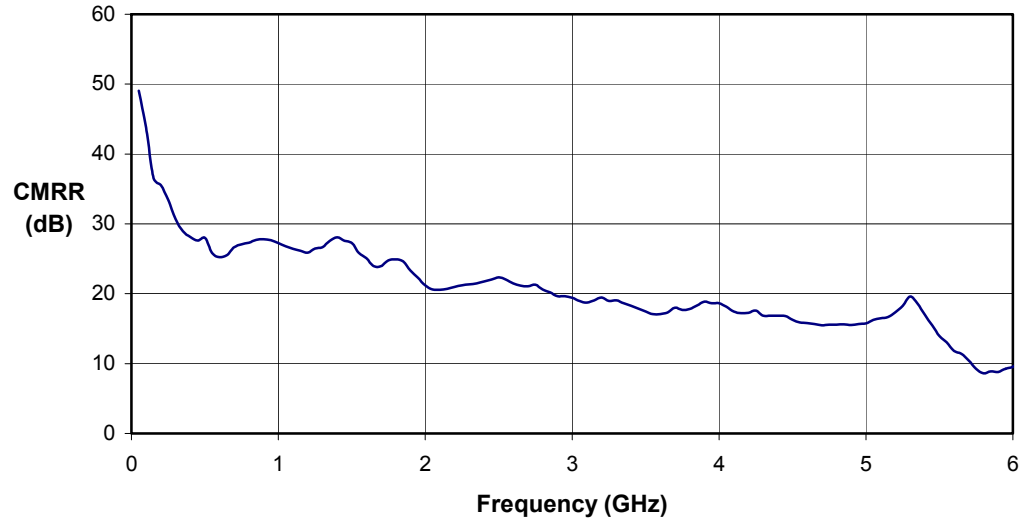


Figure 9-3. Typical D500PT CMRR

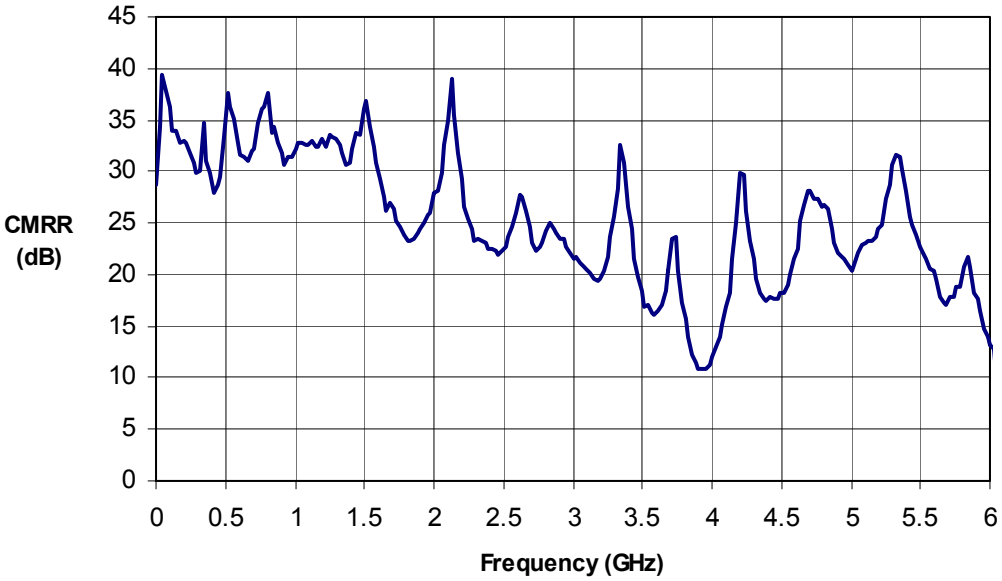


Figure 9-4. Typical D350ST-SI CMRR

BLANK PAGE

Appendix A

PERFORMANCE VERIFICATION TEST RECORD

This record can be used to record the results of measurements made during the performance verification of the WaveLink Differential Probe series.

Photocopy this page and record the results on the copy. File the completed record as required by applicable internal quality procedures.

The section in the test record corresponds to the parameters tested in the performance verification procedure. The numbers preceding the individual data records correspond to the steps in the procedure that require the recording of data. Results to be recorded in the column labeled "Test Result" are the actual specification limit check. The test limits are included in all of these steps. Other measurements and the results of intermediate calculations that support the limit check are to be recorded in the column labeled "Intermediate Results."

Permission is granted to reproduce these pages for the purpose of recording test results.

Use a new Test Record for each tested probe, probe tip module, and lead assembly

ITEMS TESTED

Item	Serial Number
WL600	
WL300	
D600A-AT	
D600ST	
D600ST-SI	
D600ST-QC	
D600ST-SP	
D500PT	
D500PT-TIP	
D350ST	
D350ST-SP	
D300A-AT	

EQUIPMENT USED:

	MODEL	SERIAL NUMBER	CALIBRATION DUE DATE
OSCILLOSCOPE			
DIGITAL MULTIMETER			
SINE WAVE GENERATOR			
PULSE GENERATOR			

TEST RECORD

Step	Description	Intermediate data	Test Result
Output Zero			
1-g	Output Voltage	_____ V	
1-i	Output Voltage after AutoZero	_____ V	
1-k	**Output Zero** (Test limit ≤ 10 mV, except D350ST < 20 mV)		_____mV
Low Range Attenuation Accuracy			
2-r	Probe Low Range Input Voltage	_____ V	
2-t	Probe Low Range Output Voltage	_____ V	
2-u	Corrected Low Range Output Voltage	_____ V	
2-w	**Low Range Attenuation Error** (Test limit ≤ 2%)		_____%
High Range Attenuation Accuracy			
3-e	Probe High Range Input Voltage	_____ V	
3-g	Probe High Range Output Voltage	_____ V	
3-h	Corrected High Range Output Voltage	_____ V	
3-j	**High Range Attenuation Error** (Test limit ≤ ±5.0%)		_____%
Rise Time			
4-k	System rise time	_____ ps	
4-p	Rise time with probe	_____ ps	
4-r	**Probe Rise Time**		_____ psec

###