# LXI Wired Trigger Bus Cable and Terminator Specifications

Revision 2.00

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**Revision history:**

| *Revision* | *Description* |
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| 1.01 April 5, 2006 | Initial revision for review |
| 1.02 April 11, 2006 | Apply Changes from Duaine Wood |
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| Editorial proposal | Revise front matter to be consistent with proposals for all standards. Minor revisions in wording of specifications. Formal definition of normative and informative. SUGGESTIONS for revising this document for consistency with other LXI standards. |
| Editorial proposal April 2, 2010 | Incorporated rules, descriptions, and performance from LXI Standard 1.3 document specific to cable construction and system performance into this document. Conrad Proft |
| Editorial proposal April 5, 2010 | Moved all test procedures to Appendices |
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| 2.00 Dec 16, 2010 | Version changes for review by LXI Consortium |
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# 1 Overview

The LXI Device Wired Trigger Bus implements a cabling system to interconnect multiple LXI Devices. The physical interface builds upon the TIA/EIA-889 Multipoint Low Voltage Differential Signaling (M-LVDS) standard. This standard uses differential current driven signals to exchange data between semiconductor devices. Each LXI Device supporting the LXI Wired Trigger Bus has a minimum of two Trigger Bus connectors. This provides a pass-through connection of the bus by routing signals through each participating instrument. A termination device is required at the end of each LXI Wired Trigger Bus connection segment, provided by the LXI Wired Trigger Bus Terminator. The terminator attaches to the second connector at each segment end, as seen in Figure 1.1.

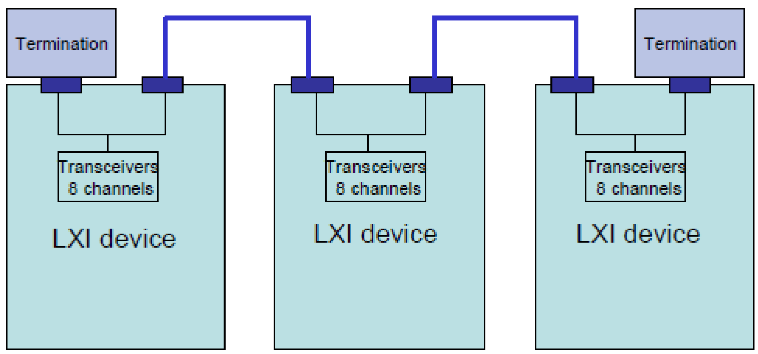


**Figure 1.1** Configuration of LXI Devices using the LXI Wired Trigger Bus

The LXI Wired Trigger Bus provides eight physically independent trigger channels, matching the number of logical channels provided by the LXI Event Message mechanism in the LXI standard. The LXI Wired Trigger Bus designates LXI0 to LXI7, while the LXI Event Message designates identifiers LAN0 to LAN7.

Trigger events made through the LXI Wired Trigger Bus or the LXI Event Message trigger system are interchangeable, since the trigger model is consistent in each mode of operation.

There are important differences in performance between the LXI Wired Trigger Bus and LXI Event Messages. LXI Event Messages are LAN-based and depend upon the LAN driver, LAN speed, software interrupts, and processor speed. The LXI Wired Trigger Bus is a dedicated bus interface with the following characteristics:

- Hardware delays on the bus cables and associated routing logic dominate the trigger delay between an event and the initiation of an action at another node
- LXI Devices connect the trigger bus signals as directly as possible from the interface to the hardware performing the task.
- Once set up there is virtually no software or firmware related delays in reaction times.

The LXI Wired Trigger Bus exhibits both low trigger delay and low trigger jitter and performance levels which are not achieved through the LAN based trigger mechanisms. In addition to supporting high performance trigger operations, the trigger bus can also be used to exchange clock signals or other data signals between LXI Devices.

## 1.1 Purpose and Scope

This document specifies the requirements to construct LXI Wired Trigger Bus Cable assemblies. It defines the mechanical construction and the electrical characteristics and expected performance of the cable. The Standard also provides construction details for the completed LXI Wired Trigger Bus cables and LXI Wired Trigger Bus termination blocks. In addition, it discusses other interconnect methods such as LXI Wired Trigger Bus Adapters and Star Hub devices.

This document focuses on the interconnection between LXI Devices that implement the LXI Wired Trigger Bus. Device specific requirements can found in the ***LXI Standard for LXI Devices***. Properly functioning interconnect cables are required by LXI Devices to comply with their LXI triggering requirements.

## 1.2 Definition of Terms

This document contains both normative and informative material. Unless otherwise stated the material in this document shall be considered normative.

NORMATIVE: Normative material shall be considered in determining whether a product is conformant to this standard. Any section or subsection designated as a **RULE** or **PERMISSION** is normative.

INFORMATIVE: Informative material is explanatory and is not considered in determining the conformance of a product supporting this standard. Any section or subsection designated as **RECOMMENDATION** or **OBSERVATION** is informative. Unless otherwise noted, examples are informative.

**RULE**: Rules **SHALL** be followed to ensure compatibility for products supporting the LXI Wired Trigger Bus. A rule is characterized by the use of the words **SHALL** and **SHALL NOT**. These words are not used for any other purpose other than stating rules.

**RECOMMENDATION**: Recommendations consist of advice to implementers that will affect the usability of the final device. Discussions of particular hardware to enhance throughput would fall under a recommendation. These recommendations should be followed to avoid problems and to obtain optimum performance.

**PERMISSION**: Permissions are included to clarify the areas of the specification that are not specifically prohibited. Permissions reassure the reader that a certain approach is acceptable and will cause no problems. The word **MAY** is reserved for indicating permissions.

**OBSERVATION**: Observations spell out implications of rules and bring attention to things that might otherwise be overlooked. They also give the rationale behind certain rules, so that the reader understands why the rule must be followed.

Any text that appears without heading should be considered as description of the specification.

## 1.3 LXI Wired Trigger Bus Cable and Terminator Conformance Requirements

The document "***LXI Consortium Policy for Certifying Conformance to LXI Consortium Standards***" gives specific requirements on conformance certification. Refer to Section 2 and Section 3 of that document for further information.

### 1.3.1 Rule – Conformance Requirements

Cable assemblies shall implement and conform to all the rules in Sections 2 and 3 of this document. Terminators shall implement and conform to all the rules in Section 4 of this document. Both cable assemblies and terminators can be marked as outlined in those respective sections.

# 2 Cable Requirements

## 2.1 Cable Mechanical Requirements

The LXI Wired Trigger Bus cable consists of eight twisted pairs. Each twisted pair is individually shielded with a wrap and a drain wire. The eight twisted pair sub assemblies are combined with a filler and wrapped with an outer shield covered with a separator.

### 2.1.1 Rule – Outer Jacket Material and Thickness

The outer jacket should be a nominal 30 mil thick, pressured PVC construction rated for 80ºC and 30 V. The outer jacket should have a minimum thickness of 24 mil per AWM style 2502. The quality of the cable affects its ability to handle the stress of cable routine

#### 2.1.1.1 Observation – Outer Jacket Color

The outer jacket color is not specified which allows each manufacture to construct cable assemblies which conform to its own corporate color schemes and standards.

### 2.1.2 Rule – Twisted Pair Wire Diameter and Insulation

Each twisted pair of wires should consist of two 26 AWG silver plated copper stranded wires. Each wire should be insulated with 14 mil nominal, 12 mil minimum cellular polyethylene rated for 80ºC 30 V. The nominal outer diameter of the insulation is 0.048" ± 0.002". Constructing the cable in this manner should achieve good signal integrity and performance.

#### 2.1.2.1 Observation

A minimum 26 AWG copper wire with a surface conductivity equal to or better than silver is required to achieve the necessary system bandwidth.

### 2.1.3 Rule – Twisted Pair Wire Color Coding

The wires used to construct the eight twisted pairs shall be color coded such that each wire is uniquely identifiable.

#### 2.1.3.1 Recommendation – Twisted Pair Wire Color Coding

It is recommended that the twisted pairs of the LXI Wired Trigger Bus cable be color coded according to Table 2.1.

#### 2.1.3.2 Permission – Twisted Pair Wire Color Coding

Since color coding does not affect electrical connectivity or performance of the wires, any other suitable color coding scheme may be used so long as each twisted pair and connection can be uniquely identified.

| Pair Number | P Color / Stripe | N Color / Stripe |
|---|---|---|
| | | |
| 1 | White / Blue | Blue / White |
| 2 | White / Orange | Orange / White |
| 3 | White / Green | Green / White |
| 4 | White / Brown | Brown / White |
| 5 | White / Gray | Gray / White |
| 6 | Red / Blue | Blue / Red |
| 7 | Red / Orange | Orange / Red |
| 8 | Red / Green | Green / Red |

**Table 2.1 Twisted Pair Wire Color Coding**

## 2.1.4 Rule – Twisted Pair Shielding

Each twisted pair of wires should be individually shielded with an Aluminum/Mylar foil. The foil should be wound with the conductive surface towards the inside along with a 28 AWG tin plated copper drain wire for connectivity to the shield.

## 2.1.5 Rule – Mechanical Construction of Twisted Pairs

Each of the twisted pairs used to construct the Wired Trigger Bus cable should be built per Figure 2.1. The materials used are identified in Table 2.2

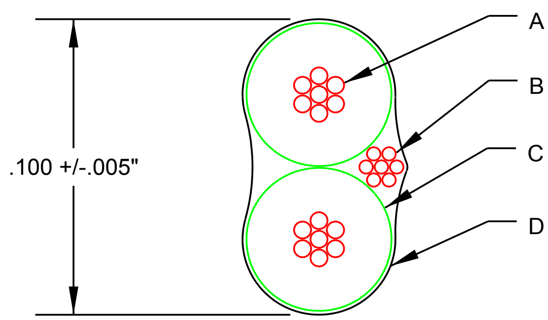


**Figure 2.1 Single Twisted Pair Assembly**

## 2.1.6 Rule – Mechanical Construction of the Completed Cable

The eight twisted pair subassemblies should be combined with a center core, wrapped with an outer shield, and jacketed according to Figure 2.2. The materials are identified in Table 2.2, which also locates each of the cable components.

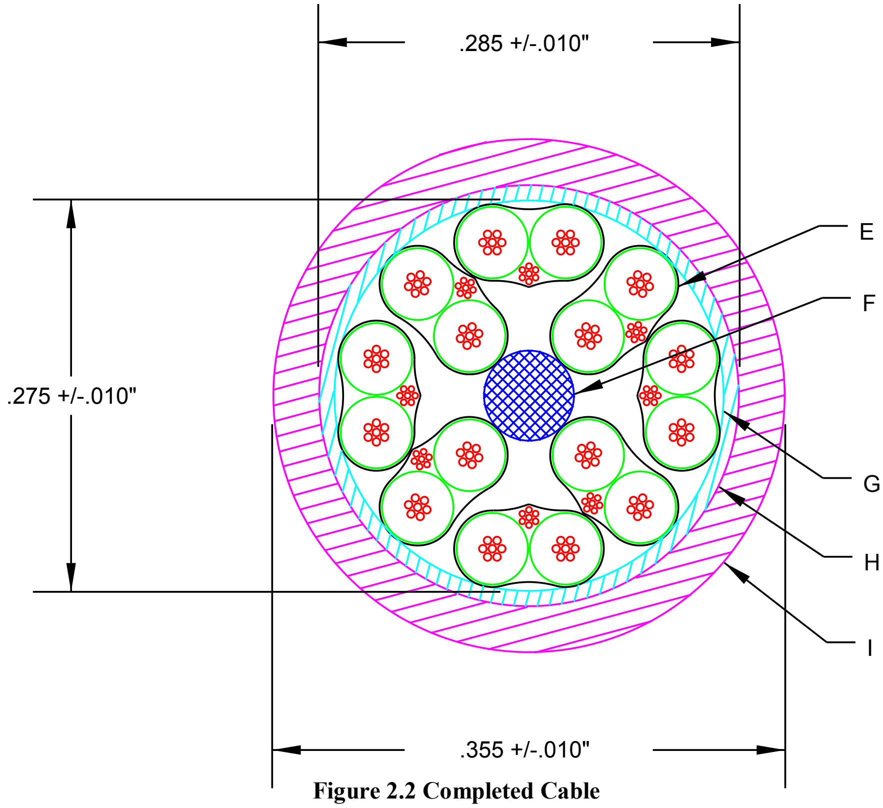


**Figure 2.2 Completed Cable**

## 2.1.7 **Rule – Materials Used**

The cable should be constructed using the material types listed in Table 2.2.

| Item | Type | Material |
|---|---|---|
| | | |
| A | Signal Wire Conductor | 26 AWG Silver Plated Copper, Stranded<br>7 x 0.0063", Concentric OD 0.019" ± 0.001" |
| B | Drain Wire | 28 AWG Tin Plated Copper, Stranded 7 x 0.005" |
| C | Signal Wire Insulation | 14 mil cellular polyethylene 80C 30V,<br>12 mil min. cellular polyethylene insulation<br>Nominal O.D. 0.048" ± 0.002"<br>AWM style 1589 |
| D | Twisted Pair Shield | Aluminum/Mylar shield. Wound foil side in. |
| | | |
| E | Twisted Pair Subassembly | See Figure 2.1 For Construction. No particular pitch is specified due to shielding requirements. |
| F | Core Filler | Polyethylene Filler. |
| G | Separator | Opaque Mylar. |
| H | Outer Shield | 38 AWG Tin/Copper spiral serve to<br>85% coverage. |
| I | Outer Jacket | 30 mil pressured PVC jacket 80°C 30 V.<br>24 mil minimum PVC jacket AWM style 2502. |

**Table 2.2 Materials used and figure identification**

#### 2.1.7.1 **Permission – Use Of Alternate Materials**

Other materials may be used so long as the cable meets all the specified electrical, mechanical, and safety requirements specified in this document.

#### 2.1.7.2 **Observation – Use of Alternate Materials**

The materials used in the construction of the cable directly affect the electrical performance, mechanical performance, and safety approvals.

## 2.2 Electrical Characteristics

A cable constructed to the standard should have the characteristics described in Table 2.3

| | |
|---|---|
| Nom. Diff. Characteristic Impedance | 100 ohms (+10 ohms, -15 ohms) |
| Nom. Inductance @ 10 kHz | 0.47 uH/meter |
| Nom. Capacitance – Conductor To Conductor @ 10 kHz | 41.0 pF/meter |
| Nom. Capacitance – Conductor To Other Conductor & Shield @ 10 kHz | 65.6 pF/meter |
| Nom. Velocity of Propagation | 74% |
| Nom. Conductor DC Resistance @ 20C | 14.57 ohms / 100 meters |
| Nom. Outer Shield DC Resistance @ 20C | 1.7 ohms / 100 meters |
| Max. Operating Voltage | 30 V RMS |

**Table 2.3 Electrical Performance Characteristics**

### 2.2.1 Rule – Electrical Characteristics

If a cable is constructed using alternate materials from those identified in Table 2.2, then the resulting cable should conform to the specifications listed in Table 2.3

### 2.2.2 Minimum Pulse Width in Driven Mode and Wired-Of Modes

When constructing cables in accordance with these specifications, the minimum pulse width of LXI Wired Trigger Bus signals transmitted in Driven Mode is 10ns for connection segments of 10 meters or less and 20 ns on connection segments of 20 meters or less. Similarly, the minimum pulse width of LXI Wired Trigger Bus signals transmitted in Wired-Or Mode is 20ns for connection segments of 10 meters or less and 40 ns on connection segments of 20 meters or less.

### 2.2.3 Testing Electrical Requirements

Appendix B gives recommendations for testing the various electrical requirements in building an LXI Wired Trigger Bus cable assembly.

# 3 LXI Wired Trigger Bus Cable Assembly

## 3.1 LXI Wired Trigger Bus Cable Assembly Requirements

The LXI Wired Trigger Bus cable assemblies consist of a length of LXI Wired Trigger Bus compliant cable wired to industry standard Micro-D connectors at each end.

### 3.1.1 Rule – LXI Wired Trigger Bus Cable Connectivity

The LXI Wired Trigger Bus cable assemblies should be wired per Table 3.1. Cable assemblies must not connect to the +3.3 volt pin, the +3.3 volt return pin, or the Reserved pins.

### 3.1.2 Rule – Connector Shielding

Each Micro-D connector should provide a shielded back shell to protect against radiated emissions and provide a mechanical strain relief.

#### 3.1.2.1 Observation – Connector Construction

The back shell may be designed as a metal casting which provides strain relief, EMI management, and an exterior finish. The connector may alternately be designed as a formed sheet metal component with a plastic boot or plastic over-mold cover to provide the finished component.

### 3.1.3 Recommendation - LXI Wired Trigger Bus Cable Labeling

An LXI Wired Trigger Bus cable can be labeled with the LXI logo, in accordance with the LXI Consortium document ***LXI Consortium Trademark, Patent and Licensing Policies*** . An example of which is shown in Figure 3.1.

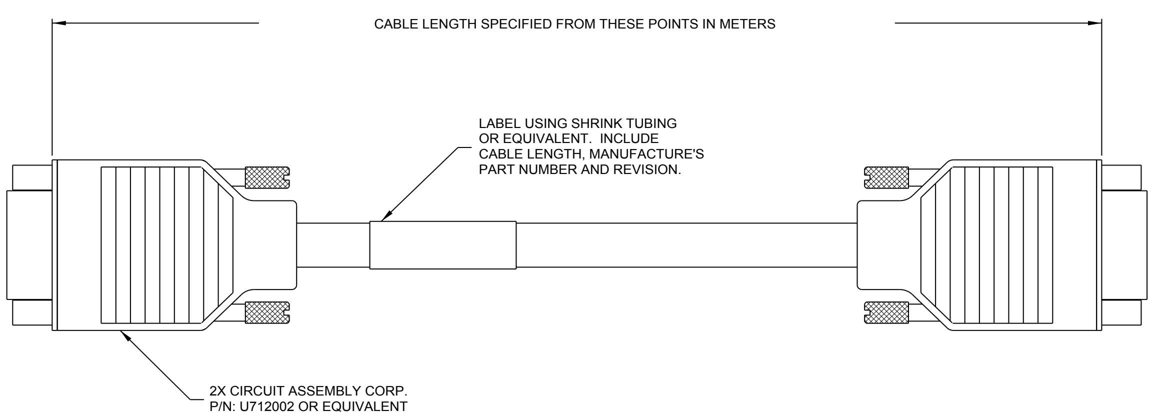


**Figure 3.1 Example Cable**

| CONN | SIGNAL NAME (Informative, see LXI Standard for LXI Devices section 5) | P1 PIN | WIRE COLOR | P2 PIN | NOTES |
|---|---|---|---|---|---|
| 1 | +3.3V | 1 | N/C | 1 | |
| 2 | +3.3V RETURN | 2 | N/C | 2 | |
| 3 | LXI1p | 3 | | 3 | Paired with pin 4 |
| 4 | LXI1n | 4 | | 4 | Paired with pin 3 |
| 5 | GND | 5 | | 5 | Drains from conn 3-4 & 6-7 |
| 6 | LXI3p | 6 | | 6 | Paired with pin 7 |
| 7 | LXI3n | 7 | | 7 | Paired with pin 6 |
| 8 | GND | 8 | | 8 | Drains from conn 9-10 & 12-13 |
| 9 | LXI5p | 9 | | 9 | Paired with pin 10 |
| 10 | LXI5n | 10 | | 10 | Paired with pin 9 |
| 11 | RESERVED | 11 | N/C | 11 | |
| 12 | LXI7p | 12 | | 12 | Paired with pin 13 |
| 13 | LXI7n | 13 | | 13 | Paired with pin 12 |
| 14 | LXI0p | 14 | | 14 | Paired with pin 15 |
| 15 | LXI0n | 15 | | 15 | Paired with pin 14 |
| 16 | RESERVED | 16 | N/C | 16 | |
| 17 | LXI2p | 17 | | 17 | Paired with pin 18 |
| 18 | LXI2n | 18 | | 18 | Paired with pin 17 |
| 19 | GND | 19 | | 19 | Drains from conn 14-15 & 17-18 |
| 20 | LXI4p | 20 | | 20 | Paired with pin 21 |
| 21 | LXI4n | 21 | | 21 | Paired with pin 20 |
| 22 | GND | 22 | | 22 | Drains from conn 20-21 & 23-24 |
| 23 | LXI6p | 23 | | 23 | Paired with pin 24 |
| 24 | LXI6n | 24 | | 24 | Paired with pin 23 |
| 25 | RESERVED | 25 | N/C | 25 | |
| | | | | | |
| 26 | CHASSIS | 26 | | 26 | Outer shield wires – attach to the connector shell. |

**Table 3.1 LXI Wired Trigger Bus Wiring**

## 3.2 LXI Wired Trigger Bus Cable Assembly Test Requirements

### 3.2.1 **Rule – LXI Wired Trigger Bus Cable Assembly Test Requirements**

The completed LXI Wired Trigger Bus Cable assembly should be tested for proper continuity and short circuits. This may be accomplished using standard cable test equipment and fixtures.

### 3.2.2 **Rule – LXI Wired Trigger Bus Cable Assembly Wire Pairing**

The completed LXI Wired Trigger Bus Cable assembly should be compliance tested for proper pairing of the differential signals.

#### 3.2.2.1 **Observation – Cable Assembly Wire Pairing**

The testing of wire pairing is required to assure that the assembly methods are correct. Wire pair testing as a part of production test is expected. Once proper assembly methods are established, and demonstrated by the compliance test, no production test for wire pairing is required. Note that continuity testing assures that all signals are connected and not cross-wire; however, it does not assure that each differential signal is correctly paired in the cable assembly.

### 3.2.3 **Wire Pair Testing**

Appendix C gives recommendations for wire pair testing.

# 4 LXI Wired Trigger Bus Terminators

## 4.1 LXI Wired Trigger Bus Terminator Mechanical Requirements

An LXI Wired Trigger Bus Terminator consists of either a 25 pin Micro-D style plug connector which mates to an LXI Device, or a module with a 25 pin Micro-D style jack which mates to an LXI Wired Trigger Bus Cable Assembly. Either device is wired to a printed circuit board which supports the required termination components, and may include additional components such as bus monitoring circuitry.

### 4.1.1 Rule – LXI Wired Trigger Bus Terminator Physical Size

The completed LXI Terminator should comply with all the requirements (both electrical and mechanical) of a 25 pin Micro-D style plug. An LXI Terminator implemented using a plug connector should be no larger than a standard connector back shell.

### 4.1.2 Recommendation – EMI Shielding

The shielded terminator connected to the metal shell of the connector protects from EMI radiation. The terminator device should provide standard jack screws to secure it to its mating connector and guarantee connectivity. See figure 4.1 for a typical implementation.

### 4.1.3 Recommendation – Labeling

The terminator can be externally labeled to indicate that the device is an LXI Wired Trigger Bus Terminator, and to which revision of this specification it complies.

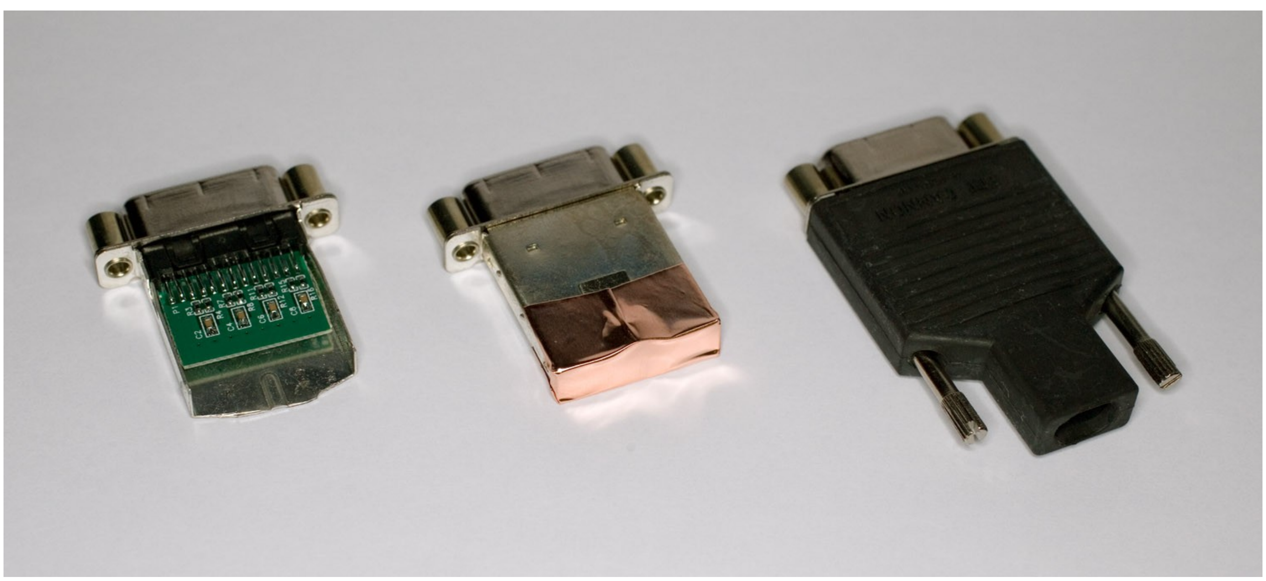

**Figure 4.1 Example LXI Wired Trigger Bus Terminators**

## 4.2 LXI Wired Trigger Bus Terminator Electrical Requirements

Each end of an LXI Wired Trigger Bus segment should be terminated using an LXI Wired Trigger Bus Terminator Block (except for devices which have a single trigger bus port and provide the termination function internally).

The Terminator Block provides a nominal 100 ohm differential termination to each of the eight LXI Wired Trigger Bus channels and an AC common mode termination. This is accomplished by wiring two 50 ohm resistors in series and connecting a 0.01uF ceramic capacitor from the center tap of the resistors to ground. See Figure 4.2 for a schematic representation of the LXI Wired Trigger Bus Terminator Block.

### 4.2.1 Rule – Termination Lengths

The connection lengths to the termination resistors and capacitors shall be kept to a minimum to assure a high quality termination. If the connection from the terminator's connector to the terminating resistors is greater than 5mm, the connections must be designed to provide a 100 ohm differential impedance up to the termination network.

#### 4.2.1.1 Example – Terminator Layout

Figure 4.3 shows a typical board layout for an LXI Wired Trigger Bus Terminator. The Printed Circuit Board is 0.700" by 0.500" in size, has two layers, and is constructed of 0.031" thick FR-4 type epoxy-glass material. The termination resistors are 0402 size thick film surface mount type, and the capacitors are 0603 size X7R dielectric surface mount type. The top layer is represented in red, and the bottom layer is represented in green.

### 4.2.2 LXI Wired Trigger Bus Termination (informative)

The LXI Wired Trigger Bus uses termination connector blocks installed at both ends of a connection segment, as shown in Figure 1.1. Each individual channel is terminated at each end by two 50-ohm (±5 %) resistors connected in series between the positive (A) and negative (B) signal wires, and a 0.01µF capacitor to ground connected to the node between the resistors, as shown in Figure 4.2. The resistor values are matched to within ±2%

### 4.2.3 LXI Wired Trigger Bus Terminator Testing

Appendix D shows recommended testing procedures for the completed LXI Wired Trigger Bus Terminator

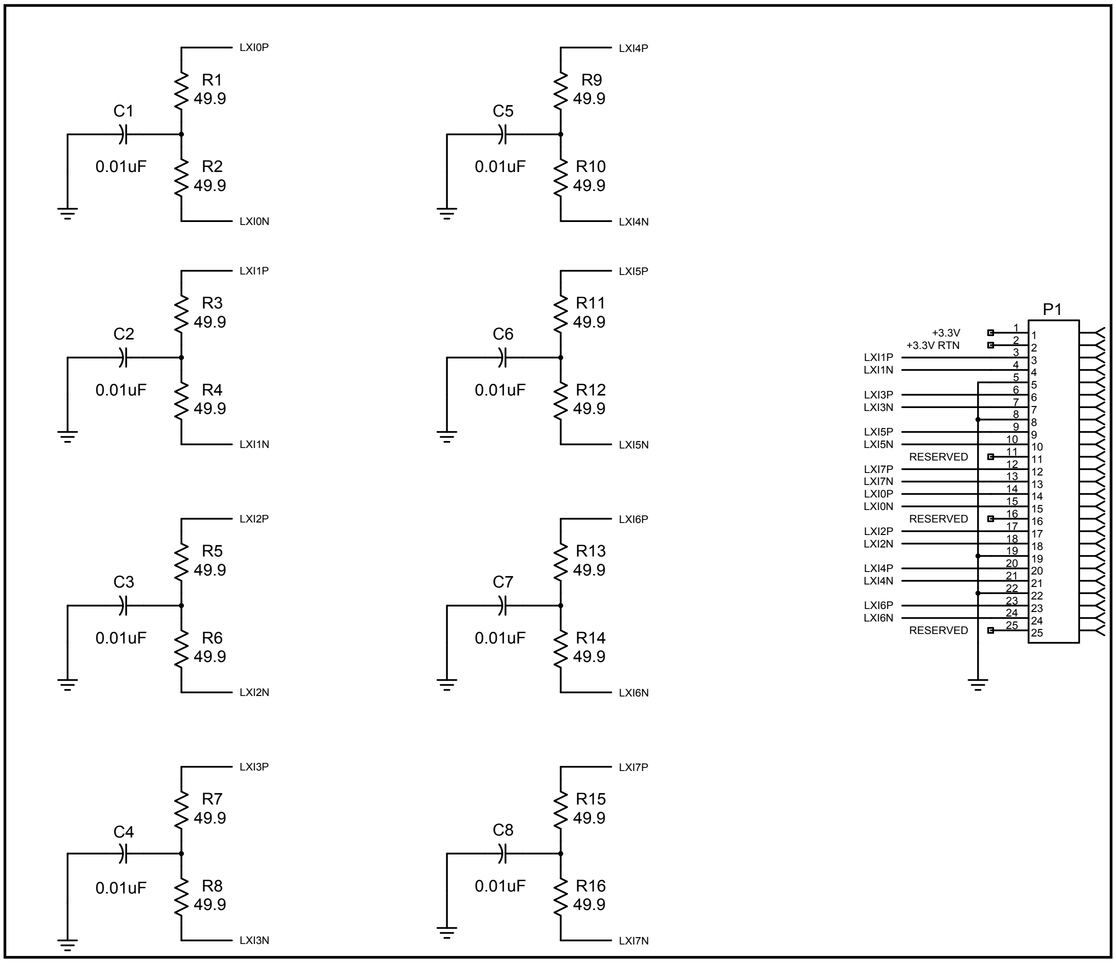


**Figure 4.2 Termination Requirements**

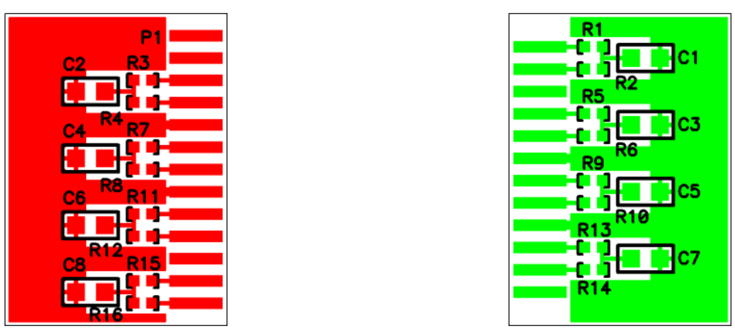


**Figure 4.3 Example termination pads**

# Appendix A.  Glossary of Terms

**AWG**

American Wire Gage.  Measure of wire diameter.

**AWM**

Appliance Wiring Material.  A UL designation for a type of wire.

**CSA**

Canadian Standards Association.

**LVDS**

Low-Voltage Differential Signaling.

**LXI**

LAN Extension for Instrumentation.

**LXI Device**

An instrument or other device which conforms to the LXI standard.

**Micro D Connector**

Connector style the commercial version of which is specified to be use on the WTB in the LXI Standard.  This connector is compatible with the high reliability version of the Micro-D connector commonly used in military applications.

**M-LVDS**

Multipoint Low-Voltage Differential Signaling conforming to TIA/EIA-899 standard.

**UL**

Underwriters Laboratory.

**TDR**

Time Domain Reflectometer. A method of measuring impedance and defects in a transmission by propagating a pulse down the line and observing the reflections as a function of time (distance down the line).

**Terminator**

Device specified in the LXI Standard that terminates the differential pair transmission line used on the WTB.

**WTB**

Wired Trigger Bus.

# Appendix B.  Recommended Electrical Testing

This section describes the tests a cable manufacturer can use to demonstrate compliance of a sample cable to the LXI Wired Trigger Bus Cable Specification.  A supplier of LXI Wired Trigger Bus Cable Assemblies should ensure that the cable used in constructing a Cable Assembly has been sample tested.

## Characteristic Impedance

The characteristic impedance of each twisted shielded pair should be measured using a Differential TDR (Time Domain Reflectometer)

### Characteristic Impedance Test Method

A 100cm sample of the cable is prepared for test by removing 3.5cm of the outer insulation material, gathering up the outer shield wires and twisting them together at one end only.  A twisted pair is exposed by removing 6mm of the shielding foil, thereby exposing two insulated wires and a bare drain wire.  The insulated wires are stripped back 2mm to expose the conductors.

Two coaxial cable assemblies are prepared using 15cm of 50 ohm 0.085” formable coaxial cable with SMA type connectors on one end.  The other end of each cable assembly has the braid and dielectric stripped back 2mm.  The stripped end of the two coaxial cables are laid side by side and the outer braids are soldered together over a length of approximately 6cm from the stripped ends.  The test cable is then attached to the coaxial cables, with the drain wire attached to the coaxial cables’ braids, and with each of the twisted pair wires connected to one of the two center conductors.  See Figures B.1 and B.1 for details.

The two SMA connectors are attached to the TDR’s test ports, and the TDR is adjusted to display the reflected waveform from the initial edge to the end of the cable (where the impedance goes toward infinity).  The TDR should then be adjusted to measure the differential impedance at approximately 6cm into the test cable to avoid erroneous readings due to the transition areas where the test cable assembly attaches to the cable under test.  Record the measured impedance and confirm that it conforms to the requirements stated in Table 2.3.

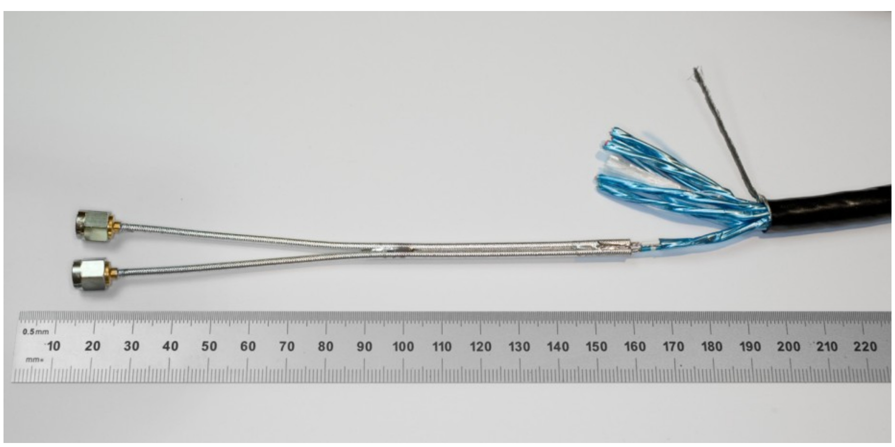


**Figure B.1**

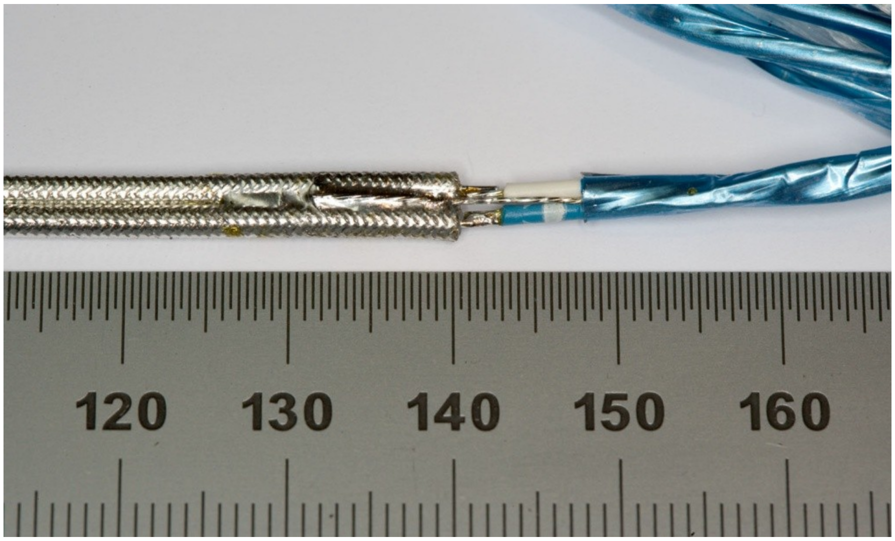


**Figure B.2**

## Inductance

The inductance of the signal conductors verified using an LCR bridge.

### Inductance Test Method

A 1.025 meter sample of cable is prepared for testing by striping back 5mm of outer jacket and cutting away the outer shield wires. A signal pair is selected, the wires are exposed by removing their inner shield foil, and are stripped back 3mm. The two signal wires along with the shield drain wire are joined together and soldered.

At the other end of the cable, 25mm of outer jacket is stripped away and the outer shield wires are cut away. Separate the eight twisted pairs and select the same pair as previously selected. Remove 25mm of its inner shield, and strip back the two signal wires 5mm. One of the two signal connections is connected to the shield drain wire.

The LCR bridge is set to measure inductance at a test frequency of 10KHz and the cable sample is connected. Connect the wire with the drain wire to the high side of the LCR bridge, and the other wire to the low side (connecting the drain wire to the high side reduces noise pickup). Record the inductance measured.

## Capacitance

The capacitance of the signal connections verified using an LCR bridge.

### Capacitance Test Method

A 1.025 meter sample of cable is prepared for testing by striping back 25mm of outer jacket and cutting away the outer shield wires. Separate the eight twisted pairs and select the same pair as previously selected. Remove 25mm of its inner shield, and strip back the two signal wires 5mm.

The LCR bridge is set to measure capacitance at a test frequency of 10KHz and the cable sample is connected. Connect one of the signal wires to the high side of the LCR bridge, and the other signal wire to the low side. Record the conductor to conductor capacitance measured.

Remove the signal wire connected to the high side of the LCR bridge and connect the shield drain wire in its place (connecting the drain wire to the high side reduces noise pickup). Record the conductor to shield capacitance.

## Velocity Of Propagation

The velocity of propagation is measured using the same equipment and setup used to measure characteristic impedance.

### Velocity of Propagation Test Method

The test cable assembly used in Figures B.1 and B.2 are connected to the differential TDR for measurement. The TDR is adjusted so that the small bump in impedance where the fixture cables attach to the test cable is visible as well as the end of the cable where the impedance goes toward infinity. Using the cursors on the TDR, measure the time from the center of the impedance bump to the point where the impedance goes toward infinity. This is the time delay through 1 meter of test cable. Note that the test cable must be accurately measured and cut to within 5mm of 1 meter.

The velocity of propagation is calculated by dividing the velocity of light by one half the measured delay (the measured delay is a round trip time up and down the test cable) times 100 percent.

$$\text{Velocity of Propagation} = 100\% \bullet \left( \frac{3.336\, {}^{nS}\!/_{M}}{{}^{1}\!/_{2}\, \Delta T\, {}^{nS}\!/_{M}} \right)$$

Record the measured velocity of propagation and confirm that it conforms to the requirements stated in Table 2.3.

## DC Resistance

The DC resistance measurement is made using a four-wire method. A digital multimeter which can resolve a minimum of 10 milliohms is required.

### DC Resistance Test Method

A 20 meter sample of the cable is prepared for test by removing 2.5cm of the outer insulation material, gathering up the outer shield wires and twisting them together at both ends. A single insulated wire is isolated from a twisted pair at both ends, and its insulation is stripped back 3mm on each end. Wire the DMM to two ends of the sample cable using the four-wire measurement technique (refer to the DMM's user manual for details). Record the measured resistance and confirm that it conforms to the requirements stated in Table 2.3 for the conductor DC resistance.

Wire the DMM to the two ends of the outer shield wires (that were gathered up in the previous step) of the same 20 meter sample. Measure the resistance of the shield wires using the four-wire measurement technique. Record the measured resistance and confirm that it conforms to the requirements stated in Table 2.3 for the outer shield DC resistance.

# Appendix C. Recommended Wire Pair Testing

An LXI Wired Trigger Bus cable is tested for proper signal pairing by testing for the presence of cross-talk to alternate channels. Since each pair is individually shielded, a properly constructed cable assembly should show very low levels of cross-talk to alternate channels. A cable assembly, which has one or more connections miss-paired, will display a notable amount of cross-talk to an alternate channel, revealing the miss-wired connection.

### Wired Pairing Test Setup

The wired pairing test setup consists of a pulse generator (Tektronix AFG3252 or equivalent), an LXI Wired Trigger Bus Adapter (Pickering Interfaces P/N 60-982 or equivalent), an LXI Wired Trigger Bus Probe (Pickering Interfaces P/N 60-981 or equivalent), an LXI Wired Trigger Bus Terminator (Circuit Assembly Corporation P/N U712003 or equivalent), An Oscilloscope with a minimum 1GHz bandwidth (Tektronix DPO4104 or equivalent), and the LXI Wired Trigger Bus cable assembly under test.

Figure C.1 shows the basic test setup. The pulse generator is wired to the LXI Wired Trigger Bus Adapter such that it can drive any one of the eight LXI Trigger channels. The LXI Wired Trigger Bus Adapter directly drives the Cable Under Test and provides the terminations required at that end of the cable. The other end of the Cable Under Test is connected to the LXI Wired Trigger Bus Probe. The LXI Wired Trigger Bus Probe has a through type connection, so it requires an external terminator. The oscilloscope monitors the outputs of the Probe and two channels are required. One channel monitors the driven channel and provides a trigger source for the Oscilloscope, and the other channel is used to check for cross-talk to the other LXI Wired Trigger Bus signal pairs.

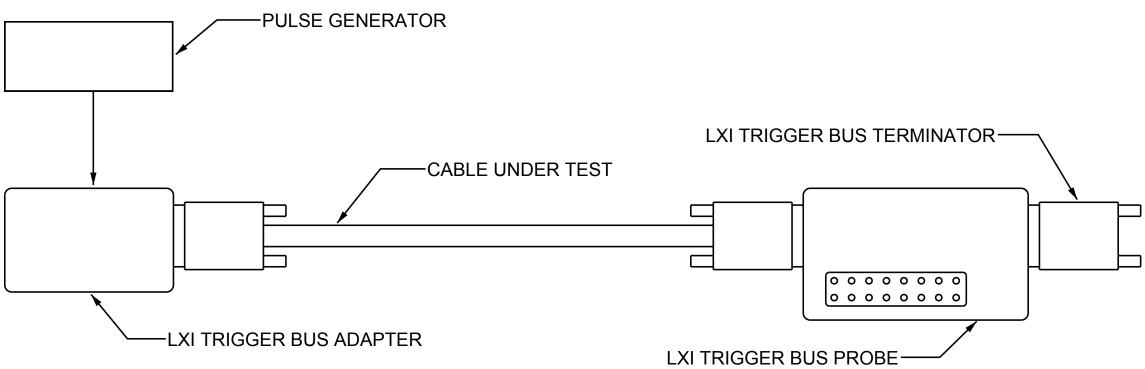


**Figure C.1 Wired pairing test setup**

The pulse generator is set to provide a 10 KHz square wave output with an amplitude appropriate to drive the LXI Wired Trigger Bus Adapter (see the user's manuals for details). The LXI Wired Trigger Bus Adapter is configured for driven mode output on all channels, and the pulse generator is connected to drive channel LXI0. The other Channels are set to a fixed low state. The oscilloscope is setup with one channel set to 200mV/division, 50 ohms, DC coupled input and is connected to the positive half of the driven channel (beginning with LXI0p). The second channel of the oscilloscope is set to 20mV/division, 1Mohm, AC coupled input. The second channel input is used to check the un-driven cable connections for cross-talk. The oscilloscope's horizontal time-base is set for 200nS/division and the oscilloscope's acquisition mode is set to average 32 readings. Note that without averaging multiple readings, the cross-talk signal will be largely buried in noise.

## Wired Pairing Test Procedure

The test for miss-wired pairs is preformed using a process of elimination technique. The pulse generator is first connected to drive LXI0 via the LXI Wired Trigger Bus Adapter. The first channel of the oscilloscope is connected to the positive output of the LXI Wired Trigger Bus Probe, and the second channel is connected to both the positive and negative outputs of LXI1 through LXI7, one output at a time. See Figures C.2 through C.5 for examples of typical oscilloscope displays for 0.5meters and 20meters in length showing both passing and failing conditions. Each output is checked for a cross-talk condition, and if any output displays this characteristic, the cable assembly shall fail this test.

Once channel LXI0 has been tested, the pulse generator output is moved to drive LXI1, and the positive and negative outputs of the LXI Wired Trigger Bus Probe for channels LXI2 through LXI7 are checked for cross-talk. LXI0 does not need to be checked, as it has already been confirmed to not have a cross-talk condition. This process is repeated until all LXI Wired Trigger Bus channels have been confirmed.

A cable assembly which has passed this test along with the basic continuity test shall be confirmed compliant.

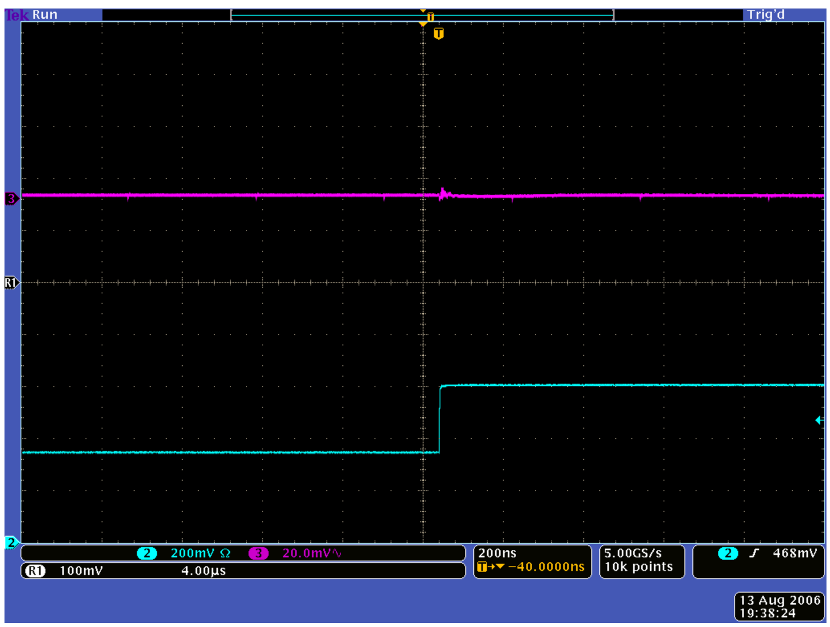


**Figure C.2 – 0.5 meter cable displaying no cross-talk**

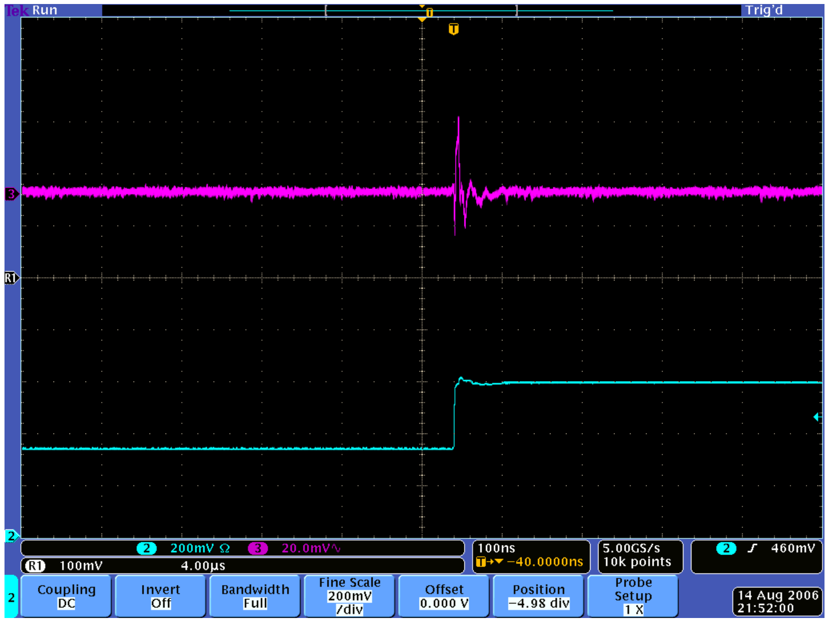


**Figure C.3 – 0.5 meter cable displaying cross-talk**

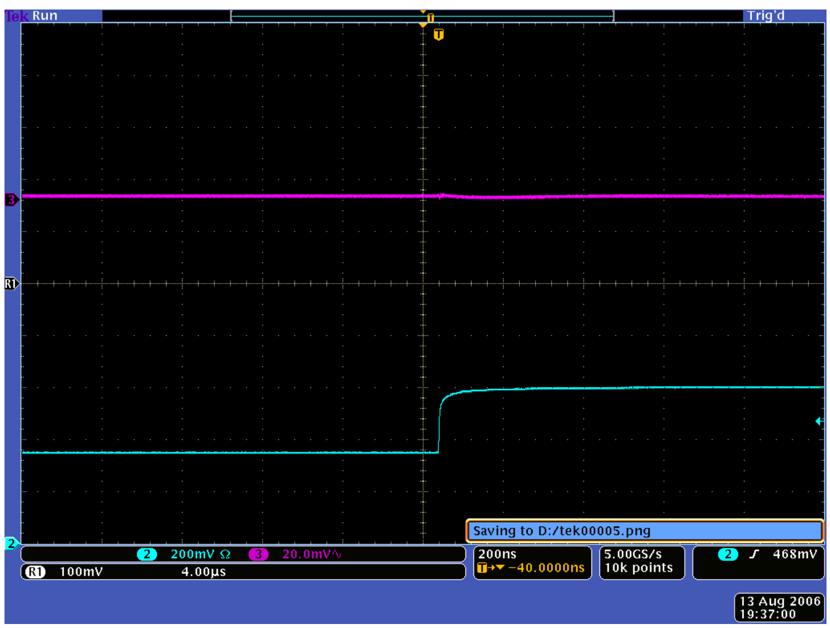


**Figure C.4 – 20 meter cable displaying no cross-talk**

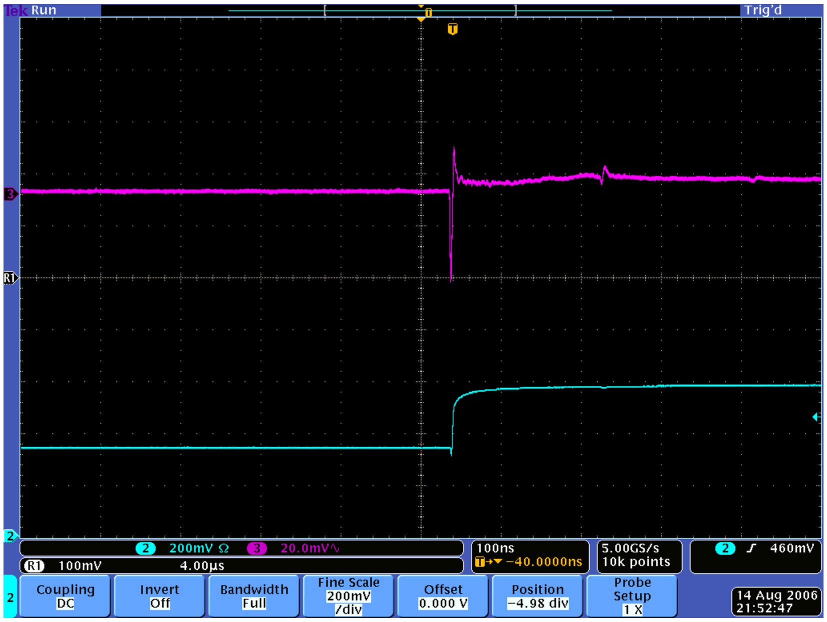


**Figure C.5 – 20 meter displaying cross-talk.**

# Appendix D. LXI Wired Trigger Bus Terminator Testing

## LXI Wired Trigger Bus Terminator Test Method

Using a precision ohm meter (such as the Keithley 2000 or equivalent), the resistance between each channel's positive and negative connection is measured using the four wire resistance measuring technique. Verify that each channel measures 100 ohms +/- 5%.

Using an LCR bridge (such as the Agilent 4263B or equivalent) set to measure capacitance and series resistance and operating at 10KHz, measure from each channel's positive and negative connection to ground. Verify that each channel connection measures 0.01uF +/- 20% with 50 ohm +/- 5% series resistance. Verify that the series resistances measured for the positive and negative connection of each channel are within 2% of each other.