Tektronix Instrument Switch
Instruction Manual

Tektronix

Contacting Tektronix

Tektronix, Inc.
14200 SW Karl Braun Drive
P.O. Box 500
Beaverton, OR 97077
USA

For product information, sales, service, and technical support:

- In North America, call 1-800-833-9200.
- Worldwide, visit http://www.tektronix.com to find contacts in your area.

Warranty

Tektronix warrants that this product will be free from defects in materials and workmanship for a period of one (1) year from the date of shipment. If any such product proves defective during this warranty period, Tektronix, at its option, either will repair the defective product without charge for parts and labor, or will provide a replacement in exchange for the defective product. Parts, modules and replacement products used by Tektronix for warranty work may be new or reconditioned to like new performance. All replaced parts, modules and products become the property of Tektronix.

In order to obtain service under this warranty, Customer must notify Tektronix of the defect before the expiration of the warranty period and make suitable arrangements for the performance of service. Customer shall be responsible for packaging and shipping the defective product to the service center designated by Tektronix, with shipping charges prepaid. Tektronix shall pay for the return of the product to Customer if the shipment is to a location within the country in which the Tektronix service center is located. Customer shall be responsible for paying all shipping charges, duties, taxes, and any other charges for products returned to any other locations.

This warranty shall not apply to any defect, failure or damage caused by improper use or improper or inadequate maintenance and care. Tektronix shall not be obligated to furnish service under this warranty a) to repair damage resulting from attempts by personnel other than Tektronix representatives to install, repair or service the product; b) to repair damage resulting from improper use or connection to incompatible equipment; c) to repair any damage or malfunction caused by the use of non-Tektronix supplies; or d) to service a product that has been modified or integrated with other products when the effect of such modification or integration increases the time or difficulty of servicing the product.

THIS WARRANTY IS GIVEN BY TEKTRONIX WITH RESPECT TO THE PRODUCT IN LIEU OF ANY OTHER WARRANTIES, EXPRESS OR IMPLIED. TEKTRONIX AND ITS VENDORS DISCLAIM ANY IMPLIED WARRANTIES OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE. TEKTRONIX' RESPONSIBILITY TO REPAIR OR REPLACE DEFECTIVE PRODUCTS IS THE SOLE AND EXCLUSIVE REMEDY PROVIDED TO THE CUSTOMER FOR BREACH OF THIS WARRANTY. TEKTRONIX AND ITS VENDORS WILL NOT BE LIABLE FOR ANY INDIRECT, SPECIAL, INCIDENTAL, OR CONSEQUENTIAL DAMAGES IRRESPECTIVE OF WHETHER TEKTRONIX OR THE VENDOR HAS ADVANCE NOTICE OF THE POSSIBILITY OF SUCH DAMAGES.

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General Safety Summary

Review the following safety precautions to avoid injury and prevent damage to this product or any products connected to it.

To avoid potential hazards, use this product only as specified.

Only qualified personnel should perform service procedures.

While using this product, you may need to access other parts of a larger system. Read the safety sections of the other component manuals for warnings and cautions related to operating the system.

To Avoid Fire or Personal Injury

Connect and Disconnect Properly. Do not connect or disconnect test leads while they are connected to a voltage source.

Observe All Terminal Ratings. To avoid fire or shock hazard, observe all ratings and markings on the product. Consult the product manual for further ratings information before making connections to the product.

Do Not Operate Without Covers. Do not operate this product with covers or panels removed.

Do Not Operate With Suspected Failures. If you suspect that there is damage to this product, have it inspected by qualified service personnel.

Avoid Exposed Circuitry. Do not touch exposed connections and components when power is present.

Do Not Operate in Wet/Damp Conditions

Do Not Operate in an Explosive Atmosphere

Keep Product Surfaces Clean and Dry

Terms in this Manual   These terms may appear in this manual:

⚠ *WARNING.* Warning statements identify conditions or practices that could result in injury or loss of life.

⚠ *CAUTION.* Caution statements identify conditions or practices that could result in damage to this product or other property.

Symbols and Terms on the Product   These terms may appear on the product:

DANGER indicates an injury hazard immediately accessible as you read the marking.

WARNING indicates an injury hazard not immediately accessible as you read the marking.

CAUTION indicates a hazard to property including the product.

The following symbols may appear on the product:

⚠
CAUTION
Refer to Manual

Service Safety Summary

Only qualified personnel should perform service procedures. Read this *Service Safety Summary* and the *General Safety Summary* before performing any service procedures.

Do Not Service Alone. Do not perform internal service or adjustments of this product unless another person capable of rendering first aid and resuscitation is present.

Disconnect Power. To avoid electric shock, switch off the instrument power, then disconnect the power cord from the mains power.

Use Care When Servicing With Power On. Dangerous voltages or currents may exist in this product. Disconnect power and disconnect test leads before removing protective panels, soldering, or replacing components.

To avoid electric shock, do not touch exposed connections.

Compliance Information

EMC Compliance

EC Declaration of Conformity – EMC

Meets intent of Directive 2004/108/EC for Electromagnetic Compatibility.

Compliance was demonstrated to the following specifications as listed in the Official Journal of European Communities:

EN 61326-1 2006. EMC requirements for electrical equipment for measurement, control, and laboratory use.[1234]

- CISPR 11:2003. Radiated and conducted emissions, Group 1, Class A
- IEC61000-4-2:2001. Electrostatic discharge immunity
- IEC61000-4-3:2002. RF electromagnetic field immunity
- IEC61000-4-4:2004. Electrical fast transient / burst immunity
- IEC61000-4-5:2001. Power line surge immunity
- IEC61000-4-6:2003. Conducted RF immunity
- IEC61000-4-11:2004. Voltage dips and interruptions immunity

EN61000-3-2:2006. AC power line harmonic emissions

EN61000-3-3:1995. Voltage changes, fluctuations, and flicker

European Contact
Tektronix UK, Ltd.
Western Peninsula
Western Road
Bracknell, RG12 1RF
United Kingdom

Australia / New Zealand Declaration of Conformity–EMC

Complies with the EMC provision of the Radiocommunications Act per the following standard, in accordance with ACMA:

- CISPR 11:2003. Radiated and Conducted Emissions, Group 1, Class A, in accordance with EN61326-1:2006.

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[1] This product is intended for use in nonresidential areas only. Use in residential areas may cause electromagnetic interference.

[2] Emissions which exceed the levels required by this standard may occur when this equipment is connected to a test object.

[3] To ensure compliance with the EMC standards listed here, high quality shielded interface cables should be used.

[4] EMC performance is dependent upon the USB host device to which the Tektronix Instrument Switch is connected. Performance has been verified when connected to a BERTScope Analyzer.

Environmental Considerations

This section provides information about the environmental impact of the product.

Product End-of-Life Handling

Observe the following guidelines when recycling an instrument or component:

Equipment Recycling. Production of this equipment required the extraction and use of natural resources. The equipment may contain substances that could be harmful to the environment or human health if improperly handled at the product's end of life. In order to avoid release of such substances into the environment and to reduce the use of natural resources, we encourage you to recycle this product in an appropriate system that will ensure that most of the materials are reused or recycled appropriately.

This symbol indicates that this product complies with the applicable European Union requirements according to Directives 2002/96/EC and 2006/66/EC on waste electrical and electronic equipment (WEEE) and batteries. For information about recycling options, check the Support/Service section of the Tektronix Web site (www.tektronix.com).

Restriction of Hazardous Substances

This product has been classified as Monitoring and Control equipment, and is outside the scope of the 2002/95/EC RoHS Directive.

Getting Started

The Tektronix Instrument Switch is a flexible device usable for general purpose applications and specific inclusion in USB 3.0 compliance testing. For USB 3.0 testing, the switch features a pattern generator for generation of Low Frequency Periodic Signaling (LFPS), used to ensure devices achieve loopback. Other features include:

- Manual switching between channels with front panel controls

- Automated control via USB

- Flexible triggering with multiple control choices

- Two main input channels (Ch 1, Ch 2) with >10 GHz analog bandwidth

- Single-ended to differential input channel for easily adding low frequency signal generators to test setups

- USB control and power with no need for additional external power

Figure 1: The Tektronix Instrument Switch

Manual Control

The Instrument Switch can be operated manually, using the pushbuttons and connectors, with power supplied through the USB connection to a host instrument. The Switch Control program and instrument drivers must be installed on the host instrument to properly power the switch.

Switch Control Program

Software control communication is through USB connection to a control host (such as a Windows PC or BERTScope Analyzer).

The Switch Control software provides additional control features, including:

- Duty Cycle setting for LFPS sequences

- LFPS Polling/Ping/Reset selection

- Custom LFPS type setup

The Switch Control program and instrument drivers must be installed on the host instrument prior to connecting the USB cable.

Tektronix USB 3.0 Receiver Testing Software

This Tektronix USB 3.0 Receiver Testing solution software is available for use with the BERTScope Analyzer. Once installed on a PC, the testing software communicates directly with the Switch Control program, for seamless operation through the user interface.

The USB 3.0 Receiver Testing software also includes a detailed remote control protocol for automated testing.

Standard Accessories

Standard USB 2.0 cable
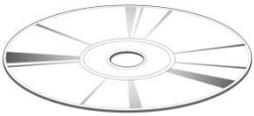
Instrument Switch Control Software CD-ROM

Driver and application/socket-server programs to be installed on a control host (BERTScope Analyzer or Windows PC) connected to the Switch via USB.

Operating Basics

The Instrument Switch is intended to be operated in a controlled laboratory environment. It is intended to operate on a bench top, or on top of another instrument such as the BERTScope Analyzer. There are four shock-absorbing feet located on the bottom of the instrument.

This instrument draws operating power through a USB connection to a host instrument, such as the BERTScope Analyzer or a Windows PC. No other power source is required.

Note: The Instrument Switch drivers must be installed on the host instrument in order to correctly supply power to the switch.

Power On Status

Connect the Instrument Switch to a BERTScope Analyzer or host PC via the USB connector on the rear panel.

Press the Power button on the front panel. A lit green LED on the button indicates that power is on.

Note: If you will be using a software switch control program, it should be installed on the control host prior to connecting the switch.

Setup

The Instrument Switch serves as a regulated gateway for passing test signals to a DUT. It can be operated using:

- The physical pushbuttons and connectors

- Switch Control software, installed on a control host

- Tektronix USB 3.0 Receiver Testing software, installed on a control host

Software control communication is through USB 2.0 connection to a control host (such as a BERTScope Analyzer or a Windows PC). The Switch Control program should be installed on this control instrument prior to connecting the USB cable.

The Switch Control software is distributed on the CD-ROM supplied as a standard accessory with the Instrument Switch.

Instrument Switch Operation

Installing the Instrument Switch in a Test Setup

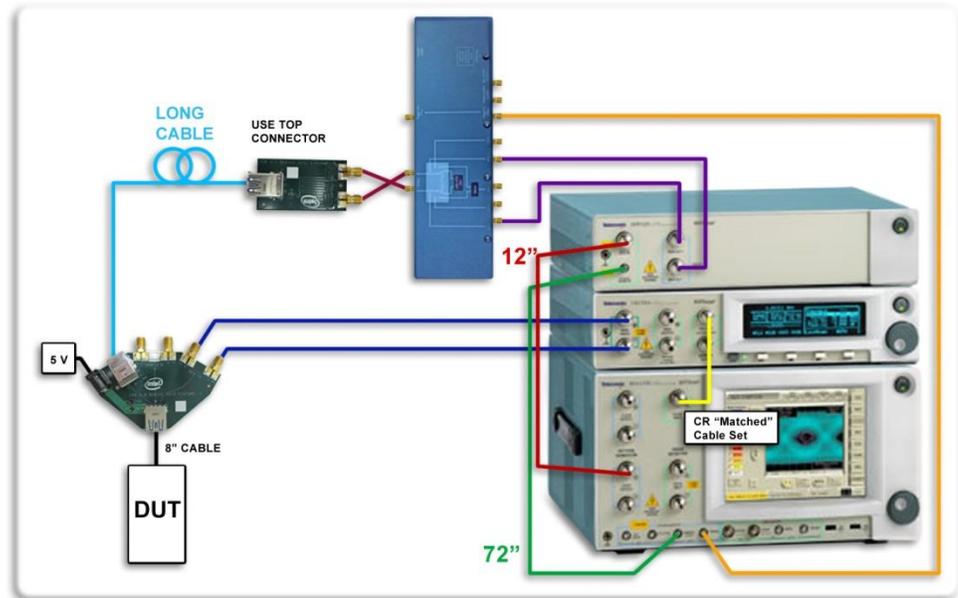Figure 2 illustrates an example test setup incorporating the Instrument Switch.

Figure 2: Example Test Setup – Jitter Tolerance Test Cabling Diagram

Switch Signal Paths

The Instrument Switch allows the selection of one of four RF signals as its output:

- Channel 1, through connectors on the front panel.

- Channel 2, through connectors on the front panel.

- Single-ended AUX Input, through a connector on the front panel. This single-ended source is split into a differential signal by a balun internal to the switch.

- Built-in Low Frequency Periodic Signal (LFPS) generator, which provides different types of USB 3.0 LFPS signals that are useful during USB 3.0 application testing. For instance, the USB 3.0 Receiver Testing solution software uses this fourth source to initiate loopback training.

Once Primary, Secondary, and Trigger sources are set, the input Primary channel is passed directly to output until a Trigger event occurs, prompting a change to the Secondary channel.

The following diagram (which appears on the top panel of the Instrument Switch) is a straightforward depiction of the switching options.
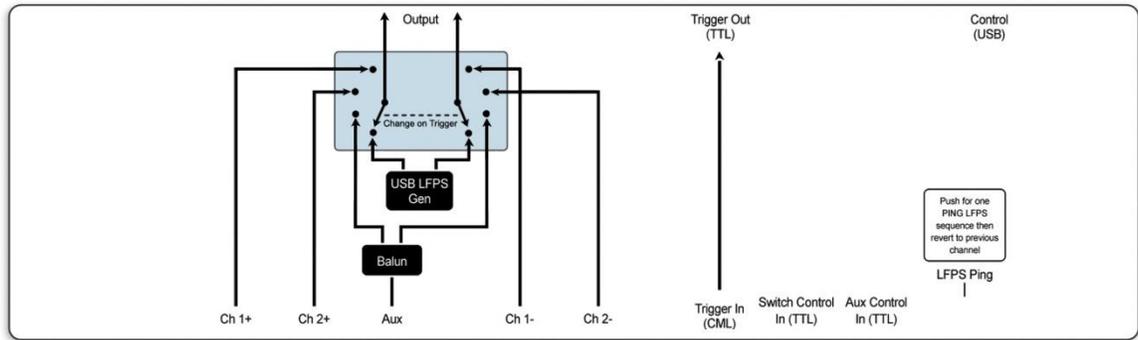

Figure 3: Instrument Switch signal paths

Manual Switch Control

Testing signals are routed through the switch using the connectors on the front and rear panels. Use the front panel pushbuttons set the Primary and Secondary channels, select the Trigger source, and insert a one-time LFPS Ping.

The Instrument Switch is powered through USB connection to a host PC or BERTScope Analyzer. The switch software drivers must be installed on the host instrument in order to correctly power the switch.
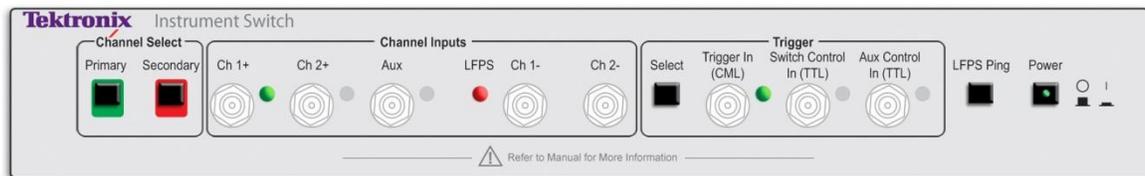
Switch Front Panel Controls and Connectors

Figure 4: Instrument Switch front panel controls and connectors

Channel Select

Primary

Use these pushbuttons to select Primary and Secondary input channels. The Primary channel is the source normally passed to the switch outputs. Upon a trigger event, input switches to the Secondary channel, if one is selected.

Press the button to advance to the next channel in sequence: Channel 1 – Channel 2 – AUX – LFPS Generator. Hold the button down to cycle through the channels. The switch will not physically change position until the button is released, allowing you to change from, for example, Channel 1 to AUX, without enabling Channel 2 in between.

Secondary

Pressing the Primary Channel Select button *clears* any Secondary channel selection, effectively 'locking' the switch to the Primary channel until a new Secondary channel is selected.

When the switch is powered on, Channel 1 is selected as the Primary channel and the LFPS generator as the Secondary channel.

Channel LEDs

An illuminated green LED indicates the Primary channel.

A red LED may be illuminated, indicating the Secondary channel *if one is selected.*

Channel 1 (+) In

SMA connector for a single-ended or differential (+) Channel 1 input, internally AC-coupled.

Channel 2 (+) In

SMA connector for a single-ended or differential (+) Channel 2 input, internally AC-coupled.

Auxiliary In

SMA connector; internally AC-coupled.

Limited to a maximum frequency of 100 MHz; an internal balun converts the single-ended signal to a differential pair of signals for transmission to the switch outputs. This is intended for use with an AFG or AWG, to generate custom low-speed signaling.

LFPS Generator	Selects the internal LFPS generator as the channel source.
Channel 1 (–) In	SMA connector for a differential Channel 1 (–) input, internally AC-coupled.
Channel 2 (–) In	SMA connector for a differential Channel 2 (–) input, internally AC-coupled.
Trigger Select	This pushbutton selects a trigger input: Trigger In – Switch Control – AUX Control.
	Only one trigger is enabled at a time, indicated by an illuminated green LED. Press the button to enable the next trigger in sequence.
	Hold the button down to cycle through the sources; the switch will not enable a new trigger until the button is released, allowing you to change from, for example, Trigger In to AUX Control, without enabling Switch Control in between.
Trigger LED	One of three green LEDs is illuminated to indicate the active Trigger Input.
Trigger In (CML)	SMA connector. A rising edge will cause a switch to the Secondary channel, if one has been selected.
	Expected signal levels are CML, with nominal input voltages of 0 V for V(ih) and -400 mV for V(il). This input has protection circuitry that prevents the 3.3 V TTL input trigger signal from causing damage to the switch.
Switch Control In (3.3 V TTL)	SMA connector. A rising or falling edge of this 3.3 V TTL-level input will cause a switch to the Secondary channel, if one has been selected.
Aux Control In (3.3 V TTL)	SMA connector. A rising or falling edge of this 3.3 V TTL-level input will cause a switch to the Secondary channel, if one has been selected.
LFPS Ping	The **Ping** pushbutton immediately switches output to the internal LFPS generator, transmits a single LFPS sequence (a 'Ping'), and immediately returns to the previously selected Primary channel.
	If the LFPS generator is selected as the Primary channel when a ping is instigated, the switch will go from tri-state to LFPS to tri-state output.
	If the LFPS generator is selected as the Secondary channel, a ping will switch from whatever state the primary channel is in to LFPS, and then back to the previous state of the Primary channel.
Power Button/LED	Press to power-on. A green LED in the button will light. Press the button again to turn off power.

Switch Rear Panel Connectors

Figure 5: Instrument Switch rear panel connectors

Control (USB)   A USB B-type connector on the rear panel provides power and software control through USB 2.0 connection to a host instrument.

Trigger Out (3.3 V TTL)   The Trigger Out connector on the rear panel outputs a 3.3 V TTL-level signal that has been internally converted from the CML-level Trigger In. This can be used to trigger additional external equipment.

The source of the output signal(s) is determined by the Primary, Secondary, and Trigger selections.

Output (–)   The Output (–) connector on the rear panel outputs a differential (–) signal. SMA connector; internally AC-coupled.

Output (+)   The Output (+) connector on the rear panel outputs a differential (+) signal. SMA connector; internally AC-coupled.

USB Switch Control

Through the USB connection, software programs installed on a host instrument can be used to manage switch operation.

Switch Control Software

The included Switch Control software program (on the Software CD-ROM shipped with the Instrument Switch) provides options in addition to manual operation, including:

- Duty Cycle setting for LFPS sequences
- LFPS Polling/Ping/Reset selection
- Custom LFPS type setup

Figure 6: Switch Control Software user interface

USB 3.0 Testing Software

The Instrument Switch is an integral part of the Tektronix USB 3.0 Receiver Testing solution. The USB 3.0 Receiver Testing software communicates directly with the Switch Control program, managing all aspects of switch operation through one interface.
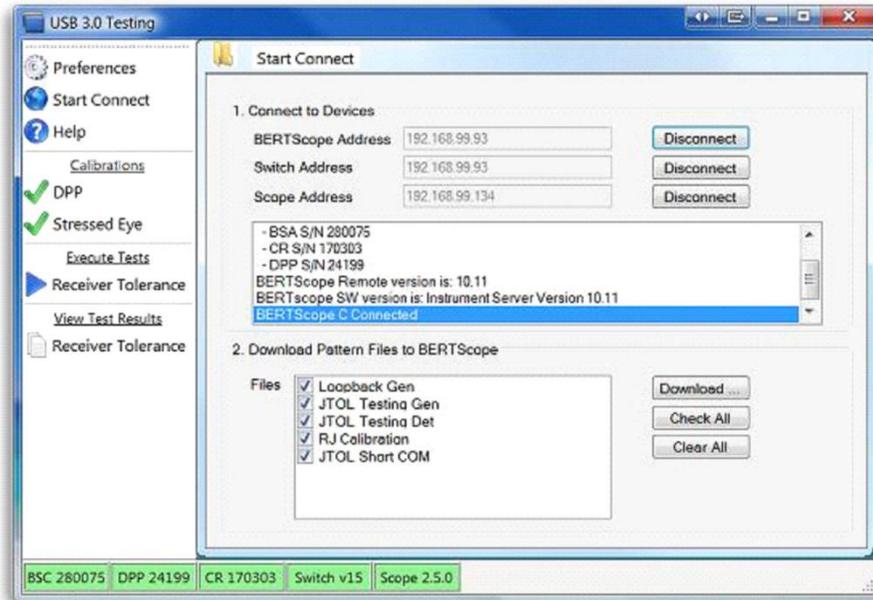

Figure 7: Tektronix USB 3.0 Testing Software user interface

Remote Control

The USB 3.0 Testing software includes a detailed remote control protocol for automated USB 3.0 receiver testing.

Remote control commands specifically for configuring and controlling the Instrument Switch are listed here. A complete command protocol is included in the USB 3.0 Receiver Testing software's online Help System.

Protocol	*Type*	*Description*	*Parameter(s)*
CONN:SWITCH [bool]	R/W Property	Connects or disconnects TCP/IP communications to Switch using default IP address and port	Boolean value indicating whether to connect (1) or disconnect (0)
PREF:SAVE	Command	Save Preferences	
PREF:SW:IP "text"	R/W Property	Instrument Switch communications TCP/IP Address	String IP address in the form 192.168.99.99
PREF:SW:PORT <int>	R/W Property	Instrument Switch communications TCP/IP Port	Decimal integer port number
PREF:SW:TO <int>	R/W Property	Instrument Switch communications Timeout	Decimal integer representing seconds
RXTEST:SW:COUNT	R-Only Property	Returns number of frequencies in receiver testing	Decimal integer value representing the number of frequencies tested

RXTEST:SW:DISPL [enum]	R/W Property	Selects whether to display a chart or table during receiver testing	Possible values include: 0 = table, 1 = chart
RXTEST:SW:PROGRESS	R-Only Property	Returns the index of the frequency currently being tested	Decimal integer value representing the 0-based index of the frequency being tested, or -1 if testing is not being performed.
RXTEST:SW:RCOUNT	R-Only Property	Returns number of rows in test results from receiver test system	Decimal integer value representing the number of test results contained in the receiver test system results table
RXTEST:SW:RESULT [int]	R-Only Property	Returns specified table row from the receiver test system results table	Returns 5 values for specified row: Test amplitude, Bits, Errors, BER, and Status strings. Status values include: Blank, Skipped, InProgress, Passed, NoSync, BERFailure, ClockError, DataError, LimitReached, Unknown.
RXTEST:SW:RUN [bool]	R/W Property	Controls the run state of the receiver test system.	Boolean value indicating whether the receiver test system is running or not.
RXTEST:SW:STATUS	R-Only Property	Returns receiver test system status	Possible return values include: NotRunning, TestStarted, TestingFreq, and LoopbackRequired.

Specifications

Analog Bandwidth (Ch 1, Ch 2) .... >10 GHz

Max. Input Voltage (Ch 1, Ch 2, AUX) .... 3 V p-p per channel

Insertion Loss (Ch 1, Ch 2)........................... 3 dB

Impedance.. 50 Ω

Switching Speed .... 400 ns (typical)

Input/Output Connectors............................... SMA 3.5 mm female

Power Supply... Via USB connection to a control host
(BERTScope Analyzer or Windows PC)

Software Control.. Via USB connection to a control host

INPUTS

Channel 1+ .... Single-ended / Differential (+)
Internally AC-coupled

Channel 2+ .... Single-ended / Differential (+)
Internally AC-coupled

AUX In... Internally converted to differential
output
Internally AC-coupled

Max. Frequency .... 100 MHz

LFPS... Internal LFPS generator
Max. Frequency .... 100 MHz

Channel 1– .... Differential (–)
Internally AC-coupled

Channel 2–... Differential (–)
Internally AC-coupled

Trigger In.. CML
Nominal Voltage............................. V(ih)   0 V
V(il)   −400 mV

Switch Control...................................... 3.3 V TTL

AUX Control .... 3.3 V TTL

OUTPUTS

Output −.. Differential (–)

Output + ... Single-ended / Differential (+)

Trigger Out... 3.3 V TTL (internally converted from
CML Trigger In)

ENVIRONMENTAL

Temperature, Operating .... +10 to 40 °C

Humidity .... Non-condensing at 40 °C, 15 to 95%

Maintenance

Cleaning

The exterior of the instrument may be cleaned using a soft cloth dampened with a 'glass and office desk surface' type cleaner. Do not use solvent or abrasive cleaning agents.

Connector Replacement

The Channel and Trigger inputs and outputs use 3.5 mm SMA connectors. Should a connector become damaged, replacements can be ordered from Tektronix.

Troubleshooting

Symptom #1: Power button pressed, green power LED does not light.

This normally means that the switch is not receiving power from the USB port to which it is connected. Verify that the USB cable is securely connected between the host PC/BERTScope Analyzer and the Tektronix Instrument Switch, and that the host instrument is not in a low power (suspend) state.

Symptom #2: Power button pressed, green power LED lights but the Channel 1 LED (green), LFPS LED (red) and/or Trigger In LED (green) are not lit.

When the Tektronix Instrument Switch is first powered on, the default configuration is as follows:

- The Primary channel is set to Channel 1.

- The Secondary channel is set to the LFPS Generator channel.

- The Trigger In (CML) input is selected.

The selection LEDs for these inputs should be lit. If the green power LED is the only LED lit, this normally means that the Tektronix Instrument Switch was not recognized and configured correctly by the host PC, typically because the switch driver has not been installed on the host PC. Verify that the switch driver has been installed on the host PC, or if necessary, reinstall the driver on the host system.

Symptom #3: Two of the Channel Input Select LEDs are lit orange.

This behavior occurs if the currently selected trigger input is receiving a fast, repeating trigger signal. The switch will continuously oscillate between the primary and secondary channels in this case, and their LEDs will be perceived as orange (actually oscillating between green and red).