Tektronix BERTScope
Clock Recovery Instruments

Quick Start User Manual

www.tektronix.com
0130-713-00

Tektronix

Tektronix BERTScope Clock Recovery Instruments

CR125A, CR175A, CR286A

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Contacting Tektronix

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Beaverton, OR U.S.A.

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

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

Warranty

All Tektronix CR125A, CR175A, and CR286A Clock Recovery Instruments are covered under the standard 1-year product 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.

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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.

NOTE: *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.

WARNING

Maintain Proper Grounding to avoid electrical shock.

No operator serviceable parts inside.

Do not remove cover.

Refer to qualified service personnel.

Use Proper Power Cord. Use only the power cord specified for this product and certified for the country of use.

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

Ground the Product. This product is grounded through the grounding conductor of the power cord. To avoid electric shock, the grounding conductor must be connected to earth ground. Before making connections to the input or output terminals of the product, ensure that the product is properly grounded.

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.

Power Disconnect. The power cord disconnects the product from the power source. Do not block the power cord; it must remain accessible to the user at all times.

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.

Use Proper Fuse. Use only the fuse type and rating specified for this product.

Wear Eye Protection. Wear eye protection if exposure to high-intensity rays or laser radiation exists.

Do Not Operate in Wet/Damp Conditions

Do Not Operate in an Explosive Atmosphere

Keep Product Surfaces Clean and Dry

Provide Proper Ventilation. Refer to the manual's installation instructions for details on installing the product so it has proper ventilation.

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.

NOTE. A notice statement identifies conditions which may result in unintended operating modes, incorrect measurement results, or require resetting the instrument or personal computers operating software interacting with it.

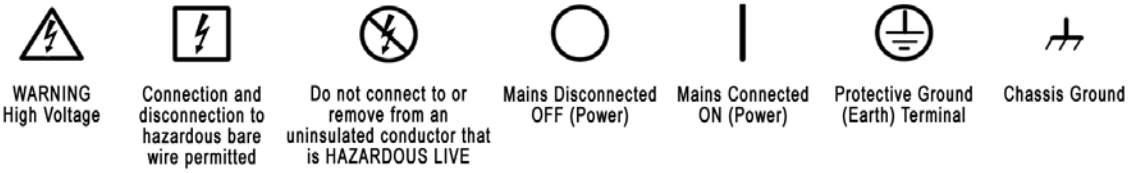
Symbols and Terms on the Product

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

To prevent damage to the instrument when the data outputs are not in use, terminate the data outputs with the SMA terminations provided.

CAUTION

To prevent damage to the high sensitivity data circuitry, ensure that the input voltage does not exceed ±5 V range, 3 V peak-peak.

Compliance Information

This section lists the EMC (electromagnetic compliance) safety, and environmental standards with which the instrument complies.

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.[1, 2, 3]
- 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.

[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.

Safety Compliance

EC Declaration of Conformity – Low Voltage

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

Low Voltage Directive 2006/95/EC

- EN61010-1: 2001. Safety requirements for electrical equipment for measurement control and laboratory use.

U.S. Nationally Recognized Testing Laboratory Listing

- UL 61010-1:2004, 2nd Edition. Standard for electrical measuring and test equipment.

Canadian Certification

- CAN/CSA-C22.2 No. 61010-1:2004. Safety requirements for electrical equipment for measurement, control, and laboratory use. Part 1.

Additional Compliances

- IEC 61010-1: 2001. Safety requirements for electrical equipment for measurement, control, and laboratory use.

Equipment Type

- Test and measuring equipment.

Safety Class

- Class 1 – grounded product.

Pollution Degree Description

A measure of the contaminants that could occur in the environment around and within a product. Typically the internal environment inside a product is considered to be the same as the external. Products should be used only in the environment for which they are rated.

- Pollution Degree 1. No pollution or only dry, nonconductive pollution occurs. Products in this category are generally encapsulated, hermetically sealed, or located in clean rooms.
- Pollution Degree 2. Normally only dry, nonconductive pollution occurs. Occasionally a temporary conductivity that is caused by condensation must be expected. This location is a typical office/home environment. Temporary condensation occurs only when the product is out of service.
- Pollution Degree 3. Conductive pollution or dry, nonconductive pollution that becomes conductive due to condensation. These are sheltered locations where neither temperature nor humidity is controlled. The area is protected from direct sunshine, rain, or direct wind.
- Pollution Degree 4. Pollution that generates persistent conductivity through conductive dust, rain, or snow. Typical outdoor locations.

Pollution Degree

- Pollution Degree 2 (as defined in IEC61010-1). Note: Rated for indoor use only.

Installation (Overvoltage) Category Descriptions

Terminals on this product may have different installation (overvoltage) category designations. The installation categories are:

- Measurement Category IV. For measurements performed at the source of low-voltage installation.
- Measurement Category III. For measurements performed in the building installation.
- Measurement Category II. For measurements performed on circuits directly connected to the low-voltage installation.
- Measurement Category I. For measurements performed on circuits not directly connected to MAINS.

Overvoltage Category

- Overvoltage Category II (as defined in IEC61010-1)

Environmental Considerations

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 Website (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.

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Introduction

This Quick Start User Manual supports the Tektronix BERTScope CR125A, CR175A, and CR286A Clock Recovery instruments.

The software-based graphical user interface is accessed through the Tektronix BERTScope Analyzer's top level 'Views' Menu, listed as Clock Recovery Control. Detailed information on the operation of the control interface can be accessed at any time through the Help menus available in any of the control views.

BERTScopePC Standalone Software installs the Clock Recovery instrument's control interface on a user-supplied PC. The BERTScopePC software is included on the CD-ROM shipped with the Clock Recovery instrument.

The instrument communicates with the Tektronix BERTScope Analyzer or Host PC through a USB interface. A USB interconnect cable is provided with the product.

Product Description

The Tektronix BERTScope CR125A, CR175A, and CR286A are fully flexible clock recovery instruments designed to make compliance testing of today's communication designs easy and accurate. With jitter being such a complex and contentious parameter, the Tektronix CR is intended to make compliance testing simple, repeatable and accurate.

Many communication standards now specify that jitter testing must be carried out using a reference clock that has been derived from the data signal using clock recovery with well defined loop bandwidth characteristics. Typically these characteristics are specified in terms of the -3 dB bandwidth of the recovery loop, the rate of roll-off of the frequency response, and the degree of response peaking allowable. These effects will greatly dictate the amount of jitter that will be present on the reference clock, and therefore the amount of jitter ultimately measured by test instrumentation.

The CR has been architected from the ground up to provide flexibility and accuracy in compliance measurements. For easy verification of compliance, the correct characteristics are automatically set when a given standard is selected from a pull-down menu. However, for users wanting to explore the limits of their designs, full control of parameters is also easily available. A good example of this is for systems where restricting the buildup of jitter is critical. Clock recovery plays a crucial role in this, and the ability to emulate a clock recovery source with excessive peaking is a great way of understanding the system sensitivity to jitter gain. The CR has variable jitter peaking that goes way beyond simple compliance, and allows jitter gain in excess of 10 dB if desired.

The Tektronix BERTScope Clock Recovery instrument is the perfect companion to the Tektronix BERTScope Bit Error Ratio Analyzer, sharing a common user interface. A single USB connection and supplied high quality microwave coax cables connect the two units.

Features and Benefits

Features	Benefits
Accurate, robust (including spread spectrum clocking) clock recovery	Recover clock when no device or system clock is available, jitter measurements cannot be any better than your clock reference
Accurate, user-controllable PLL bandwidth and peaking	Compliant clock recovery for standards testing, measured DUT jitter is dependent on PLL bandwidth
Optional jitter spectrum analysis	Spectral view and measurement of jitter in signal, calibration stress for PCIe 5 GT/s receiver test
Optional 24 MHz loop bandwidth	For PCIe Gen 3 testing

Key Specifications

Model	Clock Recovery Range	Max/min PLL Loop BW (adj)	Input Sensitivity	Peaking (adj)	Intrinsic Jitter
CR286A	1G to 28.6 Gb/s	100 kHz-12 MHz, 200 kHz-12 MHz above 14.3 GHZ – up to 24 MHz with option XLBW ext loop BW	100 mV SE, 50 mV diff, 40 mV SE, 20 mV diff – option HS All typ.	0-6 dB, 500 kHz-12 MHz, 0-5 dB 12 MHz – 24 MHz w/option XLBW	250 fs (typ)
CR175A	1G to 17.5 Gb/s				
CR125A	1M to 12.5 Gb/s				

Documentation

In addition to this Quick Start Guide, the following documents are available:

- Online Help
- Programmer Online Guide

Optional Applications

Options available for BERTScope Clock Recovery Instruments:

PCIE	Optional PLL Analysis
XLBW	Extended Bandwidth to 24 MHz

Other Documentation

Your instrument includes PDF files of relevant information:

- Remote Control Programmer Guide PDF
- Technical Specifications PDF

Installation

The Tektronix Clock Recovery Instrument is intended to be operated in a controlled laboratory environment.

The CR is intended to operate on a bench top, or on top of another instrument such as the Tektronix BERTScope Bit Error Ratio Analyzer. There are four shock-absorbing feet located on the bottom of the instrument. Operate the instrument only when positioned with the feet facing downward. Do not operate the instrument with the long axis vertical, standing on its side, as this will block the path of air required for cooling.

This instrument uses a low voltage 'soft' power switch that activates the power supply. The primary power control circuitry is always live whenever the power cable is connected to the mains. The instrument is fuse-protected to reduce the risk of fire in the event of a power supply failure. Access to the power cable for disconnection from the mains in an emergency may be required by local codes.

Standard Accessories

- Power cord
- USB cable
- Documents
- Rack mount hardware
- Replacement fuse
- BERTScopePC Standalone Software CD-ROM (installs the CR's control interface on a user-supplied PC)

Optional Accessories

- CR125ACBL — High performance Delay Matched Cable Set (required for BERTScope Analyzer and Clock Recovery instrument in SSC applications)

Operating Requirements

Place the instrument on a cart or bench. The instrument should rest on its bottom or rear feet. An optional rack mounting kit is available. Observe the following clearance requirements and dimensions:

- Top — 0 mm (0 in)
- Left and right sides — 76 mm (3 in)
- Bottom — 0 mm (0 in) standing on feet, flip stands down
- Rear — 0 mm (0 in) on rear feet
- Width — 394 mm (15.5 in)
- Height — 220 mm (8.7 in)
- Before operating the instrument, verify the ambient temperature:
  +10° C to +40 °C (+41 °F to +113 °F)

Preventing ESD

CAUTION

A direct electrostatic discharge can damage the instrument input. To learn how to avoid this damage, read the following information.

Electrostatic discharge (ESD) is a concern when handling any electronic equipment. The instrument is designed with robust ESD protection; however it is still possible that large discharges of static electricity directly into the signal input may damage the instrument. To avoid damage to the instrument, use the following techniques to prevent electrostatic discharge to the instrument.

- Discharge the static voltage from your body by wearing a grounded antistatic wrist strap while connecting and disconnecting cables and adapters. The instrument provides a front panel connection for this purpose.
- A cable that is left unconnected on a bench can develop a large static charge. Discharge the static voltage from all cables before connecting them to the instrument or device under test by momentarily grounding the center conductor of the cable, or by connecting a 50 Ω termination to one end, prior to attaching the cable to the instrument.

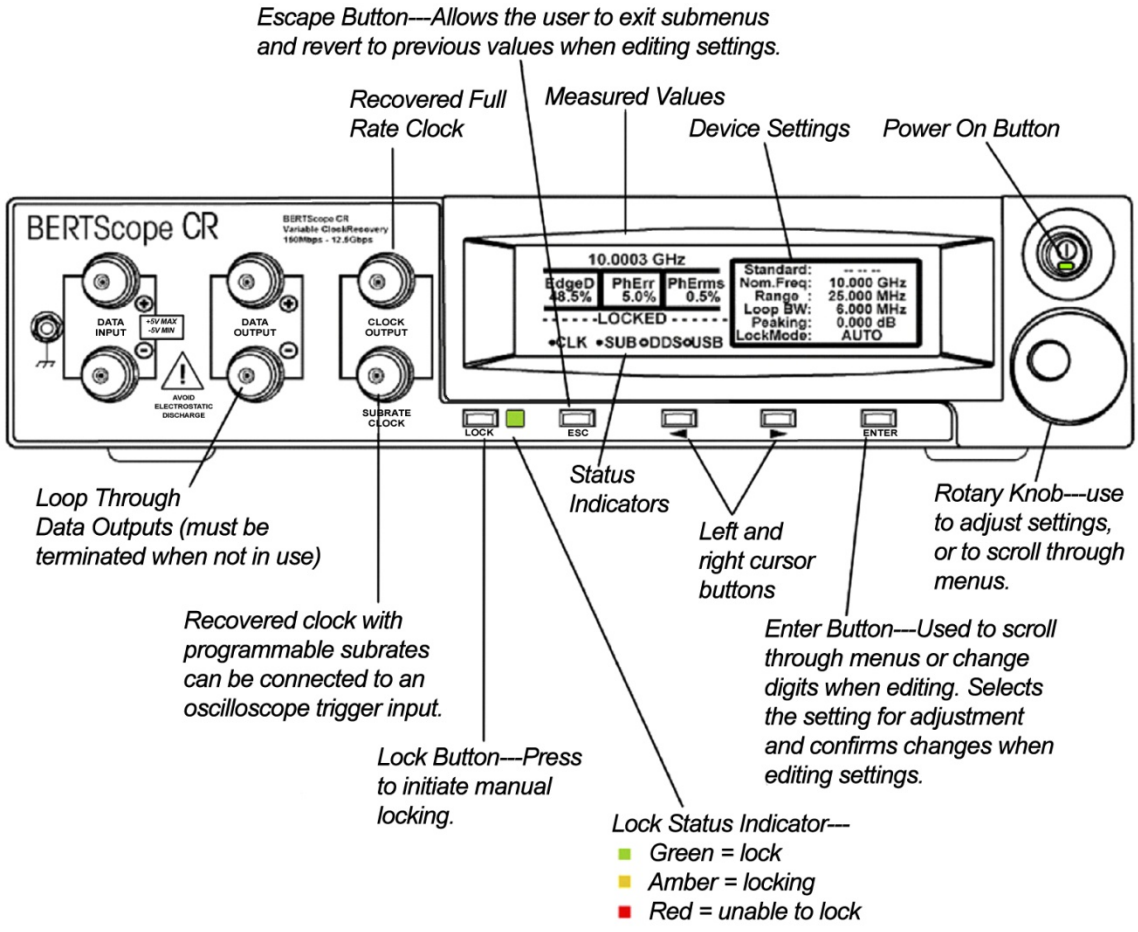
Configuration

Front Panel

Hardware connectors on the front panel of the Clock Recovery instrument:

Chassis Ground	Data In +	Data Out +	Clock Out
	Data In –	Data Out –	Subrate Clock Out

The power On/Off button is at the upper right and shows a green light when the unit is powered on. Below is the adjustment knob, which can be used to scale inputs and to zoom.



Operation

Power On

- Connect the power supply cable to a properly grounded AC supply
- Press the 'ON' button (green illumination should appear)
- Ensure that proper precautions are observed against electrostatic discharge. Using suitable high quality coaxial cables with APC-3.5, 2.92 mm, or SMA connectors, connect to the front panel interface.

Setup

After the proper connections have been made for data input and clock output and the instrument has been powered on, you can adjust the input settings.

NOTE: *Data outputs should be terminated if not in use or reflections will severely degrade performance.*

Current settings are shown on the right side of the display. Use the knob or cursor keys to scroll through menu items. Press the knob or enter key to select an item to adjust. Use the escape key to back out of a menu or cancel an adjustment. When editing a numeric setting, use the left and right cursor keys to move through digits and use the knob to make larger changes. Press the knob or enter key to accept a change, or press the escape key to cancel changes.

Many industry standards are available from the front panel menu. Select a standard and the corresponding nominal data rate, loop bandwidth, and peaking settings will be entered automatically.

The following settings can be entered manually:

Nominal Data Rate	Nominal rate of the recovered clock
Lock Range	The frequency range around the nominal rate that will be scanned during locking
Bandwidth	Bandwidth of the recovery loop measured at –3 dB
Peaking	Peaking of the recovery loop. Also sets first or second order roll-off of untracked jitter
Nominal Edge Density	Expected edge density of incoming data. Required to set bandwidth correctly.
Edge Density Mode	Sets bandwidth. Calculations are based on Nominal Edge Density or edge density measured during lock.
Clock Amplitude	Output amplitude of the full rate clock.
Subrate Amplitude	Output amplitude of the subrate clock.
Subrate Division	Division ratio of the subrate clock.

By default, all settings will be saved automatically on power off and restored at power on. You can also save current settings to one of four Setups that can be recalled later.

Several continuously updated measurements are shown on the front panel display:

Frequency	The measured frequency of the recovered clock.
Edge Density	The measured edge density. A '1010' data pattern transmitted at the Nominal Data Rate would have 100% edge density.
Phase Error RMS	The RMS phase error between the incoming data and the recovered clock.
Phase Error Pk-Pk	The peak-to-peak phase error between the incoming data and the recovered clock. This measured value will increase if jitter is present on the input data that is not being tracked by the recovered clock.
Lock Status	Reports whether the CR is locked, unlocked, or in the process of locking.

By default, the CR is configured in Auto Lock mode, where it will automatically attempt to acquire lock if the detected Phase Error exceeds the Phase Error Limit setting, or the recovered clock is unstable. Pressing the LOCK key on the CR front panel will force a relock.

The Clock Recovery instrument can be connected to a Tektronix BERTScope Analyzer through a USB cable, allowing full control of the CR through the Analyzer's touchscreen user interface. Press the Analyzer's 'View' button to access the Clock Recovery Setup menu.

Device settings are selected using the buttons on the touchscreen. All functionality is available via the Analyzer user interface, as well as through the Clock Recovery instrument's front panel.

Graphing capability is available on the Tektronix BERTScope Analyzer by pressing the oval 'To CR Analysis' button at the top of the Analyzer's Clock Recovery Control display (this Clock Recovery Analysis view can also be selected from the initial 'View' menu).

Use with Other Instruments

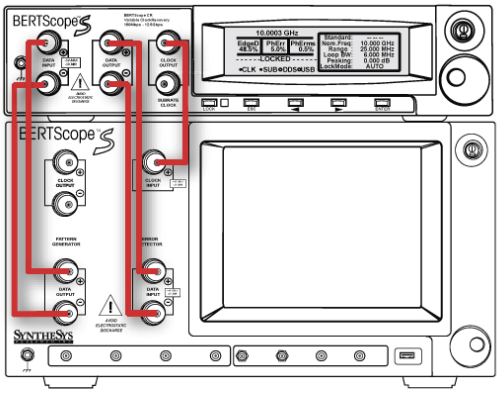
The Tektronix BERTScope CR can be used with other vendors' BERTs, other instruments, or standalone. All of the instrument's functionality is accessible through a similar user interface provided by BERTScopePC Standalone Software. The software operates in a Host PC. Operating system requirements are any 32-bit version of Microsoft Windows® XP, Vista, or 2000. 64-bit versions are not supported. Control communication is through USB, which is connected to the host computer rather than a BERTScope Analyzer. The software should be installed in the host PC prior to connecting the USB cable.

BERTScopePC software is distributed on a CD-ROM, and is supplied as a standard accessory with the CR instruments.

To connect to another instrument, here are some simple configurations to get you started:

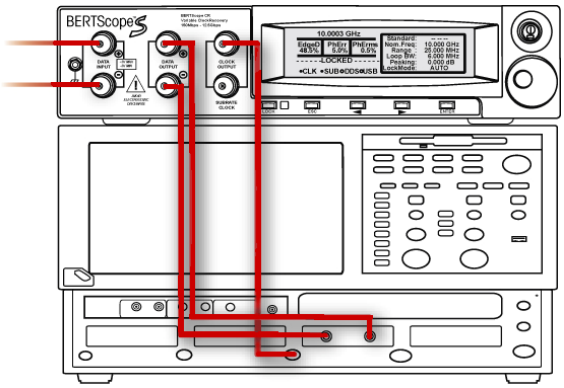
Connecting the CR to a Tektronix BERTScope Analyzer

- Analyzer Pattern Generator data output to Clock Recovery data input
- Clock Recovery data output to Analyzer Error Detector data input
- Clock Recovery clock output to Analyzer clock input



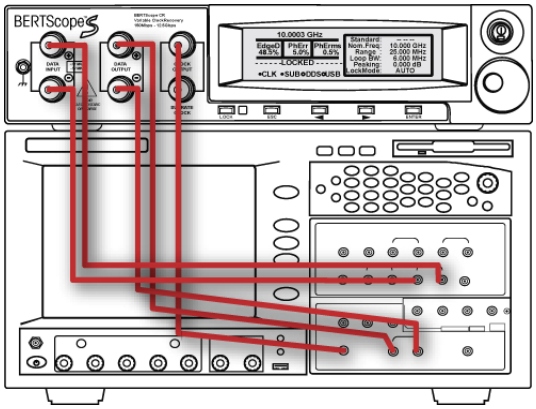
Connecting the CR to a sampling oscilloscope

- Data input to Clock Recovery from signal under test
- Clock Recovery data output to data input of oscilloscope sampling module
- Clock Recovery clock output to scope trigger input



Connecting the CR to a BERT

- BERT Pattern Generator data output to Clock Recovery data input
- Clock Recovery data output to BERT Error Detector data input
- Clock Recovery clock output to BERT clock input



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 DATA IN and DATA OUT connectors use 3.5 mm to APAC Planar Crown® adapters. These facilitate user replacement of the adapter, should it become damaged. Replacement adapters can be ordered from Tektronix.

The adapter is secured to the connector with a captive threaded mounting ring. Remove a damaged connector by grasping the knurled outer portion of the ring with your fingers and turning counter-clockwise. Do not allow foreign material to enter the connector body when replacing the adapter. To install the replacement adapter, position the two locating tabs in the corresponding slots of the instrument-mounted portion of the connector and seat the adapter. With the adapter in place, align the retaining ring and tighten by rotating clockwise. The connector should be tightened snugly 'finger-tight.' To avoid over-tightening and possibly damaging the connector, do not use a tool to tighten it.

Fuse Replacement

The instrument is protected by a fuse placed in series with the power line input. The fuse is conservatively rated and should never open through the life of the instrument. A blown fuse would generally indicate a problem with the instrument which requires factory service. It is recommended that you arrange to have the instrument serviced if you experience a blown fuse.

Calibration

The Clock Recovery instrument uses digital calibration of the output buffers. To maintain the accuracy of the output amplitude and offset, annual calibration is recommended. Contact Tektronix to schedule instrument calibration.

Specifications

Data:

Data Interfaces	50 Ω differential or single-ended, DC-Coupled APC 3.5 User-Replaceable Planar Crown® adapters
Data Rate Coverage	150 Mb/s to 12.5 Gb/s
Data Insertion Loss	0.8 dB (typical)

Clock:

Clock Interfaces	50 Ω single-ended, AC Coupled APC 3.5 User-Replaceable Planar Crown® adapters
Clock Output Range	150 MHz to 12.5 GHz (Full Rate Clock Output)
Loop Bandwidth	2.5 kHz – 12 MHz variable.
Frequency Response Roll-Off	-20 dB/ decade
Intrinsic Jitter	< 1 ps rms
Input Sensitivity	100 mV single ended (typical) 50 mV differential (typical)
Clock Output Amplitude	300 mV
Divided Clock Output	Full rate divided by 2, 4, 5, 6, 7, 8, 9, 10, 12, 14, 16, 18, 20, 24, 28, 32, 36, 64, 80, 96, 112, 128, 144
Divided Clock Interface	SMA
Divided Clock Jitter	< 1 ps rms

General:

Displayed Information	On the unit – PLL Loop Bandwidth, PLL Frequency Response, Clock Phase against frequency & time
Communication	USB cable (supplied). Unit also provides hub capability for 3 additional USB ports.

Physical:

Dimensions (W x H x D)	39.4 x 9.5 x 33.6 cm (15.5 x 3.75 x 13.25 in)
Weight	7.3 kg (16 lbs)
Power	150 W Max.
Voltage	100-240 VAC, 50/60 Hz
Power Fuse	3.15 A, 250 V, 5 mm x 20 mm, fast blow

Environmental:

Temperature, Operating	+10 °C to +40 °C (+41 °F to +113 °F)
Temperature, Non-Operating	−22 °C to +60 °C
Humidity	20 – 80%, non-condensing

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