



TCR801 Optical Clock Recovery Instrument Specifications and Performance Verification

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Important safety information

This manual contains information and warnings that must be followed by the user for safe operation and to keep the product in a safe condition.

To safely perform service on this product, see the *Service safety summary* that follows the *General safety summary*.

General safety summary

Use the product only as specified. Review the following safety precautions to avoid injury and prevent damage to this product or any products connected to it. Carefully read all instructions. Retain these instructions for future reference.

This product shall be used in accordance with local and national codes.

For correct and safe operation of the product, it is essential that you follow generally accepted safety procedures in addition to the safety precautions specified in this manual.

The product is designed to be used by trained personnel only.

Only qualified personnel who are aware of the hazards involved should remove the cover for repair, maintenance, or adjustment.

Before use, always check the product with a known source to be sure it is operating correctly.

This product is not intended for detection of hazardous voltages.

Use personal protective equipment to prevent shock and arc blast injury where hazardous live conductors are exposed.

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.

When incorporating this equipment into a system, the safety of that system is the responsibility of the assembler of the system.

To avoid fire or personal injury

Use proper power cord.	Use only the power cord specified for this product and certified for the country of use. Do not use the provided power cord for other products.
Ground the product.	This product is not grounded through the grounding conductor of the instrument power cord. To avoid electric shock, the instrument must be connected to earth ground. Before making connections to the input or output terminals of the product, make sure that the product is properly grounded through the grounding connection on the front panel.
Power disconnect.	The power cord disconnects the product from the power source. See instructions for the location. Do not position the equipment so that it is difficult to operate the power cord; it must remain accessible to the user at all times to allow for quick disconnection if needed.
Use proper AC adapter.	Use only the AC adapter specified for this product.
Observe all terminal ratings	To avoid fire or shock hazard, observe all rating and markings on the product. Consult the product manual for further ratings information before making connections to the product. Do not apply a potential to any terminal, including the common terminal. The measuring terminals on this product are not rated for connection to mains or Category II, III, or IV circuits.
Do not operate without covers.	Do not operate this product with covers or panels removed, or with the case open. Hazardous voltage exposure is possible.

Avoid exposed circuitry.	Do not touch exposed connections and components when power is present.
Do not operate with suspected failures.	If you suspect that there is damage to this product, have it inspected by qualified service personnel. Disable the product if it is damaged. Do not use the product if it is damaged or operates incorrectly. If in doubt about safety of the product, turn it off and disconnect the power cord. Clearly mark the product to prevent its further operation. Examine the exterior of the product before you use it. Look for cracks or missing pieces.
Do not operate in wet/damp conditions.	Be aware that condensation may occur if a unit is moved from a cold to a warm environment.
Do not operate in an explosive atmosphere.	
Keep product surfaces clean and dry.	Remove the input signals before you clean the product.
Provide proper ventilation.	Refer to the installation instructions in the manual for details on installing the product so it has proper ventilation. Slots and openings are provided for ventilation and should never be covered or otherwise obstructed. Do not push objects into any of the openings.
Provide a safe working environment.	Always place the product in a location convenient for viewing the display and indicators. Avoid improper or prolonged use of keyboards, pointers, and button pads. Improper or prolonged keyboard or pointer use may result in serious injury. Be sure your work area meets applicable ergonomic standards. Consult with an ergonomics professional to avoid stress injuries. Use only the Tektronix rackmount hardware specified for this product.

Service safety summary

The *Service safety summary* section contains additional information required to safely perform service on the product. Only qualified personnel should perform service procedures. Read this *Service safety summary* and the *General safety summary* before performing any service procedures.

To avoid electric shock	Do not touch exposed connections.
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 product power and disconnect the power cord from the mains power before removing any covers or panels, or opening the case for servicing.
Use care when servicing with power on	Dangerous voltages or currents may exist in this product. Disconnect power, remove battery (if applicable), and disconnect test leads before removing protective panels, soldering, or replacing components.
Verify safety after repair	Always recheck ground continuity and mains dielectric strength after performing a repair.

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.

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.

Symbols on the product

	When this symbol is marked on the product, be sure to consult the manual to find out the nature of the potential hazards and any actions which have to be taken to avoid them. (This symbol may also be used to refer the user to ratings in the manual.)
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The following symbols may appear on the product:



Preface

This document provides specifications and performance verification procedures for the TCR801 Optical Clock Recovery instrument.

Related documents

The following product related documents are available for download from www.tek.com/manuals. You can find manuals by searching on the product name and selecting the Manuals filter.

To learn about	Use this document
How to install and turn on the instrument software and hardware; read safety and compliance information.	TCR801 Installation and Safety Instructions. Printed and shipped with the instrument. Also available online as a downloadable PDF. This document contains content in English, Japanese, and Simplified Chinese.
How to operate the instrument, take measurements, navigate the UI, and how to control the instrument using programmatic commands (syntax provided).	Optical Clock Recovery Application Help. This document is accessible in the application and also available from tek.com as a downloadable PDF.
TCR801 specifications. Includes procedures to verify that the device meets warranted specifications.	TCR801 Specifications and Performance Verification Technical Reference (this document)
How to install up to two TSO820 sampling oscilloscopes, or one TSO820 and one TCR801, into a standard instrument rack using the rackmount kit.	TSO820 and TCR801 Rackmount Kit Instructions
How to declassify, sanitize, and clear memory devices in the instrument.	TCR801 Declassification and Security Instructions

Specifications

This section provides specifications for the TCR801 Optical Clock Recovery device. Guaranteed specifications are indicated by ✓ symbol. For procedures to test these guaranteed specifications, see the [Procedures](#) on page 10 in the Performance Verification section.

Clock recovery

Optical input connector type	FC-PC
Optical input damage level	Average power: 4 mW Max peak power: 10 mW
✓ Optical input sensitivity	-10 to 4 dBm at 1310 nm (typical, OMA) with PRBS13Q or similar - 8 to 4 dBm at 1310 nm (typical, OMA) with PRBS31Q, SSPRQ or similar Conditions <ul style="list-style-type: none"> • PAM4 modulated signal with TDECQ < 3.4 dB. Sensitivity at higher TDECQ might be lower depending on signal distortion. • OR PAM2/NRZ modulated signal passing 100GBASE-LR4 specification using pattern such as PRBS31 or other patterns with same or higher edge density.
Symbol rate range	51.2 - 58 GBd 25.6 - 29 GBd
Input ISI and jitter tolerance	< 49 ps pk-pk input SJ @ 2 MHz < 18.5 ps pk-pk input SJ @ 5 MHz < 11.7 ps pk-pk input SJ @ 10 MHz < 7 ps pk-pk input SJ @ 40 MHz < 6 ps pk-pk input SJ @ 100 MHz
Loop bandwidth	0.2 - 10 MHz adjustable across all data rates
Loop bandwidth tolerance	± 1 MHz at all data rates

Outputs

CLK output amplitude	1.0 ± 0.1 V @ 25 ± 5°C, peak-to-peak
✓ CLK output jitter	600 μW: < 490 fs with 53.125 GBd SSPRQ input, 4 MHz loop bandwidth 200 μW: < 300 fs RMS with 53.125 GBd PRBS13Q input, 4 MHz loop bandwidth

Behaviors

Tracking range, Locking range	± 1000 ppm
Outputs enabled/disabled	Both outputs are enabled or disabled at the same time. No individual control available.

Power ports

Power connection	2.1 mm center 12 V barrel jack used with the provided Tektronix power supply
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Communication ports

USB	USB Type B, located on the rear panel of the product for static/dynamic IP address allocation.
LAN port	Ethernet (10/100/1000), located on the rear panel of the product.

Controls and indicators

Power button	Power button to power unit on/off. Push to power unit on. Once unit is on push (and release) to attempt a relock or hold (> 5 sec) to switch unit to standby
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Display

Display type	61 mm (W) x 12 mm (H), 2 x 20 liquid crystal display (LCD).
Display resolution	5 (W) x 8 (H) pixels per alphanumeric character
Background color	White

Mechanical characteristics

Physical dimensions

Weight	10.0 lbs
Height	56 mm (2.20 in.)
Width	203 mm (7.99 in.)
Depth	561 mm (22.09 in.)

Environmental

Temperature	Operating	0 to 40°C
	Nonoperating	-20 to 60°C
Relative humidity	Operating	5% to 95% RH at up to +30°C, 5% to 45% RH above +30°C up to +40°C
	Nonoperating	5% to 95% RH at up to +30°C, 5% to 45% RH above +30°C up to +60°C
Acceleration (5 - 500 Hz)	Operating	0.27 grms
	Nonoperating	2.28 grms

Performance verification

This chapter contains performance verification procedures for the specifications marked with the check mark (✓).



Note: The performance verification procedure is not a calibration procedure. The performance verification procedure only verifies that your instrument meets key specifications. For your instrument to be calibrated, it must be returned to a Tektronix service facility.

Prerequisites

- The instrument must have been calibrated at an ambient temperature between +20 °C to +30 °C.
- The instrument must have been had a warm-up period of at least 10 minutes.
- The instrument must be in an environment with temperature, altitude, and humidity with the operating limits.

Required equipment

Requirements	Examples
Sampling oscilloscope, high bandwidth optical modules (60 GHz) and electrical modules.	DSA8300, TSO820
High speed pattern generator, capable of 51 - 58 GBd NRZ, PAM4, PRBS and SSPRQ signals.	MP19000A
Electrical to optical modulator. High bandwidth, adjustable attenuation.	Thorlabs MX40A
Real-time oscilloscope with frequency range 0 to 18 GHz. A spectrum analyzer can be use instead.	DPO70002SX
High frequency and phase stable SMA cables	SMA cables

Procedures



Note: The below procedures can be performed by using VISA or the OCR GUI

Optical input sensitivity

This test verifies the lowest optical input that the TCR801 receives before it locks. This test can be done with a variety of input sources; therefore, we have used as generic a signal as possible. We recommend that you use a high-performance input source with low TDECQ, around < 3 dB, and an ER of around 4 dB.

For this test, you will sweep across data rate and amplitude to see if the unit can lock at the specified values.

Input:

Optical source capable of 4dB ER and low TDECQ.

OMA	-10 dBm, -8 dBm
Pattern	PRBS13Q and SSPRQ

Output:

Electrical sampling module of sampling scope to output 1

Sampling scope input trigger on output clock of the input source

1. Set input source to data rate, pattern, and OMA as specified in the [Table 1: Input source settings](#) on page 11.
2. Set data rate of TCR801 to desired rate from [Table 1: Input source settings](#) on page 11, example: CREC:DRATE "53.125".
3. Send command CREC:ACQL to start the lock process.

4. Monitor the status of the output and lock by monitoring the return from CREC:LST? until it returns "locked".
5. Verify the integrity of the eye on a sampling oscilloscope, before measuring and verifying lock performance. If it locks at the specified OMA and the sampling oscilloscope shows a stable sine wave out of the output, then it passes. If it cannot lock, first check the input source. It may be that the eye is closed, there is a lower amplitude than expected, or there is a dirty optical connector/cable. If you encounter such an issue, fix and retest. If there is still no lock, then the test fails.

Table 1: Input source settings

Data rate	ER	Pattern	OMA	Lock?	Pattern	OMA	Lock?
52 GBd	4 dB	PRBS13Q	-10 dBm		SSPRQ	-8 dBm	
53.125 GBd	4 dB	PRBS13Q	-10 dBm		SSPRQ	-8 dBm	
58 GBd	4 dB	PRBS13Q	-10 dBm		SSPRQ	-8 dBm	
25.6 GBd	4 dB	PRBS13Q	-10 dBm		SSPRQ	-8 dBm	
28.5 GBd	4 dB	PRBS13Q	-10 dBm		SSPRQ	-8 dBm	

CLK output jitter

This test ensures the output jitter of the CLK output is within a given specifications limit and is low enough to generate good TDECQ results, and provide appropriate measurement results when triggered. By sweeping across data rates on the optical input and measuring the corresponding output jitter, it creates an output jitter profile.

This can be a difficult measurement to quantify. It is best to measure the additive jitter of the system for a given measurement. For this, you need to measure the random jitter of the input clock source and subtract out the random jitter component measured of the clean clock versus the output of the TCR801 via the Root Sum Square method to get the total insertion jitter. To measure the random jitter, use oscilloscope software to measure random jitter, or a histogram on the clock edge of the eye diagram, with a minimum vertical scale for maximum resolution.

Input	Optical source, ER:4 dB, PRBS13Q 200 μ W OMA.; SSPRQ, 600 μ W OMA, TDECQ < 4 dB.
Output	Sampling oscilloscope

1. Input the source to the TCR801.
2. Start a lock process using the GUI or the CREC:ACQL PI command.
3. Once locked, measure the output jitter using one of the above methods.
4. Record the value and verify it is within the tolerance. Test the data rate at 53.125 GBd and record the results in the following table.

Table 2: Output jitter measurements

Pattern	Data Rate	Input Jitter RMS (ps)	Output Jitter RMS (ps)	Calculated Insertion Jitter RMS (ps)	Test Status
600 μ W SSPRQ	53.125 GBd				
200 μ W PRBS13Q	53.125 GBd				

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