Instruction Manual

Tektronix

ORR24
Optical Reference Receiver

071-0060-00

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Tektronix, Inc., P.O. Box 1000, Wilsonville, OR 97070–1000

WARRANTY

Tektronix warrants that the products that it manufactures and sells will be free from defects in materials and workmanship for a period of one (1) year from the date of shipment. If a 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.

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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If you have not already purchased Service Assurance for this product, you may do so at any time during the product's warranty period. Service Assurance provides Repair Protection and Calibration Services to meet your needs.

Repair Protection extends priority repair services beyond the product's warranty period; you may purchase up to three years of Repair Protection.

Calibration Services provide annual calibration of your product, standards compliance and required audit documentation, recall assurance, and reminder notification of scheduled calibration. Coverage begins upon registration; you may purchase up to five years of Calibration Services.

Service Assurance Advantages

- Priced well below the cost of a single repair or calibration
- Avoid delays for service by eliminating the need for separate purchase authorizations from your company
- Eliminates unexpected service expenses

For Information and Ordering

For more information or to order Service Assurance, contact your Tektronix representative and provide the information below. Service Assurance may not be available in locations outside the United States of America.

Name	VISA or Master Card number and expiration
Company	date or purchase order number
Address	Repair Protection (1,2, or 3 years)
City, State, Postal code	Calibration Services (1,2,3,4, or 5 years)
Country	Instrument model and serial number
Phone	Instrument purchase date

Table of Contents

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.

To Avoid Fire or Personal Injury

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.

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

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

Do Not Operate in Wet/Damp Conditions.

Do Not Operate in an Explosive Atmosphere.

Keep Product Surfaces Clean and Dry.

Symbols and Terms

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. The following symbols appear on the product:

CAUTION
Static Sensitive

CAUTION
Refer to Manual

Contacting Tektronix

Phone	1-800-833-9200*****
Address	Tektronix, Inc. Department or name (if known) 14200 SW Karl Braun Drive P.O. Box 500 Beaverton, OR 97077 USA
Web site	www.tektronix.com
Sales support	1-800-833-9200, select option 1*****
Service support	1-800-833-9200, select option 2*****
Technical support	Email: techsupport@tektronix.com 1-800-833-9200, select option 3***** 1-503-627-2400 6:00 a.m. – 5:00 p.m. Pacific time

*** This phone number is toll free in North America. After office hours, please leave a voice mail message.**
Outside North America, contact a Tektronix sales office or distributor; see the Tektronix web site for a list of offices.

Getting Started

The ORR24 is an optical reference receiver that is precisely calibrated in the frequency domain for the SONET/SDH data rate of 2.488 Gb/s (STM-16/OC-48). The ORR24 reference receiver installs in the front panel compartment of a Tektronix 11800 Series Digital Sampling Oscilloscope (including the SM-11 Multichannel Unit) or Tektronix CSA 803 Communications Signal Analyzer. Along with the appropriate sampling head, the ORR24 reference receiver and the CSA 803 or 11800 series instruments can test the compliance of optical signals to specific SONET/SDH standards. An optional stand-alone power supply is also available for the ORR24 Optical Reference Receiver (see page 21).

Figure 1 shows the front panel of the ORR24 Optical Reference Receiver.

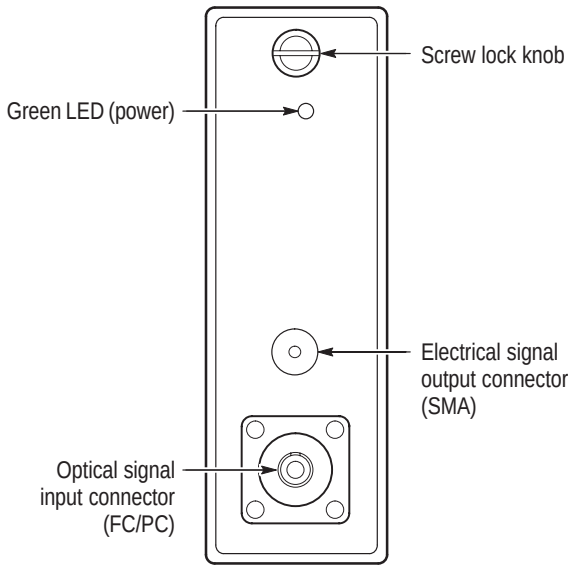

Figure 1: ORR24 Front Panel

The ORR24 Optical Reference Receiver has an FC/PC receptacle for optical signal input and a precision 3.5 mm connector for electrical signal output.

The following list highlights the key performance characteristics of the ORR24 Optical Reference Receiver:

- 1000 to 1650 nm wavelength response
- 2.0 GHz Minimum Transducer Bandwidth
- Fourth order Bessel-Thompson, 2.488 Gb/s frequency response
- Greater than 0.5 V/mW DC conversion gain at 1310 and 1550 nm

For a complete list of specifications, see page 10.

Standard Accessories

The following accessories are standard with every ORR24 Optical Reference Receiver:

- Hard case
- Instructions
- FC/PC to FC/PC 9 μm single-mode fiber jumper
- FC/ST, FC/SC, and FC/FC hybrid connectors
- Coaxial Cable (SMA-to-SMA, 50 Ω, 2 ns delay)
- SMA terminator
- Certificate of traceable calibration
- Frequency response graph

For a list of replaceable part numbers, see page 19.

Options

The following options are available at the time of purchase:

- Opt 95 Calibration data
- Opt C3 Three years calibration services
- Opt R3 Three years extended warranty

Optional Accessories

The following recommended accessories are available through Tektronix:

- Fiber-optic cables and adapters with a variety of fiber types and connector styles
- 90/10 single-mode optical splitter with FC/PC connectors
- DIN to FC fibre optic hybrid connector
- 10 dB in-line single-mode optical attenuator
- Stand-alone power supply

For a list of part numbers, see page 19.

Installation

Follow the instructions in this section to install the ORR24 Optical Reference Receiver into the Tektronix 11800 Series Digital Sampling Oscilloscope or CSA 803 Communications Signal Analyzer or to connect it to the optional power supply for stand-alone operation.

CAUTION. *The output of the Optical Reference Receiver and the input of the sampling head are subject to damage from electrostatic discharge (ESD). To prevent damage from ESD, take the following precautions:*

Always wear an anti-static wrist strap when handling a static sensitive instrument.

Keep the 50 Ω termination in place when moving or storing the instrument. Remove the termination only to connect a cable.

Discharge the inner conductor of a loose, unterminated cable before connecting it to the instrument.

11800 or CSA 803 Series

On the Tektronix 11800 Series Digital Sampling Oscilloscope or the CSA 803 Communications Signal Analyzer, the ORR24 Optical Reference Receiver installs into any of the front panel compartments.

NOTE. *To guarantee compliance with OC-48 boundary limits, you must connect the ORR24 Optical Reference Receiver to the input of an SD-22 sampling head using the 015-0560-00 cable provided. The ORR24 is designed for the electrical characteristics of the cable and the particular frequency response and low noise of the SD-22.*

Use the following procedure to install the Optical Reference Receiver and sampling head modules:

1. Switch off the measurement instrument.
2. Place the module in a compartment and slowly push it in with firm pressure.
3. Once the module is seated, turn the screw shaft on the plug-in to tighten the module in place.
4. Switch on the measurement instrument and check that all modules have power.
5. Follow anti-static precautions and connect the output of the Optical Reference Receiver to the input of the sampling head with the 015-0560-00 cable provided:
   a. Align the SMA connectors carefully.
   b. Use light, finger pressure to turn the nut. *Do not* turn the cable.
   c. Tighten the nut lightly with a wrench. For best repeatability and to prolong the life of SMA connectors, use a torque wrench and tighten the connection to the range of 7 to 10 lb-in (79 to 112 N-cm).

***NOTE**. On the CSA803 series, the Optical Reference Receiver will work in any of the power-only or sampling head compartments, but the sampling head must be installed in one of the two sampling head compartments on the right. See Figure 2.*

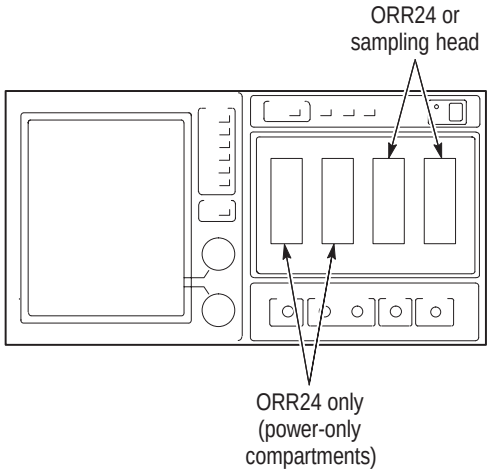

Figure 2: Front panel compartments in a CSA 803 Communications Signal Analyzer

Optional Power Supply

The optional power supply kit (Figure 3) permits stand-alone operation. The part number for the kit is on page 21.

***NOTE**. To guarantee compliance with OC-48 boundary limits, you must connect the ORR24 Optical Reference Receiver to the input of an SD-22 sampling head using the 015-0560-00 cable provided. The ORR24 is designed for the electrical characteristics of the cable and the particular frequency response and low noise of the SD-22.*

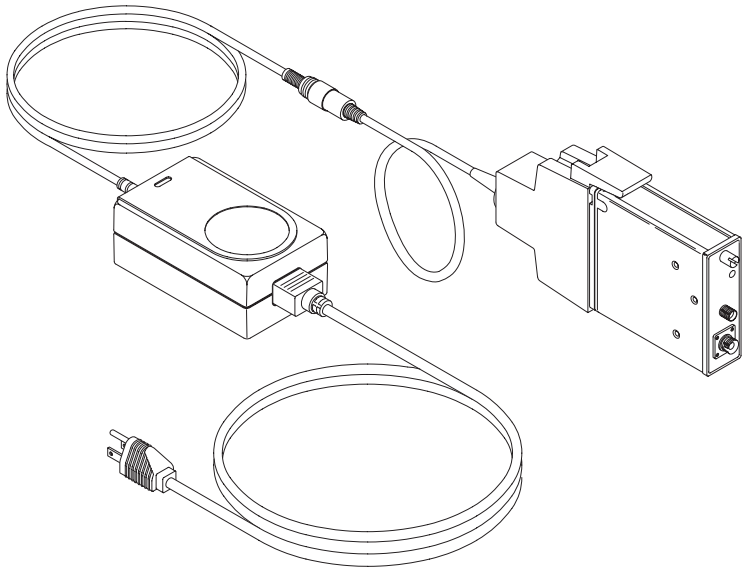

Figure 3: Installation with optional power supply kit

Operating Basics

Figure 1 shows the front panel of the ORR24 Optical Reference Receiver. The ORR24 Optical Reference Receiver has an FC/PC receptacle for optical signal input and a precision 3.5 mm connector for electrical signal output.

Handling

Handle the ORR24 Optical Reference Receiver carefully at all times.

CAUTION. *To avoid damaging the ORR24 Optical Reference Receiver, take the following precautions:*

Do not drop the Optical Reference Receiver since damage and misalignment of the photodiode optical assembly can result. Store the Optical Reference Receiver in a secure location when not in use.

Replace the protective caps on the input and output connectors when the Optical Reference Receiver is not in use.

Cleaning Optical Connectors

Small dust particles and oils can easily contaminate optical connectors and reduce or block the signal. Take care to preserve the integrity your connectors by keeping them free of contamination.

CAUTION. *To prevent loss of optical power or damage to the optical connectors, keep the connectors clean at all times.*

When cleaning the connectors with a swab, use gentle circular motions. Use only high quality cleaning supplies that are non-abrasive and leave no residue.

To reduce the need for cleaning, immediately replace protective caps on the optical connectors when not in use.

Equipment Required

Use the following items to clean the optical connectors:

- clean compressed air
- fiber-optic cleaning swabs
- isopropyl alcohol

Procedure

To clean the optical connectors, follow these steps:

1. Hold the can of compressed air upright and spray the can into the air to purge any propellant.
2. Spray the clean compressed air on the connectors to remove any loose particles or moisture.
3. Moisten a clean optical swab with isopropyl alcohol then lightly swab the surfaces of the connectors.
4. Spray the clean compressed air on the connectors again to remove any loose particles or isopropyl alcohol.

***NOTE**. Cleaning kits for optical connectors are available from a number of suppliers.*

Connecting Signals

Attach the fiber optic cable with an FC/PC connector to the FC/PC input receptacle as follows:

1. Carefully align the keyway on the receptacle with the key on the connector.
2. Tighten the nut lightly with finger pressure only.

The input of the ORR24 Optical Reference Receiver can couple to optical fibers with a core diameter of up to 9 μm. Alternate types can be coupled by use of an FC-FC jumper and the FC-FC, FC-ST, FC-SC adapters. (Refer to *Optional accessories* on page 21.)

***CAUTION.** To maintain the high performance (low return loss) of the reference receiver, connect an adapter and cable between the input of the reference receiver and the device under test. When you make connections to other devices, leave the adapter and cable in place to protect the optical connector of the reference receiver from wear.*

If you connect fiber cores larger than 9 μm, the reference receiver may still couple light, but the mismatch in core diameter will cause lower conversion gain and high insertion loss.

Attenuating Optical Signals

When using the ORR24 as a reference receiver, it may be necessary to attenuate the optical signals.

CAUTION. *To avoid damaging the optical input of the ORR24, attenuate optical signals to less than 5 mW average power or 10 mW peak power at the wavelength with highest relative responsivity.*

For linearity and measurement accuracy, attenuate the peak-to-peak swing of signal to within the specified performance of 200 μW_{p-p}.

Example:

1. You want to look at an OC-48 eye-pattern signal whose average power (un-attenuated) is about +2 dBm. The average optical power of the +2 dBm signal is equal to 1584 μW.
2. For optical signals with a 50% duty cycle , the average power is approximately one half of the peak-to-peak swing for high extinction ratio signals. This means that the peak-to-peak value of the optical signal is approximately

   2 x 1584 μW = 3168 μW_{p-p}
3. To lower the signal to within the 200 μW range, the signal must be attenuated by 3168 μW / 200 μW = 15.84; this is equal to about 12 dB of optical attenuation.

To attenuate the optical signal to the proper level, use a Tektronix OA5002 Optical Attenuator.

Specifications

This section contains the specifications of the ORR24 Optical Reference Receiver. All specifications are guaranteed unless noted as "typical." Typical specifications are provided for your convenience but are not guaranteed. Specifications marked with the ✓ symbol have corresponding checks in the *Performance Verification* section on page 12.

Table 1: ORR24 Specifications

Specification	Description
Effective wavelength range, typical	1000 nm to 1650 nm
✓ DC conversion gain	≥ 0.500 V / mW at 1310 nm ± 20 nm and 1550 nm ± 20 nm
DC conversion gain, typical	> 0.850 V / mW at 1310 nm ± 20 nm
Relative responsivity, typical	See Figure 4
DC conversion gain linearity, typical	< 3% deviation in DC conversion gain from 25 µW to 500 µW average optical input relative to conversion gain with 250 µW average optical power input
Absolute maximum nondestructive optical input	5 mW average power; 10 mW peak power at wavelength with highest relative responsivity
✓ Bandwidth	DC to 2.0 GHz (≥ – 6 dB electrical output into 50 Ω)
Frequency Response (+20° C to +35° C)	Scalar frequency response of optical-to-electrical conversion (as measured at the electrical output) falls within the SONET OC-48 and SDH STM-16, 2.488 Gb/s industry standards (Bessel-Thompson reference receiver boundary limits)[1]
Maximum non-saturating linear response to transient input	The transient optical signal response is linear (± 5%) up to 100 µW average optical power and < 200 μW_{p-p} optical power for both 1310 nm ± 20 nm and 1550 nm ± 20 nm. Linearity is relative to 200 μW_{p-p} step response
Internal Fiber diameter	core: 9 µm single-mode fiber cladding: 125 µm
Fiber connector style	female FC/PC
Optical return loss	> 30 minimum when external mating fiber is also PC style.
✓ Noise equivalent power	≤ 15 $pW/\sqrt{Hz}$ electrical output noise when terminated into 50 Ω
✓ Rise time	≤ 205 ps
✓ Aberrations	≤ $5\%_{p-p}$ total
✓ Output zero	≤ ± 1.0 mV at 20° C to 30° C and ≤ ± 3.0 mV outside this range (optical input must be zero)
External Termination impedance	50 Ω ± 2 Ω

1 **A 4th order Bessel Thompson response for a SONET/SDH 2.488 Gb/s data rate receiver should have a nominal –3 dB at 1.8666 GHz and –5.7 dB at 2.488 GHz.**

Table 1: ORR24 Specifications (cont.)

Specification	Description
Temperature	Operating: +10° C to +40° C (frequency response is only guaranteed from +20° C to +35° C) Non-operating: –55° C to +75° C
Humidity	75% non-condensing
Altitude	Operating: 4,572 m (15,000 ft) Non-operating: 15,240 m (50,000 ft)

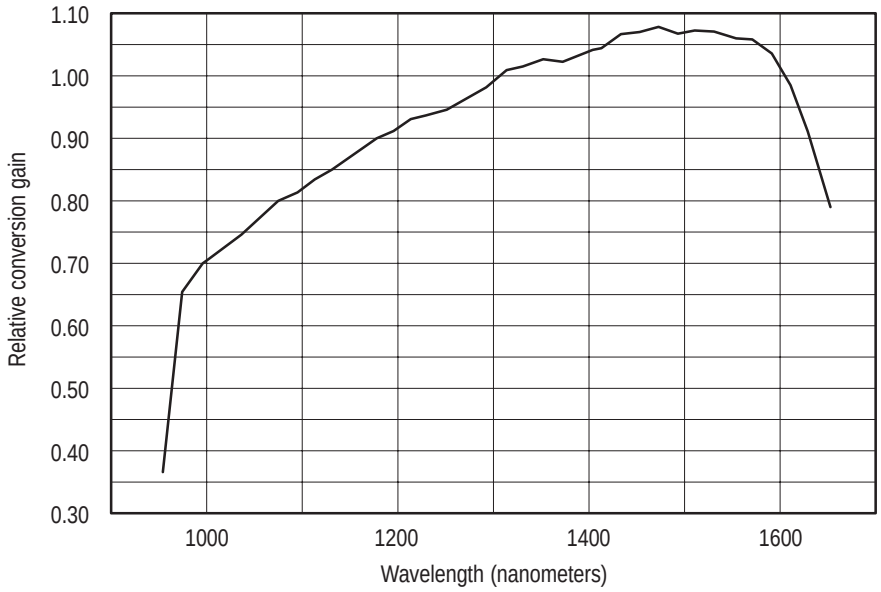

Figure 4: ORR24 relative responsivity (normalized to 1310 nm)

Performance Verification

Use the following procedures to verify the specifications of the ORR24 Optical Reference Receiver. Before beginning these procedures, see page 18 and photocopy the test record and use it to record the performance test results. The recommended verification interval is one year.

These procedures test the following specifications:

- Noise equivalent power
- Output zero
- DC conversion gain
- Rise time
- HF Aberrations
- Bandwidth/Frequency Response

Equipment Required

Table 2 lists the equipment required to perform the performance verification procedure. The types and quantities of connectors may vary depending on the specific equipment you use.

Table 2: Test equipment

Description	Minimum requirements	Example product
Optical power meter with head and adapters	Accuracy > 2.5%, resolution > 5 pW, Max power > 1 mW, calibrated from 700 nm – 1600 nm	HP 8153A with HP 811532 head
1310 nm cal source	output > 200 μW[1], stability > 0.1 dB over 5 minutes, modulated square wave @ 10 kHz with off modulation at zero-light level	Rifocs 665R–PO
1550 nm cal source	output > 200 μW (CW)[1], stability > 0.1 dB over 5 minutes, modulated square wave @ 10 kHz with off modulation at zero-light level	Rifocs 666R–PO
RF power meter	noise < .1 mV, BW > 4 GHz	HP 436A with power sensor HP 8484A

Table 2: Test equipment (cont.)

Description	Minimum requirements	Example product
1300 or 1550 nm impulse generator	pulse width < 6 ps	Clark MXR ErF ™ picosecond 1550 laser
Sampling oscilloscope with sampling head		11800 series or CSA800 series with SD-22 sampling head)
SMA-to-SMA cable	50 Ω with 2 ns delay	015-0560-00
PC with GPIB port and printer	printer output of sampled waveforms	
Adjustable single-mode optical attenuator	4 decades, 9 µm core fiber, FC-style connectors	Tektronix OA5002
Digital voltmeter	4 1/2 digit	Keithley 2000 or Tektronix DMM916
50 Ω termination	± 1%	011-0049-01
BNC-to-banana adapter	BNC female to dual banana	103-0090-00
Optical cable	FC-FC multimode, 9 µm, 2 meters	174-1910-00
Inline optical adapter	FC female to FC female	131-5039-00
Low-pass filter	1 GHz	Mini Circuits SLP 1000

1 **CW and modulated mode available: modulation with OFF level at or below 0.1 µW, optical falltime < 1 µs**

NOTE. *To guarantee compliance with OC-48 boundary limits, you must connect the ORR24 Optical Reference Receiver to the input of an SD-22 sampling head using the 015-0560-00 cable provided. The ORR24 is designed for the electrical characteristics of the cable and the particular frequency response and low noise of the SD-22.*

The reference receiver under test and the test equipment and should be warmed up for 20 minutes at an ambient temperature between 20 and 30° C.

Output Zero

1. Attach the output of the ORR24 to the voltmeter inputs with a 50 Ω termination and BNC-to-banana adapter.
2. Install the optical dust cover on the input of the ORR24.
3. Check that output voltage is ≤ ± 1 mV. Record the result on the test record.

DC Conversion Gain

***NOTE**. Make sure that the optical connector ends of both the fiber from the optical attenuator output and the ORR24 under test input fiber are well cleaned before performing this step. See the cleaning instructions on page 7.*

1. Connect the 1310 nm laser source to the input of the optical attenuator.

***NOTE**. The longer wavelengths of 1310 nm and especially 1550 nm in single mode fiber are sensitive to loss in fiber due to bending of the fiber. The fiber bend radius of the ORR24 fiber input should lay with >1.5 inch bend radius along the fiber's entire length. Although this precaution must be maintained throughout the entire performance verification procedure, it is especially important for this step in order to accurately adjust and measure the DC conversion gain of the ORR24.*

2. Connect the optical attenuator output to the optical power meter using single mode optical cable with FC connectors. Use the appropriate optical power meter sensing head with calibrated measurement for a wavelength span including 1310 nm and 1550 nm. Be sure the optical power meter wavelength setting and optical attenuator setting is at 1310 nm. Enable the optical output.

3. Adjust attenuator or the optical source so that the optical power meter reads 200 μW.

4. Move the FC fiber end (the one now adjusted to 200 μW average power) from the optical power meter and connect it to the ORR24 input under test.

5. Attach voltmeter with 50 Ω termination to ORR24 output.

6. Record the voltmeter reading. The 1310 nm conversion gain in units of V/mW is

(voltmeter reading) × *5*

7. Record the 1310 nm conversion gain on the test record.

8. Disconnect the 1310 nm laser from the optical attenuator, and reconnect the 1550 nm laser source. Set the optical attenuator to the correct wavelength.

***NOTE**. Do not disturb the fiber connection between the optical attenuator output and the ORR24 input.*

9. Adjust the optical attenuator until the voltmeter reading is the same as in step 6 above ± 1%.

10. Without moving the optical attenuator from the position in the previous step, disconnect the output fiber of the optical attenuator from the inline adapter with the ORR24 and insert the optical attenuator output into the optical power meter.

11. Adjust the optical power meter to the calibrated wavelength setting of 1550 nm. Note the absolute power displayed. The 1550 nm conversion gain in units of V/mW_{opt} is

    ((200 μW) / (measured 1550 power)) × (1310 nm conversion gain)

12. Record the 1550 nm conversion gain on the test record.

Noise Equivalent Power

Power the ORR24 under test using the digital sampling oscilloscope.

1. Zero the RF power meter.

2. Connect the ORR24 output channel to the RF power meter using a 1 GHz low-pass filter in series.

3. With the dust cover on the input to the ORR24, the RF power meter should read less than

$$\frac{[15\ pW_{opt}\ /\ \sqrt{Hz}\ \times\ \sqrt{1\ GHz} \times (measured\ conversion\ gain\ in\ V/W_{opt})]^2}{50\ \Omega}$$

$$= 4.5 \times 10^{-15} \times (measured\ conversion\ gain\ in\ V/W_{opt})^2$$

$$= W_{elec}$$

(**NOTE :** $V/W_{opt} = V/mW_{opt} \times 1000$)

4. Record the calculated and measured results on the test record.

Rise Time and HF Aberrations

1. Connect the output of the optical impulse generator to the ORR24 optical input through the optical attenuator.
2. Connect the trigger output of the optical impulse generator to the trigger input of the digital sampling oscilloscope with a 50 Ω, 5X electrical attenuator in series with the trigger input.
3. Connect the ORR24 output to the digital sampling oscilloscope input using a relatively short 50 Ω cable (i.e. < 1 meter).
4. Set the optical source to the 1 MHz rate and low energy mode. Adjust the optical attenuator so that the height of the impulse is about 200 mV_{p-p}.
5. Set the digital sampling scope to 10 mV/div vertical scale, 100 ps/div horizontal scale, 1024-point record length, and insure the entire impulse waveform is within the display region. Shift the horizontal record so that the start of the impulse is within the first two divisions of the horizontal scale on the display.
6. Average the waveform a minimum of 256 times, and store the averaged waveform.
7. Recall the stored waveform, and measure the mean signal level before the start of the impulse (i.e. measure the average vertical offset in the record length preceding the impulse; if the impulse generator is temporarily disabled, then the average DC level of the entire record length can be used instead).
8. Program the digital sampling oscilloscope to display the integral of the stored waveform minus the mean signal level before the impulse.
9. Measure the rise time of the integrated impulse response and insure that it is less than or equal to 205 ps. Record the rise time on the test record.
10. Turn on the horizontal bar cursors and set them at the 0 and 100% levels of the waveform, using the level 500 ps after the 50% point of the step as 100% level. Record the difference between the two levels.
11. Now set the cursors on the minimum and maximum overshoot and undershoot points. Record the difference of the two levels. Divide the difference voltage due to the aberrations by the step size and ensure that the result is less or equal to 5%. Record the actual percentage on the test record.

Bandwidth/Frequency Response

1. Recall the impulse waveform acquired in Step 6 on page 16.
2. Using a controller attached to the digital sampling oscilloscope via GPIB (i.e. a PC, MAC, workstation, etc.), download the 1024-point, averaged impulse response.
3. Using the available controller software (i.e. Labview, etc) perform an FFT (Fast Fourier Transform) on the 1024-point impulse response; this transforms the time-domain impulse response to a scalar frequency response.
4. Check that the frequency response from DC to 2 GHz is greater than or equal to –6 dB where dB = 20log (V_{log}/V_{dc}) or electrical power into 50 Ω.

Test record

Model/Serial Number: _____ Certificate Number: _____

Temperature: _____ RH %: _____

Date of Calibration: _____ Technician: _____

Performance test		Minimum	Measured	Maximum
Output zero		N/A		±1 mV
DC conversion gain	at 1310 nm ± 20 nm	0.500 V/mW$_{opt}$		N/A
DC conversion gain	at 1550 nm ± 20 nm	0.500 V/mW$_{opt}$		N/A
Noise equivalent power		N/A		_____W$_{elec}$ (calculated)
Rise time		N/A		205 ps
HF aberrations		N/A		5%$_{P-P}$ total
Bandwidth, DC to 2 GHz		– 6 dB	(attach plot)	N/A

Replaceable Parts

For information about replaceable parts, contact your Tektronix sales representative.

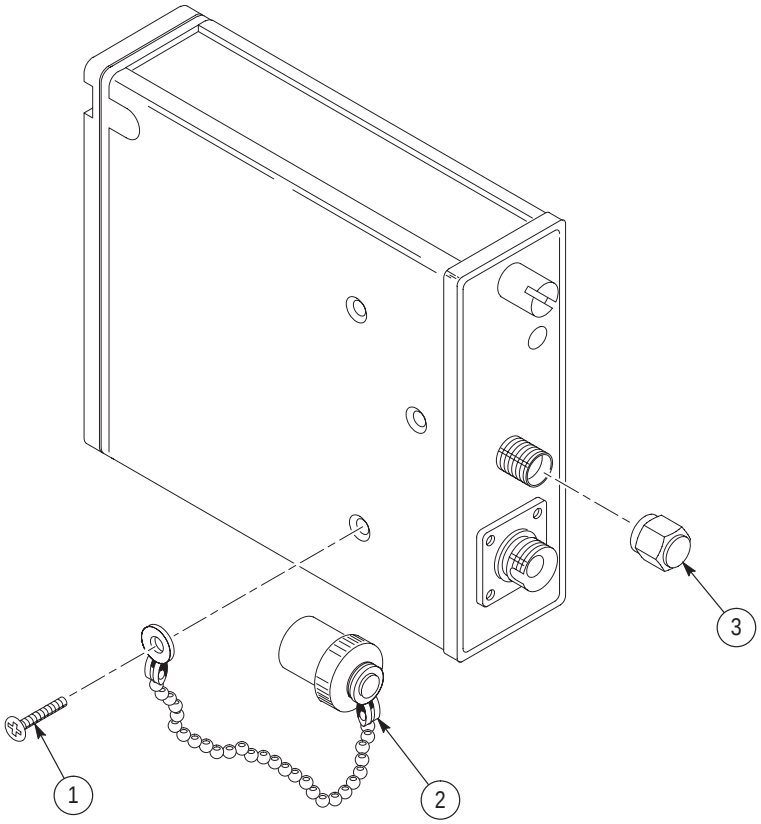

Figure 5: ORR24 replaceable parts

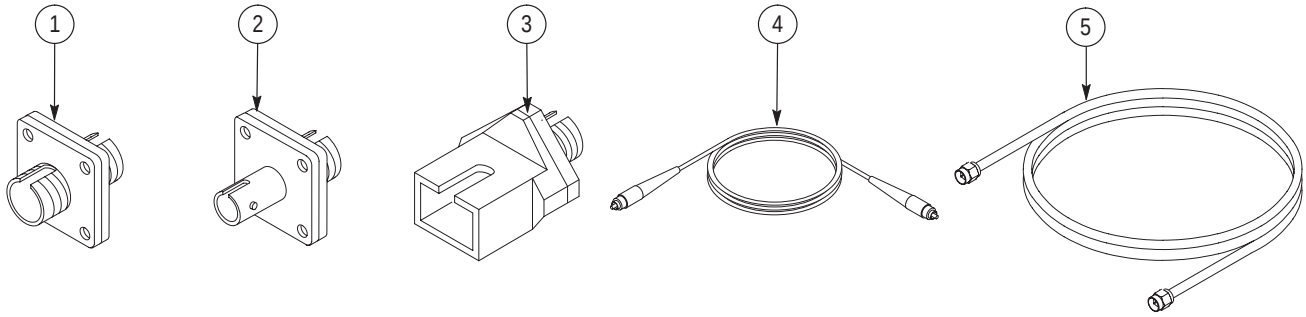

Figure 6: Standard accessories

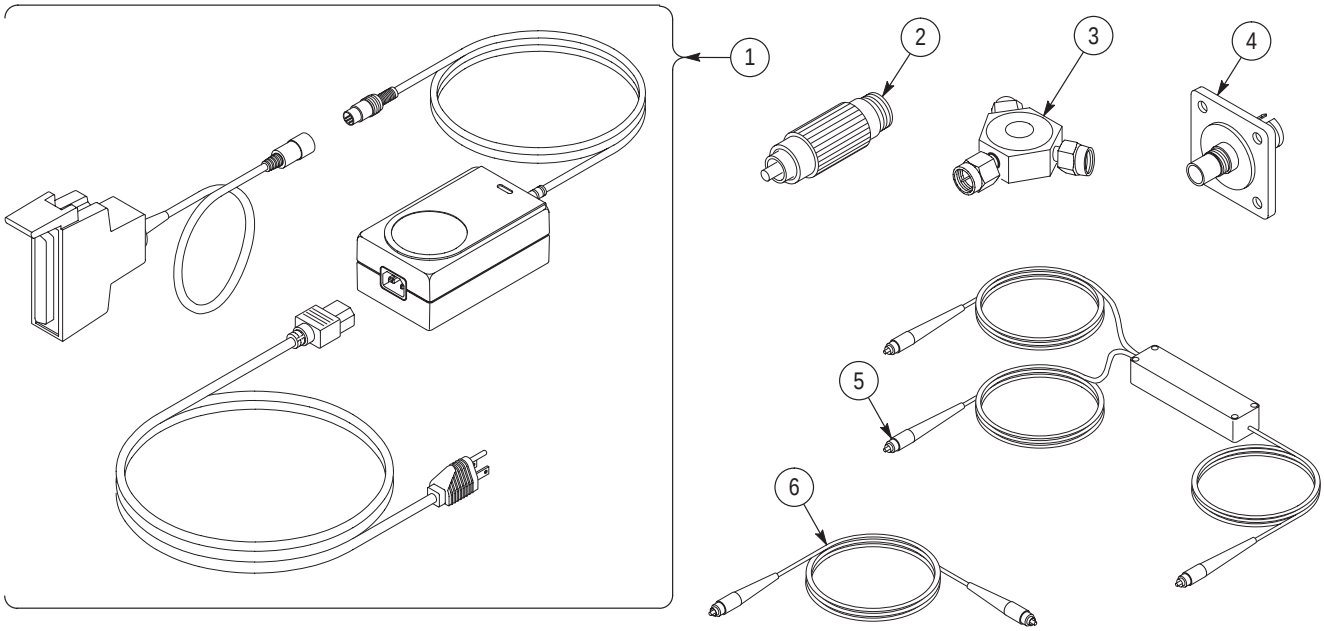

Figure 7: Optional accessories

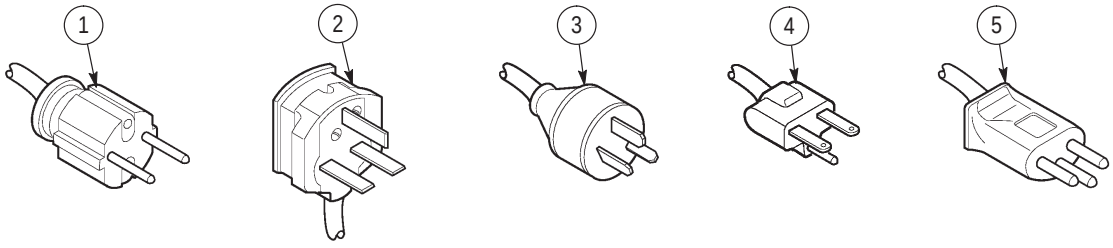

Figure 8: Optional power cords

Replaceable parts list

Fig. & index number	Tektronix part number	Serial no. effective	Serial no. discont'd	Qty	Name & description	Mfr. code	Mfr. part number
5–1	211–0001–00			1	SCREW,MACHINE:2–56 X 0.25,PNH,STL CD PL,POZ	93907	ORDER BY DESCRIP
–2	200–3658–00			1	COVER,CONNECTOR:FC,W/CHAIN	80009	200–3658–00
–3	015–1022–00			1	TERMN,COAXIAL:50 OHM,0.5W,SMA	26805	2001–4401–00
					Standard accessories		
6–1	131–6252–00			1	CONN:FC TO FC SQUARE MOUNT ADAPTER,W/ZIRCONIA CERAMIC SLEEVE	0C5R7	CO92290
–2	131–6250–00			1	CONN:FC TO ST ADAPTER W/ZIRCONIA CERAMIC SLEEVE	0C5R7	C032980
–3	131–6251–00			1	CONN:SC TO FC SQUARE FLANGE ADAPTER W/ZIRCONIA CERAMIC SLEEVE	0C5R7	C002453
–4	174–1910–00			1	CA ASSY FBR OPT:SM 2ML FC/PC TO FC/PC	05JW7	SGMGM–AA0002
–5	015–0560–00			1	CABLE,DLY,COAX:50 OHM,2NS,W/CONN,SMA,MALE,EACH END	0GZV8	SF104PE,460MM,2X1 1SMA–451
	071–0060–00			1	MANUAL,TECH:INSTRUCTION,ORR24,DP	80009	071–0060–00
					Optional accessories		
7–1	016–1609–00			1	POWER CORD KIT:ADAPTER CABLE & US POWER CORD	80009	016–1609–00
–2	119–5118–00			1	ATTEN,OPTICAL:30MM,L10DBFOR 1310/1550NM,FC CONN.FA100–35–10–HP,CTS710	0LK97	FA100–35–10–HP
–3	015–0565–00			1	POWER DIVIDER:50 OHM,3 SMA,FEMALE CONN	64537	D293S
	015–1014–00			1	PWR DIVIDER,RES:50 OHM,SMA	64537	D241S
–4	020–2209–00			1	ACCESSORY KIT:CONNECTOR,OPTICAL,DIN TO FC SQUARE MOUNT ADAPTER,	80009	020–2209–00
–5	174–3737–00			1	FIBER OPTIC:COUPLER, 1 X 2 SPLITTER, WAVELENGTH INDEPENDENT, 90/10 RATIO, ATT. 0.1 DB, REFLE	0C5R7	3–0102–10–B–UFC–0 1–UFC–01
–6	174–1497–00			1	CA ASSY,FBR OPT:SINGLE MODE,2M L FC/PC TO DIAMOND 2.5	80009	174–1497–00
	174–1385–00			1	CA ASSY,FBR OPT:SGL MODE,2M L,FC/PC DIAMOND3.5	80009	174–1385–00
	174–1386–00			1	CA ASSY,FBR OPT:SINGLE MODE,2M L,FC/PC–ST	80009	174–1386–00
	174–1387–00			1	CA ASSY,FBR OPT:SGL MODE,2M L,FC/PC–FC/PC	80009	174–1387–00
	174–1388–00			1	CA ASSY,FBR OPT:SGL MODE,2M L,FC/PC–BICONIC	80009	174–1388–00
	174–2322–00			1	CABLE,FIBER OPT:JUMPER,2 METER,62.5 MICRON,FC/PC TO FC/PC	62712	174–2322–00
	174–2323–00			1	CABLE,FIBER OPT:JUMPER,2 METER,62.5 MICRON,FC/PC TO BICONIC	62712	174–2322–00
	174–2324–00			1	CABLE,FIBER OPT:JUMPER,2 METER,62.5 MICRON,FC/PC TO SMA 906	62712	PC/SK–20–002A

Replaceable parts list (cont.)

Fig. & index number	Tektronix part number	Serial no. effective	Serial no. discont'd	Qty	Name & description	Mfr. code	Mfr. part number
					Optional Power Cords		
8–1	161–0066–09			1	CA ASSY,PWR:3,0.75MM SQ,250V/10A,99 INCH,STR,IEC320,RCPT,EUROPEAN,	2W733	ORDER BY DESCRIPTION
–2	161–0066–10			1	CA ASSY,PWR:3,1.0 MM SQ,250V/10A,2.5 METER,STR,IEC320,RCPT X 13A,FUSED UK PLUG(13A FUSE),UNI	TK2541	ORDER BY DESCRIPTION
–3	161–0066–11			1	CA ASSY,PWR:3,1.0MM SQ,250V/10A,2.5 METER,STR,IEC320,RCPT,AUSTRALIA,SAFTEY CONTROLLED,	80126	ORDER BY DESCRIPTION
–4	161–0066–12			1	CA ASSY,PWR:3,18 AWG,250V/10A,98 INCH,STR,IEC320,RCPT X NEMA 6–15P,US,SAFTEY CONTROLLED,	S3109	ORDER BY DESCRIPTION
–5	161–0154–00			1	CA ASSY,PWR:3,1.0MM SQ,250V/10A,2.5 METER,STR,IEC320,RCPT,SWISS,SAFTEY CONTROLLED,	5F520	86515030

Manufacturers cross index

Mfr. code	Manufacturer	Address	City, state, zip code
05JW7	PURDY ELECTRONICS CORP	INTEROPTIC DIVISION 720 PALOMAR AVE	SUNNYVALE, CA 94086
0C5R7	ALCOA FUJIKURA LTD	150 RIDGEVIEW CIRCLE	DUNCAN, SC 29334
0GZV8	HUBER & SUHNER INC	19 THOMPSON DRIVE	ESSEX JUNCTION, VT 05452–3408
0LK97	JDS FITEL INC	570 WEST HUNT CLUB RD	NEPEAN, ONTARIO CA ONTARIO K2G 5W8
26805	M/A COM OMNI SPECTRA INC	MICROWAVE CONNECTOR DIV 140 4TH AVE	WALTHAM, MA 02254
2W733	BELDEN WIRE & CABLE COMPANY	2200 US HWY 27 SOUTH PO BOX 1980	RICHMOND, IN 47374
5F520	PANEL COMPONENTS CORP	PO BOX 115	OSKALOOSA, IA 52577–0115
62712	SEIKO INSTRUMENTS USA INC	ELECTRONIC COMPONENTS DIV 2990 W LOMITA BLVD	TORRANCE, CA 90505
64537	KDI/TRIANGLE ELECTRONICS INC	60 S JEFFERSON RD	WHIPPANY, NJ 07981
80009	TEKTRONIX INC	14150 SW KARL BRAUN DR PO BOX 500	BEAVERTON, OR 97077–0001
80126	PACIFIC ELECTRICORD CO	747 WEST REDONDO BEACH PO BOX 10	GARDENA, CA 90247–4203
93907	CAMCAR DIV OF TEXTRON INC	ATTN: ALICIA SANFORD 516 18TH AVE	ROCKFORD, IL 611045181
S3109	FELLER U.S. CORPORATION	72 VERONICA AVE UNIT #4	SOMERSET, NJ 08873
TK2541	AMERICOR ELECTRONICS LTD	UNIT–H 2682 W COYLE AVE	ELK GROVE VILLAGE, IL 60007