| Specifications | OE425/525 | OE455/555 |
|---|---|---|
| Wavelength Range: | 500–870 nm<br>460–870 nm (0.1 V/mW) | 950–1630 nm<br>800–1630 nm (0.1 V/mW) |
| Conversion Gain: | 0.5 V/mW | 1.1 V/mW |
| Bandwidth: | 4.5 GHz (6 GHz optical) | 3.5 GHz (4.5 GHz optical) |
| Equivalent Noise: | 2.2 µW rms | 1.0 µW rms |
| Maximum Optical Power (at 5% saturation): | 2.2 mW | 1.0 mW |
| Rise Time (typical): | 90 ps | 108 ps |
| Maximum Safe Input: | 5.5 mW | 2.5 mW |
| Temperature Drift: | 0.00275 dB/deg. C | 0.00275 dB/deg. C |
| Frequency Response Ripple: | 1.1 dB | 1.1 dB |
| Connector Type: | FC/PC | FC/PC |
| Temperature (Operating): | 5 ˚C to 40 ˚C | 5 ˚C to 40 ˚C |
| Temperature (Non-Operating): | -20 ˚C to 60 ˚C | -20 ˚C to 60 ˚C |
| Humidity (Operating): | 5% to 80% RH* (non-condensing)<br>*50% RH above 30 ˚C | 5% to 80% RH* (non-condensing)<br>* 50% RH above 30 ˚C |
| Humidity (Non-Operating): | 5% to 95% RH* (non-condensing)<br>*75% RH above 30 ˚C and<br>45% RH above 40 ˚C | 5% to 95% RH* (non-condensing)<br>*75% RH above 30 ˚C and<br>45% RH above 40 ˚C |
| Certification: | CE Approved. Conforms to EN 61010-1 (Safety) and EN 61326-1 (EMC) | CE Approved. Conforms to EN 61010-1 (Safety) and EN 61326-1 (EMC) |

### Operating Environment

The Converter is intended for indoor use and should be operated in a clean, dry environment. The design of the Converter has been verified to conform to EN 61010-1 safety standard.

### Calibration

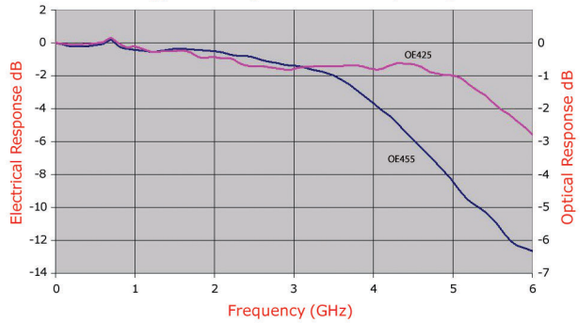
The recommended calibration interval is one year. Calibration should be performed by qualified personnel only.

### Cleaning

The exterior of the Converter should only be cleaned with a soft cloth moistened with either water or 75% isopropyl alcohol solution. Under no circumstances should moisture be allowed to penetrate the Converter.

The fiber connectors can be cleaned by blowing residue-free air into the connector to remove loose particles.

### Typical Response vs. Frequency




**CAUTION** The Converter's fiber connectors should be kept clean and only mated to other well cleaned connectors.

### Safety Symbols & Terms

The following symbols and terms may appear on the Converter's cover, or in this manual, and alert you to important safety considerations.

Refer to the accompanying information or documents in order to protect against personal injury or damage to the instrument.

**CAUTION** Calls attention to a procedure, practice or condition which, if not followed, could possibly cause damage to equipment. If a CAUTION is indicated, do not proceed until its conditions are fully understood and met.



900828-01

OPERATOR'S MANUAL

LeCroy

# OE425/525
# OE455/555

## Optical-to-Electrical Converters

## Application

The OE4XX and OE5XX are optical-to-electrical converters with multimode fiber inputs. They are specifically designed for the measurement of optical telecommunication signals. The Converters are straightforward plug-in probes, and are compatible with all LeCroy instruments equipped with the ProBus® intelligent probe interface, or with ProLink equipped DSOs.

The OE4XX models fit BNC (ProBus) connectors or ProLink DSOs using a BNC adapter (TPA-BNC). The OE5XX models fit ProLink connectors.

DC, AC, and impulse light intensities can be measured (with the DSO automatically converting units to Watts) as cursor or parameter measurements are being made.

The OE4XX and OE5XX converters are compatible with LeCroy WavePro® and WaveMaster™ DSOs.

**CAUTION** The fiber cable is fragile, handle with care.

## Application as Optical Reference Receiver

With the OE4XX and OE5XX, you can filter the optical signal in a precise way, in accordance with ITU-T G.957 and other optical standards (such as IEEE802.3) so that the scope and probe chain will constitute an Optical Reference Receiver, per Annex B of G.957.

The OE4XX and OE5XX, when used with a WaveMaster or WavePro 7000 series DSO, have a response vs. frequency that follows a 4th order Bessel-Thompson low-pass filter whose -3 dB cutoff frequency is set by the user-adjustable data rate. This filter adapts to the probe automatically, so it remains calibrated regardless of the channel on which it is used.

## Quantity of Light

What the scope displays is actually the voltage resulting from the conversion of the light signal by an optical-to-electrical converter. The efficiency of this conversion (V/W) depends on the wavelength of the incident light.

The OE4XX and OE5XX are designed to operate optimally over different wavelengths. The OE455 and OE555 operate over the 950 to 1630 nm range, while the OE425 and OE525 respond in the range from 500 to 870 nm. The probes are calibrated at 1550 nm and 800 nm, respectively. Therefore, when other wavelengths of light are measured, the power displayed by the scope will differ slightly from the actual value.

The detectors are “multimode”; they will remain accurate when used with either single or multimode optical fibers.

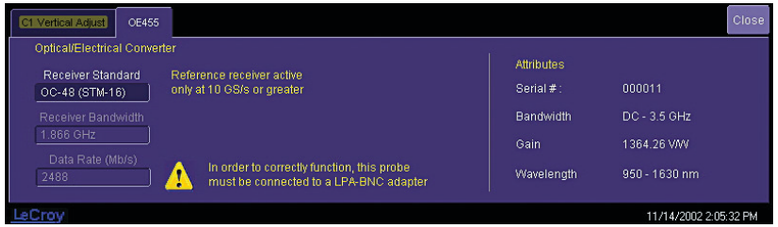



**Figure 1. O/E Reference Receiver Dialog from WaveMaster or WavePro 7000 Series DSO**

Another factor affecting the measurement of power is the insertion loss of cables chained between the light source and the probe. Each optical connection will typically cost between 0.3 and 0.5 dB (7% to 12%) of light output. Scope calibration is based on light at the probe FC connector.

## Measurements of Small Amounts of Light

Through “Enhanced Resolution” and “Averaging” of mathematical functions, it is possible to measure very small signals that represent minute amounts of light. However, the offsets generated by temperature changes can become significant.

If the absolute amount of light is to be measured, you should plan for frequent scope re-calibrations, or minimize temperature variations. But if only the amplitude of light modulation is to be measured, this is not critical.

## Operation with WaveMaster DSO

The OE4X5 probes use ProBus style connectors. Therefore, when they are to be used with a WaveMaster DSO, a BNC-BMA adapter must be used.

When a WaveMaster or WavePro 7000 series DSO is used, the probe response can be read directly. The example dialog shown in Figure 1 is displayed when you select from the **Vertical** drop-down menu the channel to which the O/E is connected.

The probe information is listed at the right of the dialog and the reference receiver filter selection is shown at the left. The reference receiver is set to a given standard by selecting it from the **Receiver Standard** menu.

You can also select a user-defined filter from the **Receiver Standard** menu and then enter either the **Receiver Bandwidth** or **Data Rate** in the appropriate field. These two values are related in that the receiver bandwidth is 75% of the data rate. Only one of the two parameters need be entered; the other will be computed automatically.

A selection is also available for disabling the reference receiver filter.

When the probes are used with the WaveMaster or WavePro 7000 series DSO in combination with the universal reference receiver, the probe response is automatically matched to the scope and channel, and the bandwidth response is adjusted to the user-selected data rate.

## Optical Reference Receiver Background Information

An Optical Reference Receiver has a filter that implements the transfer function:

$$\frac{105}{105+105y+45y^2+10y^3+y^4} \quad \text{(Eq. 1)}$$

where y is defined as $2.114\times\frac{2\pi f}{2\pi f_r}i$ (Eq. 2)

and $f_r$ is the reference frequency (chosen as $0.75f_0$) and $f_0$ is the bit rate (for example, 2.4488 GHz for OC48/STM4). The form of the transfer function is the inverse of a Bessel Polynomial (see Krall, H. L. and Fink, O., “A New Class of Orthogonal Polynomials: The Bessel Polynomials,” Trans. Amer. Math. Soc. 65, 100-115, 1948). Filters implementing Bessel polynomials as denominators of the transfer function are called Thompson filters, hence the name “fourth order Thompson-Bessel” for the transfer function. The order n Bessel polynomial is simply given by the formula:

$$\sum_{k=0}^{n} x^k \frac{(2n-k)!}{2^{n-k}k!(n-k)!} \quad \text{(Eq. 3)}$$

The factor 2.114 in Equation 2 simply ensures that the norm squared of the transfer function reaches (the “-3 dB point”) at the reference frequency. The main property of the Bessel-Thompson filter is a minimal group delay distortion. The group delay is defined by the derivative of the phase delay with respect to the frequency of an input sine wave. When quoted in “UI,” the group delay is normalized to the bit rate’s period. The group delay of the fourth-order Bessel-Thompson filter at low frequencies is:

$$\frac{2.114}{1.5\pi f_0} = \frac{0.4486}{f_0} \quad \text{(Eq. 4)}$$

The group delay diminishes monotonically, reaching 0.1512 UI at a frequency of two times the bit rate. The difference between the group delay at zero frequency and the group delay at a given frequency is called the group delay distortion. The conformity of the response to the specifications for the combination of probe and scope channel is verified in detail on a clean optical impulse at the factory.