# Application Note
# OPM Measurements Using the OPM5XX and OPM2XX

## Introduction

The Optical Power Meter (OPM) is one of the most basic tools that a fiber optic technician can be provisioned with. This document will provide basic information on the use of OPM's and how to get the most accurate measurements.

## Basic Measurements

Optical power meters can be used to measure absolute power levels and insertion losses or gains of fiber optic cables and devices. Absolute power is measured in dBm and insertion loss is measured in dB.

## Loss and Gain Measurements

Loss and gain can be calculated with the following formula.

$$P_{(dB)} = 10\log P_{OUT}/P_{IN}$$

If the input power to a fiber optic cable is 1mW and the output power is 0.5mW the loss (negative) is 3dB.

If the input power to an amplifier is 0.5mW and the output power is 1mW the gain (positive) is 3dB.

Refer to Application Note for detailed measurement instructions: **Using the fiberTOOLS Sources and Detectors**

## Power Measurements

Absolute power is measured with respect to 1mW as shown in the formula below. Setting the OPM to dBm (no reference) will allow the OPM to measure the absolute optical power in dBm.

$$P_{(dBm)} = 10\log P_{OUT}/1mW$$

If the output power is 1mW the power is 0dBm.

If the output power is 2mW the power is +3dBm. Doubling optical power is a 3dB gain.

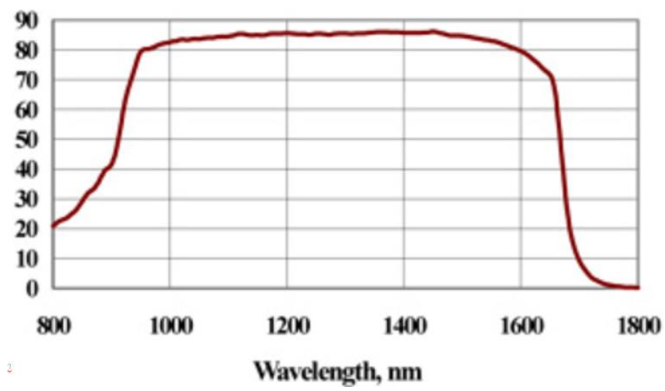
If the output power is 14.85µW (0.00001485W) the power is -18.28dBm. This is a typical power level for a FTTH installation.

Notice how a very small number can be easily expressed in decibels (dB or dBm).

This table gives a summary of the relationship between dBm, mW and W.

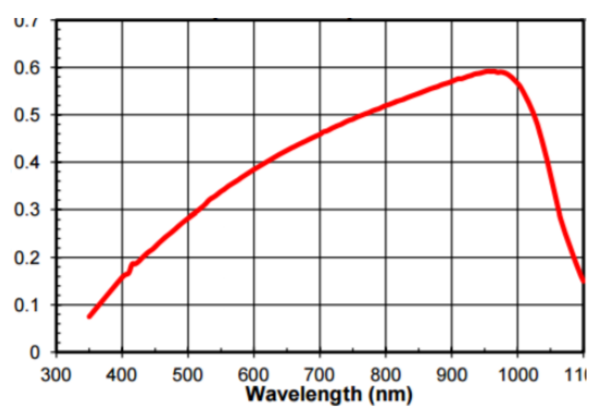
| dBm | mW | Watts |
|---|---|---|
| +10 | 10 | 0.01 |
| 0 | 1 | 0.001 |
| -10 | 0.1 | 0.0001 |
| -20 | 0.01 | 0.00001 |
| -30 | 0.001 | 0.000001 |
| -40 | 0.0001 | 0.0000001 |

**Calibrated Wavelengths**
All measurements must be made with the OPM being set to the wavelength being measured. Optical power meters typically have calibrated wavelengths such as 850, 1300, 1310, 1490, 1550 and 1625nm. Setting the OPM wavelength to for instance 1550nm, normalizes the responsivity curve for an accurate measurement at 1550nm. Applying a signal of 1310nm when the OPM is set to 1550nm will result in a measurement error as the 1310nm calibration curve is not being used.



**Responsivity Curve for Indium Gallium Arsenide (InGaAs) Detector**

The responsivity of an InGaAs diode is fairly consistent across the wavelength range but the responsivity becomes less responsive at the extents of the measurable wavelengths. The accuracy of the calibration at 850nm is a challenge due to the slope at this region. This results in higher uncertainty of the accuracy specification at 850nm. Optical power meters such as the OPM510 will provide sufficient accuracy at 850nm but for best results a Silicon (Si) detector such as the 567XL should be used as the responsivity curve is much more sensitive at 850nm. Silicon detectors are not sensitive at longer wavelengths such as 1310nm and 1550nm so the 567XL OPM is a good choice when very careful measurements need to made at 650, 780 and 850nm.

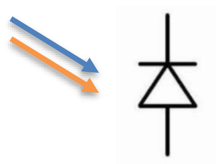


**Responsivity Curve for Silicon (Si) Detector**

When insertion loss measurements are made, the OPM wavelength must be set to the same wavelength as the laser source. This means that the only wavelength radiating onto the detector OPM is the laser wavelength. Since the OPM is set to the same wavelength as the laser, the measurement is valid. Insertion loss measurements are expressed in dB.

If the OPM is being used to measure the absolute optical power from a fiber that is transmitting more than one wavelength, the OPM will display the summation of power of all wavelengths. The

wavelength that the OPM is set to is only the calibrated wavelength and is NOT measuring the power at only that one wavelength.
The photodiode in the OPM transforms the total amount of light from all wavelengths into a current which is then represented as the optical power displayed on the screen. If two different wavelengths of light are radiated onto the photodiode at the same time, the power displayed will be the sum of the optical powers for the two wavelengths.

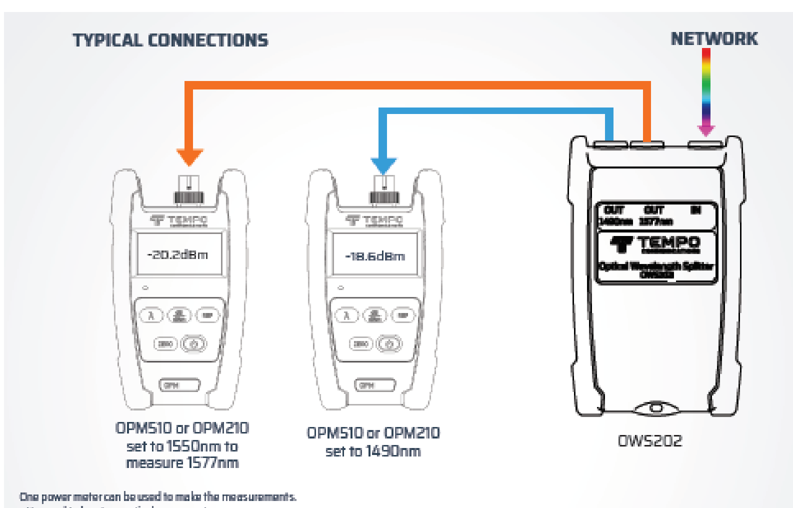


$P_{TOTAL} = P_1 + P_2$ (in Watts)

If there is a 1490nm signal and a 1577nm signal on the same fiber and both are 1mW (0dBm), the OPM will display +3dBm (2mW). You can check this by plugging the numbers into this formula:

$$P(\text{dBm}) = 10\log P_{OUT}/1\text{mW}$$

**PON & DWDM OPM's**
To be able to measure the optical power of each wavelength can be accomplished if a wavelength specific OPM is used such as a DWDM, CWDM or PON OPM. These OPM's have WDM's and filters to separate the wavelengths to individual detector diodes. <u>As a result, these OPM's are very expensive.</u>
In networks that support GPON and 10G PON both 1490nm and 1577nm are transmitted to all customers. The technician needs to be able to measure the optical power of the desired wavelength that is required for a particular ONT without the influence of the other technologies signal.
The OWS202 is capable of separating 1490nm and 1577nm into individual ports. Each port then will only have that individual wavelength present. A conventional OPM such as the OPM5XX or OPM2XX can now be used to measure the optical power at these two wavelengths with no influence from the other signal.




The reason that the 1577nm signal can be measured using the 1550nm calibrated wavelength is that the error introduced is minimal as the responsivity difference between 27nm of the InGaAs detector is negligible. Refer to the InGaAs responsivity curve above.