Introduction

An Optical Power Meter usually knows as Fiber optical power meter is a device that used to measure the absolute optical signal and relate fiber optic loss. The term usually refers to a device for testing average power in fiber optic systems.

When you install and terminate fiber optic cables, you need to test them. A test should be conducted for each fiber optic cable plant for three main areas: continuity, loss, and power. In order to do this, you'll need a fiber optic power meter.

The Ellmax Fibre-Optics Power Meter measures the mean optical power emanating from an SMA terminated cable, and has a measurement range of below 1nW to 1mW, and -60dBm to 0dBm. A meter pointer indicates the received optical power level, and this meter has both linear and dBm scales. Examples of the type of optical measurements that may be made with the meter are:

a) transmitted power levels
b) minimum and actual received power levels
c) attenuation measurements of cable routes
d) long-term monitoring of route attenuation, using the meter output socket.

A pointer scale has been incorporated into the equipment in favour of a digital readout, since a scale has a number of advantages:

1. it is easier to read at a glance
2. changing optical levels are easily interpreted on a pointer scale
3. dBm and linear scales can be combined on the one meter face.

The main advantage of a digital readout over a pointer scale is that the reading accuracy is higher. This advantage can also be obtained with the Ellmax meter by connecting a DVM, set to d.c., to the output socket of the meter, where the linear full scale reading = 1.00V. The meter is calibrated at a wavelength of 820nm, and the response is relatively flat between 800nm and 850nm, varying less than 4% between these wavelengths.

FIBRE-OPTICS POWER METER

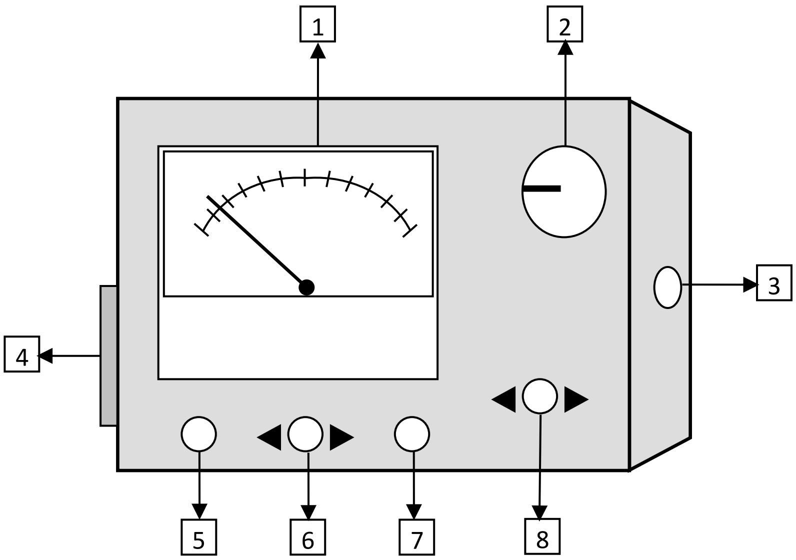


Figure-1: Ellmax Fiber Optic Power Meter

1. Analogue meter showing received optical power level, with dBm and linear power scales. Also gives battery check indication.
2. Rotary range switch with following six dial settings: dBm: —50, —40, —30, —20, —10, 0 Watts, linear full scale: 10nW, 100nW, 1µW, 10µW, 100µW, 1mW. For dBm reading, add switch setting to dBm scale of meter reading. For Watts reading, switch setting is linear full scale meter reading.
3. Large area Si receive diode housing with SMA* (Standard 9mm) connector, for optical input.
4. Battery holder for 9V 'radio' battery. Typical life for alkaline battery is 500 hours.
5. Output socket, 3.5mm, 5kΩ output impedance. Linear full scale = 1.00V. Maximum signal without overload = 2V. Output is for long-term monitoring applications, or high accuracy of reading using a DVM set to d.c.
6. ON/OFF/BATTERY CHECK switch for battery. Does not control optional external supply.
7. 2.5 mm socket for optional external supply of +7V to +15V d.c. For long-term monitoring applications (current drawn is typically 1.0 mA at 9V).

8. Momentary toggle switch for optimum accuracy of scale reading. Two ranges of +3dBm, Watts x2 and —3dBm, Watts x 1/2.

USING THE FIBRE-OPTICS POWER METER

To measure the optical power level at an SMA terminated cable, first use the battery check switch to ensure that the battery is O.K., and then switch the battery ON (refer to the previous section for a full description of connecting power supplies). Connect the SMA* terminated cable to be measured to the SMA* detector housing at the side of the meter. Set the rotary switch to the position that gives the maximum on-scale meter deflection, then note the scale reading and the switch position in dBm or Watts, as required, and combine them according to the following instructions:

(i) **dBm:** add switch dBm setting to dBm scale reading of meter.
For example, a switch setting of —30dBm, and a scale reading of —2.4dBm, gives a measurement of —32.4dBm.

(ii) **Watts:** the switch Watts setting is the linear full scale meter reading.
For example, a switch setting of 1µW, and a scale reading of 7.3 gives a measurement of 0.73µW (since the full scale reading of 10 units is equivalent to 1µW, as set by the switch position). For optimum accuracy of scale reading (i.e. to maximize the on-scale meter deflection), the toggle switch should be used according to the instructions given above the meter scale.

The dBm measurement is then obtained by adding the toggle dBm setting to the combined result of the scale reading/rotary switch setting. The measurement in Watts is obtained by multiplying the toggle watts setting by the combined result of the scale reading/rotary switch setting.

In order to obtain digital readout accuracy, a Digital Voltmeter (DVM) set to d.c. may be connected to the output socket. The linear full scale meter reading, as set by the switch position, is equal to 1.00V on the DVM. For example, a switch setting of 10µW and a DVM reading of 0.655V gives a measurement of 6.55µW (since the full scale reading of 1.00V is equivalent to 10µW, as set by the switch position). The DVM reading is essentially a linear measurement in Watts, but it may be converted to dBm by using the formula given in the next section.

To measure extremely low power levels (below 200pW), the "dark" reading (i.e. the DVM reading with the dust cap on the diode housing) should be subtracted from the DVM reading of the power level being measured, with the meter set on its most sensitive range of 10nW. In this way, it is possible to measure power levels below 50pW.

dBm or Watts

Either dBm or Watts may be used as units in optical power measurements, and the choice is left to the user of the equipment. dBm units are often preferred in optical insertion loss or attenuation measurements, since dB losses add through an optical route. Linear power units are frequently used in measuring transmitted output power levels and minimum received power levels, since terminal equipment is often specified in these units.

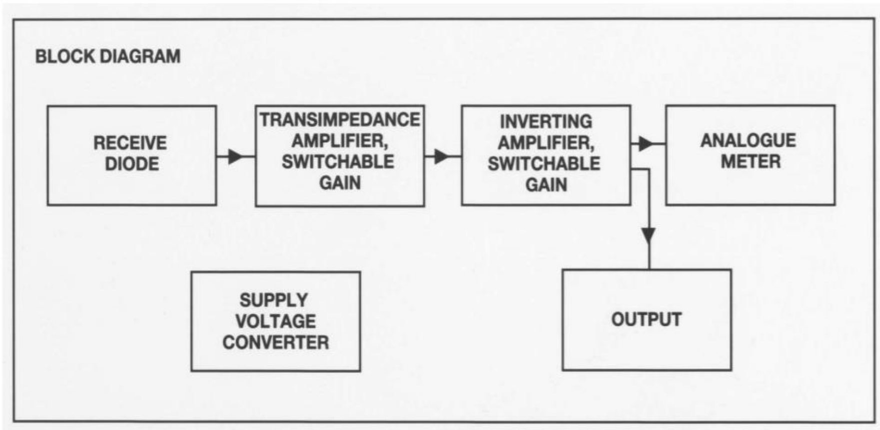
It is easy to convert from one unit to another by using the formula that defines dBm:

$$\mathbf{dBm = 10 \log_{10} P,}$$

where P is the power in mW, and, conversely, P = anti-$\log_{10}$ (dBm/10), or 10 to the power of (dBm/10).

Also, the units of dBμ are sometimes used, with dBμ = 10 log10 P0, where P0 is the power in μW. It follows that dBμ = dBm +30.

BRIEF TECHNICAL DESCRIPTION OF METER



OPTICAL POWER MEASUREMENTS

EQUIPMENTS

Fiber-optical power meter

Digital Voltmeter

0.5m-5m fiber cables

Cable Connector

Fiber optic transmitter

Fiber Optic Receiver

PROCEDURE:

1. Remove the fiber-optic power meter from your training set. Push the ON / OFF battery switch to the CHECK direction and observe whether the device battery level is sufficient. If not, replace the old battery with a new 9V battery.

2. Push the ON / OFF battery switch to the ON direction and switch the tool on. Make sure that the optical input on the right edge is closed, if it is open, turn the screw cap to close it.

3. Set the rotary range switch to the highest stage, 0dBm / 1mW.

4. Open the screw plug of the optical input slowly and observe whether the pointer moves on the scale.

5. Move the rotary range switch to a lower stage and observe the pointer. Repeat this process until the rotary switch is at the lowest level and interpret the reason for the movement on the scale.

6. After adjusting the rotary switch to a level where the pointer is fully scaled, cover the optical input with your finger. Then observe the changes in the movement of the pointer by covering the optical input with the plug of the device and interpret the reason of movement of the pointer.

7. Re-open the cover of the optical input and read the scale at the most appropriate level, and note the optical power in scales of dBm and Watts.

8. Connect one end of the 0.5m length fiber cable to the input of the optical power meter. While you are lightening using the flashlight to the other end, observe the movement of the pointer as the light entering the fiber cable is gradually increasing. Interpret the movement of the pointer in the scale meter.

9. Move the flashlight closer to the end of the fiber cable to maximize the radiation transmitted to the fiber, and note the highest optical power you measured.

10. Connect the free end of the 0.5m length fiber cable to the optical output of the fiber-optic transmitter. Set the transmitter device in ANALOG mode, optical power meter to -20dBm / 10μW.

11. Adjust the output power of the transmitter until it shows -1 on the scale of the power meter (corresponds to - 21dBm).

12. Observe both the analogue scale meter and the voltmeter that you connect to the power meter. Note the values of analogue scale meter and voltmeter and measure the power of the light transmitted by length fiber of 0.5 m.

13. Remove the 0.5m long fiber cable and connect the 5m fiber cable instead. Repeat the process given in step 12. Compare and interpret the measurement results in units of dBm and Watts for both cables by measuring from both the analogue scale and the voltmeter's digital indicator.

14. Connect fiber cables of 0.5 and 5-meters using a fiber connecter. Now, attach one end of the connected fiber cable to the transmitter and the other end to the power meter. Repeat the measurements and interpret the results.

15. Set the optical power meter to -30dBm / 10μW. Adjust the output power of the transmitter until it shows 0 (-30dBm) on the scale of the power meter. Repeat 12-14 for the transmitter power.