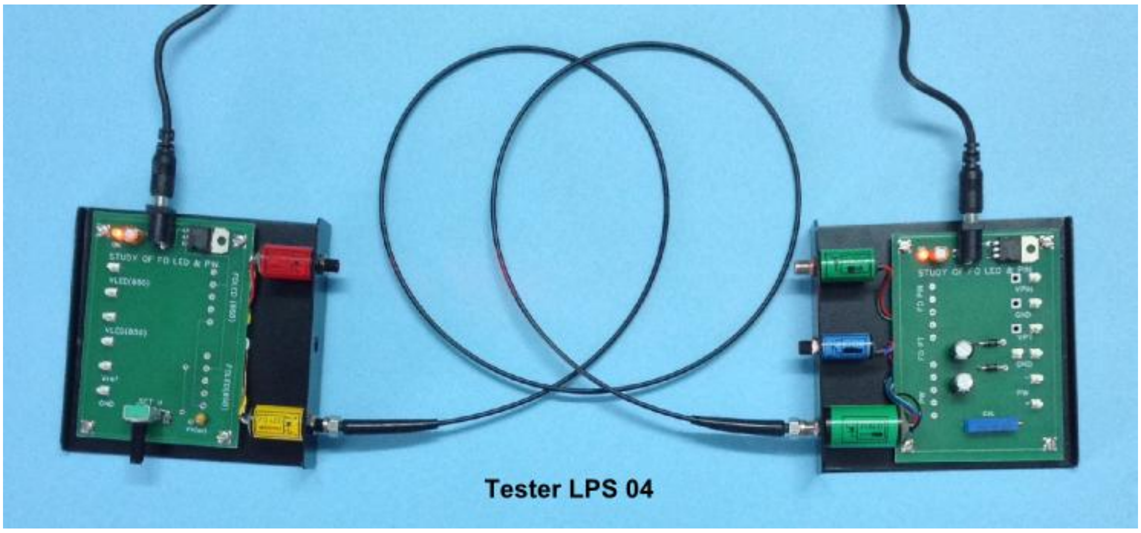
DC Characteristics of Fiber Optic LEDs, PIN Photodiode and Phototransistor

LABORATORY MANUAL: TESTER LPS04



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0. Introduction

0.1 Tester LPS04

Tester LPS04 described here is an optimized set-up to conduct a comprehensive study of all DC parameters of a set of fiber optic sources and detectors commonly used in optical fiber communication systems. The studies cover fiber optic components that have standard SMA connectors to couple with SMA-SMA connectorised PMMA (plastic) optical fiber (POF) cables.

Tester LPS04 provides for study of fiber optic LEDs (660nm and 850nm), a PIN photodiode and a phototransistor. It has a built-in optical power meter and the associated power supplies. Apart from LPS04, the accessories required are (a) SMA-SMA connectorised 1-metre PMMA cable and (b) 31/2-digit digital multi-meters

0.2 Optoelectronic Components

Optoelectronic components relating to optical fiber communication are described at length in the prescribed text books and references. The actual devices employed in LPS04 are sourced from reputed international manufacturers such as Siemens, Optek, Osram etc. These affordable entry-level components have been in use commercially for over 20 years now. The specific components are:

SMA Connectorised FO LED at 660nm Wavelength, **FO LED (660)**
SMA Connectorised FO LED at 850nm Wavelength, **FO LED (850)**
SMA Connectorised FO PIN Photodiode, **FO PIN**
SMA Connectorised FO Phototransistor, **FOPT**

We also source SMA connectorised FO Laser Diodes operating at 650nm suitable for POF cables. These devices are however configured with additional circuitry for intensity modulation (IM) experiments.

0.3 AC Performances and Communication Applications

It may be noted that the scope of Tester LPS04 is limited to DC studies only. AC performances and communication applications of these components are covered in other Testers in the same series. Optoelectronic components from the same family are employed in the design and realization of the communication circuitry. These are described in Testers **ALS04** and **EPS04** in the series

0.4 ST Connectorised FO LEDs, PIN Diodes and Phototransistors

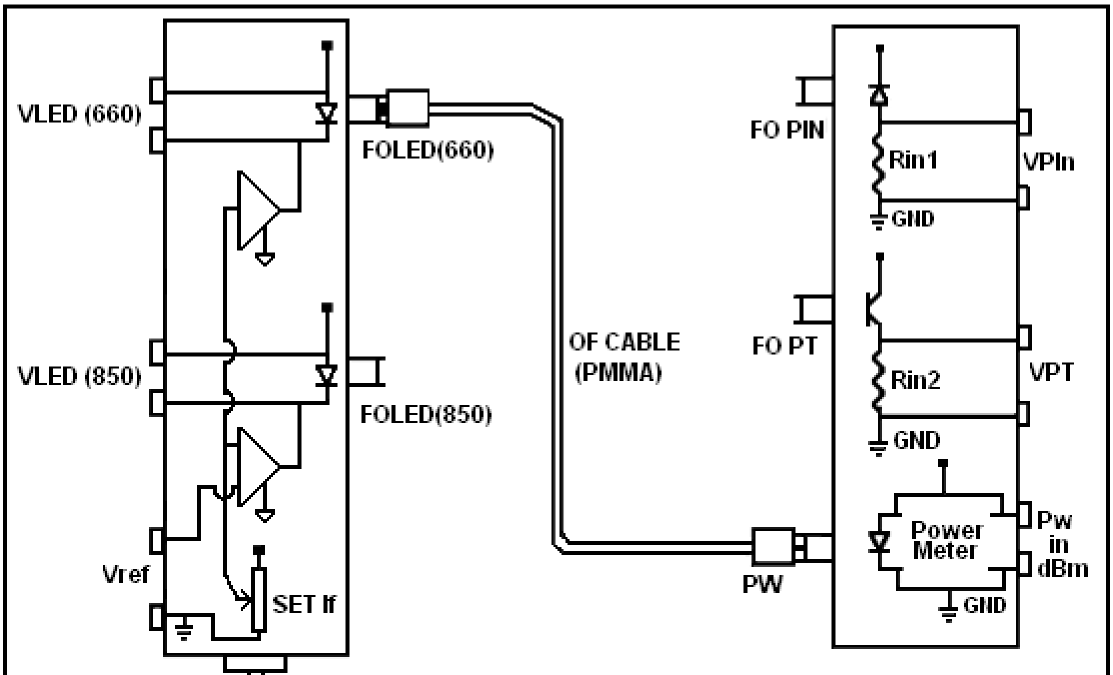
We source a full range of ST connectorised FO LEDs (660nm and 850nm), FO PIN diodes and FO phototransistors. These devices work with ST connectorised glass multimode graded index and single mode optical fiber cables. It must be mentioned that the glass fiber losses are very high at 660nm.

0.5 Data Sheets on FO Components/ Cables/ Power meter Module

These are included in Annexure I and Annexure II of this laboratory manual for ready reference and use. It may be noted that actual results may vary from those shown in the data sheets due to (a) component tolerance (b) wear and tear (c) accumulation of dirt at the terminals.

1. Experimental Set-up for Tester LSP04

The Experimental set-up for LPS04 comprises 2 parts (a) transmitter section and (b) the receiver section. The two sections are linked by the optical fiber cable. These are explained in greater length below.



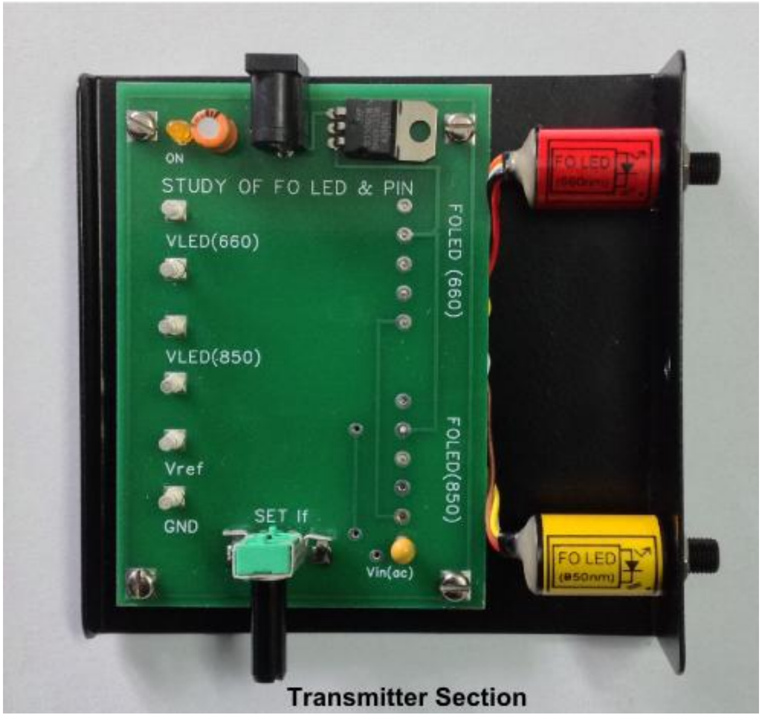
Schematic of Experimental Set-Up

1.1 Transmitter Section This section has two SMA terminated fiber optic LEDs with wavelengths 660nm and 850nm. The LEDs, designated as, **FOLED (660nm)** and **FOLED (850)** are driven by identical linear current drivers that are controlled by the **SET If** potentiometer. The LED forward current, If, is given by Vref/ 50. If is settable in the range 0 to 25 mA. **Vref** is measured with a DMM. The voltage drop between the anode and the cathode of the forward biased FOLEDs are measured across the terminals marked **VLED (660nm)** and **VLED (850nm).** It may be mentioned that the optical output from FOLED (850) will not be visible. The section is powered by a separate 9 Vdc power pack. The regulated supply is 6Vdc.

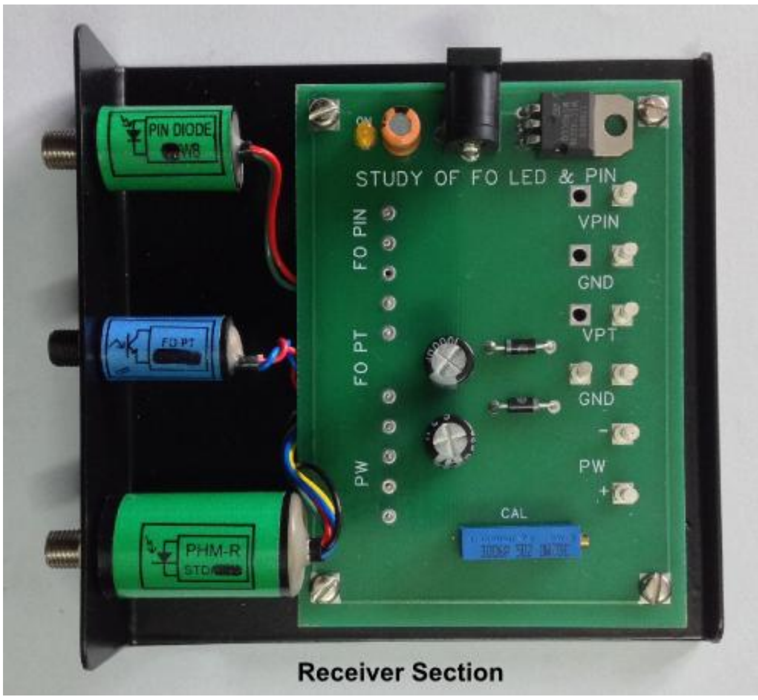
1.2 Receiver Section This section has three SMA-terminated optoelectronic devices (a) fiber optic PIN photodiode, **FO PIN**, (b) fiber optic phototransistor, **FO PT** and (c) optical power meter marked **Pw**. The photocurrent, of the reverse biased FO PIN diode resulting from light incident on its active photosensitive surface is measured by recording the voltage, **VPIN**, across **Rin1**. Rin1 is fixed at **10Kohms** in our experiments. Likewise, the photocurrent of the FO phototransistor is measured by recording the voltage **VPT** across **Rin2.** Rin2 is fixed at **100 ohms**.

1.2.1 Power Measurement The optical port, **Pw**, facilitates measurement of optical power decibels, **dBm** (referred to **1mw**). The voltage (in mV) at the **electrical terminals Pw** divided by 10, directly gives Pw in dBm
As an example, **-100 mV** measured across Pw is equivalent to **-10.0 dBm** of optical power. This when converted to a linear value corresponds to **0.1 mw** or **100 uW** of optical power. It is to be noted that the optical power meter has been calibrated at

660nm. The power meter readings for other wavelengths will have to be corrected manually, as described later.



Transmitter Section



Receiver Section

1.3 Optical Fiber Cable The LEDs are connected to the receiver side through a **1-metre PMMA cable terminated with SMA connectors**. The loss in the cable has to be taken into account to compute the optical power output at the LED ports. It is to be noted that optical fiber loss varies with wavelength. Corrections for spectral sensitivity are to be applied to obtain P_c are covered later.

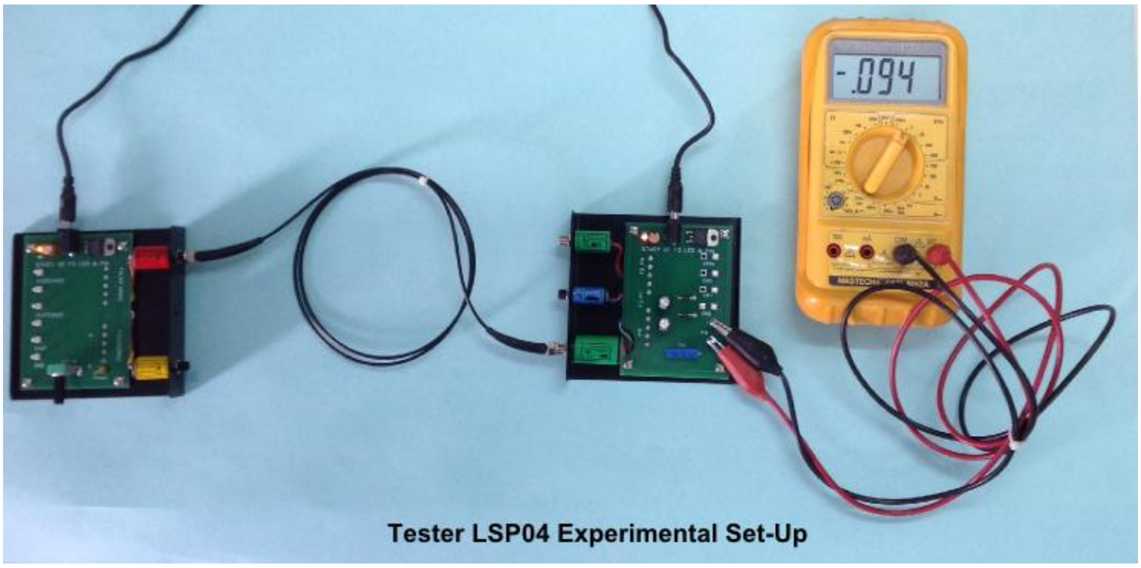
All optical connections may please be done with extreme care as improper use can damage the cable as well the devices, permanently.

2 Procedure for Measurements with Tester LPS04

LPS04 is set up as shown in the schematics. Measurements will be done using 2 or 3 DMMs. The readings will be recorded in a single table, **Table 2.1**. For the purpose of analysis this more tables will be constructed from this table.

Step1 Power the system up. Connect a DMM across V_{Ref} in the range 2000mV. Adjust SET I_f knob and set V_{Ref} to 500mV. This corresponds to an I_f of 10 mA in the FO LEDs. Connect one end of the FO cable to the FO LED 660 port.

Step2 Record the V_f for FO LED (660)



Tester LSP04 Experimental Set-Up

Step3 Connect the other end of the FO cable to the P_w Port. Note the power meter reading, Pw. Please note that Pw in dBm= Pw (mV)/10

Step4 Next, shift the OF cable from Pw to the FO PIN port and record VPIN

Step5 Now shift the OF cable from FO PIN to the FO PT port and record VPT.

Step6 Repeat Step2 to Step6 other values of I_f ranging from 1mA to 30 mA.

Step7 Repeat the above steps for FO LED 850

Table 2.1 Readings Recorded

No Sl	V_{Rref} mV	FO LED 660				FO LED 850			
		V_f mV	P_w dBm	V_{PIN} mV	V_{PT} mV	V_f mV	P_w dBm	V_{PIN} mV	V_{PT} mV
1	10								
2	20								
	2400								
	3000								

I_f readings may be selected to cover the full range of the FO LEDs It may be noted that P_w increases by 3db when I_f is doubled in the linear range. It also may be noted that P_w increases by 10 dB when If increases by 10 times in the linear region.

3 Analysis of Recorded DC Measurements

New tables are created from Table 2.1 to study all the DC parameters of the optoelectronic devices under consideration.

3.1 Forward Voltage of FO Light Emitting Diodes.

From a quick look at Table 3.1.1, it is observed that V_f of FO light emitting diodes increases with the forward current I_f. This is as expected. It is also observed that V_f is different for different wavelengths. This is also as expected.

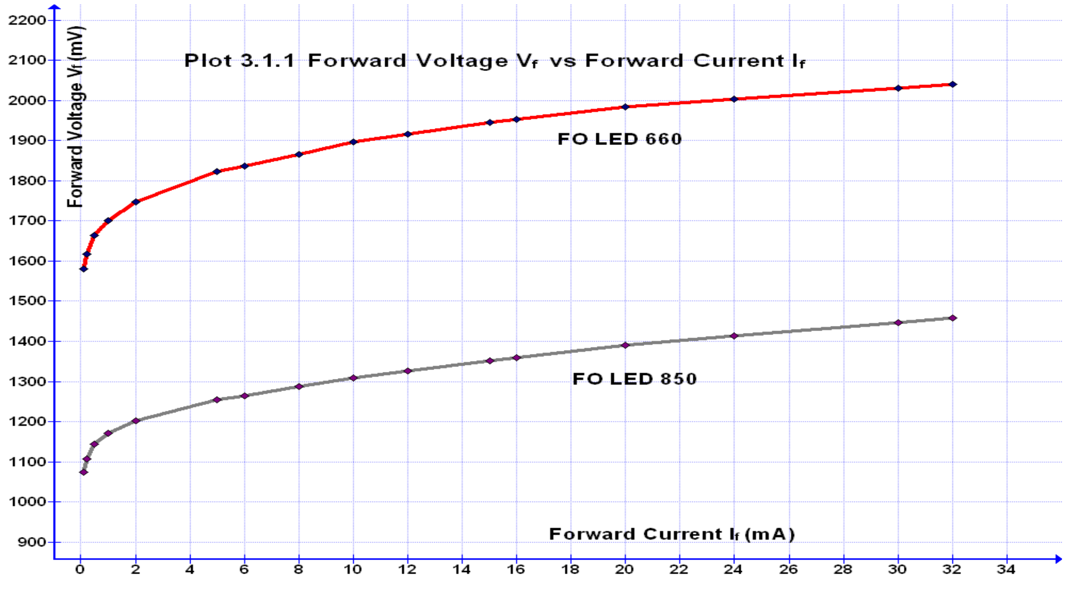
V_f assumes significance in that the overall power conversion efficiency of an LED is inversely proportional to it. The overall power conversion efficiency of an FO LED is given by $\eta_{pc} = P_c/P_e$ where P_c is the optical power in mw coupled to the optical fiber and P_e is the electrical power across the device. In the present context $P_e = V_f \text{ X } I_f$. Detailed discussions on this aspect is covered later.

In realization of practical electronic LED drive circuits, V_f is a parameter that needs close attention. With use of low voltage power supplies in modern circuits, V_f itself may be close to the system power supply. Display of V_f in some communication systems, facilitates monitoring of optical power output from an FO LED

Table 3.1.1 V_f as a function of I_f

I_f=V_{REF}/50 (mA)	FO LED 660		FO LED 850	
	V_f (mV)	P_e= (V_f*I_f) (mW)	V_f (mV)	P_e= (V_f*I_f) (mW)
1.0				
32.0				

Inference Plot 3.1.1 represents a typical V_f–I_f curve from one of our standard Tester LPS04. As will be observed from the graph, V_f increases gradually but non-linearly with I_f. The band gap for FO LED 660 is higher than that of FO LED 850. This is reflected in the V_f of the LEDs. By monitoring V_f of a LED used in a communication circuit, it is possible to indirectly determine its optical power output from this plot.



3.2 Coupled Optical Power P_c and Conversion Efficiency of FO LEDs

The optical power coupled into the cable P_c, at the FO LED port, for a given I_f is an important parameter in designing communication systems. Most FO LEDs have a region where the coupled optical power P_c is linearly related to the forward current I_f. Analog optical transmission systems employ this region for distortion free transmission of analog signals, using linear intensity modulation (IM) techniques.

Two wavelengths, namely, 660nm and 850nm have been selected for our studies. 660nm is a standard operating wavelength for PMMA FO cables, with losses in the region 0.15 to 0.2 db per metre. 850nm is better suited for glass multimode fibers with core cladding ratios of 50/125 and 62.5/125 (microns) with losses less than 3 to 4 db per km. In our studies, we have chosen an 850nm LED despite a loss of 2.2db/metre in a PMMA fiber, only for the purpose of comparison with a 660nm LED. To compute P_c, we need to apply two corrections to P_w, which is the power incident at the power meter port. Firstly, the loss in the connecting cable is to be corrected for. Loss in the cable is dependent on the cable length and wavelength of the FO LED. Secondly, spectral sensitivity corrections for the power meter sensor are to be applied. The optical power meter has been calibrated at 660nm. For other wavelengths, suitable corrections are to be applied. These are discussed later. In this analysis, we will study the linearity of P_c as a function of I_f in three ways.

Firstly, we will plot P_c (dBm) vs I_f on a semi-logarithmic graph sheet and study the linearity.

Secondly, to study the linearity on a linear scale we will convert P_c in dBm into its linear equivalent value in micro-watts (uw) and plot P_c (uw) Vs I_f on a linear graph. The linear optical power coupled into the fiber, P_c (uW) is computed from the equation:

$$\mathbf{P_c\ (uw) = \log^{-1}\{0.1 \times P_c\ (dbm)\} \times 1000} \qquad \textbf{Eq 3.2.1}$$

Thirdly, to study the linearity on a linear scale, we will use the V_{PIN} vs I_f data recorded for the PIN Diode. Please note that the optical power meter sensor and FO PIN Diode employed in the experiment are identical. The linear optical power coupled into the fiber is given by:

$$\mathbf{P'_c\ (uw) = k \times V_{PIN}\ (mA)} \qquad \textbf{Eq 3.2.2}$$

We obtain k by solving Eq 3.2.1 and Eq 3.2.2 for a representative value of I_f (say 10mA) that falls in the mid linear region of the FO LED. The dimension of k is current; we will designate k_{660} & k_{850} for FO LED 660 and FO LED 850 respectively.
In this analysis, we will also assess the overall power conversion efficiency of the FO LED. A small fraction of the electrical energy is converted to optical power.
The electrical power across the FO LED is given by the equation

$$\mathbf{P_e = I_f \times V_f} \qquad \textbf{Eq 3.2.3}$$

The overall power conversion efficiency as a percentage is given by

$$\eta_{pc} = \mathbf{P_c/P_e \times 100} \qquad \textbf{Eq 3.2.4}$$

Table 3.2.1 Coupled Power P_c & Conversion Efficiency, η_{pc}, of FO LED 660

I_f (mA) = V_{REF}/100	P_c(dBm)= P_w+0.4	P_c (uw) = $\log^{-1}$ {0.1 X P_c (dbm)} x 10^3	P'_c(uw) = K_{660}*V_{PIN}	η_{pc} (%) = P_c/P_e *100
1				
32				

Note1: The power meter is calibrated by the manufacturer at 660nm to read optical power directly in dBm and hence requires no correction for spectral sensitivity.

Note2: The typical loss in a PMMA cable is around 0.18 db per meter at 660 nm with a connector loss of 0.2 db. We assume a total cable loss of 0.4 db for the 660nm LED for a 1-metre PMMA cable.

Note3: k_{660} will be computed at I_f= 10 mA. In the example k_{660}= mA

Table 3.2.2 Coupled Power P_c & Conversion Efficiency, η_{pc}, of FO LED 850

I_f (mA) = V_{REF}/100	P_c(dBm)= P_w+0.9	P_c (uw) = $\log^{-1}$ {0.1 X P_c (dbm)} x 10^3	P'_c(uw) = K_{850}*V_{PIN}	η_{pc} (%) = P_c/P_e *100
1				
32				

Note1The spectral sensitivity of the power meter detector at 850nm is +1.5db as compared to that at 660nm. A correction of -1.5 db is hence applied.

Note2 Loss per metre of PMMA fiber at 850nm is 2.2 db. We assume a total loss of 2.4 db for a 1-metre PMMA cable. Manufactures of PMMA cables do not specify fiber attenuation at 850nm as the losses above 700nm are very high. The loss shown here is derived from measurements made with 5-metre and 10-metre reference cables at 850nm.

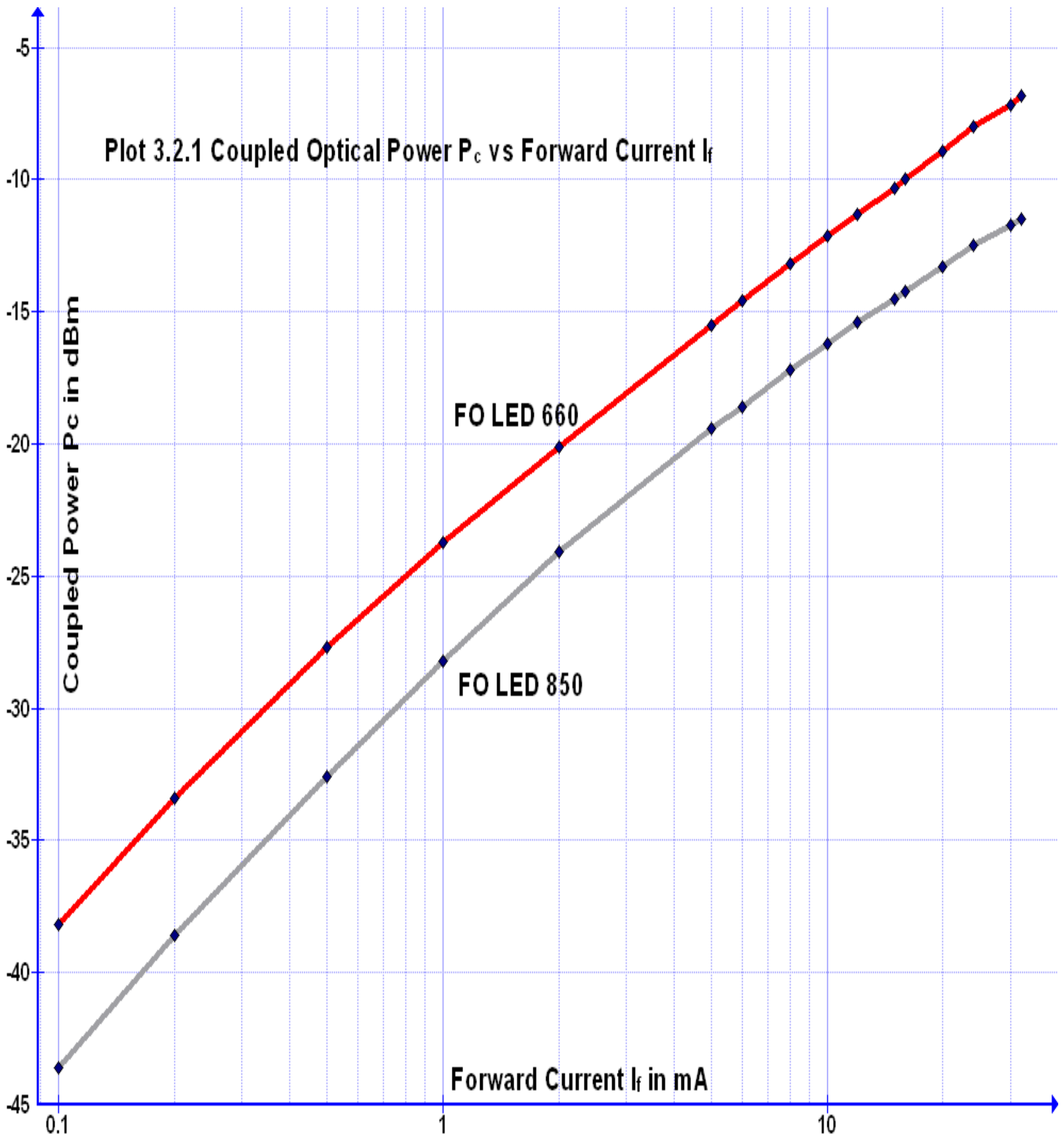
Note3: k_{850} will be computed at I_f= 10 mA. In this example k_{850}= mA

Inferences

From Table 3.2.1 and Table 3.2.2 we plot the following graphs: Plot 3.2.1, Plot 3.2.2 and Plot 3.2.3.

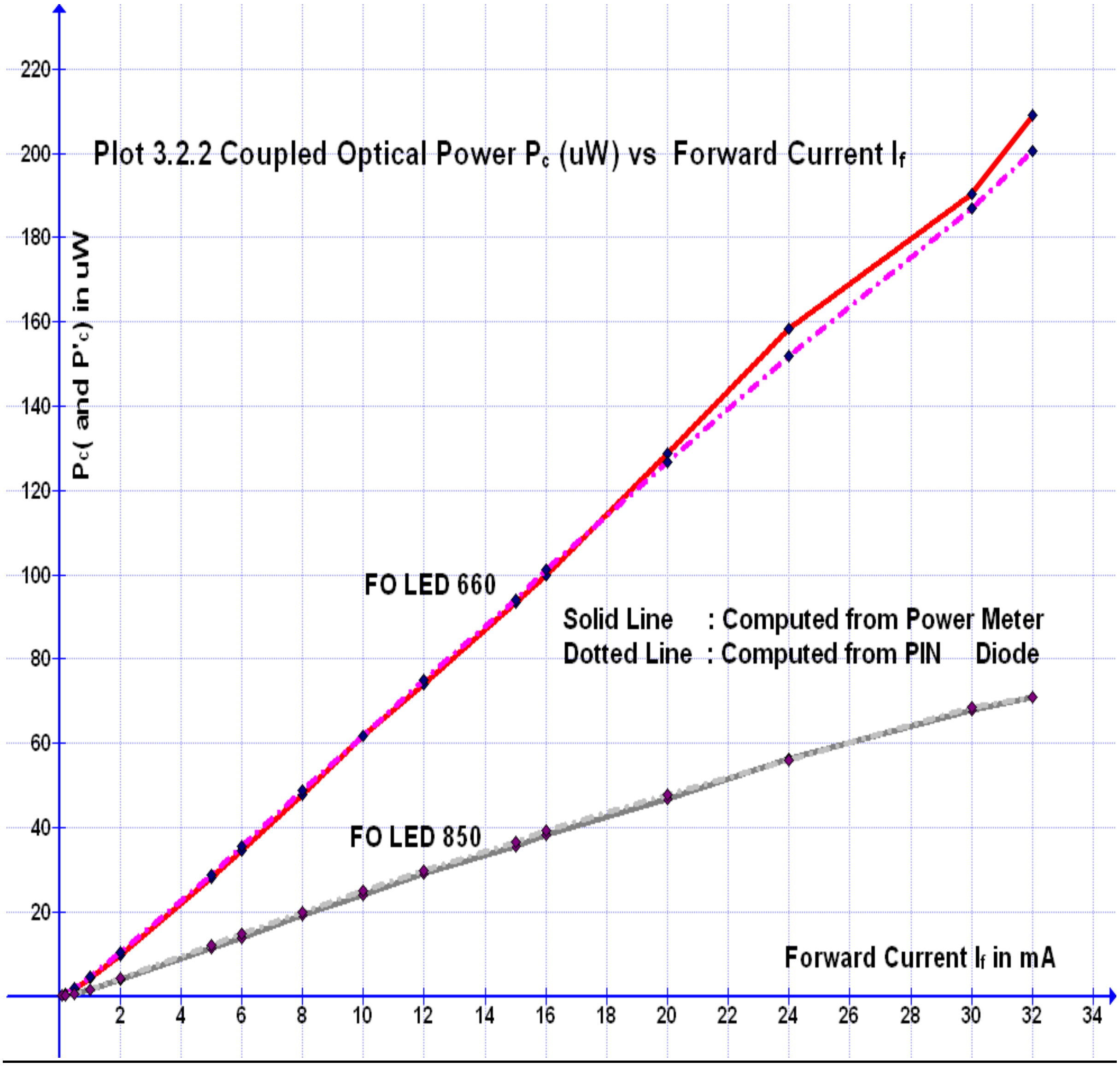
Plots 3.2.1 and Plot 3.2.2 pertain to the linearity of coupled optical power with I_f.

Plot 3.2.3 pertains to the overall conversion efficiency of the LEDs against I_f
All computations in the tables have been done using MS Office Excel and all graphs have been plotted employing a free graph software.



Inferences

The above is the plot of a typical set of FO LEDs operating at 660nm and 850nm.
I_f is represented on a log X-axis. P_c (dBm) is on a linear Y-axis.
From the graph it is clear that the P_c varies linearly with I_f over a wide range in both the FO LEDs.
The two curves run almost parallel for the entire range of measurement



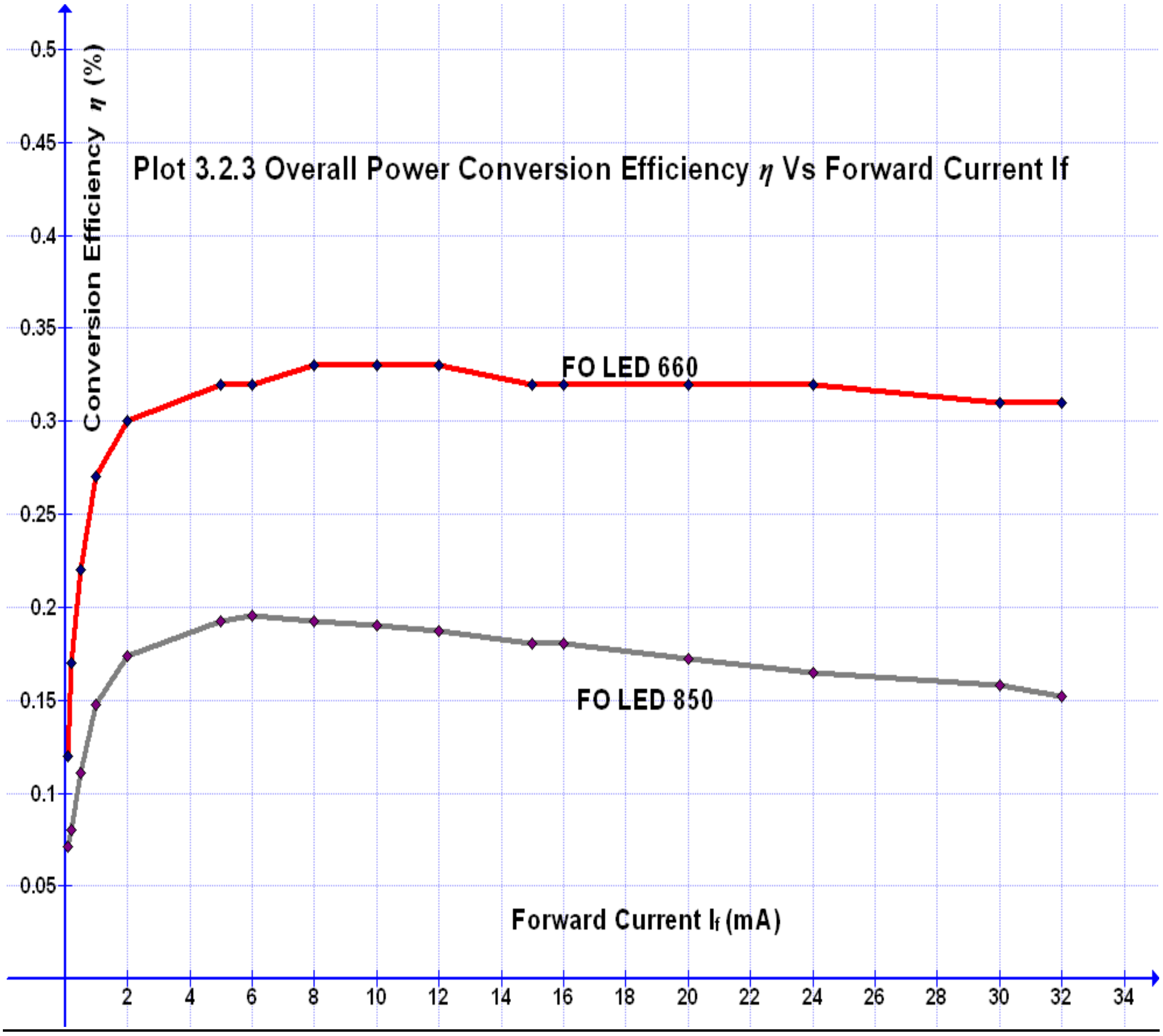
Inferences

Plot 3.2.2 comprises 4 curves namely, P_c (uW) and P'_c (uW) for FO LED 660 and FO LED 850 represented on the linear Y-axis against I_f represented on the X-axis.

It may be noted that except for minor deviations, the coupled power P_c or P'_c vary linearly with I_f, over the I_f range of 2 to 20 mA..

The PIN Diode and the sensor of the optical power meter have identical linear properties, except for one measurement with the FO LED 660nm at 24 mA. This could even be due to a measurement error.

The slope in the usable Linear Intensity Modulation (IM) range of I_f= 5mA - 15mA is 65uW/mA for FO LED 660. The corresponding slope for FO LED 850 is 24uW/mA.



Inferences

Plot 3.2.3 gives a linear representation of the overall conversion efficiency of optical coupled power as a function of the FO LED forward current.

It may be seen that for FO LED 660, over a wide range of current η remains flat and constant. However with increasing current, we observe a droop for FO LED 850.

Over the If range of 5mA to 15 mA η is approximately 0.33% for FO LED 660, whereas for FO LED 850 it is around 0.19 %.

3.3 DC Characteristics of FO PIN Diode and FO PT

The FO PIN photodiode and the FO phototransistor are two popular optical detectors used in low end optical communication systems. These devices have varying spectral range, spectral photosensitivity, dark currents, radiant sensitive areas etc. In both devices, the photocurrent varies linearly with the incident optical power over a specified operational region. This facilitates use of these devises in demodulation of intensity modulated incident optical input. While a phototransistor, when configured as an emitter follower, provides for high photocurrent I_{PT}, and optimum bandwidth, the photocurrent from an FO PIN diode, I_{PIN} is much lower but it facilitates high speed operations due to its low junction capacitance

The phototransistor when configured as an emitter follower with a load resistance R_{in2} will be satisfactory for most IM demodulation applications. In the experiment R_{in2}= 100 Ω. The photo diode will require a preamplifier stage. In this experiment we have used only a resistor R_{in1}= 10K Ω.

In this analysis we will study the photocurrents of FO PIN, I_{PIN}, and FO PT, I_{PT}, as functions of incident optical power P_{in} at the respective ports. P_{in} will be derived from P_w taking into account the corrections required for the spectral sensitivity of the optical power meter.

Table 3.3.1 Photocurrents of FO PIN Diode and FO PT at 660nm

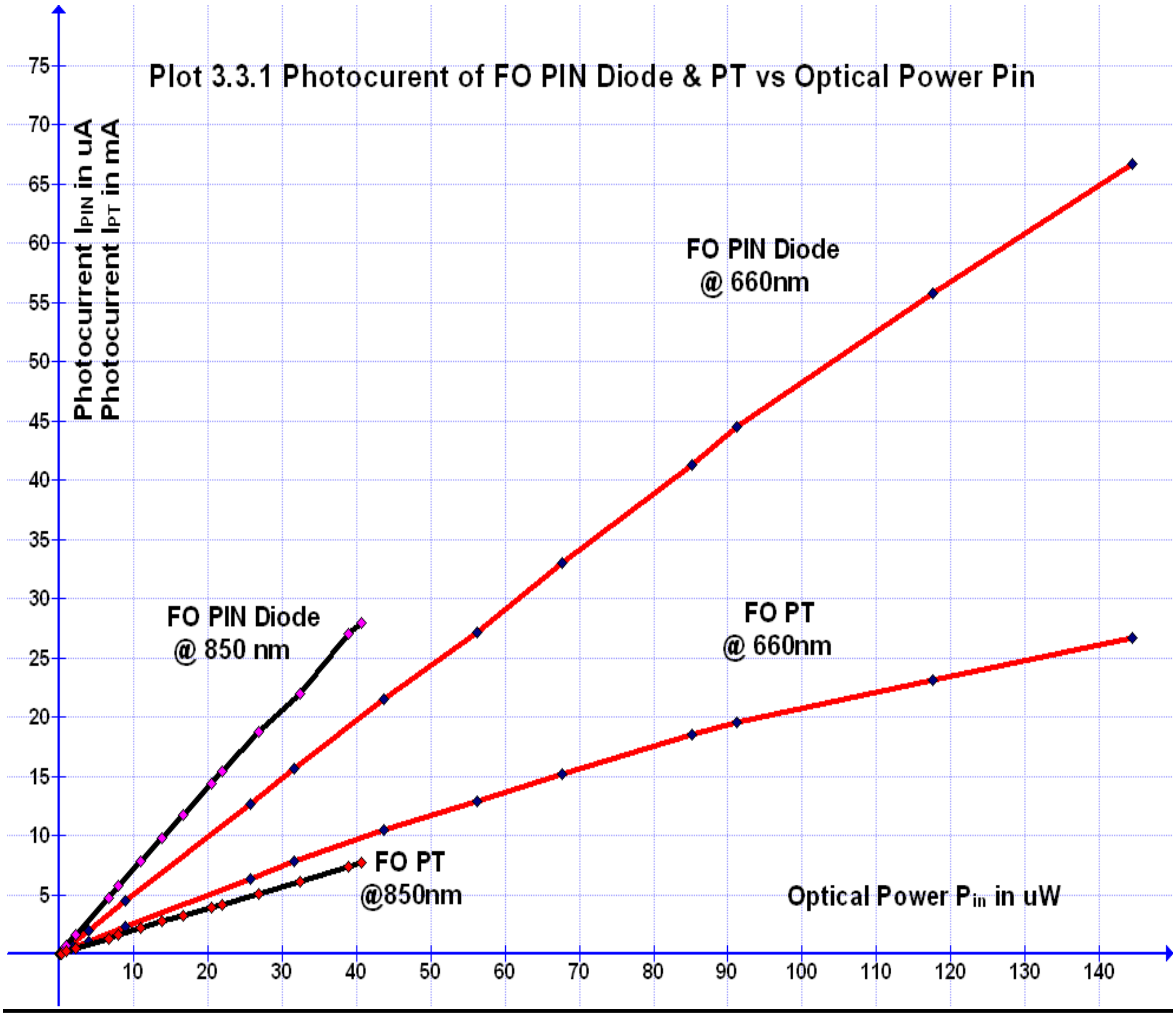
P_{in}(dBm)= P_w+0.0	P_{in} (uw) = $\log^{-1}$ {0.1 X Pin (dbm)} x 10^3	I_{PIN}(uA) = V_{PIN}/10	I_{PT}(mA) = V_{PT}(mV)/100

Note1: The power meter is calibrated by the manufacturer at 660nm to read optical power directly in dBm and hence requires no correction for spectral sensitivity.

Table 3.3.2 Photocurrents of FO PIN Diode and FO PT at 850nm

P_{in}(dBm)= P_w+1.5	P_{in} (uw) = $\log^{-1}$ {0.1 X Pin (dbm)} x 10^3	I_{PIN}(uA) = V_{PIN}/10	I_{PT}(mA) = V_{PT}(mV)/100

Note1The spectral sensitivity of the power meter detector at 850nm is +1.5db as compared to that at 660nm. A correction of -1.5 db is hence applied.
The above tables have readings drawn from Table 2.1



Inferences

Plot 3.3.1 displays the response of the FO PIN Diode and FP PT to incident optical power at 660nm and 850 nm.

While the linear incident power P_{in} is shown on the X-axis, the photocurrents from the FO PIN Diode and FO PT are displayed on the Y-axis. On the Y-axis, the photocurrent I_{PIN} is in uA. Please note that on the Y-axis, the photocurrent I_{PT} is in mA.

The common feature of all the 4 graphs is that the photocurrent varies linearly with the optical input power

For 660 nm the slopes of the curves for the FO PIN and the FO PT in the P_{in} range of 70 to 90 uW are 0.5 uA/uW and 185 uA/uW, respectively. It may be seen that the current gain of the FO PT is 370 times that of the FO PIN Diode at 660nm.

For 850nm the slopes of the curves for FO PIN and FO PT at Pin=20 uw are 0.7 uA/uW and 190 uA/uW repectively

ANNEXURE I

SMA Connectorised Basic Optical Fiber Cables and Components

1. General Information

For 20 years, Telenet Systems have been manufacturing a wide range of affordable but professional SMA connectorised optical fiber cables, optical sources and optical detectors that cater to a number of industrial and educational applications. These well-documented products facilitate experimenters and professional users to design a variety of fiber optics systems on their own, that include laboratory trainers. Conversion of existing electrical systems to optical fiber systems is possible using these devices and cables. While the full range is low-priced, there is no compromise in the quality, reliability and standardisation. The cables / components covered in this data sheet are

- # SMA-SMA Connectorised PMMA Cable
- # SMA Connectorised Light Emitting Diode @ Wavelength of 660nm
- # SMA Connectorised Light Emitting Diode @ Wavelength of 850 nm
- # SMA Connectorised Light Emitting Diode @ Wavelength of 950 nm
- # SMA Connectorised Phototransistor (400nm to 1100nm)
- # SMA Connectorised Photo PIN Diode (400nm to 1100nm)

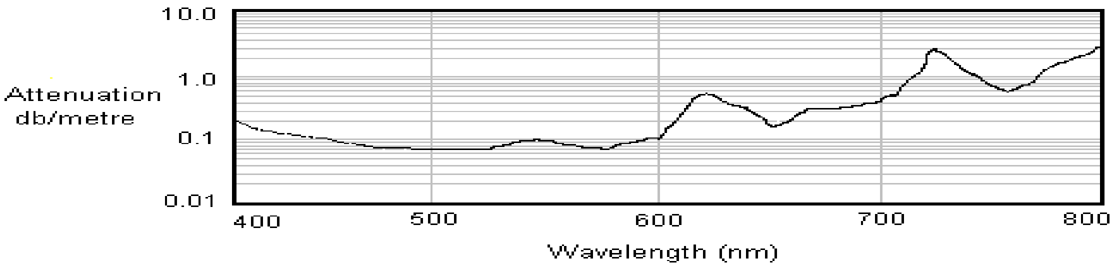
2.0 SMA-SMA Connectorised PMMA Cables

The SMA-SMA connectorised cable or patch cord, with PMMA fiber, finds application in short distance analog and digital signal transmission. The step index fiber has a large area of cross section and a high numerical aperture, facilitating easy coupling with transmitting and receiving devices. Light is guided along a fiber of one millimeter approximately to distances of a few tens of metres.

2.1 Specifications of PMMA Cable

#	Core Material:	polymethyl methacylate
#	Cladding Material:	Fluorinated polymer
#	Fiber Structure:	Step index type
#	Core/Cladding Diameter:	960u/1000u
#	Core Refractive Index:	1.492
#	Cladding Refractive Index:	1.405 to 1.417
#	Numerical Aperture:	0.5 (typical)
#	Acceptance Angle:	55 to 60 degrees
#	Attenuation at 660nm:	Typical 0.2-0.3dB/m
#	Jacket Material:	Polythene (black) 2.2mm OD

2.2 Spectral Attenuation of a PMMA Fiber



2.3 Cable Ordering Information:

#	OF Cable PMMA-0.5	Half metre PMMA cable/ SMA-SMA connector
#	OF Cable PMMA-1.0	One metre PMMA cable with SMA-SMA connector
#	OF Cable PMMA-2.0	Two metre PMMA cable with SMA-SMA connector
#	OF Cable PMMA-3.0	Three metre PMMA cable with SMA-SMA connect
#	OF Cable PMMA-5.0	Five metre PMMA cable with SMA-SMA connector

3.0 SMA Connectorised Light Emitting Diode with Wavelength of 660 nm

The optical fiber Light Emitting Diode (LED), operating at 660nm, couples around -10 to-13 dBm of optical power into a 1000 micron PMMA fiber. The LED is terminated with an optical SMA 905 connector made of glass-filled nylon and is panel mountable. The LED is suitable for speeds over 1MHz.

3.1 Specifications of FO LED(660nm)

#	Peak Wavelength	:	660nm with spectral width of 45nm
#	Forward Voltage (Vf)	;	1.9V at @If=10 ma
#	Reverse Voltage (Vr)	:	5 Volts
#	Forward Current (max)	:	20 ma (avg)
#	Coupled Optical Power	:	-10 to -13 dbm @ If=10ma into PMMA cable
#	Case Dimensions	:	Case of 11mm dia/20mm length
#	Electrical Leads	:	Black (CA)/Red(AN) /Teflon insulated
#	Ordering Code	:	Light Emitting Diode SMA/660

4.0 SMA Connectorised Light Emitting Diode with Wavelength of 850 nm

The SMA (905) connectorised Light Emitting Diode-850nm is an infrared light source operating at a wavelength of 850nm. The specifications are:

4.1 Specifications of FO LED(850nm)

#	Peak Wavelength	:	850 nm with spectral width of 50nm
#	Coupled Optical Power	:	-15 to -12 dbm @ If=10ma
#	Forward Voltage	:	1.7 Vdc (typical)
#	Reverse breakdown	:	5 Vdc
#.	Case Dimensions	:	Case of 11mm dia/20mm length
#.	Electrical Leads	:	Black (CA)/Green (AN) /Teflon
#	Ordering Code	:	Light Emitting Diode SMA/850

5.0 SMA Connectorised Light Emitting Diode with Wavelength of 950 nm

The SMA (905) connectorised Light Emitting Diode-950nm is an infrared light source operating at a wavelength of 950nm. The specifications are:

5.1 Specifications of FO LED(890nm)

#	Peak Wavelength	:	950 nm with spectral width of 50nm
#	Coupled Optical Power	:	-15 to -12 dbm @ If=10ma
#	Forward Voltage	:	1.5 Vdc (typical) @ If=10ma
#	Reverse breakdown	:	5 Vdc
#.	Case Dimensions	:	Case of 11mm dia/20mm length
#.	Electrical Leads	:	Black (CA)/Yellow (AN) /Teflon
#	Ordering Code	:	Light Emitting Diode SMA/950

6.0 SMA Connectorised Phototransistor (400nm to 1100nm)

The device is a wideband optical receiver with high responsivity at 660nm, when coupled to a 1 mm PMMA fiber. The device is terminated with an optical SMA connector made of glass-filled nylon. The phototransistor is suitable for speeds over 500kHz.

6.1 Specifications of FO Phototransistor

#	Peak Responsivity	:	850 nm
#	Spectral Range	:	400 to 1100 nm
#	Dark current	:	100 na (max)
#	Sensitivity @660nm	:	1.5 to 2 V @ -10dbm/ Rin=100 ohms
#	CE Breakdown Voltage	:	30 V (min)
#	EC Breakdown Voltage	:	5 V (min)
#	Rise/Fall Time (100ohms)	:	1 us (typ) for Rin=100 ohms
#	Case Dimensions	:	Case of 11mm dia/20mm length
#	Electrical Leads	:	Red(C)/ Blue (E) /Teflon insulated
#	Ordering Code	:	Phototransistor SMA/WB

7.0 SMA Connectorised Photo PIN Diode (400nm to 1100nm)

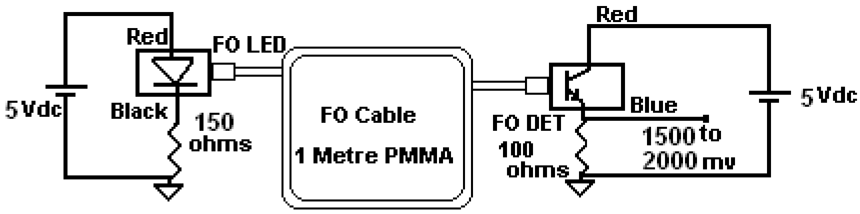
The fiber optic PIN photodiode is a high speed device with a metal SMA connector. The specifications are as given below:

7.1 Specifications of FO Photo PIN Diode

#	Sensitivity @ 660nm	:	40- 50 mV @ -10dbm/Rin=1kohm
#	Spectral range	:	400-1100 nm
#	Dark Current	:	2 na (typ)
#	Peak Response	:	850 nm
#	Rise Time and Fall Time	:	20ns
#.	Case Dimensions	:	Case of 11mm dia/20mm length
#.	Electrical Leads		Red (A)/Green(C) /Teflon insulated
#	Ordering Code	:	Photo PIN Diode SMA/WB

8.0 Typical Test Set-up

For the circuit given below, the output will be in the range shown. The readings are typical and will vary from piece to piece. This is given for a typical 660nm FO LED and FO phototransistor.



Quick Check Test Circuit

ANNEXURE II

Fiber Optic Micromodule for Optical Power Measurements, Mdel PHM-R/STD

1. General Information

The fiber optic micromodule, PHM-R/STD comprises an encapsulated panel mountable device that receives optical power through a multimode step index plastic fiber at 660nm (or other multimode GI glass fibers such as 50/125, 62.5/125, 100/140, 200/230 etc) and converts it into an electrical voltage that is equivalent to the optical power measured in dBm. The FO module employs SMD technology to achieve a high degree of reliability and compactness. Teflon leads (5 in all) provide for easy integration with other circuitry. The device requires only a few external components to realise desired functions. The industry standard fiber otpic SMA connector (optical terminal) provides for rugged and consistently repeatable operations. The power meter operates from a single 6Vdc source.

2 Specifications of PHM-R/STD

#	Wavelength Calibrated	:	660nm
#	Fiber Types	:	PMMA/Glass
#	Detector	:	Si PIN Diode
#	Wavelength Range	:	400 to 1100 nm
#	Optical Connector	:	SMA 905
#	Power Range	:	-5dbm--55.0
#	Accuracy	:	+/- 0.3 dB

(Note: 0 dBm corresponds to 1 milliwatt and -60dBm corresponds to 1nanowatt of optical power)

#	Power Supply	:	6Vdc
#	Vout(mV)/10	:	Power in dBm
#	Ordering Code	:	Micromodule PHM- R/STD

Note

PHM-R/STD is calibrated based on the device specifications provided by the device manufacturer. It is not calibrated against National/International standards. The user may recalibrate the module to any standard that he desires, setting the trimmer shown in the figure above.