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Precision Optical Transceivers Attenuation Test Operation

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Optical Attenuator Test Fixture Datasheet

Purpose: This datasheet serves as a reference for the specifications, and data of the test fixture. This documents contains all the information necessary to characterize the system.

Background Info

The optical and electronic components used in the test fixture were selected to achieve a response that could match the Arduinos ADC specifications. The signals read by the ADC could then be processed in software so attenuation could be measured. The input optical power and output optical power signal conditioning circuitry directly affect the attenuation value measured. The photodiode characteristics directly affect the measurement. The Responsivity of the photodiode effects the current flowing through the photodiode and thus the voltage we are reading at the output of the circuit.

The TransImpedance Amplifier (TIA) circuit translates the photodiode current to a voltage. Thus a TIA is needed to measure the input power and the output power. The circuit for both the input power and output power for the 1310nm laser wavelength was simulated and two equations that translate the voltage to an optical power were generated. The equations include the photodiodes responsivity and the output voltage of the TIAs with a changing photodiode current. The parameters used in the equations for input power and output power are shown below.

1310 Equations

Table 1: Parameters of the 1310nm optical system

Symbol	Parameter	Units	Value
$R_{E\text{-}in}$	Input Photodiode Responsivity	A/W	0.2116
$R_{E\text{-}out}$	Output Photodiode Responsivity	A/W	0.9
G_{in}	Input TIA Transfer Function	Ω	47687.343
G_{out}	Output TIA Transfer Function	Ω	20182.389

The generic equation for obtaining an optical power from a voltage is shown in equation 1.1. The equations for the input optical power and output optical power are shown in equations 1.2 and 1.3.

$$P = 10 * \log_{10}\left(1000 * \frac{V}{R_E * G}\right) \text{ [dBm]} \qquad (1.1)$$

$$Pin = 10 * \log_{10}(1000 * \frac{V_{pin}}{0.2116*47687}) \text{ [dBm]} \qquad (1.2)$$

$$Pout = 10 * \log_{10}(1000 * \frac{V_{pout}}{0.9*20182})\text{[dBm]} \qquad (1.3)$$

The attenuation for the system is calculated using equation 1.4.

$$Attenuation = Pin - Pout - calibration(1310nm) \qquad (1.4)$$

Where the calibration value is the optical loss in the connectors and fibers used to transport light through the system. The calibration value is measured with a loopback plugged into the Box's input LC port and running the calibration function through the serial port or touch screen.

1550 Equations

The parameters used to measure attenuation in the 1550nm wavelength system are shown in Table 2.

Table 2: Parameters of the 1550nm optical system

Symbol	Parameter	Units	Value
$R_{E\text{-}in}$	Input Photodiode Responsivity	A/W	0.1419
$R_{E\text{-}out}$	Output Photodiode Responsivity	A/W	0.95
G_{in}	Input TIA Transfer Function	Ω	26120.927
G_{out}	Output TIA Transfer Function	Ω	4752.7937

The equations for the input power and output power is shown in equations 1.4 and 1.5 respectively.

$$Pin = 10 * \log_{10}(1000 * \frac{V_{pin}}{0.1419*26120.927}) \qquad (1.4)$$

$$Pout = 10 * \log_{10}(1000 * \frac{V_{pout}}{0.95*4752.7937}) \qquad (1.5)$$

The equation used to calculate attenuation is shown in equation 1.6.

$$Attenuation = Pin - Pout - calibration(1550nm) \qquad (1.6)$$