ThermOptics™

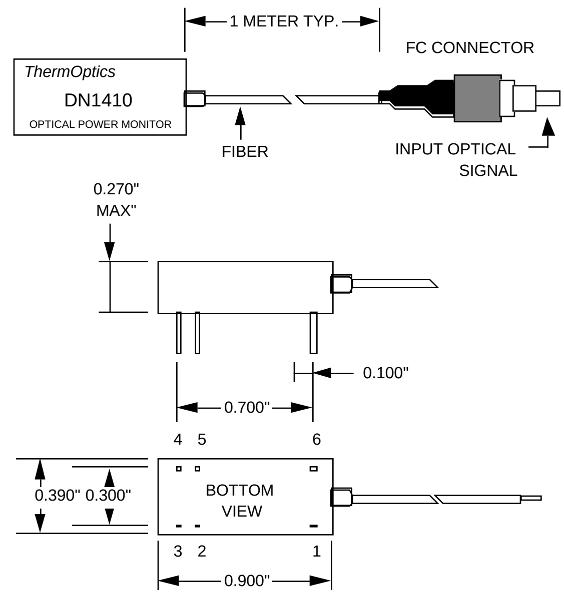
TECHNICAL DATA

Designers' Data Sheet

DN1410

FIBEROPTIC POWER MONITOR

The DN1410 is an optical power monitor using an InGaAs photodiode detector. The input optical signal is delivered through a FC connector that is attached to a single mode fiberoptic cable. The optical output of the fiber is then coupled directely to the photodiode. The resultant photodiode current is appllied by a Log Amplifier which produces the DN1410 output. The DN1410 output voltage is proportional to the incomming optical power in dBm and is capable of measuring optical power from -70dBm to 0dBm at a wavelength of 1550nm. The DN1410 is ideally suited for monitoring optical power in fiber optic communication systems.



MECHANICAL DIMENSIONS

FEATURES

- 70dB DYNAMIC RANGE
- CONVERTS OPTICAL POWER LEVELS FROM 100pW to 1mW
- 0.500 VOLTS OUTPUT PER DECADE INCREASE IN OPTICAL POWER
- OPERATES FROM SINGLE +5 VOLT POWER SUPPLY
- SMALL SIZE 0.39" X 1.0" X 0.265"

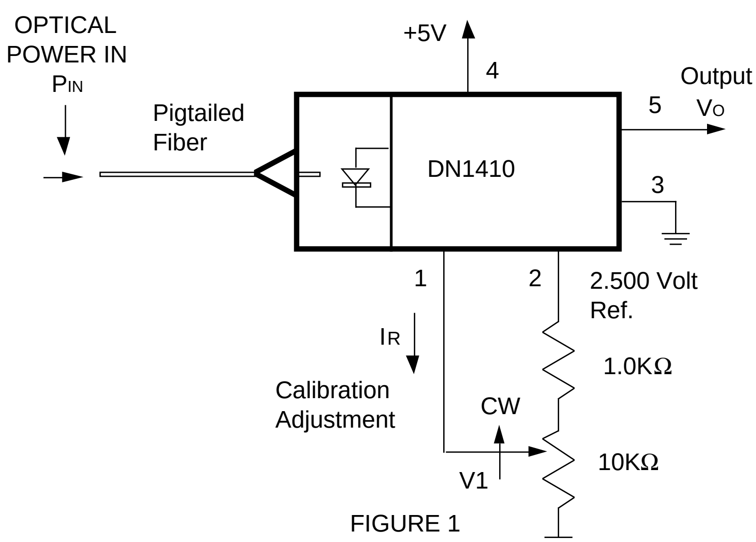


FIGURE 1

The pigtailed DN1410 assembly is calibrated by introducing an optical signal of known magnitude into the fiber and adjusting the calibration potentiometer so that the output voltage corresponds to the input power level.

Example:

One hundred microwatts of optical power @1550nm is introduced into a fiber that is terminated to the InGaAs photodiode inside the DN1410. The output voltage (Vo) will typically be 3.470 Volts when Pin 1 is grounded (the potentiometer is all the way CCW). Rotate the potentiometer CW until the output is 3.500 Volts. The optical power monitor is now calibrated at 1550nm.

The calibration control can be driven from an external voltage source such as the output of a digital to analog converter. This would allow the power monitor to be automatically calibrated in a systems application.

INPUT POWER		OUTPUT VOLTAGE
Watts	dBm	Volts
1 mW	0	4.000
100 µW	-10	3.500
10 µW	-20	3.000
1 µW	-30	2.500
100 nW	-40	2.000
10 nW	-50	1.500
1 nW	-60	1.000
100 pW	-70	0.500

Equation relating optical power input P_{IN} to output voltage V_O.

$P_{IN} = 20(V_O - 4)$ dBm

Example:

$V_O = 2.750$ Volts

$P_{IN} = 20(2.750 - 4) = -25$dBm

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OPERATION OF THE DN1410

The DN1410 is a differential logarithmic transimpedance amplifier. The output voltage (V_O) is the difference between the logarithims of the input current and a reference current and is stated in equation 1.1. Note that V_O = 2.5 Volts when these two input currents are equal.

1.1 $$V_O = \frac{\text{Log } I_{IN} - \log I_R}{2} + 2.500 \pm 0.050$$

Where:
I_{IN} is the input current flowing out of the photodiode and
I_R is the reference current flowing out of Pin 1 of the DN1410. I_R is given in equation 1.2.

1.2 $$I_R = \frac{V_R - V_1}{R_A}$$

Where:
V1 is the voltage developed by voltage divider circuit in Figure 1. VR is the 2.5V Ref. and RA is a 1.25MΩ resistor that is internal to the DN1410.

RELATIONSHIP BETWEEN PHOTODIODE CURRENT AND OPTICAL POWER

The inut current current (I_{IN}) of the DN1410 is related to optical power (P) by equation 1.3. when the source of input current comes from the pigtailed photodiode in the DN1410.

1.3 $$I_{IN} = R \bullet P \quad \text{or} \quad \text{Log } I_{IN} = \text{Log }(R \bullet P) = \text{Log } R + \text{Log } P$$

Where:

P is the optical input power in Watts.
R is the responsivity of the photodiode. *R* is typically 0.90 Amperes/Watt at 1550nm for an InGaAs photodiode.

Optical power is generally stated in dBm which is defined as decibles relative to one milliwatt. Power in dBm (P_{dBm}) is related to power in Watts by equation 1.4.

1.4 $$P_{dBm} = 10\text{Log }(P \bullet 10^{+3}) = 10\text{Log }(P) + 30 \quad \text{or} \quad \text{Log } P = \frac{P_{dBm}}{10} - 3.000 \quad \text{dBm}$$

For example: Input power P = one milliwatt (10^{-3} Watts) then P_{dBm} = 0 dBm

It then follows that the output voltage V_O of the DN1410 is given in equation 1.5.

1.5 $$V_O = \frac{P_{dBm}}{20} + \frac{\text{Log } R - \text{Log } I_R}{2} + 1.000 \pm 0.050$$

By adjusting I_R in the calibration process the term $\left[\frac{\text{Log } R - \text{Log } I_R}{2} + 1.000 \pm 0.050\right]$ in the above equation is forced to be equal to + 4.000 Volts.

The equation for output voltage vs. input power in dBm then becomes.

1.5 $$V_O = \frac{P_{dBm}}{20} + 4.000 \text{ Volts}$$

Output voltage of the DN1410 vs. input optical power is shown in TABLE 2

TABLE 2

INPUT POWER		OUTPUT VOLTAGE
Watts	dBm	Volts
1 mW	0	4.000
100 µ W	-10	3.500
10 µ W	-20	3.000
1 µ W	-30	2.500
100 nW	-40	2.000
10 nW	-50	1.500
1 nW	-60	1.000
100 pW	-70	0.500

MAXIMUM RATINGS

Positive Supply Voltage V+ ------------------------ 10V
Storage Temperature ---------------- -55°C to +125°C
Specified Temperature Range ----- -25°C to +75°C

ELECTRICAL CHARACTERISTICS V+ = 5V is unless otherwise noted and input power is @ 1550nm.

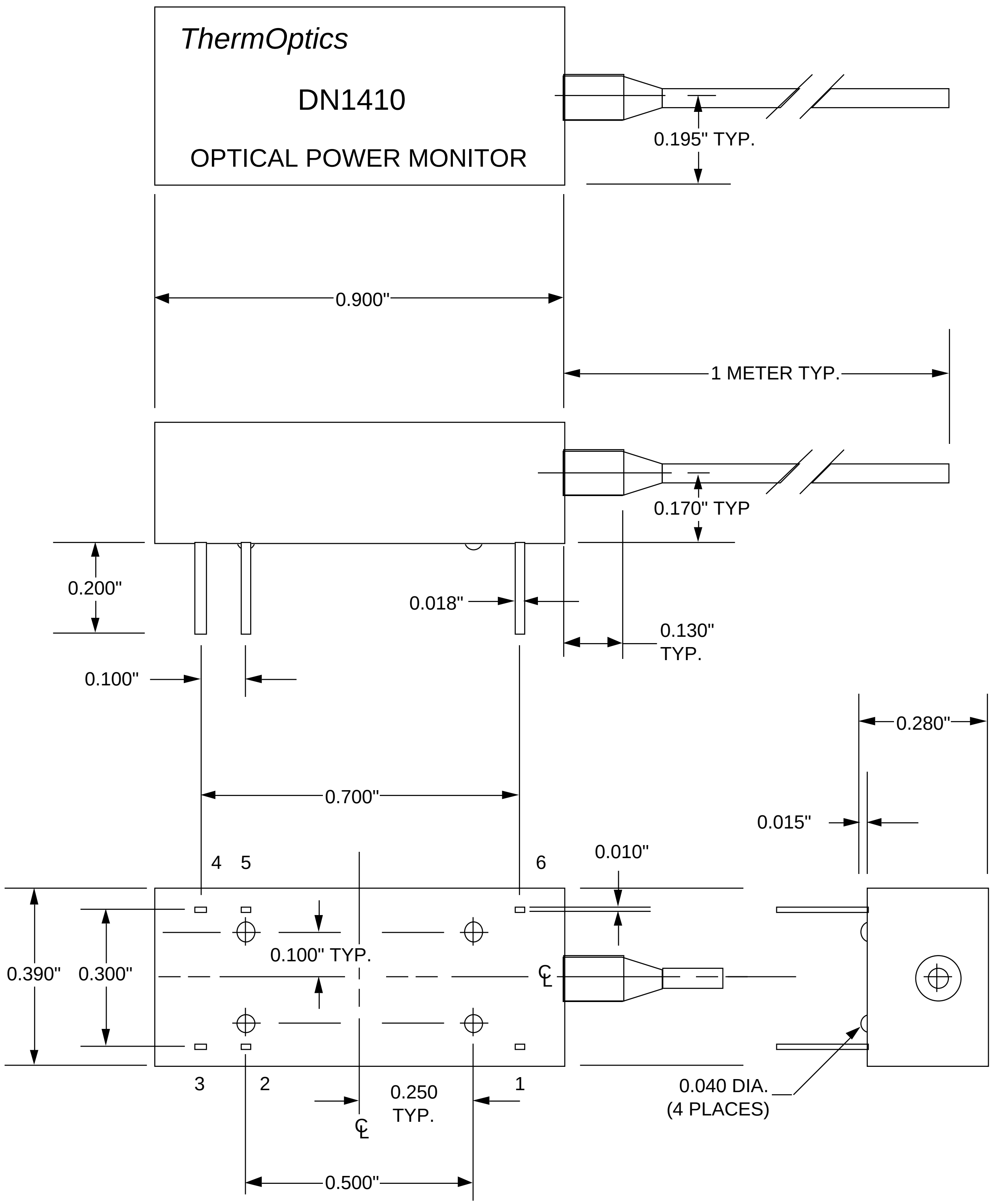
SYMBOL	PARAMETER	CONDITIONS	MIN	TYP	MAX	UNITS
V_S	Power Supply Voltage (Pin 4 to Pin 3)		4.5		10.0	V
I_S+	Power Supply Current (Pin 4 to Pin 3)		1.5	2.0	3.0	mA
V_R+	Voltage Ref. (Pin 2)	Sourcing 100µA or less	2.590	2.500	2.510	V
TCVR	Voltage Reference Temperature Coefficient			10	30	ppm/°C
ΔV_O	Difference in V_O for a Decade Change in input optical power @ TA = 25°C	P_{IN1} = 1µW to P_{N2} = -10µW	0.499	0.500	0.501	V
ΔV_O	Difference in V_O for a Decade Change in input optical power @ TA = 75°C	P_{IN1} = 1µW to P_{N2} = 10µW	0.497	0.500	0.503	V

OUTPUT VOLTAGE vs. INPUT POWER @1550nm

INPUT POWER	OUTPUT VOLTAGE @ 25°C			OUTPUT VOLTAGE @ 75°C		
	MIN	TYP	MAX	MIN	TYP	MAX
1mW	4.000	4.016	4.020	4.020	4.038	4.045
100µW	3.497	3.502	3.504	3.500	3.507	3.510
10µW	3.000	3.000	3.000	2.980	3.002	3.020
1µW	2.499	2.500	2.501	2.480	2.500	2.520
100nW	1.997	2.000	2.003	1.980	2.000	2.020
10nW	1.497	1.500	1.503	1.480	1.500	1.520
1nW	0.997	1.000	1.003	0.975	1.000	1.025
100pW	0.495	0.500	0.505	0.450	0.500	0.750

TABLE 1

The DN1410 is set to an Output Voltage of 2.500V at an input power of 1.0µW.The circuit shown is Figure 1 is used to calibrate the DN1410. Table 1 shows the output voltage limits at other input power levels for ambient temperatures of +25°C and +75°C.



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REVISIONS				DRAWN JMP	DATE 4-23-01	ThermOptics™ 1004 MALORY WAY CARSON CITY, NEVADA 89701	
REV.	DESCRIPTION	DATE	CHECK	ORIGINATOR	DATE	TITLE DN1410 PACKAGE DRAWING	
				ENG	DATE	SIZE A / CAGE NO. OMS76	DRAWING NUMBER 100109
				MFG	DATE		
				QA	DATE	SCALE	