

DATA SHEET

DN135

CURRENT TO VOLTAGE CONVERTER FOR PIGTAILED PHOTODIODE FIBER OPTIC POWER MONITORS

The DN135 is a current to voltage converter that is intended for use in fiber optic power monitors. The device converts current from a photodiode to voltage that is proportional to the incoming optical power in dBm. The DN135 functions equally well with InGaAs and Silicon photodiodes.

FEATURES

- 70dB DYNAMIC RANGE
- CONVERTS CURRENT LEVELS FROM 100pA to 2mA
- 0.500 VOLTS OUTPUT PER DECADE INCREASE IN OPTICAL POWER
- OPERATES FROM ± 5 VOLTS SUPPLIES

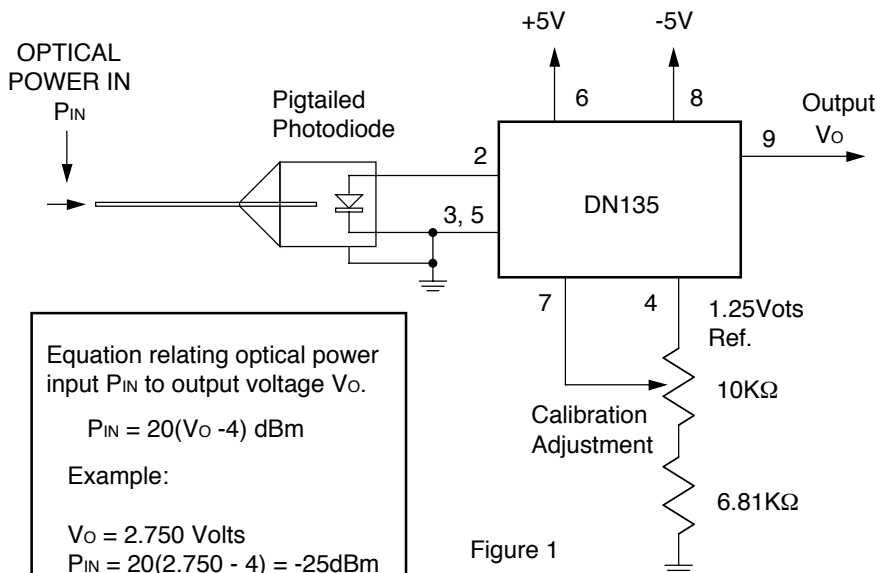


Figure 1

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

$$P_{IN} = 20(V_o - 4) \text{ dBm}$$

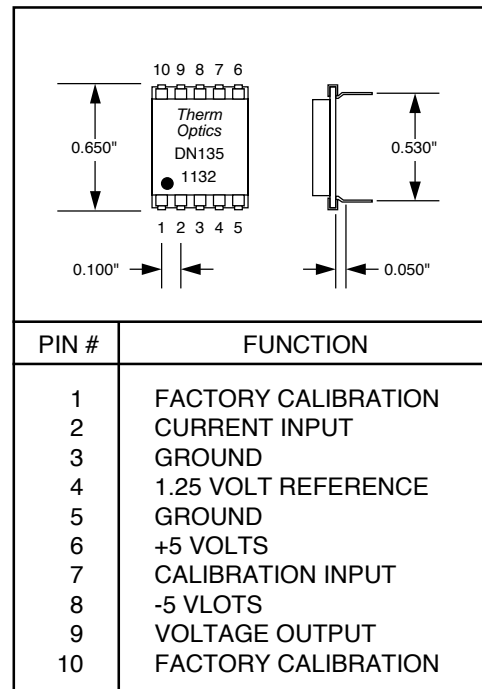
Example:

$$V_o = 2.750 \text{ Volts}$$

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

INPUT POWER		OUTPUT VOLTAGE
Watts	dBm	Volts
2 mW	+3	4.150
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

INPUT CURRENT	OUTPUT VOLTAGE
Amperes	Volts
2 mA	4.150
1 mA	4.000
100 μA	3.500
10 μA	3.000
1 μA	2.500
100 nA	2.000
10 nA	1.500
1 nA	1.000
100 pA	0.500



The pigtailed photodiode and DN135 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 in an InGaAs photodiode.* Adjust the calibration control shown in Figure 1 until the output voltage indicates 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.

*A typical InGaAs photodiode may have a responsivity of 0.9mA/mWatt of optical power at 1550nm. This would provide an output of current of 90μA with an input power of 100μW. The calibration control corrects for variations in the responsivity of various photo diodes.

EQUATION RELATING THE OUTPUT VOLTAGE OF THE DN135 TO THE INPUT CURRENT.

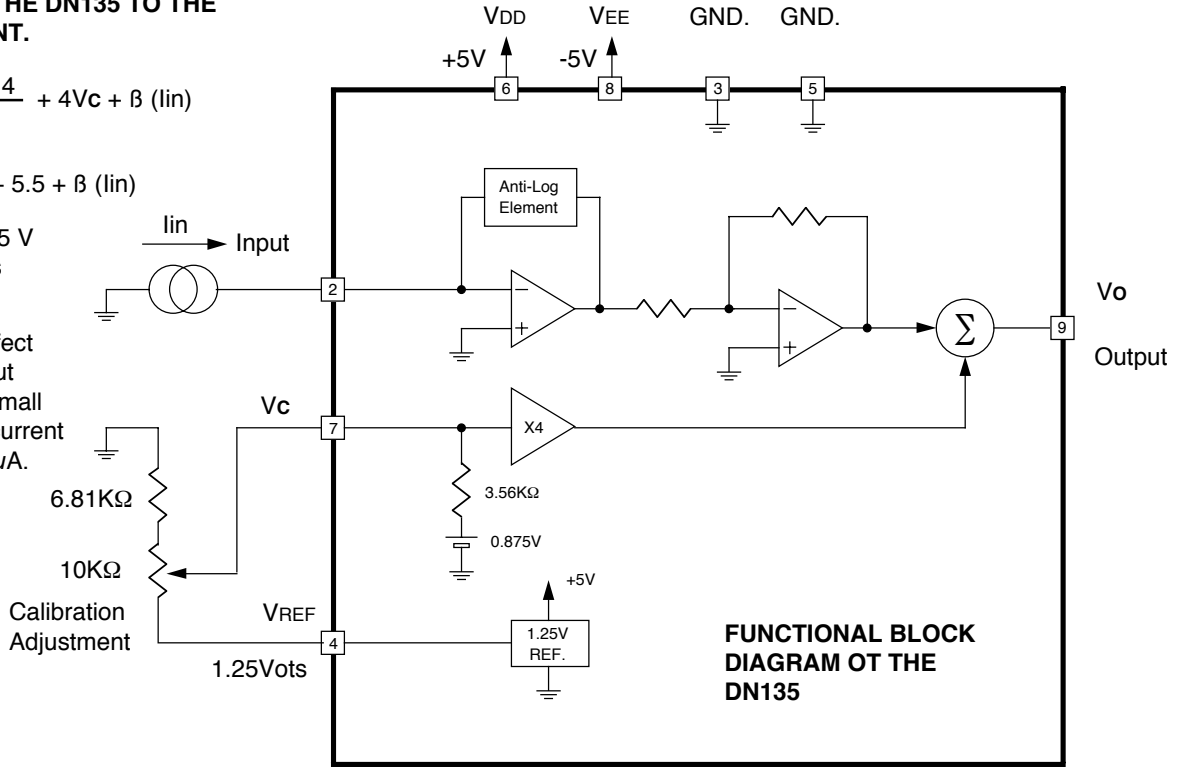
$$V_o = \frac{\text{Log}(\text{lin}) + 4}{2} + 4V_c + \beta(\text{lin})$$

or

$$V_o = \frac{\text{Log}(\text{lin})}{2} + 5.5 + \beta(\text{lin})$$

When $V_c = 0.875\text{ V}$
lin is in Amperes

$\beta = 0.010 \pm .002$
at 25°C . The effect of β on the output voltage is very small when the input current is less than $100\mu\text{A}$.

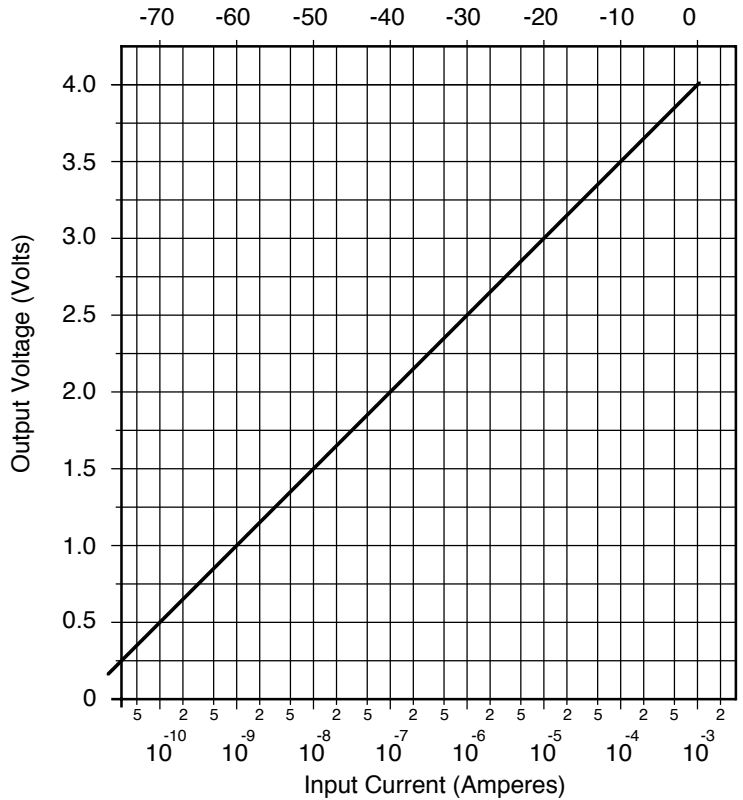


OUTPUT VOLTAGE vs. INPUT CURRENT FOR THE DN135

Input Current	Output ¹ Voltage T= 25°C	Output ¹ Voltage Tol. T= 25°C	Output ¹ Voltage Tol. T= -20°C to +75°C
Amperes	Volts	Volts	Volts
1 mA	4.000	+0.012	+0.024
100 μA	3.500	±0.002	±0.010
10 μA	3.000	±0.000	±0.010
1 μA	2.500	±0.001	±0.010
100 nA	2.000	±0.002	±0.010
10 nA	1.500	±0.002	±0.010
1 nA	1.000	±0.002	±0.020
100 pA	0.500	±0.005	±0.150

1. This is the output voltage after the DN135 has been calibrated to produce an output voltage of 3.000 Volts with an input current of $10\mu\text{A}$ at an ambient temperature of 25°C

OUTPUT VOLTAGE vs. INPUT CURRENT/OPTICAL POWER
Optical Input Power (dBm)

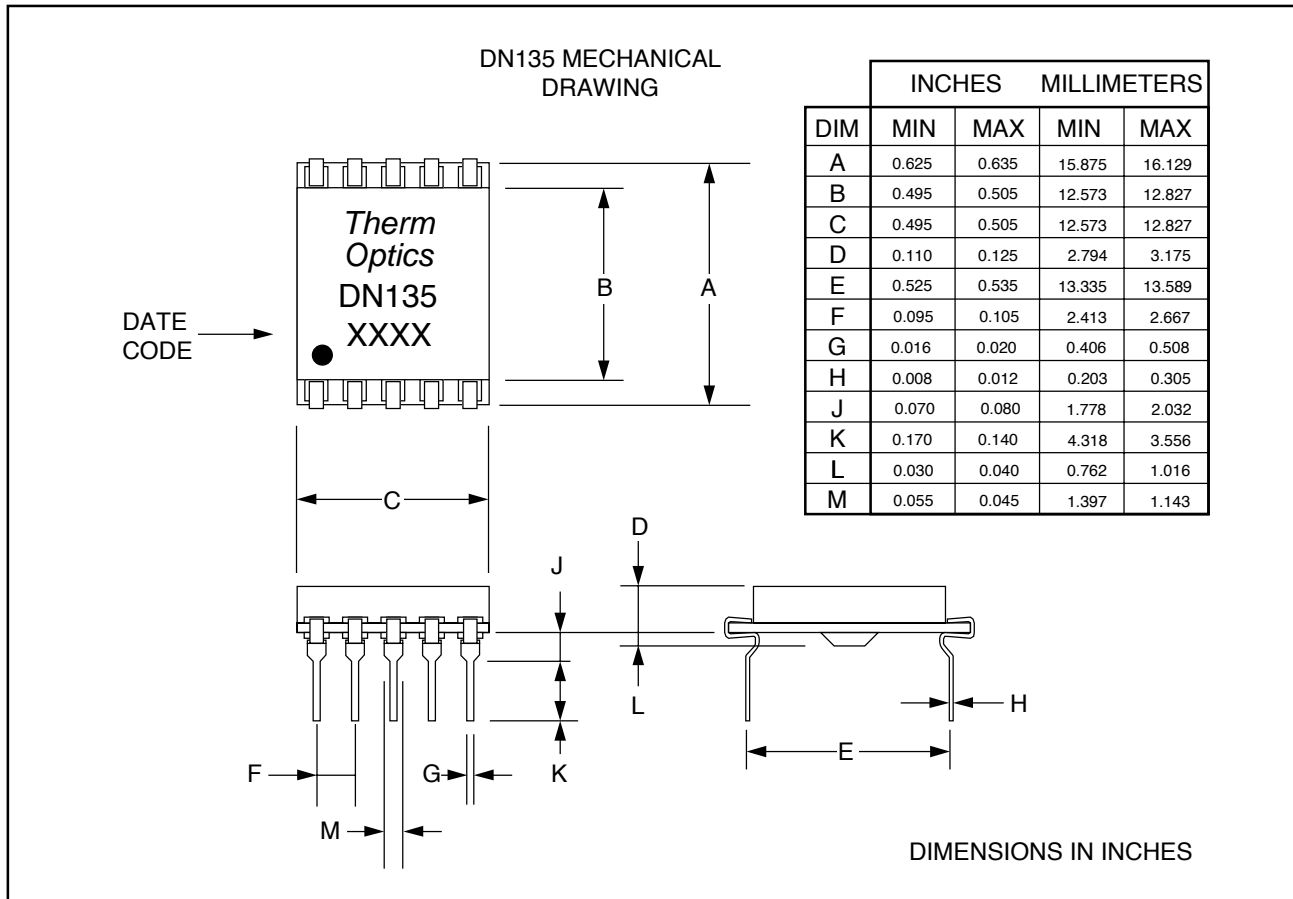


The input stage of the DN135 is a transimpedance amplifier with a non linear feedback element that produces the logarithmic transfer function of the amplifier. The input resistance of a transimpedance amplifier is given in equation 1.1.

$$1.1 \quad RIN = \frac{RFB}{A} \quad \text{Where (RFB) is the resistance of the feedback element and (A) is open loop gain of the operational amplifier}$$

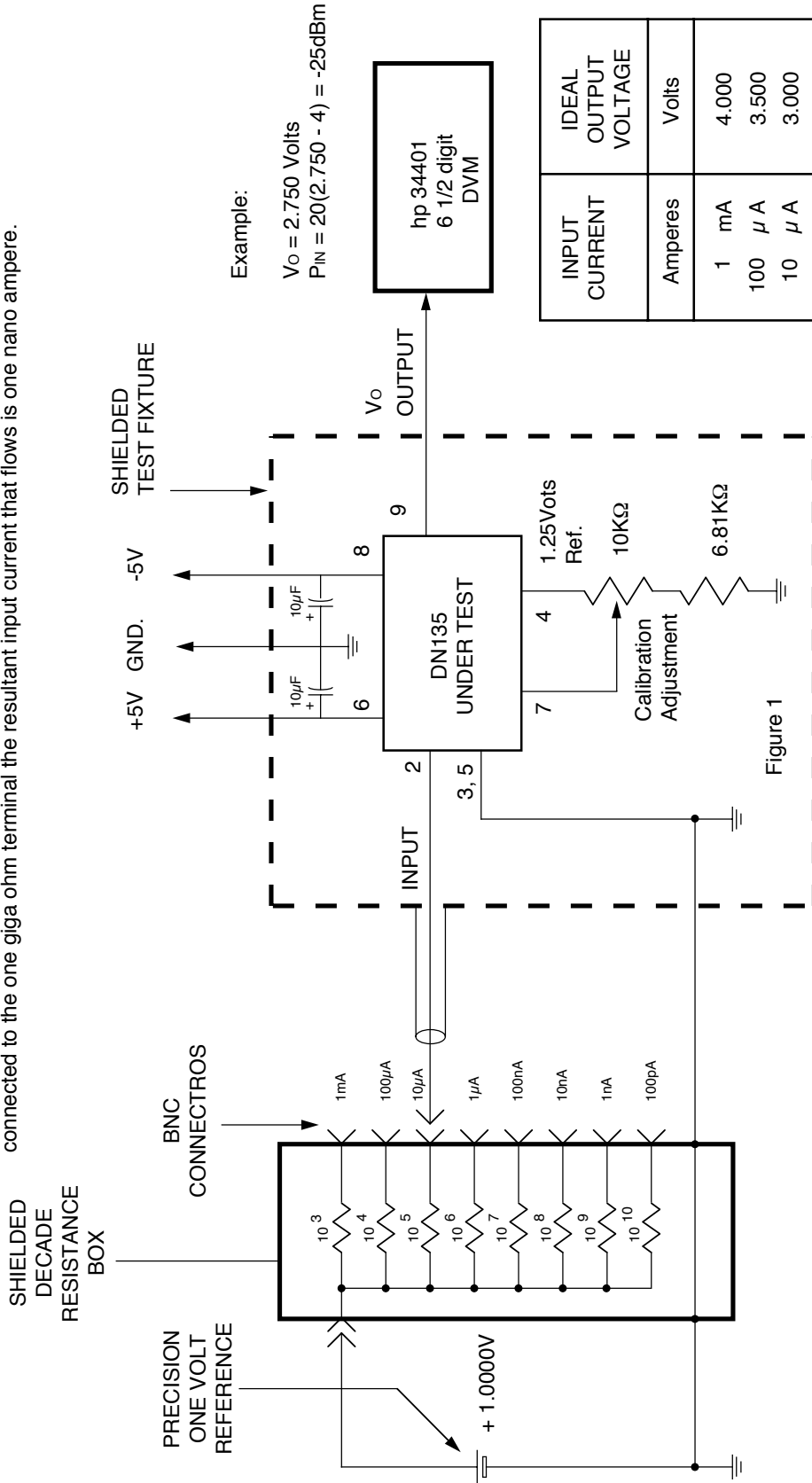
The incremental resistance of the feedback element is low (25Ω) at high input current levels (1mA) and is very large (250MΩ) at low input current levels (100pA). The DC open loop gain of the input amplifier is typically 250,000. The table below shows the nominal input resistance of the DN135 as a function of input current.

IIN	INCREMENTAL FEEDBACK RESISTANCE	TYPICAL AMPLIFIER INPUT RESISTANCE
1 mA	25Ω	< 1Ω
100 μA	250Ω	< 1Ω
10 μA	2.5KΩ	< 1Ω
1 μA	25KΩ	< 1Ω
100 nA	250KΩ	1Ω
10 nA	2.5MΩ	10Ω
1 nA	25MΩ	100Ω
100 pA	250MΩ	1KΩ



DN135

The circuit below illustrates the test fixture that we use to test the DN135. We measure the output voltage over seven decades of input current ranging from 100pA to 1mA. The input of the DN135 is a virtual ground so that the current that flows into Pin 2 is equal to the 1.000 Volt reference divided by the resistor that is selected in the decade resistance box. For instance if the input is connected to the one giga ohm terminal the resultant input current that flows is one nano ampere.



Example:

$$V_o = 2.750 \text{ Volts}$$

$$P_{in} = 20(2.750 - 4) = -25\text{dBm}$$

hp 34401
6 1/2 digit
DVM

INPUT CURRENT	Amperes	IDEAL OUTPUT VOLTAGE	Volts
1	mA	4.000	
100	μ A	3.500	
10	μ A	3.000	
1	μ A	2.500	
100	nA	2.000	
10	nA	1.500	
1	nA	1.000	
100	pA	0.500	

Figure 1