Intronics Power ®

Complete Log Ratio Module

MODEL 756

FEATURES
- Complete Log Ratio Module
- Provides Log Ratio of Current
- Provides Log Ratio of Voltage
- Dynamic Range of 7 Decades of Ratio

APPLICATIONS
- Log Ratio or Antilog Ratio of Voltages
- Log Ratio or Antilog Ratio of Currents
- Absorbance Measurements (see Figure 2)

GENERAL DESCRIPTION

Model 756 is a complete temperature compensated DC log ratio module, containing two channels for processing input variables. Channel 1 features a high quality FET amplifier with bias current of only 10pA. Using this input, signals spanning 4 decades can be processed with less than 1% error. By applying signals spanning up to 3 decades to channel 2, overall performance of 1% can be achieved for ratios covering a dynamic range of 10 million to 1 (7 decades).

Designed primarily for photometer applications, model 756 replaces two log modules, a subtractor, and associated circuitry. The signal sources for these applications are usually photo diodes which should be operated in the zero-volt mode (short circuit current). When connected as shown in Figure 2, the summing junctions provide virtual grounds, thereby forcing the input currents to be the short circuit current of the photo diodes.

PRINCIPLES OF OPERATION

CURRENT LOG RATIO

Current log ratio is accomplished by model 756 when two currents, I_{sig} and I_{ref}, are applied directly to the input terminals (see Figure 1). The two log amps process these signals providing voltages which are proportional to the log of their respective inputs. These voltages are then subtracted and applied to an output amplifier. The scale factor, when connected as shown, is 1V/dec. However, other scale factors may be achieved by using an external/feedback resistor for A_3 instead of the internal 15kΩ. The governing equation for this optional adjustment is:

$$R \approx \left(\frac{15k\Omega}{V}\right) K_{DES}$$

where R represents the total feedback resistance of A_3, and K_{DES} is the desired scale factor.

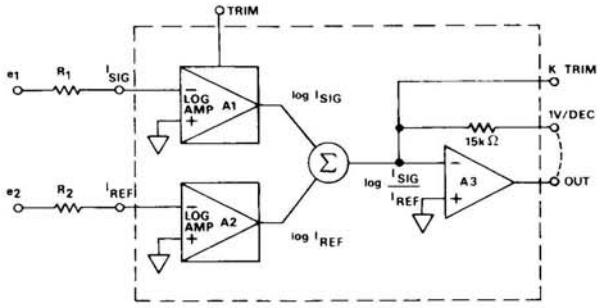

Figure 1. Functional Block Diagram of Model 756

VOLTAGE LOG RATIO

The principle of operation for voltage log ratio is identical to that of current log ratio after the voltage signal has been converted to a current. To accomplish this conversion, an external resistor is attached from the voltage signal to the appropriate input current terminal of the 756. Input currents are then determined by:

$$I_{sig} = \frac{e_1}{R_1}, \; I_{ref} = \frac{e_2}{R_2}$$

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SPECIFICATIONS (typical at +25°C and ±15V unless otherwise noted)

Current Log Ratio
Transfer Equation $e_0 = -K \log \frac{i_1}{i_2}$, i_1 = sig, i_2 = ref

Transfer Equation including Error Terms $e_0 = -K \left[\log \left(\frac{i_1 - I_{b1}}{i_2 - I_{b2}} \right) + E_{os3} \right]$

Voltage Log Ratio
Transfer Equation $e_0 = -K \log \left[\frac{e_1}{e_2} \times \frac{R_2}{R_1} \right]$

Transfer Equation including Error Terms $e_0 = -K \left[\log \left(\frac{\frac{e_1 - E_{os1}}{R_1} - I_{b1}}{\frac{e_2 - E_{os2}}{R_2} - I_{b2}} \right) + E_{os3} \right]$

Parameter	Value
Signal Current, i_1 [1]	10nA to 100μA (4 decades)
Reference Current, i_2 [1]	100nA to 100μA (3 decades)
Log Conformity[2]	±0.5% (2 decades, i_2 constant)
	±1.0% (4 decades, i_2 constant)
Scale Factor, K[1,3]	1V ±1% ±0.04%/°C
Bias Current, I_{b1}	10pA, doubles/10°C
Bias Current, I_{b2}	10nA, max, ±1%/°C
Offset Voltage, E_{os1} [3]	±1mV, max, 25μV/°C
Offset Voltage, E_{os2}	0.5mV, max, 30μV/°C max
Output Offset, E_{os3} [3]	±10mV, max, 85μV/°C

Small Signal Response

i_{in}	f_t
1nA	1kHz
1μA	8kHz
100μA	25kHz

Slew Rate

i_{in} (increasing) time		i_{in} (decreasing) time	
1nA to 10nA	70μs	10nA to 1nA	200μs
10nA to 100nA	25μs	100nA to 10nA	50μs
100nA to 1μA	25μs	1μA to 100nA	25μs
1μA to 100μA	20μs	100μA to 1μA	20μs

Noise in 10kHz B.W.
V_n, INPUT 1 3μV rms
V_n, INPUT 2 3μV rms
I_n, INPUT 1 0.1pA rms
I_n, INPUT 2 20pA rms

Rated Output
Log Mode ±10V at 5mA
Antilog Mode ±10V at 4mA

Power
Quiescent Current 3mA at ±15V
Recommended Supply Model 915[4]
PSRR 54dB

Package Size 1.5" x 1.5" x 0.4"

[1] Positive for positive inputs (N type), negative for negative inputs (P type).
[2] The log conformity specification is referred to input (R.T.I.). Note: 1% error R.T.I. is equivalent to 4.3mV of error at output for K = 1V.
[3] Externally trimmable.
[4] Model 915 is a 0.1% regulated dual 15V supply at 25mA. For higher current capability consider models 904 (50ma), 902 (100mA) or 920 at 200mA.

Specifications subject to change without notice.

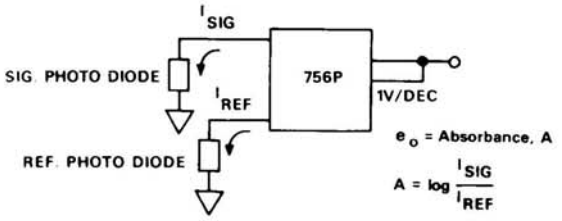
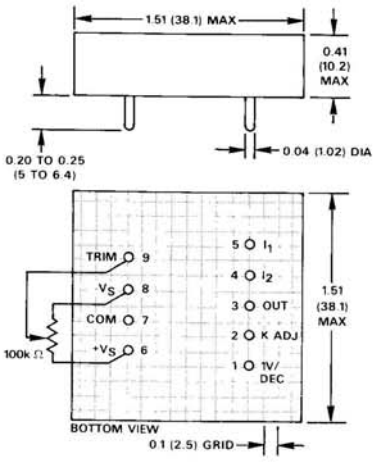


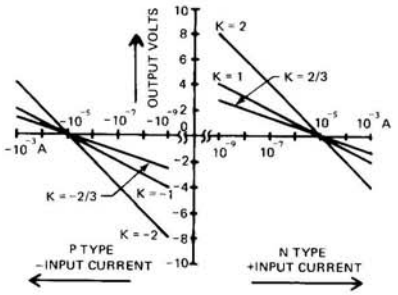
Figure 2. Photometry Application of Model 756

OUTLINE DIMENSIONS

Dimensions shown in inches and (mm).



TRANSFER CURVES



Plot of output voltage vs. input current for Model 756 connected in log mode and I_{ref} = 10μA. To use the same curve for input voltage, calculate i_{in} as e_1/R_1 (see Figure 1).

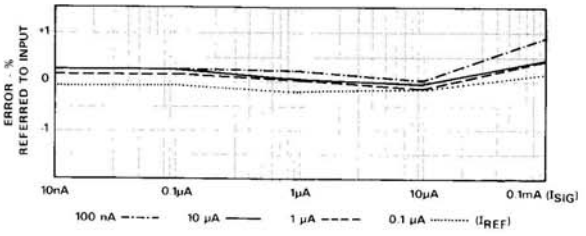


Figure 3. Typical % Error (R.T.I.) vs I_{sig} Over 7 Decades of $\frac{I_{sig}}{I_{ref}}$