MODEL 751P/N

PRECISION LOGARITHMIC MODULE

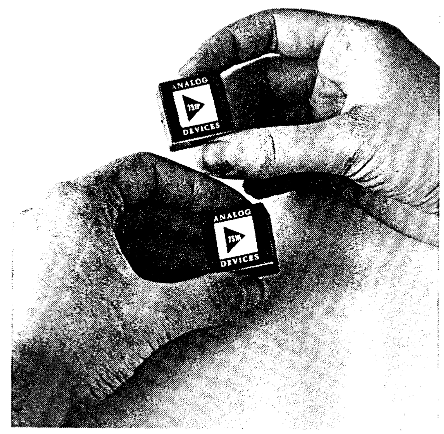
FEATURES

Wide Dynamic Range, 10pA to 1mA

Calibrated 1V/Decade Output

Temperature Compensated to 0.05%/°C

Low Cost - $20(100 quantity) - $38(1-9)



APPLICATIONS

Current or Voltage Ratiometers

Logarithmic Compressors

Exponential Expanders

Arbitrary Powers and Roots

ANALOG DEVICES

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LOGARITHMIC DEVICES – A MATTER OF NOMENCLATURE

In *communication* or *audio* parlance, a logarithmic or exponential amplifier is one in which the input and output wave shapes are identical, and the output level varies as the logarithm or a power of the input level, averaged over many cycles of the signal frequency. In *analog* technology, however, the output is proportional to the logarithm or a power of the *instantaneous* value of the input signal. The logarithm of zero being an indeterminate number, a zero input signal condition is ruled out and analog logarithmic devices are confined to a single quadrant.

DESCRIPTION

Model 751P/N Logarithmic Modules contain the nonlinear components needed to instrument a wide range of exponential, logarithmic and ratio measuring circuits in the "analog" sense of those words. The circuitry includes a pair of silicon transistors – NPN types in the Model 751N and PNP types in the Model 751P – and a temperature compensating voltage divider.

The transistors are chosen for their conformity to the ideal logarithmic current-to-voltage relationship; their characteristics are closely matched and they are thermally coupled to minimize temperature differences between their junctions. The voltage divider, used in the feedback network of an operational amplifier, is designed to boost the voltage difference between the two transistors to one volt per decade of current ratio through them, while simultaneously compensating for the temperature dependence of the matched transistor pair. Each module is adjusted and calibrated to assure compliance to the specifications given herein.

The Model 751P/N is normally used in conjunction with one or more operational amplifiers and thus the circuitry of the module is brought out on separate pins to allow maximum versatility of interconnection. The unit is molded into an epoxy filled module which can be soldered directly onto a printed circuit board or plugged into an optional mating socket.

THE GENDER – 751P or 751N

Transistors are one-way devices. The collector current of an NPN transistor must flow into the collector, while that of a PNP model flows out of the collector terminal. The arrows in the conventional transistor schematics point the way!

In selecting a 751 module for a trans-diode or transistor connection, establish the direction of the signal current flow and specify 751P or N accordingly. Photomultiplier and ion chamber currents generally require a -P model. Most other applications, including all diode connections, are better instrumented with a model 751-N, as these, typically come with a closer transistor match and thus give better accuracy. Note that a diode connected transistor is a two-terminal device which can be oriented to suit the direction of the signal current.

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PRINCIPLE OF OPERATION

If the base and collector of a forward biased transistor are held at the same voltage, its base-emitter voltage is proportional to the logarithm of the collector current. This basic property may be exploited by connecting the transistor in the feed-back network of an operational amplifier in one of the three basic configurations shown below. With each, the collector current range of close conformity to the ideal logarithmic function is marked.

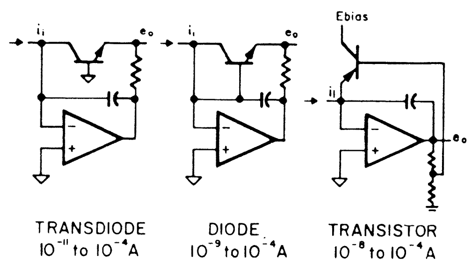


FIGURE 1. BASIC LOGARITHMIC CONFIGURATIONS

All three basic configurations are subject to intolerable temperature sensitivity and dynamic instability unless a few straight-forward circuit design precautions are taken. Model 751 contains the required set of matched temperature compensating components. For the theoretical know-how and a set of proven circuits, see "Analog Dialogue", Vol. II No. 2.

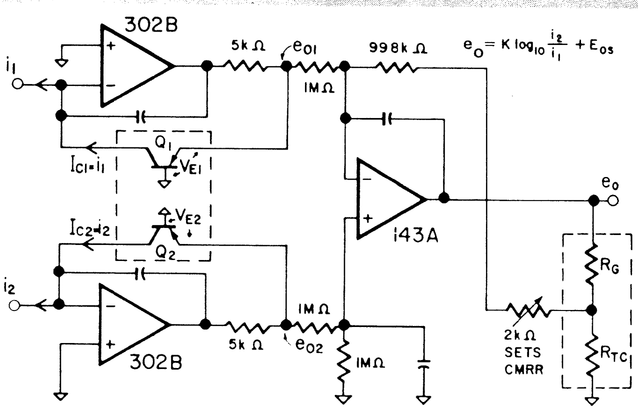
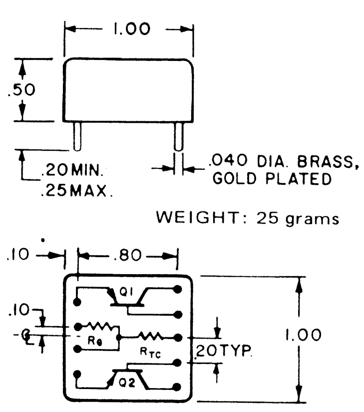


FIGURE 2. TEST CIRCUIT: LOG OF CURRENT RATIO

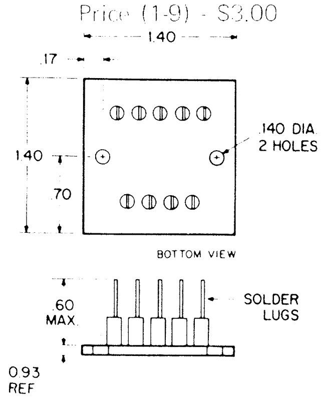
OUTLINE DIMENSIONS



OPTIONAL MATING SOCKET

AC1016

Price (1-9) - $3.00



SPECIFICATIONS

(Typical at 25°C unless stated differently.)
(For 751P and 751N, unless shown separately.)

TRANSISTORS

Maximum Ratings:	751P	751N
V_{EBO}	5V	4V
V_{CBO}	40V	40V
V_{CEO}	40V	25V
I_C	.05A	0.1A
P_D	0.5W	0.3W

Current Gain:

$h_{fe1}, h_{fe2} \geq 100 @ I_C = 10\mu A$

Transistor Match @ $V_{CB1} = V_{CB2} = 0$:

$|V_{BE1} - V_{BE2}| < 0.5mV, 1nA < I_{C1} = I_{C2} < 0.1mA$

RESISTORS:

$R_{TC} = 955\Omega \pm 1\% @ 25°C, +0.3\%/°C$

$R_G = 15k\Omega \pm 2\%$, selected

PERFORMANCE IN TEST CIRCUIT (Fig. 2)

All amplifiers zeroed and not contributing errors

$$e_o = K \log_{10} \frac{i_2}{i_1} + E_{os} \quad \text{(definition)}$$

$$K = K_{25} + \frac{\Delta K}{\Delta T}(T - 25°C) \qquad E_{os} = E_{os25} + \frac{\Delta E_{os}}{\Delta T}(T - 25°C)$$

Composite Specifications:
(Typical unless stated otherwise.)

$K_{25} = 1000 \pm 5$(max) mV/decade, $1nA < i_1, i_2 < 0.1mA$
± 15mV/decade, $100pA < i_1, i_2 < 1mA$

$\frac{\Delta K}{\Delta T} = \pm 0.45$(max)mV/decade/°C, $1nA < i_1, i_2 < 1mA$
$= \pm 0.45$mV/decade/°C, $100pA < i_1, i_2 < 1nA$

$E_{os25} = \pm 8$(max)mV, $1nA < i_1, i_2 < 0.1mA$
± 15mV (751P), ± 8mV (751N) — $100pA < i_1, i_2 < 1mA$

$\frac{\Delta E_{os}}{\Delta T} = \pm 0.1$(max)mV/°C, $1nA < i_1, i_2 < 1mA$
± 0.25mV/°C (751P), ± 0.15mV/°C (751N) — $100pA < i_1, i_2 < 1nA$

TEMPERATURE RATINGS:

Performance to above specifications:	10 to 60°C
Operating:	−25 to 85°C
Storage:	−55 to 100°C

PRICE

1-9	$38.
10-24	$30.

All specifications subject to change without notice

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