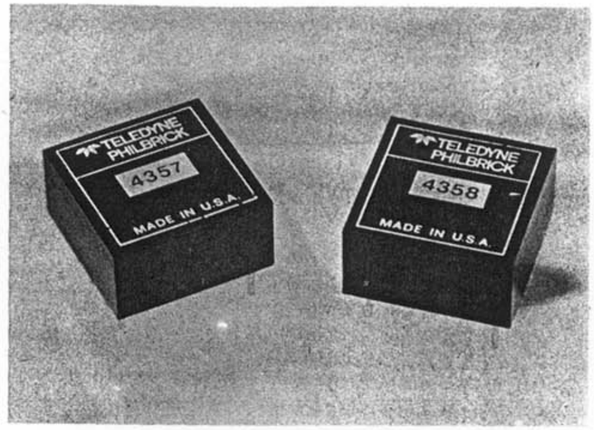
TELEDYNE PHILBRICK

4357/4358 TEMPERATURE COMPENSATED LOGARITHMIC OPERATORS

Teledyne Philbrick Models 4357 and 4358, when utilized with two low bias current operational amplifiers, will produce an accurate temperature compensated logarithmic amplifier which responds to 6 decades of positive (Model 4357) or negative (Model 4358) input current, or 4 decades of input voltage. The silicon transistors incorporated in these "log modules" feature superior logarithmic response plus a tight V_{be} match for excellent tracking and minimum offset errors. The temperature-compensated voltage divider precisely tracks the temperature dependence of the active elements, and provides an output slope of 1 volt per decade change in current ratio.

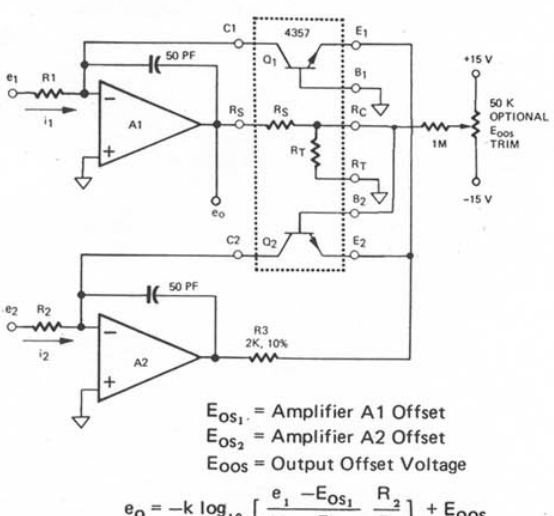


APPLICATIONS

Basic Log Ratio Circuit

This log ratio circuit (see Figure 1) employs the Model 4357 logarithmic element plus two low input bias current operational amplifiers and five passive circuit components, to produce an accurate, stable, temperature-compensated output. If the log of a single variable is desired, e_2 may be replaced by a reference voltage. Although Models 4357/4358 feature an internal scaling resistor (R_S) selected to provide a calibrated output slope of 1.000 volt/decade, the pin configuration permits substitution of external components if a different scale factor is required.

This circuit is ideal for such applications as single quadrant logarithmic compression of a wide dynamic range signal for meter display, logarithmic preamplifier for photomultiplier or ion chamber systems, and circuits to perform such mathematical computations as raising analog signals to arbitrary powers (or roots).



E_{OS_1} = Amplifier A1 Offset
E_{OS_2} = Amplifier A2 Offset
E_{OOS} = Output Offset Voltage

$$e_O = -k \log_{10} \left[\frac{e_1 - E_{OS_1}}{e_2 - E_{OS_2}} \, \frac{R_2}{R_1} \right] + E_{OOS}$$

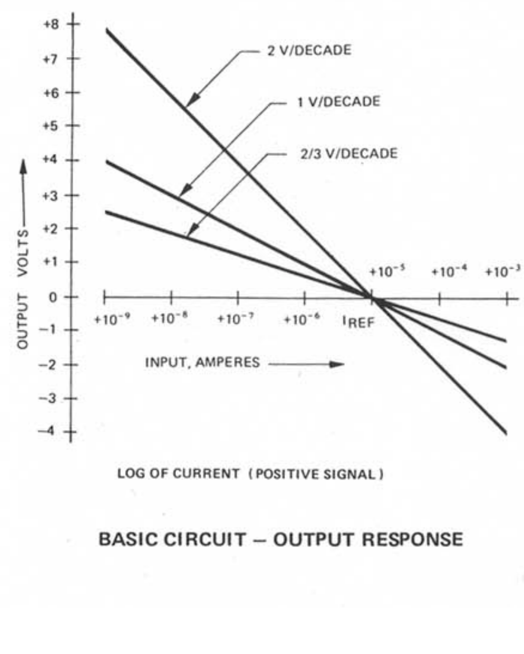
Figure 1. Basic Log Ratio Circuit

FEATURES

- Temperature Compensated
- Logs over 6 Decades
- Superior Logarithmic Conformity
- Low Cost

APPLICATIONS

- Logging/Antilogging
- Linearizing Exponential Signals
- Mathematical Computations
- Signal Compression to Eliminate Range Switching



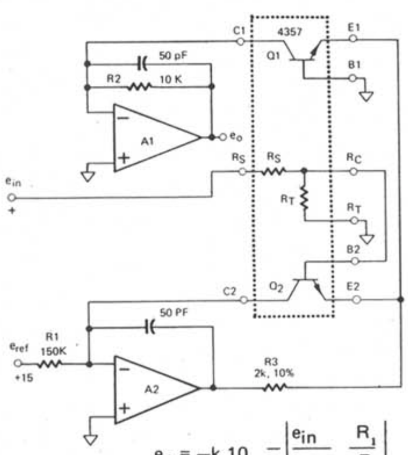
BASIC CIRCUIT – OUTPUT RESPONSE

SPECIFICATIONS Typical @ +25°C, unless otherwise specified

DYNAMIC RANGE	
Current	120 dB
Voltage	80 dB
LOG CONFORMITY OF READING (Referred to Input)	
1 nA to 10 nA	1%
10 nA to 100 μA	1%
100 μA to 1 mA	1%
TEMPERATURE DRIFT	
Scale Factor	
+10 to +60°C	±0.04%/°C
Offset	
+10 to +60°C	±0.1 mV/°C
SLOPE	
Fixed	1 V/Decade
Adjustable	Yes
RATED OUTPUT I & V	Depends on Amplifier
BANDWIDTH	
1 nA	80 Hz
1.0 μA to 1 mA	Depends on Amplifier
RESISTOR VALUES	
R_t	1 kΩ ±10 Ω
R_s/R_t	15.92 ±0.5%
MAXIMUM TRANSISTOR VALUES	
V_{CBO}, 4357	30 V min
V_{CBO}, 4358	40 V min
V_{CEO},	30 V min
V_{EBO}, 4357	4 V min
V_{EBO}, 4358	5 V min
I_C	250 mA max
PD	350 mW max
$\lvert V_{be1}-V_{be2}\rvert$ @ I_e = 1 μA to 100 μA	0.5 mV max
H_{fe1}, H_{fe2} @ I_{c1}, I_{c2} = 10 μA	46 dB, min

Antilog Circuit (Exponential Expander)

This antilog circuit, or exponential expander, (see Figure 2) is basically a rearrangement of the log ratio circuit. This configuration is useful in signal processors for communication systems, and may be used in conjunction with logging circuits to perform a variety of mathematical manipulations.



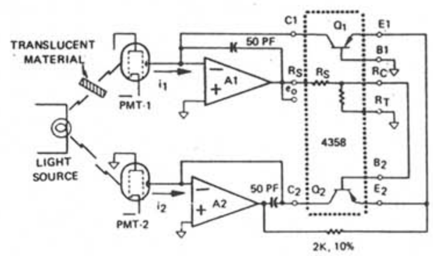
$$e_o = -k\,10^{-\left|\frac{e_{in}}{e_{ref}}\,\frac{R_1}{R_2}\right|}$$

For the component value shown: $e_o = 10^{-|e_{in}|}$

Figure 2. Antilog Circuit (Exponential Expander)

Translucence Measuring Circuit

There are several applications where ratio or log ratio of two inputs is very important. An example is a circuit which measures the amount of light passing through translucent materials. (See Figure 3.) An interesting feature of the application is that although the intensity of the light source may vary due to temperature or age, the ratio output in decibels does not change. This is due to Photo-multiplier #2 being used as a variable reference.

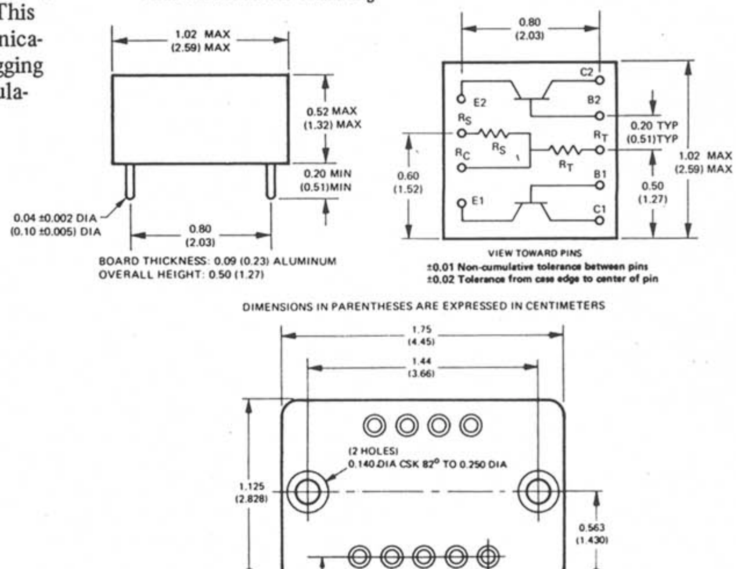


$$e_o = -k \log_{10}\left[\frac{i_1}{i_2}\right]$$

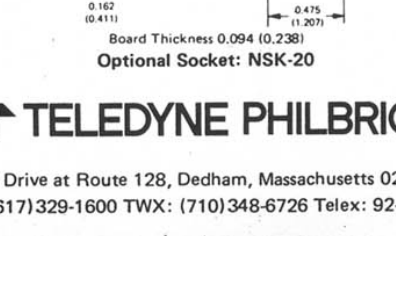
Figure 3. Translucence Measuring Circuit

NOTES

1. Figures 1 and 2 utilize Model 4357 for positive currents and voltages. Model 4358 would be used for negative inputs.
2. In log mode e_1 and e_2 must never be zero ($\log_{10} 0 = -\infty$).
3. Resistors shown are 1/4 Watt precision metal film types unless otherwise specified.
4. Recommended amplifiers are Models1421, 1425 and 1426. Principle restriction is $I_{bias} \leqslant 1$ nA.
5. To increase scale factor, connect ≈ 17 kΩ for extra volt/decade in series with R_S.



DIMENSIONS IN PARENTHESES ARE EXPRESSED IN CENTIMETERS



Board Thickness 0.094 (0.238)

Optional Socket: NSK-20

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