Model 449
Log/Lin Ratemeter
Operating and Service Manual

Printed in U.S.A.

EG&G ORTEC Part No. 733270
Manual Revision B

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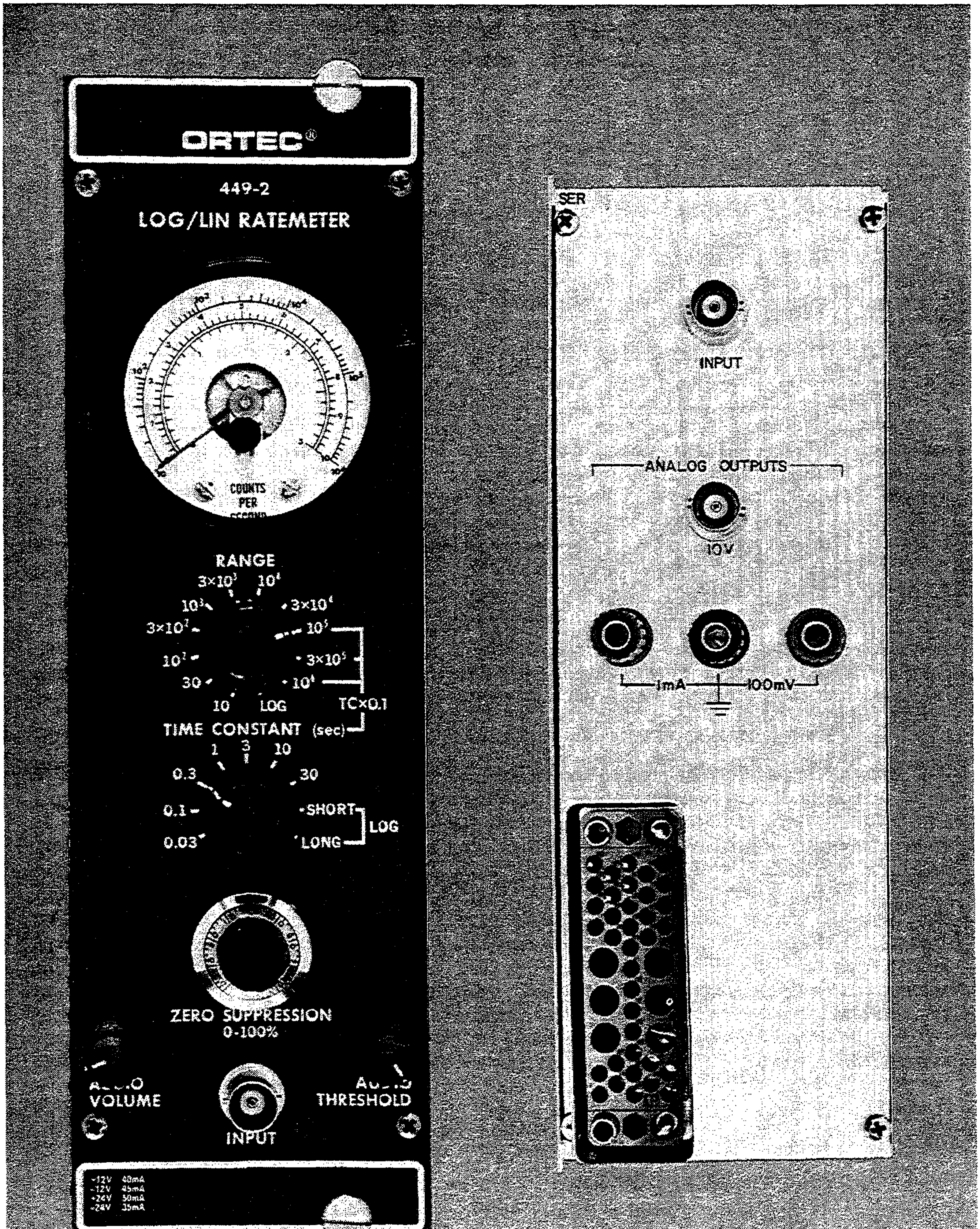

The ORTEC 449 looks the same as the 449-2 except that it has no audio volume or threshold control on the front panel.

ORTEC 449 LOG/LIN RATEMETER WITH OPTIONAL 449-2 AUDIBLE OUTPUT

1. DESCRIPTION

1.1 GENERAL

The ORTEC 449 is a double-width NIM-standard modular ratemeter that measures the average count rate of input pulses. The measurements are based on a selected full-scale rate, with a wide range of selections for linear indications and for logarithmic indications. When the input pulse rate is fairly constant, a linear range can be selected that will accommodate the rate, whether it is low, medium, or high. When the input pulse rate varies through a wide range, the logarithmic scale will expand the range for better interpretation of changes when the rate is low and will still accommodate the high count rates within the same total range. There are 11 linear ranges with full-scale values of 10 counts/sec through 10^6 counts/sec. The range of the log scale is 10 through 10^6 counts/sec in 5 decades.

A variety of time constants can be selected. Each selection determines the relative averaging capacity for measurements of varying counting rates and also the time interval after a sudden rate change until the indication reaches an equilibrium. The proper selection is a function of the average counting rate, the selected range, and the purpose for which the measurement is made (to measure a true average rate or to identify rate changes quickly).

1.2 DATA AVAILABILITY

Any measured counting rate will be shown on the front-panel meter with a 240° full-scale deflection for accurate readability. It is also available through rear-panel connectors as a proportional analog value of voltage or current. The outputs on the rear panel can be used to drive a recorder, an external indicating meter, an oscilloscope, and/or a device such as the ORTEC 461 Alarm Control.

The full-scale range of the current output is 0 to 1 mA. This is intended for an input to a current-type recorder that is adjusted for 1 mA full scale. The full-scale range of the comparable voltage output is 0 to 100 mV, intended for use as the input to a voltage-type recorder that is adjusted for 100 mV full scale. Both outputs are furnished through binding posts that are appropriate for the recorder interconnections.

The full-scale range of the analog output through the rear-panel BNC connector is 0 to 10 V, which is furnished through an output impedance of 100Ω.

For any measurement the proportional meter deflection and the proportion of the analog full-scale values will always be equal. For example, when the meter reads 50% of full scale, the three analog outputs will be 500 μA, 500 μV, and 5 V respectively.

1.3 OPTIONAL AUDIBLE OUTPUT

The optional audible output is identified as the ORTEC 449-2. When it is included, the frequency of the sound from the speaker will be a tone in the range 0 through 500 Hz. The actual frequency will be proportional to the relative meter deflection.

There are two controls for the audible output: a volume control and a threshold adjustment. The threshold can be advanced to eliminate all sound output until the counting rate exceeds a selected level; from the threshold up to the full-scale range, the audio frequency will be proportional to the meter deflection, as it would have been with no suppression.

2. SPECIFICATIONS

PERFORMANCE

LINEAR 11 ranges from 10^1 to 10^6 counts/sec full scale in 1 - 3 - 10 steps.

Dead Time ≤0.3% of the average pulse spacing for ranges from 10^1 through 3×10^4 counts/sec; ≤1% on 10^5 range; ≤3% on 3×10^5 range; and ≤10% on 10^6 range.

Rate Overload Maintains full-scale output for a X300 overload to a limit of 10^7 counts/sec.

Temperature Stability ≤±0.05%/°C, 0 to 50°C.

Analog Output Nonlinearity ≤±0.15% of full scale for ranges from 10^1 through 3×10^4 counts/sec; ≤±2% of full scale for ranges from 10^5 through 10^6 counts/sec.

Meter Accuracy ≤±2% of full scale.

LOGARITHMIC One 5-decade range from 10^1 to 10^6.

Temperature Stability ≤±0.25% of full scale per °C, 0 to 50°C.

Analog Output Error ≤±2.5% of full scale.

Standard Deviation ~15% for Short log time constant; ~5% for Long log time constant.

Slewing Rate Dependent on input rate; for any rate, Short log time constant provides X10 faster response than Long log time constant.

CONTROLS

RANGES 12-position switch selects counts per second for full-scale linear rates of 10, 30, 100, 300, 10^3, 3×10^3, 10^4, 3×10^4, 10^5, 3×10^5, or 10^6; or a log range of 5 decades from 10 to 10^6 counts/sec.

TIME CONSTANT 9-position switch selects an integrating time constant of 0.03, 0.1, 0.3, 1, 3, 10, or 30 sec for linear ranges from 10 to 3×10^4 counts/sec or for any of these values divided by 10 for 10^5, 3×10^5, and 10^6 ranges; Short and Long for logarithmic range.

ZERO SUPPRESSION 10-turn precision potentiometer with duo-dial shifts the zero-reference level from 0 to 100% ±5% of full scale for any linear range.

AUDIBLE OUTPUT VOLUME (in 449-2 option only) Front-panel control to adjust the volume of the speaker output.

AUDIBLE OUTPUT THRESHOLD (in 449-2 option only) Front-panel control to suppress all audible outputs below the adjusted threshold.

INPUT

BNC front- and rear-panel connectors, dc-coupled input with Z_{in} ~1 kΩ.

Polarity Accepts both positive and negative inputs.

Amplitude ±3 V min, ±30 V max.

Width 50 nsec min, no max limit.

Pulse Pair Resolving Time 50% of full-scale error for pulse pair separation of one dead time; 0.1% of full-scale error for pulse pair separation of two dead times.

OUTPUTS

FRONT-PANEL METER 240° deflection; ±2% of full-scale accuracy; includes 3 scales: linear 0 to 3 counts/sec; linear 0 to 10 counts/sec; logarithmic 10 to 10^6 counts/sec.

ANALOG OUTPUT +10 V full scale through 100Ω; rear-panel BNC.

RECORDER OUTPUTS 3 binding posts on rear panel.

Voltage Output 100 mV full scale through 100Ω.

Current Output 1 mA full scale through 10 kΩ.

ELECTRICAL AND MECHANICAL

POWER REQUIRED +24 V, 50 mA; +12 V, 30 mA; -24 V, 35 mA; -12 V, 45 mA.

WEIGHT (Shipping) 5.5 lb (2.5 kg).

WEIGHT (Net) 3.5 lb (1.5 kg).

DIMENSIONS Standard double-width NIM module (2.70 in. by 8.714 in.) per TID-20893 (Rev.).

RELATED EQUIPMENT

The ORTEC 449 Log/Lin Ratemeter can accept logic input pulses from any source at rates up to 10^6 counts/sec and indicate the average input count rate. Typical logic pulse sources include discriminators, single-channel analyzers, coincidence circuits, and pulse generators. All ORTEC modules that are designed for these functions provide output pulses that are compatible with the 449 input requirements.

The output circuits include recorder outputs for either a current-sensitive recorder or a voltage-sensitive recorder. A separate analog output can be used to drive an ORTEC 461 Alarm Control, a voltmeter, an alternate analog recording or control device, or an oscilloscope.

3. INSTALLATION

3.1 GENERAL

The 449 Log/Lin Ratemeter is designed for installation and operation in an ORTEC 401A/402A Bin and Power Supply, or equal. The Bin and Power Supply is designed for relay rack mounting and is usually installed in a rack that houses other electronic equipment. Therefore any vacuum tube equipment or other heat source that operates in the same rack with the 449 must be sufficiently cooled with circulating air to prevent localized heating of the transistorized and integrated circuits in the 449. The maximum limit for safe operation of the 449 is 50°C (120°F), and the temperature of equipment mounted in racks can easily exceed this limit unless precautions are taken.

3.2 CONNECTION TO POWER

The 449 does not include any internal power supply but must obtain its operating power from the standard bin and power supply in which it is installed for operation. Always turn off the power before inserting or removing instrument modules. The ORTEC NIM modules are designed so that a full complement of modules in the bin will not overload the bin power supply. However, this may not be true when the bin contains modules of other than ORTEC design, and power supply voltages should be checked when other modules are inserted. The ORTEC 401A/402A has test points on the Power Supply control panel to monitor the dc voltages.

When using the 449 outside the 401A/402A Bin and Power Supply, be sure that your extension cable includes the Power Supply grounding circuits specified in the recommended standards of TID-20893 (Rev.). Both high-quality and power-return ground connections are specified to ensure proper reference voltage feedback into the Power Supply, and these must be preserved in extension cables. Be careful to avoid ground loops when the module is operated outside the Bin.

3.3 INPUT CONNECTION

Connect the source of pulses for which the rate is to be measured to either the front- or rear-panel Input BNC connector. Each input pulse triggers an internal discriminator when its amplitude exceeds 3 V of either polarity. The maximum safe amplitude that should be furnished to the 449 is ±30 V. Since both connectors are connected directly in parallel, they should not be used simultaneously.

3.4 RECORDER CONNECTION

A strip-chart recorder can be connected to the 449 output in order to obtain a permanent record of the variations in count rates that are measured by the 449 through any time interval. The three binding posts on the rear panel are intended for connection to the recorder. The black binding post is a common ground for both types of recorder output. One of the red binding posts is marked 1 mA and will be used to connect the output to a current-type recorder input. The other red binding post is marked 100 mV and will be used to connect the output to a voltage-type recorder input.

3.5 ANALOG 10-V OUTPUT

The Analog 10-V Output BNC connector on the rear panel also furnishes an output voltage that is proportional to the meter deflection for any operating range. The full-scale range of this output circuit is 0 to +10 V, and the output is furnished through an output impedance of 100Ω.

The principal purpose for the Analog Output is for interconnection from the 449 Ratemeter to an ORTEC 461 Alarm Control, and this interconnection will require a coaxial cable with BNC connectors on both ends.

A direct connection from the Analog 10-V Output can be made to any measuring device that can use this range. This can be a voltmeter, an oscilloscope, or a similar instrument as desired. The input impedance of the measuring instrument should be very high compared with the 100Ω output impedance of the 449 in order to use the ±0.5% accuracy of the output to advantage.

4. OPERATION

4.1 GENERAL

The function of the 449 Ratemeter is to accept input pulses of either polarity, with amplitudes in excess of 3 V, and with any shape or duration and to indicate the average rate in counts per second at which the input pulses occur. The measurement of the rate itself may be the desired end result, or it may be monitored for the purpose of control or to signal an alarm when a dangerous condition is sensed.

The average input rates of random signals can be expected to vary, but the range of rates will normally lie within some small total range. The variety of selectable full-scale linear ranges is furnished to permit selection of any one range that will accommodate the highest rate to be expected during an experiment and yet position the readings for the normal average rates within the central portion of the full-scale range. Each linear range can be used with zero suppression to accommodate the same span of rates with up to twice the full-scale maximum rate. When a very wide variation of the count rates is encountered, the logarithmic range will generally be preferred because it provides greater resolution for the lower counting rates than is furnished by a linear range with an equivalent full scale of 10^6 counts/sec.

A variety of selectable time constants is also furnished in the 449. The appropriate time constant for any specific application depends on several parameters. In general, shorter time constants will permit faster response to variations in count rates, and longer time constants will tend to smooth out short-term fluctuations. More information is included in the statistical theory discussions that follow.

4.2 THEORY OF OPERATION

The Ratemeter operates by applying a fixed amount of charge per input pulse into a tank capacitor. In the interval between input pulses the capacitor discharges through some resistance. As input pulses continue to occur, an equilibrium is reached between the average charging and discharging current, and the voltage across the capacitor is then functionally dependent on the input pulse rate. The 449 includes a resistor for the capacitor discharge for linear dependence and a transistor for logarithmic dependence. These two types of circuits are discussed separately.

Figure 4.1 is a block diagram of the ORTEC 449 Log/Lin Ratemeter that shows the relations between its internal functions.

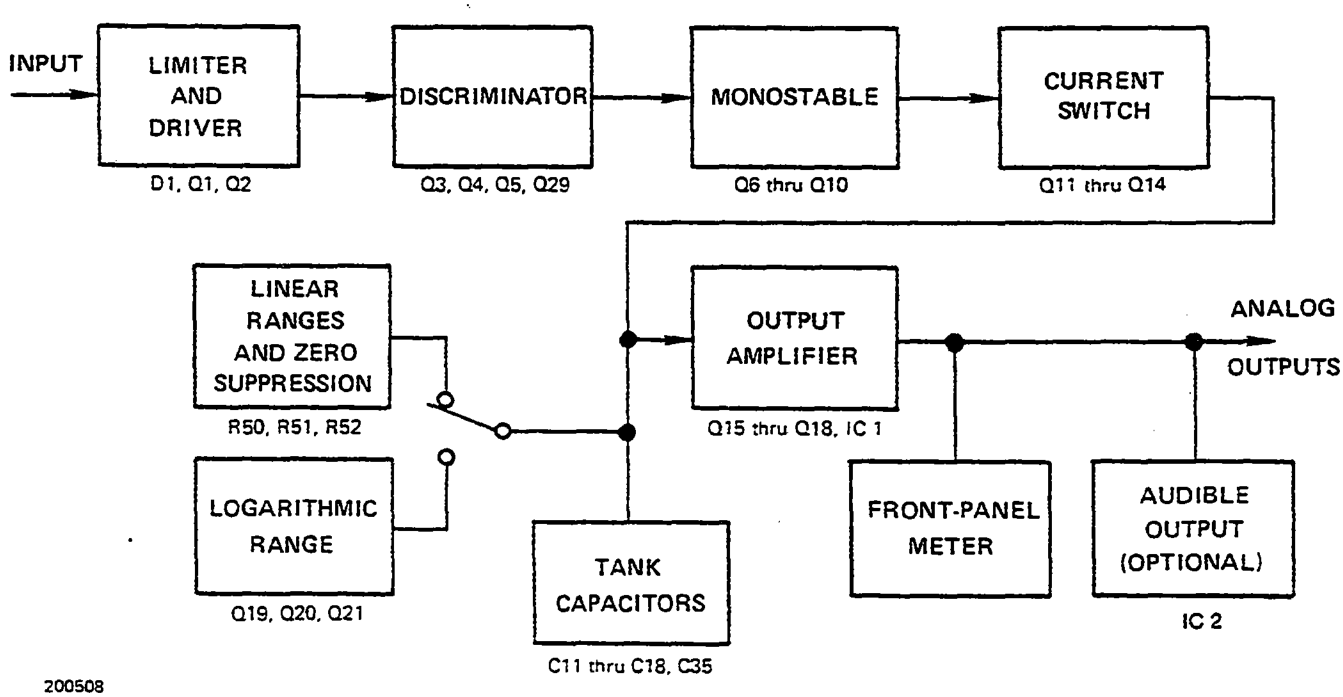

Fig. 4.1. Simplified Block Diagram of ORTEC 449 Log/Lin Ratemeter.

4.3 LINEAR OPERATION

If the average input pulse rate is n and the charge per input pulse is Q_0, then the average charging current is nQ_0. At equilibrium the discharge current $\overline{V}/R$ is equal to the charging current so that

$$\overline{V} = nQ_0R \ . \qquad (1)$$

A simplified equivalent circuit of the tank capacitor circuit is shown in Fig. 4.2. The waveform at the right shows how the voltage across capacitor C increases to an equilibrium, and the fluctuations suggest that a time constant has been selected that is short with respect to the interval between input pulses.

It can be shown that

$$V = \overline{V}\,(1 - e^{-t/T}) \ , \qquad (2)$$

where T = RC, which is the time constant of the circuit.

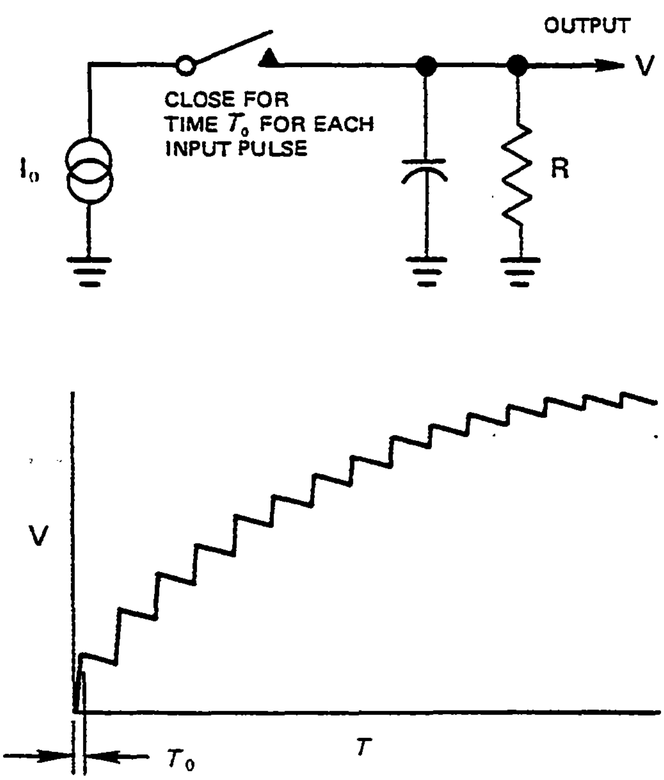

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Fig. 4.2. Simplified Equivalent Tank Capacitor Circuit.

The standard deviation of a single observation for randomly spaced pulses is

$$\overline{V^2} = \frac{1}{2}\, Q_0^2 \cdot nT \ , \qquad (3)$$

$$\epsilon = \frac{\sqrt{\overline{V^2}}}{\overline{V}} = \frac{1}{\sqrt{2nT}} \ . \qquad (4)$$

The relative standard error (ϵ) depends upon the input pulse rate and the selected time constant. These relations are shown in Fig. 4.3.

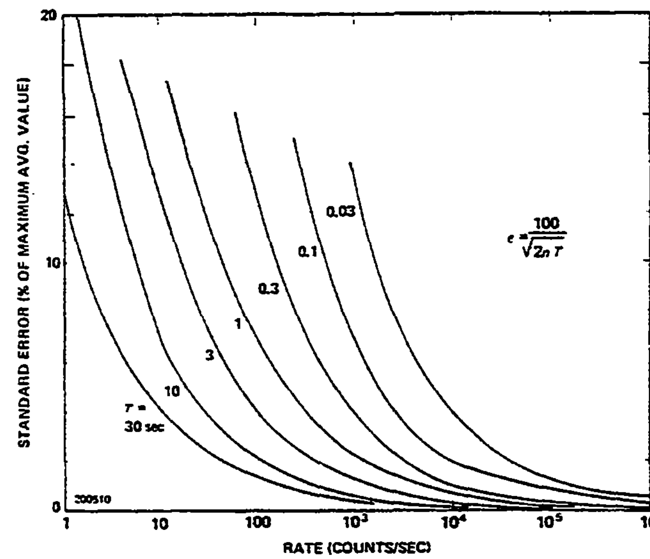

Fig. 4.3. Relative Standard Error.

The ratemeter output is often recorded on a strip-chart recorder, and a lower standard error can be obtained by using more data. Figure 4.4 is a typical graph obtained with a strip-chart recorder. From this figure, the mean count rate and the standard deviation can be estimated.

Fig. 4.4. Typical Recorder Output.

Using the expression T_m to identify the duration of observation in seconds and T for the time constant, the error of the average value found by the above method is reduced by the factor K_σ with the following formula:

$$K_\sigma = \left\{ 2\frac{T}{T_m}\left[1 - \frac{T}{T_m}\left(1 - e^{-T_m/T}\right)\right] \right\}^{1/2} \qquad (5)$$

The curve of Fig. 4.5 illustrates this relation for T_m/T ratios from 1 through 100.

Equilibrium time is defined as the amount of time that is required for the 449 indication to reach an average value within one probable error (0.675σ). This can be calculated from Eqs. (2) and (4):

$$T_e = T \ln\left(\frac{1}{0.675\epsilon}\right) = 1.15T \log 4.4nT \ . \qquad (6)$$

These relations are shown in Fig. 4.6.

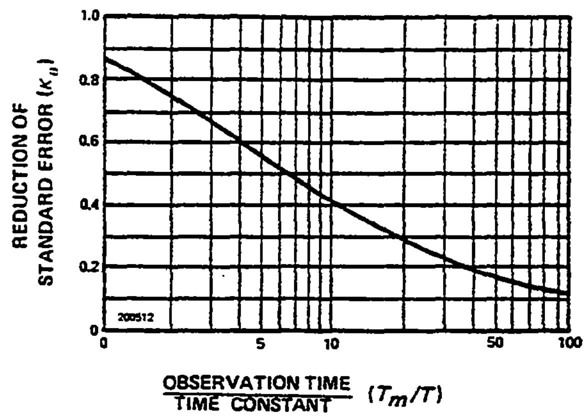

Fig. 4.5. Correction Factors for Standard Error as a Function of Observation Time.

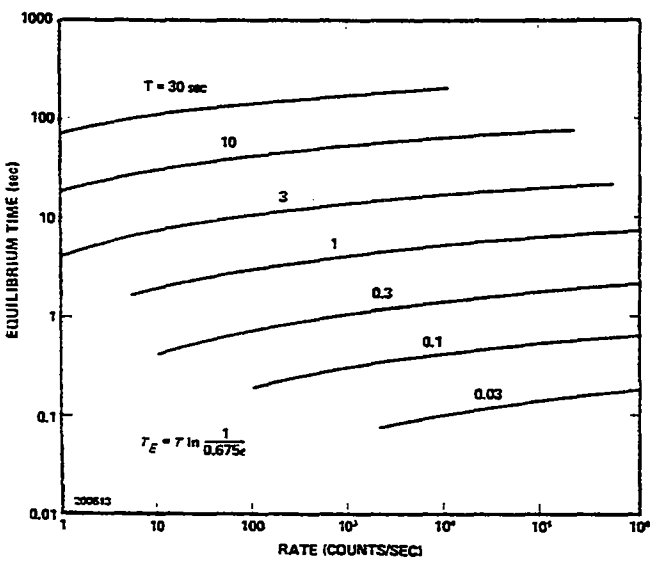

Fig. 4.6. Equilibrium Time.

4.4 ACCURACY OF LINEAR RANGES

The accuracy of readings on the front-panel meter is limited by the meter error, which is ±2% of full scale. The accuracy of the analog outputs is much better than the meter indications, as shown in the instrument specifications. This discussion and the specifications shown in Section 2 are related to the accuracy of the analog outputs.

The major cause of error is the finite charging time of the tank capacitor. For all the ranges below 10^5, the error is kept below ±0.15% of full scale. The error increases for the higher ranges: ±0.2% for 10^5, ±0.5% for 3×10^5, and ±1.5% for 10^6. This error is not random and the correction factor can be obtained from Fig. 4.7. The curves in Fig. 4.7 are exact for periodic inputs and remain essentially the same for random inputs except for the curve for the 10^6 range, where the dotted portion shows corrections for random inputs. As shown in Fig. 4.7, the correction factor M is a function of both the range being used and the percent of full scale of the indication. This illustrates that the best accuracy is obtained by selection of the range that provides an indication nearest to 80% of full scale for any input:

$$M = \frac{1-\epsilon}{\epsilon}\,, \tag{7}$$

where

$$\epsilon = \frac{ax\,(1 - 1.22x)}{1 + 1.22ax}\,,$$

$$x = \frac{n}{n_{max}}\,,$$

$$a = 0.8 n_{max}\,(T_0)\;.$$

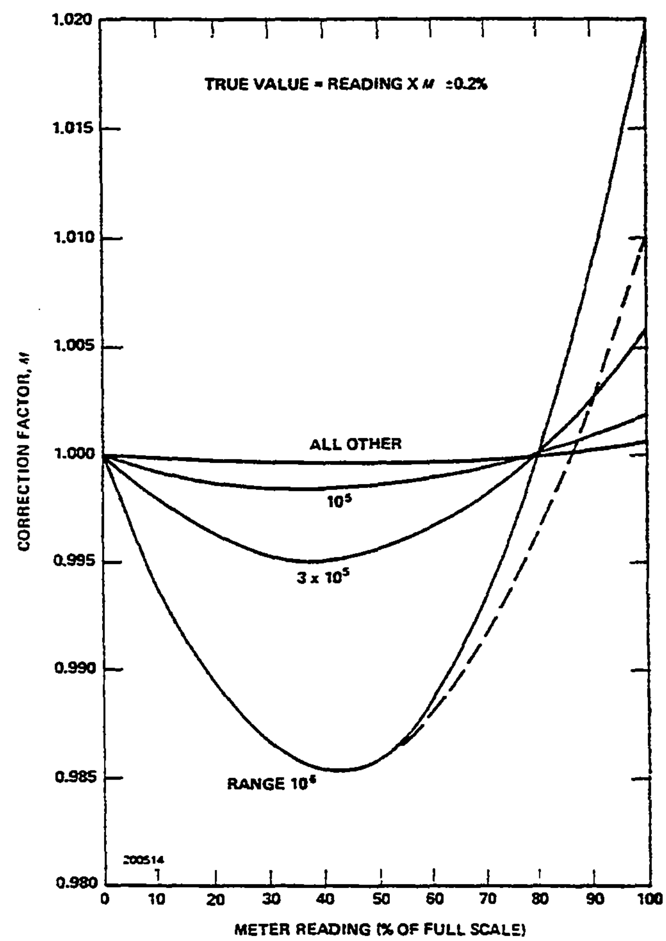

Fig. 4.7. Accuracy of Meter Readings.

The basic accuracy of any linear range can be used to extend the range to twice its normal maximum level with the aid of the Zero Suppression circuit. The principle of operation is to furnish a constant current that is subtracted from the signal current. The amount of current that is subtracted is determined by the front-panel precision 10-turn potentiometer, and the range for zero suppression is equal to the selected full-scale range. The same full-scale range is effective above the offset zero that is selected by the potentiometer adjustment. The accuracy of the potentiometer setting on its duo-dial is ±0.25%.

An example of the purpose for using Zero Suppression is an observation of a rate that varies around 150 counts/sec. This can be observed at half scale on the 300-count/sec range, and the accuracy will be based on the 300-count/sec full-scale rate. The same rate can be observed at half scale on the 100-count/sec range with Zero Suppression advanced to 100%, and the accuracy will be based on the 100-count/sec full-scale rate. Another example is the observation of a variable rate that is superimposed on a constant background, where suppression can compensate for the background.

4.5 LOGARITHMIC OPERATION

For the logarithmic range the nonlinear resistance (r) of the collector-to-base circuit of a transistor is used as the discharge circuit for the tank capacitor:

$$r = \frac{kT}{qi_r} = \frac{V_T}{i_r} \qquad V = V_T \ln \frac{i_r}{i_{co}}. \tag{8}$$

When the resistance r is included in the simplified circuit of Fig. 4.2 in place of the resistance R, the average indication and standard error can be shown to be

$$V = 2.3\, V_T \log \frac{n}{n_o}, \tag{9}$$

$$\epsilon = \frac{\text{rms}}{\text{mean value}} = \sqrt{\frac{Q_o}{2CV_T}}. \tag{10}$$

In these equations V_T is thermal voltage, which is ~30 mV at 25°C. The mean value, $\bar{V}$, is temperature-dependent, and therefore a differential transistor pair is used to lower the temperature coefficient.

From Eq. (10), the standard error is theoretically independent of the rate. The ORTEC 449 Ratemeter provides two time constants for log operation to permit a selection of ϵ. They are called Long and Short and correspond to approximately 5% and 15%. In practice, however, the observed standard error will always be smaller, especially at higher rates, because of the limited bandwidth of the amplifier and of the meter and recorder.

4.6 ACCURACY OF LOGARITHMIC RANGE

The accuracy of the log range is less than that for the linear ranges. This is primarily due to the actual difference between the response of the logarithmic circuit and a true logarithmic distribution. The typical nonlinearity and temperature coefficient are shown in Fig. 4.8.

4.7 RESPONSE TO AN INPUT RATE CHANGE

The response of the 449, operating as a log ratemeter, to an input rate step change is always monotonic. The speed of response depends on the initial and final rate ratio as shown in Fig. 4.9. For any rate change the Long time constant has a rise time that is 10 times that of the Short time constant.

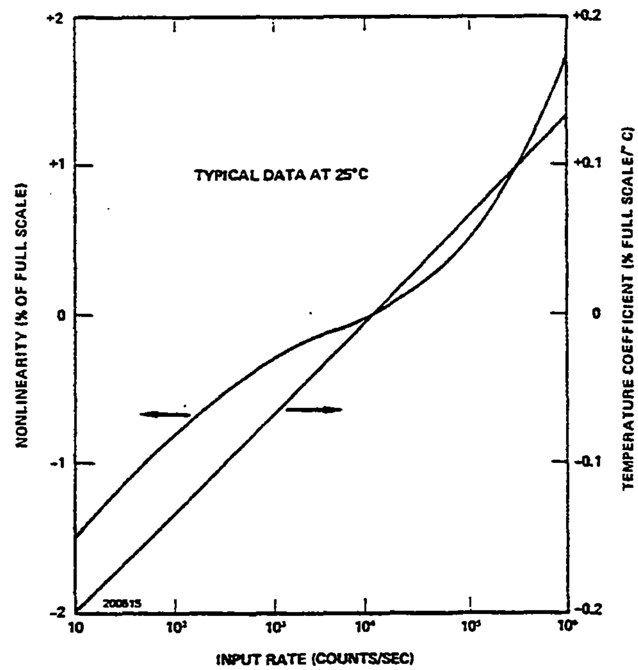

Fig. 4.8. Nonlinearity and Temperature Coefficient for Log Operation.

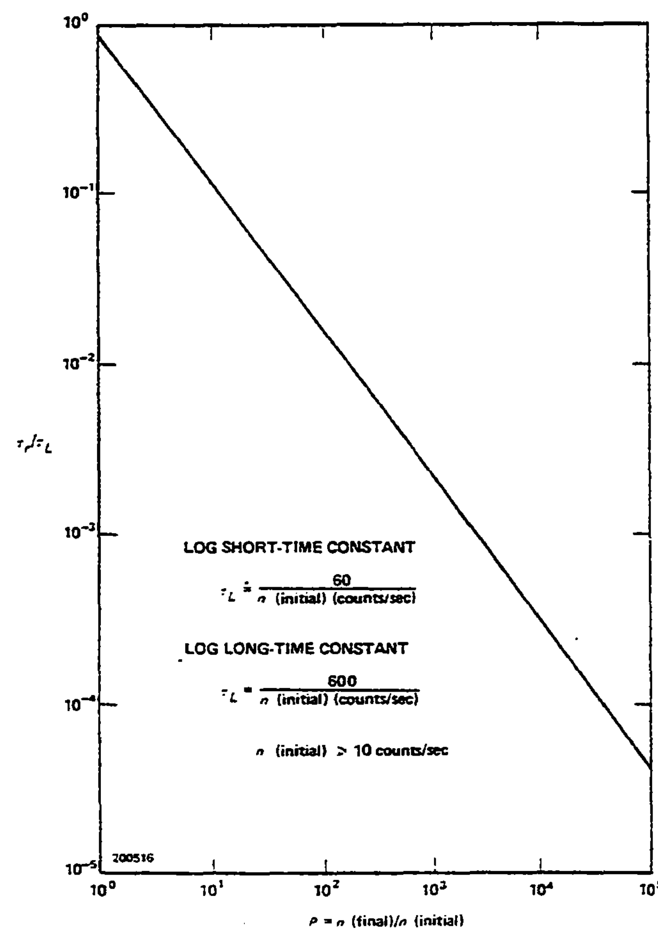

Fig. 4.9. Response Time for the Log Range.

For example, using Fig. 4.9, suppose that the input rate changes from 10^2 to 10^5 counts/sec. Then ρ is $10^5 \div 10^2 = 10^3$. From this, the curve shows that $\tau_r/\tau_L = 2.6 \times 10^{-3}$ sec or 2.6 msec. If the log time constant is Short, $\tau_L = \frac{60}{10^2} = 0.6$, so that $\tau_r = 2.6 \times 10^{-3} \times 0.6 = 1.56$ msec.

If the initial rate is <10 counts/sec, the rise time for a small rate change (to 10^2) can be extremely long. For larger changes the rise time approximately follows the curve with n (initial) $\geqslant$ 10 counts/sec.

4.8 OPTIONAL AUDIBLE OUTPUT

When the 449-2 Audible Output is included in the 449 Ratemeter, the tone produced in its speaker will reflect the relative input count rate. As the input count rate increases toward a full-scale level, the pitch of the tone will rise through an audible range to approximately 500 Hz.

Two controls are associated with the Audible Output: a volume control to adjust the intensity of the sound output, and a threshold control to eliminate all response below the adjusted level. The range of the threshold control is from 0 through full scale; so it can be set to discriminate against just the lowest count rate or it can be advanced until the significance of having any audible output is equivalent to an alarm.

To adjust the controls for the desired operation of the audible output, reduce the threshold control to minimum and provide input pulses to the 449. Adjust the volume control to produce the desired intensity when the count rate is at the minimum level for which an audible output is desired. Then advance the threshold control to the point where the sound will be cut off by any further advance of the control.

As each new range is selected, the relation between the actual audible tone, the threshold setting, and the input count rate will be changed. The tone and the threshold setting are directly related to the percent of full-scale meter deflection and analog output.

5. CIRCUIT DESCRIPTION

5.1 GENERAL

The 449 Log/Lin Ratemeter, with the optional 449-2 Audible Output, has circuits as shown in schematic 449-0101-S1. A simplified block diagram of the instrument is shown in Fig. 4.1. Each input pulse is used to trigger a discriminator, causing a controlled amount of current to be pumped into a tank capacitor. The average voltage across the tank capacitor is dependent on the rate of input pulses since it has a discharge path with a time constant that is long compared with the charging time. The voltage on the tank capacitor is then amplified into an output dc level and is furnished to the front-panel meter, to the optional 449-2 Audible Output circuit, and to the Analog Output connectors on the rear panel.

5.2 INPUT CIRCUIT

Either positive or negative input pulses can be furnished into the input circuit, Q1 or Q2. They are limited by D1, and the input is protected to ±30 V. As an input pulse increases through 3 V, either polarity, it triggers the discriminator, Q3 to Q5, and the discriminator output is furnished through emitter-follower Q29 to trigger a monostable.

5.3 MONOSTABLE AND CURRENT SWITCH

The monostable, Q6 to Q10, has a natural period that is selected by the front-panel Range switch. The output is shaped by Q11 and Q12 and is used to control current switch Q13 and Q14. A current magnitude through Q13 or Q14 is also selected by the front-panel Range switch, and the result is that a controlled quantity of charge is furnished from the current switch into a tank capacitor for each input pulse into the 449.

5.4 TANK CAPACITORS AND OUTPUT AMPLIFIER

The tank capacitors are C11 through C18 and C35. One of these is selected for each setting of the Time Constant switch to accept the charge pulses from the current switch. The remaining capacitors are connected into a precharging circuit to reduce response time whenever the Time Constant switch is changed. The rate of discharge of the selected tank capacitor for linear ranges is controlled by R51. When the Log Range is selected, the discharge circuit is through Q19 to Q21 to form the logarithmic response. The Zero Suppression circuit, R50 and R52, furnishes a subtractive current at the amplifier input for any linear range, and the range retains its span but operates with a suppressed zero.

5.5 OUTPUTS

The output amplifier, Q15 to Q18 and IC 1, furnishes an output dc level that is determined by the input pulse rate and by the range selection. The range of the dc level is from 0 to +10 V, and the voltage is applied directly to the front-panel meter, to the rear-panel Analog outputs, and to the optional 449-2 Audible Output circuit.

The front-panel meter circuit operates on a range of 0 to +10 V full scale and is deflected in proportion to the output voltage. The meter has a 240° deflection and an accuracy of 2% of full scale.

The accuracy of the Analog 10-V Output is held to ±0.5%. It is furnished through R77 to the BNC connector on the rear panel and is also connected through R74 to the 1-mA Recorder binding post. The third output circuit is through voltage divider R75 and R76 for the output to the 100-mV Recorder binding post.

5.6. OPTIONAL 449-2 AUDIBLE OUTPUT

The output of the 449, 0 to +10 V dc, is fed to three sections of IC2, a voltage-controlled oscillator (VCO), which provides an output pulse, the frequency of which is proportional to the input voltage. VCO output is fed to driver Q31, then to the audio volume control, R109, mounted on the front panel. Output transistor, Q28, provides the power amplification to drive a speaker mounted on the bottom of the chassis.

IC2-B will gate the VCO "On" for input signals above the level set by the front-panel-mounted audio threshold control, R103.

6. CALIBRATION

6.1 EQUIPMENT REQUIRED

The following test equipment, or equal, is required to perform calibration on the 449 Log/Lin Ratemeter:

Tektronix Type 184 Precision Frequency Pulse Generator
Digital Voltmeter
Oscilloscope

6.2 MEASUREMENT OF TEST POINT VOLTAGES

Test Points TP1, TP2, and TP3 provide easy checks of critical voltages in the 449 to determine that its circuits are operating normally. The voltage at TP1 must be 0.75 ±0.25 V to indicate that the input discriminator is operating properly. The voltage at TP2 must be within limits of 0 to 2 mV to indicate a proper quiescent condition in the current switch, Q13 and Q14. The voltage at TP3 indicates the proper condition of the matched FET's and must be 2 ±1 V.

6.3 OUTPUT ZERO LEVEL

With no input pulses into the 449, the output dc level at the rear-panel BNC connector should be within the limits of -30 mV to 0 V. If it is not, adjust the Zero trim potentiometer, R62, to correct.

6.4 RANGE CALIBRATION

Trim potentiometers are used to individually calibrate each range. Each potentiometer is available through the top of the module, and its associated range is identified on the printed circuit board adjacent to the potentiometer. Be sure that the protective side covers are mounted on the module before calibrating the instrument, and operate the module outside the 401A/402A Bin and Power Supply by using an ORTEC Power Extension Cable (or equivalent) to furnish operating power to the module.

Set the Zero Suppression control on the front panel at 0. For each range, adjust the corresponding trim potentiometer for a digital voltmeter reading according to Table 6.1. Be sure that the cable from the precision frequency generator to the 449 input is terminated properly.

The front-panel meter indications should agree with the frequency settings within the ±2% meter tolerance except for the Log range; the meter should read between 8×10^3 and 1.5×10^4 for the check that is made at 10,000 counts/-sec for this range. If observation of the front-panel meter indication is the ultimate use for the 449, rather than observation of an instrument that is operated with its Analog output, the above calibrations can be made for accurate meter indications rather than for the indicated output voltage levels.

Table 6.1. Range Calibration

Range	Use Time Constant	Input Pulse Period	Input Pulse Frequency (counts/sec)	Analog 10-V Output	Adjusting Potentiometer
10^6	0.3	1 μs	1 M	9.85	R47
3×10^5	0.3	5 μs	200 k	6.70	R34
10^5	0.3	10 μs	100 k	10.00	R36
3×10^4	0.3	50 μs	20 k	6.67	R37
10^4	0.3	0.1 ms	10 k	10.00	R38
3×10^3	0.3	0.5 ms	2 k	6.67	R39
10^3	0.3	1 ms	1 k	10.00	R40
3×10^2	0.3	5 ms	200	6.67	R41
10^2	(0.3)*1	10 ms	100	10.00	R42
3×10^1	(0.3)*1	50 ms	20	6.67	R43
10	(1)*3	0.1 s	10	10.00	R44
Log	Short	0.1 ms	10 k	6.00	R31

*When two time constants are shown, use the first time constant for a rough setting and follow with the second time constant for fine adjustment.

6.5. TROUBLESHOOTING

The following voltages and waveform details are intended to indicate the typical values as a means of detecting malfunctioning in the event of instrument failure. Before checking any of the circuit details, see that the 401A/402A dc output voltages are within their specified tolerances.

Set the Range switch of the 449 at 10^4. Set the Time Constant switch at 0.3. Set the Zero Suppression control at 000 dial divisions.

Location	Typical Voltage
Q2 C	- 10.8
TP 1	+ 0.7
Q4 C	0
Q8 C	+ 12.0
Q9 E	+ 1.0
Q13 B	+ 9.1
Q14 B	+ 8.0
TP 2	0
TP 3	>+1, <+3
IC 1-3	+ 11.2
IC 1-7	+ 17
Q19A B	+ 0.176
Q19A C	+ 11.17

Measure the monostable output pulse width at the collector of Q7 for each Range switch setting. Each indicated duration should be within ±5% of the pulse width shown below:

Range	Pulse Width (μs)
10	300
30	100
10^2	30
3×10^2	10
10^3	3
3×10^3	1
10^4	0.3
3×10^4	0.1
10^5	0.1
3×10^5	0.1
10^6	0.1
Log	0.1

6.6. FACTORY REPAIR

The ORTEC 449 Log/Lin Ratemeter can be returned to the ORTEC factory for service and repair at a nominal cost. Our standard procedure for repair ensures the same quality control and checkout that are used for a new instrument. Always contact Customer Services at ORTEC, (615) 482-4411, before sending in an instrument for repair to obtain shipping instructions and so that the required Return Authorization Number can be assigned to the unit. This number should be written on the address label and on the package to ensure proper handling when it reaches the factory.

BIN/MODULE CONNECTOR PIN ASSIGNMENTS FOR STANDARD NUCLEAR INSTRUMENT MODULES PER DOE/ER-0457T

Pin	Function	Pin	Function
1	+3 volts	23	Reserved
2	−3 volts	24	Reserved
3	Spare Bus	25	Reserved
4	Reserved Bus	26	Spare
5	Coaxial	27	Spare
6	Coaxial	*28	+24 volts
7	Coaxial	*29	−24 volts
8	200 volts dc	30	Spare Bus
9	Spare	31	Spare
*10	+6 volts	32	Spare
*11	−6 volts	*33	117 volts ac (Hot)
12	Reserved Bus	*34	Power Return Ground
13	Spare	35	Reset (Scaler)
14	Spare	36	Gate
15	Reserved	37	Reset (Auxiliary)
*16	+12 volts	38	Coaxial
*17	−12 volts	39	Coaxial
18	Spare Bus	40	Coaxial
19	Reserved Bus	*41	117 volts ac (Neut.)
20	Spare	*42	High Quality Ground
21	Spare	G	Ground Guide Pin
22	Reserved		

Pins marked (*) are installed and wired in EG&G ORTEC's 4001A and 4001C Modular System Bins.