ECG903,ECG908

OPERATIONAL AMPLIFIERS

ECG903 – 12-VOLT TYPE, 12-Lead TO–5 Style
ECG908 – 12-VOLT TYPE, 14-Lead Plastic Dual In-line (TO–116)

- These types feature low noise figures and improved characteristics for offset voltage, offset current, bias current and impedance.
- Both types are electrically identical.
- Designed for use in telemetry, data processing, instrumentation and communication equipment.
- Built in temperature stability from -55°C to +125°C for the TO-5 style, and from 0°C to +70°C for the plastic dual in-line package.

HIGHLIGHTS

Open-Loop Voltage Gain	70	dB typ.
Common-Mode Rejection Ratio	103	dB typ.
Input Impedance	10	kΩtyp.
Input Offset Voltage	1	mV typ.
Input Offset Current	0.5	..A typ.
Input Bias Current	4.7	..A typ.
Static Power Drain at - 12V	175	mW typ.
- 6V	30	mW typ.
- 3V	7	mW typ.

APPLICATIONS

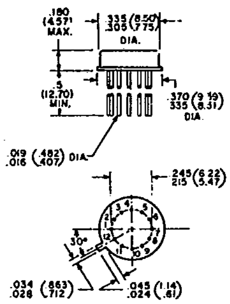
- Narrow-Band and Band-pass Amplifier
- Operational Functions
- Feedback Amplifier
- DC and Video Amplifier
- Multivibrator
- Oscillator
- Comparator
- Servo Driver
- Scaling Adder
- Balanced Modulator-Driver

DIMENSIONAL OUTLINES

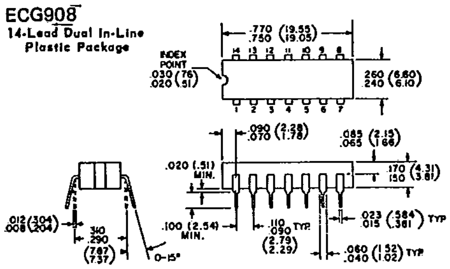
Dimensions in Inches and Millimeters

Dimensions in parentheses are in millimeters and are derived from the basic inch dimensions as indicated.

ECG903 TO-5 Style 12-Lead Package

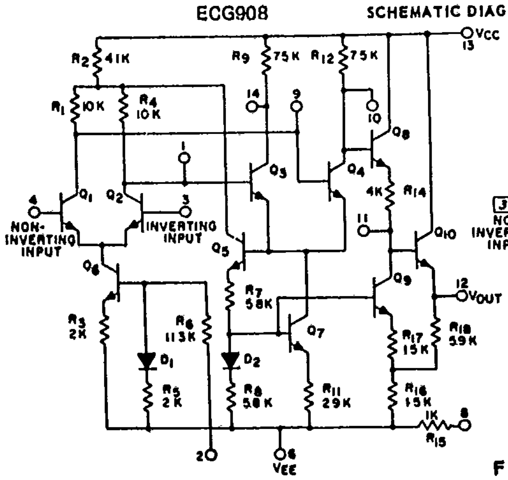


ECG908 14-Lead Dual In-Line Plastic Package



SCHEMATIC DIAGRAMS

ECG908



ECG903

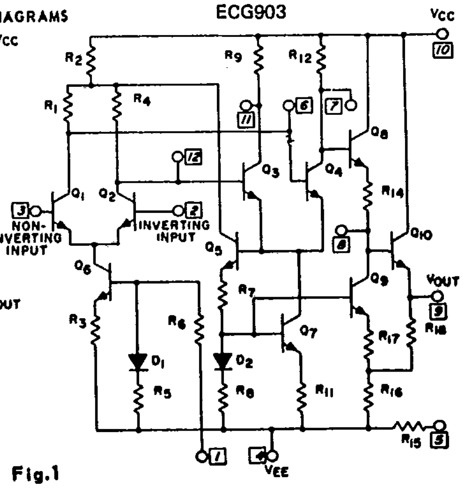


Fig.1

ABSOLUTE-MAXIMUM VOLTAGE AND CURRENT LIMITS, $T_A = 25°C$

Voltage or current limits shown for each terminal can be applied under the indicated voltage or other circuit conditions for other terminals

All voltages are with respect to ground (common terminal of Positive and Negative DC Supplies)

Terminal ECG903	Terminal ECG908	Voltage or Current Limits Negative	Voltage or Current Limits Positive	Circuit Conditions Terminal ECG903	Circuit Conditions Terminal ECG908	Circuit Conditions Voltage
12	1	DO NOT APPLY VOLTAGE FROM AN EXTERNAL SOURCE TO THIS TERMINAL				
1	2	-16 V	0 V	4 10	6 13	-16 +12
2	3	-8 V	+1 V	1 3 4 10	2 4 6 13	0 0 -12 +12
3	4	-8 V	+1 V	1 2 4 10	2 3 6 13	0 0 -12 +12
-	5	NO CONNECTION				
4	6	-20 V	0 V	1 10	2 13	0 +12
-	7	NO CONNECTION				
5	8	DO NOT APPLY VOLTAGE FROM AN EXTERNAL SOURCE TO THIS TERMINAL				
6	9	DO NOT APPLY VOLTAGE FROM AN EXTERNAL SOURCE TO THIS TERMINAL				
7	10	0 V	+14 V	1 4 10	2 6 13	0 -12 +12
8	11	DO NOT APPLY VOLTAGE FROM AN EXTERNAL SOURCE TO THIS TERMINAL				
9	12	30 mA		4 10 400 Ω Between Terminals 6 & 12 ECG908 4 & 9 ECG903)	6 13	-12 +12
10	13	0 V	+20 V	1 4	2 6	0 -12
11	14	0 V	+14 V	1 4 10	2 6 13	0 -12 +12
CASE		Internally connected to Terminal No.6, ECG908 No.4, ECG903(Substrate) DO NOT GROUND				

ELECTRICAL CHARACTERISTICS at $T_A = 25°C$

Characteristics	Symbols	Special Test Conditions Terminal No.8 ECG908, Terminal No.5 ECG903 Not Connected Unless Otherwise Specified	ECG903 ECG908 Min.	Typ.	Max.	Units	Typical Characteristic Curves Fig.
STATIC CHARACTERISTICS:							
Input Offset Voltage	V_{IO}	VCC = +6V, VEE = -6V = +12V, = -12V	- -	- 1	- 2	mV	2
Input Offset Current	I_{IO}	= +6V, = -6V = +12V, = -12V	- -	- 0.5	- 1.6	μA	2
Input Bias Current	I_I	= +6V, = -6V = +12V, = -12V	- -	- 4.7	- 6	μA	3
Input Offset Voltage Sensitivity: Positive	$\Delta V_{IO}/\Delta V_{CC}$	= +6V, = -6V = +12V, = -12V	- -	- 0.096	- 0.5	mV/V	none
Negative	$\Delta V_{IO}/\Delta V_{EE}$	= +6V, = -6V = +12V, = -12V	- -	- 0.156	- 0.5	mV/V	none
Device Dissipation	P_T	= +6V, = -6V = +12V, = -12V	- -	- 175	- -	mW	none
		5 shorted to 9: VCC = +6V, VEE = -6V 8 shorted to 12: VCC = +12V, VEE = -12V	- -	- 500	- -	mW	none

Characteristics	Symbols	Special Test Conditions Terminal No.8 ECG908, Terminal No.5 ECG903 Not Connected Unless Otherwise Specified	ECG903 ECG908 Min.	Typ.	Max.	Units	Typical Characteristic Curves Fig.
DYNAMIC CHARACTERISTICS: All tests at f = 1 kHz except BW_{OL}							
Open-Loop Differential Voltage Gain	A_{OL}	VCC = +6V, VEE = -6V = +12V, = -12V	- 66	- 70	- -	dB	6 & 7
Open-Loop Bandwidth at -3 dB Point	BW_{OL}	= +6V, = -6V = +12V, = -12V	- 200	- 320	- -	kHz	6 & 7
Slew Rate	SR	VCC = +6V, VEE = -6V = +12V, = -12V; Rs = 1 kΩ	- -	- 7	- -	V/μs	none
Common-Mode Rejection Ratio	CMR	VCC = +6V, VEE = -6V = +12V, = -12V	- 80	- 103	- -	dB	12
Maximum Output-Voltage Swing	$V_{O(P-P)}$	= +6V, = -6V = +12V, = -12V	- -	- 14	- -	V_{P-P}	9 & 10
Input Impedance	Z_{IN}	= +6V, = -6V = +12V, = -12V	- 7.5	- 10	- -	kΩ	13
Output Impedance	Z_{OUT}	= +6V, = -6V = +12V, = -12V	- -	- 85	- -	Ω	16
Common-Mode Input-Voltage Range	V_{CMR}	= +6V, = -6V = +12V, = -12V	- -	- -0.65 -8	- -	V	none
Noise Figure	NF	VCC = +3V, VEE = -3V = +6V, = -6V = +9V, = -9V = +12V, = -12V; Rs = 1 kΩ	- - - -	6.3 8.3 10 11	9 12 14 16	dB	17

	ECG903	ECG908
OPERATING TEMPERATURE RANGE	-55°C to +125°C	0°C to +70°C
STORAGE TEMPERATURE RANGE	-65°C to +200°C	-25°C to +85°C

	ECG903	ECG908
MAXIMUM SIGNAL VOLTAGE	-8 V to +1 V	-4 V to +1 V
MAXIMUM DEVICE DISSIPATION	600 mW	300 mW

TYPICAL STATIC CHARACTERISTICS AND TEST CIRCUITS

Terminal Numbers in Circles are for ECG908
Italic Numbers in Square Boxes are for ECG903

INPUT OFFSET VOLTAGE AND CURRENT

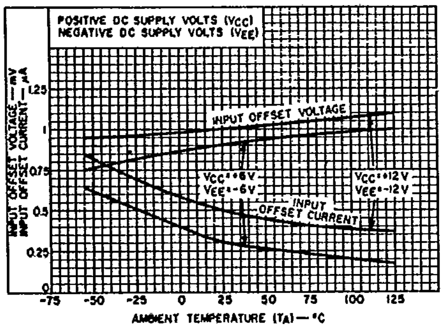


Fig.2

INPUT BIAS CURRENT

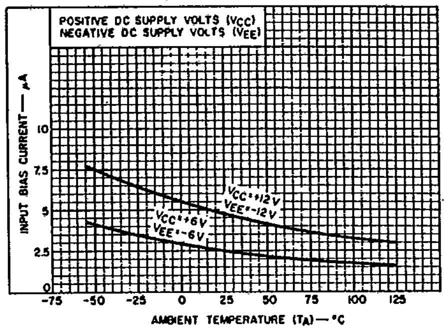


Fig.3

INPUT OFFSET VOLTAGE, INPUT OFFSET VOLTAGE SENSITIVITY, AND DEVICE DISSIPATION TEST CIRCUIT

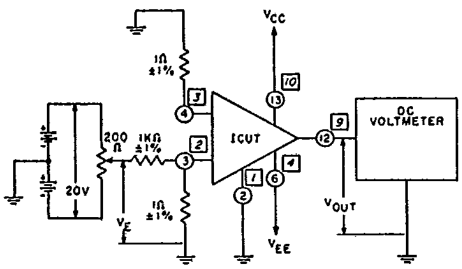


Fig.4

Procedure:

Input Offset Voltage

1. Adjust V_E for a DC Output Voltage (V_{OUT}) of 0 ± 0.1 volts.
2. Measure V_E and record Input Offset Voltage in millivolts as $V_E/1000$.

Input Offset Voltage Sensitivity

1. Adjust V_E for a DC Output Voltage (V_{OUT}) of 0 ± 0.1 volts.
2. Increase $|V_{CC}|$ by 1 volt and record output voltage (V_{OUT}).
3. Decrease $|V_{CC}|$ by 1 volt and record output voltage (V_{OUT}).
4. Divide the difference between V_{OUT} measured in steps 2 and 3 by the change in V_{CC} in steps 2 and 3.

$$\frac{V_{OUT}}{V_{CC}} = \frac{V_{OUT}\,(\text{Step 2}) - V_{OUT}\,(\text{Step 3})}{2\ \text{volts}}$$

5. Refer the reading to the input by dividing by Open Loop Voltage Gain (A_{OL}).

$$V_{IO}/V_{CC} = \frac{V_{OUT}/V_{CC}}{A_{OL}}$$

6. Repeat procedures 1 through 5 for the Negative Supply (V_{EE}).
7. Device Dissipation
   $P_T = V_{CC}I_C + V_{EE}I_E$
   I_C = Direct Current into Terminal 13 or 10
   I_E = Direct Current out of Terminal 6 or 4

INPUT OFFSET CURRENT AND INPUT BIAS CURRENT TEST CIRCUIT

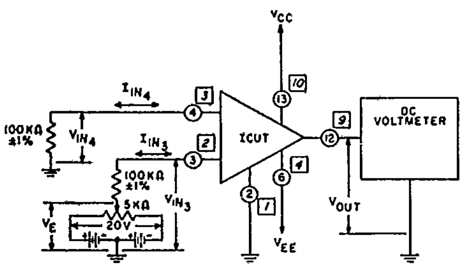


Fig.5

Procedure:

Input Bias Current and Input Offset Current

1. Adjust V_E for $|V_{OUT}| < 0.1$ V DC.
2. Measure and record V_E and V_{IN4}
3. Calculate the Input Bias Current using the following equation:

$$I_{I4} = \frac{V_{IN4}}{100\ k\Omega}$$

4. Calculate the Input Offset Current using the following equation:

$$I_{IO} = V_E/100\ k\Omega$$

TYPICAL DYNAMIC CHARACTERISTICS AND TEST CIRCUITS

Terminal Numbers in Circles are for ECG908
Italic Numbers in Square Boxes are for ECG903

OPEN LOOP VOLTAGE GAIN vs. FREQUENCY FOR ECG903

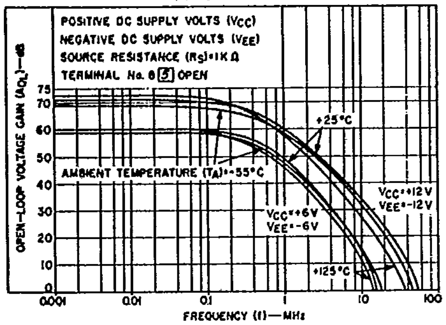


Fig.6

OPEN LOOP VOLTAGE GAIN vs. FREQUENCY FOR ECG908

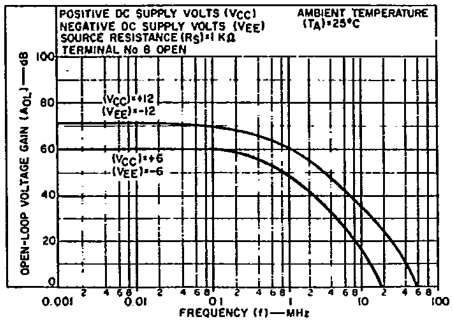
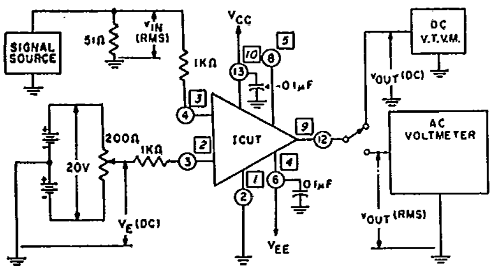


Fig.7

OPEN-LOOP DIFFERENTIAL VOLTAGE GAIN, MAXIMUM PEAK-TO-PEAK OUTPUT VOLTAGE, AND OPEN-LOOP BANDWIDTH AT -3 POINT TEST CIRCUIT



Procedure:
1. Adjust V_E for V_{OUT} = ±0.1 V DC.
2. Measure Open-Loop Differential Voltage Gain (A_{OL}) at f = 1 kHz

$$A_{OL} = 20 \, \text{Log}_{10} \frac{V_{OUT}}{V_{IN}}$$

3. Measure Maximum Peak-to-Peak Output Voltage at f = 1 kHz
4. Measure Open-Loop Bandwidth at -3 dB Point
Reference Level = A_{OL} at 1 kHz

Fig.8

MAXIMUM PEAK-TO-PEAK OUTPUT VOLTAGE vs. LOAD RESISTANCE FOR ECG903

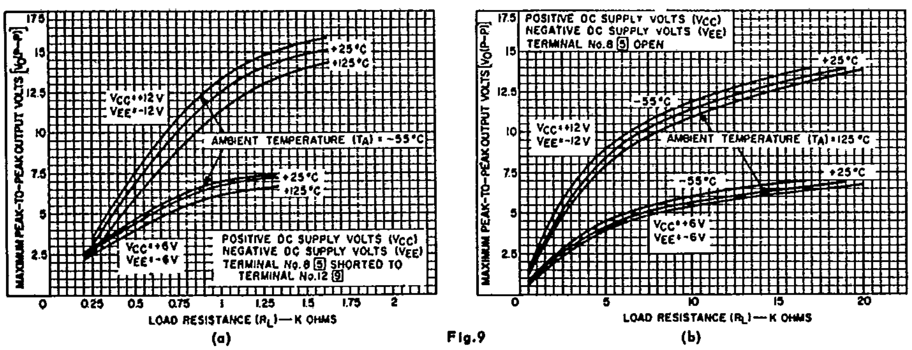


Fig.9

TYPICAL DYNAMIC CHARACTERISTICS AND TEST CIRCUITS

MAXIMUM PEAK-TO-PEAK OUTPUT VOLTAGE vs. LOAD RESISTANCE FOR ECG908

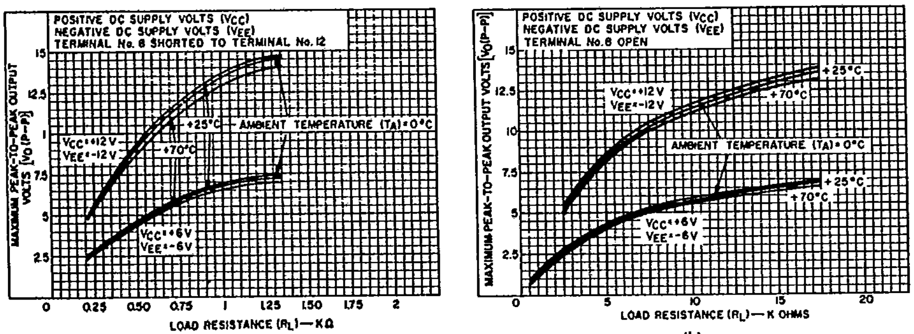
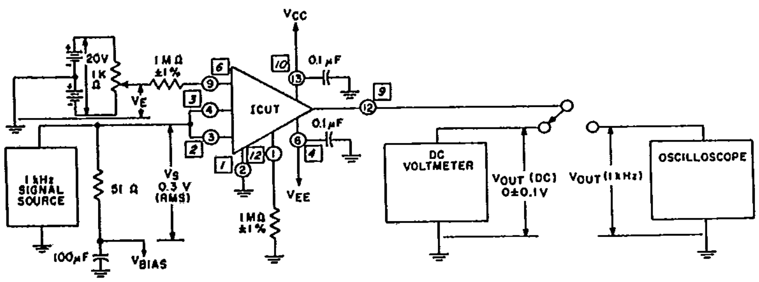


Fig.10

COMMON-MODE REJECTION RATIO AND COMMON-MODE INPUT-VOLTAGE-RANGE TEST CIRCUIT



Procedures:

Common-Mode Rejection Ratio:

1. Set $V_{BIAS} = 0$. Adjust V_E for $V_{OUT}(DC) = 0 \pm 0.1$ V.
2. Apply 1-kHz sinusoidal input signal and adjust for $V_S = 0.3$ V (RMS).
3. Measure and record the RMS value of V_{OUT}. An oscilloscope is used for this measurement so that the output signal may be visually separated from noise output.
4. Calculate Common-Mode Voltage Gain:
   $A_{CM} = V_{OUT}/V_S$
   A_{CM} in dB $= -20 \log_{10} V_S/V_{OUT}$
5. Calculate Common-Mode Rejection Ratio:
   CMR in dB = A_{DIFF} in dB - A_{CM} in dB.

Common-Mode Input-Voltage Range:

1. Calculate and record CMR for various positive and negative values of V_{BIAS} within the maximum limits shown on Page 2. The Common-Mode Input-Voltage Range limits are those values of V_{BIAS} at which CMR is 6 dB less than that calculated in Step 5 of the procedure given above.

Fig.11

COMMON-MODE REJECTION RATIO vs. FREQUENCY

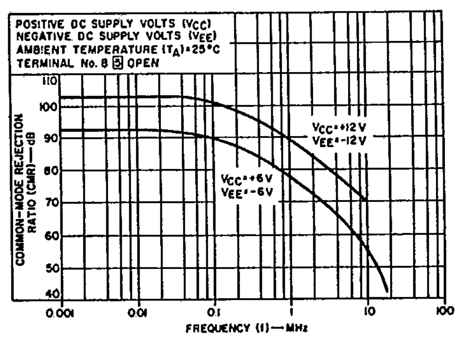


Fig.12

TYPICAL DYNAMIC CHARACTERISTICS AND TEST CIRCUITS

SINGLE-ENDED INPUT IMPEDANCE vs. TEMPERATURE

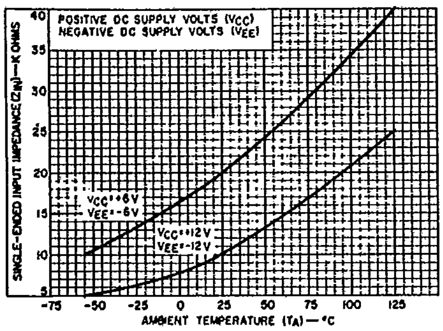


Fig.13

SINGLE-ENDED INPUT IMPEDANCE TEST CIRCUIT

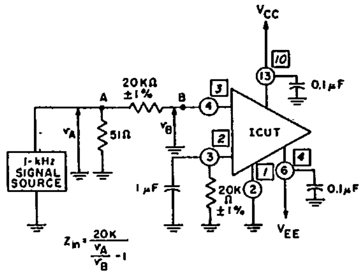


Fig.14

OUTPUT IMPEDANCE TEST CIRCUIT

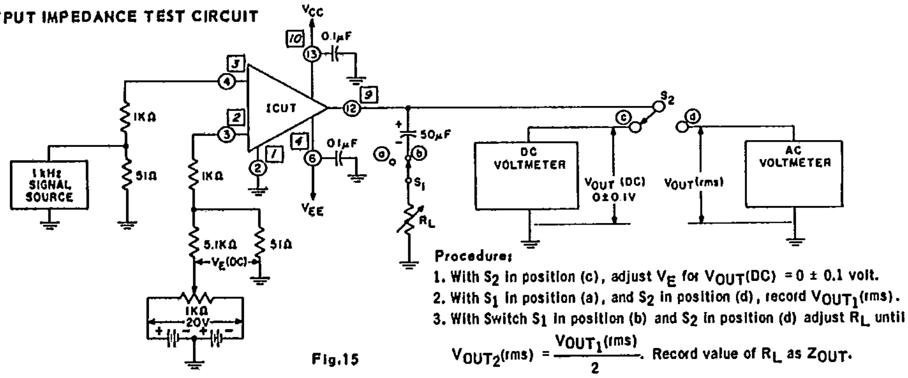
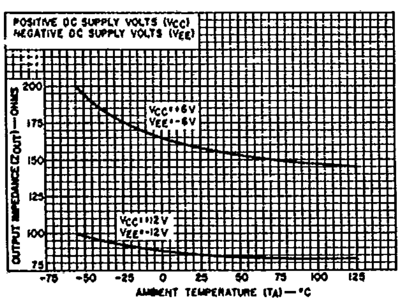


Fig.15

Procedure:

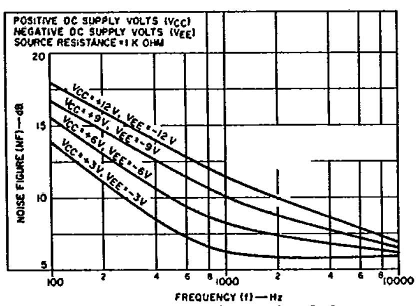
1. With S_2 in position (c), adjust V_E for $V_{OUT}(DC) = 0 \pm 0.1$ volt.
2. With S_1 in position (a), and S_2 in position (d), record V_{OUT_1}(rms).
3. With Switch S_1 in position (b) and S_2 in position (d) adjust R_L until

$$V_{OUT_2}(rms) = \frac{V_{OUT_1}(rms)}{2}.$$ Record value of R_L as Z_{OUT}.



OUTPUT IMPEDANCE vs. TEMPERATURE

Fig.16



NOISE FIGURE vs. FREQUENCY

Fig.17

NOISE FIGURE TEST CIRCUIT

Fig.18