



MANUAL PART NO.
13-804615-55

**GOULD UNIVERSAL
AMPLIFIER MODELS
13 4615 55 and 13 4615 56**

TABLE OF CONTENTS

SECTION	DESCRIPTION	PAGE
I	GENERAL INFORMATION	
	1.1 SPECIFICATIONS	1.2
	1.2 ACCESSORIES	1.3
II	INSTALLATION	
	2.1 INITIAL INSPECTION	2.1
	2.2 PHYSICAL INSTALLATION	2.1
	2.3 SIGNAL CONNECTIONS	2.1
	2.4 OUTPUT AND POWER	2.2
	2.5 PATIENT COMMON	2.2
	2.6 DIMENSIONS	2.2
III	OPERATION	
	3.1 INTRODUCTION	3.1
	3.2 CONTROLS AND INDICATOR	3.1
	3.3 OPERATION	3.3
	3.3.1 Preliminary	3.3
	3.3.2 Off-Center Zero Operation	3.3
	3.3.3 DC Operation	3.3
	3.3.4 AC Operation	3.3
	3.3.5 Output Amplitude	3.3
	3.3.6 FM Tape Output	3.4
	3.3.7 Calibration Button	3.4
	3.4 TYPICAL APPLICATIONS	3.4
	3.4.1 General	3.4
	3.4.2 Phonocardiogram	3.5
	3.5 GROUND ISOLATION AMPLIFIER	3.5
IV	MAINTENANCE	
	4.1 GENERAL	4.1
	4.2 MAINTENANCE	4.1
	4.3 TROUBLESHOOTING	4.1
	4.4 STAR DIAGRAM	4.1
	4.5 CALIBRATION	4.4
V	THEORY OF OPERATION	
	5.1 CIRCUIT DESCRIPTION	5.1
	5.2 SURGE ARRESTORS	5.1
	5.3 INPUT AMPLIFIER AND DIVIDER	5.1
	5.4 SUPPRESSION VOLTAGE	5.1
	5.5 HIGH PASS FILTER – FIRST SECTION	5.1
	5.6 BUFFER AMPLIFIER U201	5.4
	5.7 LOW PASS FILTER – FIRST SECTION	5.4
	5.8 GAIN AMPLIFIER U202	5.4
	5.9 BUFFER AMPLIFIER U203	5.4
	5.10 HIGH PASS FILTER – SECOND SECTION	5.4
	5.11 GAIN AMPLIFIER U204	5.4
	5.12 LOW PASS FILTER – SECOND SECTION	5.4

SECTION	DESCRIPTION	PAGE
V	THEORY OF OPERATION (Continued)	
	5.13 OUTPUT AMPLIFIER	5.4
	5.14 TAPE AMPLIFIER	5.4
	5.15 RIGHT LEG DRIVER U304	5.4
	5.16 INTERNAL CALIBRATION SIGNAL	5.4
	5.17 SENSOR AMPLIFIER	5.5
VI	PARTS IDENTIFICATION	6.1

LIST OF ILLUSTRATIONS

FIGURE	TITLE	PAGE
1-1	GOULD UNIVERSAL AMPLIFIER	1.1
2-1	ECG CONNECTIONS	2.1
2-2	PULSE CONNECTIONS	2.2
2-3	OUTLINE DIMENSIONS	2.3
3-1	FRONT PANEL CONTROLS	3.1
3-2	INTERNAL CONTROLS	3.2
3-3	GROUND ISOLATION AMPLIFIER	3.6
4-1	STAR DIAGRAM (1 of 2)	4.2
4-2	STAR DIAGRAM (2 of 2)	4.3
4-3	CALIBRATION CONTROLS	4.4
5-1	BLOCK DIAGRAM	5.2
5-2	INPUT AMPLIFIER	5.3
6-1	UNIVERSAL AMPLIFIER	6.4
6-2	AMPLIFIER BOARD ASSEMBLY	6.9
6-3	INPUT BOARD ASSEMBLY	6.11

LIST OF TABLES

TABLE	TITLE	PAGE
2-1	INPUT CONNECTIONS	2.1
2-2	OUTPUT SIGNALS	2.2

SECTION I

GENERAL INFORMATION

The Gould Universal Amplifier, Model 13-4615-55 or 13-4615-56 (with patient isolation) is a versatile medical research and clinical quality instrument. It is designed for electrocardiography, electroencephalography, phonocardiography and many other procedures. The amplifier features a wide range of ac/dc sensitivities, high input impedance and a full complement of accessible and understandable controls.

The Universal Amplifier is designed for operation with Gould 2000 Series Direct Writing Recorders, Gould Monitor System or in a portable or rack-mounted case for use with other types of readout instruments. In a recorder, it receives operating power directly from a companion pen drive amplifier located in the same analog complexity, eliminates power supply noise pickup, and improves reliability.

A ten-position full-scale switch selects nine stepped ac or dc sensitivities. In addition, a vernier control provides stepless adjustment between 1 and 2.5 times the setting on the fixed sensitivity control. The front-panel millivolt/volt switch can increase range by 1000X. OFF position on the full-scale switch disconnects the input signal; it does not de-energize the module.

A momentary calibration signal of 1 millivolt or 1 volt (internally selectable to 50 microvolts or 50 millivolts) is available with the front-panel push-button for ease of voltage calibration.

Zero suppression is provided with eight voltage ranges, each of which has a resolution of one part per thousand. Thus, the static portion of any complex signal can be suppressed a known amount and the dynamic portion amplified for more detailed evaluation. The attenuator position can be altered without readjusting the zero suppression control.

Optional 10-microampere current limiting isolators provide patient microshock protection. These are factory installed in Model 13-4615-56. A Light Emitting Diode on the front panel glows green

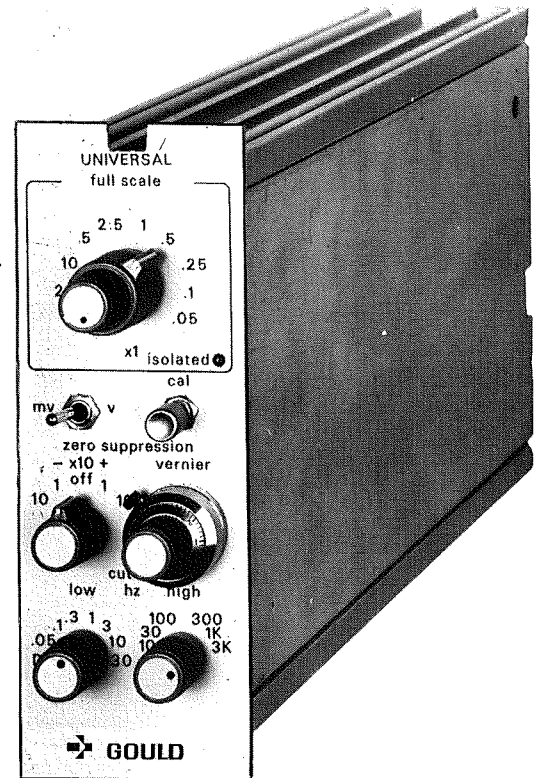


FIGURE 1-1 GOULD UNIVERSAL AMPLIFIER

when the isolators are used. Defibrillator protection is provided in the amplifier and protects the unit from voltages up to 2.5 kilovolts for 20 milliseconds.

The Universal Amplifier will condition signals from finger, ear, and radial pulse transducers, and from carotid pulse and heart sound microphones.

An 8-position Low Pass Filter Switch selects from dc through 30Hz. The 6-position High Pass Filter Switch selects from 10Hz to 3kHz. Common mode rejection is greater than 80dB at 60Hz with 5-kilo-ohm unbalance. Filter roll-off is -12dB per octave $\pm 15\%$ of indicated frequency.

1.1 SPECIFICATIONS

Measurement Range	
AC	50 microvolts full scale to 25 volts full scale
DC	500 microvolts full scale to 25 volts full scale
Attenuator Steps	
AC	0.05, 0.1, 0.25, 0.5, 1, 2.5, 5, 10 and 25 millivolts full scale plus X1000 multiplier (volts)
DC	0.5, 1, 2.5, 5, 10 and 25 millivolts full scale plus X1000 multiplier (volts)
Attenuator Inaccuracy	$\pm 0.5\%$ of calibrated step
Attenuator Non-linearity	$\pm 0.1\%$ of full scale
Input Circuit Configuration (ac and dc)	Differential and balanced to common
Input Impedance	
Millivolt Ranges	100 megohms each input to common
Volt Ranges	2.5 megohms each input to common
Pulse Input	
Circuit Configuration	Single ended, floating
Impedance	Greater than 10 megohms
Common Mode Rejection	Greater than 80dB (-55) and 75dB (-56) at 60Hz with 5-kohm unbalance on mv F.S. ranges. Greater than 40dB on volts F.S. ranges.
Overload Recovery Time	
DC	Less than 10 milliseconds
AC	Compatible with time constant
Maximum Safe Voltage	
Continuous	400 volts peak either input to common 500 volts peak common to chassis
Defibrillator	2.5 kilovolts for 20 milliseconds
Zero Line Instability (After 30 minute warm-up)	
AC (at 50uV full scale sensitivity)	$\pm 0.1\%$ of full scale per 24 hours $\pm 0.1\%$ of full scale for 10% line change $+0.2\%$ of full scale per $^{\circ}\text{C}$
DC (at 500uV full scale sensitivity)	$\pm 2\%$ of full scale per 8 hours $\pm 1\%$ of full scale for 10% line change $\pm 1\%$ of full scale per $^{\circ}\text{C}$ referred to input
Gain Instability (After 30 minute warm-up)	
AC (at 50uV full scale sensitivity)	$\pm 0.03\%$ of full scale per 24 hours $\pm 0.03\%$ of full scale for 10% line change $\pm 0.03\%$ per $^{\circ}\text{C}$
DC (at 500uV full scale sensitivity)	$\pm 0.03\%$ of full scale per 24 hours $\pm 0.03\%$ of full scale for 10% line change $\pm 0.03\%$ per $^{\circ}\text{C}$
Amplifier Output	
Recorder Output Voltage	± 5.0 volts into 2 kilohms to greater
Circuit	Single ended to common
Non-linearity	$\pm 0.1\%$ of full scale
Impedance	Less than 5 ohms
Monitor Output	± 5.0 volts into 2 kilohms or greater
Tape Output	Adjustable from 0 to ± 5.0 volts into 2 kilohms or greater
Frequency Response	
Low Cutoff	0.05, 0.1, 0.3, 1, 3, 10, 30Hz (-3dB)
High Cutoff	10, 30, 100, 300, 1000, 3000Hz (-3dB)
Filter Rolloff	12dB/octave, $\pm 15\%$ of indicated frequency

Noise (From 50-kilohm source)	
0.05 – 10Hz	Less than 2uV peak-to-peak referred to input
0.05 – 3kHz	Less than 50uV peak-to-peak referred to input
Zero Suppression	
Millivolt Ranges	±10 millivolts, ±100 millivolts calibrated
Volt Ranges	±2.5 volts, ±25 volts uncalibrated
Resolution	±0.1% of suppression range
Non-linearity	±0.03%
Inaccuracy	±0.5%
Stability (After 30 minute warm-up)	
With Time	±0.05% per 24 hours
With Temperature	±0.05% per °C
With Line	±0.02% for 10% line change
Noise	±0.05% of suppression range
Operating Temperature	0° C to +50° C (+32° F to + 122° F)
Storage Temperature	-40° C to +70° C (-40° F to + 158° F)
Humidity	80% from 0° to +30° C (+32 to +86° F) non-condensing
Vibration and Shock	Best commercial practice
Power Input	
DC Voltage	±15V ±4% at 100 milliamperes
Line and Load Regulation	±0.5%
Ripple	5 millivolts rms maximum
Weight (Amplifier only)	3.6 pounds (1.5kg)
Dimensions (Amplifier only)	6.1 in. H x 2.2 in W x 12.6 in. D (15.5cm H x 5.6 cm W x 32 cm D) Depth dimension includes attenuator knob and chassis mounted connector
Mounting	Retained from rear
Signal Input Connector	Multi-pin mating connector supplied with each Amplifier (Model 11-5407-50)
Leakage (13-4615-56 only)	
With 220Vac applied to any input combination	less than 10ua rms

1.2 ACCESSORIES

Three-Lead ECG Cable Kit	684791-1
Heart Sound Microphone	689836-1
Finger Pulse Transducer	688333-3
Ear Pulse Transducer	687196-2
Radial Pulse Transducer	687198-2
Carotid Pulse Transducer	689837-1

SECTION II INSTALLATION

2.1 INITIAL INSPECTION

Prior to any electrical connections or operation of this equipment, visually examine the unit for broken or loose knobs, dented or nicked panels and damaged connectors.

2.2 PHYSICAL INSTALLATION

This unit may be mounted in a Gould 2000 Series Recorder frame, in a Gould Preamplifier Frame or a portable carrying case or a Gould Monitoring System.

a. Insertion

To install the preamplifier into its appropriate slot:

1. Slide the preamplifier into the enclosure until the rear output card edge connector is engaged.
2. Tighten the rear retaining screw. This locks the preamplifier into the enclosure.
3. Connect the input signal connector and secure it by grasping rear of connector and pushing it onto the female connector. A snap will be heard as the connector locks on and an orange colored ring will be visible.

b. Removal

1. Disconnect the input connector by pulling on the locking ring.
2. Loosen the rear retaining screw. The preamplifier will move forward about 1/8 of an inch.
3. Carefully slide the entire preamplifier out of the enclosure.

2.3 SIGNAL CONNECTIONS

All input connections may be made to connector P-101 (Model 11-5407-50) per Table 2-1. Figure 2-1 shows input connections for ECG applications and Figure 2-2 shows input connections for pulse applications.

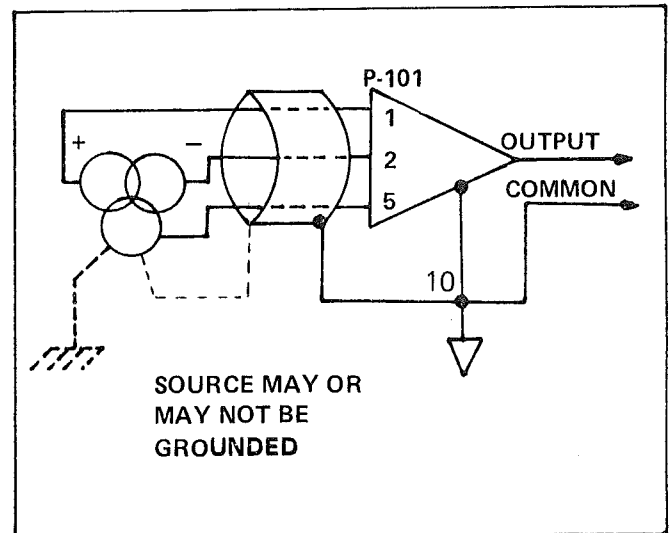


FIGURE 2-1 ECG CONNECTIONS

NOTE: Do not terminate cable shield at signal source when recording from Bioelectric signal sources.

**TABLE 2-1
INPUT CONNECTIONS**

J-101 PIN #	INPUT LEAD
1	Left Arm (+)
2	Right Arm (-)
3	Not Connected
4	Not Connected
5	Right Legsignal common
6	-15vdc
7	+15 Vdc
8	Pulse Input
9	Pulse Excitation
10	Pulse & ECG cable shield
11	Not Connected
12	Not Connected

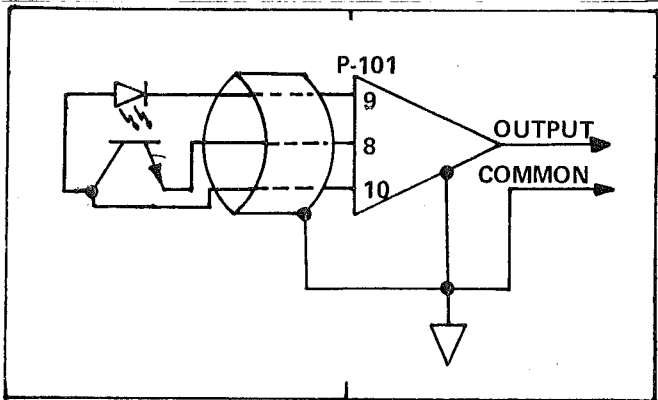


FIGURE 2-2 PULSE CONNECTIONS

2.4 OUTPUT AND POWER

This amplifier is designed to operate on regulated + and -15Vdc @ 200ma power supplies. Output and power connections are made through a 16 pin card edge connector at the rear of the unit. The

mating connector is located in the rear of the preamplifier slot of the recorder, carrying case or frame. The amplifier provides a 5 volt full scale output signal. Refer to Table 2-2 for Output signal listing.

2.5 PATIENT COMMON

Whether or not the right leg connection is isolated depends upon which type amplifier is used. With Model 13-4615-55, the RL is an isolated "driven ground". The right leg driver is capable of sinking up to 2 microamps and force the patient to virtual ground, thus eliminating unwanted noise.

With Model 13-4615-56, the patient is isolated by 10 microampere current limiters.

2.6 DIMENSIONS

Refer to Figure 2-3 for outline dimensions.

TABLE 2-2
OUTPUT SIGNALS

SIGNAL NAME	TERMINAL NUMBER *		TYPICAL USE	CONFIGURATION
	ON PREAMP FRAME & CARRYING CASE	ON PREAMP CAGE 11-1202-15		
Recorder Output	9	1	Recorder input	±5v maximum into 2Kohm or greater
Monitor Output	11	5	Scope Input	±5v maximum into 2Kohm or greater
Tape Output	4	11	FM Tape Recorder	Level adjustable from 0 to ±5.0V into 2Kohm or greater.
Common	8	3	Signal LOW low all output signals	

*Terminals located on rear of preamplifier cage or carrying case.

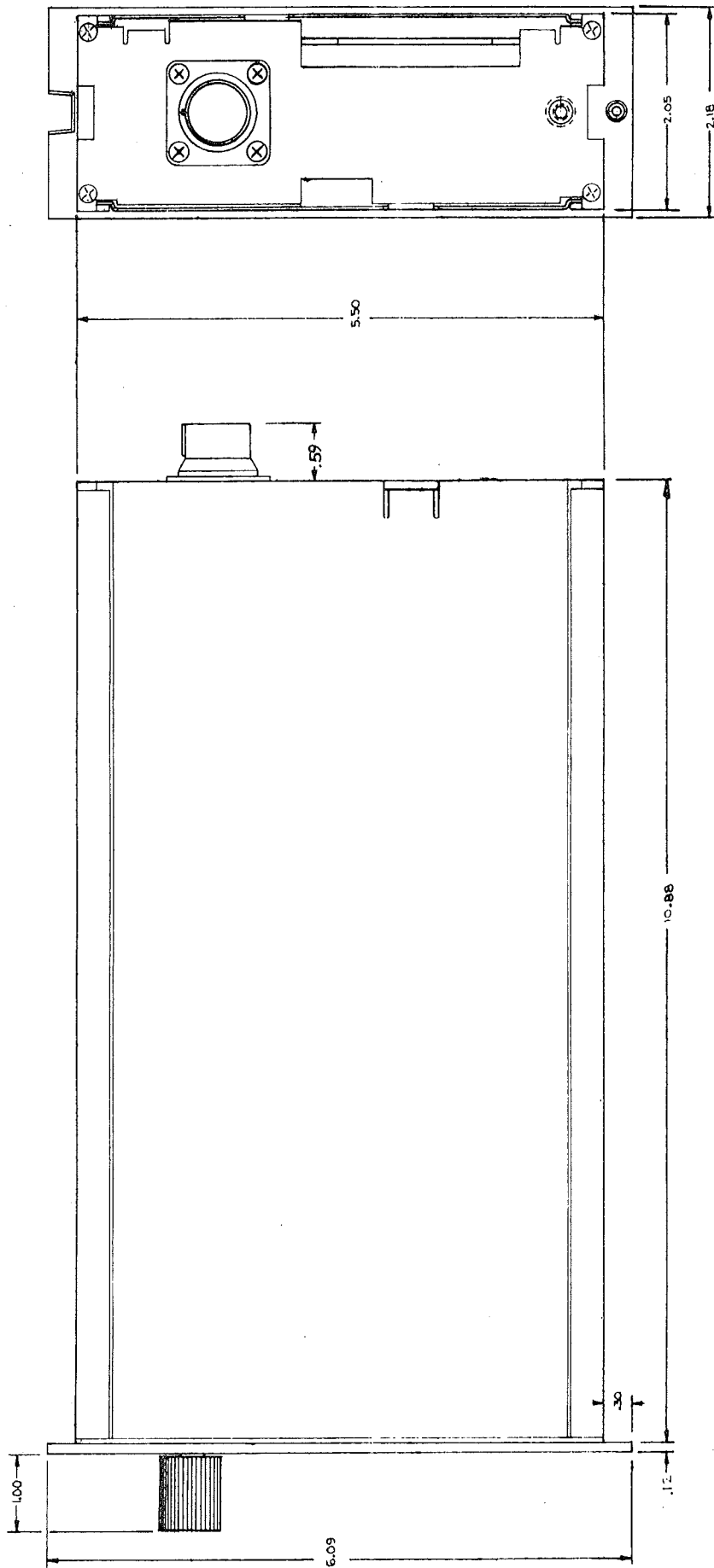


FIGURE 2-3 OUTLINE DIMENSIONS

SECTION I

GENERAL INFORMATION

1.1 INTRODUCTION

The Gould Model 13-4615-30 D. C. Bridge Preamplifier (Figure 1-1) is a high gain preamplifier designed to work with resistive transducers, including strain gages and strain gage based transducers. It is designed for use with Gould 2000 series recorders, and receives its operating power from a companion pendrive amplifier located in the same analog channel of the recorder.

This single channel preamplifier module expands measurement capability of the recorders to include strain gages, strain gage based transducers, resistance temperature devices and low-level DC input signals. Common mode rejection of 130db at dc and 100db at 60Hz permits operation in noisy industrial environments.

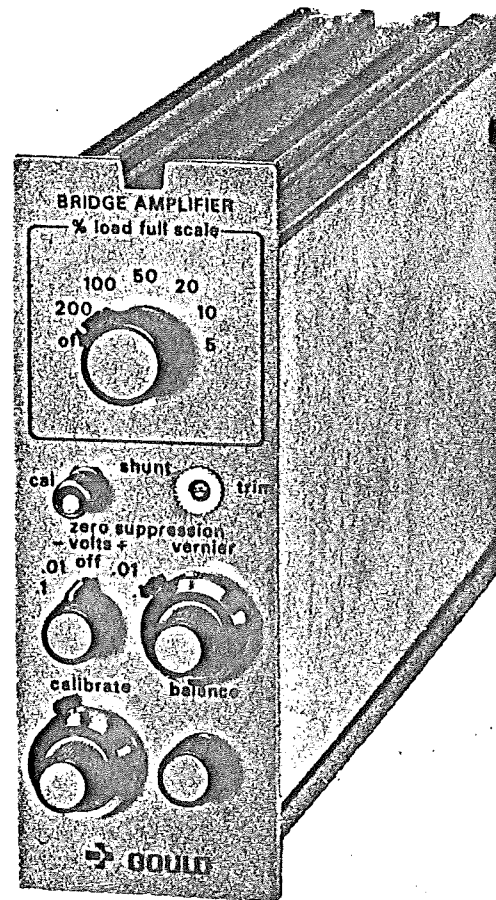
Calibrated Zero Suppression is provided with four voltage ranges, each of which has a resolution of one part per thousand. The attenuator position can be altered without readjusting the zero suppression control.

Both the input circuit and the dc excitation supply are fully floating, which permits the preamplifier to be operated at potentials up to 500 volts off-ground. A variable sensitivity (CALIBRATE) control has a continuous pre-calibrated range from 1 to 10, and a maximum resolution of one part per thousand. This calibrated sensitivity control provides known amplifier gain settings for each of the 6 fixed gain ranges, assuring precise direct calibration for all types of signal inputs.

Internal switching is provided for selection of ± 5 or ± 10 volt dc excitation, positive or negative shunt calibration, and bridge excitation polarity reversal. Low-pass output filtering is internally selectable to eliminate objectionable high frequency signal components.

a. Important Features of the D.C. Preamplifier

1. Ten turn calibrate dial for calibration to a known transducer sensitivity or gage factor.
2. Shunt Cal pushbutton to set calibrate dial to a known load in conjunction with the shunt trim pot.
3. Zero suppression to ± 0.1 volt.
4. Zero suppression vernier for setting suppression between zero volts and maximum range.
5. Bridge balance pot.
6. Either ± 5 volts or ± 10 volts excitation, switch selectable.
7. Internal terminals for bridge completion resistors, calibration resistors, or "+" or "-" cal. selection.



bi 1677

FIGURE 1-1 GOULD MODEL 13-4615-30
D.C. BRIDGE PREAMPLIFIER

GENERAL INFORMATION

1.2 SPECIFICATIONS

All operating specifications are based on 5 volts excitation, 350 ohms across input and a sensitivity (gage factor) of 2.0 mv/volt unless otherwise stated.

<u>Signal Input</u>	Differential.
Circuit	
Impedance	50K ohms
Measurement Range	250 microvolts full scale to 100 millivolts full scale
Maximum Sensitivity	25 microinch/inch full scale with 4 active arm bridges (gage factor of 1).
Sensitivity Steps	5, 10, 20, 50, 100 and 200% of load full scale and off.
Maximum Safe Voltage	50 volts peak-either input terminal to common. 500 volts peak-common to chassis.
<u>Signal Output</u>	Single ended to common.
Circuit	
Voltage:	
Linear Range	+5.0 volts into 2 K ohms or greater.
Minimum Load Resistance	Zero ohms (Short circuit proof).
Calibration Inaccuracy	$\pm 0.1\%$ of full scale in the 100% of (at 25° C and nominal line voltage) load setting with the calibration dial set to 2.
Attenuator Accuracy	$\pm 0.5\%$ of calibrated step.
Non-Linearity	$\pm 0.1\%$ of full scale.
Impedance	Less than 5 ohms.
Instability	At a calibration setting of 2 and attenuator setting of 5% of load full scale, after 15 minutes warmup.
Zero with Time	± 25 mv/24 hours. ($\pm 0.5\%$ of full scale/24 hours.)
Zero with Line	± 10 mv for a 10% line change ($\pm 0.2\%$ full scale for a 10% line change).
Zero with Temp	± 10 mv/° C ($\pm 0.2\%$ of full scale/° C).
Gain with Temp	$\pm 0.05\%$ /24 hours after 15 minute warmup.
Gain with Line	$\pm 0.1\%$ for $\pm 10\%$ line change.
Gain with Temp	$\pm 0.03\%$ /° C.

GENERAL INFORMATION

Frequency Response
Without Filter d-c to 100Hz $\pm 0.5\%$ (Less than 3 dB down at 5 kHz)
With Internal 5 Hz Filter 3 dB down at 5 Hz $\pm 10\%$
Filter Rolloff 12 dB/octave or 40 dB/decade

Noise Less than 1% of full scale from dc to 100Hz.
Common Mode Rejection:
Common to Chassis Greater than 100db from dc to 60Hz at 100 ohm unbalance.

Bridge Excitation

Voltage 5 or 10 volts dc, $\pm 0.1\%$ internally selectable.
100 ma capacity. Normal or reverse polarity internally selectable.

Noise 0.1% peak-to-peak from dc to 1KHz.

Stability (after 15 minute warmup)

Temperature $\pm 0.05\%/^{\circ}\text{C}$
Time $\pm 0.05\%/24$ hours.
Line $\pm 0.1\%$ for $\pm 10\%$ line change.

Zero Suppression

Range -.1, -.01, off, +.01, +.1 volts.
Inaccuracy $\pm 0.5\%$

Non-Linearity $\pm 0.3\%$
Resolution $\pm 0.1\%$ of suppression range.

Stability (after 15 minutes warmup)

With Time $\pm 0.2\%/week$
With Temp $\pm 0.05\%/^{\circ}\text{C}$
With Line $\pm 0.02\%$ for $\pm 10\%$ line change.

Noise $\pm 0.05\%$ of suppression range.

Environment

Temperature:

Storage -40°C to $+70^{\circ}\text{C}$.
Operating 0°C to $+50^{\circ}\text{C}$.

Humidity, Non-Condensing:

Operating 95% relative humidity; 0°C to 30°C .
Less than 95% relative humidity; 30°C to 50°C .

GENERAL INFORMATION

Physical Characteristics

Dimensions Refer to Figure 2-3 Outline Dimensions
Weight 3.6 lbs (1.5kg)
Mounting Retained from Rear.
Finish Molded Front Panel, Color:
Light Parchment.

Controls

Front Panel:
% Lead Full Scale Selects % of load for a full
scale output.

Shunt:
Cal Push button switch that connects shunt CAL R,
trim pot, or both across one arm of bridge.

Trim Multi turn pot for calibrating bridge.

Zero Suppression (-volts+) Selects range and polarity of
suppression voltage.

Zero Suppression (Vernier) Provide calibrated setting of suppression
voltage from 0% to 100%.

Calibrate Sets mv/v sensitivity of preamplifier.

Balance Multi-turn pot to balance bridge.

NOTE: No Pen Position Control

Internal:

Input Zero 15 turn pot to set zero of input amplifier.

Output Zero Single turn pot to set zero of output amplifier.

Input Bal Single turn pot to balance inputs 1
and 2 to common.

.1V CAL 15 turn pot to set accuracy of .1
volt suppression.

.01V CAL 15 turn pot to set accuracy of .01
volt suppression.

5V CAL 15 turn pot to set accuracy of 5 volt
bridge excitation.

10V CAL Single turn pot to set accuracy of 10 volt
bridge excitation.

GENERAL INFORMATION

Normal-Reverse Switch Slide switch to reverse the polarity of the excitation voltage.

+CAL, -CAL Terminals provided for jumper to produce either a positive or negative voltage when the CAL R, is placed across one arm of the bridge.

5Hz Filter Terminals and capacitors provided to permit adding an active filter.

Rear Panel:

Input Guarded Multi-pin Connector (Proprietary). Mating Connector 11-5407-03 supplied.

Output Card edge mates with AMP 582140-5 or equivalent.

Power Input From Recorder

Voltage DC ± 15 volts, ± 0.6 volts @ 100ma.

Line and Load Regulation $\pm 0.5\%$
Ripple 5mv max.

Voltage AC 13 vrms @ 200ma.

System Specifications When used with Series 2000 Recorders

Gain Accuracy $\pm 0.7\%$ of full scale.

Non-Linearity $\pm 0.45\%$ of full scale.

Instability (at 2mv/v cal setting and 5% of load full scale).

Zero with Time $\pm 0.6\%$ of full scale/24-hours.
Zero with Temp $\pm 0.3\%$ of full scale/ $^{\circ}$ C.
Zero with Line $\pm 0.3\%$ of full scale for a 10% line change.

Gain with Time $\pm 0.15\%$ /24 hours.
Gain with Line $\pm 0.6\%$ for a 10% line change.
Gain with Temp $\pm 0.08\%$ / $^{\circ}$ C.

Frequency Response Refer to Specifications, 2000 Series Recorder Manual.

Noise Less than 1% of full scale peak-to-peak.

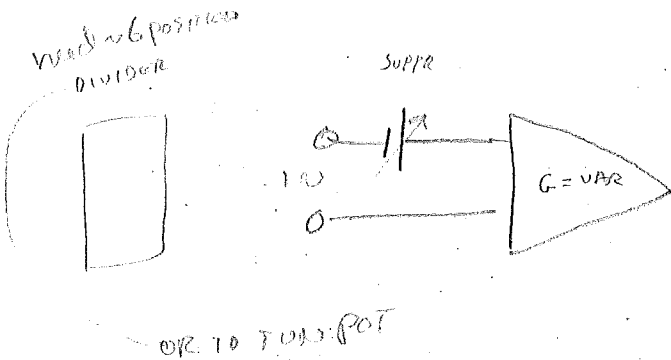
Maximum Safe Input ± 50 volts peak, inputs 1 and 2 to common.

Common Mode Rejection Refer to Specifications, page 1.3 of this manual.

Accessories

- * *Extender Card and Cable Assembly 887291
- *Balance Resistor 1-265469-15001
- *Calibration Resistor:
 - 15K ohm (120 ohm bridge) 1-265969-15001
 - 50K ohm (350 ohm bridge) 1-265969-50001
- * *Bridge Completion Resistor:
 - 120 ohm 242879-121
 - 350 ohm 10-240368-350R0
- *Input Connector 11-5407-03

*Supplied with Preamplifier
 * *Ordered Separately



INSTALLATION

3. Connect the transducer excitation pair to connector pins 6 and 7, and the outer shield to the sensor enclosure and to the guard ring.

NOTE: Detailed instructions for connecting one, two or four arm gages is given in Section III, Operation.

c. Grounding

1. For most applications, with both the sensor and sensor enclosure floating, both dotted jumpers shown in Figure 2-2 should be in place.

2. If either the bridge or the sensor enclosure is grounded, the jumper from AMPLIFIER COMMON to CHASSIS GROUND must be removed.
3. If the bridge is to be operated off-ground at a potential (500 volts maximum) the jumper from AMPLIFIER COMMON to CHASSIS GROUND must be removed.
4. Both jumpers must be removed if the Preamp is to be used as a DC amplifier with a grounded signal source configuration. Observe good grounding practice; make certain that the shield is tied to earth ground at one point and one point only.

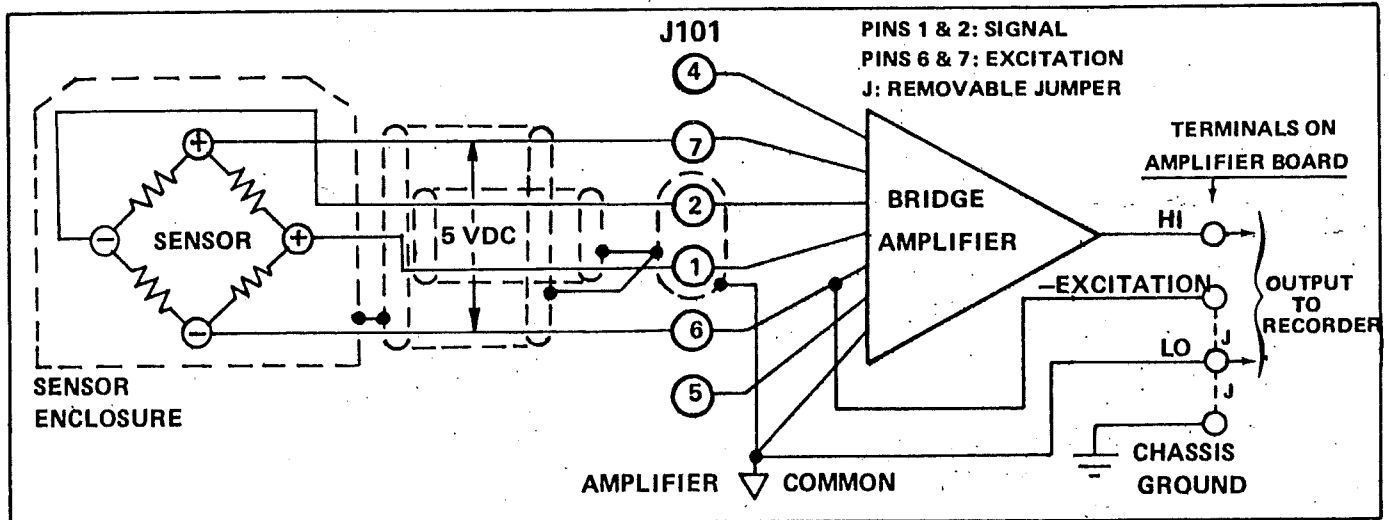


FIGURE 2-2 TYPICAL SIGNAL CONNECTIONS

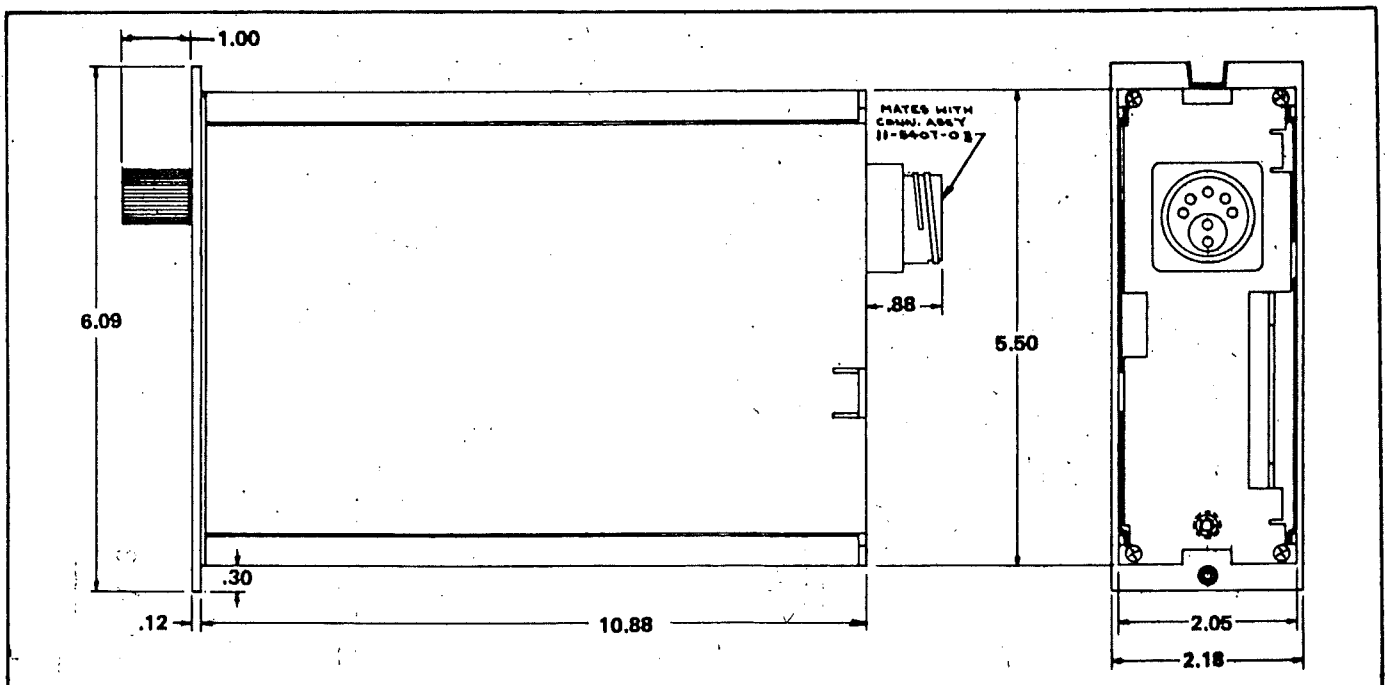


FIGURE 2-3 OUTLINE DIMENSIONS

SECTION III OPERATION

3.1 INTRODUCTION

This section describes and illustrates the controls of the Universal Amplifier and provides complete operating instructions, with examples as necessary.

3.2 CONTROLS AND INDICATOR

Controls listed below are shown in Figure 3-1 except as noted.

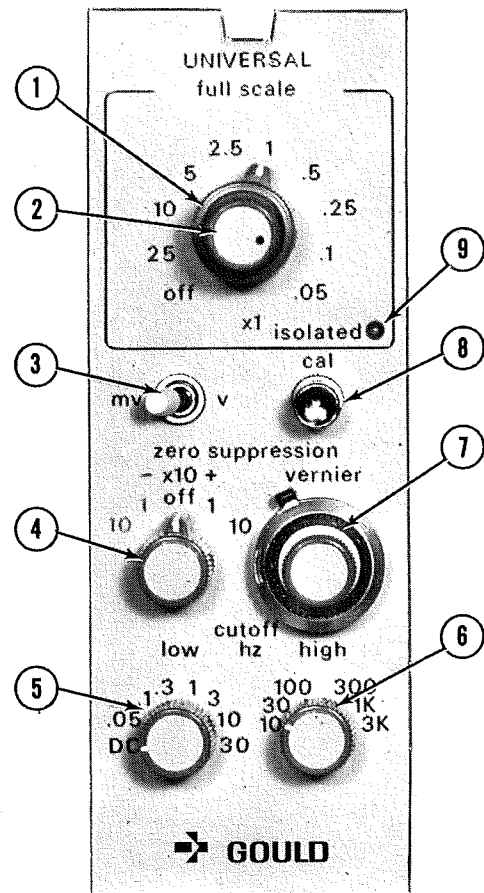


FIGURE 3-1 FRONT PANEL CONTROLS

ITEM NO.	CONTROL	DESCRIPTION
1	Sensitivity Control	Ten position switch provides nine preset ranges and OFF. Settings represent the input necessary to cause full scale output.
2	Vernier Sensitivity	Provides continuous adjustment from 1.0 to 2.5 times the setting on the stepped Sensitivity Control to cause full scale output.
3	Millivolt-Volt Switch	Whether stepped Sensitivity settings are in millivolts full scale or volts full scale determined by this switch.
4	Zero Suppression Switch	Connects selected zero suppression voltage to Zero Suppression Vernier Control.

ITEM NO.	CONTROL	DESCRIPTION
5	Low Cutoff	Selects low frequency cutoff at 8 points from DC to 30Hz. Provides -12dB/Octave rolloff.
6	High Cutoff	Selects high frequency cutoff at 6 points from 10Hz to 3KHz. Provides -12dB/Octave rolloff.
7	Zero Suppression Vernier	Provides known calibrated zero suppression offset voltage in mv mode to eliminate static portion of input signal. In volts mode, zero suppression is uncalibrated.
8	Calibrate Pushbutton	With mv-V switch in Volt position, pressing button provides either 50mv or 1 volt (internal switch selectable). In millivolt position, provides 50 microvolts or 1 millivolt at output. This allows calibration and/or correlation of all display devices.
9	Isolation Indicator	Green light emitting diode illuminates when patient isolation components are installed.
10	.05-1 Switch (see Figure 3-2)	Internal control which selects either .05 or 1 (millivolt or volt, depending on setting of mv-V switch) calibration signal.
11	FP-NORM (see Figure 3-2)	Selects input to recorder. NORM: Signals applied to pins 1, 2, 5 and 10 of J-101. FP: Sensor input J-101 pins 8, 9 and 10. This is an internal control.
12	Resistor (E3 to E4) (see Figure 3-2) ..	Internal optional mounting location to change output level of unity-gain tape output buffer. If this resistor is installed, tape output voltage V_T is equal to recorder output voltage V_R times the ratio of the optional resistor R to the total resistance in that line: $V_T = V_R \frac{R}{R + 2.5K}$. With no resistor installed $V_T = V_R$.

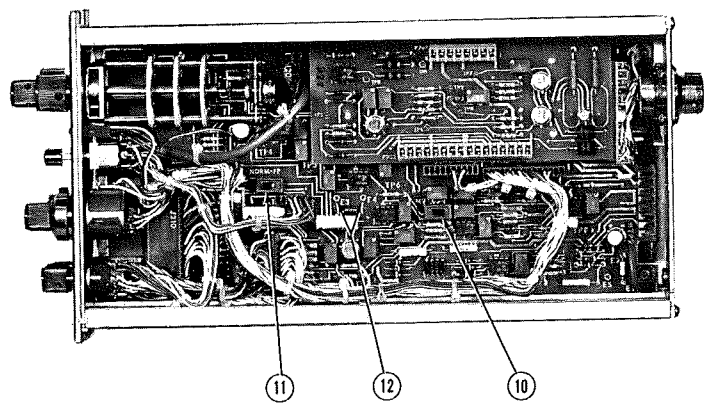


FIGURE 3-2 INTERNAL CONTROLS

3.3 OPERATION

3.3.1 Preliminary

1. Before installing amplifier in recorder or case, set front panel controls to the following position:

FULL SCALE	OFF
ZERO SUPPRESSION	OFF
VERNIER	0.0
X1	Fully CW
LOW CUTOFF	DC
HIGH CUTOFF	30
MV-V	V

2. Remove right side cover of amplifier and set the internal controls to the appropriate position.
3. Replace side cover and install amplifier.
4. Apply power to system and allow 15 minutes warmup before beginning procedure.
5. Attach patient electrodes and/or transducers as required, observing best medical practices.
6. If the largest amplitude of input signal is known, set FULL SCALE and MV-V switches to appropriate positions. If not, operate recorder at 5mm/sec. Start in least sensitive position (25 volts full scale) and increase sensitivity until an acceptable amplitude output is achieved.
7. The unit is now ready to be used in the desired procedure.

3.3.2 Off-Center Zero Operation

It is often desirable to record signals which will always appear on one side of zero, i.e., will contain a significant static dc component. In such cases, the recorder PEN POSITION control is used to displace the output reference voltage. Operation in this manner does not affect the performance of the amplifier: its specifications remain unchanged. While this capability is available on both ac and dc ranges, it is useful only during dc operation.

3.3.3 DC Operation

In the DC setting of the LOW CUTOFF switch, all of the amplifier sections of this unit will "pass on"

or couple any dc offset present on the input. This offset represents the static or constant portion of the signal. If it is desired to see this (such as using the amplifier to provide a beats per minute output), the Low Cutoff Switch must be in the DC position.

3.3.4 AC Operation

If the input signal contains an unwanted constant or slowly changing component, one of the Low Cutoff settings other than DC should be used. The non-DC settings attenuate that portion of the input below the frequency indicated by the Low Cutoff Switch.

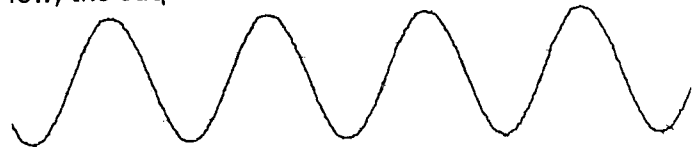
EXAMPLE: The input signal is a 20Hz sinewave superimposed on a 3Hz triangular wave. In the DC position the output would look like this:



However, with the Low Cutoff set to 10Hz: the trace would look like this:



These traces are shown with the High Cutoff set at 30Hz or higher. If reset to 10Hz High and DC low, the output would be:



This demonstrates that the High Cutoff attenuates any signal of a higher frequency than that to which the High Cutoff is set. These controls can therefore be used to analyze the same input signal several times, allowing you to look at a different (and specific) range of frequencies each time.

3.3.5 Output Amplitude

The output of the Universal Amplifier is 5 vdc full scale for any non-OFF setting of the FULL SCALE switch. For example, set FULL SCALE to 5 and MV-V to mv (millivolt range). An input of 2mv peak to peak will cause a 2 volt peak to peak output. In the 25mv FULL SCALE position, an input of 2mv p-p will yield a 0.4 volt peak to peak output.

With an 8 mv p-p input, the output will be 1.6v peak to peak. Note that the output amplitude will be affected by the settings of High and Low Cutoff switches and variable sensitivity as well as the FULL SCALE switch. See paragraph 3.3.4 for an explanation of the Cutoff switches. The variable sensitivity control enables you to determine what input will generate a 5v peak to peak output signal. The full scale setting is linearly adjusted anywhere from $\pm 50\mu\text{v}$ full scale to ± 25 volts full scale and can be used up to ± 6.25 volts.

EXAMPLE: The input connected has a maximum 8V peak to peak amplitude. You desire to represent 8V peak to peak as a 5v peak to peak (full scale) output. To do this, place the mv-v switch to V and FULL SCALE to OFF. Apply +8vdc to the input and adjust the recorder pen position to right chart edge. Now place the FULL SCALE switch to 5 and rotate the variable sensitivity control until the pen is exactly on left chart edge. Full scale is now 0 to 8 vdc input.

This instrument can also be used to display a voltage range with something other than 0vdc at one end.

EXAMPLE: You wish to monitor a signal which can vary between +2mvdc and -2mvdc. Set FULL SCALE OFF and mv-v to mv. Apply +2.0mvdc to input. Adjust recorder pen position to right chart edge. Place FULL SCALE switch to 2.5 and adjust variable sensitivity to place pen on left chart edge. Change input to -2mvdc. Now turn ZERO SUPPRESSION switch to -1 and vernier control to 2.00. The instrument is adjusted for a range of -2.00mv (right chart edge) to +2.00mv (left chart edge).

NOTE: Zero Suppression is calibrated in millivolts mode only. When operating in volts mode, this unit is calibrated to a maximum of ± 25 vdc.

To calibrate the output in the volts mode, connect an input of known amplitude to be suppressed. Then adjust the zero suppression controls to produce the desired output. Remove calibrating input and connect signal. Unit is ready to use.

3.3.6 FM Tape Output

Because a full scale signal of 5vdc is too high for most instrument tape recorders, provision is made to decrease the amplitude of the tape output. This does not affect the recorder output level. A resistor

is mounted between terminals E3 and E4. Then the tape output voltage (V_T) is equal to recorder output voltage (V_R) times the ratio of the optional resistor (R) to the total resistance in that string.

EXAMPLE: Tape input level must be limited to 1vrms (2.828v peak to peak) In this case:

$$R = \frac{V_T (2.5K)}{V_R - V_T}$$

$$R = \frac{2.828 \cdot 2500}{5.000 - 2.828}$$

$$R = \frac{7070}{2.172}$$

$$R = 3255 \text{ ohms}$$

3.3.7 Calibration Button

During the display of signals on a recorder or oscilloscope, it is often convenient to introduce a known amplitude signal. On a chart recording this is used to correlate one chart to another. This signal is also used to adjust the gain of an oscilloscope to a known input level.

When the front panel CAL pushbutton is depressed and held, it disconnects the input signal from the amplifier. It inserts a DC calibration signal of either 0.05 or 1.0 depending on setting of internal switch S-203. Further, the CAL switch automatically places the amplifier in the DC mode so that the cal signal level will remain constant when the Low Cutoff switch is in a non-DC setting. When the CAL button is released the input is connected to the amplifier and the Low Cutoff is as indicated on the front panel.

3.4 TYPICAL APPLICATIONS

3.4.1 General

The Gould Universal Amplifier accommodates either ac or dc signals at different maximum sensitivities; therefore this unit can be used for any biomedical application which requires signal amplification.

The following analog recordings are especially well suited to this signal conditioner:

Electrocardiogram Lead I	Electroencephalogram
Electrogastrogram	Electromyogram
Electroretinogram	Electronystagmogram
Phonocardiogram	

In addition to the above applications, the Universal Preamplifier is ideally suited to interface with other instrumentation, such as flow-meters, dye-dilution equipment, and PH meters. Even though the output of such apparatus may be of sufficient magnitude to make further voltage amplification unnecessary, other capabilities of this signal conditioner are often advantageous or essential. These include permanent and constant calibration, frequency filtering, and power amplification.

3.4.2 Phonocardiogram

By using the Universal Amplifier in conjunction with a high-quality instrument tape recorder and a Gould direct-writing oscillograph, superb cardiograms can be obtained in ink on low-cost chart paper.

Without FM tape, the direct recording of highfidelity a phonocardiogram on chart paper is impossible, owing to the oscillograph upper frequency limitation of 400Hz. This problem is avoided by first recording the phonocardiogram on FM tape at a tape speed of 30 inches per second. The tape is then played back at a speed of 15/16 inches per second.

This technique results in a recording on chart paper with an effective bandwidth of 0 to 12,800Hz (400Hz times 32).

After this maximum-bandwidth recording, the tape can then be played back again at other settings

of the HIGH CUTOFF control for comprehensive bandwidth analysis.

This technique can also be employed using a multi-channel oscillograph with the phonocardiogram on one channel and one or two leads of ECG on other channels.

3.5 GROUND ISOLATION AMPLIFIER

Pin 5 of input connector is not connected solidly to ground but is called a "driven ground" and is actually separated from ground by 2.8 megohms. It is driven to ground potential by an amplifier shown in Figure 3-3.

NOTE: Also refer to Preamplifier schematic 291354.

Under normal operation this arrangement minimizes 60-cycle noise in the output owing to the fact that the amplifier's output current is returned to the patient, lowering his floating potential. Therefore, anything connected to pin 5 appears to be at chassis-ground potential. Yet should a high-common-mode voltage appear suddenly between ground and patient the amplifier will be driven to saturation and the 2.8 megohms of resistance effectively ungrounds the patient.

This "ungrounding" occurs instantly—and for the duration of the potentially hazardous voltage. The isolation amplifier offers a very low impedance to ground during normal operation, and an extremely high impedance whenever a hazardous potential between the patient and ground exists.

Moreover, the Gould isolation amplifier cancels out more than 2 ua of noise pickup, an achievement which permits recording in a room plagued with relatively high electrical noise.

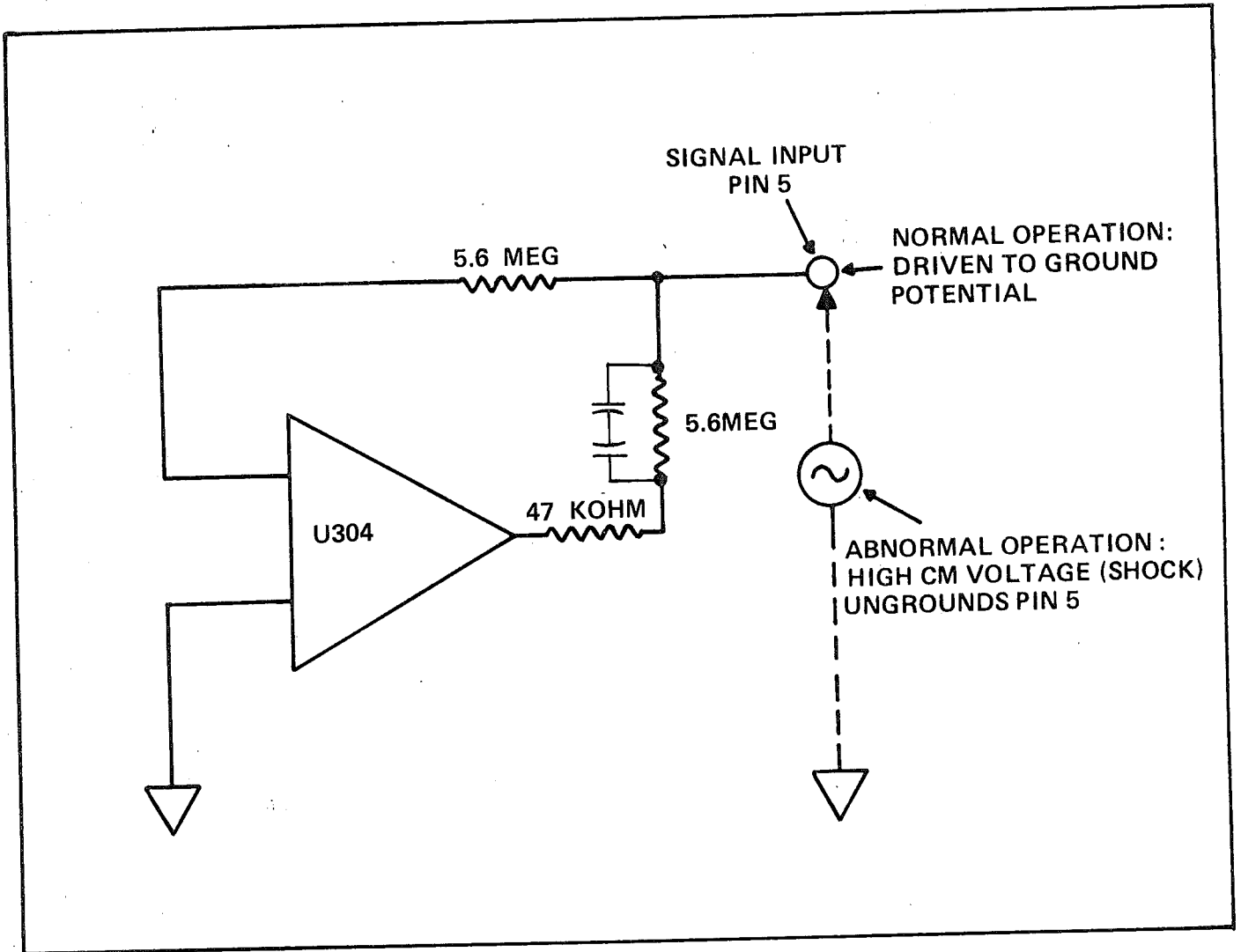


FIGURE 3-3 GROUND ISOLATION AMPLIFIER

SECTION IV MAINTENANCE

4.1 GENERAL

In addition to maintenance procedures, this section contains information on calibration and troubleshooting.

4.2 MAINTENANCE

a. General

Maintenance on the preamplifier is limited to cleaning only.

b. General Cleaning

CAUTION

- 1) *BEFORE ATTEMPTING TO CLEAN THE PREAMP, TURN POWER OFF AND REMOVE FROM ENCLOSURE.*
- 2) *AVOID USE OF CHEMICAL CLEANING AGENTS WHICH MIGHT DAMAGE PLASTIC OR PRINTED SURFACES. DO NOT USE CHEMICALS WHICH CONTAIN TOLUENE, CELLUSOLVE, ACETONE OR SIMILAR SOLVENTS.*

EXTERIOR: Remove loose dust with a soft cloth or small paint brush. Dirt which remains can be removed with a soft cloth dampened in a mild detergent and water solution. **DO NOT USE ABRASIVE CLEANERS.**

INTERIOR: Dust in the interior should be removed occasionally due to its electrical conductivity under high humidity conditions. Blow off accumulated dust with dry low pressure air. Remove any dirt which remains with a soft paint brush or a soft cloth dampened in a mild detergent and water solution. A cotton-tipped applicator is useful for cleaning in narrow spaces and/or printed circuit boards.

4.3 TROUBLESHOOTING

Troubleshooting may be performed in conjunction with the STAR and Schematic diagrams and the following test equipment: ECG Simulator, Oscilloscope, Gould Model OS4000 or equivalent.

4.4 STAR DIAGRAM

In order to facilitate troubleshooting of Gould Universal Amplifier, the following Signal Tracing And Replacement (STAR) Diagram's included. A STAR diagram is a block diagram, expanded to

include certain wiring diagram information, schematic diagram information and engineering maintenance information (signal levels, waveforms, test points, etc). Initially, this diagram can be used in conjunction with the Theory of Operation in Section V of this manual. As service personnel gain familiarity and experience with the equipment, the need to refer to the supporting descriptive text will gradually be eliminated.

The STAR diagram provides the essential information required to isolate a fault to a functional block. To use the STAR diagram, perform the Preliminary Setup procedure below. Then, by applying the scope probe to each test point in numerical order, proceed through the information on the diagram for that test point. Having done this, the block immediately prior to the "bad" test point indicates in which area the trouble lies. Going to that area on the board (and the schematic) components may be checked to find the failure. Be sure to verify that all power supply voltages are present and correct.

1. Set Front Panel Controls as follows:

Full Scale	OFF
Zero Suppression	0.0
Mv-V	MV
Variable Sensitivity	X1
Low Cutoff	.05
High Cutoff	300
2. Set Internal Controls as follows:

FP-Norm	NORM
.05-1	1
3. Remove unit right side cover.
4. Connect input to power source: +15vdc and 13vrms or power from a Gould 2000 Series Recorder and extender cable.
5. Allow unit to warm up for 15 minutes.
6. Attach ECG Simulator to Amplifier per Table 2-1.
7. Place Full Scale to 10 position.
8. Set oscilloscope to DC coupling, 100mv/cm and 50usec/cm. Probe should be 1:1 attenuator type.
9. To check STAR No. 3 (TP8) set zero suppression switch to -10 and vernier to 10.00. Afterwards, return switch to OFF.
10. Proceed to troubleshoot unit.
11. Remove test equipment when finished.

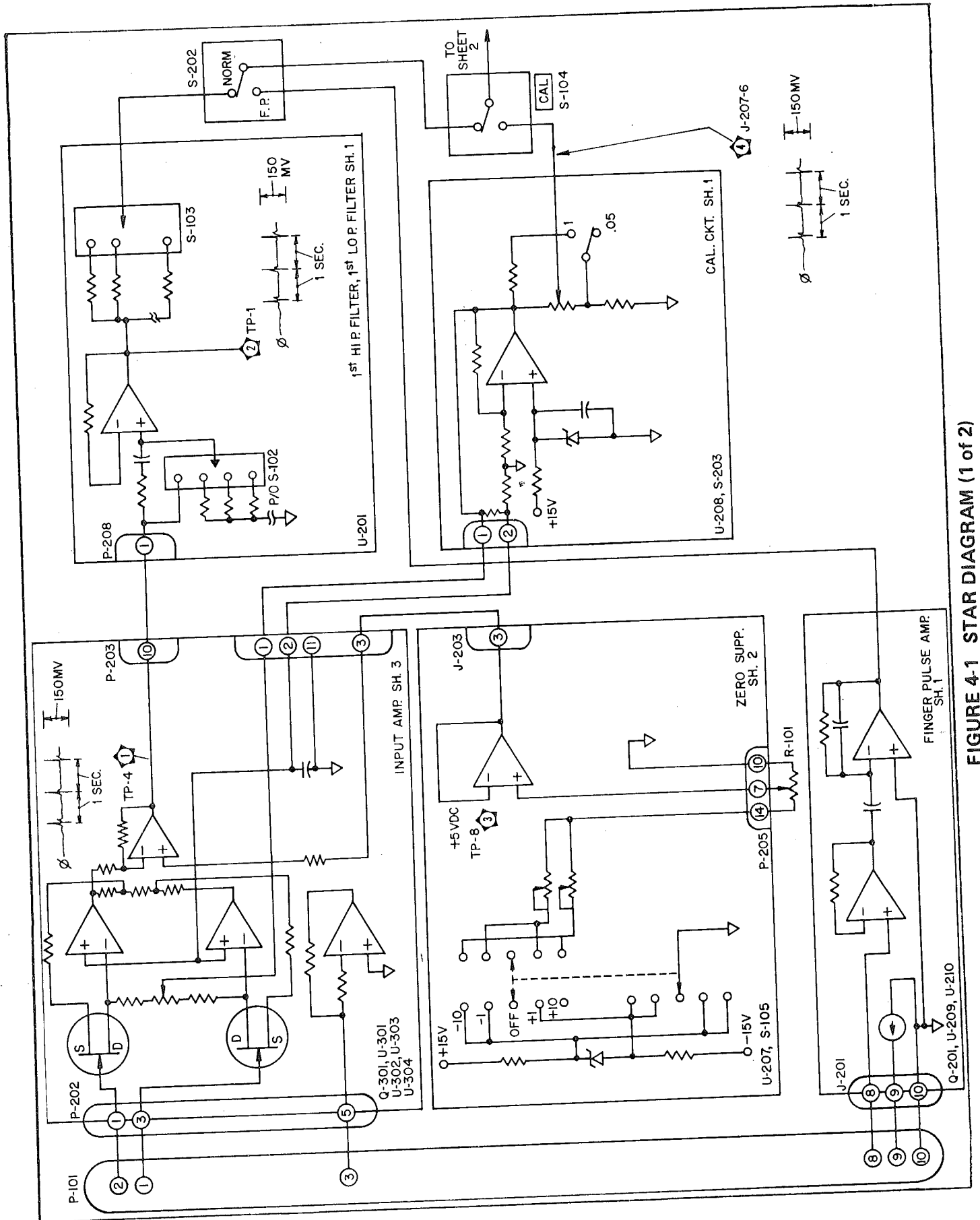


FIGURE 4-1 STAR DIAGRAM (1 of 2)

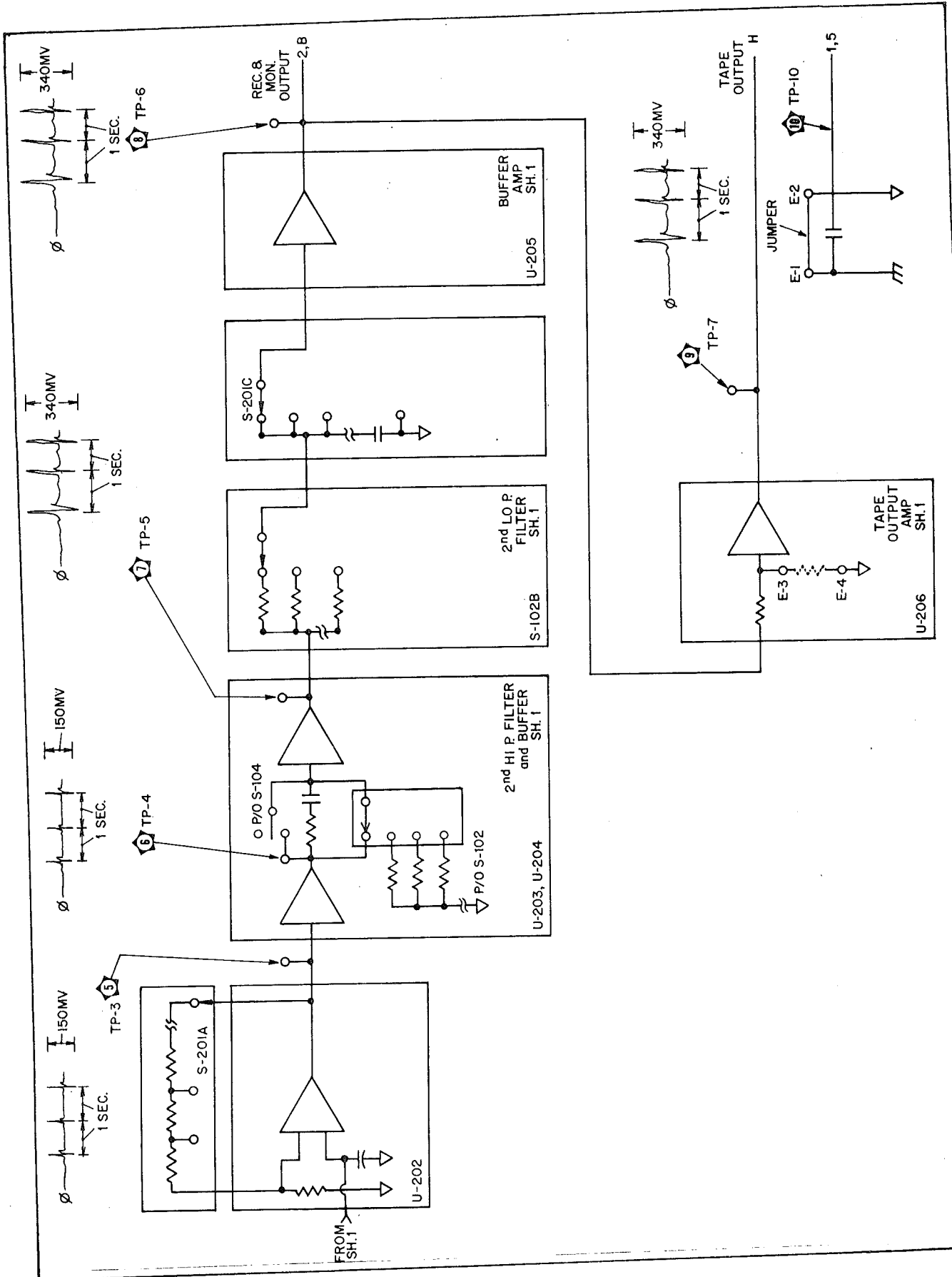


FIGURE 4-2 STAR DIAGRAM (2 of 2)

4.5 CALIBRATION

a. General

The Gould Universal Amplifier has been accurately calibrated before shipment from the factory and should give long trouble free service. Should recalibration be required, it should be performed by qualified technical personnel only.

CAUTION
CALIBRATION SHOULD NOT BE ATTEMPTED UNLESS SUITABLE, SPECIFIED TEST EQUIPMENT IS USED.

NOTE: Performance checks in this section specify limitations based on optimum "new-equipment" values. Should any results be unacceptable, please see the troubleshooting section of this manual or your Gould Service Representative.

b. Test Equipment Required

The following is a list of test equipment necessary for calibration.

1. Extender card and cable assembly, Gould P/N 887291 (necessary if power is furnished by Gould 2000 Series recorder or preamplifier power supply).
2. Digital multimeter AC/DC Fluke 8100A or equivalent.
3. A.C. Source: Wavetek Model 110 or equivalent.
4. D.C. Source: 0.5% accuracy; Electronic Development Corp. Model - VS330H or equal.
5. Oscilloscope: Gould Model OS3500 or equal.
6. D.C. Power Supply: ± 15 vdc $\pm 4\%$ @ 100ma each.

c. Preliminary Procedure

1. Remove right side cover from preamp (Figure 4-3).

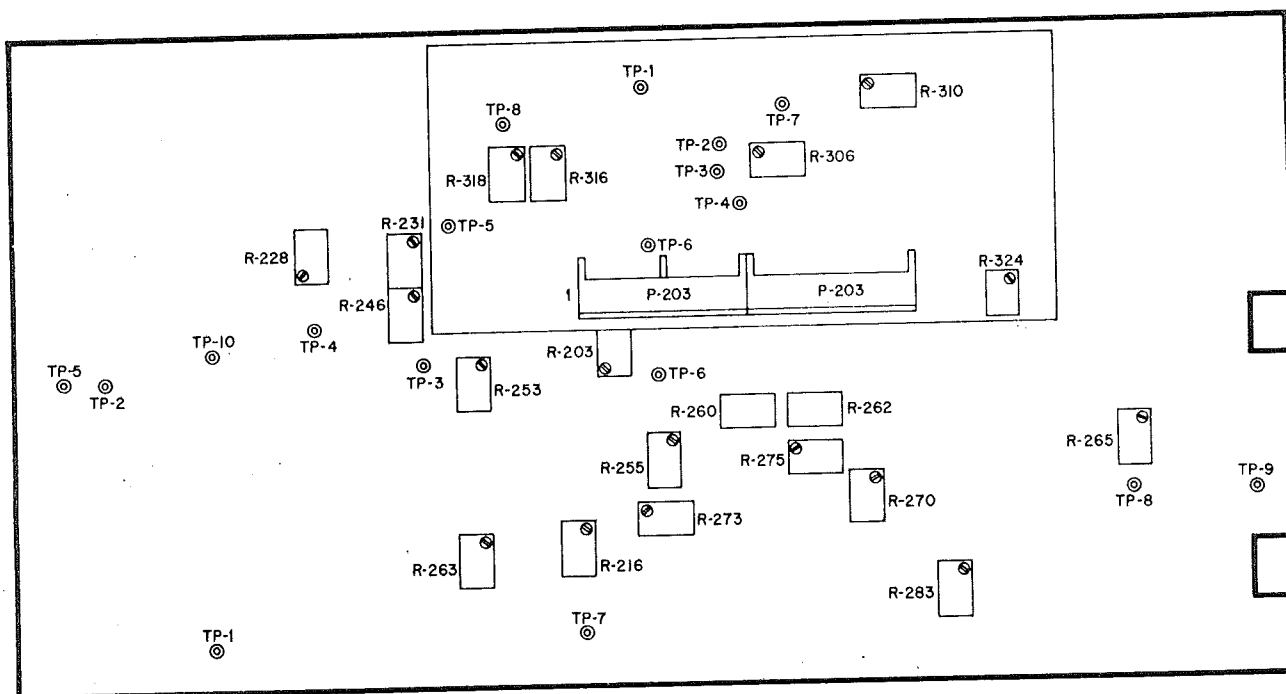


FIGURE 4-3 CALIBRATION CONTROLS

+10mv from J201 pin 1 (High) to 2. Set front panel SUPPRESSION switch to +1. Adjust R262 for $0V \pm 2mv$.

6. Change input to +100mv and move SUPPRESSION switch to +10 position. Adjust R260 for $0V \pm 5mv$.
7. Remove input, DVM and jumpers. Set front panel ZERO SUPPRESSION switch to OFF and vernier to 0.0.

f. Internal CAL Voltage

1. Tie together P-101 pin 1, 2, 5 and 10. Set front panel FULL SCALE switch to .05 position and LOW CUTOFF to 30.
2. Place the internal .05-1 switch to the .05 position. Depress the front panel CAL pushbutton and adjust R273 for $+5.0V \pm 10mv$.
3. Set the front panel FULL SCALE switch to the 1 position and the internal .05-1 switch to 1.
4. Depress the front panel CAL pushbutton and adjust R275 for $+5.0V \pm 2mv$.

5. Remove DVM but leave jumper installed. Set FULL SCALE switch to OFF.

g. Final Zero Adjust

1. Install right side cover and set preamp in vertical position. Apply power and allow 30 minute warmup time after installing side cover.
2. Set front panel controls as follows:

MV-V	V
FULL SCALE05
LOW CUTOFF	DC
HIGH CUTOFF	10

3. Connect DVM to output pins 2 (High) and 5 of printed circuit edge connector. Adjust R318 to $0V \pm 25mv$.
4. Set MV-V switch to MV and FULL SCALE to .5. Adjust R310 for $0V \pm 50mv$.
5. Repeat steps 3 and 4 as necessary as these controls are interactive.
6. Remove jumpers, power and DVM. Set front panel FULL SCALE to OFF. Unit is ready for use.

SECTION V

THEORY OF OPERATION

The Universal Amplifier, Model 13-4615-55, consists of surge arrestors on each input lead, divider, input amplifier, suppression network, high pass and low pass filters, interstage amplifiers with calibrated gain in steps, X1 attenuator and output amplifiers. In addition it contains a built in calibration signal and a pulse sensor amplifier. It also contains a specialized amplifier — the right leg driver.

5.1 CIRCUIT DESCRIPTION

See Figure 5-1 Block Diagram and schematic 291354 (located after parts section).

5.2 SURGE ARRESTORS

Each input lead is protected by surge arrestors (E201, 202, 203). The arrestors will clip an incoming voltage to approximately 900V within microseconds and protect the circuitry from damage.

5.3 INPUT AMPLIFIER AND DIVIDER

(See Figure 5-2)

The input amplifier is preceded by a 5:1 divider in order to extend the amplifier range to 25V. The divider is selected by front panel MV-V switch S101.

The input amplifier consists of a pair of monolithic FET's Q101 and associated circuitry, arranged to form an instrumentation amplifier. Op amps U301 and 302 have their plus (+) inputs tied to a reference voltage, while their minus (-) inputs are connected to the drain resistors of the FET's. The op amp outputs are tied back to the sources of their respective FET's.

Due to op amp action the drain voltage is forced to the same potential as the reference voltage and the output of the op amps will produce the correct bias on the sources to cause the proper drain current for this potential. Thus a constant 200ua current flows in each FET.

This drain current remains constant so long as the FET's are operated within their linear range. The op amps also buffer and amplify while acting as constant current sources since the potential difference between the plus and minus input need only change by an amount $e = \frac{E_o}{A_{OL}} \cdot E_o =$

output voltage and A_{OL} = open loop gain of the op amp.

The closed loop gain of the input amp is given by:

$$1 + \frac{R304 + R311}{R305} = 1 + \frac{20K}{408} = 50 \text{ in the MV}$$

range since R305 is connected. The gain is controlled by MV-V switch S101.

The supply voltage for the FET amplifier is zener referenced and buffered by op amp U208. The supply voltage is divided and used as a reference voltage for op amps U301 and 302 by resistors R267 and R268.

The outputs of U301 and U302 are summed into U303 by resistors R312, R314, R315 and R317 to produce a single ended output. Potentiometer R316 balances the inverting and non-inverting gain of U303.

Potentiometer R310 is used to balance the offset to voltages of the FET's in the mv range and R318 balances the op amp U303 in volts ranges.

5.4 SUPPRESSION VOLTAGE

A stable suppression voltage is generated by zener reference CR201. It is then divided down by R261 and R262 and potentiometer R101 for the 1 range or else R259 and R260 and R101 for the 10 range. The polarity is determined by which end of the zener is grounded.

The amount of suppression voltage is determined by the setting of Vernier suppression pot R101. The voltage is buffered and summed into U303 to null out d.c. input voltages.

Front panel switch S105 selects the full scale range and polarity of suppression.

5.5 HIGH PASS FILTER — FIRST SECTION

The output of U303 is connected to buffer amplifier U201 thru one half of the front panel Low Cutoff switch S102. The signal is either directly connected to U201 in the DC setting or coupled through capacitor C201 in any of the .05 through 30Hz settings. The cutoff is determined by resistors R207 through R213.

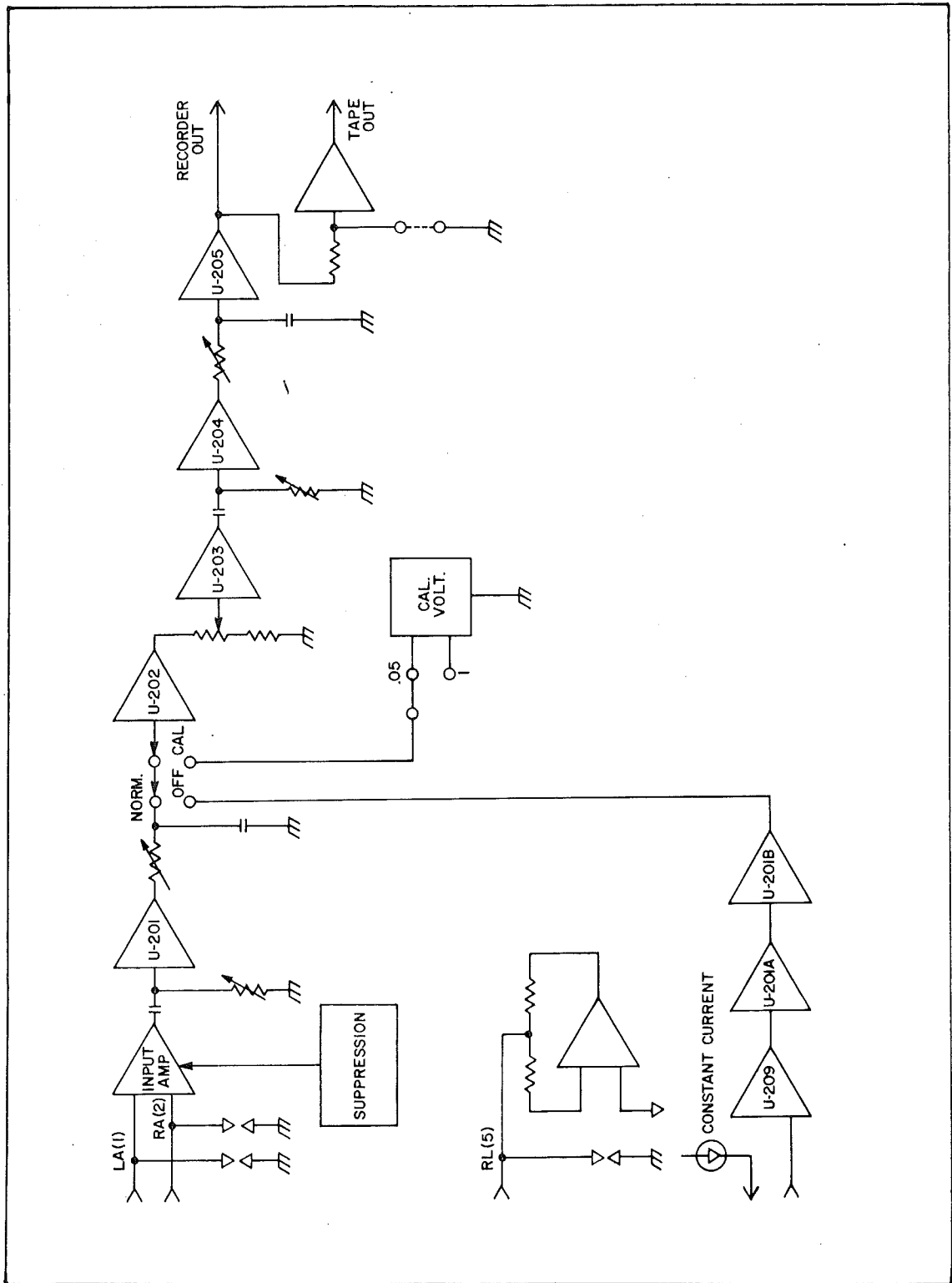


FIGURE 5-1 BLOCK DIAGRAM

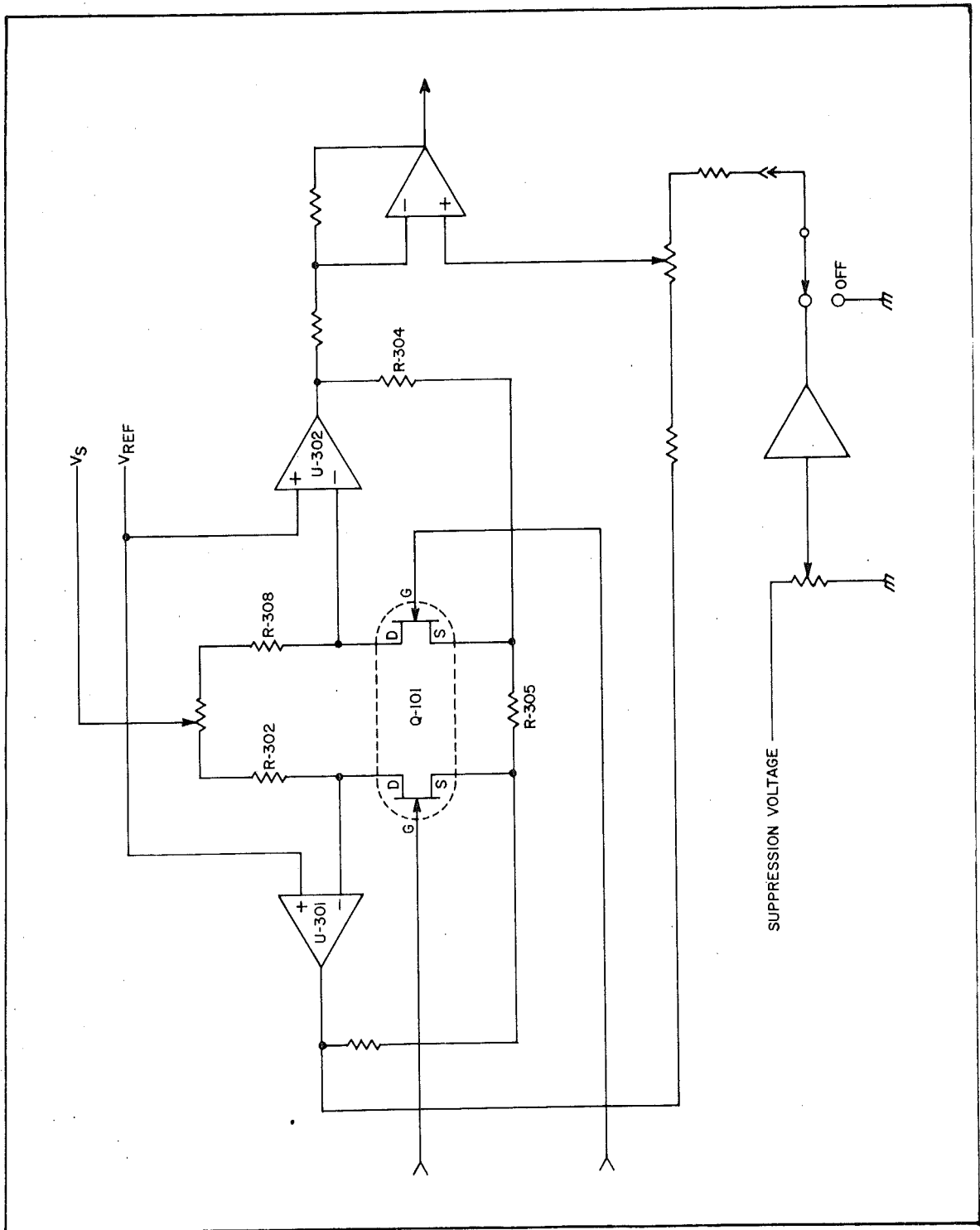


FIGURE 5-2 INPUT AMPLIFIER

5.6 BUFFER AMPLIFIER U201

Op amp U201 acts as a buffer for the output of the high pass filter. It also provides a gain of 4 in the MV setting of the MV-V switch and a gain of approximately 1 in the V setting.

5.7 LOW PASS FILTER – FIRST SECTION

The output of U201 is connected to one half of a low pass filter by front panel High Cutoff selector switch S103. Resistors R217 through R222 along with capacitor C202 determine the cutoff frequency.

5.8 GAIN AMPLIFIER U202

The output of the low pass filter is buffered by amplifier U202. U202 also provides calibrated gain steps by means of resistor R223 and gain resistors R224 through R227. The resistors are selected by front panel full scale switch S201. The output of U202 is connected to the front panel X1 sensitivity control R229. This control allows the sensitivity to be varied by a factor of 2.5 times the calibrated full scale setting.

5.9 BUFFER AMP U203

The wiper of R229 is connected to unity gain amplifier U203 to prevent loading and provide a linear gain change with rotation of the pot.

5.10 HIGH PASS FILTER – SECOND SECTION

The output of amplifier U203 is connected to the second half of the high pass filter. The operation of this section is identical to that of first section as previously described. It is composed of capacitor C203 along with resistors R234 through R240 and is controlled by the front panel Low Cutoff switch S102. Together the two sections of the high pass filter provide a 12dB/Oct filter at selected frequencies from DC to 30Hz.

5.11 GAIN AMPLIFIER U204

The output of the high pass filter is connected to U204 which buffers the filter and provides calibrated gain steps by means of resistor R245 and gain resistors R241 through R244. The gain resistors are selected by the front panel full scale switch S201.

5.12 LOW PASS FILTER – SECOND SECTION

The output of U204 is connected to the section of the low pass filter composed of resistors R247 through R252 and capacitor C204 and is controlled by front panel High Cutoff switch S201. The two sections of the filter provide a 12 dB/Oct rolloff for selected frequencies from 10 to 3KHz.

5.13 OUTPUT AMPLIFIER

The output of the low pass filter is connected to unity gain amplifier U205 to prevent loading. U205 provides a low output impedance for driving chart recorders.

5.14 TAPE AMPLIFIER

The output of U205 is also connected to tape amplifier U206 through resistor R254 to drive tape recorders. Terminals are provided (E3-E4) for the insertion of resistors to vary the output of U206 in order to accommodate various recording levels. Refer to Operation Section for calculation of U206 output amplitude.

5.15 RIGHT LEG DRIVER U304

The right leg lead of the Universal amplifier is not connected directly to circuit common. Instead it is connected to the inverting input of FET op amp U304 through 5.6 megohm resistor R322. Due to the action of the op amp the inverting input of U304 is forced to the same potential as the non-inverting input which is connected to chassis common.

Thus the right leg lead, when attached to a patient, causes the patient to see a virtual ground connection under normal conditions of capacitive line pick-up. However under an abnormal condition – such as the patient being accidentally connected to line – the amplifier will saturate and normal op amp action will cease.

When this happens the patient will float up to line potential, but the maximum current which can flow in the right leg lead is limited by the parallel combination of the two 5.6 meg resistors less than 50 ua.

5.16 INTERNAL CALIBRATION SIGNAL

During the recording of signals it is often convenient to introduce a calibration signal for later

reference. When the front panel momentary push-button CAL switch is depressed it disconnects the normal signal from amplifier U202 and inserts a DC calibration signal of either .05 or 1 depending upon the setting of internal slide switch S203. The CAL switch automatically places the amplifier in the DC mode so that the CAL signal level remains constant when the Low Cutoff filter switch is in one of the AC coupled settings.

The CAL signal is automatically multiplied by the setting of the MV-V switch.

5.17 SENSOR AMPLIFIER

The sensor amplifier is composed of a constant current source to drive the sensor LED and is AC

coupled into high impedance amplifier U209.

Amplifier U209 provides a gain of approximately 5. The output of U209 is connected to a two section active filter composed of U210A and U210B and associated components.

The output of U210B is connected to internal slide switch S202. When placed in the FP position the normal signal path is interrupted and the sensor amplifier output, U210B, is connected to U202 and sensor pulses are displayed on the chart recorder.

SECTION VI

PARTS IDENTIFICATION

This equipment has been accurately calibrated and adjusted before shipment from the factory and should give long, trouble-free service. For servicing beyond the scope of the instructions contained in this manual or the technical equipment available, contact your nearest Gould Service Engineer listed on the warranty card shipped with the equipment.

The following parts lists and schematic diagrams are designed to assist in servicing and repairing the equipment. For replacement parts, refer to the appropriate figures and parts lists in this section. The items listed present the lowest assembly or part, but do not necessarily imply they are for sale.

Contact your local service branch for availability

of salable components, assemblies or parts.

To assure prompt and satisfactory delivery of replacement parts, include the following with the purchase order:

1. Name and model number of the instrument.
2. Description of the parts as listed in the manual.
3. Gould part number.

NOTE: Do not use the **SYMBOL NUMBER** from the parts list for identifying desired parts on the order.

EXPLODED VIEW PARTS LIST
 AMPLIFIER ASSEMBLY, UNIVERSAL HI-GAIN 13-4615-55,-56
 FIGURE 6-1

ITEM NUMBER	PART NUMBER	DESCRIPTION	SYMBOL NUMBER
	13-4615-55	Amplifier Assy, Universal Hi-Gain	
	13-4615-56	Amplifier Assy, Universal Hi-Gain, Isolated	
1	889845	Board Assy, Non-Isolated (See Figure 6-2) (-55 only)	
1	891851	Board Assy, Isolated (See Figure 6-2) (-56 only)	
†	890682	Amplifier Sub Assy - Universal Hi-Gain (-55 only)	
†	891864	Amplifier Sub Assy - Universal Hi-Gain (-56 only)	
2	686421	Cover Assy	
3	685944-1	Frame	
4	889846	Board Assy (See Figure 6-3) (-55 & -56)	
	13-262716-4004	Screw, Self-Tapping	
		----- *	
	690662	Switch Assy	
5	230048	Switch, Pushbutton	S-104
6	287489	Key, Polarizing	
7	287491-6	Connector	P-207
8	1-287490	Contact, Elec	
	790645	Switch Assy	
9	286151-11	Switch, Rotary	S-102
10	1-287490	Contact, Elec	
11	287491-10	Connector	P-208,P-209
12	287489	Key, Polarizing	
	790646	Harness Assy	
13	286151-10	Switch, Rotary	S-103
14	287491-15	Connector	P-201
15	287489	Key, Polarizing	
16	1-287490	Contact, Elec.	
	890647	Harness Assy	
17	230050-103	Resistor, Vari	R-101
18	286151-9	Switch, Rotary	S-105
19	290477	Switch, Toggle	S-101
20	287491-10	Connector	P-204, P-206
21	287489	Key, Polarizing	
22	1-287490	Contact	
23	287491-2	Connector	XDS-101
24	287491-15	Connector	P-205
	790663	Connector Assy (A-P)	
	31-119918-4005	Screw	
	1-216741-411	Lockwasher	
		----- *	
25	9-281501-12	Connector	P-201
26	281506-4	Contact	
27	288932	Contact	
28	288926	Connector	J-101
29	788971	Panel Assy, Rear (A-P)	
	13-262716-4004	Screw, Self-Tapping	
		----- *	

EXPLODED VIEW PARTS LIST
 AMPLIFIER ASSEMBLY, UNIVERSAL HI-GAIN 13-4615-55,-56
 FIGURE 6-1 (Continued)

ITEM NUMBER	PART NUMBER	DESCRIPTION	SYMBOL NUMBER
30	691818	Cover, Side	
31	390681	Panel, Sub	
	13-262715-4004	(A-P)	
		Screw, Self-Tapping	
		----- *	
32	790667	Panel Assy, Silkscreened	
33	285651-12	Knob	
34	284990	Knob, Turns Counting	
35	285650	Knob	
36	285652-1	Knob	
37	230049	Button	
38	285651-2	Knob	
39	285653-1	Knob	
40	663800-1	Nut, Knurled	
41	289397-1	Diode, LED-Green	CR-101
† Not a Procurable Part			

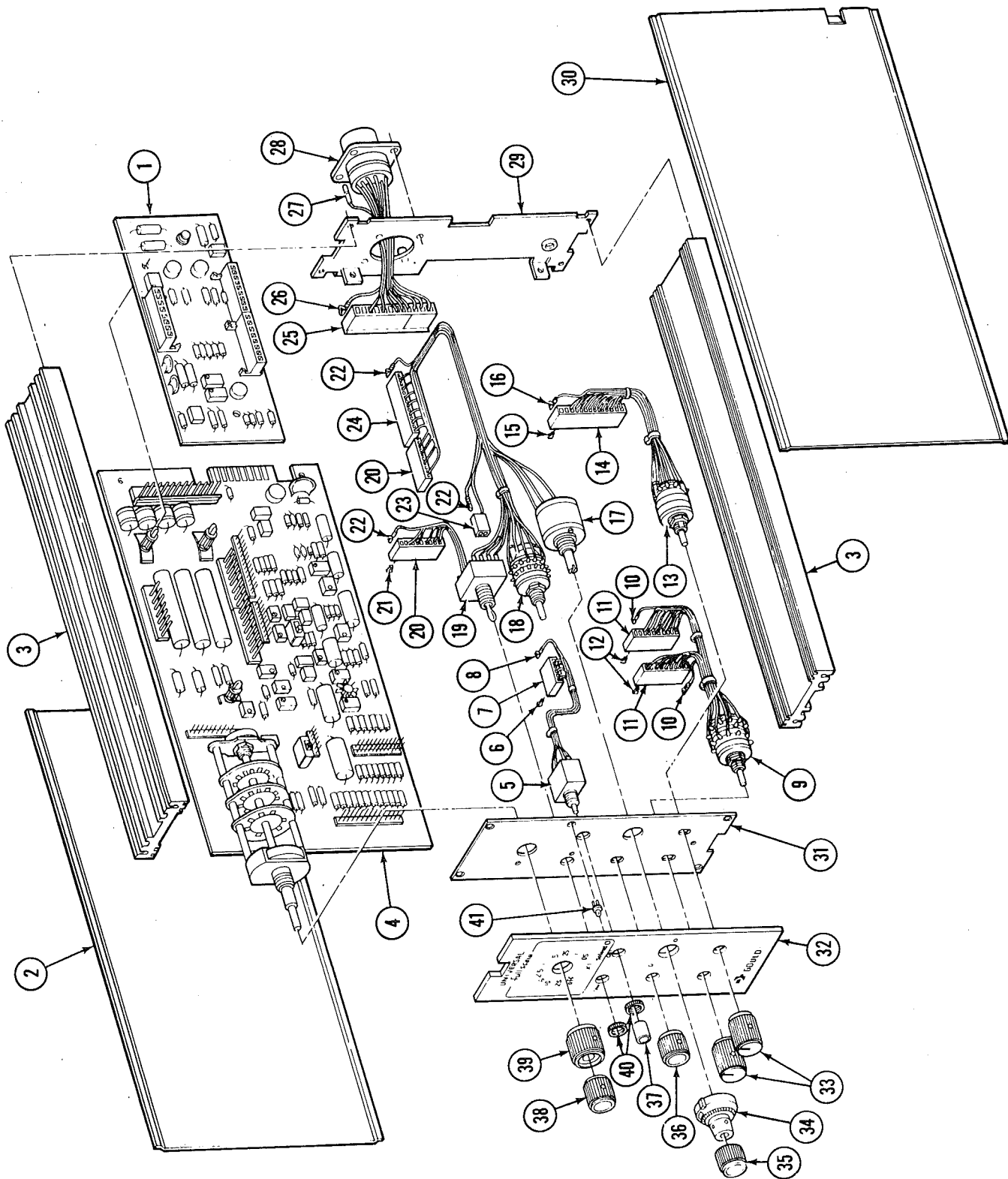


FIGURE 6-1 UNIVERSAL AMPLIFIER 13-4615-55,56

EXPLODED VIEW PARTS LIST
 AMPLIFIER BOARD 889845 and 891851
 UNIVERSAL AMPLIFIER 13-4615-55,56
 FIGURE 6-2

SYMBOL NUMBER	PART NUMBER	DESCRIPTION
	489468	Board, Printed Circuit
C201	290067-205	Capacitor, 2uf
C202	10-125904-203	Capacitor, 0.02uf
C203	290067-205	Capacitor, 2uf
C204	10-125904-203	Capacitor, 0.02uf
C205	262585-475	Capacitor, 4.7uf
C206*	262585-475	Capacitor, 4.7uf
C207*	290067-104	Capacitor, 0.10uf
C208*	10-247116-103	Capacitor, 0.01uf
C209	290067-334	Capacitor, 0.33uf
C210	290067-104	Capacitor, 0.10uf
C211	290067-334	Capacitor, 0.33uf
C212	10-125904-203	Capacitor, 0.02uf
C213	290091-203	Capacitor, 0.02uf
CR201	280435-2	Diode, 1N823A
CR202	280435-2	Diode, 1N823A
CR203	249747	Diode, 1N752A
CR204	244896	Diode, 1N458A
CR205	244896	Diode, 1N458A
E1 Thru E5	265154	Contact
E201 Thru. E203	283172-1	Surge Protector
J201	1-281711-12	Connector, 12 pin
J202	9-285575-8	Connector, 8 pin
J203	9-285575-8	Connector, 8 pin
J204	1-287495-10	Connector, 10 pin
J205	1-287495-15	Connector, 15 pin
J206	1-287495-10	Connector, 10 pin
J207	1-287495-6	Connector, 6 pin
J208	1-287495-10	Connector, 10 pin
J209	1-287495-10	Connector,
J210	1-287495-15	Connector, 15 pin
Q201	247149	Transistor
R201	1-265969-20003	Resistor,
R202	25-265969-47502	Resistor, 475 Kohm
R203	269085-203	Resistor, variable, 20Kohm
R204	25-265969-47502	Resistor, 475 Kohm
R205	1-265969-20003	Resistor

* Board Assy 891851 only.

EXPLODED VIEW PARTS LIST
 AMPLIFIER BOARD 889845
 UNIVERSAL AMPLIFIER 13-4615-55, -56
 FIGURE 6-2 (Continued)

SYMBOL NUMBER	PART NUMBER	DESCRIPTION
R206	5-283654-1R0	Resistor, 1 ohm
R207	1-281851-40000	Resistor, 4 Kohm
R208	R1-288308-12001	Resistor, 12 Kohm
R209	1-281851-40001	Resistor, 40 Kohm
R210	25-284694-12002	Resistor, 120Kohm
R211	25-265969-40002	Resistor, 400Kohm
R212	25-265969-12003	Resistor, 1.2 Mohm
R213	5-241111-225	Resistor, 2.2 Mohm
R214	25-288308-50000	Resistor, 5 Kohm
R215	R1-288308-15001	Resistor, 15 Kohm
R216	269085-203	Resistor, variable, 20Kohm
R217	1-281851-16900	Resistor, 1.69Kohm, 1%, 1/8w
R218	1-281851-51100	Resistor, 5.11Kohm, 1%, 1/8w
R219	1-281851-16901	Resistor, 16.9 Kohm, 1%, 1/8w
R220	1-281851-51101	Resistor, 51.1 Kohm, 1%, 1/8w
R221	1-281851-16902	Resistor, 169Kohm, 1%, 1/8w
R222	1-281851-51102	Resistor, 511Kohm, 1%, 1/8w
R223	R1-288308-20000	Resistor, 2Kohm
R224	R1-288308-20000	Resistor, 2Kohm
R225	R1-288308-40000	Resistor, 4Kohm
R226	R1-288308-12001	Resistor, 12. Kohm
R227	R1-288308-20001	Resistor, 2 Kohm
R228	269085-203	Resistor, variable, 20 Kohm
R229		Resistor, Part of S201
R230	1-281851-50000	Resistor, 5Kohm
R231	269085-103	Resistor, variable, 10Kohm
R232		Not Used
R233	5-283654-1R0	Resistor, 1 ohm, 5%, 1w
R234	1-281851-40000	Resistor, 4 Kohm
R235	R1-288308-12001	Resistor, 12Kohm
R236	1-281851-40001	Resistor, 40Kohm
R237	25-284694-12002	Resistor, 120Kohm
R238	25-265969-40002	Resistor, 400Kohm
R239	25-265969-12003	Resistor, 1.2 Mohm
R240	5-241111-225	Resistor, 2.2Mohm
R241	R1-288308-60000	Resistor, 6Kohm, .1%, 1/8w
R242	R1-288308-10001	resistor, 10Kohm, .1%, 1/8w
R243	R1-288308-20001	Resistor, 20Kohm, .1%, 1/8w
R244	R1-288308-60001	Resistor, 60Kohm, .1%, 1/8w
R245	R1-288308-40000	Resistor, 4Kohm

EXPLODED VIEW PARTS LIST
 AMPLIFIER BOARD 889845
 UNIVERSAL AMPLIFIER 13-4615-55, -56
 FIGURE 6-2 (Continued)

SYMBOL NUMBER	PART NUMBER	DESCRIPTION
R246	269085-103	Resistor, variable, 10Kohm
R247	1-281851-16900	Resistor, 1.69Kohm, 1%, 1/8w
R248	1-281851-51100	Resistor, 5.11 Kohm, 1%, 1/8w
R249	1-281851-16901	Resistor, 16.9 Kohm, 1%, 1/8w
R250	1-281851-51101	Resistor, 51.1Kohm, 1%, 1/8w
R251	1-281851-16902	Resistor, 169Kohm, 1%, 1/8w
R252	1-281851-51102	Resistor, 511Kohm, 1%, 1/8w
R253	269085-103	Resistor, variable, 10Kohm
R254	25-288308-25000	Resistor, 2.5Kohm
R255	269085-103	Resistor, variable, 10Kohm
R256	5-241111-102	Resistor, 1Kohm
R257	1-281851-11000	Resistor, 1.1Kohm
R258	1-281851-11000	Resistor, 1.1Kohm
R259	25-288308-14000	Resistor, 1.4Kohm
R260	269085-202	Resistor, variable, 2Kohm
R261	25-288308-10502	Resistor, 105Kohm
R262	269085-203	Resistor, variable, 20Kohm
R263	269085-102	Resistor, variable, 500ohm
R264	1-281851-13701	Resistor, 13.7Kohm
R265	269085-103	Resistor, variable, 10Kohm
R266	1-281851-16900	Resistor, 1.69Kohm
R267	1-281851-90000	Resistor, 9Kohm
R268	R1-288308-40000	Resistor, 4Kohm
R269	25-288308-40000	Resistor, 4Kohm
R270	269085-202	Resistor, variable, 1Kohm
R271	25-265969-33300	Resistor, 3.3Kohm
R272	1-281851-49502	Resistor, 49.5Kohm
R273	269085-201	Resistor, variable, 200ohm
R274	25-265969-303R0	Resistor, 380ohm
R275	269085-502	Resistor, variable, 5Kohm
R276	1-281851-20001	Resistor, 23Kohm
R277	5-241111-471	Resistor, 470ohm
R278	5-241111-161	Resistor, 160ohm
R279	5-241111-104	Resistor, 100Kohm
R280	5-241111-475	Resistor, 4.7Mohm
R281	1-281851-50000	Resistor, 5Kohm
R282	1-281851-19101	Resistor, 19.1Kohm
R283	269085-103	Resistor, variable, 10Kohm
R284	5-241111-224	Resistor, 220Kohm
R285	5-241111-224	Resistor, 220Kohm

EXPLODED VIEW PARTS LIST
 AMPLIFIER BOARD 889845
 UNIVERSAL AMPLIFIER 13-4615-55,-56
 FIGURE 6-2 (Continued)

SYMBOL NUMBER	PART NUMBER	DESCRIPTION
R286	5-241111-333	Resistor, 33Kohm
R287	5-241111-184	Resistor, 180Kohm
R288	5-241111-184	Resistor, 180Kohm
R289	5-241111-224	Resistor, 220Kohm
S201	289744	Switch, Rotary
S202	289742	Switch, Slide
S203	289742	Switch, Slide
TP1 Thru TP10	265763-3	Contact
U201	291721	Semiconductor
U202	291721	Semiconductor
U203	289385	Semiconductor
U204	289385	Semiconductor
U205	289385	Semiconductor
U206	280863-3	Semiconductor
U207	289385	Semiconductor
U208	289385	Semiconductor
U209	289385	Semiconductor
U210	283948	Semiconductor
CR206	291757	Current Regulator (891851 only)
CR207	291757	Current Regulator (891851 only)
CR208	291757	Current Regulator (891851 only)

EXPLODED VIEW PARTS LIST
INPUT BOARD ASSEMBLY 889846
UNIVERSAL AMPLIFIER 13-4615-55
FIGURE 6-3

SYMBOL NUMBER	PART NUMBER	DESCRIPTION
C301	240352-501	Capacitor, 500pf
C302	240352-501	Capacitor, 500pf
C303	288755-104	Capacitor, 0.1mf
C304	288755-104	Capacitor, 0.1mf
C305	262585-475	Capacitor, 4.7mf
C306	262585-475	Capacitor, 4.7mf
C307	262585-475	Capacitor, 4.7mf
C308	262585-475	Capacitor, 4.7mf
C309	10-288757-560	Capacitor, 56pf
C310	10-288757-560	Capacitor, 56pf
P202	9-285314-8	Connector
P203	9-285314-8	Connector
Q301	291729	Field Effect Transistor
R301	1-290003-60001	Resistor, 60Kohm, 1%, 3w
R302	R05-246659-20001	Resistor, 20Kohm, .05%, 1/4w
R303	1-281851-50R00	Resistor, 50ohm, 1%, 1/8w
R304	R1-288308-10001	Resistor, 10Kohm, .1%, 1/8w
R305	25-288308-400R0	Resistor, 400 ohm, .25%, 1/8w
R306	269085-101	Resistor, 100ohm variable, 20%
R307	1-290003-60001	Resistor, 60Kohm, 1%, 3w
R308	R05-246695-20001	Resistor, 20Kohm, .05%, 1/4w
R309		Not Used
R310	269085-101	Resistor, 100ohm variable, 20%
R311	R1-288308-10001	Resistor, 10Kohm, .1%, 1/8w
R312	R1-288308-50000	Resistor, 5Kohm, .1%, 1/8w
R313		Not Used
R314	R1-288308-50000	Resistor, 5Kohm, .1%, 1/8w
R315	25-288308-50000	Resistor, 5Kohm, .1%, 1/8w
R316	269085-201	Resistor, 200ohm variable, 20%
R317	25-288308-50000	Resistor, 5Kohm, .1%, 1/8w
R318	269085-103	Resistor, 10Kohm variable, 20%
R319	5-241111-101	Resistor, 100ohm, 5%, 1/4w
R320	5-241111-101	Resistor, 100ohm, 5%, 1/4w
R321	5-241111-473	Resistor, 47Kohm, 5%, 1/4w
R322	5-115557-565	Resistor, 5.6Mohm, 5%, 1/2w
R323	5-115557-565	Resistor, 5.6Mohm, 5%, 1/2w
R324	269085-501	Resistor, 500 ohm variable, 20%
TP1 thru TP8	265763-3	Contact, Male
U301	289661	Integrated Circuit
U302	289661	Integrated Circuit
U303	289661	Integrated Circuit
U304	289385	Integrated Circuit

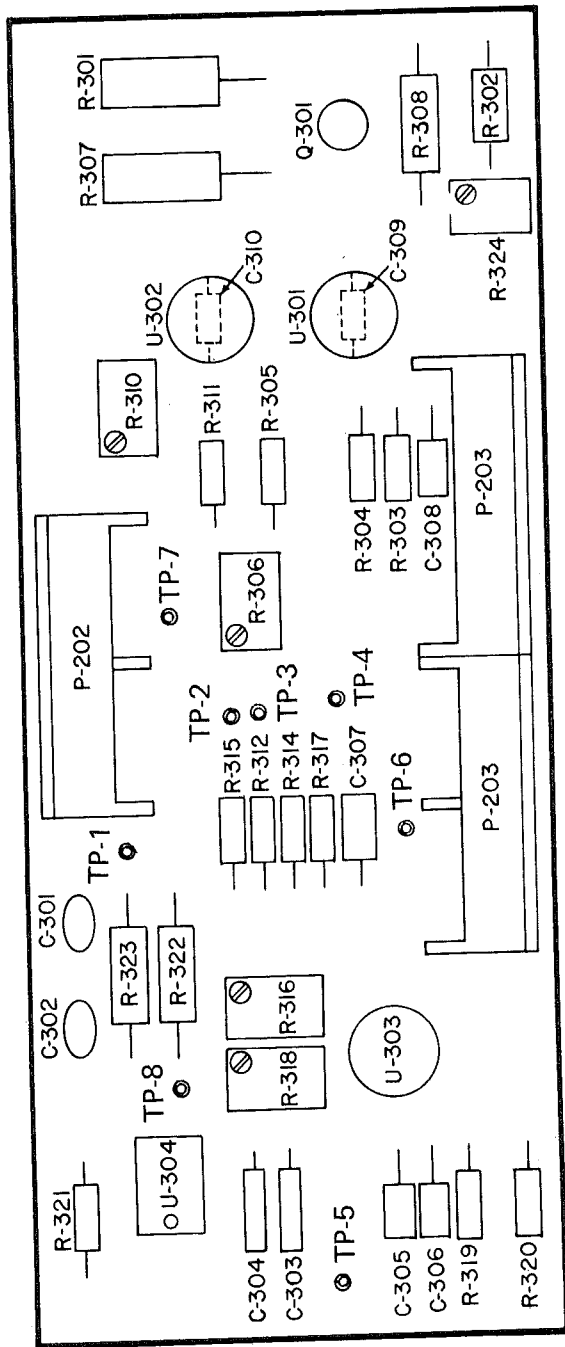


FIGURE 6-3 INPUT BOARD ASSEMBLY 889846

REV	REVISIONS	DATE
A-1	REVISED PER DAN 23713	2-7-78
B-1	REVISED TO INCLUDE 13-4615-56 : E. HOLTAKISS	4-9-78
C-1	REVISED PER DON 24256	10-6-78
D-1	REVISED PER DON 27904	3-24-81

