

**MAN/DOLPHIN COMMUNICATION**

**Final Report**

**15 December 1966 - 13 December 1967**

**APPENDIX B**

**Technical Manual MSA-2**

**Prepared for**

**U.S. NAVAL ORDNANCE TEST STATION  
China Lake, California**

**Contract No. No. N00123-67-C-1103**

**by**

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## Introduction

The MSA 1 is a real time multiple filter spectrum analyzer containing a built-in multichannel recorder. Electrical signal input is bandpass filtered, passed through an automatic gain control circuit if desired, and fed to a bank of L-C filters. The output of each filter is converted to D.C. current which drives a fixed recording stylus. Dry electrosensitive recorder paper is used, so that the presence of current in a stylus is indicated by a dark trace. Dynamic range of this readout is six to seven shades of gray, corresponding to a 30 to 40 db. range of current. Thirty styli spaced .05 inch apart are employed.

## Operating Instructions

### 1. Power Requirements

Insert the female end of the a. c. power cord into the male connector located on the rear panel of the unit. Plug the male end into a 115 volt 60 Hz a. c. grounded outlet. (NOTE: the chassis is isolated from the power line except for stray capacitance in the power transformers and motor. In applications using a high-gain preamplifier or other sensitive equipment, it may be preferable to ground the MSA chassis via the preamplifier, rather than the power cord, in order to avoid a ground loop.)

### 2. Control Settings

Two gain controls facilitate optimum readout adjustment. The WRITING control sets overall darkness of the trace, and the INPUT control is used to adjust image contrast. In operation, the controls are adjusted so that the panel meter reads approximately 0 db when signal is present, and drops 6 to 12 db for background noise only. This applies only when the AGC is switched to the ON position; otherwise the input is amplified linearly and the two controls are simply cascaded. When the AGC is switched OFF, the writing control should be at maximum clockwise setting, and the writing density adjusted with the INPUT control for minimum distortion. Maximum contrast and differentiation between signal levels is obtained with the AGC off.

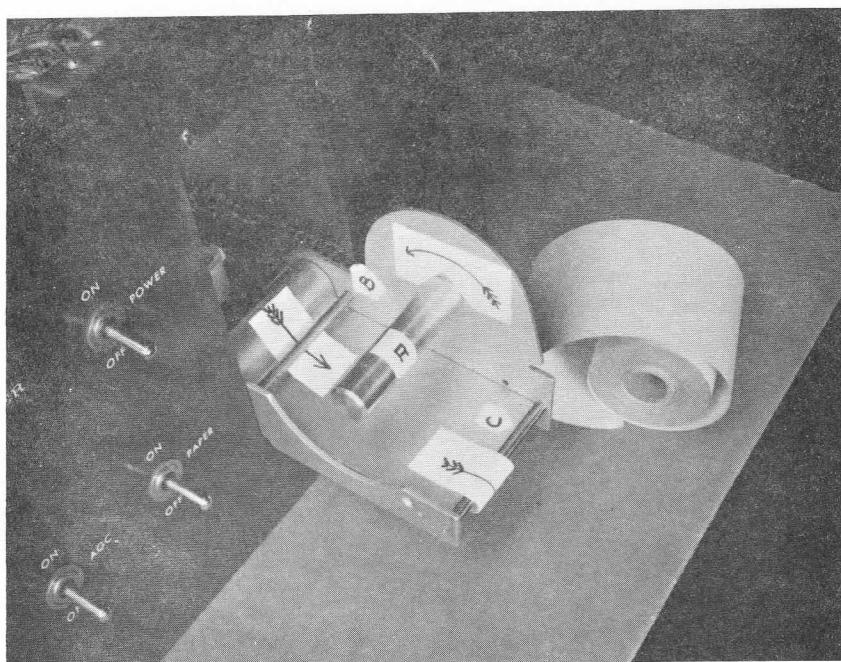
Voltages for the electronic circuitry are controlled by the POWER switch located near the top of the recorder opening in the front panel. Power should be switched off whenever the

recorder is being opened or closed, and to avoid accumulation of a deposit on the styli whenever the paper is not moving but input signals are present. Paper motion is controlled by the PAPER switch, independent of the POWER switch. A jack on the rear panel is connected to an internally-powered 24-volt relay in parallel with the toggle switch.

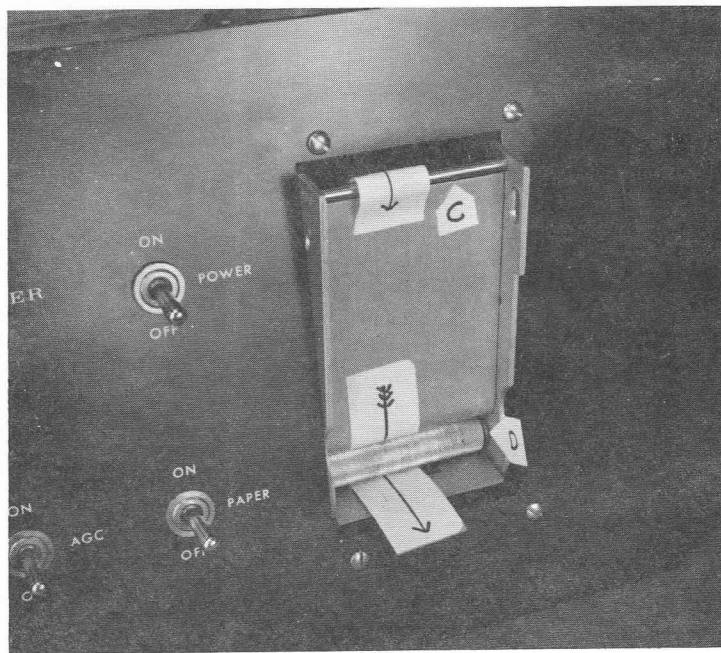
Input is connected at the front panel by means of a standard quarter-inch phone plug. The input signal is bandpass filtered so that the AGC circuitry responds only to signals in the overall bandpass of the spectrum analyzer.

### 3. Loading Recorder Paper

1. Turn POWER switch OFF before opening recorder
  2. Open the recorder by means of the protruding tab at upper right corner of the recorder opening. Pull out and down.
  3. Unroll about six inches of paper and insert end behind and under guide rod B. After passing under the guide rod, coated side of the paper must be up.
  4. Pull end of recorder paper about six inches beyond guide rod C.
  5. Slide roll over spindle A.
  6. Rewind paper slightly to take up slack.
  7. Fold paper around guide rod C and close recorder.
  8. Insert end of paper at top of paper drive wheel D.
  9. Turn PAPER switch to ON position briefly to engage paper.
4. Connect the desired input at the front panel jack, using a standard 1/4 inch phone plug.



Loading of recording paper



##### 5. Use of the AGC Mode

- a. Switch AGC on
- b. Set writing control to maximum (cw).
- c. Set input control to minimum (ccw).
- d. Adjust input system for background noise only at the input of the MSA.
- e. Turn power switch on.
- f. Advance input control until VU meter reading levels off ( reduce writing level if VU indicator is driven off scale).
- g. Set writing control for 0 db. indication.
- h. Apply signal to input system.
- i. Reduce input control for 0 db. indication with signal applied.
- j. Switch paper drive on.
- k. Readjust level controls if desired.

### Troubleshooting

CAUTION! DANGEROUS VOLTAGES ARE PRESENT ON ALL PRINTED CIRCUIT CARDS. THE FILTER AND DRIVE AMPLIFIER ELECTRONICS ARE AT -150 VOLTS WITH RESPECT TO THE CHASSIS.

If a single filter appears to be malfunctioning, the corresponding stylus should be inspected for damage or dirt accumulation. Bent styli may be straightened with small long-nose pliers and cleaned with carbon tetrachloride, lighter fluid, or other solvents. The electronic drive circuit may be tested as outlined in the description of PC 4a; if trouble is found in the circuit, it is wise to replace all of the transistors in the stylus driver rather than trying to isolate a single defective transistor. In the event of transistor failure the environmental conditions should be checked carefully to make sure that adequate air flow is available and that transistor case temperature does not exceed 140 degrees F.

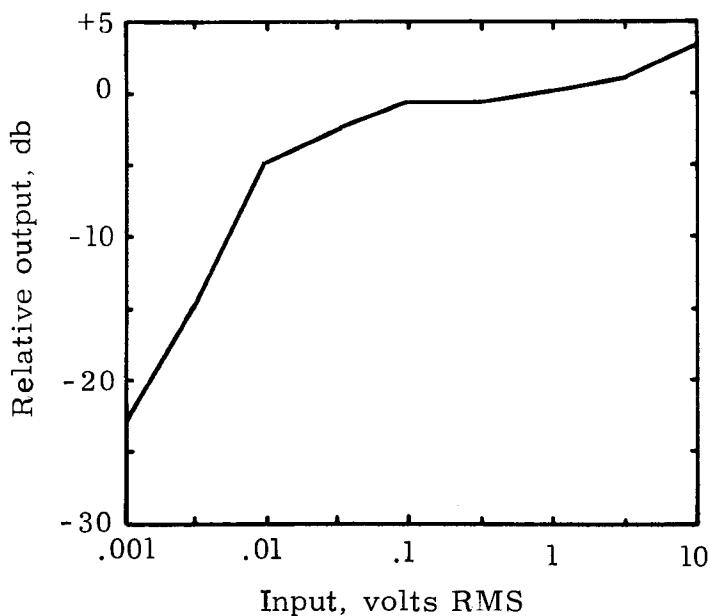
If several adjacent filters do not appear to be producing output, locate the associated printed circuit card, check the terminals for possible corrosion, and be sure the terminals are firmly seated in the circuit board connector socket.

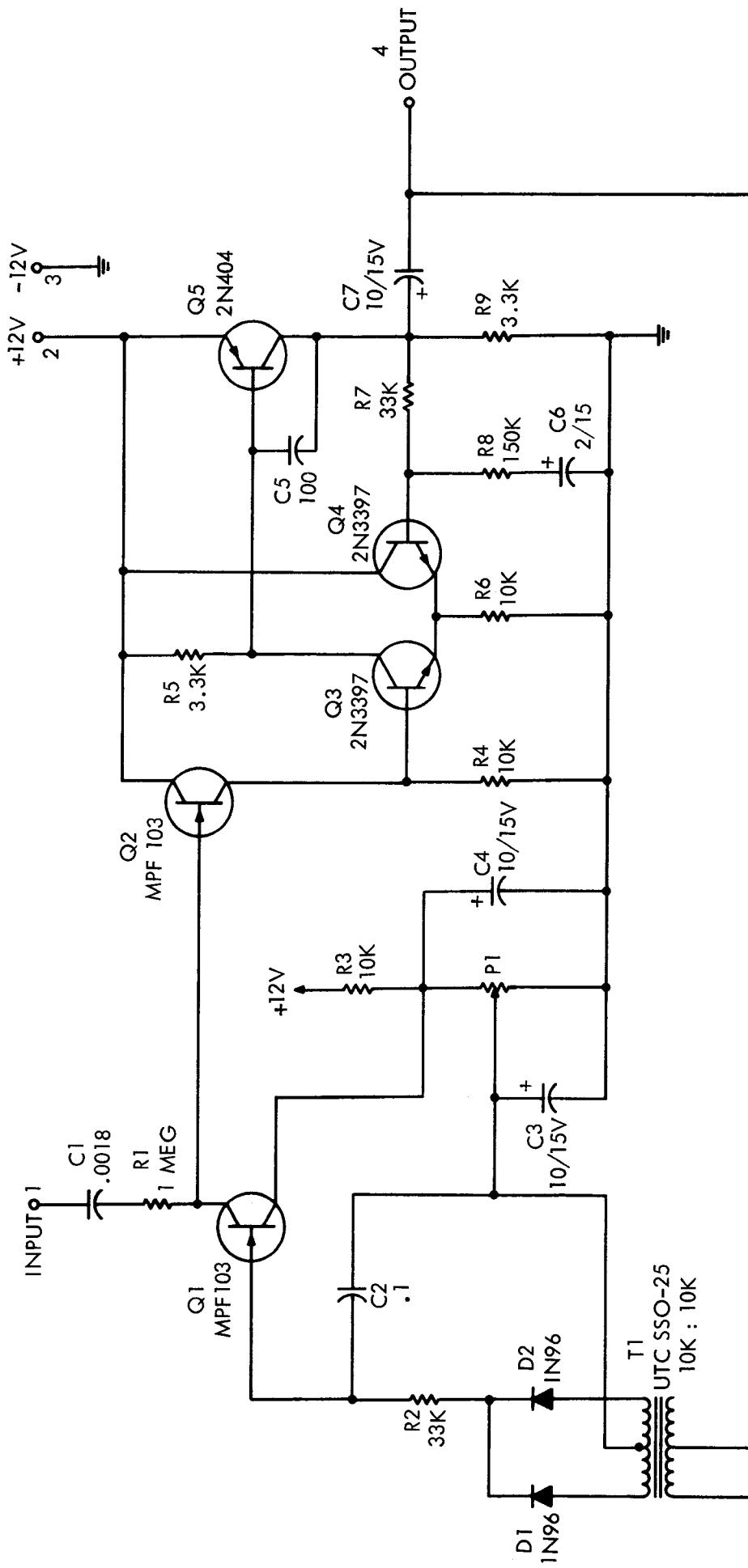
Nonuniform writing sensitivity from filter to filter may be caused by misalignment of the stylus assembly. The stylus mounting bracket may be loosened and, with a variable signal generator test input, the stylus assembly adjusted for uniform writing darkness.

## PC 20: AGC Module

The drain-to-source resistance of a field effect transistor varies inversely with  $1-V_g/V_p$ , where  $V_g$  is the gate voltage and  $V_p$  the pinch-off voltage of the transistor. This resistance is linear to within 1% provided that the signal voltage does not exceed 100 mv peak-to-peak. The resistance varies from a few hundred ohms at zero gate voltage to several megohms at cutoff for the MPF-103 transistor. With 1 Megohm input resistance the MPF-103 acts as a shunt attenuator with a 50 to 60 db range. In the circuit of PC 20, the drain voltage signal is applied to a second MPF 103 connected as a high input impedance source follower. The signal voltage is then amplified by a factor of 100. The output is full wave rectified and filtered, and the resultant dc is used to bias the transistor used as a variable resistor. Potentiometer P1 delivers offset voltage to the gate of the FET and permits adjustment of the output signal. A curve of the AGC characteristic of this module is shown below.

Transfer characteristic  
of PC-20 AGC Module:





P1 (output level): Burns 3607P-1-103 10K.

LISTENING, INC.  
PC-20 SCHEMATIC  
AGC MODULE  
13 FEB 1967 SL MOSHIER

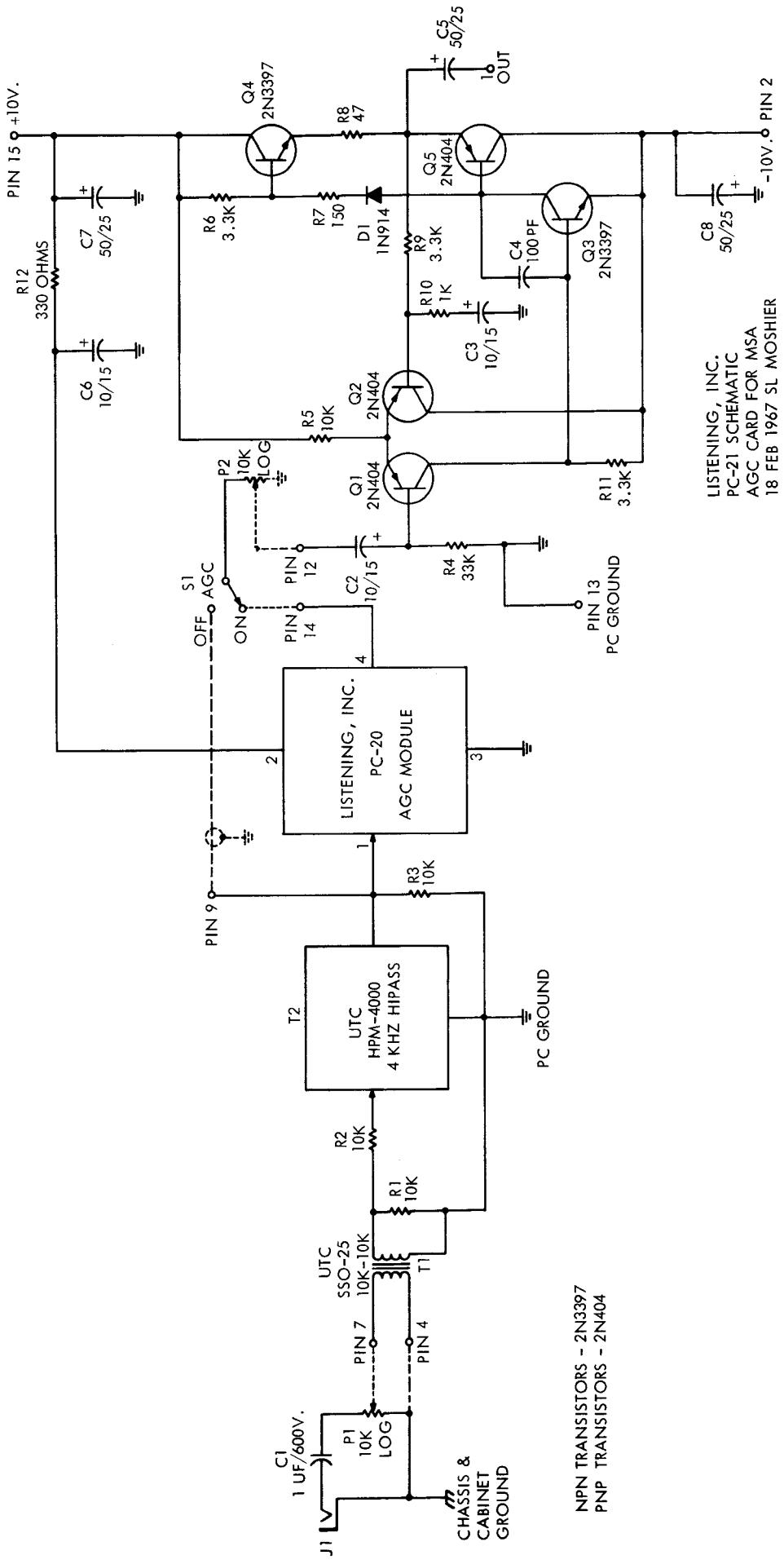
## PC 21: MSA AGC

PC 21 accepts input from the panel-mounted input preamplifier via a 10k : 10k transformer. The preamplifier operates at chassis potential, while the AGC card is at - 150 volts with respect to the chassis. The input is applied to a high-pass filter with a 40 db per octave cutoff outside the passband of the filter bank.

After filtering, the signal is amplitude controlled by a PC 20 AGC module adjusted for 0.5 volt rms output. The module is mounted inside a shield can. The signal is now brought out to the front panel WRITING control and back to a power amplifier with a voltage gain of 10. The output of this amplifier drives the filter bank. Connections are brought out to switch the AGC module in or out of the circuit.

### Pin Connections:

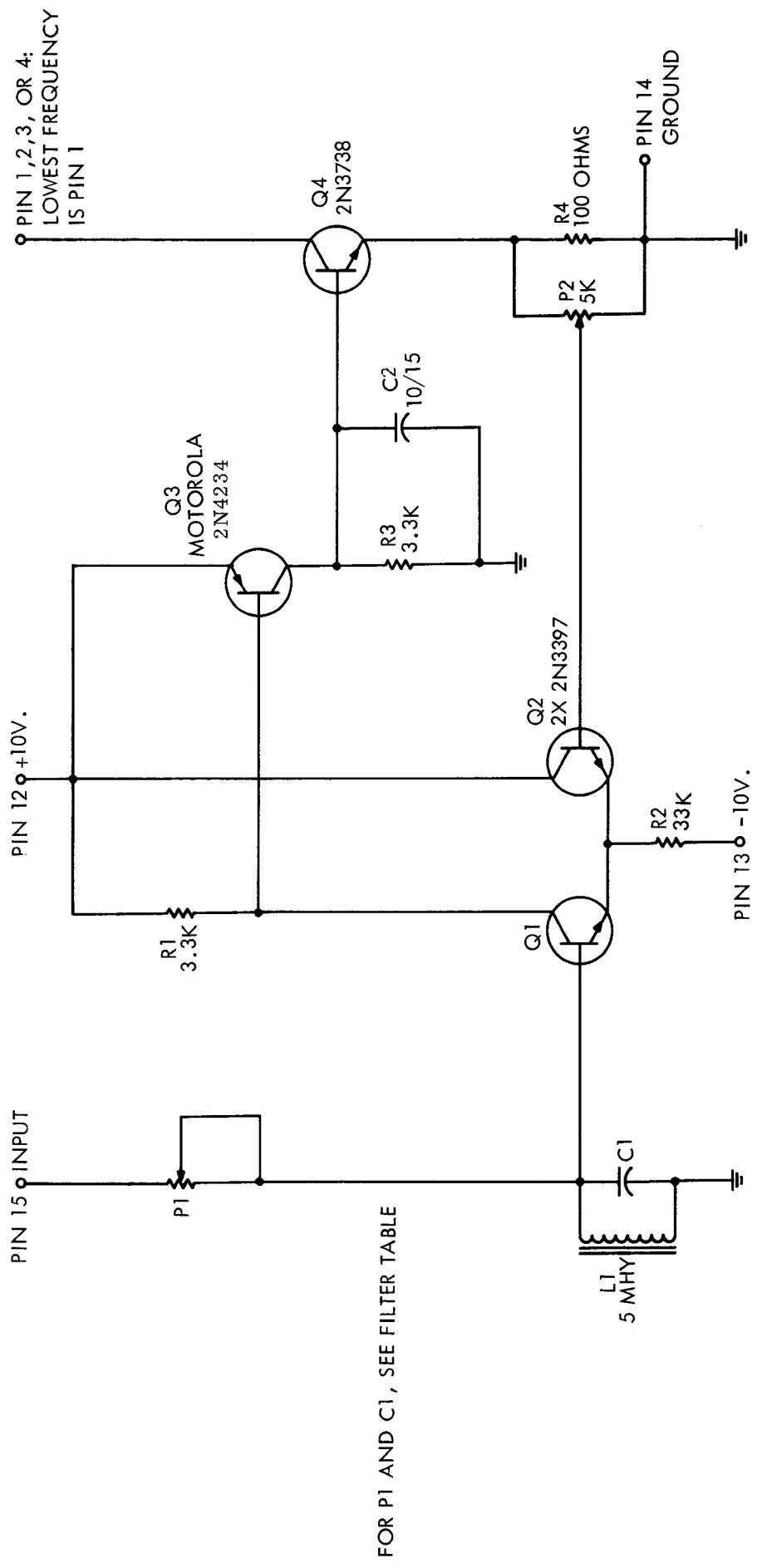
1. Output to filters
2. -10 volts
4. Input signal
7. Input signal (chassis ground)
9. Filtered input to AGC switch "off" position
12. Input to power amplifier to AGC switch common.
13. Circuit board ground
14. AGC output from PC 20, to AGC
15. + 10 volts



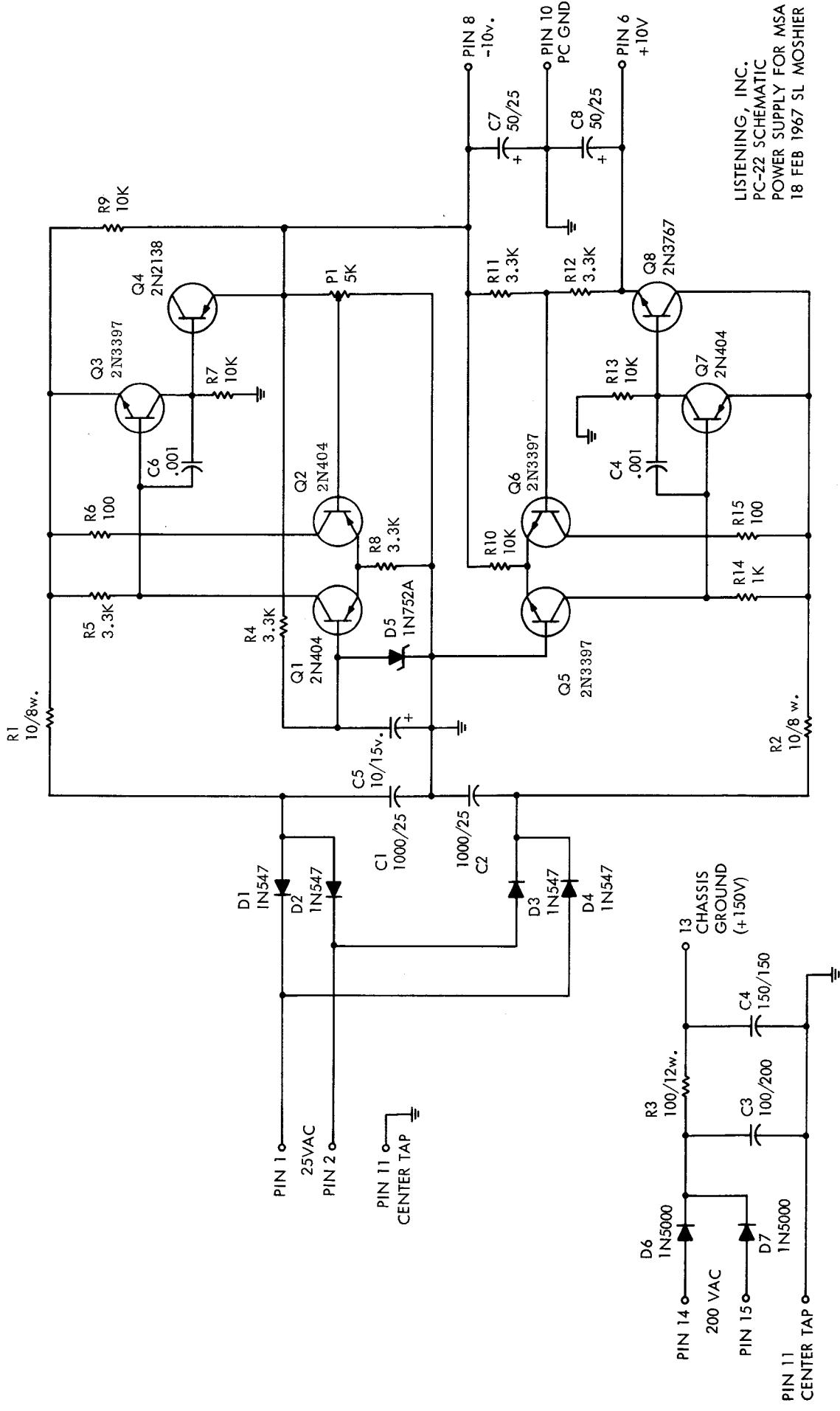
#### PC 4a Filter and Stylus Driver

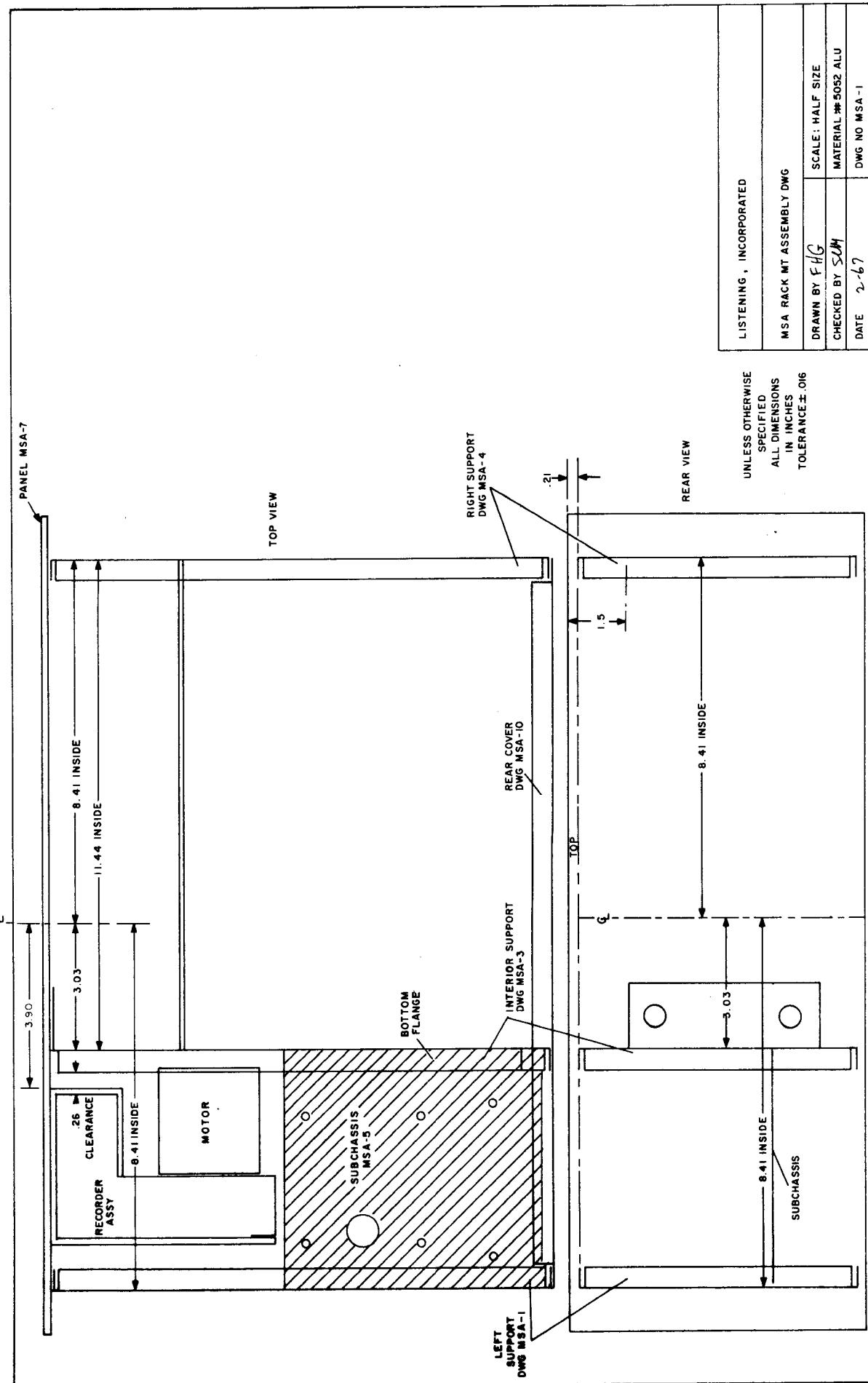
Signal input is filtered by a tuned LC circuit; potentiometer P1 adjusts the filter bandwidth. The ac voltage across the tuned circuit is fed to a differential peak rectifier having a 30 msec RC time constant inside the feedback loop. Output current in the collector of the power transistor is adjusted by potentiometer P2.

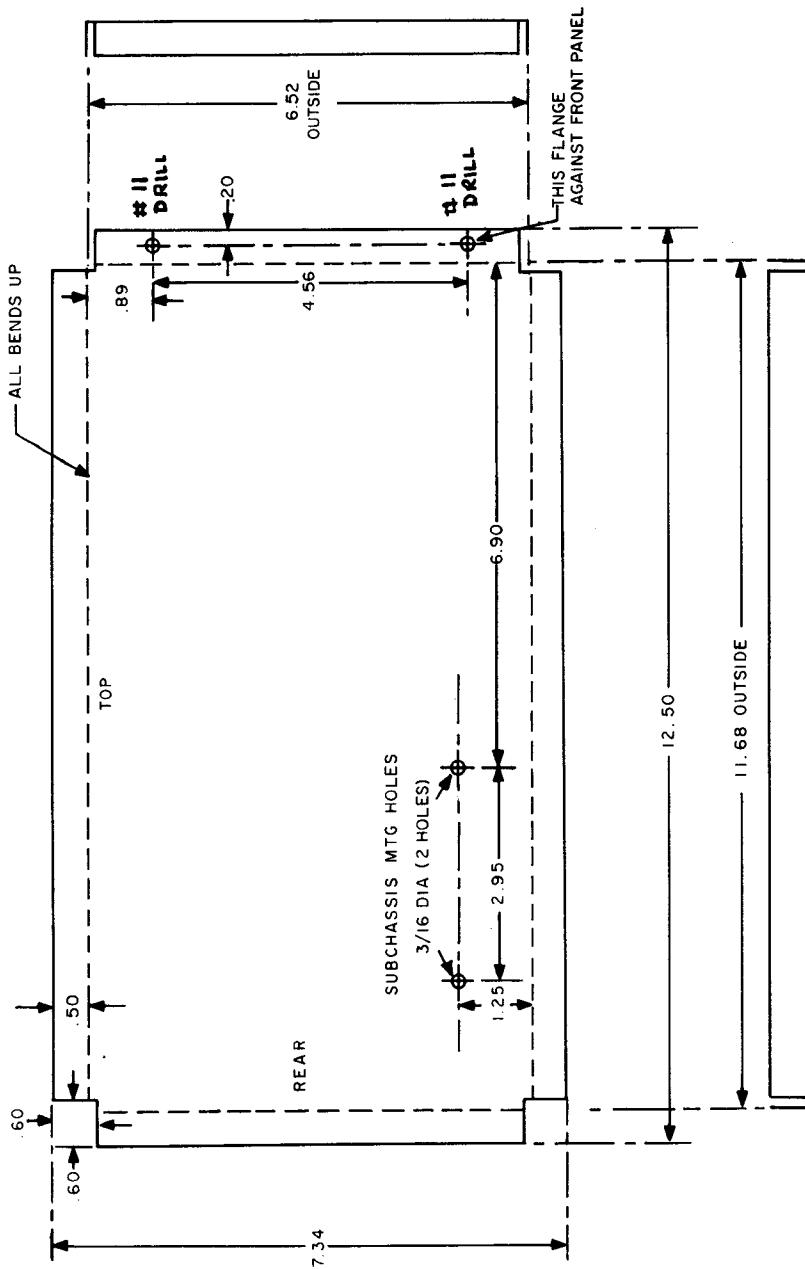
If testing of the circuit is required, the writing stylus should be insulated from the chassis by opening the recorder. Then a milliammeter can be inserted with the positive terminal connected to the chassis and the negative terminal connected to the appropriated output pin on the printed circuit card, or directly to the power transistor case. A zero db (3 volts rms) sine wave input signal at the center frequency of the filter should produce 40 mA dc output current. Filter bandwidth is specified at the 6 db (half-current) points.



LISTENING, INC.  
 PC-4a SCHEMATIC  
 FILTER & STYLUS DRIVER MODULE  
 FOR MSA  
 18 FEB 1967 SL MOSHIER





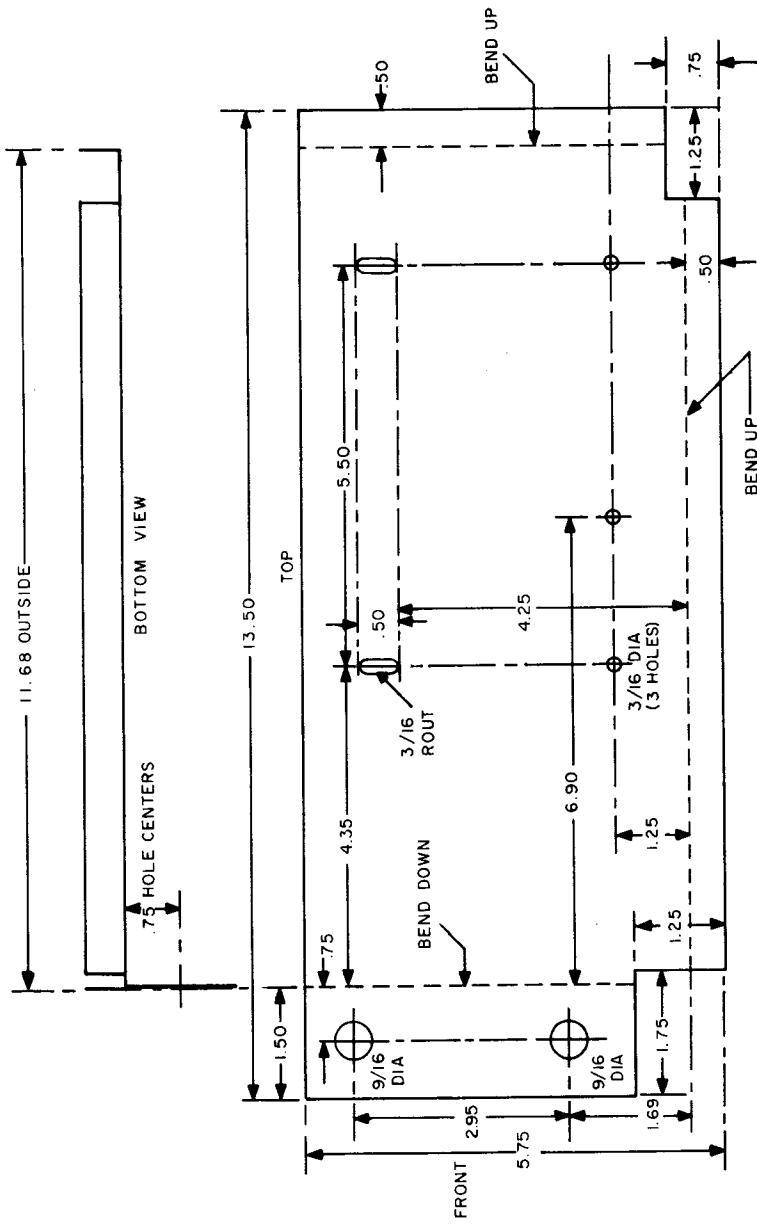


UNLESS OTHERWISE SPECIFIED  
ALL DIMENSIONS IN INCHES  
TOLERANCE  $\pm .016$

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LEFT SUPPORT QUANTITY = 1

DRAWN BY FHC	SCALE : HALF SIZE
CHECKED BY SCW	MATERIAL # 5052 ALU 0.016 THK
DATE 2-67	DWG NO MSA 2

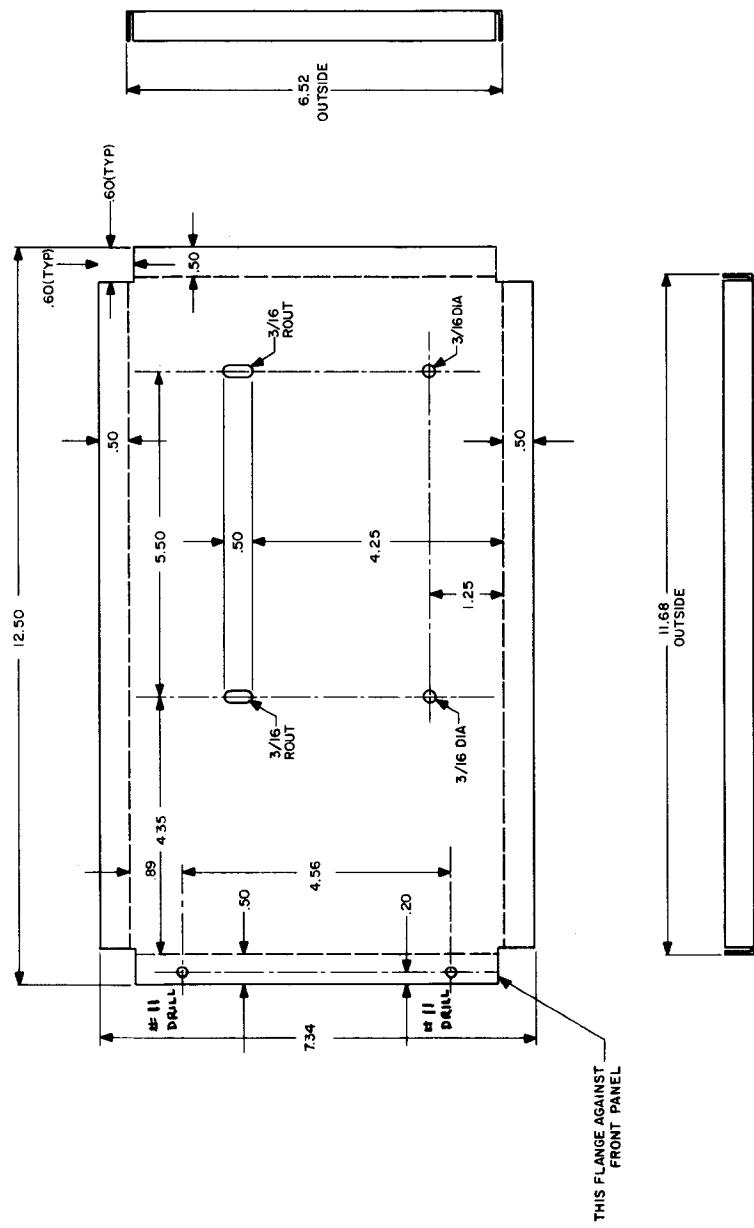


UNLESS OTHERWISE SPECIFIED  
ALL DIMENSIONS IN INCHES  
TOLERANCE  $\pm .016$

LISTENING, INCORPORATED

INTERIOR SUPPORT QUANTITY: 1

DRAWN BY F/H/G.	SCALE : HALF SIZE
CHECKED BY SLM	MATERIAL #5052 ALU 080 THK
DATE 2-67	DWG NO MSA 3

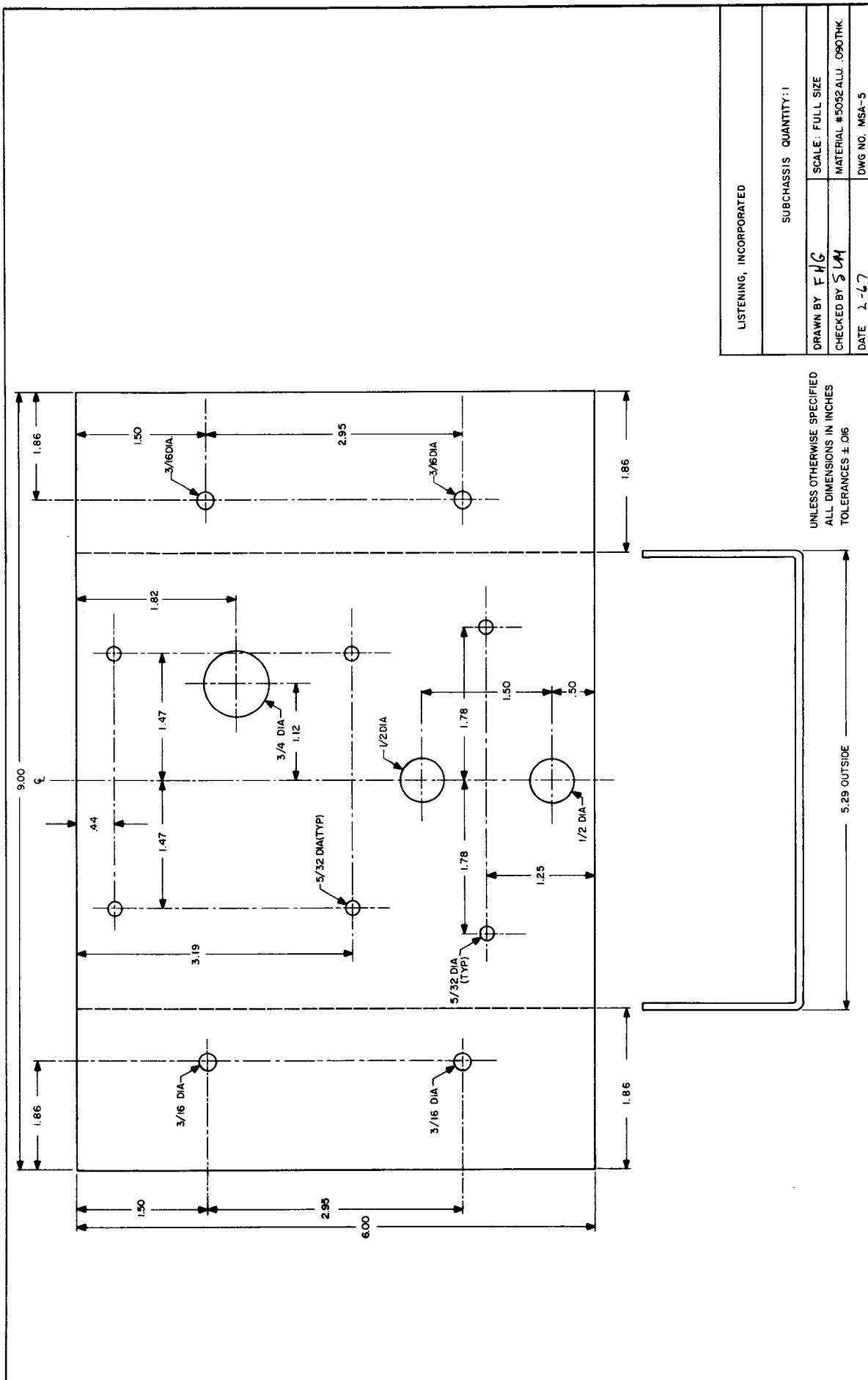


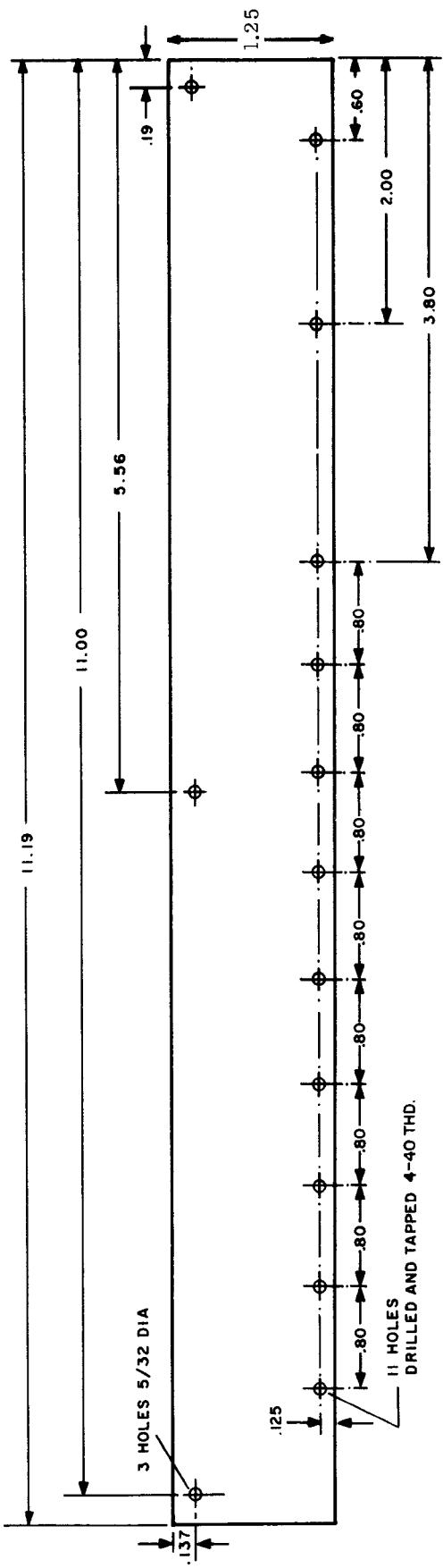
UNLESS OTHERWISE SPECIFIED  
ALL DIMENSIONS IN INCHES  
TOLERANCE  $\pm .016$

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RIGHT SUPPORT QUANTITY: 1

DRAWN BY	SCALE: 1/2 SIZE
CHECKED BY <i>S. M.</i>	MATERIAL #5052 ALU. 0.50 THK.
DATE 2-67	DWG NO. MSA-4



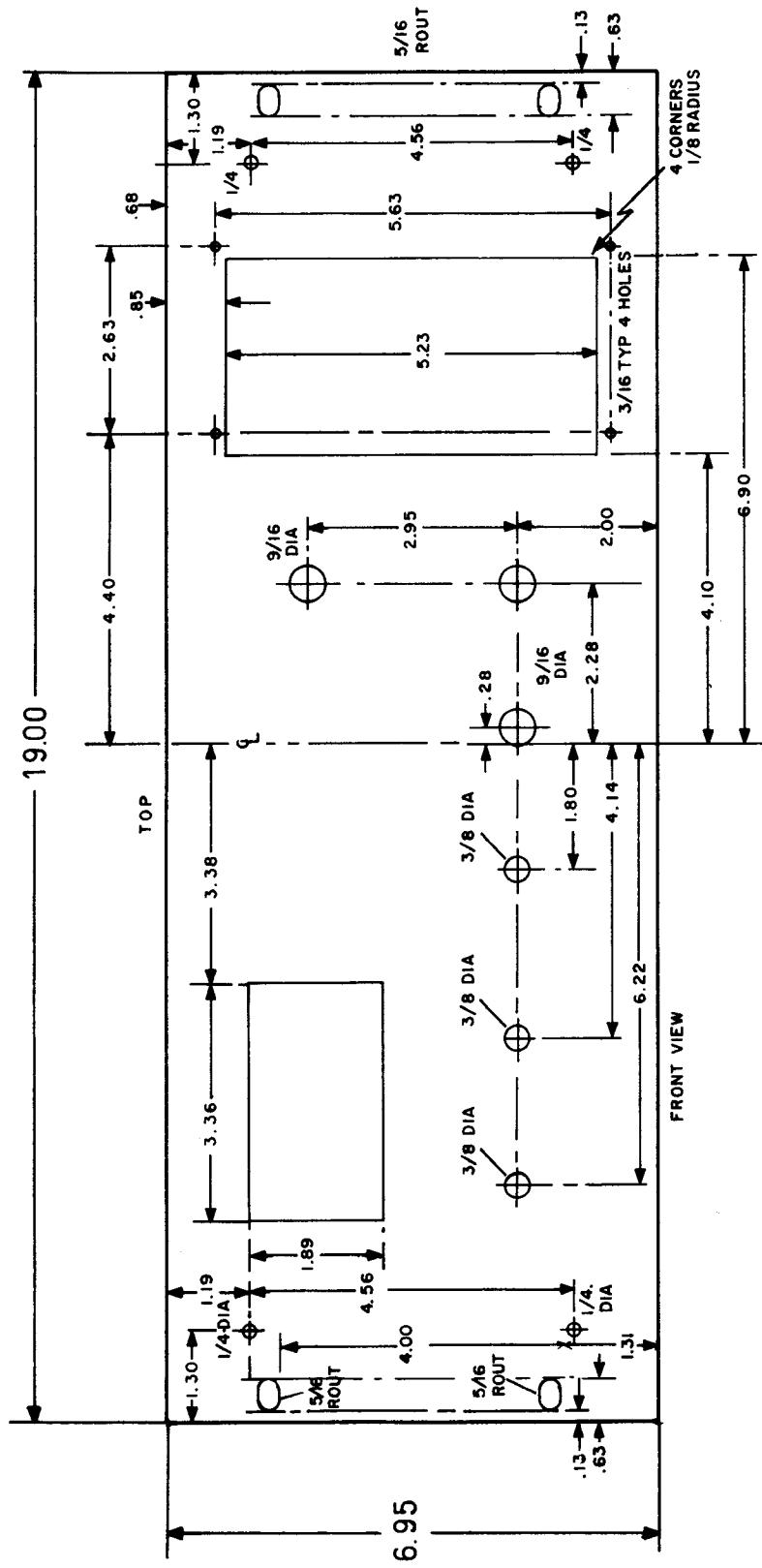


UNLESS OTHERWISE SPECIFIED  
ALL DIMENSIONS IN INCHES  
TOLERANCE  $\pm 0.016$

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CONNECTOR MOUNTING PLATE QUANTITY:2

DRAWN BY F. Gray	SCALE: FULL SIZE
CHECKED BY SLM	MATERIAL # 5052 ALUM .125 THK
DATE 2-6-7	DWG NO. MSA-6

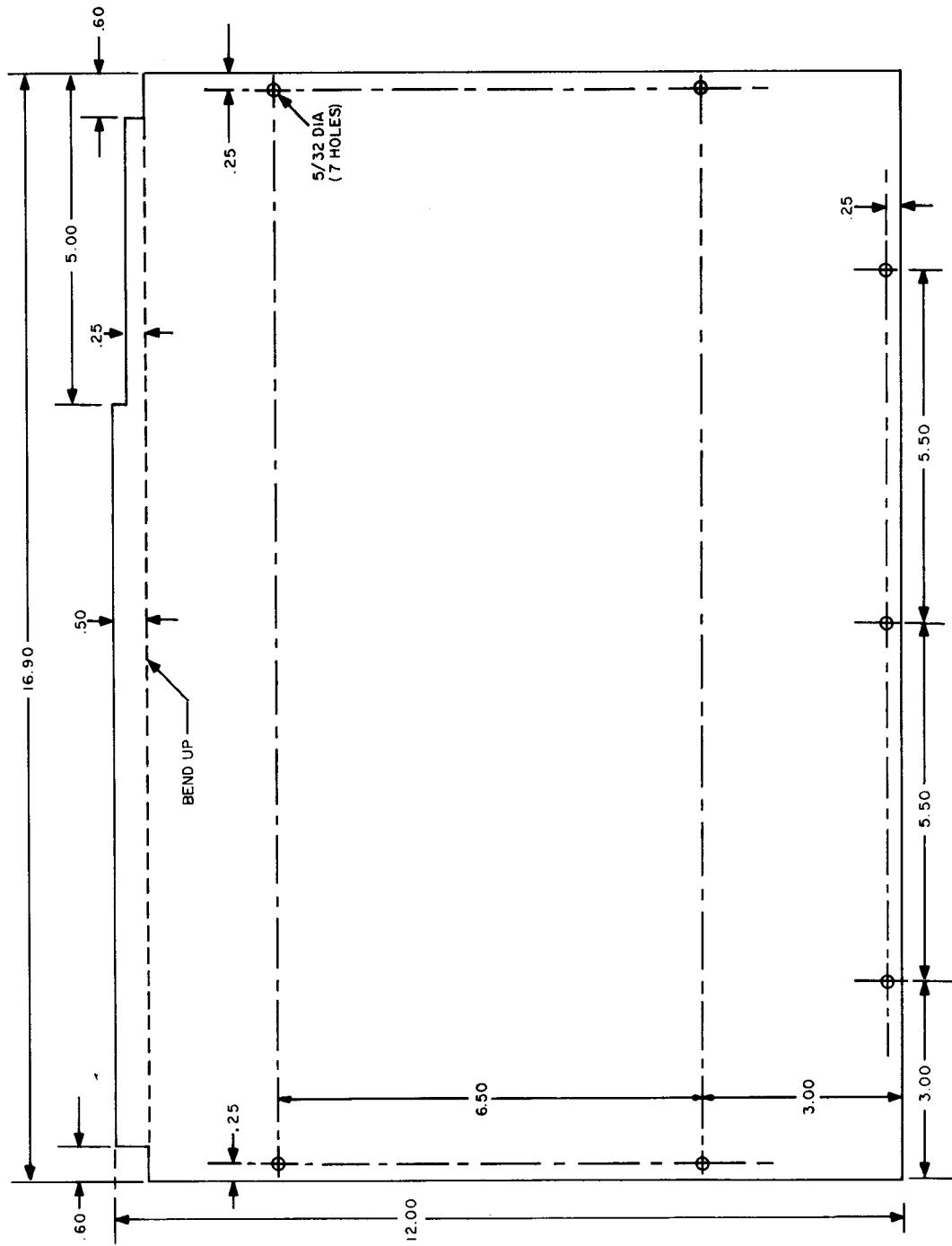


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MSA RACK MT. FRONT PANEL QUANTITY: 1

DRAWN BY F/G	SCALE: FULL SIZE
CHECKED BY <u>SUM</u>	MATERIAL # 5052 ALUM 3/16THK
DATE 2-67	DWG NO. MSA -7

UNLESS OTHERWISE SPECIFIED  
ALL DIMENSIONS IN INCHES  
TOLERANCE  $\pm .016$

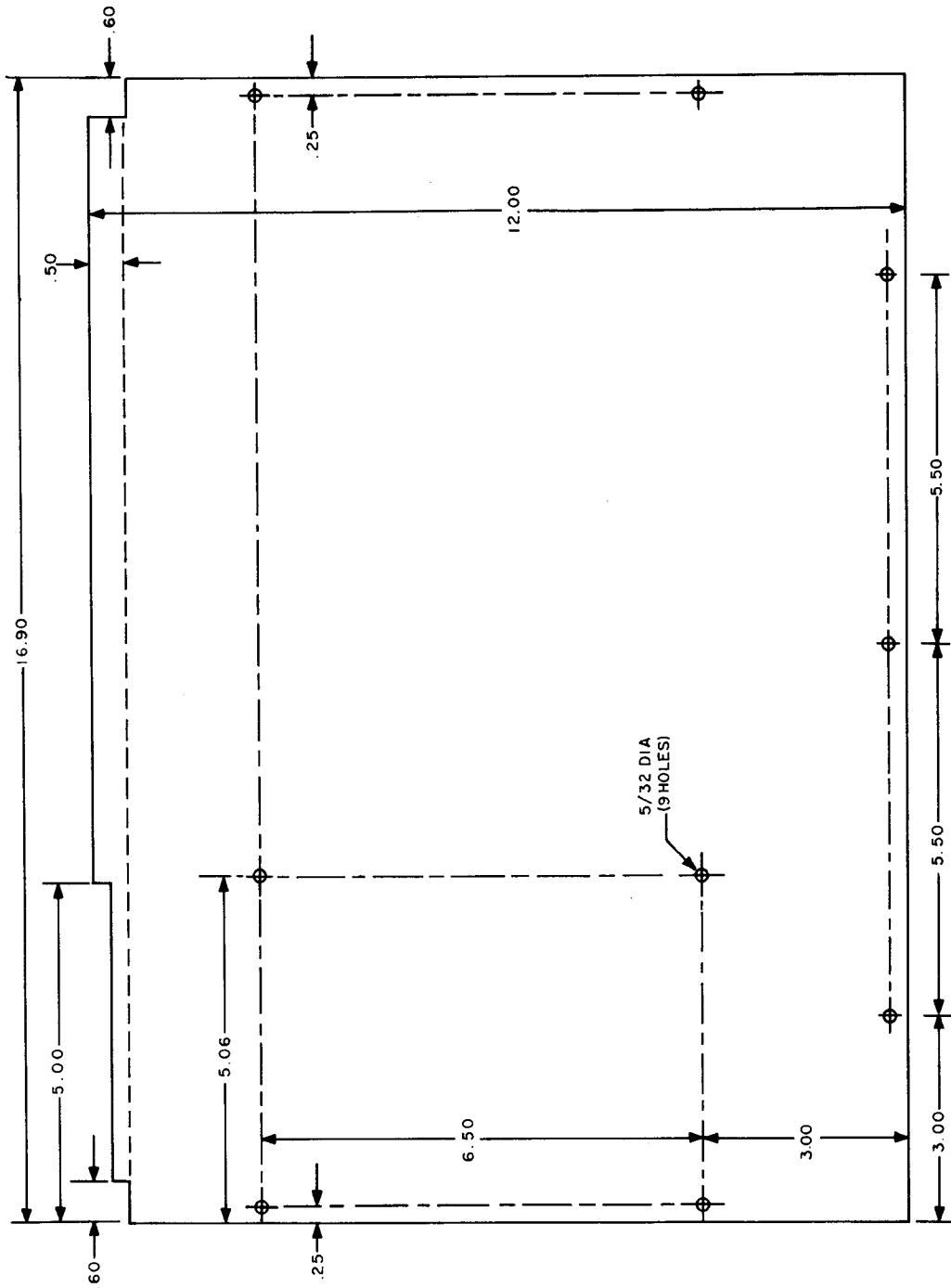


UNLESS OTHERWISE SPECIFIED  
ALL DIMENSIONS IN INCHES  
TOLERANCE  $\pm .016$

LISTENING, INCORPORATED

MSA RACK MT TOP COVER

DRAWN BY <i>FHG</i>	SCALE: HALF SIZE
CHECKED BY <i>SJM</i>	MATERIAL # 5052 ALU .090 THK
DATE 2-6-7	DWG NO MSA 8



UNLESS OTHERWISE  
SPECIFIED  
ALL DIMENSIONS  
IN INCHES  
TOLERANCE  $\pm 0.16$

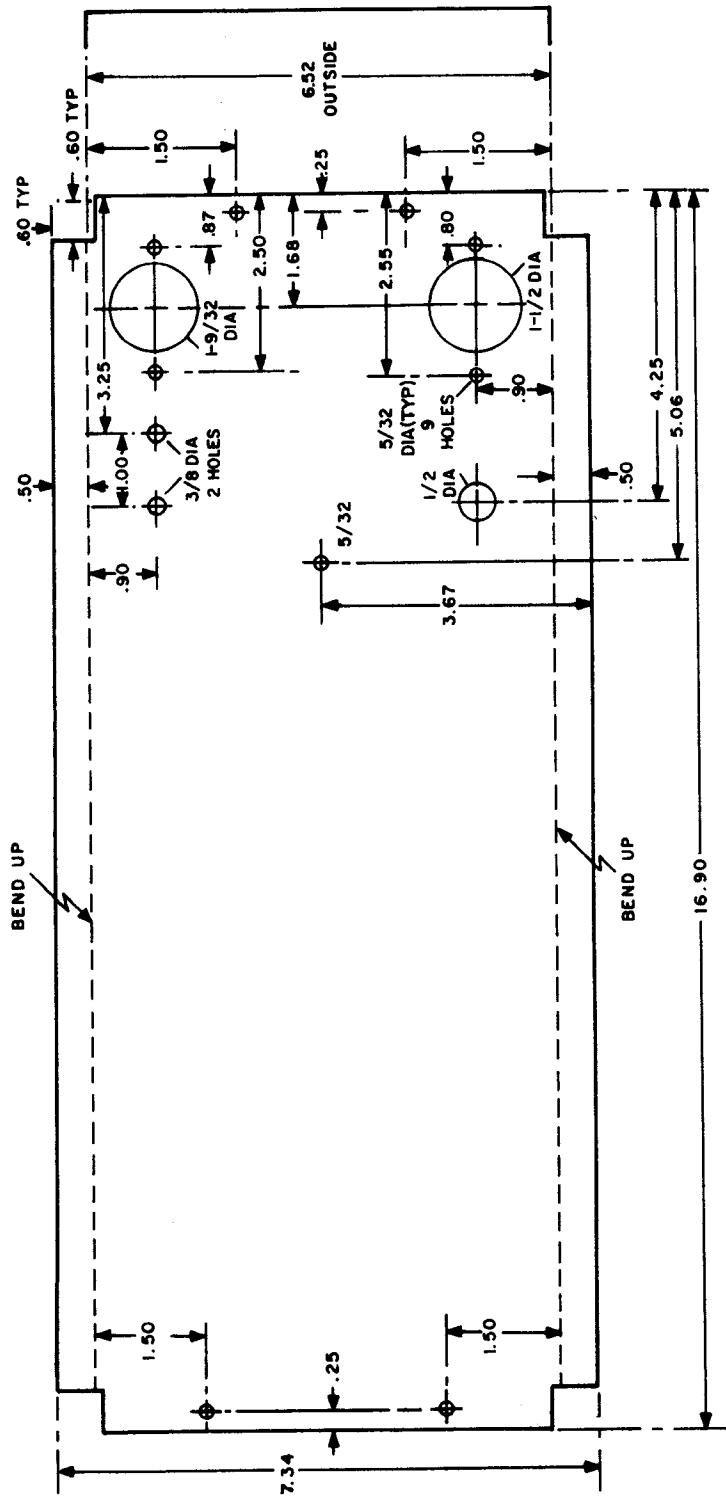
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MSA BACK MT BOTTOM COVER

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UNLESS OTHERWISE SPECIFIED  
ALL DIMENSIONS IN INCHES  
TOLERANCE  $\pm 0.16$

LISTENING, INCORPORATED

### REAR COVER QUANTITY: 1

DRAWN BY	F H G	SCALE: HALF SIZE
CHECKED BY	S M	MATERIAL: #5052 ALUM .090 THK.
DATE	2-67	DWG NO. MSA-10