LEVEL GUARD

AGC AMPLIFIER

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SECTION I
GENERAL INFORMATION

1.1 General

This manual gives detailed installation and operational instructions, as well as theory of operation and alignment descriptions for the Elcom Specialty Products (ESP) Level Guard AGC Amplifier.

1.2 Functional Description

The Level Guard is a superior single-band AGC (automatic gain control) amplifier that is capable of holding the output level within several dB of a preset ceiling, despite input variations of 10 to 20 dB. The signal is processed by an optical attenuator consisting of an LED (light emitting diode) and an LDR (light dependant resistor). This technique yields very smooth and unnoticeable level control while offering fast attack, and a switchable (fast or slow) non-linear release function. Since audio level is not controlled by actively biased semiconductors, distortion -- especially intermodulation -- is minimized. Overall performance will thus reveal itself in the form of very clean audio, with its action remaining inaudible at all times.

The device is designed to be compatible with most limiters currently on the market. While its attack time is fast, its release time is quite slow. Utilizing closed-loop control theory (refer to Section IV, Theory of Operation), the Level Guard is designed to perform a "gain riding" function. It is not intended to significantly alter the amplitude range of the program material by compression. It is basically similar to an operator "riding a pot", but with superior speed and accuracy.

The ESP Level Guard is ideally suited for automated stations where source level can vary trememdously, or for live operations where operators do not carefully control program levels. The

unit is also very useful in studio work, particularly in mix-down sessions,to help prevent the total level from exceeding a preset point. It also can be used as the gain controlling device directly ahead of telephone lines to help maximize signal-to-noise ratio and prevent distortion. Figures 1 through 3 depict common AM installations, Figures 4 through 6, FM mono, and Figures 7 through 10 illustrate typical FM stereo operation.

To assist the ATS (Automatic Transmission System) station in meeting FCC modulation limits, especially when using the ESP Insta-Peak II Dual Spectrum Audio Processor and WBL (Wide Band Limiter) for FM or MP-12 Modulation Processor for AM, an electronic servo system has been incorporated in the Level Guard. When properly connected to the modulation monitor peak flasher, gain reduction is increased in increments (internally adjustable), up to 20 dB or more.

The input of the Level Guard is transformer balanced bridging (10 k ohms), making it a perfect match for all applications, even in production rooms where several bridging devices may be connected in parallel to the output of a 600 ohm console. The output of the Level Guard is also transformer balanced and designed to source into 600 ohms.

Two units may be electrically interconnected to prevent image shift in stereo operation. However, any number may be strapped for recording studio multitrack applications.

A front panel switch permits the meter to read output level or amount of gain reduction. An internal meter amplifier controls meter ballistic performance and prevents audio distortion that otherwise would result from the non-linear load of the meter.

The Level Guard, with only two front panel controls -- Gain and Gain Reduction -- makes installation and adjustment simple and reliable.

1.3 Physical Description

The standard ESP equipment frame holds two Level Guards for stereo operation, or one Level Guard and a blank panel for mono applications. The package is standard 19 inch rack mount, 3½ inches (2 rack units) high, and 12 inches deep.

Audio in and out, and modulation monitor peak flasher control connections are made to a seven-screw terminal barrier block. Stereo interconnect is via a three-pin DIN jack.

1.4 Service and Repair

Should you ever encounter any difficulty in the operation or maintenance of your ESP Level Guard, simply call the authorized distributor from whom it was originally purchased, or Elcom Specialty Products in Sacramento, California direct at (916) 453-0859. ESP pledges complete customer service and satisfaction.

1.5 Warranty

A standard Elcom Specialty Products warranty card has been included with your Level Guard. To validate your two-year warranty, please complete and return the postcard section within ten days directly to ESP as addressed. (The Post Office will not deliver it without postage.)

1.6 Specifications

Input Impedance	10 K ohms transformer balanced
Output Impedance	600 ohms transformer balanced
Input Level	-20 dB minimum to +20 maximum
Output Level	+10 dB nominal, +20 maximum
Maximum Gain	20 dB
AGC Range	30 dB
Frequency Response	±0.5 dB, 50 to 15 kHz
Harmonic Distortion	Less than 0.5% at 10dBm output and 10 dB gain reduction

Signal-to-noise ratio	70 dB below + 10 dBm output
Attack Time	Less than 50 mS
Release Time	15 or 30 seconds, selectable, from 10 dB of gain reduction
Power Requirement	90 to 140VRMS, 50/60 Hz, 5W (at 115VRMS)

ATS Characteristics

Control Requirement	Contact closure to ground when flasher is on (unit pulls to +15VDC when inactive)
GR Servo Increment	Up to 3 dB per flash; adjustable
GR Servo Retrigger Rate	Controlled by monitor; 6 seconds maximum
Maximum GR Servo Range	20 dB

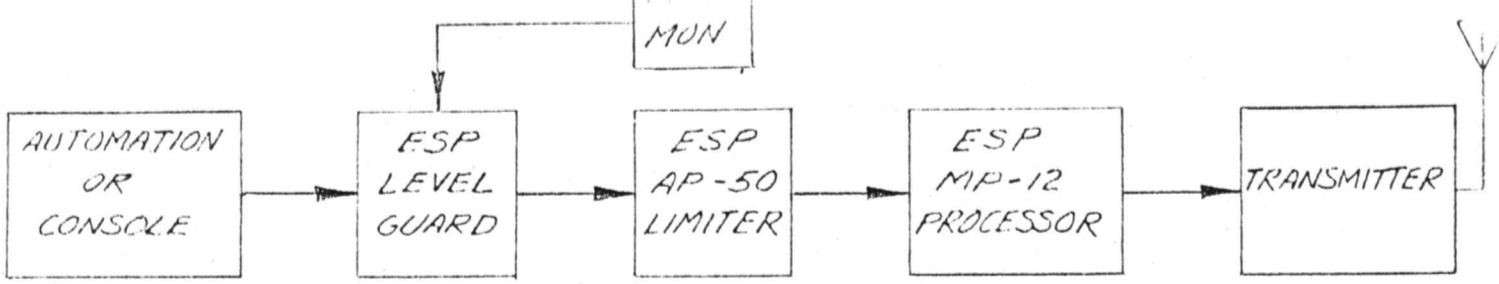


FIGURE 1

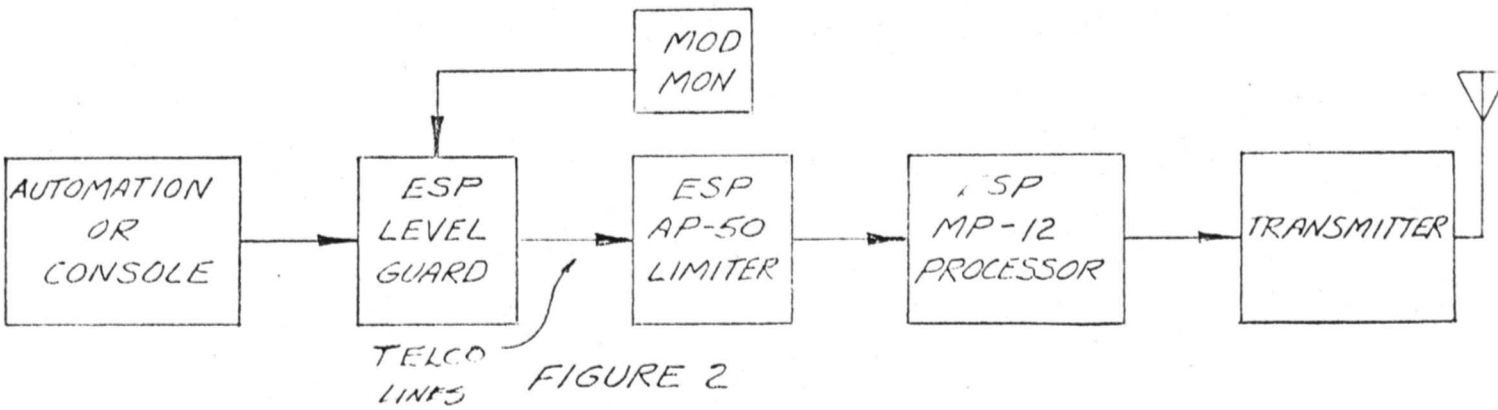


FIGURE 2

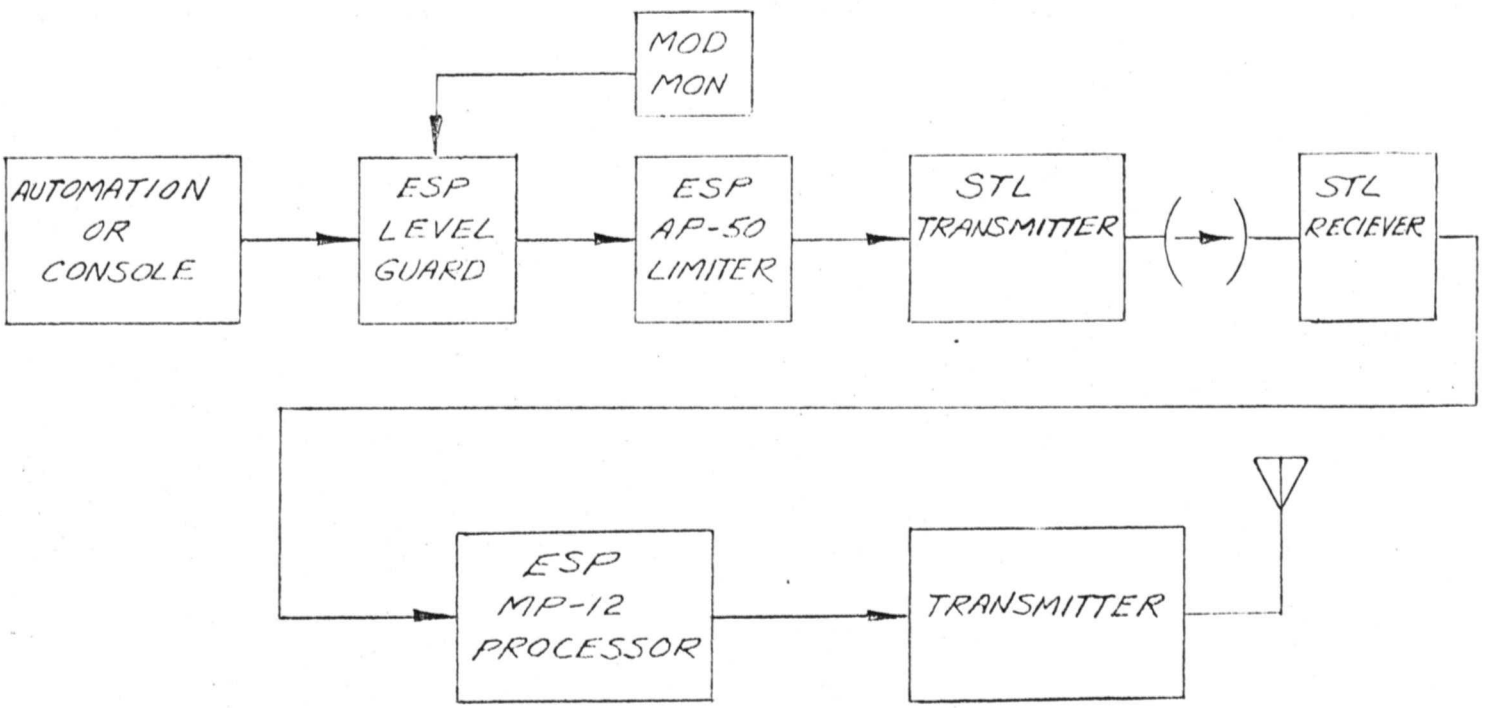


FIGURE 3

TYPICAL AM INSTALLATIONS

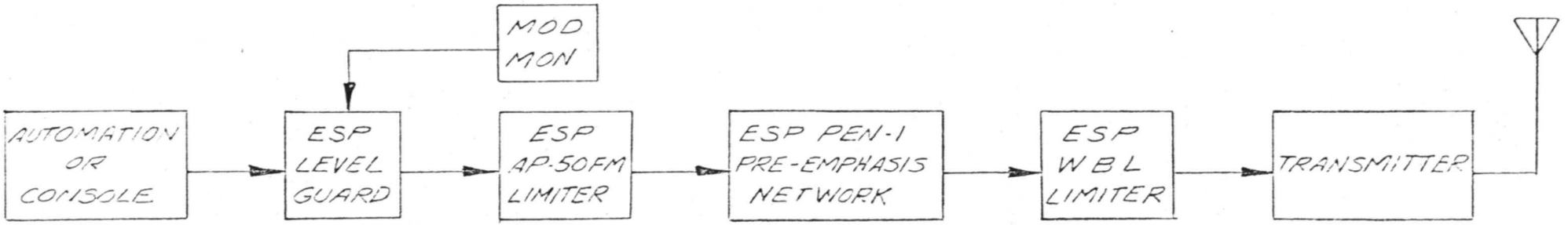


FIGURE 4

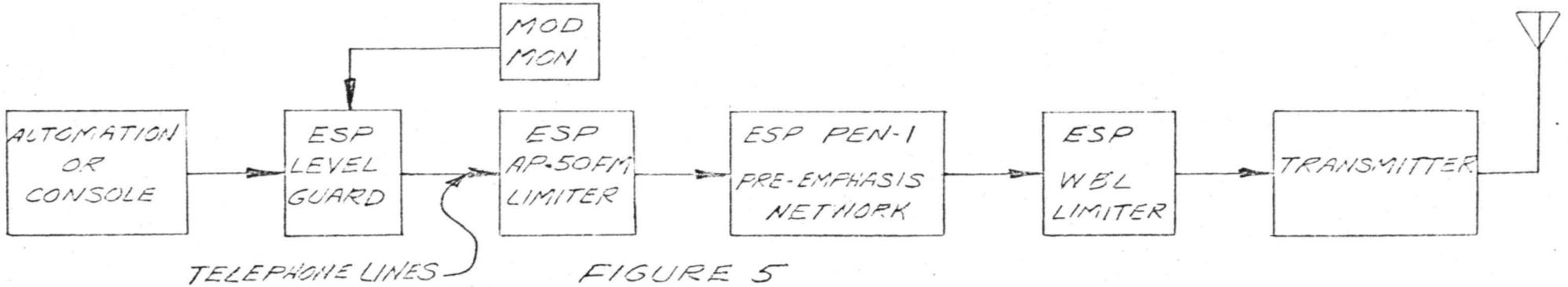
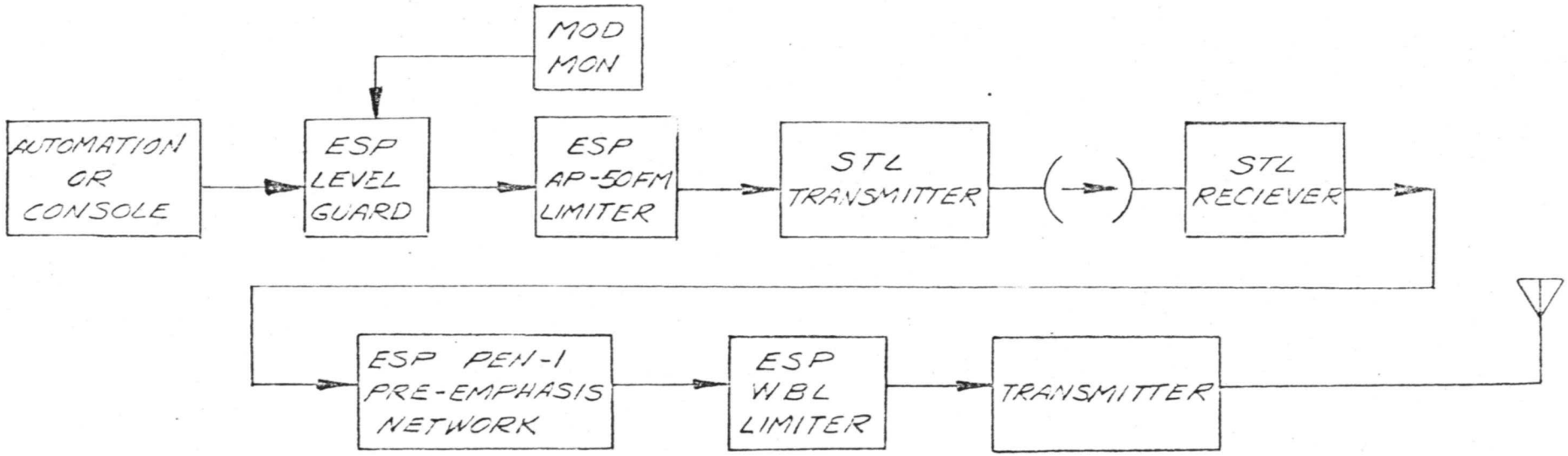


FIGURE 5



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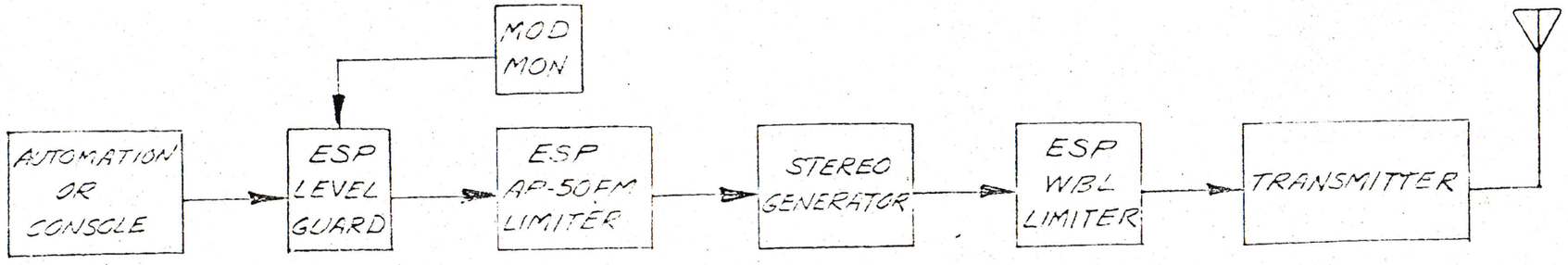


FIGURE 7

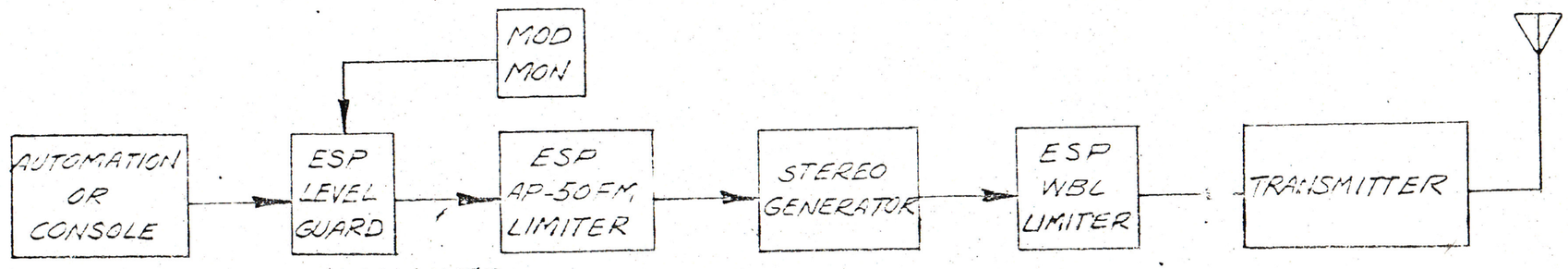


FIGURE 8

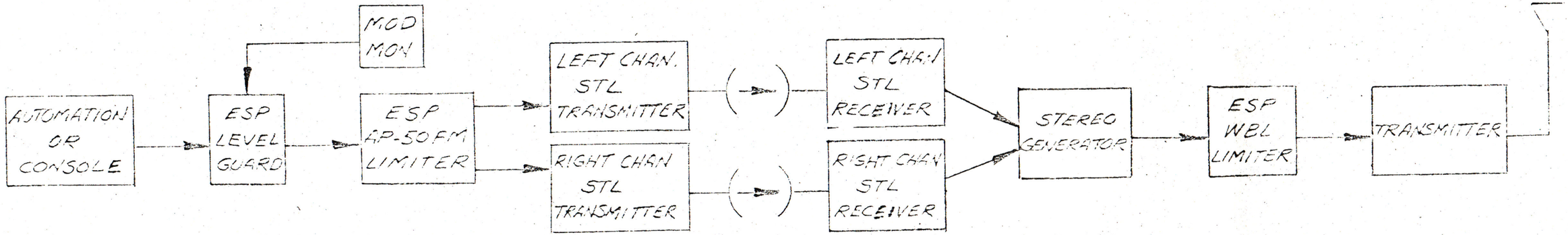


FIGURE 9

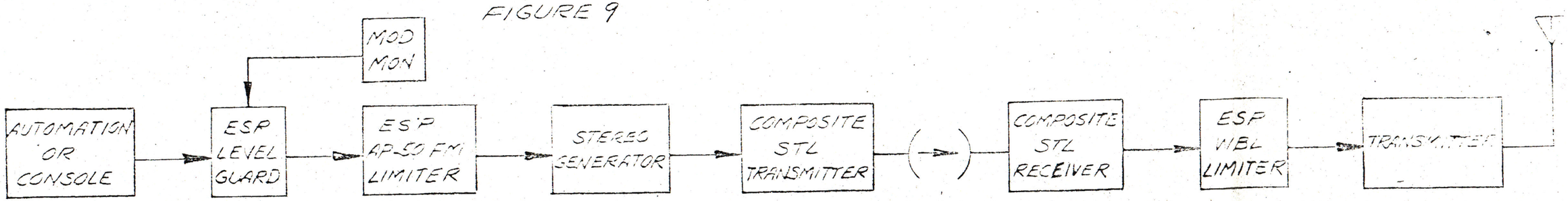


FIGURE 10

SECTION II
INSTALLATION

2.1 Unit location and Installation

The ESP Level Guard may be located in any rack, and since it is normally not adjusted frequently, it need not be located at a convenient operating height. However, it is recommended that it not be placed directly above high heating emitting equipment such as vacuum tube units or even super-power solid state monitor amplifiers. The ambient temperature of the Level Guard should never exceed 45°C (113°F).

2.2 Electrical Connections

The input of the Level Guard should be connected to the output of the desired device using any standard two-conductor shielded cable. If the source requires termination -- especially if it has an output transformer -- install a 620 ohm, ½ watt carbon resistor across the + and - input terminals on the Level Guard (the standard input impedance of the Level Guard is 10 K ohms, bridging). Insure that the shield is connected to the ground terminal.

If the Level Guard is driven by an unbalanced source, connect the "hot" lead to the + input terminal, and tie the shield to both the - and ground terminals.

The output of the Level Guard should then be connected to the input of the following device, again using two-conductor shielded cable. The output is 600 ohms transformer balanced and will therefore directly drive all standard broadcast and studio equipment.

If stereo operation is proposed, interconnect the Level Guards with the special jumper cable provided. The technique of strapping left and right channel gain reduction control circuits prevents stereo image shift and provides for better modulation control.

For stations using ATS or those who desire superior overmodulation protection, the internal G.R. (Gain Reduction) Servo System

may be employed.

Depending on the modulation monitor, it may be possible to directly connect the Level Guard to the monitor or you may have to install an isolation relay. To avoid any chance of damage, PROCEED WITH CAUTION. (Note: The Level Guard requires a contact closure to ground control signal to activate the ATS circuitry.)

For a mono Level Guard, Figures 11 through 13 depict some of the more common modulation monitor control outputs. Figure 11 is perhaps the simplest, having available an isolated pair of normally-open relay contacts to which the Level Guard may be directly connected. If the monitor provides an isolated uncommited collector NPN transistor (the transistor's collector is not connected to anything else inside the monitor), as in Figure 12, connections should be made directly as indicated. Figure 13 illustrates a grounded emitter NPN transistor that is internally connected to the monitor's peak light. If the voltage on its collector is +15 VDC or higher with the peak light off, connect the Level Guard as indicated. However, if the voltage is lower, or the monitor does not provide control as described, select a relay of the proper voltage and rating, connect its coil to the monitor, and its normally-open contacts to the Level Guard. (AM stations usually connect it to the negative peak light to help reduce distortion.)

For stereo Level Guard operation, refer to Figures 14 through 16. Modulation monitor connections are the same as described above.

BEFORE MAKING ANY CONNECTIONS TO THE MONITOR, STUDY ITS MANUAL THOROUGHLY, and compare it with the examples provided. If in doubt, contact your authorized ESP distributor, or ESP direct.

Apply primary power to the Level Guard, and proceed with Section III, Operational Set-Up.

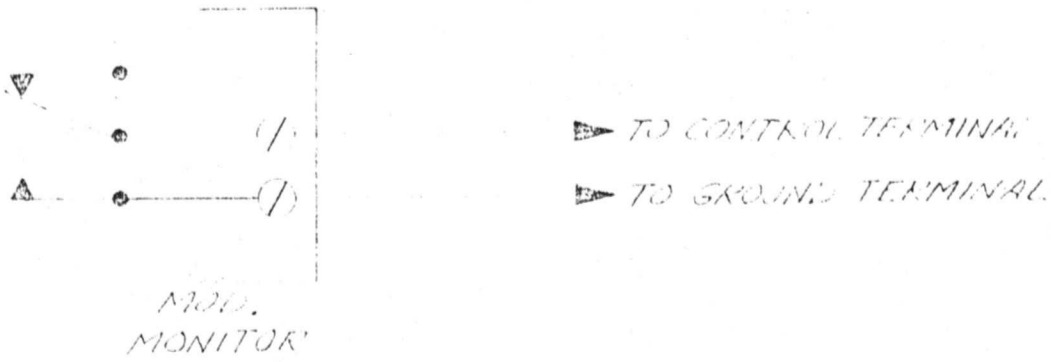


FIGURE 11

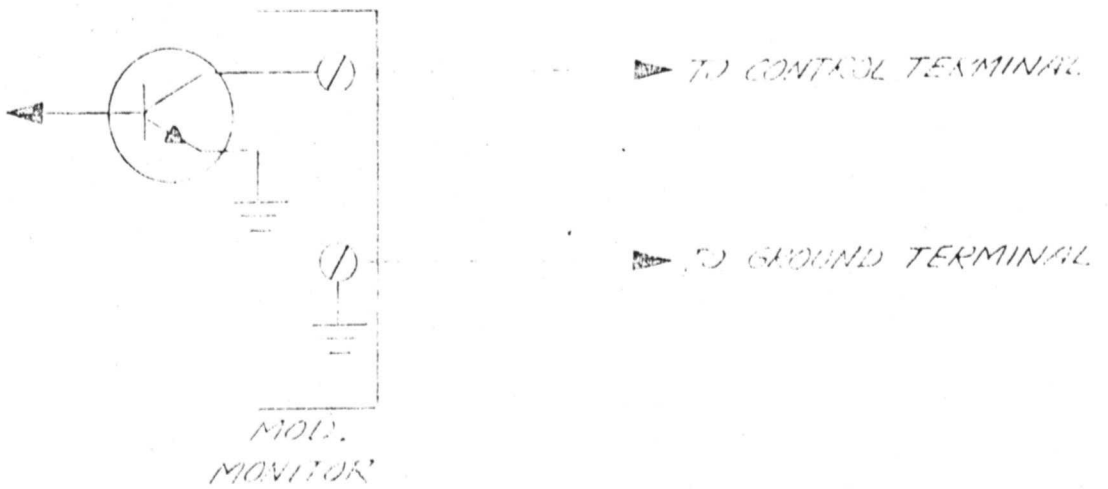


FIGURE 12

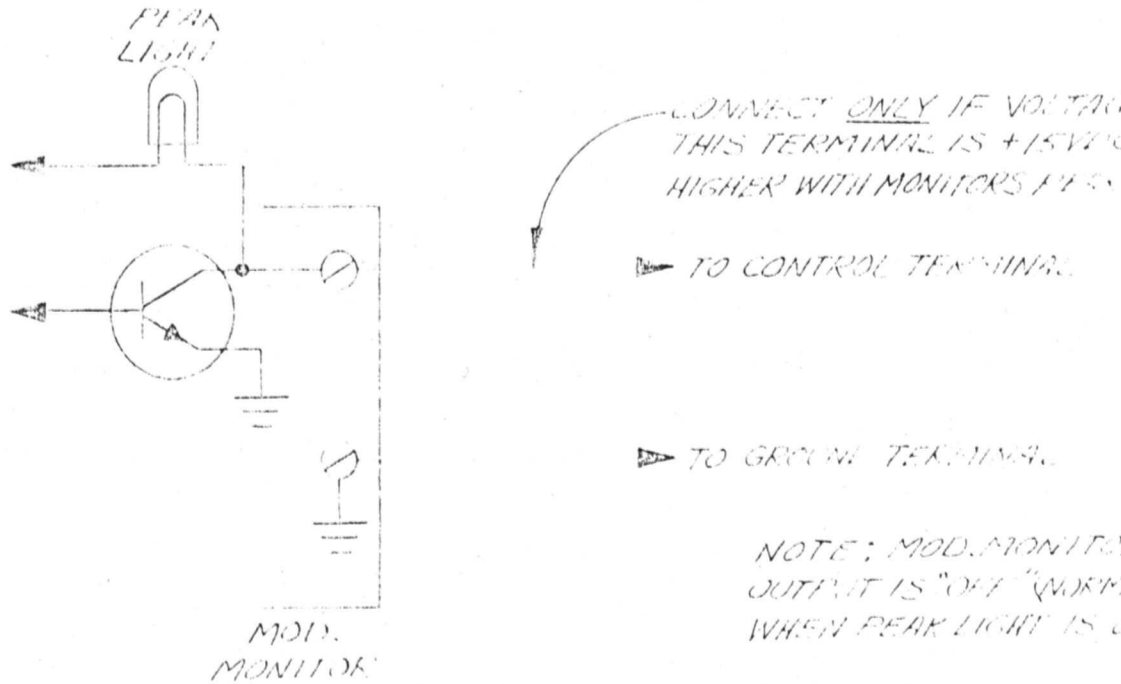


FIGURE 13

PEAK FLASHER CONNECTIONS MANUAL NO. 500-0

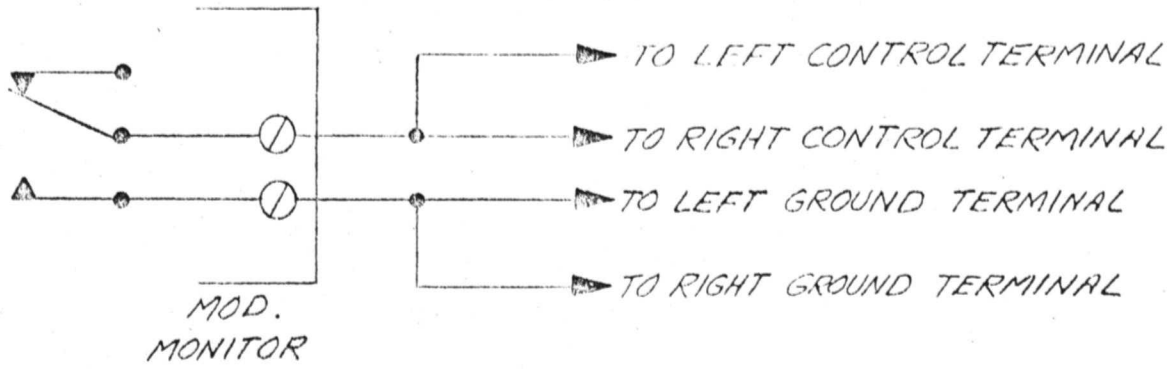


FIGURE 14.

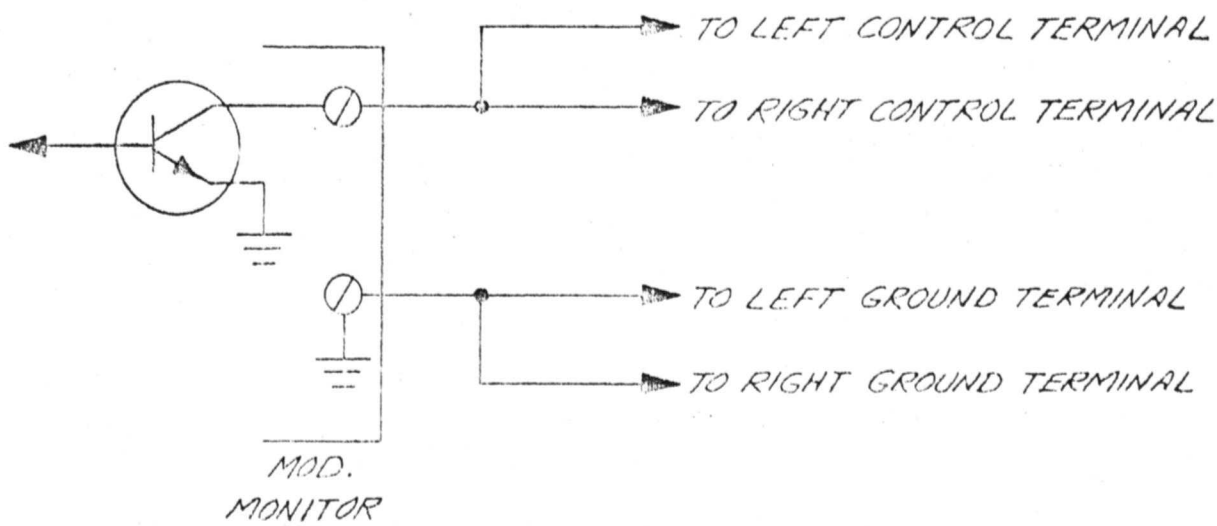


FIGURE 15

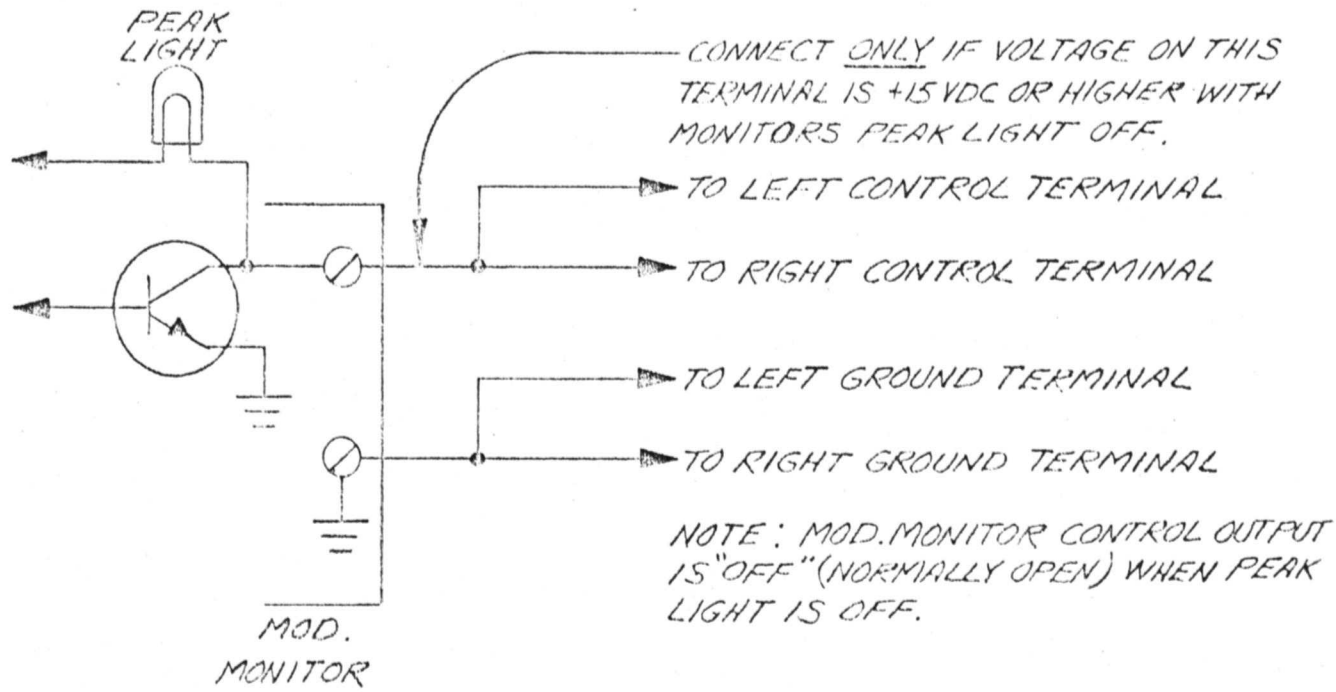


FIGURE 16

PEAK FLASHER CONNECTIONS STEREO LEVEL GUARD

SECTION III
OPERATION

3.1 General

Preliminary set-up of the Elcom Level Guard is very simple, requiring adjustment of only two front panel controls: Gain and Gain Reduction.

Controls internal to the Level Guard are: output level meter calibrate, G.R. (Gain Reduction) meter zero, G.R. meter calibrate, and G.R. Servo Increment. These controls have been maticulously adjusted at the factory, and normally do not require attention in the field. However, complete alignment is described in detail in Section V, Maintenance.

3.2 Gain Adjustment

With the Gain Reduction control set full counter-clockwise (no gain reduction), feed any convenient frequency tone, such as 400 Hz or 1 kHz, into the source driving the Level Guard. Adjust the source for proper output level (+8 dBm is most typical in broadcast, +4 for recording studios). Advance the Gain Control on the Level Guard for the desired output level as read on the front panel meter, with the Meter switch in the OUT position. The meter is calibrated to indicate +10 dBm as 0 vU. Therefore, if + 8 dBm out is desired, adjust the Gain Control for a meter reading of -2 VU.

It is recommended that + 10 dBm out (0 VU) never be exceeded under normal operating conditions. This provides for more than 10 dB of headroom, thus avoiding any chance of output clipping.

3.3 Preface to Gain Reduction Adjustment

If the Level Guard is used to just generally oversee operating levels, 3 to 6 dB of peak gain reduction will generally suffice. However, if the Level Guard is used with an automation system,

where large differences between sources are prevelant, 6 to 10 dB of peak gain reduction is perhaps a better operating range.

3.4 Gain Reduction Adjustment

After the Gain Control has been properly calibrated, apply programming at the proper level and verify that the output of the Level Guard is indicating as adjusted -- less than +10 dBm (below 0 VU on the front panel meter). If not, adjust the Gain Control as necessary.

Place the meter switch in the G.R. (Gain Reduction) position. The meter should indicate "0" (no gain reduction).

SLOWLY advance the Gain Reduction control until you reach its threshold (the meter should indicate about 0.5 dB of gain reduction, or so, on peaks). Switch the meter to OUT and verify that it is still indicating the desired level. Without disturbing the setting of the Gain Reduction control, SLOWLY advance the Gain control until the desired amount of gain reduction is indicated on the front panel meter (the output level will remain constant).

When the Level Guard is operating within its gain reduction control range, the output level can be increased by REDUCING the Gain Reduction control, or reduced by INCREASING the Gain Reduction control. Gain reduction is increased by INCREASING the Gain control, and decreased by DECREASING the Gain control.

To adjust a stereo Level Guard, it is advisable to apply a mono signal and adjust each channel as described above, with the interconnecting cable disconnected. Then, if possible, apply a 400 Hz or 1 kHz tone to each and balance Gain and Gain Reduction controls if necessary. Then restrap the units.

Feel free to experiment with different values of gain reduction until an optimun setting is found for your format and operation. The Level Guard may be operated at gain reductions up to 30 dB without pumping or degradation of audio quality.

3.5 Release Time

The Level Guard is equipped with a front panel release time switch. It selects between F (fast), representing a total recovery time of 15 seconds from 10 dB of gain reduction, and S (slow), which offers 30 seconds from 10 dB of gain reduction.

This switch setting is left strictly to the discretion of the user, but generally rock and MOR formats often prefer F, and beautiful music and classical tend to use S.

3.6 ATS G.R. Servo System

When the electronic Gain Reduction Servo feature is properly connected, as described in Section II, Installation, the user will be afforded incomparable modulation control, particularly if the entire ESP audio processing package for FM or AM is employed.

One internal control sets the specific operation of this function -- Gain Reduction Servo Increment adjusts the amount the gain reduction increases each time the modulation monitor peak flasher triggers.

G.R. Servo Increment is adjustable up to 3 dB of gain reduction per peak flasher trigger. It has been calibrated at the factory for a standard value of 1 dB. This amount has been determined to be optimum after extensive field testing with various program material and audio processing equipment. However, if this amount does not produce the desired results, it may be altered as described in Section V, Maintenance.

3.7 Proof-of-Performance Measurements

The FCC requires that all compression and limiting be disabled during the annual proof-of-performance.

This is easily accomplished on the Level Guard by turning the Gain Reduction control fully counter-clockwise. However, if more than several dB of peak gain reduction was used in

normal operation, it may then be necessary to reduce the gain of the Level Guard to restore normal system operating levels.

SECTION IV
PRINCIPLES OF OPERATION

4.1 General

The ESP Level Guard fully exploits the advantages of the optical attenuator for audio level control, which provides for gain reduction up to 30 dB without pumping or distortion.

A feature unique to the Level Guard is its ATS Servo System. When connected to the modulation monitor, peak modulation excursions detected by the monitor provides control information for the Level Guard which accordingly adjusts output level.

4.2 Audio Control Theory (Refer to Figure 18)

Audio level is controlled by a closed-loop Servo System. The gain reduction (G.R.) amplifier, Integrated Circuit IC4, is driven from the output of the audio amplifier, IC1. When the level exceeds a preset threshold, the G.R. amplifier causes Transistor Q3 to turn on, which turns on Optical Attenuator AT1 and attenuates the signal. As the signal level decreases at the output of IC1, the G.R. amplifier decreases its drive to Q3 which reduces the attenuation effects of AT1. Thus, IC4 and Q3 form a feedback network around IC1 which is capable of maintaining the output at a very precise level.

4.3 Program Audio Path

Primary Components: T1, IC1, T2

Audio connected to the input terminals is applied to input transformer T1. Resistor R4 is a front panel control that adjusts gain. R5 and Optical Attenuator AT1 form a voltage divider network that controls the input signal. Integrated Circuit IC1 is a wideband amplifier; its output is connected to the output transformer, T2, the meter amplifier, IC2, and the gain reduction amplifier, IC4.

4.4 Gain Reduction Circuitry

Primary Components: IC4, Q3, AT1

The front panel Gain Reduction control, R31, adjusts level to the G.R. amplifier, Integrated Circuit IC4, the output of which is rectified and filtered and applied to the base of Transistor Q3. Resistors R33 and R34 and Diode D9 hold Capacitor C25 charged below the turn-on threshold of Q3, AT2, and AT1 to reduce initial attack time. The S (slow) release time is set by the value of R38. Front panel Release switch S2 parallels a matching value resistor, R36, in the F (fast) position to divide the release time by approximately two. Q3 provides drive for AT2 -- the optical attenuator used to develop G.R. metering -- and audio attenuator AT1. Stereo interconnect is accomplished by strapping the emitter of Q3 in each unit together.

4.5 Metering Circuitry

Primary Components: IC2, M1, AT2

Switch S1 in OUT: The output of Integrated Circuit IC2, the metering amplifier, is rectified by Diodes D1 and D2, and applied through the front panel switch, S1, to the meter. The meter is calibrated to read 0 VU at +10 dBm output by internal control R10.

Switch S1 in G.R.: The meter, M1, is held at 0 VU (indicating no gain reduction) by applying a positive voltage through Resistors R41 and R42 (R41 is internal and adjusted to produce the reading of 0 VU). D10 and D11 prevent Capacitor C26 from being charged above about 1.3 volts. When gain reduction occurs, the resistance of Optical Attenuator AT2 decreases, pulling the meter line to the minus supply, and corresponds to the action of audio attenuator AT1. Gain reduction metering is calibrated by internal control R40.

4.6 ATS G.R. Servo System

Primary Components: AT3, AT4, IC3, Q1

The heart of the ATS G.R. Servo System is the dual timer, Integrated Circuit IC3. When the ATS control terminal is pulled to ground, both Optical Isolators AT3 and AT4 turn-on. Capacitor C14 charges and triggers the charge pump; the timer's "on" time is controlled by internal control R20 which is adjusted to generate a pulse width that produces a nominal 1 dB of gain reduction per trigger. Every time the peak light flashes on, the charge pump reduces the gain by an additional 1 dB. If the peak light stays on continously for more than about 5.5 seconds, the charge pump is internally retriggered by the second timer. Each pulse by the charge pump increases the voltage of C21 which causes Transistor Q1 to turn-on and reduce the G.R. threshold and hence, reduce output level. Q2 is controlled by Q1, and causes LED A1 to illuminate when Q1 turns-on indicating that the ATS Servo System has been activated.

4.7 Power Supply

Primary Components: T3, U1, U2

Capacitors C28 through C31 and L1 and L2 form a double-pi network for RF filtering. Diodes D12 through D15 form a full-wave bridge rectifier, which is filtered by C32 and C34, and regulated to + and -15 volts by positive regulator U1 and negative regulator U2. LED A2 is used to indicate the presence of power.

SECTION V
MAINTENANCE

5.1 General

The ESP Level Guard is completely solid state, including its regulated power supply. Careful test and adjustment at the factory, combined with stable and reliable parts should provide long trouble-free operation without the need for realignment.

However, if adjustment is determined to be required, proceed with the specific instructions that follow.

NOTE: All internal adjustments can be made by removing the top cover of the unit. Refer to Figure 17 for the location of each control. The output should always be terminated in 600 ohms resistive.

5.2 Output Level Meter Calibration

Set the front panel Gain control fully clockwise and the front panel Gain Reduction control fully counterclockwise.

Connect a properly operating audio generator to the input terminals of the Level Guard. Using a test frequency of 1 kHz, adjust the generator's output to produce + 10 dBm at the output terminals of the Level Guard as read on a calibrated AC VTVM (insure that the Level Guard is properly terminated in 600 ohms resistive).

Finally, with the Meter switch in the OUT position, adjust R10, Output Level Calibrate control, until the front panel meter indicates exactly 0 VU.

5.3 Gain Reduction Meter Zero

Gain reduction meter zero adjustment is made without any connections to the input of the Level Guard, and after the ATS LED has been extinguished for at least 5 minutes.

Set the Meter switch to the G.R. position and adjust R41, Gain Reduction Meter Zero control, until the meter reads precisely 0 VU.

5.4 Gain Reduction Meter Calibrate

Set the Gain control to its full clockwise position, and the Gain Reduction control to full counterclockwise.

Connect an audio generator to the input terminals of the Level Guard. Set the frequency to 1 kHz and adjust the generator's output level to produce +10 dBm at the output of the Level Guard as read on an AC VTVM.

Slowly advance the Gain Reduction control until the output level -- as indicated on the AC VTVM -- drops to +3.0 dBm (yielding 7 dB of gain reduction).

Set the Meter switch to the G.R. position and adjust R40, Gain Reduction Meter Calibrate control, to produce a front panel meter reading of exactly -7 VU.

5.5 Gain Reduction Servo Increment Calibrate

Set the Gain control fully clockwise and the Gain Reduction control fully counterclockwise.

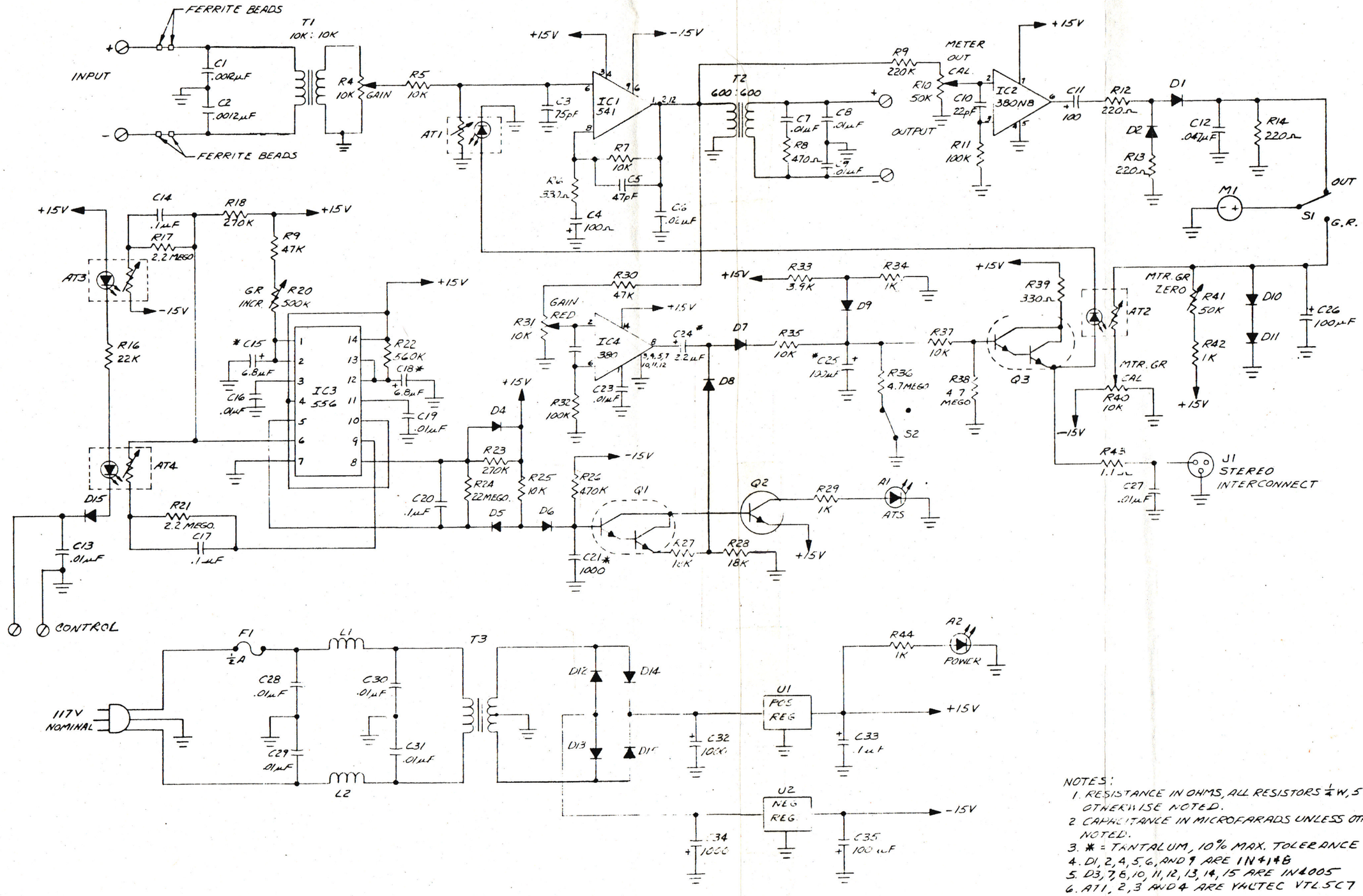
An audio generator should then be connected to the input of the Level Guard. Use a frequency of 1 kHz, and set the generator's output level to produce +10 dBm at the output of the Level Guard as measured on an AC VTVM.

Slowly advance the Gain Reduction control to drop the output level to +7.0 dBm (3 dB of gain reduction).

Temporarily connect the ATS control terminal on the rear panel barrier block to ground.

Adjust R20, Gain Reduction Servo Increment control, to produce about 0.6 to 0.7 dB gain reduction increase on the first step (the output level will drop by the specified amount), and

exactly 1.0 dB increase on the several following steps as indicated on the AC VTVM. Although this control may be increased to provide up to 3 dB of gain reduction per step, extensive field tests have proven that 1 dB is optimum for most stations. If two Level Guards are to be used for stereo operation, both units should be adjusted to within about 0.1 dB for best results.



NOTES:
1. RESISTANCE IN OHMS, ALL RESISTORS ¼W, 5% UNLESS OTHERWISE NOTED.
2. CAPACITANCE IN MICROFARADS UNLESS OTHERWISE NOTED.
3. * = TANTALUM, 10% MAX. TOLERANCE
4. D1, 2, 4, 5, 6, AND 9 ARE 1N4148
5. D3, 7, 8, 10, 11, 12, 13, 14, 15 ARE 1N4005
6. AT1, 2, 3 AND 4 ARE YAUTEC VTL5C7

HIGHEST NO. USED
AT
AT4
C35
D15
IC4
L2
Q3
R44
S2
T3
U2

SCHEMATIC DIAGRAM
LEVEL GUARD

DRAWN BY R.A.G. 1977

FIG. 18

5-5

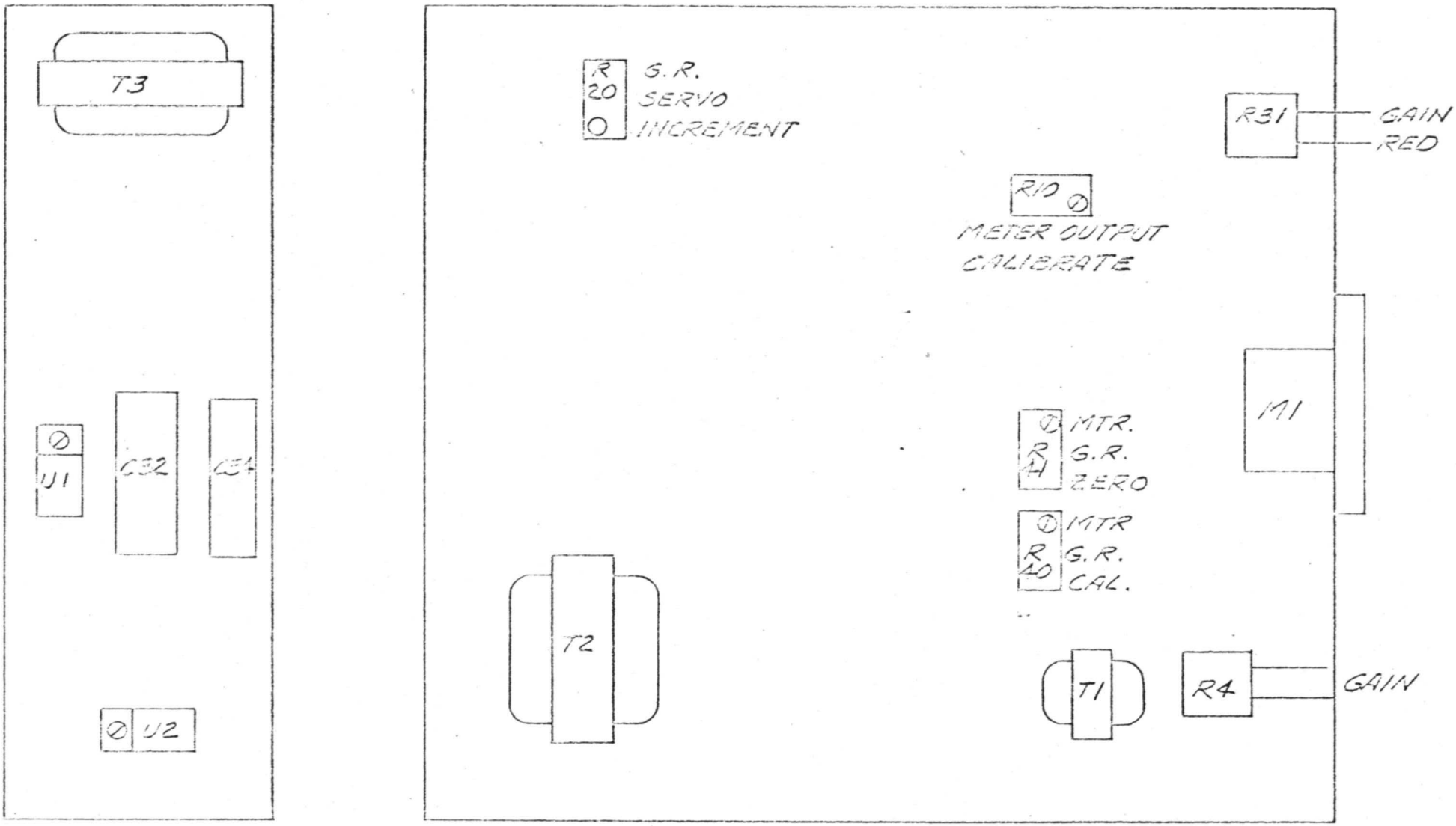
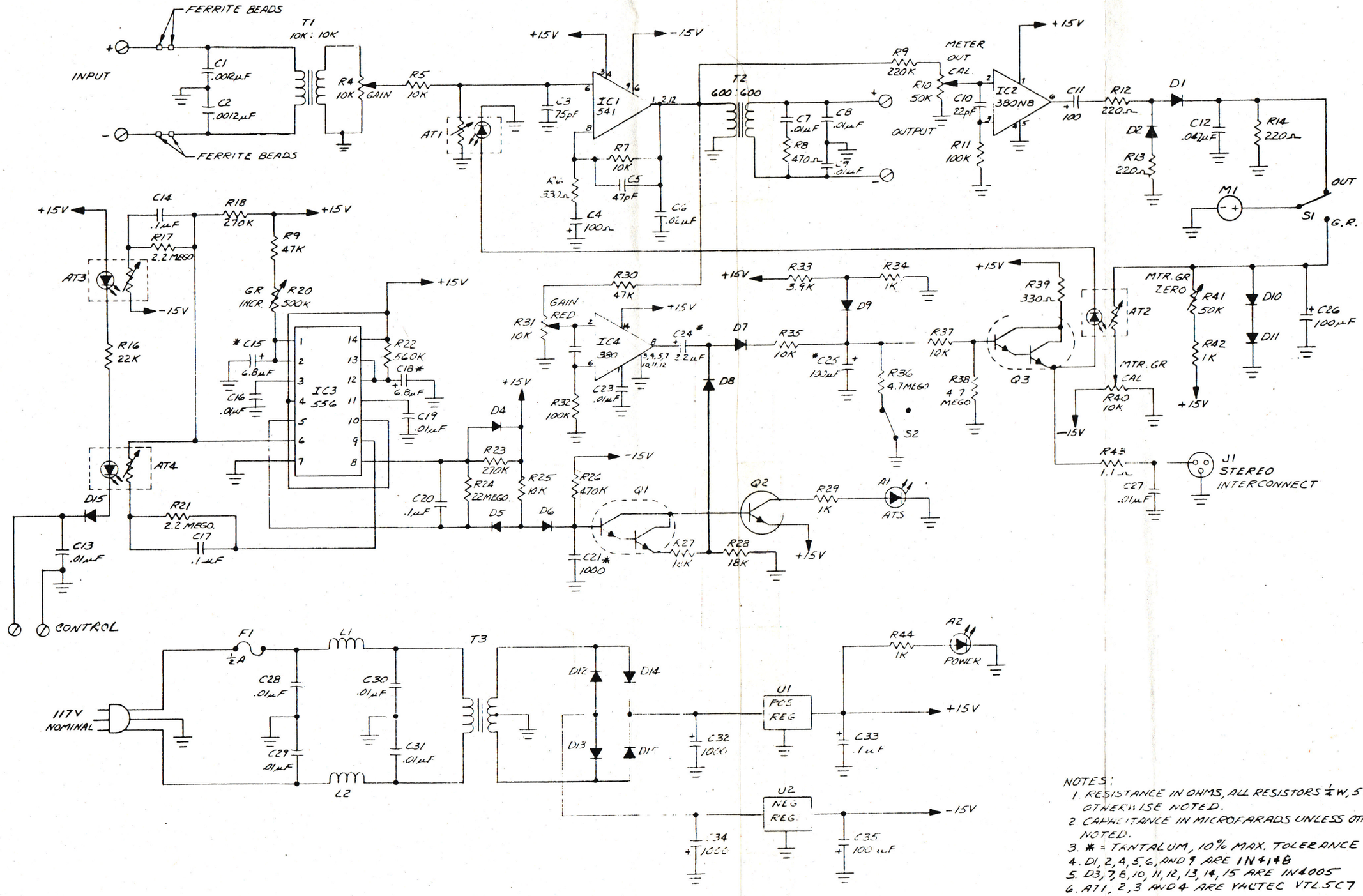


FIGURE 17
COMPONENT LOCATIONS



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2. CAPACITANCE IN MICROFARADS UNLESS OTHERWISE NOTED.
3. * = TANTALUM, 10% MAX. TOLERANCE
4. D1, 2, 4, 5, 6, AND 9 ARE 1N4148
5. D3, 7, 8, 10, 11, 12, 13, 14, 15 ARE 1N4005
6. AT1, 2, 3 AND 4 ARE YAKTEC VTL5C7

HIGHEST NO. USED
AT
AT4
C35
D15
IC4
L2
Q3
R44
S2
T3
U2

SCHEMATIC DIAGRAM
LEVEL GUARD

DRAWN BY R.A.G. 8-4-77

FIG. 18

5-5

SECTION VI
REPLACEABLE PARTS

6.1 Ordering Information

When ordering replacement parts for the Level Guard AGC amplifier, give the reference designation and the part number. To order a part not listed in Paragraph 6-3 of this section, give a complete description of the part including function and location.

Order parts form your distributor or from:

Elcom Specialty Products, Inc.
2810 Redding Avenue, #E
Sacramento, Ca. 95820 USA
Telephone: (916) 453-0859
Cable: "Elcom"

6.2 Parts Location

The location of the parts listed in Table 6-2 is shown on page 5-4 (Component Layout) of this instruction manual.

6.3 Tables of Replacement Parts

A list of manufacturers of component parts for the various units that make up the Level Guard AGC Amplifier is provided by Table 6-1. The manufacturer of the particular part listed in the parts list (Table 6-2) is indicated by a Federal Supply Code Number which is used to identify the manufacturer as listed in Table 6-1.

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This proof of performance is provided to insure that this piece of equipment meets all manufacturing specifications.

Model AGC

Customer Riggins Electronics Sales Date 6-5-80 Serial # 131

Mechanical

Aligement ✓ Control indicator position ✓

Hardware ✓ Meter mechanical zero ✓

Electronics

Fuse 1/2 A std. ✓ Power LED operation ✓

Power Supply Pos. 15.35 V. Neg. 15.11 V.

Caliberation output meter at +10 DBM for VU ✓

Caliberation gain reduction for OVU ✓

GR meter calibration at - 7 VU ✓

ATS control LED operation ✓

Adjustment of ATS for 0.6 to 0.7 DB of GR ✓

Check for 1 DB of GR on successive steps ✓

Monitor voltage pulse pin 9 IC-3 for 5 to 6 sec daration ✓

ATS release time fast 15 sec ✓ Slow 30 sec ✓

Harmonic Distortion		Frequency Responce	
50 HZ	.24%	-.30	DB
100 HZ	.15%	-.15	DB
400 HZ	.10%	-.20	DB
1 KHZ	.10%	0	DB
5 KHZ	.15%	+.10	DB
10 KHZ	.18%	+.40	DB

Signal to Noise -70 db

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Model AGC

Customer Riggins Electronics Sales Date 6-5-80 Serial # 132

Mechanical

Aligement ✓ Control indicator position ✓

Hardware ✓ Meter mechanical zero ✓

Electronics

Fuse 1/2 A std. ✓ Power LED operation ✓

Power Supply Pos. 14.94 V. Neg. 15.05 V.

Caliberation output meter at +10 DBM for VU ✓

Caliberation gain reduction for OVU ✓

GR meter calibration at - 7 VU ✓

ATS control LED operation ✓

Adjustment of ATS for 0.6 to 0.7 DB of GR ✓

Check for 1 DB of GR on successive steps ✓

Monitor voltage pulse pin 9 IC-3 for 5 to 6 sec daration ✓

ATS release time fast 15 sec ✓ Slow 30 sec ✓

	Harmonic Distortion	Frequency Responce
50 HZ	.20%	-.40 DB
100 HZ	.19%	-.20 DB
400 HZ	.14%	-.20 DB
1 KHZ	.10%	0 DB
5 KHZ	.10%	+.20 DB
10 KHZ	.19%	+.60 DB

Signal to Noise _____ db

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