DISCRIMINATE AUDIO PROCESSOR

AGC-PEAK LIMITER

MODEL 310

Manufactured by:
DORROUGH ELECTRONICS
WOODLAND HILLS, CALIFORNIA
(213) 999-1132

D O R R O U G H

DISCRIMINATE AUDIO PROCESSOR

S P E C I F I C A T I O N S

-20 Position:

Input Sensitivity:	-30 dBm
Input Impedance:	600 ohms balanced

0 Position:

Input Sensitivity:	-10 dBm
Input Impedance:	20 K balanced bridging

Maximum Output:	+24 dBm 600 ohms balanced
Harmonic Distortion:	Less than 1%

In "TEST" Position:

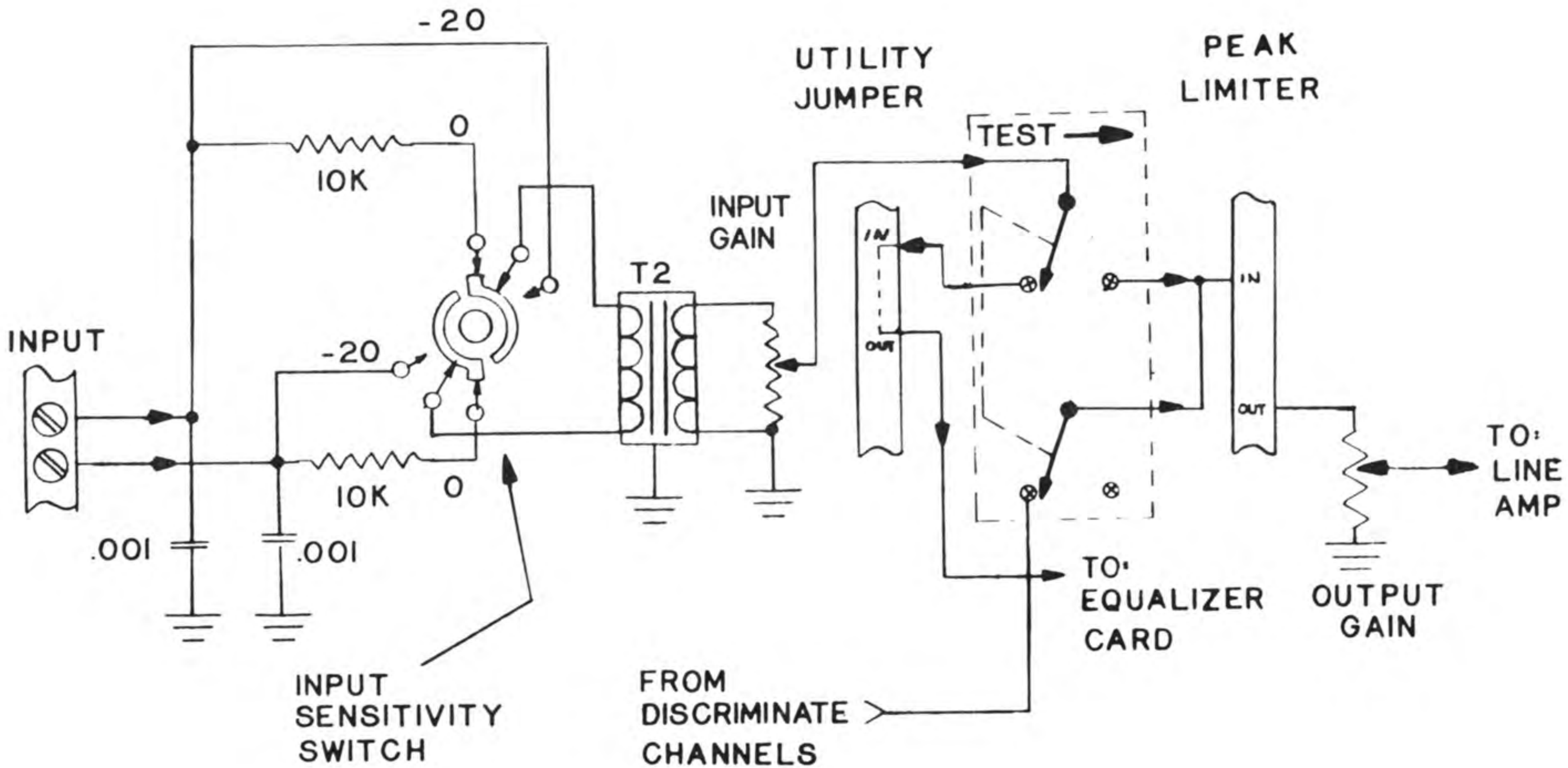
Frequency Response:	30 Hz to 15 kHz ± 1 dB
Signal to Noise:	Better than 65 dB 30 to 15 kHz

SPECIAL INSTRUCTIONS: Unit is designed to operate directly at the input of the transmitter.

Power requirements:	117 VAC* 50-60 Hz 35 watts
*Strappable 220 VAC	See page 50
Physical Dimensions:	3-1/2 x 19 x 13"

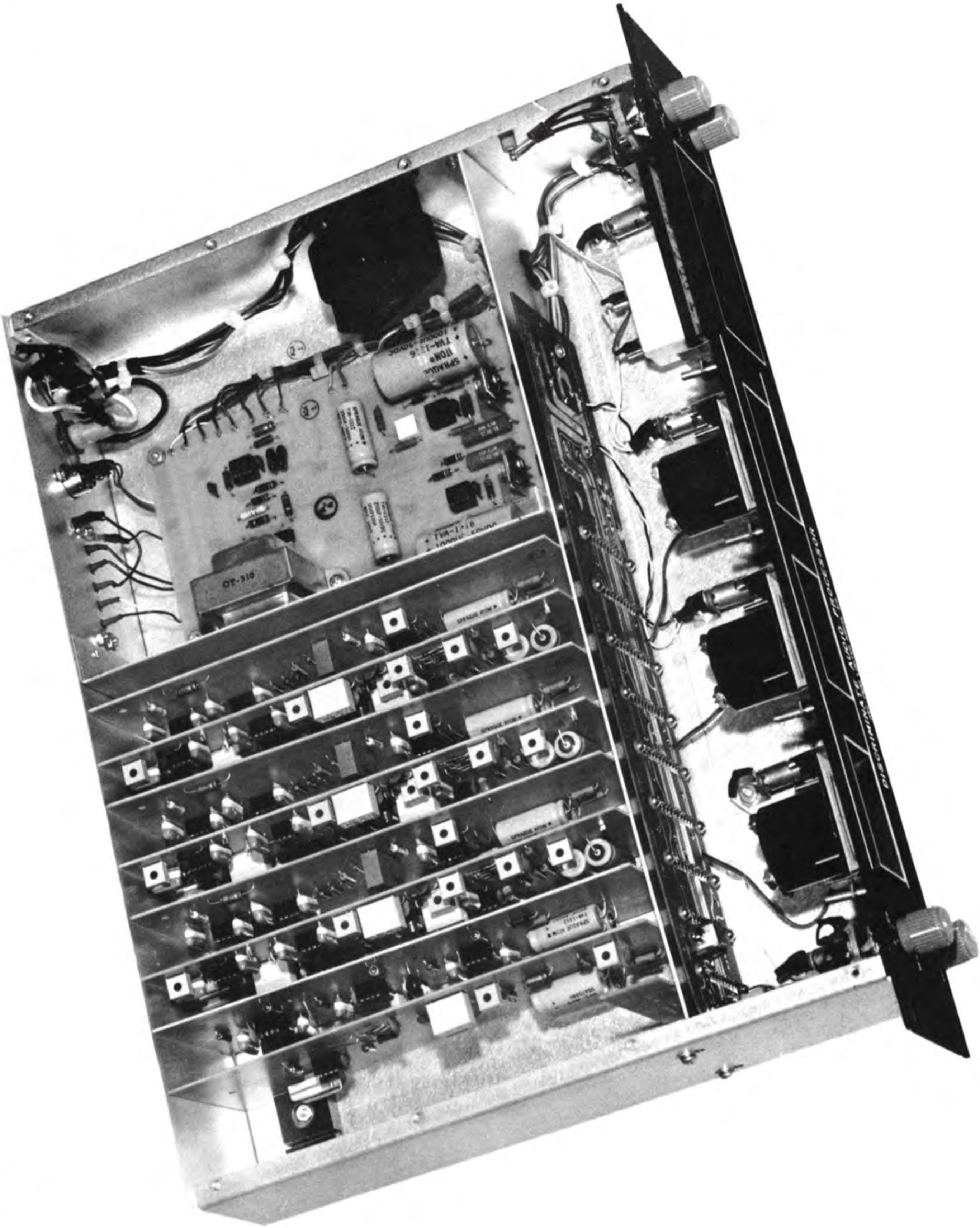
P R O O F   O F   P E R F O R M A N C E

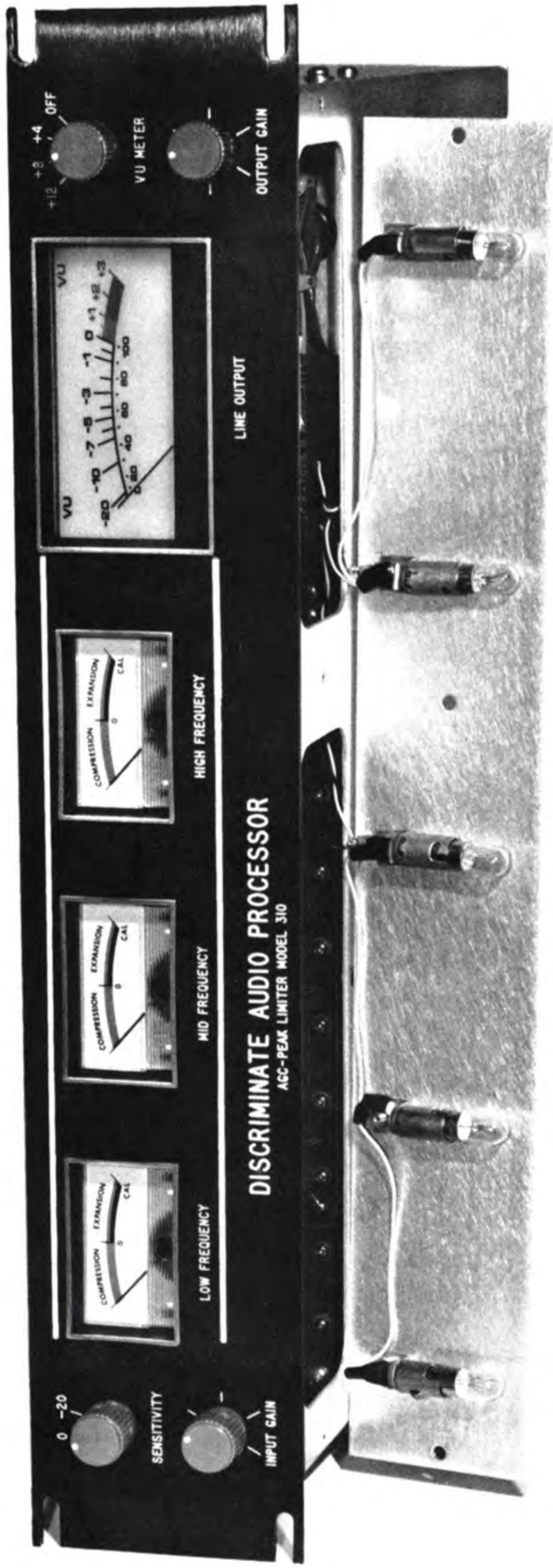
Actual proof-of-performance measurements should be conducted with the sensitivity switch in the "TEST" position. (This switch is located inside the meter compartment in units prior to Serial #021223.) This switch bypasses the parallel channels and connects the front panel control directly to the peak limiter input. Be careful not to overdrive the limiter card during measurements. Turn the output control fully open, and use the input control to control the modulation level.



SIGNAL FLOW
PROOF SWITCH
DAP 310


DISCRIMINATE AUDIO PROCESSOR
ACC-PEAK LIMITER MODEL 310
LOW FREQUENCY
MID FREQUENCY
HIGH FREQUENCY
COMPRESSION
EXPANSION
CAL
LINE OUTPUT
VU
VU METER
+12 +8 +4 OFF
OUTPUT GAIN
SENSITIVITY
0 -20
INPUT GAIN


DISCRIMINATE AUDIO PROCESSOR
OT-310


DISCRIMINATE AUDIO PROCESSOR
AGC-PEAK LIMITER MODEL 310
VU METER
OFF
+4
+8
+12
OUTPUT GAIN
LINE OUTPUT
HIGH FREQUENCY
MID FREQUENCY
LOW FREQUENCY
COMPRESSION
EXPANSION
CAL
SENSITIVITY
0
-20
INPUT GAIN

I N T R O D U C T I O N

I N T R O D U C T I O N

Since the advent of audio processing devices in the mid-thirties, the broadcaster has sought to raise the average energy level of the program content, while limiting peak excursions of this material at the 100% point through the use of audio processing equipment.

Although technical refinements in the design of this early approach have improved the signal to noise, attack time and distortion characteristics, the basic AGC circuit is still that of a high-class wide-band ac voltage regulator. Obviously, we have failed to consider the simple physics assigned to the problem. The basic task of the audio processor is to PROCESS ENERGY, while LIMITING peak excursions of AMPLITUDE to a preset level. Note that the term used is ENERGY, not amplitude.

ENERGY is a function of POWER. POWER is a function of AMPLITUDE AND TIME. Note that the basic AC VOLTAGE REGULATOR has an EFFECT UPON AMPLITUDE ONLY.

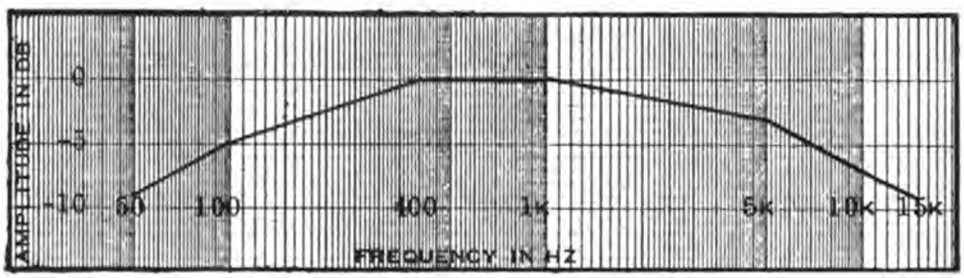
The design of wide-band audio processors is based on amplitude regulation only, and results in gain reduction of the entire program content during the duration of the peak, plus the release time of the device. This common effect can be illustrated, for example, when program material consisting of a sustained violin note and a periodic beat of a bass drum (exhibiting greater amplitude) are both fed into a wide-band processor; the amplitude of the bass drum will cause rapid attenuation of the violin note for the duration of the beat, and for the attendant recovery time of the device.

This, in effect, "punches a hole" in the program material. This unnatural effect of modulation of the basic waveform by peak excursion is a form of intermodulation distortion and is discordant with respect to program material.

AGC amplifiers with slow recovery times reduce the basic program average. Conversely, AGC amplifiers with rapid recovery times exhibit greater energy content during the peak, confusing the control gate, producing a fluttering effect.

Also of note is that program material does not display an equal amplitude characteristic. Therefore the use of wide-band AGC circuitry acts to reduce the intelligibility of the harmonics of the program content, because the AGC action is controlled by the amplitude of the program material in the low and mid frequency ranges.

Spectrum analysis of music and speech material exhibits amplitude rolloffs at both the low and high frequency ends of the spectrum as illustrated below:



Energy content is predominant in the fundamental tone which appears in the low and mid frequency portions of the audible spectrum. This is illustrated in the preceding curve by observing that the amplitude of the mid frequencies are at maximum with the low frequencies exhibiting a gentle rolloff of approximately 3 dB/octave, in order to maintain the equal energy characteristic. A reduction in the energy content in the harmonics of fundamental tones accounts for the rolloff in amplitude at the higher frequencies.

Although modification of the audio spectrum can be made with an equalizer to increase the high frequencies into the AGC amplifier, thus giving the high frequencies equal footing as presented to the control gate, record clicks and inherent inconsistencies in high frequencies result in attenuation in overall loudness during the duration of high frequency peaks and the recovery time of the AGC amplifier. Equalization after wide-band AGC compression amplifies these uncontrolled peaks, as they are normally under threshold of the AGC amplifier, giving unknown amplitude parameters on the high frequency peaks.

Obviously we want to transfer this energy from the source to the listening area in its purest form. Therefore the logical approach is parallel processing, which has distinct advantages. Low frequencies will not attenuate high frequencies, and high frequencies will not attenuate low frequencies. The use of broad crossovers allows a certain amount of leakage between channels. This leakage serves to mask compression effects. Compression even on a single instrument such as a bass note which is being compressed in the low frequency channel would be restricted in dynamics as we listen to just that channel. But because the bass note, although attenuated, leaks into the mid and high frequency channels under the threshold of compression, this leakage, when summed, serves to mask the restricted effect of the low end of the spectrum. Listening to musical material processed in this manner, we notice the total sound more readily than any small part of it. This is known as the psycho-acoustic masking effect.

Recognizing this information, the design of DAP incorporates parallel processing with an amplitude response curve approximating the spectral density of the program material being processed.

The audio input to the device is fed to an active three-way bandpass filter network which develops into three different outputs, as follows:

Low frequency range	20 - 120 Hz
Midrange	120 - 6.5 kHz
High frequency range	6.5 - 15 kHz

These active filters exhibit a 3 dB per octave slope, which allows the AGC action of each discriminate channel to be controlled by the peak amplitude of the filtered program material. The low phase shift of this gentle slope is a factor in the listening quality and produces no obvious effect when a gliding tone crosses over from one band to another.

The output of each bandpass filter is fed to the input of an individual processing system, each with its own independent input and output control. The control functions of each of the three discriminate channels allows the user to boost or reduce the signal into and from each channel separately; this, in effect, shapes the spectrum to a specific energy curve, achieving a more consistent response, thus maintaining the integrity of the program material.

The discriminate bands are then combined and fed into a peak clipper. Contrary to popular conception, soft peak clipping is advantageous when used in the proper perspective. The basic limiting and compression in the three discriminate channels is accomplished in the individual discriminate stages, and then recombined prior to insertion into the clipper stage. However, it is possible to see peaks from the individual discriminate processors which may add in phase to produce some peaks in the order of 1 dB above the average level, thus requiring additional limiting.

Conventional wide-band limiting was not considered acceptable to the application as this 1 dB peak would reduce the level of modulation of the entire system by 1 dB for the duration of the peak, plus the recovery time of the limiter, effectively reducing modulation from 100% to 90% during recovery. This is demonstrative that maximum effectiveness of the DAP is realized in the absence of wide-band processing equipment in the broadcast chain. Instead, the use of soft limiting such as experienced in the overload of vacuum tubes is incorporated, allowing a higher level of modulation to be processed without the attendant ringing in transformers which follow.

Prior to any audio processing, program material will exhibit some asymmetrical qualities, particularly in speech. The use of audio processing devices reduces the asymmetrical quality of this program material.

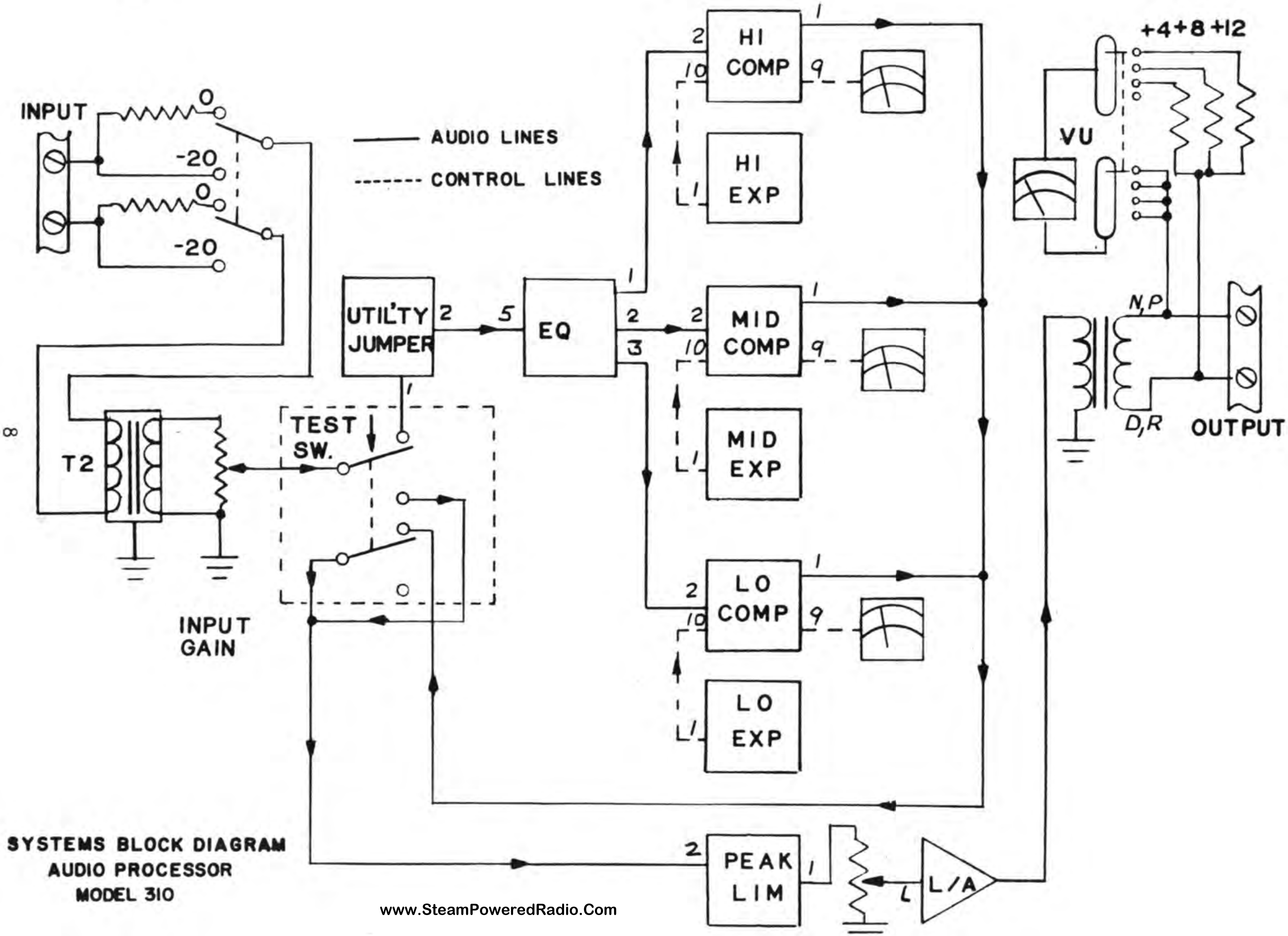
Basically the goal of asymmetrical modulation (in AM broadcasting) is to limit the negative peaks to 100% of 0% carrier level, while allowing positive peaks to reach, but not exceed, 125% of carrier level. Administration of this practice is analogous to clamping the negative peaks to the carrier base line, such as accomplished in D. C. restorer circuitry. Phase flopping will direct asymmetrical peaks to appear in the positive direction, instantaneously shifting the base line, accomplishing a net accumulation of slightly more than 1 dB during some peak half cycle excursions. This is best accomplished with transmitter circuitry that has the ability to reference the modulated waveform to 0% carrier level. Not all transmitters are designed with this concept. The average plate-modulated transmitter, for example, is not so designed.

The most practical way to increase loudness is to increase the energy content (RMS power) of the program waveform, while limiting peak excursions. Loudness is a function of both amplitude (voltage) and duration. This is immediately apparent when observing the antenna current meter under modulation conditions.

The Tri-Band circuitry incorporated in the DAP is designed to increase the average energy or RMS content of the program material in relationship to the peak excursion of this waveform, thus diminishing the necessity of asymmetrical modulation in reality.

May we suggest that the DAP be evaluated as the only audio processor in the broadcast chain, and that the factory-adjusted controls remain undisturbed until the listening quality has been fully evaluated.

S I G N A L   F L O W



SYSTEMS BLOCK DIAGRAM
AUDIO PROCESSOR
MODEL 310

EQUALIZER CARD

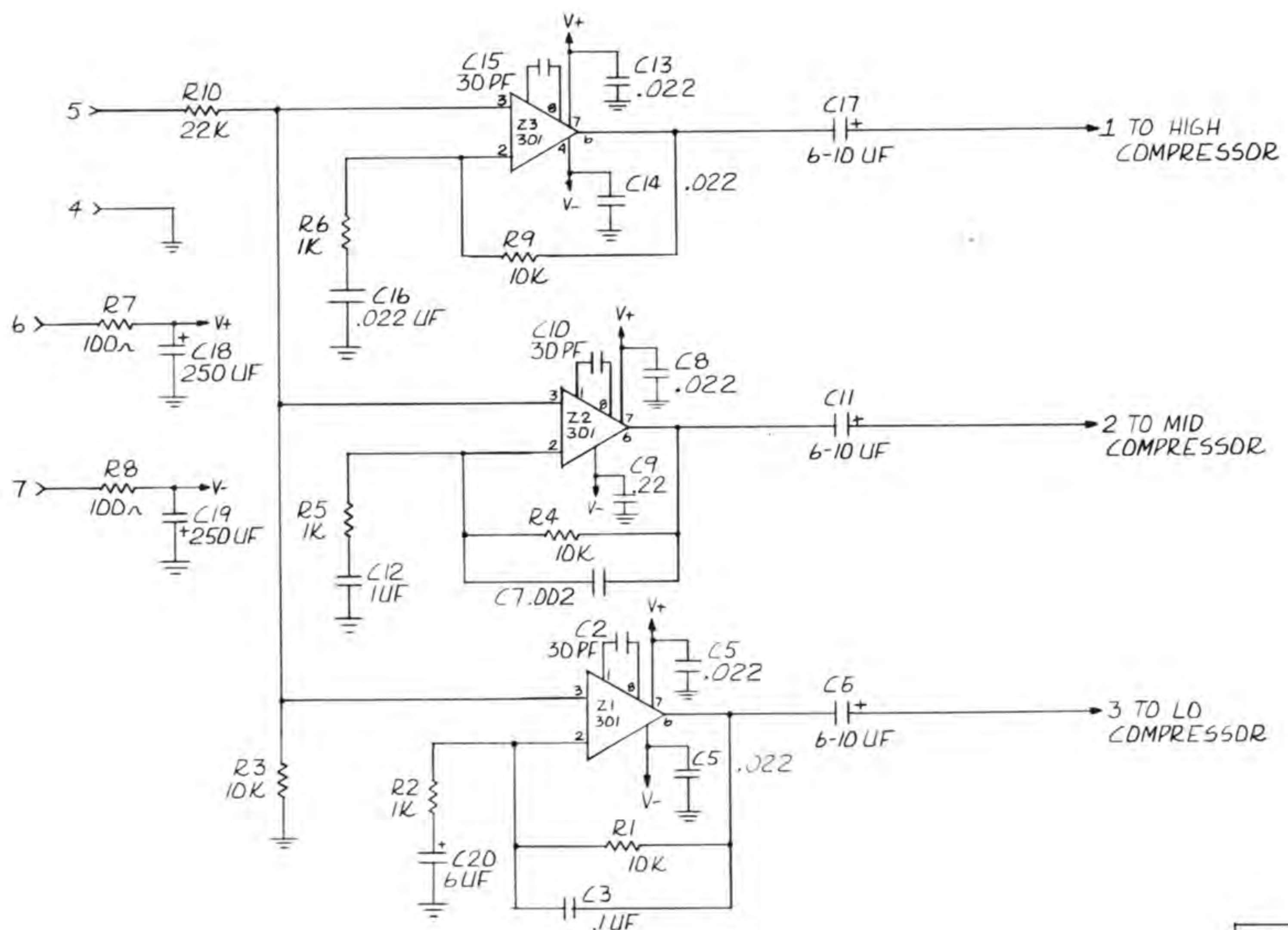
The equalizer card consists of three active bandpass filters designed to divide the spectrum of program material into three discriminate bands. The program is fed in parallel to all three bandpass filters.

The bandpass for the low frequency filter (Z-1) is determined by feedback loop R_1 C_3 as fed to the inverting input determining the high frequency roll-off of this gentle 3 dB per octave 125 Hz filter. Roll-off frequencies below 15 Hz is accomplished by shunting the inverting input through R_2 C_{20} to ground.

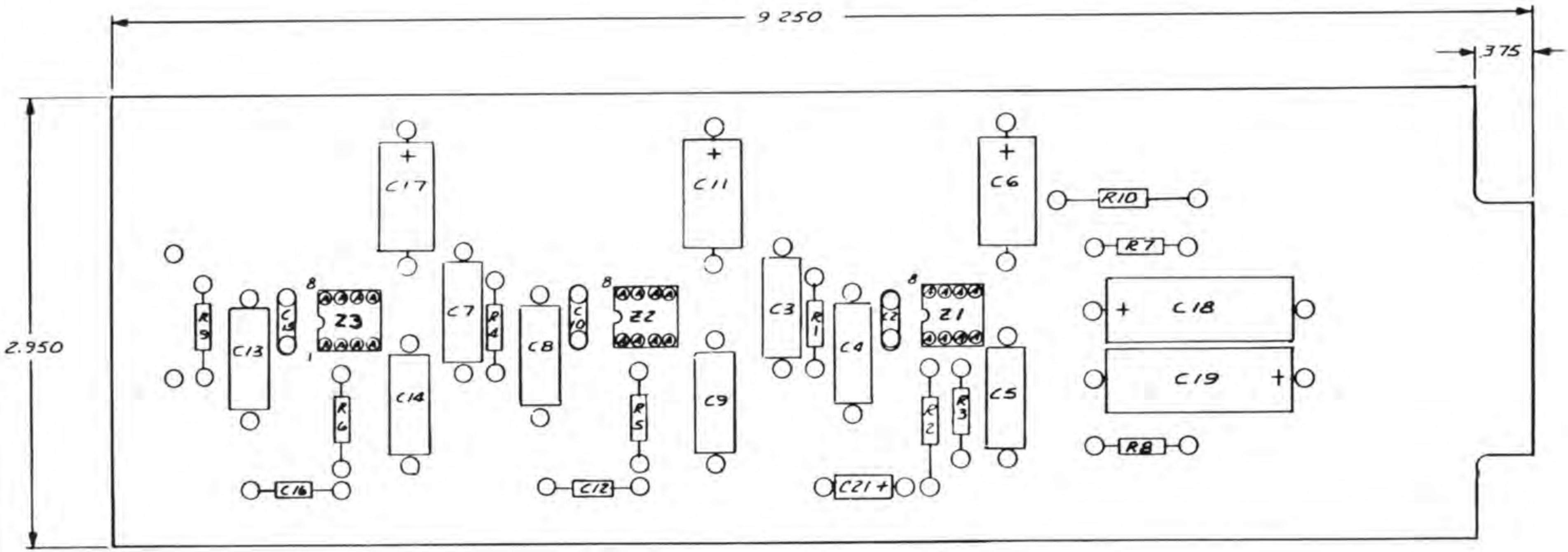
The bandpass of the mid-frequency filter (Z-2) is determined by feedback loop R_4 C_7 as fed to the inverting input determining the high frequency roll-off of 6.5 kHz for this 3 dB per octave filter. The low frequency 3 dB per octave roll-off of this filter is 125 Hz, and is accomplished by shunting the inverting input through R_5 C_{12} to ground.

The bandpass of the high frequency filter (Z-3) is determined by feeding back to the inverting input through R_9 and shunting the low frequencies at 3 dB per octave at the roll-off frequency of 6.5 kHz through R_6 C_{16} to ground.

The output of each individual filter is then fed to the corresponding compressor card.



EQUALIZER CIRCUIT		
MODEL NO DAP-310	REV. C.	DRAWN BY: MARCUS & ASSOC.
DORROUGH ELECTRONICS		



NOTES:
1 MATERIAL: 2 OZ CU. EPOXY GLASS .062
2 LEAD TIN .0003 TO .0005
HOT OIL FUSE.
3 HOLES MARKED A .035 DIA
ALL OTHER HOLES .043 DIA.

PC ASSEMBLY – EQUALIZER	
FOR DORROUGH ELECTRONICS	
	316 A

COMPRESSOR CARD

The compressor card contains five operational amplifiers, a full wave rectifier and a voltage-controlled attenuator.

The input is applied to R_3, the input level attenuator, and fed to both the expander card as well as the non-inverting input of Z-1. Normal gain stability of this amplifier is accomplished by feedback loop R_{14} R_{31} to the inverting input.

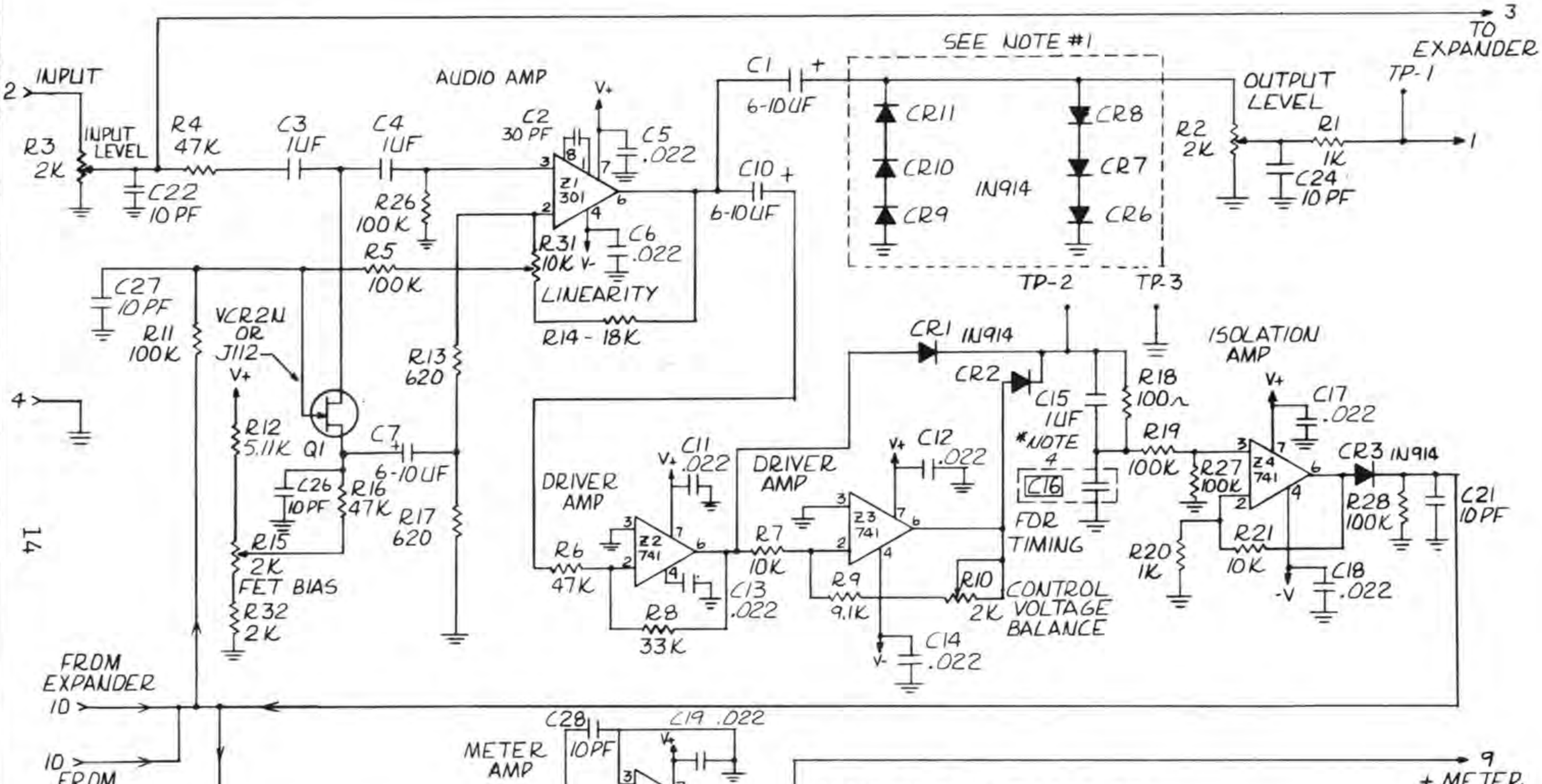
The output signal of Z-1 feeds two driver amplifiers, Z-2 and Z-3, which drive diodes CR_1 and CR_2 providing full wave rectification of the signal. Symmetry of the rectifier is accomplished by feedback loop R_{10} (ADJ) and R_9 to the inverting input of Z-3. The rectified signal is fed through R_{18} to timing capacitor C_{16}. Discharge path R_{19} and R_{27} provides the release time for capacitor C_{16}. This DC voltage is fed to the non-inverting input of Z-4, the output of which feeds through CR_3 (blocking diode) to the control buss.

The control buss feeds the gate of the voltage-controlled attenuator Q-1, which controls the amount of input audio applied to the inverting input of Z-1, thereby limiting the gain of Z-1.

R_{15} controls the bias on Q-1 which, in turn, determines the threshold in the expansion range that the control voltage from the compressor will predominate. Proper adjustment of FET (Q-1) bias R_{15} is essential to optimum overall performance.

The output of Z-1 is fed to the output of the card for connection to the peak limiter. Diode circuitry CR_6 - CR_{11} is a protective device and does not conduct unless the peak output level is exceeded by failure of the control voltage to control the gain of Z-1.

Z-5 is a meter amplifier for the individual compressor-expander meters. Control R_{25} adjusts the meter to the calibrate point (see Maintenance, "Initial Adjustments").

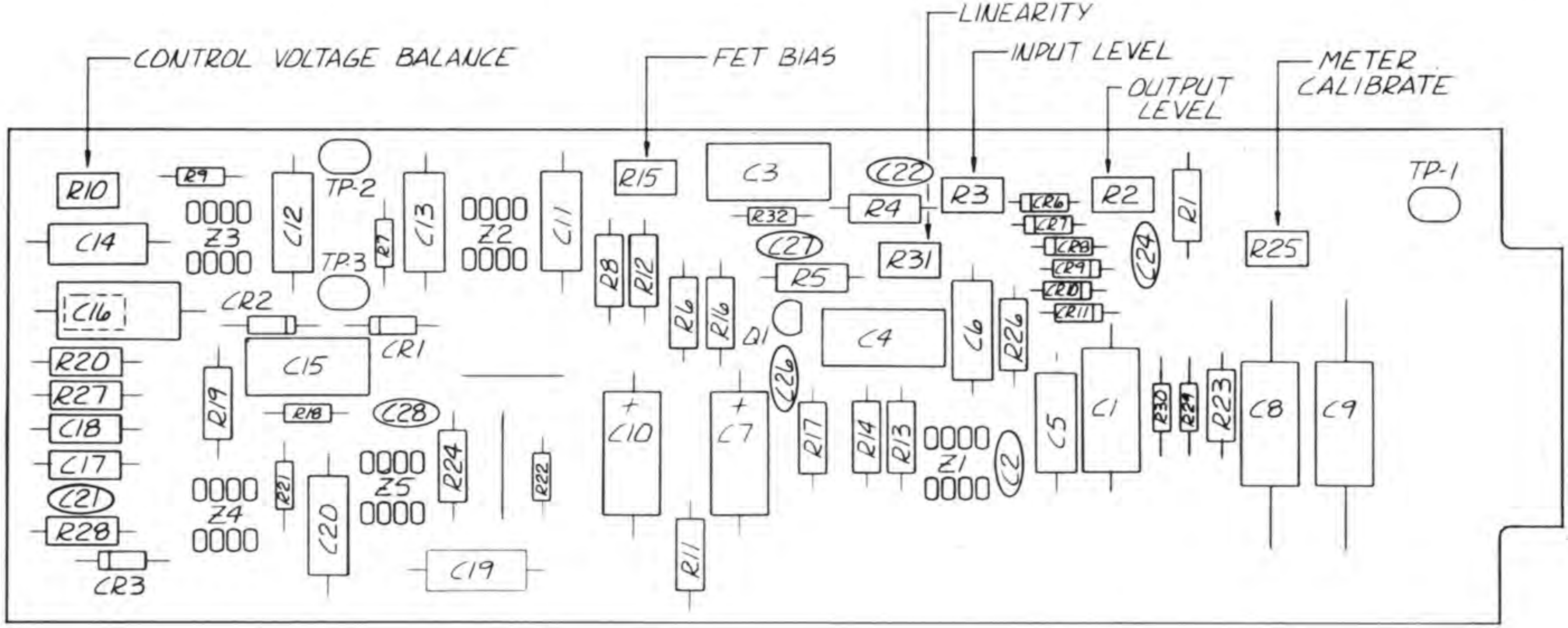


NOTES: 1. CR6 THRU CR11 DO NOT CONDUCT UNLESS A CONTROL VOLTAGE FAILS TO CONTROL Z1.
2. RESISTORS 1/2 WATT 5% CARBON.
3. CAPACITOR VALUES IN MICROFARADS, EXCEPT AS NOTED.
4. C16 COMPONENT VALUES.

LOW COMP.	10 MFD
MID COMP.	6-10 MFD
HI COMP.	5 MFD

COMPRESSOR CIRCUIT		
MODEL NO. DAP-310	REV. D.	DRAWN BY: MARCUS & ASSOC.
DORROUGH ELECTRONICS		

REVISIONS			
LTR	DESCRIPTION	DATE	APPROVED
D.	REV. FOR MFG. REL.	5-18-78	M.M.



NOTES:

1. C16 CAPACITOR VALUES.
   - LOW COMP 10 MFD.
   - MID COMP 6-10 MFD.
   - HI COMP 5 MFD.

TOLERANCES UNLESS OTHERWISE SPECIFIED FRACTIONS DEC ANGLES ± ± ±		COMPRESSOR CARD		
APPROVALS	DATE	P.C. LAYOUT		
DRAWN DOUG	5-78			
CHECKED		SCALE 1:1	SIZE C	DRAWING NO.
		DO NOT SCALE DRAWING		SHEET

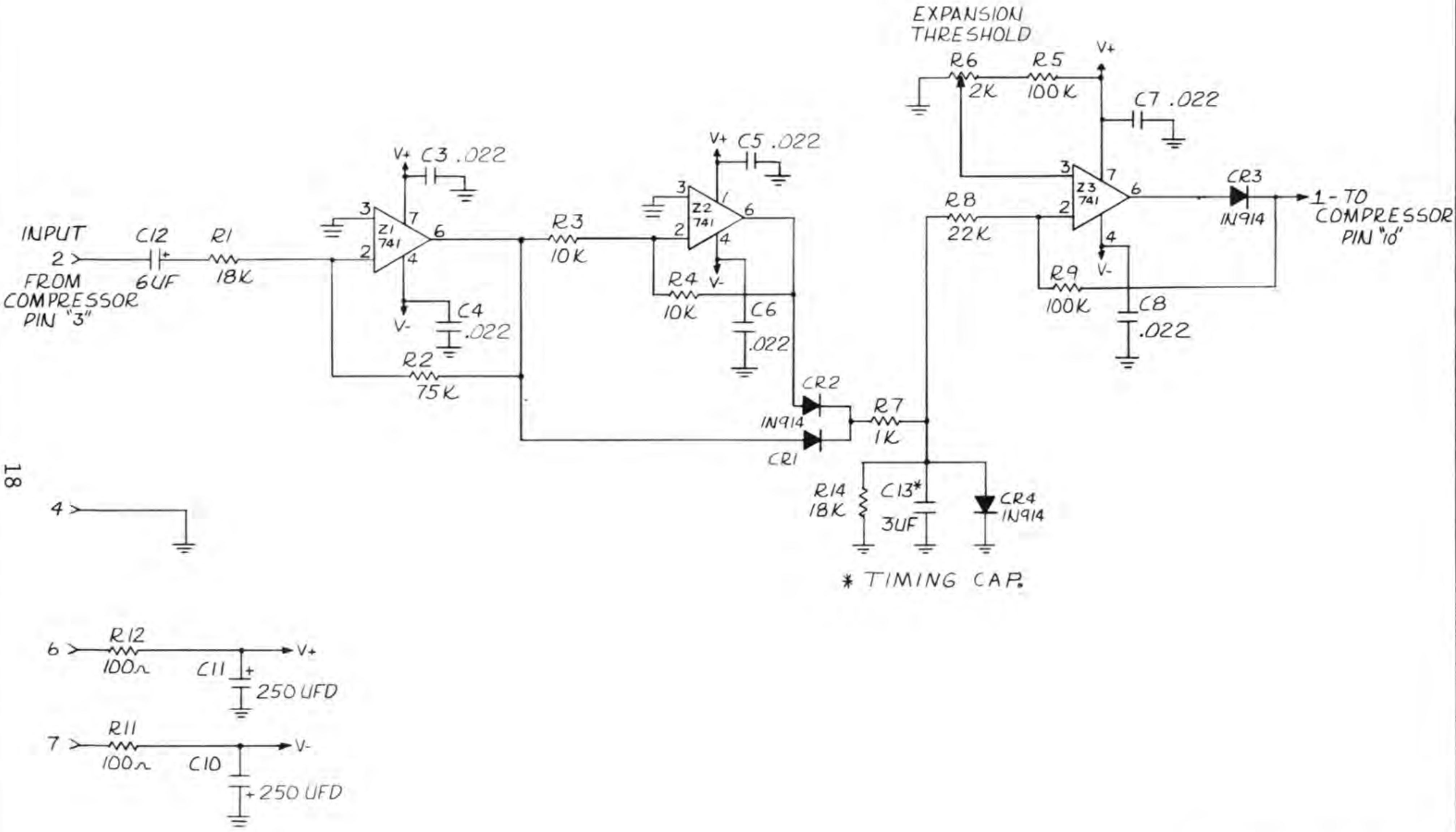
EXPANDER CARD

The expander card consists of two operational amplifiers, a full wave rectifier, and a comparator/buffer.

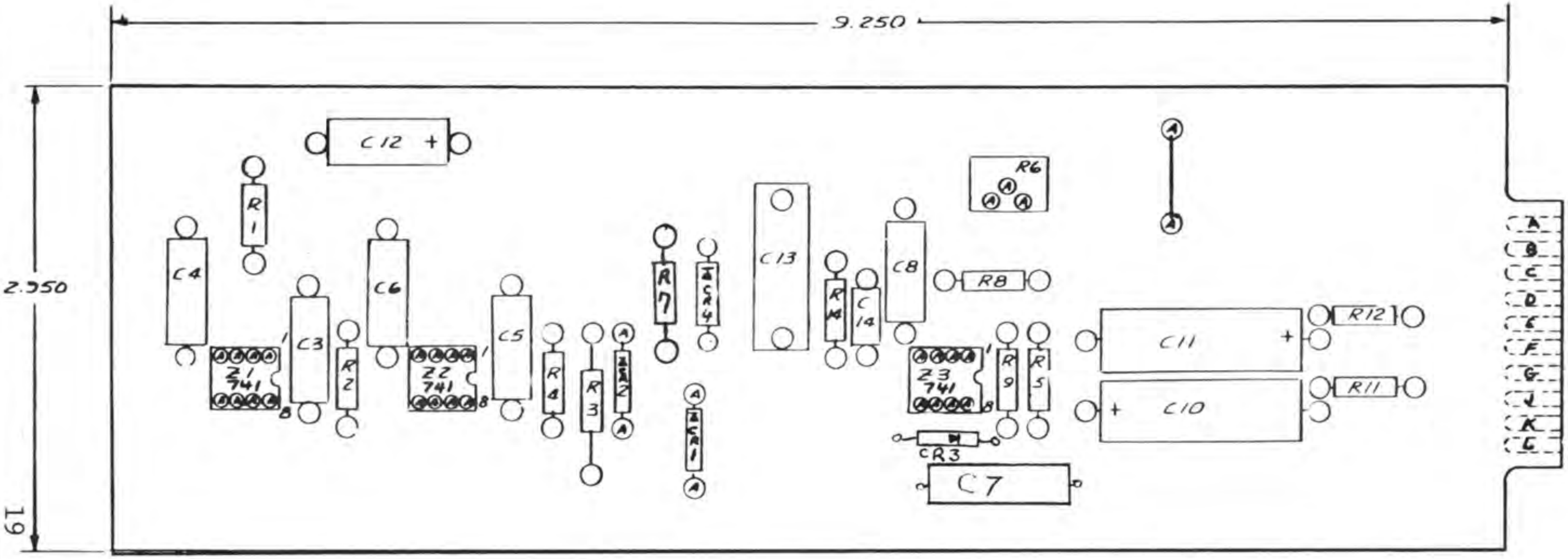
The audio input from the compressor board is fed to operational amplifier Z-1. Normal gain stability of this amplifier is accomplished by feedback resistor R_2 to the inverting input.

The output of Z-1 feeds the inverting input of Z-2 as well as CR_1. Z-2 is a phase inverter. The output of Z-2 feeds CR_2. CR_1 and CR_2 form a full wave rectifier. The rectified signal is fed to timing capacitor C_{13}. Discharge path R_{14} provides the release time for capacitor C_{13}. The voltage at the input of the RC circuit is limited by CR_4 and fed to the inverting input of Z-3 through R_8. R_9 provides positive feedback to the inverting input of Z-3. Voltage divider network R_5 and R_6 provide a bias on the non-inverting input of Z-3. Adjustment of R_6, expansion threshold control, sets the DC output voltage of Z-3 for connection to the control buss on the compressor card.

With no audio input at the input of the expander card, the expansion threshold control provides the necessary bias for Z-3 which, in turn, controls the quiescent condition of the control buss. With no audio input to the combination of the expander and compressor cards, approximately 17 dB of gain reduction is experienced. As low signal levels appear at the input of the expander card, they in turn produce a DC level at the inverting input of Z-3. Z-3 accepts this signal in opposition to the bias level as set by the expansion threshold control (R_6) reducing the DC level on the control buss, which in turn defeats quiescent attenuation, effectively providing expansion. As the input level to the expander is increased, the voltage at the output of the expander card is reduced to the crossover point, where the compressor is the dominant influence on the control buss.



EXPANDER CIRCUIT		
MODEL NO. DAP-310	REV. C.	DRAWN BY: MARCUS + ASSOC.
DORROUGH ELECTRONICS		



NOTES:

1. MATERIAL: 2OZ CU. EPOXY GLASS .062.
2. LEAD TIN .0003 TO .0005
   HOT OIL FUSE.
3. HOLES MARKED (A) .035 DIA.
   ALL OTHERS .043 DIA.

P.C. EXPANDER 310		
FOR DORROUGH ELECTRONICS		
E Ellis		
	313	A

PEAK LIMITER CARD

The input to the peak limiter is fed from the combined outputs of the compressor cards. The level is controlled by R_1 and fed through an RC network $R'_x\ C_x$ to the inverting input of Z-1.

Network $R'_x\ C_x$ is chosen to meet pre-emphasis requirements where applicable.

R_2 provides for feedback to the inverting input for normal gain stability. DC bias control of the non-inverting input affects the symmetry of the output.

The output of Z-1 is fed through load resistor R_6 to diodes CR_1 and CR_2. These diodes conduct upon the presence of an audio signal. The amount of current flow through these diodes is dependent upon the amount of signal and the DC bias controlled by the R_5 symmetry control. Current levels through these diodes have a negligible effect at normal levels of modulation because of square law characteristics of diodes. However, as the signal increases, the current flow increases at a more rapid rate and peak limiting is experienced. It's most important that this function is understood, as the adjustment of the input and symmetry controls plays an important role in the resultant sound quality of the final product. The output of the limiter is connected to the inverting input of Z-2 through isolation resistor R_7.

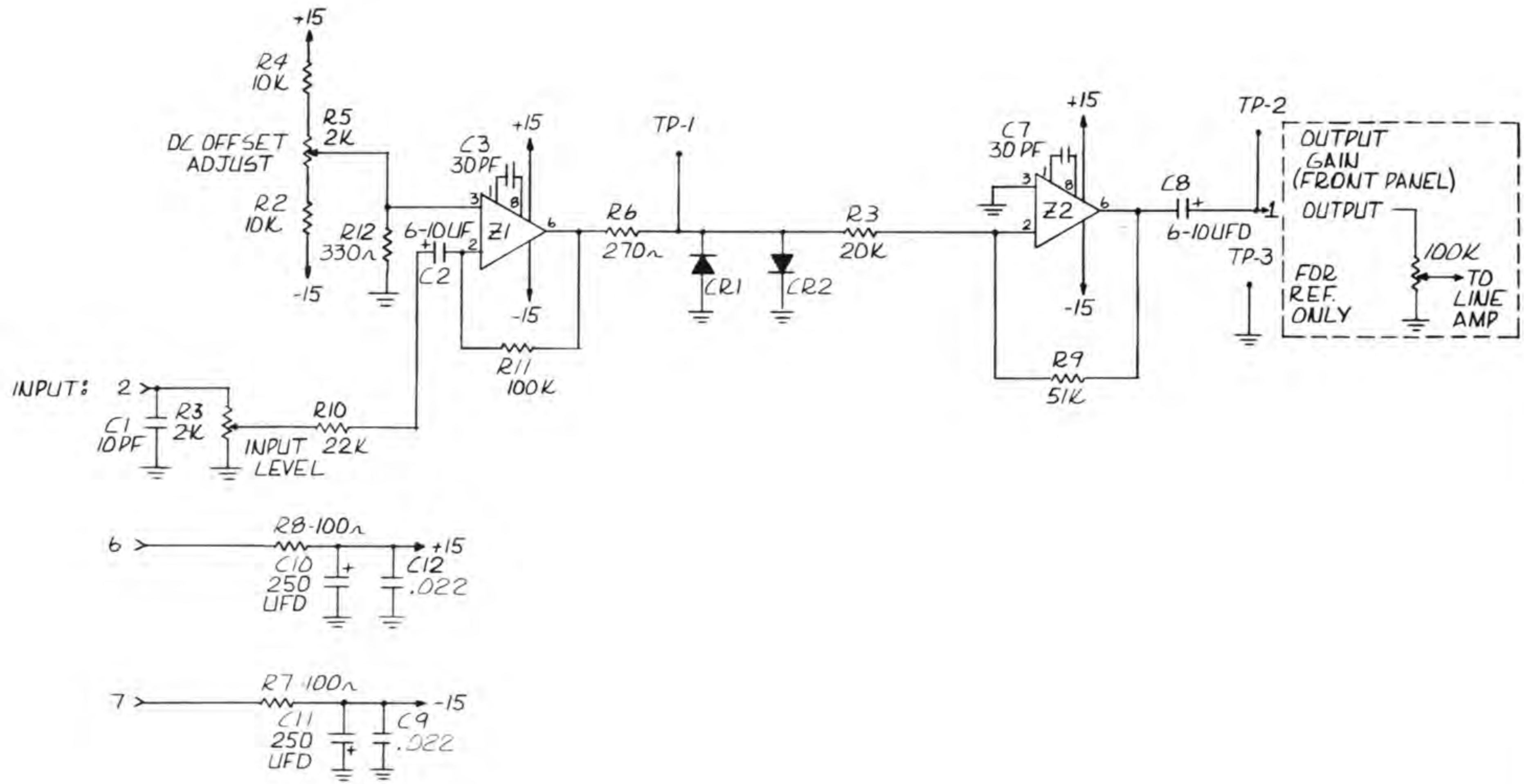
Network $R_x\ C_x$ provides de-emphasis opposite to input pre-emphasis network $R'_x\ C_x$.

The output of Z-2 is fed through the output gain control, located on the front panel, to the line amplifier-power supply board.

LOW PASS FILTER (FM PEAK LIMITER)

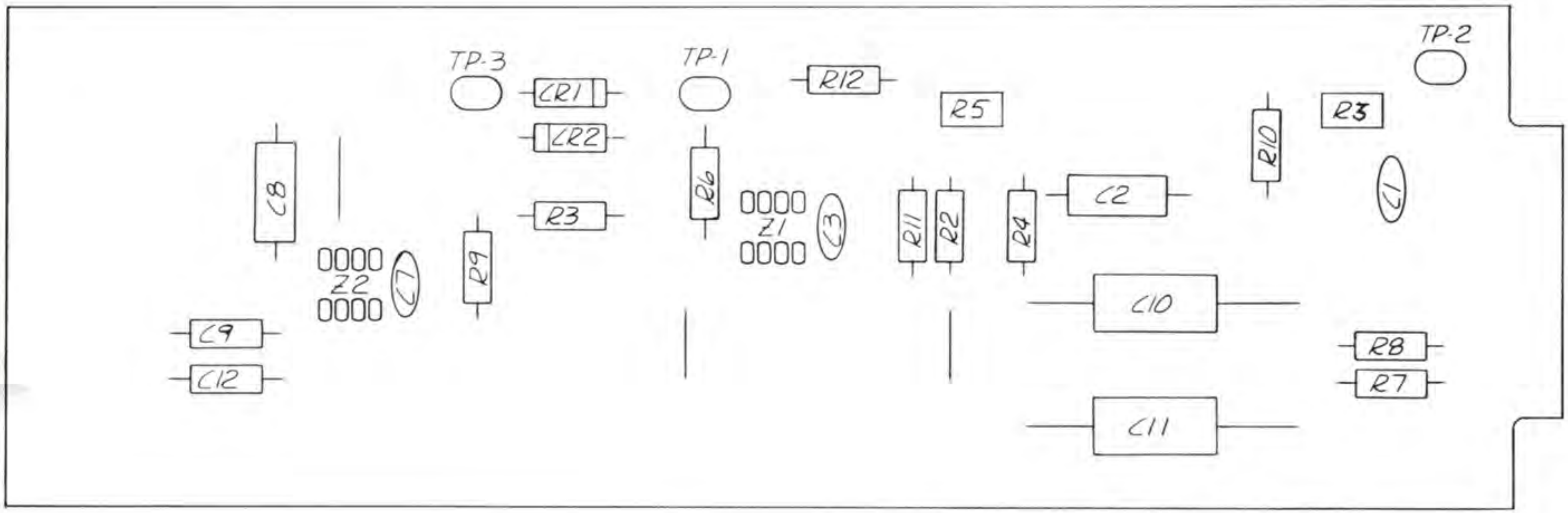
The low pass filter is designed to prevent high frequency energy from interfering with the 19 kHz pilot. This filter follows the output of the de-emphasis circuit Z-2, which also serves as a low impedance source. The filter itself is an active "twin T" tuned to 19 kHz, and is composed of R_{12}, R_{13}, C_{16}, C_{14}, C_{17}, R_{15}, R_{17}, R_{22}, C_{20} and Z-3. The circuitry surrounding Z-4 is that of a voltage follower used to provide isolation for the filter.

NOT USED
1. CAPACITOR - C5



PEAK LIMITER CIRCUIT-AM		
MODEL NO. DAP-310	REV. D	DRAWN BY: MARCUS & ASSOC.
DORROUGH ELECTRONICS		

LTR	DESCRIPTION	DATE	APPROVED
D.	REV. FOR MFG. REL.	5-15-78	M.M.



TOLERANCES UNLESS OTHERWISE SPECIFIED			PEAK LIMITER AM
FRACTIONS ±	DEC ±	ANGLES ±	
APPROVALS	DATE		P.C. LAYOUT
DRAWN DOUG	5-78		
CHECKED			SCALE 1:1 / SIZE C / DRAWING NO
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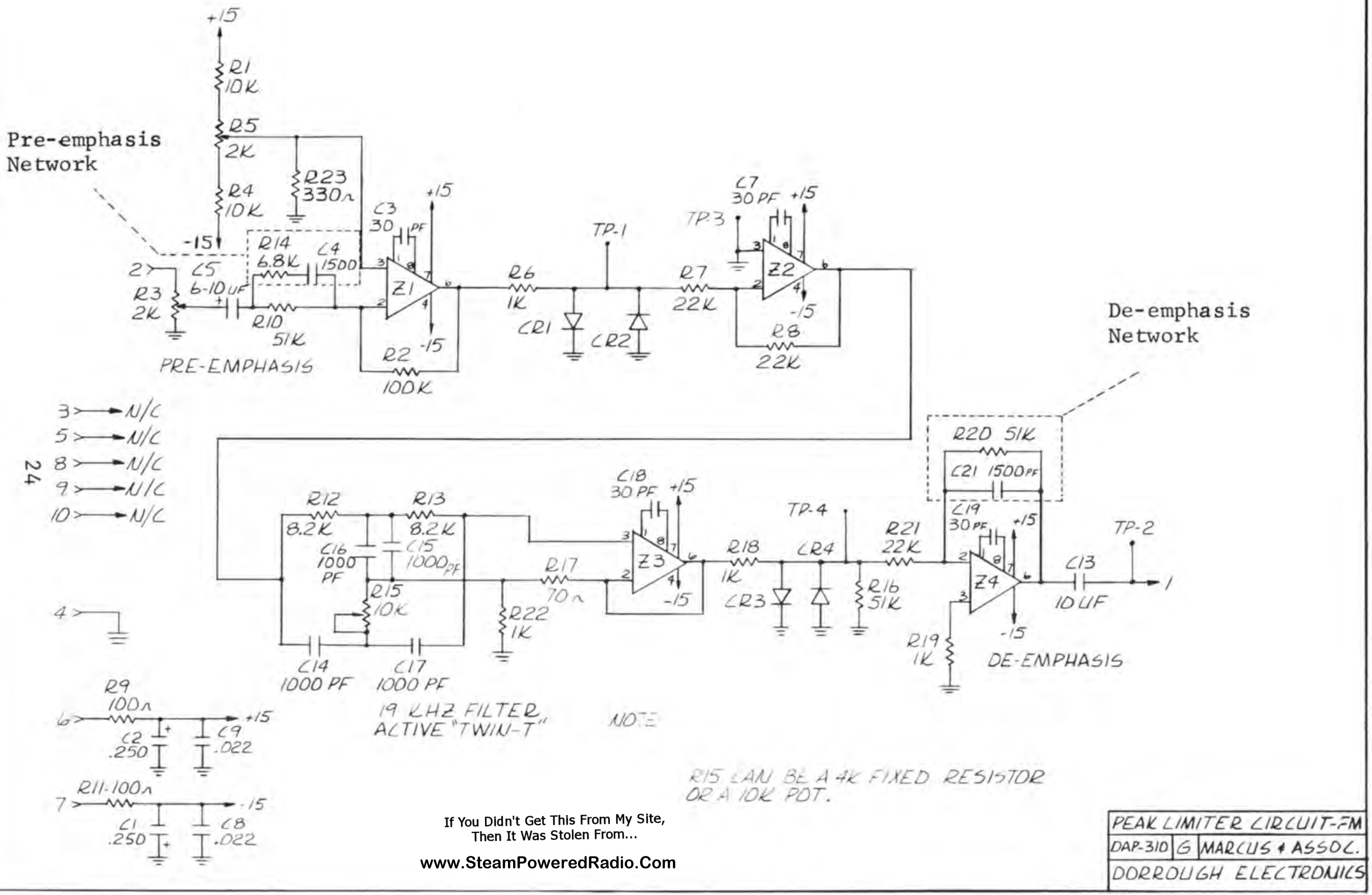
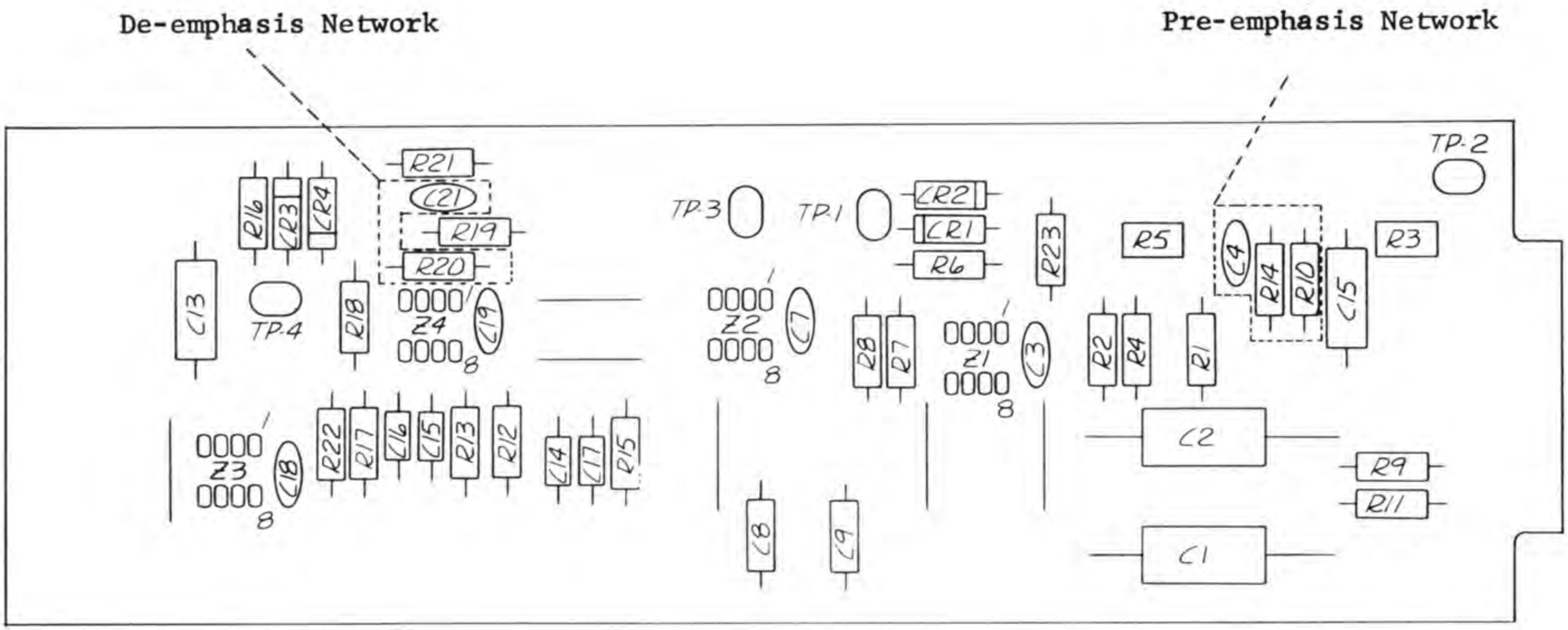


Pre-emphasis Network
De-emphasis Network
PRE-EMPHASIS
DE-EMPHASIS
R1 10K
R5 2K
R4 10K
R23 330Ω
R14 6.8K
C4 1500
C5 6-10 UF
R3 2K
R10 51K
C3 30 PF
Z1
R2 100K
R6 1K
CR1
CR2
TP-1
TP-3
C7 30 PF
R7 22K
Z2
R8 22K
R12 8.2K
R13 8.2K
C16 1000 PF
C15 1000 PF
R15 10K
C14 1000 PF
C17 1000 PF
R22 1K
R17 70Ω
C18 30 PF
Z3
R18 1K
CR3
CR4
TP-4
R16 51K
R21 22K
R20 51K
C21 1500 PF
C19 30 PF
Z4
R19 1K
C13 10 UF
TP-2
+15
-15
3 N/C
5 N/C
8 N/C
9 N/C
10 N/C
R9 100Ω
C2 .250
C9 .022
R11 100Ω
C1 .250
C8 .022
19 KHZ FILTER ACTIVE "TWIN-T"
NOTE
R15 CAN BE A 4K FIXED RESISTOR OR A 10K POT.
PEAK LIMITER CIRCUIT-FM
DAP-310 G MARCUS & ASSOC.
DORROUGH ELECTRONICS

REVISIONS			
LTR	DESCRIPTION	DATE	APPROVED
G.	REV. FOR MFG. REL.	5-15-78	M.M.



NOTE

R15 CAN BE A 4K FIXED RESISTOR
OR A 10K POT.

TOLERANCES UNLESS OTHERWISE SPECIFIED FRACTIONS ± DEC ± ANGLES ±	PEAK LIMITER - FM
APPROVALS / DATE — DRAWN DOUG 5-78 — CHECKED	P.C. LAYOUT
SCALE 1:1	SIZE C — DRAWING NO.
DO NOT SCALE DRAWING	SHEET

LINE AMPLIFIER/POWER SUPPLY BOARD

LINE AMPLIFIER

The signal from the peak limiter is fed through the output gain control (front panel) to the inverting input of Z-3. Gain stability is accomplished through feedback loop R_{20} C_{12}.

The DC power required by Z-3 from the ± 15 volt power supply is sensed by the bases of transistors of Q-5 and Q-6 forming a complementary pair amplifier which aids the output of Z-3, providing a low impedance source to the output transformer. Available output level from the line amplifier is ± 24 dBm.

A 4 to 6 dB pad may be connected at the output of the transformer to provide isolation between the output transformer of the DAP and the input transformer of the transmitter.

POWER SUPPLY

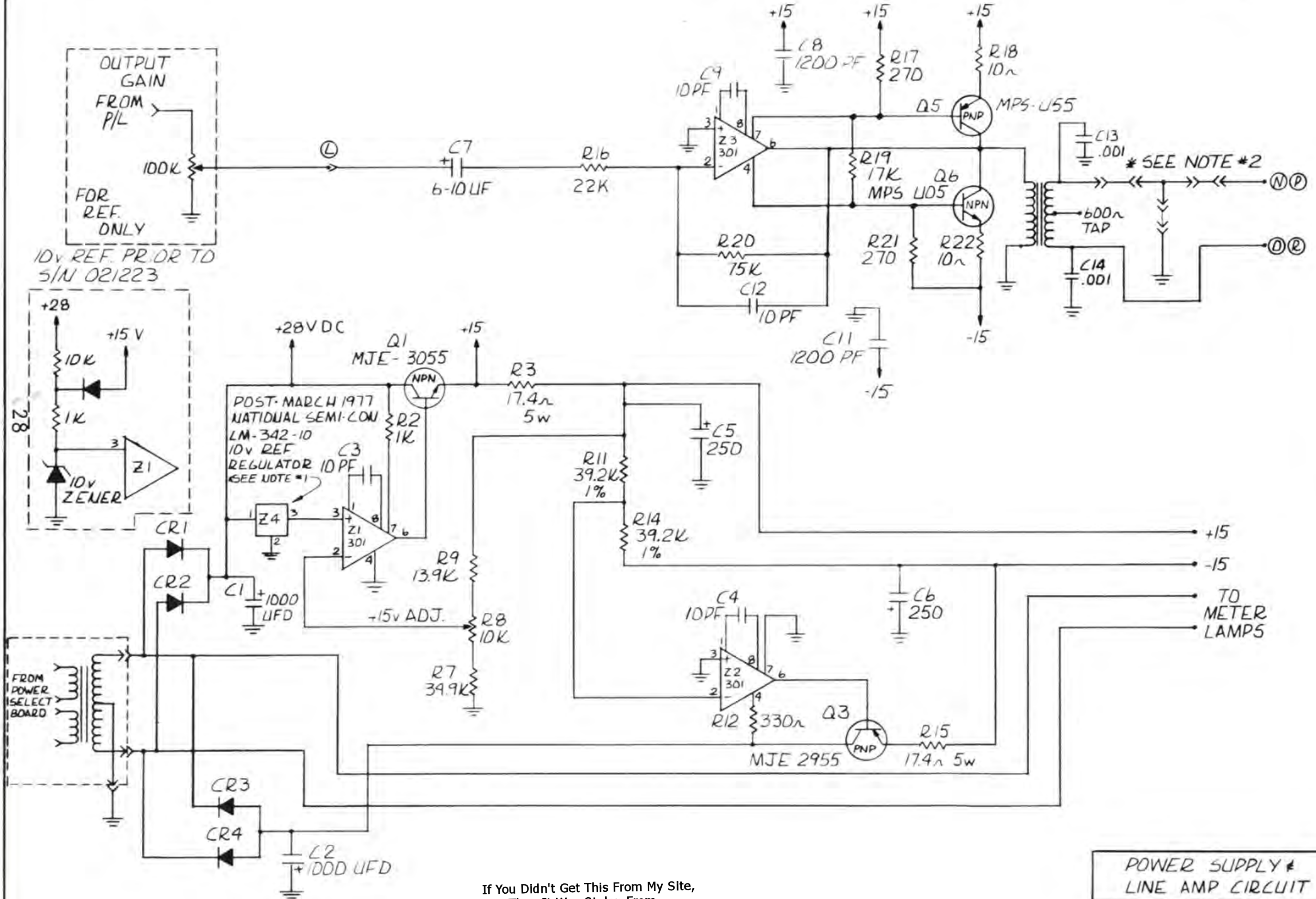
The power supply is a conventional full wave bridge rectifier which feeds Q-1 and Q-2 series pass regulators capable of providing currents to 2 amperes with nominal output voltages of

$\pm$ 15 v. Voltage comparators Z-1 and Z-2 control the regulating action of Q-1 and Q-2. The choice of large filter capacitors and regulated voltage control produce low ripple.

OPTIONAL INCREASE IN LINE AMPLIFIER GAIN

Occasionally there is need for additional line amplifier gain to fulfill the requirement of higher line levels for the operation of some transmitters.

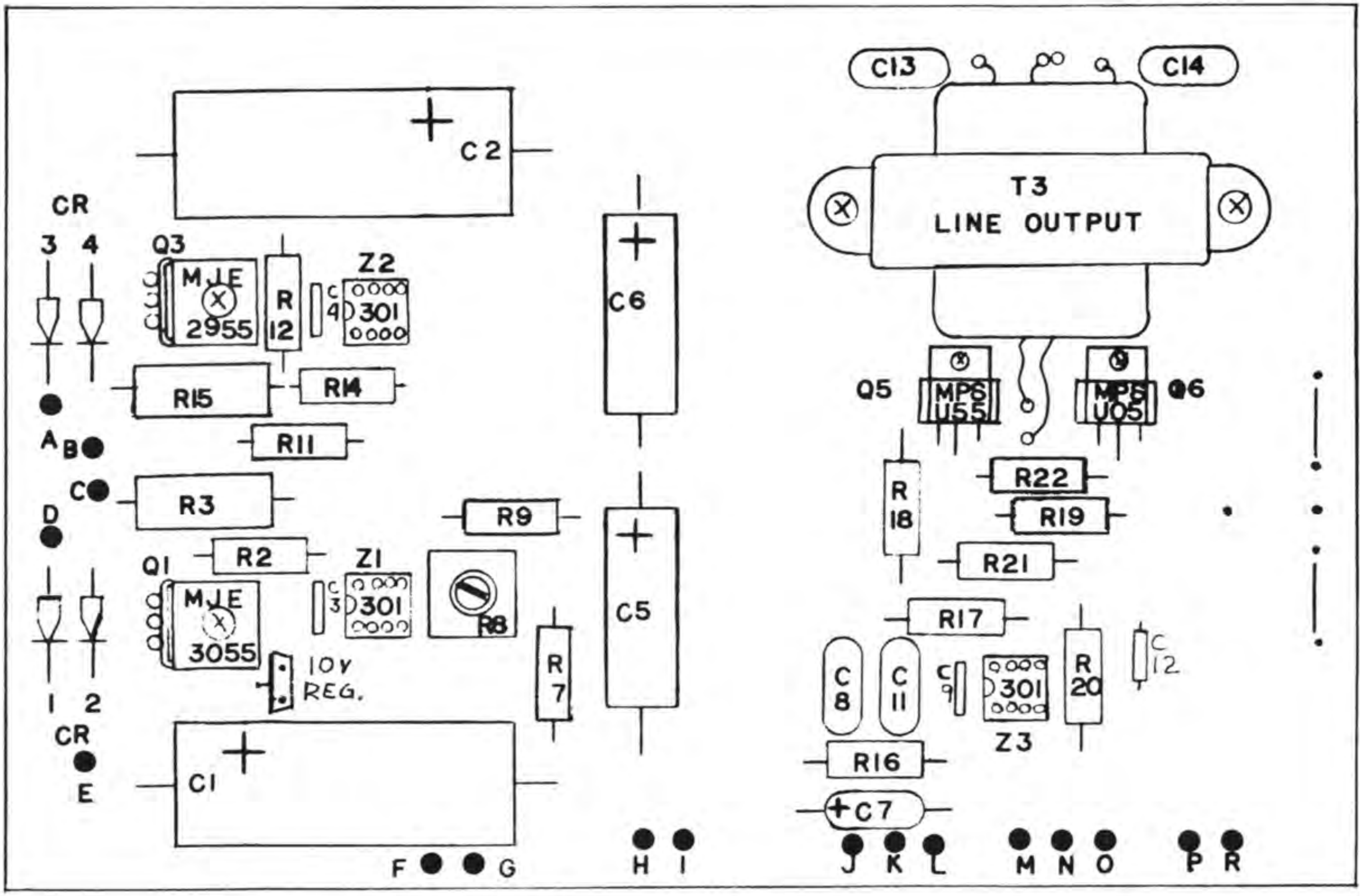
Should this need arise, this can be accomplished by removing feedback resistor R_{20}(75K) on the line amplifier board, (see Pg 28 and 29) and replacing it with a 150K.



POWER SUPPLY & LINE AMP CIRCUIT

MODEL NO.	REV.	DRAWN BY:
DAP-310	C	MARCUS & ASSOC.

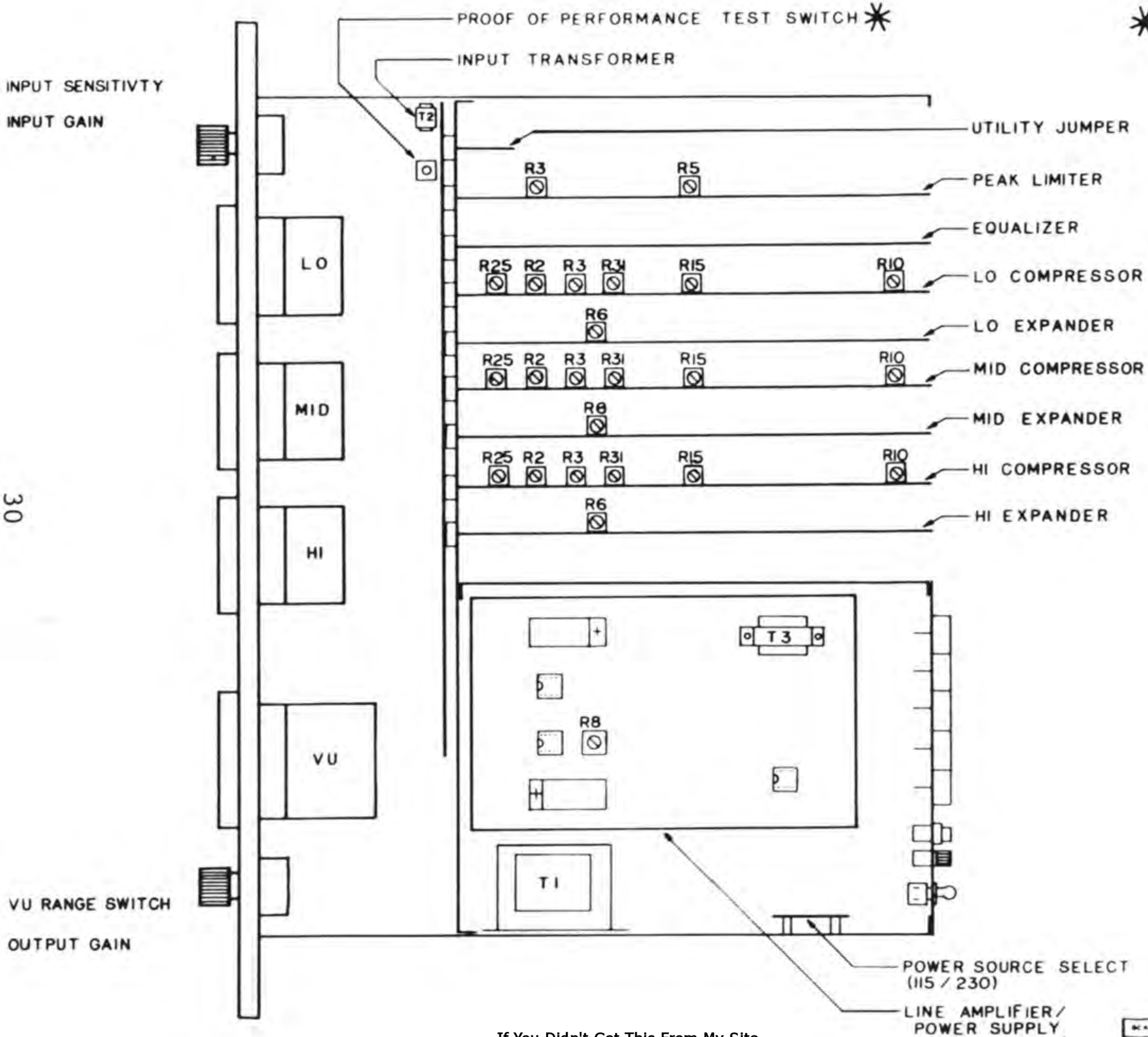
DORROUGH ELECTRONICS



POWER SUPPLY/LINE AMPLIFIER
PC ASSEMBLY

I N S T A L L A T I O N

A N D   I N I T I A L   S E T U P



✱ PROOF OF PERFORMANCE TEST SWITCH IS INCORPORATED INTO THE INPUT SENSITIVITY SWITCH ON ALL SYSTEMS SERIAL NO. 021223 AND ABOVE.

ADJUSTMENT KEY

R2 — OUTPUT LEVEL
R3 — INPUT LEVEL
R5 — DC OFFSET
R6 — EXP. THRESHOLD
R8 — VOLTAGE ADJ.
R10 — SYMMETRY
R15 — FET BIAS
R25 — METER CAL
R31 — LINEARITY

SCALE NONE DATE 2-2-76	APPROVED BY	DRAWN BY R.A. REVISED C-2/2/
PHYSICAL LAY-OUT		
DORROUGH ELECT		310

INSTALLATION

AND INITIAL SETUP

This processor was fully aligned prior to shipment, in accordance with the following procedure. Since the alignment procedure is relative to subjective judgment, variable adjustments allow deviation from the recommended to suit the individual taste.

Remove the top cover before installation. Mount the unit in the rack, leaving at least 3-1/2" above the unit for making adjustments.

The DAP requires a standard 3-1/2" rack height and 13" of rack depth.

The input sensitivity switch is a 20 dB fixed bridging pad at 20K ohms in the zero position. In the -20 position, the input terminals look directly into the 600 ohm input transformer.

The Processor should be terminated in 600 ohms with a 4 to 6 dB pad, and fed directly into the transmitter's input transformer. (Note: If two transmitters are to be coupled to one Processor, it should be done with a resistive splitting pad, as transformers or amplifiers tend to add overshoot to the waveform, defeating the action of the peak limiter.)

Before applying power, adjust the front panel input and output controls fully counter-clockwise. Apply power and allow the unit a few minutes to stabilize.

Inactivate the peak limiter by adjusting R_3 on the limiter card to approximately the 1/4 open position. Do not be concerned about modulation percentage at this time. Adjust R_3 on the <u>high frequency compressor</u> to the fully clockwise position.

Apply normal program material or, preferably, a pink noise signal, at normal operating level, to the Processor. Adjust the front panel input control clockwise, observing the small <u>high frequency meter</u>. During the travel of the input control, note that this meter (ignore the other two small meters for the moment) will move upward to the right, showing slight gain expansion. As the gain is increased, the meter will reach a peak and then deflect to the left as compression occurs. Continue increasing the gain until the needle fluctuates approximately 1/2 of the way into the blue region. Leave the panel input control at this setting. This assures ample headroom at the equalizer card ahead of the processing channels.

Watch the action of the mid frequency and low frequency meters. Now, if necessary, adjust the R_3 input control on the mid frequency and low frequency compressor boards until they approximate the action of the high frequency meter. Be sure to check carefully the physical layout for the correct location of these controls.

For STEREO, the signal source should be fed monophonically and in phase to each unit simultaneously (with the stereo jumper cable disconnected) as the gain is increased both units should be adjusted with the individual R_3 input controls until they track equally.

These adjustments have established the proper AGC range. The following adjustments are subjective and will allow the station to project the overall "SOUND" desired, and will be accomplished with the R_2 output adjustment of each channel. The R_2 control on the mid frequency card should be 3/4 of the way open to establish a standard level for driving the limiter card, and will allow for subjective adjustment of the low frequency and high frequency R_2 controls.

Adjustment of the R_2 (or output) control on both the high and low frequency cards is subjective. However, an output test point is provided on each of the compressor cards (see TP-1). The output level from each of the compressor cards can be measured individually by removing the other two compressor cards and measuring with an audio voltmeter at this point.

Subjective listening tests conclude that proper adjustment with a pink noise input signal will produce an output signal on the output of the low frequency card that is 1 dB below that measured on the mid frequency output. The output of the high frequency card will be 6 dB below that measured on the mid frequency output, making the relative positions of R_2 on the low and high frequency cards to be in the approximate 3/4 and 1/2 open positions respectively. This concludes the adjustment of the expander-compressor cards.

OPTIONAL EVALUATION PROCEDURE

The electronics industry has produced much in the line of sophisticated hardware. However there is a very simple approach to evaluating the performance of amplifiers and processors.

Engineers for years have discussed the ultimate amplifier as a wire with gain. The obvious measurement technique for evaluation of this product would be to compare its output with its input. This is accomplished by feeding a signal (pink noise or program) to the device, as well as to the input of a mixing amplifier. The output of the device under test is fed 180^{o} out of phase to the second input of the mixing amplifier. The mixing inputs are then adjusted for a null at the output of the mixing amplifier. This output will contain all the products which are at difference with the input, and can be observed on an oscilloscope and earphones.

This approach is useful in evaluating system performance under dynamic conditions, and is recommended in the adjustment of the DAP.

SETUP OF THE OUTPUT PEAK LIMITER FOR AM USE

Place the test switch in the "TEST" position.

Feed a test signal of 1,000 Hz to the Processor.

Adjust the front panel output control, while watching the modulation monitor meter in the negative polarity position, until an average of 60% modulation is indicated. Note that if 60% modulation cannot be obtained, the input control can be adjusted to obtain the desired level.

Switch the modulation monitor to the positive polarity position, noting the differential between the negative and positive peaks. Slowly rock R_5 on the peak limiter card, while alternately watching the negative and positive readings on the modulation meter. R_5 may be adjusted for a higher level on the positive peaks than on the negative peaks. This is accomplished with the R_5 DC offset control (Asymmetry).

Because of the discriminate channels, though your transmitter may be capable of 125% modulation, it is important that the difference between the negative and positive peaks be no more than 1 dB apart for better fidelity and substantially lower intermodulation distortion. This means that even though the modulation meter will indicate less than 125% in positive peaks, the consistent density from the Processor allows greater RMS level.

Rotate both input and output controls fully counter-clockwise. Place the test switch in the opposite, or normal operating position, from "TEST."

Feed a test signal of 1,000 Hz to the Processor. Rotate the input control until this signal is observed in the compression range of all three discriminate meters. Note that the mid frequency meter will show heavy compression. This is necessary to allow all three compressor cards to contribute to the input of the peak limiter.

Adjust the peak limiter control R_3 clockwise to the point of audible distortion, then retard it slowly until it disappears. Connect a harmonic distortion meter on TP-2 of the peak limiter card. The total harmonic distortion should read approximately 2-1/2% at this point. If not, adjust R_3 so that the THD at TP-2 is 2-1/2% (note that the level at TP-2 will vary with the adjustment of R_3, however the parameter under adjustment is THD).

Note that although the figure of 2-1/2% distortion might frighten the purist, this figure is representative of the distortion on peak excursions presented to the limiter, and not related to the general RMS amplitude normally associated with total harmonic distortion. Limiting in excess of this recommended figure will dampen the punch and depth of the program material, and will produce a "busy" sound.

Remove the 1,000 Hz tone and replace with pink noise or program material at normal operating levels. Adjust the input control to note action on all three discriminate meters, and then adjust the output control until full modulation is achieved.

Adjustment of the Processor is now complete.

An A/B comparison between the Discriminate Audio Processor and your former processing equipment, will make the differences immediately apparent.

In situations where additional brightness is desired, it is recommended that rather than disturb the output adjustments of the Tri-Band system, the high frequency content can be accentuated by *placing a 33K resistor in series with a .008 uf capacitor across R_{10} (22K) on the peak limiter board. See Pg 22 and 23.

*NOTE: Since this modification changes the frequency response of the DAP, it must be removed for proof measurements.

SETUP OF THE OUTPUT PEAK LIMITER FOR FM USE

Place the test switch in the "TEST" position.

Feed a test signal of 1,000 Hz to the processor.

With the transmitter in the stereo mode, adjust the left channel processor front panel output control until an average of 80% is indicated on the total modulation meter in the negative polarity position. Note that the stereo jumper normally connected between the two processors should not be connected at this time. Switch the modulation meter to the positive polarity position. The meter reading should be identical to the reading in the negative polarity position. If not, adjust R_5 on the peak limiter for an equal reading.

Rotate the left channel input and output controls fully counter-clockwise and follow the instructions as above for alignment of the right channel.

Place the test switch in the opposite or normal operating position from "TEST" on both left and right channel processors.

With a 1,000 Hz tone of equal amplitude and in phase, *fed* to both processors, rotate the input control of the left channel processor until this signal is observed in the compression range of all three discriminate meters. Note the mid frequency meter will show heavy compression. This is necessary to allow all three compressor cards to contribute to the input of the peak limiter.

Adjust the peak limiter control R_3 clockwise to the point of audible distortion, then retard it slowly until it disappears. Connect a harmonic distortion meter on TP-2 of the peak limiter card. The total harmonic distortion should read approximately 2% at this point. If not, adjust R_3 so that the THD at TP-2 is 2%. (Note that the level at TP-2 will vary with the adjustment of R_3, however the parameter under adjustment is THD.)

Note that although the figure of 2% distortion might frighten the purist, this figure is representative of the distortion on peak excursions presented to the limiter, and not to the general RMS amplitude normally associated with total harmonic distortion.

Limiting in excess of this recommended figure will dampen the punch and depth of the program material, and will result in listener fatigue.

Rotate the left channel input control fully counter-clockwise and follow the instructions as above for setting the peak limiter on the right channel processor.

Following the adjustment of the peak limiters on both left and right processors, remove the 1,000 Hz tone and replace with pink noise or program material fed monophonically and in phase at normal operating levels.

Adjust the input control on the left processor to note action on all three discriminate meters. Next, adjust the input control on the right processor to that observed on the left channel processor.

Next, advance the output control on each processor until full modulation is achieved on each channel. Connect the stereo jumper.

Adjustment of the Processor is now complete.

An A/B comparison between the DAP and your former processing equipment will make the differences immediately apparent.

M A I N T E N A N C E

INITIAL ADJUSTMENTS

EQUIPMENT REQUIRED

1. Low distortion audio oscillator
2. General purpose oscilloscope
3. Distortion analyzer
4. DC voltmeter

INSTRUCTIONS

Remove top cover of unit. All controls are viewed from the top. The test switch should be to the left position.

Before making any adjustments, verify power supply output at -15½ volts. Using a DC voltmeter, connect positive lead to chassis ground and negative lead to B- tie point (located at the junction of tie point and blue wire) on the power supply amplifier board. A -15½ volt reading here indicates proper operation of both sides of the supply.

Turn the expansion threshold controls R_6 on the expander boards fully counterclockwise. This will remove quiescent reduction and meters will move up to the calibrate position. Turn

R_3 on the peak limiter board fully counterclockwise and adjust R_5 to mid-position.

Set each FET bias control R_{15} fully counterclockwise on each of the discriminate channel compressor boards (low, mid and high). Set each output control R_2 and each input control R_3 to mid position.

Set linearity R_{31} on all compressor boards counterclockwise, and adjust the symmetry control R_{10} to approximately mid range position.

FET BIAS

This bias adjustment is typical for each of the compressor/ expander boards.

Verify that the low/mid/high meters are all at the full scale calibrate position. If adjustment is necessary, use R_{25} (meter calibrate) on the appropriate compressor card. Note: R_{25} is first control on each compressor card as viewed from front of unit. Adjust expansion control R_6 on expander board clockwise until meter pointer deflects downscale to the blue-black junction. Leave R_6 control at this setting. This indicates the expander circuit is injecting proper quiescent gain reduction.

Set the sensitivity switch on the front panel to zero and the input gain control to the mid point.

Apply 1,000 Hz tone at approximately +8 dBm to the rear input terminals.

Slowly rotate R_3 input on each of the compressor boards clockwise, noting that the low/mid/high meter will move upscale through the expansion range. This procedure verifies that the audio tone is nullifying the quiescent gain reduction and returning the field effect transistor to full gain.

Proper adjustment of the FET bias R_{15} is essential to optimum overall performance. This control determines the point in the expansion range that the control voltage from the compressor takes over. Maximum expansion is obtained with the meter at full scale (to the right).

Slowly rotate bias control R_{15} on each compressor card clockwise until meter deflects left to the mid-compression range. Now decrease input control R_3 to the full counter-clockwise position, noting that the meter will return to the blue-black junction. Again, slowly increase input control R_3 to point where peak expansion occurs and compressor control voltage begins to take over. Proper bias control setting will be achieved when peak expansion action causes meter to deflect halfway to the letter "E" in the word expansion. Through trial and error, continue slight clockwise rotation of the bias control followed by rocking the input control back and forth until this degree of peak expansion is achieved.

Note: If meter fails to travel through expansion range and/or sporadically moves left into the compression range as audio is alowly applied, a condition of under-bias has occurred. In this case, slowly rotate bias control counterclockwise while rocking input control to determine proper expansion action as described above.

Once FET bias adjustment has been accomplished for each channel, the following procedure will establish an operating range in which the input control R_3 is set. Rotate the front panel input control fully counterclockwise. R_3, high frequency input control, should be fully open. The R_3 mid frequency input control should be approximately 1/4 of the way open, and the R_3 low frequency input control should be approximately half way open. (See Installation and Initial Setup.)

The following procedure is for adjustment of the R_{31} linearity control on each compressor card for minimum distortion. Rotate R_2 output control on the high frequency compressor card half way open clockwise. Rotate output control R_2 fully open on the mid frequency compressor card and rotate R_2 output control on the low frequency compressor card 2/3 open. These settings will establish a mix from the discriminate channels.

Rotate the input control to a point where the 1,000 Hz tone has passed through expansion threshold and indicates some amount of compression in each channel.

This may require a slight adjustment of the individual R_3 input controls.

Connect a distortion analyzer to test point 1 on any of the three individual channel compressor boards. (These test points are for factory alignment procedures. However, in actual circuit operation, they are in parallel.)

Set the distortion analyzers for a reference level. (With some analyzers, there may not be enough output to reach the "set level" point. However, any convenient reference may be used.)

Make conventional distortion measurements. Adjust R_{31} on each of the boards for lowest overall distortion.

Distortion should be checked at 100 Hz, 1,000 Hz and 10,000 Hz. As the audio generator is stepped between the three frequencies, the appropriate R_3 input control will require small adjustments to maintain overall compression threshold.

Overall distortion should be better than one per cent. Disconnect the distortion analyzer for now.

CONTROL VOLTAGE-DIODE BALANCE (SYMMETRY)

With a 1,000 Hz tone, again make sure that all three channels show slight compression.

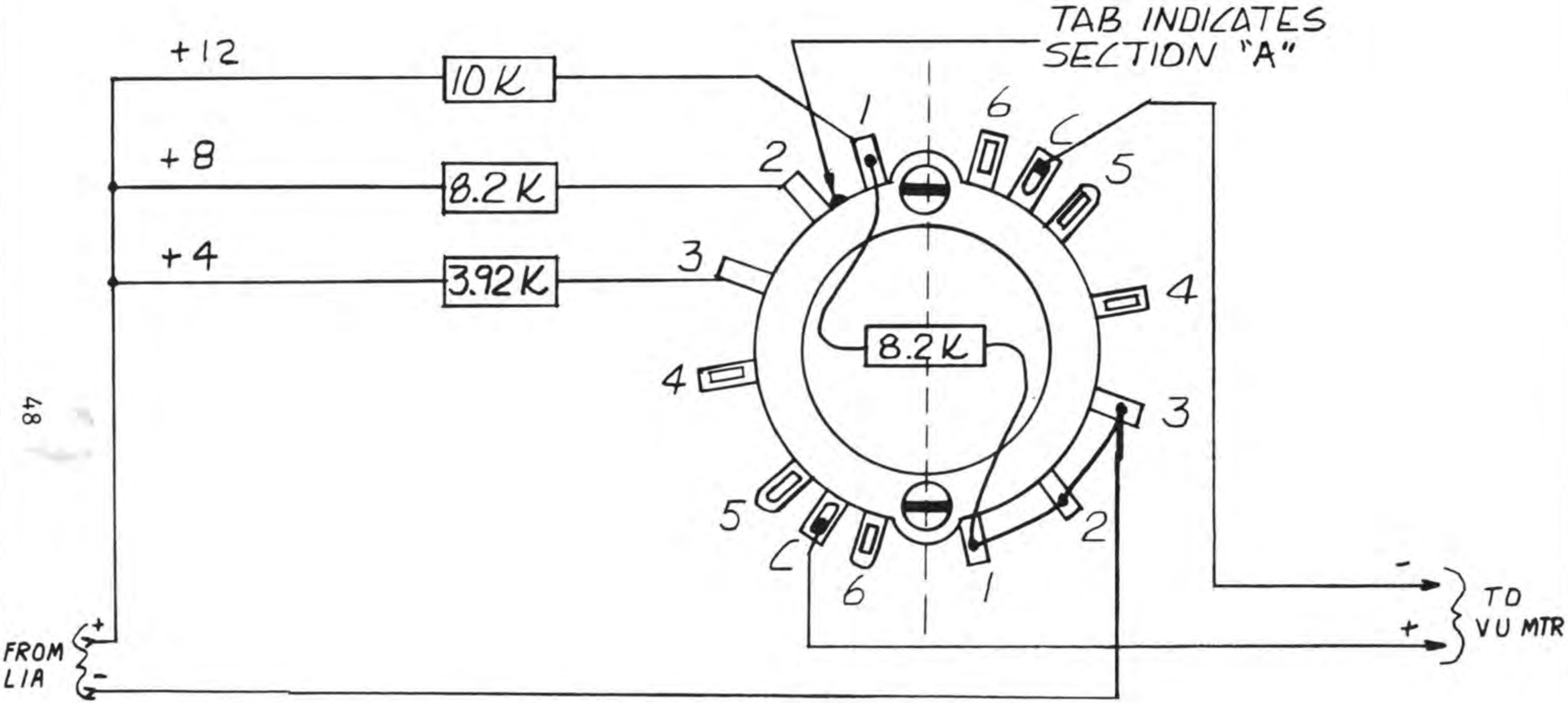
Connect an oscilloscope from test point 3 to ground. (Test point 2 is ground and is located at the top rear of the individual compressor boards.) Test point 3, for Symmetry, is located just below test point 2.

Increase the sensitivity of the scope until the waveform is easily discerned. This voltage is small. Should additional sensitivity be required to view this waveform, the use of the distortion analyzer as an amplifier provides a satisfactory solution to the problem.

Adjust the sweep so that four cycles of sawtooth waveforms are displayed. Slowly rotate Symmetry control R_{10} throughout its entire range while carefully watching the scope, to the point the sawtooth waves will form an even pattern in height and amplitude. Both rectifiers are now switching evenly. Symmetry control R_{10} should be left in this position. Return the R_3 input controls to the settings previously marked above.

DC OFFSET ADJUSTMENT (R_5) (PEAK LIMITER CARD)

With the test switch in the "TEST" position, feed a 1,000 Hz signal to the Processor. Next, adjust the Processor front panel output control for an average of 60 to 80% on the modulation meter, with the meter in the negative polarity position. Switching the modulation meter to the positive polarity position, observe the reading. The meter reading should be identical to the reading in the negative polarity position. Adjust R_5 (DC offset) for equal readings.



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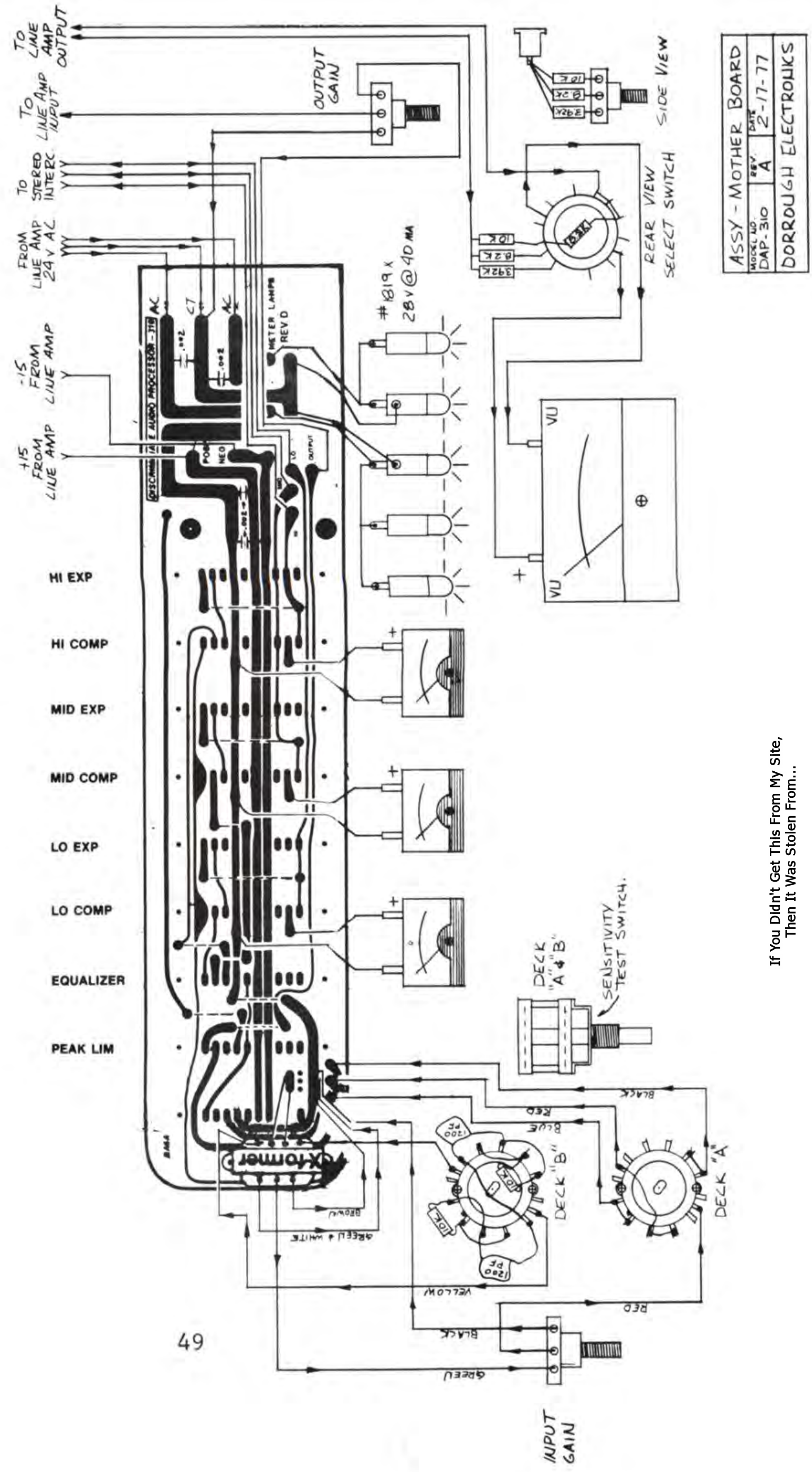
DATE: 1-23-77		REVISED
ASSY: VU METER SELECT SWITCH		
PROJECT: DORROUGH DAP-310		DRAWING NUMBER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TO LINE AMP INPUT
OUTPUT GAIN
TO STEREO INTERC.
FROM LINE AMP 24 V AC
-15 FROM LINE AMP
+15 FROM LINE AMP
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REAR VIEW SELECT SWITCH
10K
8.2K
392K
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METER LAMPS REV D
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OUTPUT
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HI COMP
MID EXP
MID COMP
LO EXP
LO COMP
EQUALIZER
PEAK LIM
X-former
DECK "A" & "B"
SENSITIVITY TEST SWITCH
BLACK
RED
BLUE
1200 PF
DECK "B"
DECK "A"
BROWN
GREEN & WHITE
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INPUT GAIN
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MODEL NO. DAP-310
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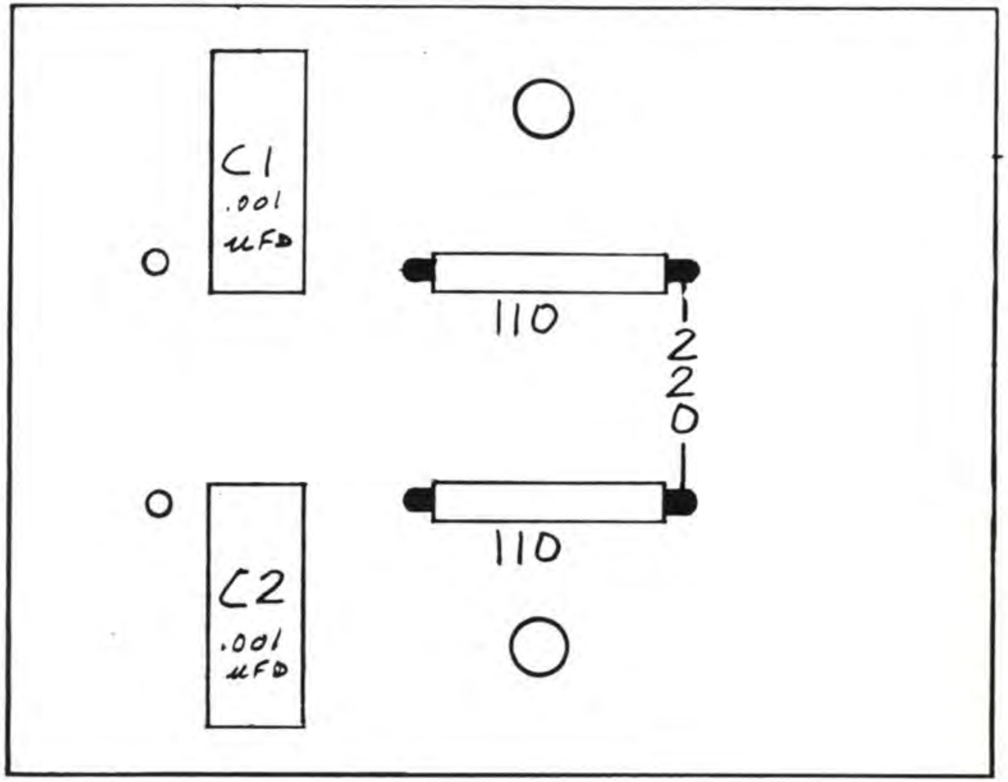
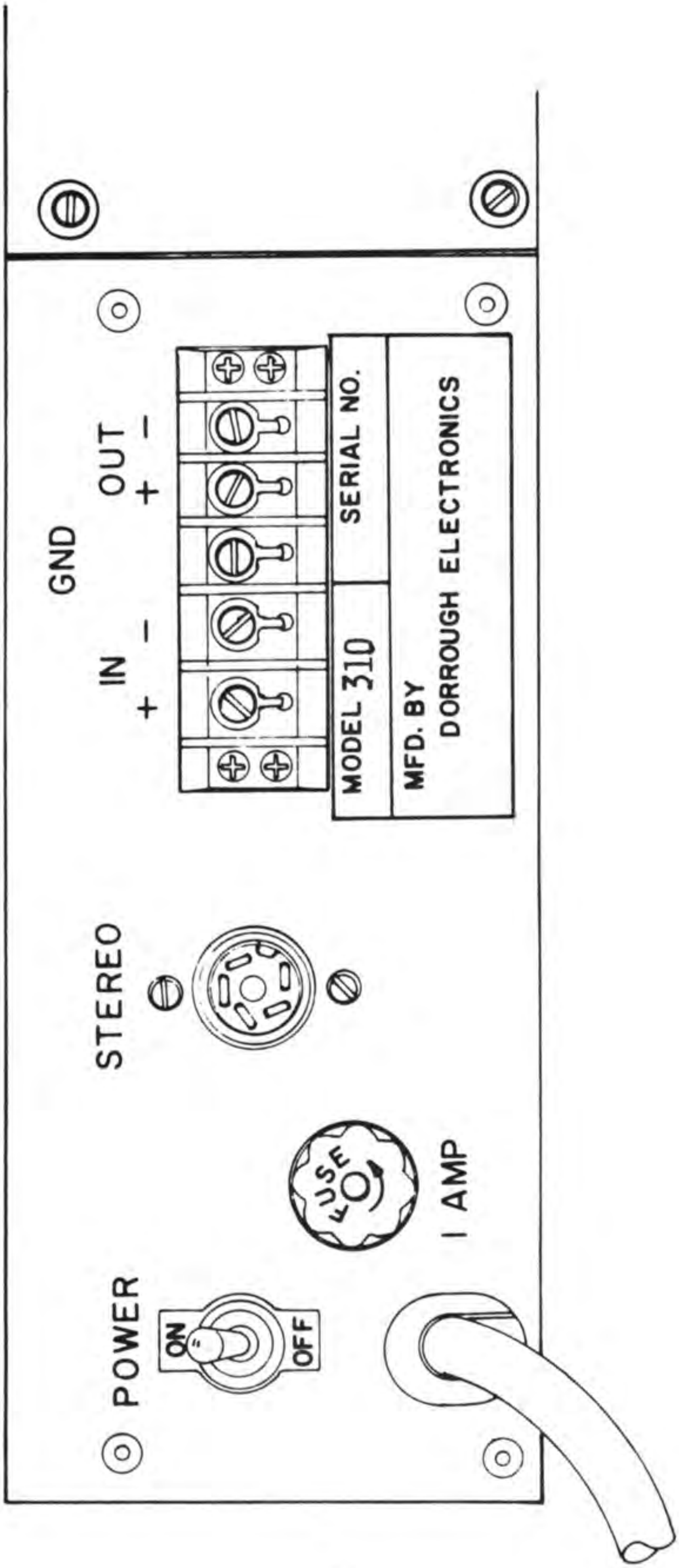
DATE 2-17-77
DORROUGH ELECTRONICS



NOTES:

FOR 110V OPERATION JUMPER AS SHOWN. FOR 220V OPERATION REMOVE JUMPERS & REPLACE WITH ONE JUMPER IN THE 220 POSITION

SCALE: 2x	APPROVED BY: [signature]	DRAWN
DATE: 1-8-77		SH. 1 OF
ASSY, POWER SEL. BOARD		
PROJECT: DORROUGH DAP-310		DRAWING NUMBER


GND
IN
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STEREO
FUSE
1 AMP
POWER
ON
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