

BEFORE PROCEEDING WITH COMPLETE UNPACKING AND SETUP,
CONSULT UNPACKING AND INSPECTION INSTRUCTIONS ON PAGE 7

model 529

ROOM EQUALIZER

150 →



United Recording Electronics Industries

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SECTION I

GENERAL INFORMATION

1-1. DESCRIPTION. The UREI Model 529 1/3-octave Room Equalizer was designed specifically for room equalization, or tuning of sound playback and sound reinforcement systems.

Each of the 27 controls provides a continuous attenuation of as much as 15 dB. The filters are centered on standard ISO 1/3-octave frequencies from 40 Hz to 16 kHz. Additional LOW-CUT and HIGH-CUT filters may be used to shape the "band ends". These have a typical attenuation of 18 dB per octave below the -3 dB points. The low-cut filter is tunable from 30 Hz to 240 Hz and the high-cut filter from 3.5 kHz to 20 kHz. All filters are active minimum phase networks. The skirts combine for a minimum of ripple and phase shift when they are used in conjunction.

The gain structure of the 529 may be altered by a rear chassis switch to accommodate various program input levels from -20 dBm to +20 dBm with optimum signal to noise ratio and low distortion (see Fig. 1,2). Gain loss due to the attenuation of the equalization filters may be compensated with an adjustable front panel gain control up to 20 dB.

An optional accessory, the 529SC Security Cover may be installed over the front panel to provide protection against inadvertent disturbance of the equalization controls in a fixed installation.

1-2. ELECTRICAL SPECIFICATIONS.

- GAIN : Adjustable from unity gain to +20 dB with controls set flat and E.Q. switched IN; unity gain when E.Q. is switched OUT.
- DISTORTION : 0.5% maximum at +24 dBm output; 20 Hz to 20 kHz.
- FREQUENCY RESPONSE : ± 1 dB 20 Hz to 20 kHz, with E.Q. switched OUT.
- CALIBRATION OF ATTENUATION : Within 1 dB of indicated setting to -5 dB; within 1.5 dB of indicated setting to -15 dB.
- EQUIVALENT INPUT NOISE : Less than -90 dBm in 0 dB input level position; less than -72 dBm in +20 dB input level position (E.Q. switched IN; 15.7 kHz Noise Bandwidth).
- INPUT IMPEDANCE : 600 or 10 k ohms, unbalanced to ground.

RATED LOAD : 600 ohms resistive.

RATED OUTPUT : +24 dBm; (+30 dBm = clipping point).

OUTPUT : Floating (transformer isolated).

EQUALIZATION :

40	400	4.0 k
50	500	5.0 k
63	630	6.3 k
80	800	8.0 k
100	1.0 k	10.0 k
125	1.25 k	12.5 k
160	1.6 k	16.0 kHz
200	2.0 k	
250	2.5 k	
315	3.15 k	

ACCURACY : ± 3% of center frequencies.

FILTER BANDWIDTH : 1/3-octave at -3 dB points with 6 dB of attenuation.

$$\text{Bandwidth (Octave or fractions thereof)} = \frac{\log \frac{f1}{f2}}{\log 2}; Q = \frac{fo}{f1-f2}$$

FILTER RESPONSE : LC active feedback type equalizers.

CUTOFF FILTER RANGES: Low-cut, 30 Hz to 250 Hz continuous tunable;
High cut, 3.5 kHz to 20 kHz continuous tunable.

FILTER RESPONSE : 3-pole Butterworth; attenuation = 18 dB/octave below -3 dB points.

ENVIRONMENT : Operating temperature from 0°C to +50°C.
Storage temperature from -20°C to +60°C.

POWER REQUIREMENTS : 115/230 Volts AC, ± 15%, 50/60 Hz, less than 10 Watts;

Fuse: 1/8 Amp @ 115V
1/16 Amp @ 230 V

1-3. CONTROLS.

EQUALIZATION : 27 vertical slider potentiometers,
 continuously variable 0 to -15 dB.

H.F. CUT : Continuously variable from 3.5 kHz to 20 kHz
 (-3 dB points), screwdriver adjustable.

L.F. CUT : Continuously variable from 30 Hz to 240 Hz
 (-3 dB points); screwdriver adjustable.

GAIN : Screwdriver adjustable control;
 range unity to +20 dB.

E.Q. IN/OUT : Toggle switch.

POWER : Toggle switch and pilot light.

MAINS VOLTAGE : Rear panel slide switch; 115/230 V.

INPUT IMPEDANCE : Rear panel slide switch; 600 ohms or 10 k ohms.

INPUT LEVEL : Rear panel slide switch; 0 dBm or
 +20 dBm maximum.

TERMINATIONS : Rear panel barrier strip IN/OUT.
 6' 3-wire power cable.

1-4. PHYSICAL SPECIFICATIONS.

DIMENSIONS : 19" x 3 $\frac{1}{2}$ " rack panel;
 depth behind panel = 8".

WEIGHT : 13 pounds.

SHIPPING WEIGHT : 17 pounds.

FINISH : Front panel, Horizontally brushed clear
 anodized aluminum.

 Chassis, Cadmium plated steel.

OPTIONAL ACCESSORY : Model 529SC Security Cover.

SECTION II

THEORY OF OPERATION

For the following text, refer to the Block Diagram, Fig. #9, page # 15.

2-1. INPUT SECTION. The signal is applied to the input preamplifier (IC 1) through the attenuator R2, R3. The gain structure of this stage varies depending upon the setting of the input level switch. The amplified signal is then coupled to the filter sections and to the bypass switch E.Q. IN/OUT.

2-2. OUTPUT SECTION. This section consists of amplifier IC 6 and discrete output power transistors, followed by an isolation transformer and the output terminals. Optimum performance is obtained with a 600 ohm resistive load. The gain structure of the output amplifier also depends on the setting of the input level switch.

2-3. INPUT LEVEL SWITCH. The input level switch is located on the rear of the chassis, and permits optimizing the operation in two program level ranges: nominally -20 to 0 dBm and 0 to +20 dBm.

2-3-1. When the switch is in the "0 dB" position the net gain of the input stage is +10 dB; i.e. -10 dB due to the input attenuator and +20 dB gain in the op-amp IC 1. The net gain of the output stage is -10 dB; i.e. -20 dB in the amplifier and +10 dB due to the output transformer. The total system gain remains unity (Fig. 1).

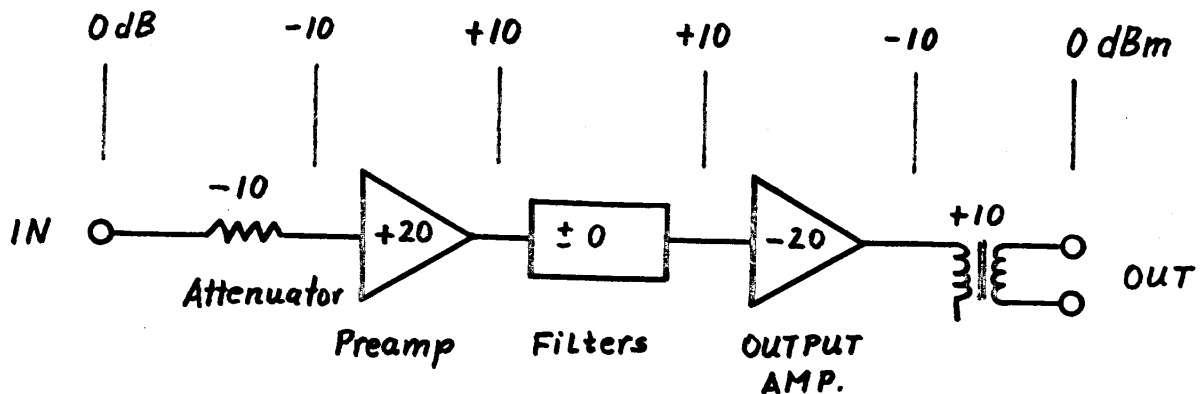


Figure 1. GAIN STRUCTURE, 0 dB SWITCH SETTING

2-3-2. If the switch is in the "+20 dB" position the net gain of the input stage is -10 dB; i.e. -10 dB due to the input attenuator and unity gain in the preamp IC 1. The output stage has a total gain of +10 dB; i.e. unity gain in the amplifier and +10 dB due to the output transformer. Again, the total gain is 0 dB (Fig. 2).

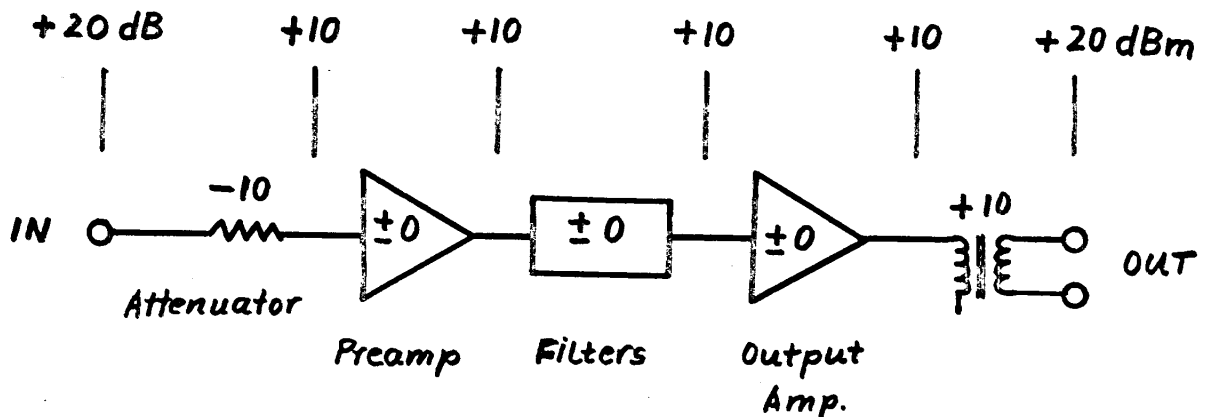


Figure 2. GAIN STRUCTURE: +20 dB max INPUT LEVEL

These two internal gain options are provided to accommodate different average program levels and still maintain best signal to noise ratio through the filter sections.

2-3-3. In critical applications where an even greater signal to noise ratio is required the input attenuator may be altered. Replacing R2 with a jumper and R3 with a 10 K ohm resistor will add 10 dB of gain to the input preamp. The input level switch will not be affected by this change; however, the program level must be closely controlled since the result is a loss of 10 dB of headroom before clipping.

2-4. FILTER SECTIONS. From the preamplifier stage the signal is coupled into the E.Q. AMPLIFIERS. These are LC active feedback type equalizers with minimum ripple and minimum phase shift. They combine properly to assure a smooth E.Q. characteristic (see Fig. 3, 5, and 6).

27 individual circuits are tuned to the standard ISO/ASA center frequencies in 1/3-octave steps. All filters have a constant bandwidth of 1/3-octave (measured between the -3 dB points) with the attenuator set at -6 dB. These tuned circuits share 4 op-amps (see Block Diagram Fig. 9). The function of each vertical slider is identical: when the slider is at the negative input of the op-amp (no cut) the gain of that frequency band is unity. If the slider is moved toward the positive input of the E.Q.-amplifier a voltage division of the input signal occurs in a narrow band of frequencies due to the low series resonant

impedance of the LC circuit. This causes a reduction in output level at the tuned circuit resonant impedance of the LC circuit, resulting in a reduction of output level at the tuned circuit resonant frequency. The maximum attenuation is 15 dB. In many instances several filter frequencies will be attenuated simultaneously. The resulting curve reflects the combining action of those filters. For example: a -10 dB setting of 3 adjacent 1/3-octave filters will yield attenuation over a 1-octave range with a maximum depth of approximately 15 dB (Fig. 5).

LOW-CUT, HIGH-CUT FILTERS.

These filters are provided to achieve desired shelving of the band ends. They are of the Butterworth type and have unity gain within the passband. Below the -3 dB point the slope is 18 dB per octave. This slope rate is adequate for rejection of energy outside the desired bandwidth, while minimizing phase problems usually associated with steep filter skirts. The -3 dB point is continuously variable for the low-cut filter from 30 Hz to 240 Hz and for the high-cut filter from 3.5 kHz to 20 kHz (Fig. 4).

2-5. GAIN CONTROL. The gain control is provided at the output of the filter sections before the signal is coupled through the E.Q. IN/OUT switch into the output amplifier.

Due to the attenuator settings the program material will usually experience some average level loss. The gain control can compensate with additional gain of up to 20 dB (Compare Fig. 8, Curves I and II).

SECTION III

INSTALLATION

3-1. UNPACKING AND INSPECTION. Carefully examine the contents of the shipping carton for any sign of physical damage which could have occurred in transit. Though your 529 was carefully packed at the factory and the container was designed to protect the unit through rough handling, accidents do happen.

IF DAMAGE IS EVIDENT, DO NOT DESTROY ANY OF THE PACKING MATERIAL OR CARTON, AND IMMEDIATELY NOTIFY THE CARRIER OF A POSSIBLE CLAIM FOR DAMAGE. SHIPPING DAMAGE CLAIM MUST BE MADE BY THE CONSIGNEE.

The shipment should include, in addition to the 529 unit itself and this instruction manual:

- a. A two-part warranty card, bearing the same serial number as the unit.
- b. If ordered, the accessory 529SC Security Cover (Check the packing slip and purchase order to verify this option).

In order to activate the one-year warranty, the card should be completed and the return portion mailed immediately.

3-2. ENVIRONMENTAL CONSIDERATIONS. The model 529 will operate satisfactorily over a wide range of ambient temperatures, from 0°C to +50°C (+32°F to +122°F). If it is installed in an equipment rack together with high heat producing equipment (such as power amplifiers), adequate ventilation should be provided to prolong the life of components. Also, while coils and other circuitry susceptible to hum pickup are sufficiently shielded from moderate electromagnetic fields, installation should be planned to avoid mounting the 529 immediately adjacent to large power transformers, motors, etc.

To comply with existing Electrical Codes, the 529 is supplied with a three-wire AC power cord, the grounding pin of which is connected to the chassis. In some installations, this may create ground-loop situations, if a significant potential difference exists between a grounded metal enclosure in which the chassis is installed, and the AC conduit ground. If hum is experienced, check for this possibility by using a 3-wire to 2-wire AC adaptor at the power receptacle, ungrounding the AC plug.

3-3. POWERING. The Model 529 may be operated from either 110-125 VAC or 220-240 VAC mains supply, 50 or 60 Hz single phase, depending on the position of the power transformer input switch. This is a recessed slide switch, which is located adjacent to the fuse post and line cord entry on the rear of the chassis. Unless a tag on the line cord specifies otherwise, the unit was delivered ready for operation from 110-125 VAC mains. Verify this before applying power to the unit by checking that the number 115 appears near the bottom of the slide switch window. The AC fuse should be 1/8 A, slo-blo.

To change for operation with 220-240 VAC, use a small screwdriver in the horizontal slot of the slide switch. Push down firmly until the number 230 appears at the top of the window. (To change for 110-125 VAC, push up). For 220-240 VAC operation the line fuse should be changed to 1/16 A slo-blo for proper protection of the unit.

3-4. EXTERNAL CONNECTIONS. Input and output signal pair wires should be connected as indicated on the rear chassis above the terminal strip following standard practices.

If the output is to be connected to a high impedance circuit, a 620 ohm resistor ($\frac{1}{2}$ Watt) should be shunted across the \dagger and COM output terminal to assure proper output loading.

3-5. LEVEL ADJUSTMENTS. The Model 529 is designed to operate basically as a unity gain device (with all E.Q. controls set at 0), although up to 20 dB of gain is available when the E.Q. switch is in the IN position.

Two program level ranges are accommodated by the position of the INPUT LEVEL SWITCH on the rear of the chassis (see Section II, paragraph 2-3).

Since the clipping point is +30 dBm output level the internal headroom is a function of the GAIN control setting and the input level.

3-6. ACCESSORY. If the 529 was purchased without the accessory 529SC Security Cover, and it is desired to later add this feature, remove the two dummy screws located in the left and right centers of the front panel. The Security Cover is furnished with captive screws to mate with these holes.

SECTION IV

OPERATING PROCEDURE

4-1. GENERAL CONSIDERATIONS, E.Q. TECHNIQUES. Correct equalization improves a sound system in several ways. Peaks in the frequency response will cause coloration of the audio signal. They will mask adjacent frequencies and will also affect the intelligibility of the program material within the room. In sound reinforcement systems the maximum available acoustic level is limited by those frequencies whose amplitudes exceed average level of the rest of the spectrum. These frequencies will cause ringing and feedback of the system when their gains approach or exceed unity.

Therefore, the aim of room equalization is to adjust the frequency response of the sound system in its environment for the smoothest curve possible. In addition, the shaping of the "house curve" to a desired characteristic is achieved with equalization techniques. It has been found in practice that it is not always desirable to attempt to equalize to the last dB all minor anomalies in the response of an acoustical system. This often results in an artificial or "processed" sound. Also, it sometimes requires extreme filter settings with unwanted introduction of phase shift problems. If the final results are within a 3 dB envelope of the desired theoretical values the equalization should be considered successful.

Consideration should also be given to the fact that different frequencies are attenuated differently when traveling through air. As the distance between the sound source and the listening position increases, it is natural for high frequencies to be attenuated more. If equalization is performed to create a perfectly "flat" response, particularly throughout a large room, the resulting sound will be excessively bright when close to the source.

A house curve which produces a natural response in sound systems is subjective and a matter of personal preference as well as a function of the primary use of the location. However a flat response up to about 3 to 6 kHz and then an attenuation of 3 dB per octave is frequently used (Fig. 7).

Although there is no definite answer to which is the best method of room equalization our research and experience has resulted in the development of the UREI 529 Room Equalizer. Earlier methods employed individual very narrow band rejection filters for those segments of the frequency spectrum which caused the undesired characteristics. However the obvious advantage of a 1/3-octave bandwidth filter set is the ability to shape any curve necessary to correct major anomalies. This is achieved through the combining action of the 529 filters (Fig.8).

4-2. FREQUENCY RESPONSE MEASUREMENTS. Before any equalization of a sound system in its environment should be attempted a few requirements must first be fulfilled:

- a. The entire system should be free of hum, noise, oscillations and RF interference, because these are problems which should be solved separately.
- b. Also the frequency characteristic of the system must be measured before an effective equalization can be expected.

One of the simplest and yet most accurate and effective methods to measure the response of a system employs the SONIPULSE Acoustic Analyzer 100-A.

This patented instrument is also a UREI development. It uses a periodic test signal which contains all the harmonics of interest in the audio range. The advantages over systems using random noise are: shorter integration periods, especially at low frequencies, better accuracy because of the absence of fluctuations, and greater reproducibility of results due to the nature of the test signal.

The SONIPULSE uses the same 27 center frequencies as the 529 Equalizer. When measuring a sound system the instrument is switched through its range (40 Hz to 16 kHz) and a curve of the system response is established (See Raw House Curve, Fig. 7).

4-3. EQUALIZATION PROCEDURE. Examination of the measured curve will show the deficiencies of the sound system within its environment. A good starting point is to set the controls of the 529 Room Equalizer to the inverse of the measured curve using the frequency band with the lowest level as "0 dB Reference" (Fig. 8/I).

Although other techniques may be used, the following procedure is recommended for equalization and level adjustments, since it optimizes the EQ IN/EQ OUT gain of the system, permitting all EQ to be switched OUT in an emergency without causing the system to go into feedback:

- a. The 529 should be installed in the system (electrically) following the microphone mixer amplifier output, and preceding the power amplifiers.
- b. Establish a "normal" microphone mixer output level, and optimize the INPUT LEVEL switch position of the 529 (See Section II, Page 4).
- c. Turn the 529 GAIN control completely CCW (unity gain). Switch EQ OUT.

- d. With the entire system activated, increase the POWER AMPLIFIER gain until feedback occurs, then back off to a desired safety setting (i.e., 3 dB or 6 dB below feedback point) and note this setting.
- e. Switch EQ IN, and proceed with equalization using your standard techniques until a desired "house curve" has been achieved and you are satisfied with the system performance.
- f. Reset the POWER AMPLIFIER gain to the setting noted in (d).
- g. Now, with mixer amplifier gain set exactly as it was in (d), turn the 529 GAIN CONTROL clockwise slowly until feedback occurs, then back it off to the desired safety setting. (Note: If equalization resulted in all or most of the 529 EQ controls being near the bottom of their ranges, gain may be insufficient to produce feedback. This indicates either a serious deficiency in the system, or incorrect equalization technique. Some of the frequencies, representing the lowest points on the raw house curve, should not be attenuated.)

By utilizing this procedure, the EQ IN/OUT switch may be operated without the system going into feedback. (Of course, if equalization is effective, the system gain will be necessarily lower in the EQ OUT position.) This permits temporary by-passing of all the active filter circuitry of the 529 should a component failure occur.

4-4. L.F. CUT, H.F. CUT. Examination of the filter curve after equalization adjustments have been made will show that the band ends (low frequency and high frequency extremes) could overdrive the amplifiers or speakers if program material contains energy at these frequencies; i.e. microphone pops, etc. Adjust the tunable L.F. CUT and H.F. CUT filters until the resulting system response curve loses its "bathtub" shape and the desired house curve rolls off smoothly at each end, (Fig. 8/II).

SECTION V

MAINTENANCE

5-1. GENERAL. The Model 529 is ruggedly constructed and should provide years of trouble free use with normal care. All parts used are conservatively rated for their application, and workmanship meets the rigid standards you have learned to expect in UREI products.

No special preventive maintenance is required.

5-2. REPAIRS AND WARRANTY. The Model 529 is factory warranted against defects in material and workmanship for one year after initial purchase. This Warranty must be activated at time of purchase by returning the registry portion of the Warranty Card to the factory. Should a malfunction ever occur, the dealer from whom the unit was purchased will be glad to handle return for factory repair; or, it may be shipped directly to the factory for prompt service. Be sure that it is well packed in a sturdy carton, with shock-absorbing material such as foam rubber, styrofoam pellets or "bubble-pack" completely filling the remaining space. Particular attention should be paid to protecting the equalization control arms and other protruding parts. Include a note describing the malfunction, and instructions for return. We will pay one-way return shipping costs on any in-warranty repair.

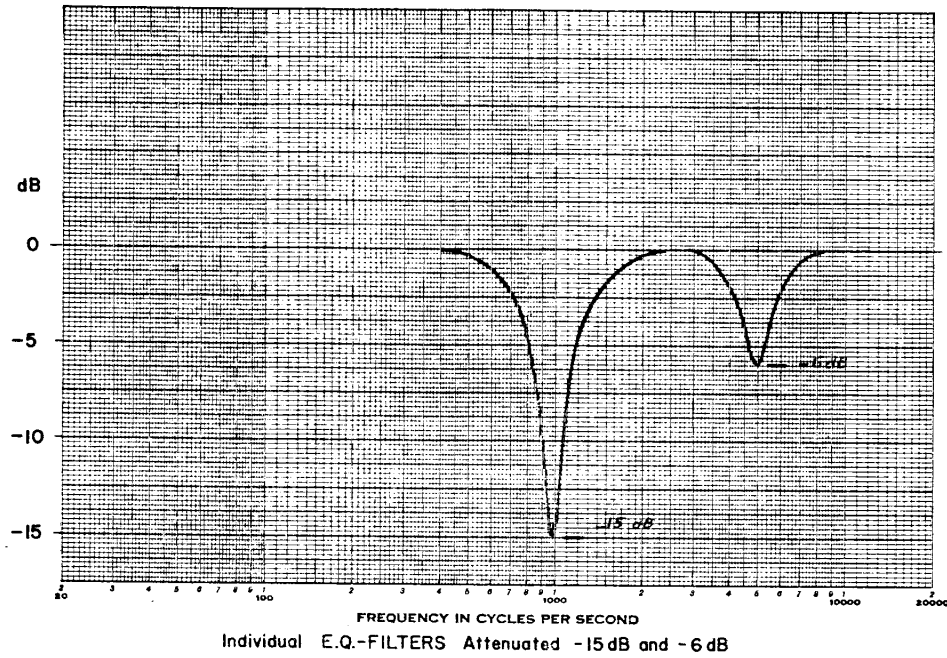


FIG. 3

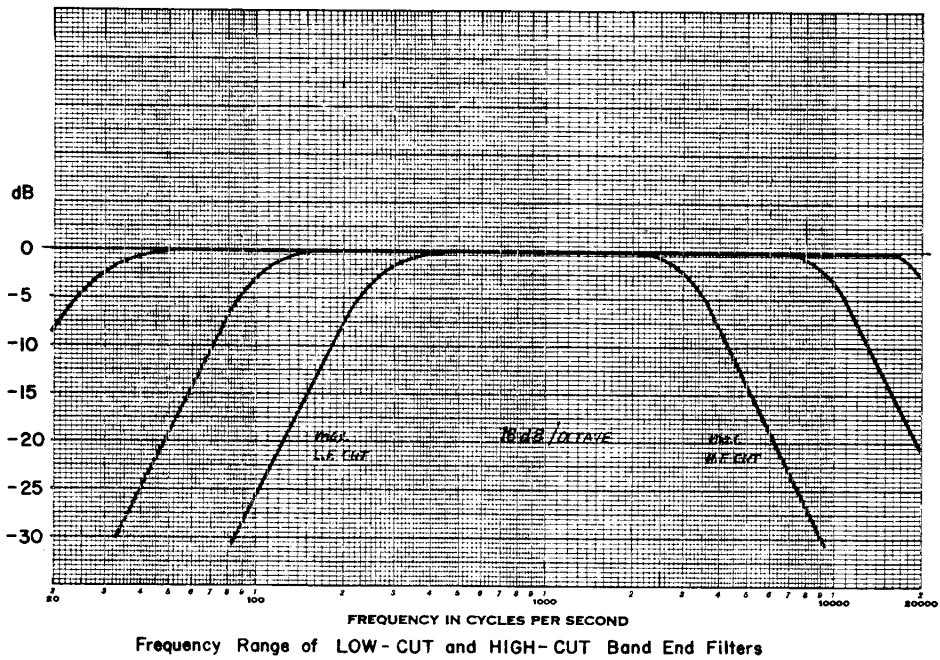


FIG. 4

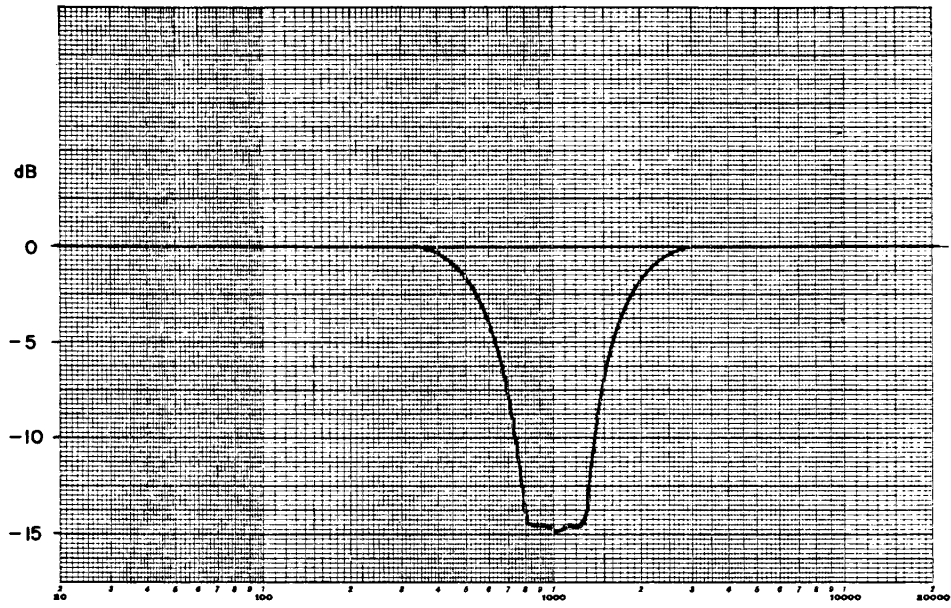


FIG. 5

Three Adjacent E.Q.-FILTERS Combined ; 800 Hz and 1250 Hz = -10 dB ; 1000 Hz = -8 dB Attenuated

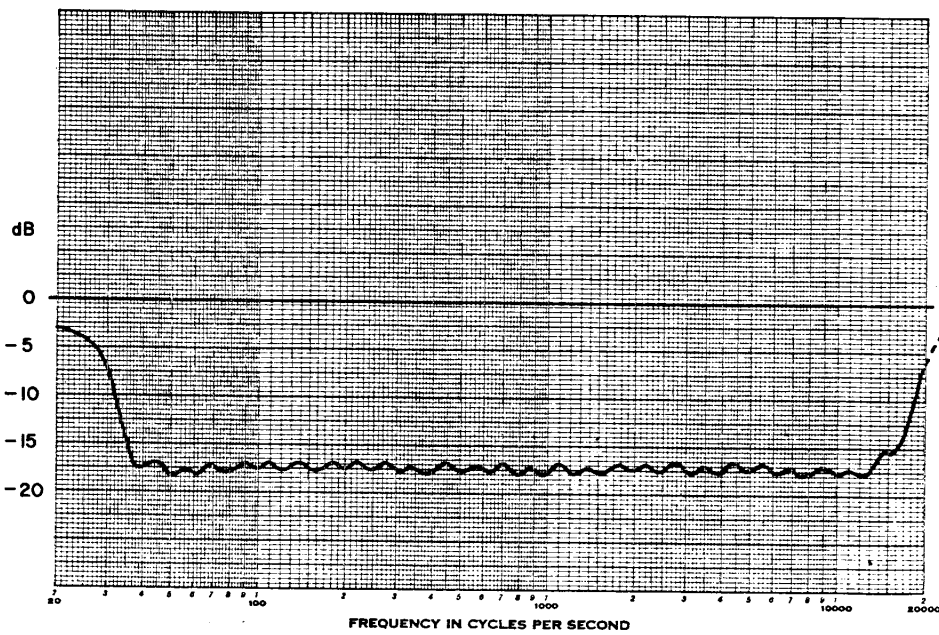


FIG. 6

All E.Q.-FILTERS Attenuated To -10 dB Setting

SONIPULSE SYSTEM ANALYSIS

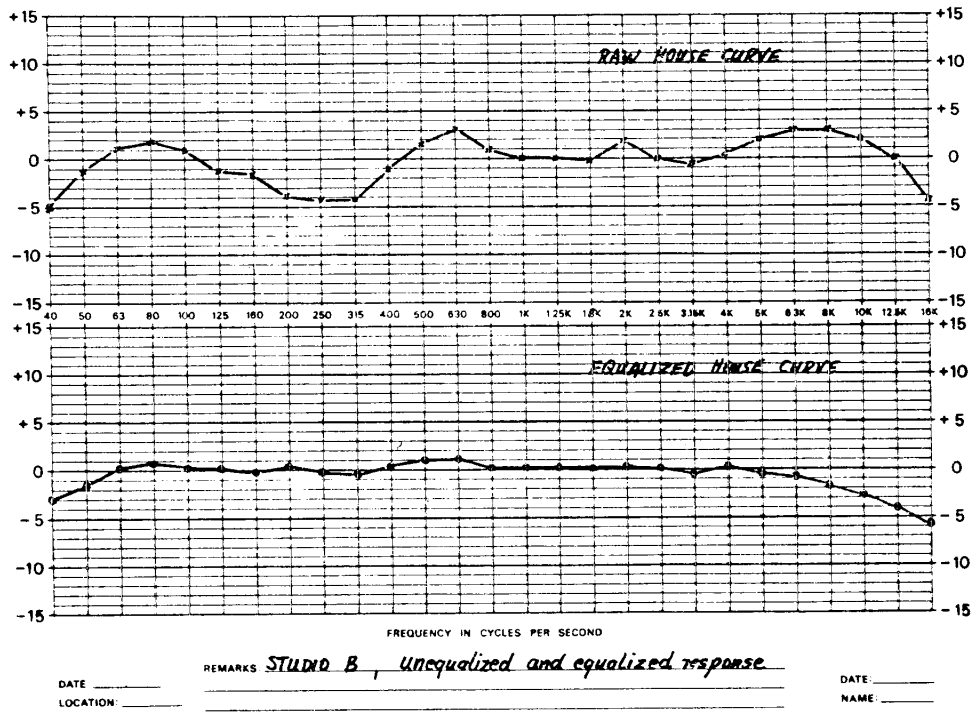


FIG. 7

SONIPULSE SYSTEM ANALYSIS

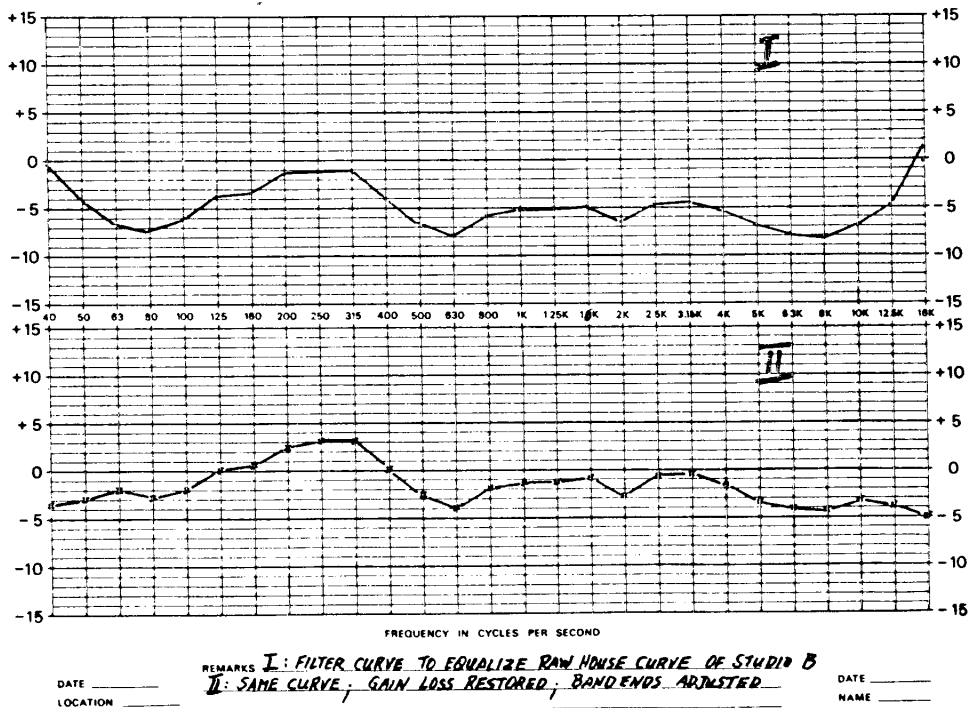


FIG. 8

BLOCK DIAGRAM.

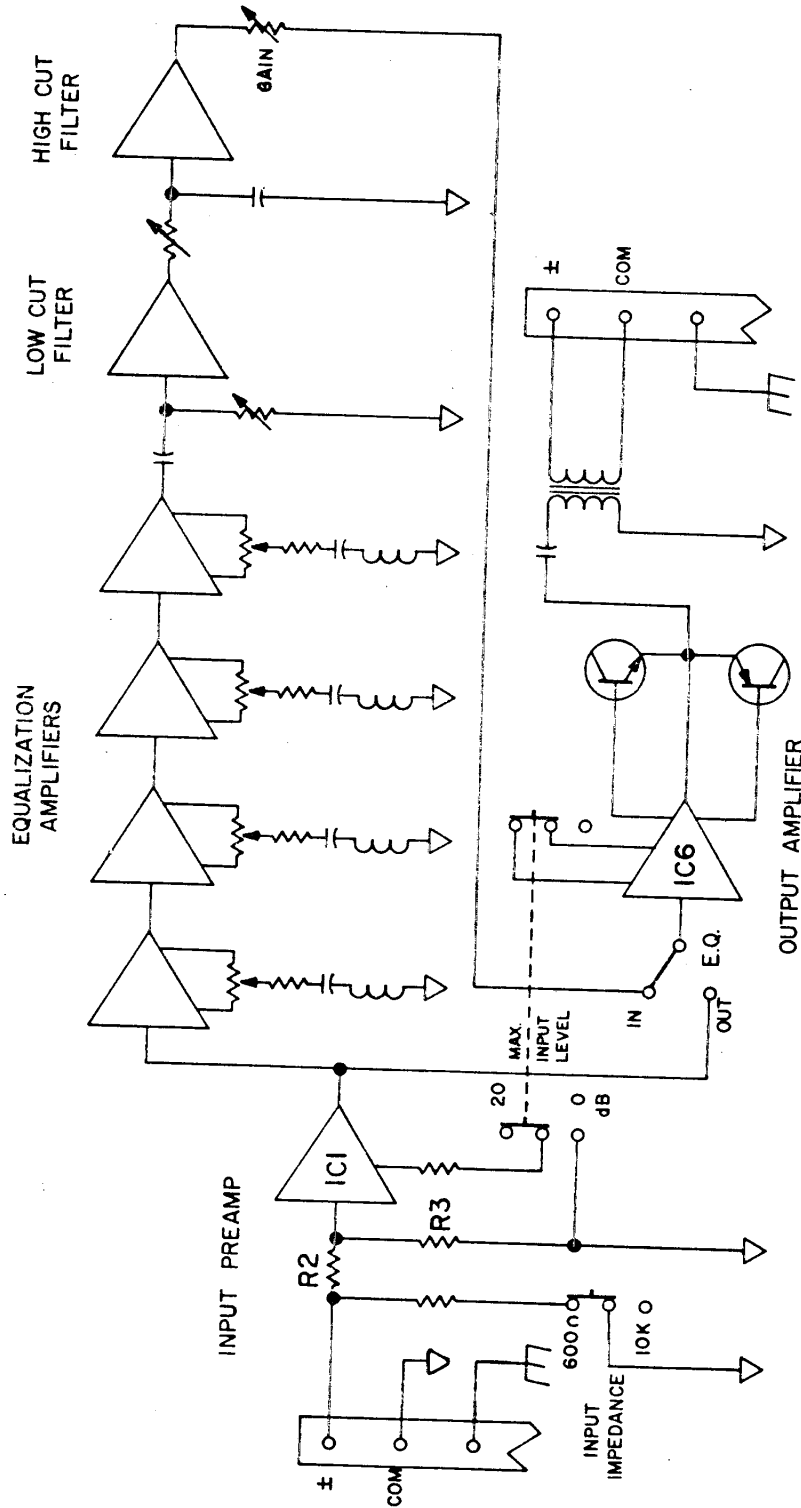
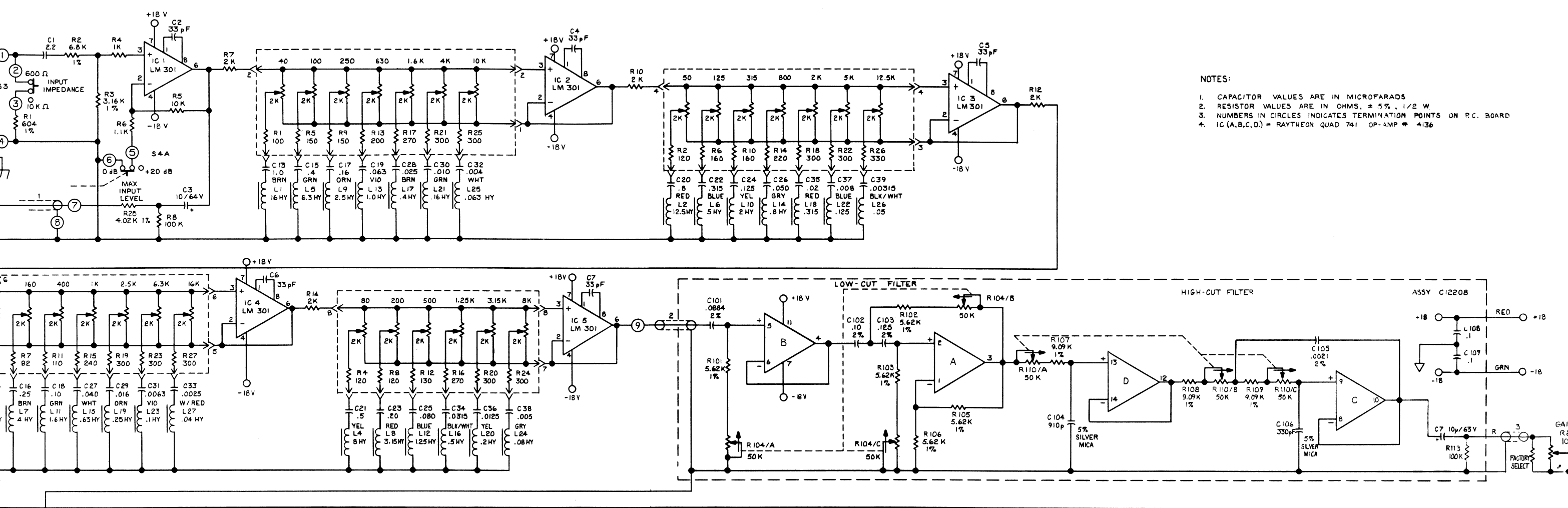
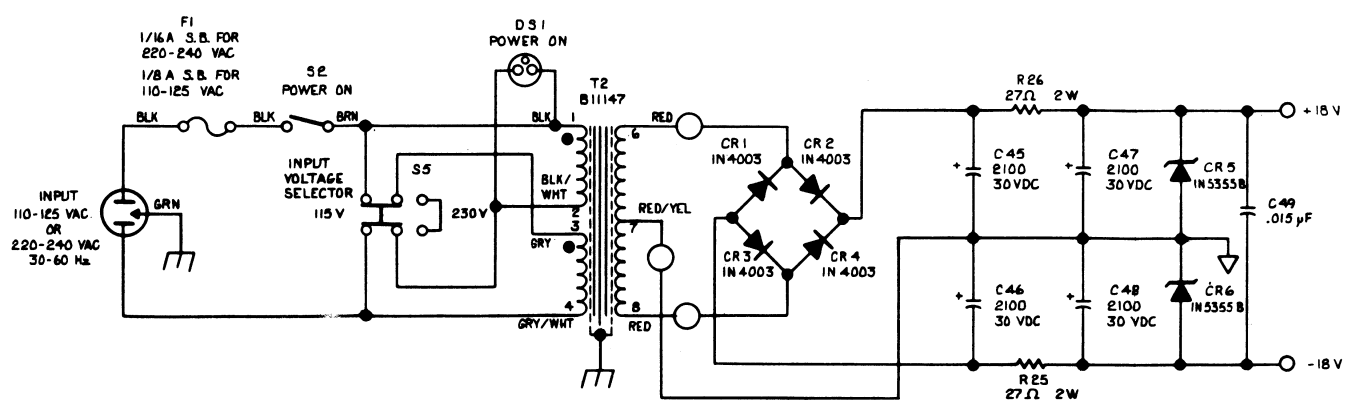
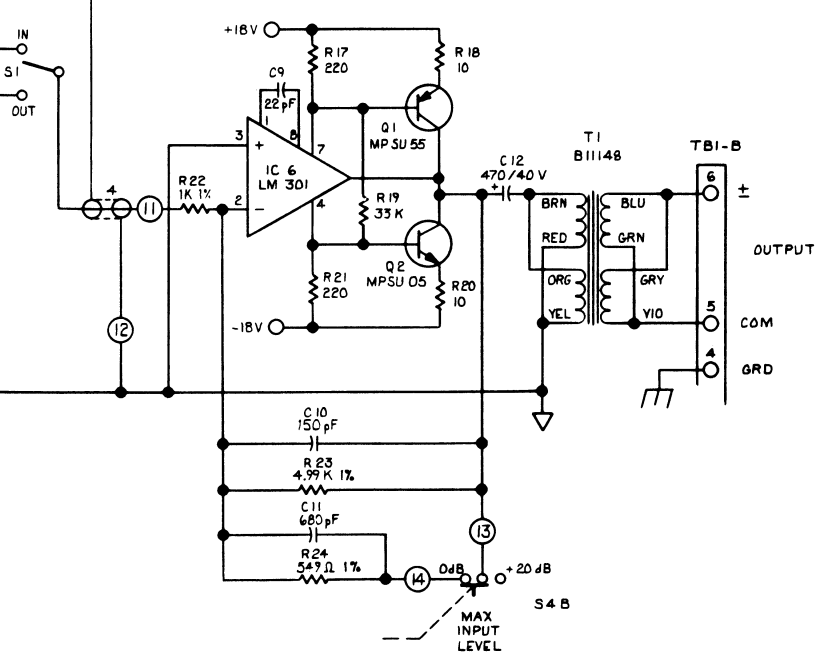


FIG. 9



- NOTES:
1. CAPACITOR VALUES ARE IN MICROFARADS
 2. RESISTOR VALUES ARE IN OHMS, ± 5%, 1/2 W
 3. NUMBERS IN CIRCLES INDICATES TERMINATION POINTS ON P.C. BOARD
 4. IC (A,B,C,D) = RAYTHEON QUAD 741 OP-AMP # 4136



REV A EFFECTIVE SERIAL # 151

UNITED INDUSTRIES	SCHEMATIC GRAPHIC EQUALIZER	
	DATE 8-6-74	REV 1
DEPARTMENT LOS ANGELES CALIFORNIA	CHECKED BDM	APPROVED R12238