

BEFORE PROCEEDING WITH COMPLETE UNPACKING AND SETUP,
CONSULT UNPACKING AND INSPECTION INSTRUCTIONS ON PAGE 6

model 532
GRAPHIC EQUALIZER



United Recording Electronics Industries

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SECTION I

GENERAL INFORMATION

1.1 DESCRIPTION. The UREI Model 532 is a graphic equalizer containing circuitry to modify the frequency response characteristics of audio signals. It contains nine vertical level controls for adjusting the relative amplitude of signals in bands one octave wide and centered from 50 Hz to 12.5 kHz. The unit also includes an EQ IN/OUT switch, and an LED input overload indicator.

1.2 SPECIFICATIONS.

ELECTRICAL:

GAIN	: Unity \pm 1 dB.
FREQUENCY RESPONSE	: \pm 1 dB 20 Hz to 20 kHz with EQ out.
OPERATING LEVEL (NOMINAL)	: 1.23 V (+4 dBm) for best signal to noise ratio with adequate headroom.
DISTORTION	: < 0.5% THD at +20 dBm 30 Hz to 15 kHz.
INPUT IMPEDANCE	: 20 kohm, balanced or unbalanced.
RATED LOAD	: 600 ohms resistive.
RATED OUTPUT	: +20 dBm into 600 ohms (7.75 V RMS).
OUTPUT CIRCUIT	: Transformer isolated floating.
MAXIMUM INPUT LEVEL	: +20 dBm (LED overload indicator).
EQUIVALENT INPUT NOISE	: Below -90 dBm with EQ switched in. (15.7 kHz noise bandwidth, input and output terminated with 600 ohms).
EQUALIZATION FREQUENCIES	: 50, 100, 200, 400, 800, 1600, 3150, 6300, 12500 Hz.
FILTER BANDWIDTH	: 1 octave at 8 dB boost or cut.
BOOST/CUT RANGE	: \pm 10 dB at center frequencies.
FILTER TYPE	: Synthesized LC.
ENVIRONMENTAL REQUIREMENTS	: Operation from 0 ^o C to +50 ^o C. Storage from -20 ^o C to +60 ^o C.

POWER REQUIREMENTS : 115 ± 15% VAC 50/60 Hz less than 10 watts.
or
220 ± 15% VAC 50/60 Hz less than 10 watts.

FUSES : 1/4 amp at 115 VAC; 1/8 amp at 230 VAC.

CONTROLS:

EQUALIZATION : 9 Vertical controls.

EQ IN/OUT : Front panel toggle switch.

POWER : Front panel toggle switch.

MAINS VOLTAGE : Rear chassis slide switch.

TERMINATIONS : Rear panel barrier strip for input and
output, 5' (1.5 meter) 3-wire power cable.

PHYSICAL:

DIMENSIONS : 3½" high x 8½" wide x 8" deep.
(89 x 216 x 203 mm)

WEIGHT : 6 lb. (2.72 kg.)

SHIPPING WEIGHT : 7 lb. (3.18 kg.)

FINISH : Front panel horizontally brushed, clear
anodized aluminum. Chassis cadmium
plated steel.

ACCESSORIES : SR-21 single rack mount Kit.
DR-21 double rack mount kit.
for 19-inch or DIN size rack.

SECTION II

THEORY OF OPERATION

(Refer to the Schematic Page #16)

2.1 INPUT AMPLIFIER. Signal is applied to a differential input amplifier sections A and B. The input accepts balanced or unbalanced sources. Common mode rejection is typically better than 40 dB. A factory selected resistor R3 is installed parallel to R4 or R6 to trim CMRR if necessary. The input amplifier has a gain of -3 dB. This reduces the possibility of the filter section being overloaded on high input signal levels.

2.2 FILTER SECTION. The output of the input amplifier is connected to the filter amplifiers F1, F2, and F3. Each of the filter amplifiers is connected to three L-C-R filters.

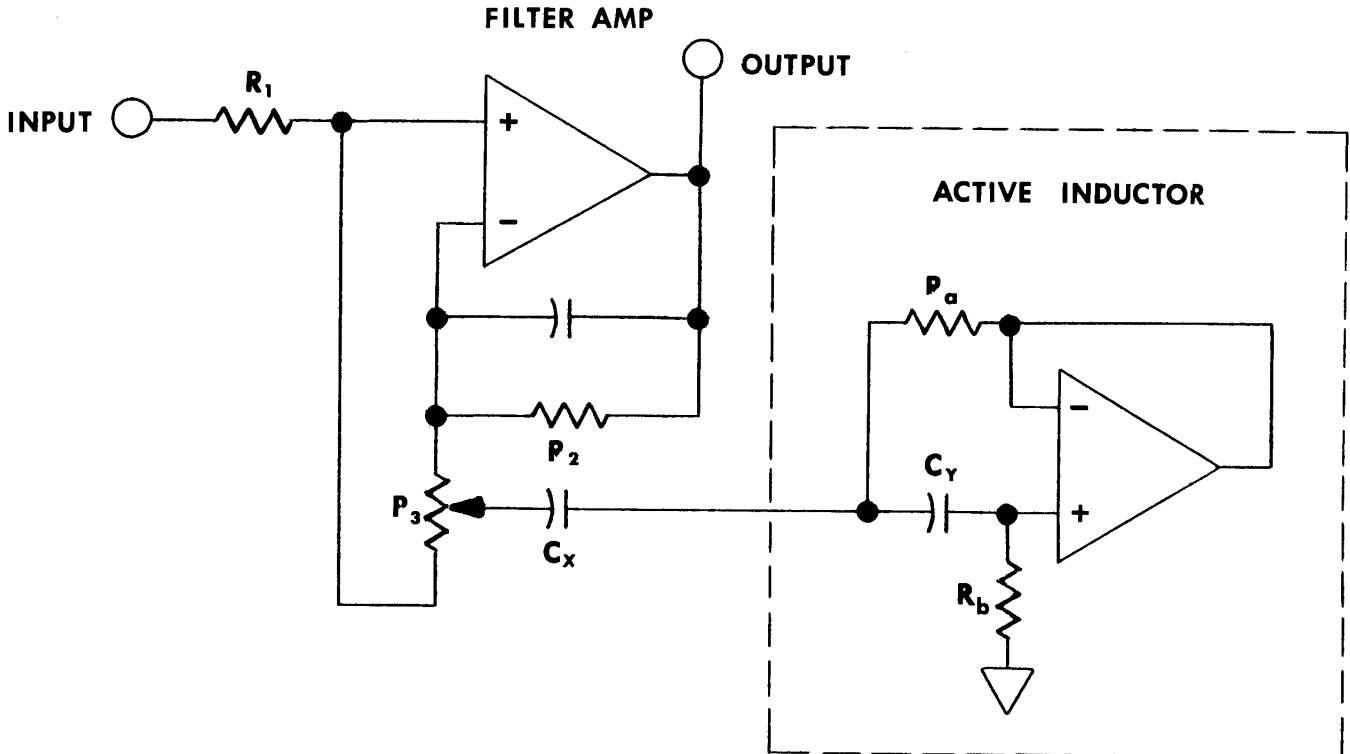


Figure 2-2 TYPICAL FILTER SCHEMATIC

Referring to Figure 2-2, the filter amplifier is connected as a unity gain follower because R1 and R2 are equal. With the potentiometer connected as shown, consider the result if the wiper of the pot were connected to AC ground. As the wiper is moved towards the positive input of the filter amplifier a voltage division of the input signal takes place, thus reducing the output of the amplifier. As the wiper of the

pot is moved towards the negative input of the filter amplifier a voltage division takes place also but this voltage division is of the negative feedback and as the impedance at the negative input of the amplifier is decreased the voltage at the output of the amplifier is increased. With the control at midpoint any voltage division occurs equally in the input signal and the feedback signal, and the filter amplifier is once again a unity gain follower.

In the Model 532, the wiper of the potentiometer is connected to a synthesized series L-C circuit in which component values have been chosen to resonate at a given frequency and with a "Q" of 1.414 at approximately 8 dB of boost or cut. Because the wiper of the pot is connected to AC ground through the L-C network, the voltage division which takes place in the filter amplifier is effective only for the frequencies in the band covered by the individual L-C network. A total of nine such L-C-R networks are used in the Graphic Equalizer.

2.3 THE ACTIVE INDUCTOR. The Model 532 does not use conventional coils to form its L-C-R networks. Rather the inductors are synthesized through the use of a circuit known as an active inductor, shown in Figure 2-2. To understand the operation of this circuit we look at the frequency response characteristic of a capacitor as shown in Figure 2-3 (a).

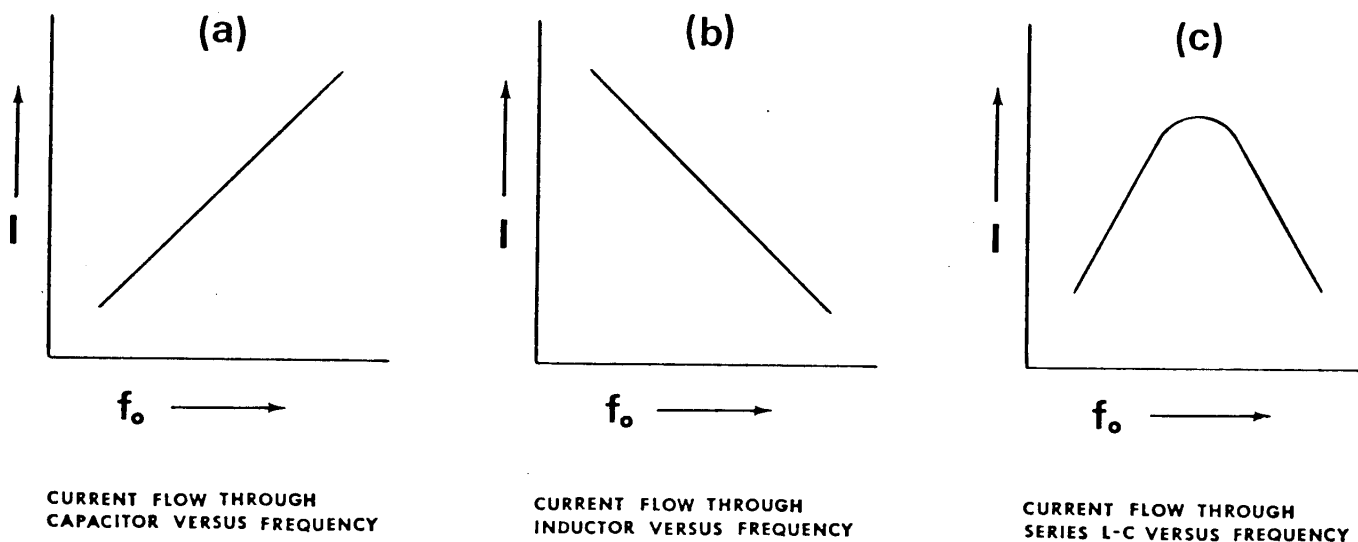


Figure 2-3

As frequency increases, capacitive reactance decreases and more current flows through the capacitor. An inductor as seen in Figure 2-3(b) functions in just the opposite manner. As frequency increases, inductive reactance increases and less current flows through the inductor. The active inductor circuit uses a capacitor and an operational amplifier to

simulate the action of an inductor. If we remove capacitor C_y from the circuit in Figure 2-2 we see that current flows into the circuit through resistor R_a to the virtual ground of the operational amplifier output. If we now return capacitor C_y to the circuit we see that with increase in frequency there will be current flow through the capacitor which will increase with frequency. This increase in current flow will be seen as an increase in voltage across resistor R_b which will be reflected in an increase in output voltage of the operational amplifier. This increased voltage results in a decrease in current flow through resistor R_a . This change in current flow through resistor R_a follows the chart 2-3(b) which is that of an inductor. The current flow through the active inductor in series with capacitor C_x is seen in Figure 2-3(c) in which the peak current is achieved when the inductive reactance of the inductor equals the capacitive reactance of the capacitor. This point is the resonant frequency of the circuit.

2.4 OUTPUT AMPLIFIER. The output of filter amplifier F3 feeds the input of section C which drives the power output stage. The gain of the output stage is set by the ratio of R_{11} and R_{12} and restores the slight loss taken in the input stage and also compensates for the insertion loss of the output transformer.

2.5 OVERLOAD INDICATOR. Section D of IC1 is normally biased for no current flow through the Light Emitting Diode (CR4). If the signal at the input amplifier is more than +18 dB the threshold of the overload indicator is exceeded and the L E D flashes at a slow repetition rate. The threshold of the overload indicator is approximately 2 dB below clipping of the input amplifier (see also 3.6).

2.6 POWER SUPPLY. The Power Supply is bipolar employing two integrated circuit voltage regulators VR1 and VR2 to provide low ripple plus and minus 15 V DC. Tantalum capacitors C30 and C31 maintain low output impedance of the supplies at high frequencies.

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 532 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 CLAIMS MUST BE MADE BY THE CONSIGNEE.

The shipment should, in addition to the 532 unit itself and this instruction manual, include a two-part warranty card, bearing the same serial number as the unit. In order to activate the one-year warranty, the card must be completed and the return portion mailed immediately.

3.2 ENVIRONMENTAL CONSIDERATIONS. The Model 532 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 circuitry susceptible to hum pickup is sufficiently shielded from moderate electromagnetic fields, installation should be planned to avoid mounting the 532 immediately adjacent to large power transformers, motors, etc.

To comply with existing Electrical Codes, the 532 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 problems if a significant potential difference exists between the 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 532 may be operated from either 100-130 VAC or 200-240 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 100-130 VAC mains. Verify this before applying power to the unit by checking that the number 115 appears near the right of the slide switch window. The AC fuse should be MDL $\frac{1}{4}$ A (Slo-Blo).

To change for operation with 200-240 VAC, use a small screwdriver in the slot of the slide switch. Push firmly to the right until the number 230 appears in the window. (To change for 100-130 VAC, push to the left). For 200-240 VAC operation the line fuse should be changed to MDL 1/8 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 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 + and - output terminal to assure proper output loading.

If the output is to be connected to an unbalanced circuit the - output terminal should be connected to the GND terminal.

If the input is connected to an unbalanced source the high side of the line should be connected to the + input terminal and the low side of the line should be connected to - and GND.

3.5 SIGNAL TO NOISE. The output noise of the Model 532 is quite low, less than -90 dBm, and with a nominal +4 dBm input signal the signal to noise of the system will in no way be degraded by the installation of the unit. In some instances it may be necessary to operate the 532 with lower input levels (see Sec. 3.6). If this is necessary, remember that the output noise is relatively constant, varying slightly with EQ setting, and that any reduction in input level will reduce the signal-to-noise ratio of the system. A reduction of 10 dB is acceptable in most cases, but the greatest signal-to-noise ratio consistent with consideration of amplifier headroom is definitely a goal to be desired. This is especially true in sound systems which have increased acoustic gain due to equalization, for in such systems all signals, including noise, are amplified more.

In some installations the signal level to succeeding pieces of equipment must be limited to some lower voltage level (as for example a power amplifier with an input sensitivity of 0.1 V RMS for full output). Obviously a +4 dBm (1.23 V RMS) signal will drive the amplifier into overload. It is therefore necessary to reduce the voltage at the input of the amplifier. Such reduction of the voltage level should be accomplished following the Model 532 where it does not degrade the signal-to-noise ratio. This may be accomplished with a potentiometer at the input to the power amplifier or with a suitable loss pad.

3.6 INPUT AND OUTPUT LEVELS AND OVERLOAD. The input amplifier of the Model 532 is capable of being driven by signals up to a level of +20 dBm (7.75 V RMS). The input overload circuit detects peak signals which exceed a level of +18 dB (6.15 V RMS) and flashes the L E D indicator. The circuit will detect very short duration transients and

flashes the indicator at a rate slow enough to be seen. The output amplifier is capable of delivering +20 dBm into a 600 ohm load.

If the equalization controls are in the flat position or attenuated no special care is necessary with regard to input signal level other than keeping it below +20 dBm. However if any of the controls are adjusted for boost then it must be remembered that at the frequencies affected by that control the gain of the amplifier is greater than unity and the maximum input signal level which is allowable at those frequencies is reduced by the amount of gain at those frequencies. For example, if the 400 Hz control is set for 5 dB of boost an input signal level of +15 dBm at 400 Hz would result in an output signal level of +20 dBm. Because +20 dBm is the maximum capability of the output amplifier the maximum input level permissible at 400 Hz without overload has become +15 dBm. At moderate amounts of boost this should not present a problem but if, for example, all controls are in full boost some frequencies will be boosted as much as 15 to 16 dB due to the combining effect of adjacent filters. This would bring the maximum input level down to +4 or +5 dBm and under such circumstances the input level should be reduced to a safe level to avoid output amplifier overload.

SECTION IV

OPERATING PROCEDURE

4.1 GENERAL CONSIDERATIONS. The reason for frequency response tailoring of audio systems is to compensate for response anomalies occurring in the system and its environment and to adjust the system response curve to some desired shape. In some systems this means adjusting for best overall flatness of response through the entire audio range, and in other instances a different response shape is desirable.

Three important characteristics of audio systems may be improved by judicious application of corrective equalization techniques. They are:

- (1) **Feedback.** In public address and sound reinforcement systems the maximum acoustic gain that may be obtained for a microphone in the vicinity of a loudspeaker of that system will be determined by the feedback loop created when sound from the loudspeaker enters the microphone, reinforcing the signal level until the system goes into oscillation as unity gain is exceeded. This feedback loop is easily attainable if some frequencies in the audio range are reproduced at higher levels than the rest of the frequency band. If the level of the frequency or frequencies which are being reproduced at an exaggerated level can be reduced, then the sound system gain may be increased without feedback.
- (2) **Intelligibility.** For an audience in a hall to understand a lecturer, or for a night club audience to hear the words which a vocalist is singing there are two requirements:
 - (a) The volume level of the source sound must be sufficiently loud as to be heard clearly and not masked by other sounds which may be present in the listening environment, and
 - (b) The sound which the listener hears must be intelligible to him. It may not be heavily distorted or garbled. There are a number of causes for poor intelligibility in a sound system. Among them are: amplifier or speaker distortion, inadequate projection of the higher frequencies which are necessary for the recognition of words, and frequency band masking. The frequency band from approximately 1 kHz to 5 kHz is very important to recognition of sibilant and consonant sounds and if the sound system has inadequate output in this frequency band, or if an adjacent band has considerably greater output which "covers up" the sounds in the intelligibility band the words may simply not be understood. Equalization is very helpful to correct some of these problems.

- (3) Distortion of frequency response balance. Sources of sound which may be amplified through a sound system start out with some specific internal relationships of frequency balance. If in being processed through an audio system this balance is disturbed by variation in frequency response then truly the sound has been distorted. Thus if a clarinet which has very specific characteristics in regard to the levels of the various harmonics with relationship to the fundamental tone is processed through a non-flat response audio system then the resultant sound is simply not the distinctive sound which that clarinet originally produced.

The remainder of this section is devoted to a general description of the equalization process and some suggestions for successful applications of the Model 532. Techniques are continuously being improved upon. Therefore this discussion should be considered only as a starting point for those who are new to the field and as a general review for those who are already proficient in the methods used.

4.2 BEFORE EQUALIZATION. Corrective equalization is no more THE ONE SOLUTION to the problems faced by designers or users of audio systems than any other single aspect of design or use. Used correctly it is a powerful tool; but if it is assumed to be the best solution to any or all problems, without careful consideration of all possible alternatives, results may be disappointing. If the sound system is not thoroughly checked out before equalization procedures are attempted much time may be wasted. We feel that it is important to mention a few of the important tests which should be made prior to the start of corrective room equalization. The list is not intended to be exhaustive. Rather it is intended to point out that unless you know what the sound system IS doing you may find it difficult (if not impossible) to make it do what it SHOULD do.

Pre Equalization Check-Out Procedures:

- (1) Check frequency response, signal to noise, and distortion characteristics of the components of the system and the system as a whole, at operating levels which cause no degradation of system performance characteristics.
- (2) Check phasing of signal lines from all inputs to amplifier outputs.
- (3) Check loudspeakers to see that all units function, that there are no rattles due to loose screws or cabinets poorly attached to walls. Check phasing of all loudspeakers, and loudspeaker aiming.
- (4) Check phasing of all microphones.
- (5) Check that all electronic components of the system are connected correctly, that correct signal levels are observed, that loads are where they should be. Check system for oscillations, RF-interference and hum.

- (6) Make sure to have a good system ground, and that shielding and grounding are done in accordance with good practices.
- (7) The AC electrical power to the system should be of good stability, adequately protected, and the wire size large enough to avoid excessive voltage drop when large amounts of power are drawn.

4.3 MEASUREMENT TECHNIQUES. Several different methods are currently being used to measure the response characteristics of a sound system in its acoustic environment. Currently the most popular methods include swept sine waves measured on an audio voltmeter or graphic recorder; pink noise measured in 1/3 octave bands on a real time analyzer, and the Sonipulse Acoustical Audio System Analyzer. This patented instrument is also a UREI product. It uses a periodic test signal which contains all harmonics of interest in the audio range. Basically all of the measurement methods are similar in technique -- differing only in hardware. They all involve generating a known quantity of audio signal, transmitting it through the sound system and reading the results through a calibrated microphone and read-out device. The microphone is located in the listening area and its position is changed to see if there are response variations in different locations. The response variations are then averaged to obtain the RAW HOUSE CURVE. Corrective equalization procedures are then begun, based on this curve. Many problems associated with level balance between multiple speakers in large arrays, acoustic deficiencies, and speaker aiming, and locating faults will show up on the curves taken in various locations in the listening area and for good results these faults should be corrected by re-balancing of levels and re-aiming or relocating speakers -- not by equalization. In systems which use electronic crossovers or multi-amplifier configurations the balance should be checked and adjusted between low and high frequencies and between speakers covering different parts of the listening area.

4.4 ADJUSTMENT OF EQUALIZERS. Room equalization is performed as a series of approximations of control settings. Looking at the sample raw house curve in Figure 4-4 we can infer that if an inverse electrical response curve were placed in the audio chain that the result would be a flat frequency response.

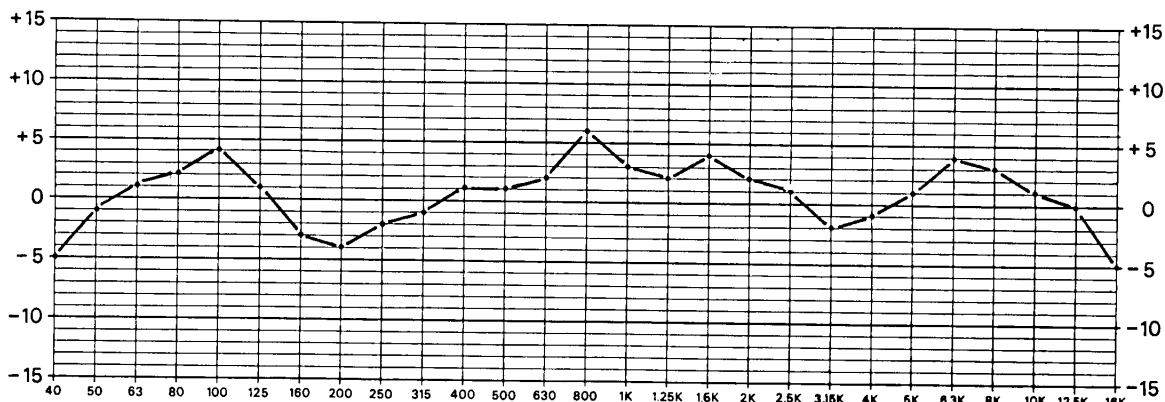


Figure 4-4 TYPICAL RAW HOUSE CURVE

The graphic equalizer is the tool with which this inverse curve is approximated. Because there are combining effects between adjacent filters it is necessary to make settings on the equalizer and then to re-check the room response to see if the adjustments are correct. Additional adjustments and measurements are made until the desired result is obtained. At this point the difference becomes important between the Model 532, which is an octave graphic equalizer, and the Models 527-A and 529, which are 1/3 octave graphic equalizers. The 1/3 octave graphic equalizers have 27 control adjustments for the frequency range, giving the user the ability to more precisely control the amplitude variations in the system. But, depending on the amount of response variation in the system the octave equalizer may be able to approximate the same curve for many installations. And it is important to understand that an approximation may be enough to make a very real difference. The ultimate measuring instrument and the one which is the final judge of any equalization is the trained human ear.

4.5 SOME PROBLEMS WITH CORRECTIVE ROOM E.Q. As stated earlier, the process of corrective equalization of sound systems is not a cure-all. There are some rooms which, because of very long reverberation times and poor acoustic configuration cannot be materially improved. There are others in which the acoustics and the sound system are already so well in tune with each other that there is little need for correction. It is for the majority of situations which lie in the realm between unsolvable and relatively perfect that corrective equalization is intended. Many of the problems that people seem to get into when performing corrective equalization stem from a tendency to over-kill. It has been found in practice that it is not usually 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 shifts. 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. 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 kHz and then an attenuation of 3 dB per octave above 3 kHz is frequently used. Widely disparate control settings should be avoided if at all possible. A control panel in which adjacent adjustment knobs are 8 - 10 dB apart may look interesting but the resultant sound probably will not sound natural. In these days of concern over things ecological it is good to remember the catchy phrase that "Less is More."

This is especially true in the application of equalization. Basically, anytime you put electrical signal through a filter you introduce phase shift. The amount of phase shift at any particular frequency depends on the amount of boost or cut at that frequency, and the Q of the filter. It is entirely possible to adjust a system for frequency response "flatness" and end up with a phase response which is extremely radical. This will result in the aforementioned "processed" sound.

In an attempt to eliminate feedback with the Model 532 radical control settings may result. This not only causes phase problems but will also tend to make "holes" in the frequency response because of the broad shape of the filter curves. Use of the Model 532 to eliminate feedback should be done mindful of the possible deterioration of the program material as a result of these "holes". Another UREI product, the Model 560 Feedback Suppressor is specifically designed to "tune-out" a very narrow band of frequencies which may cause ringing without drastically altering the program material.

4.6 OTHER USES. The Model 532 finds application in many areas in addition to room equalization. Some of the other uses are listed below.

- (1) Creative frequency shaping of recorded material in the recording studio. The very low output noise and high signal handling capability make the Model 532 suitable for use in any studio situation.
- (2) Reduction of proximity effect due to close-talking use of cardioid microphone. A decrease of only 2 dB or less in the 200-400 Hz region may significantly improve the intelligibility of what otherwise would be a very "boomy" sound.
- (3) Elimination of excess high frequencies and sibilance especially at high sound pressure levels. A slight reduction in level at 6.3 kHz may eliminate much of the harshness which is experienced when loudspeakers and amplifiers are operated close to their power limits.
- (4) Sound effect processing such as "Telephone Sound."
- (5) Sound effects tapes for theatrical productions may be made through the Model 532 to ensure consistency of quality of the recorded material and to pre-equalize for correct sound from the particular loudspeakers to be used. If the tapes are pre-equalized, adjustments during the show are reduced to volume adjustment and speaker selection. If the show goes on the road to some other auditorium the Model 532 may be inserted in the line to account for the different acoustics while retaining the original total balance of sounds from effect to effect.

- (6) Many sound systems are required to serve rooms in which different acoustic environments prevail in different areas: for example, the under-balcony area of a theatre versus the balcony area. For such installations use of a Model 532 in the amplifier-speaker chain covering one section of the room may allow for more consistent sound quality throughout the room.
- (7) Murphy's Law says that once everything has been checked out in a sound system and particular microphones have been selected to serve all functions, it is inevitable that someone will insist on using his own microphone for which the system is not equalized and which thus seriously degrades the quality of sound. The law also states that an ancient 78 RPM record must be played but whatever playback equalizer was originally used is anybody's guess and since it is five minutes before the program begins there is no time to guess anyway. At such times the Model 532 may be the exact "Thing-a-ma-bob that Does the Job."
- (8) The Model 532 will also find application in the radio station production studio to change the frequency response of material to be recorded for later broadcasts.

Occasionally some recordings do not meet the quality standards set for broadcast material. Re-recording through the 532 Equalizer may improve the material significantly.

As a creative tool the 532 can be used during the preparation of commercials and other promotional recordings. If the high frequencies are boosted a bright commanding sound will result, whereas attenuating the highs and boosting the midrange creates a more mellow and relaxed characteristic. These changes may be introduced without degrading the articulation or clarity of the message.

- (9) Sound systems which distribute background music usually lack the quality of studio monitors because the loudspeakers are selected for their low cost.

In addition the perceived sound often lacks highs and lows due to Fletcher-Munson effect.⁽¹⁾ These deficiencies, common in background music systems, may be corrected to a great extent through the use of the 532 Equalizer.

- (10) Further suggestions and help to use the Equalizer to its greatest potential may be found by reading additional publications, such as: "Sound System Engineering" by Don and Carolyn Davis. First Edition, Howard W. Sams Co., Indianapolis.

(1) See also: Audio Cyclopedia, H. M. Tremaine, Second Edition Section 1.76, pages 20, 22.

SECTION V

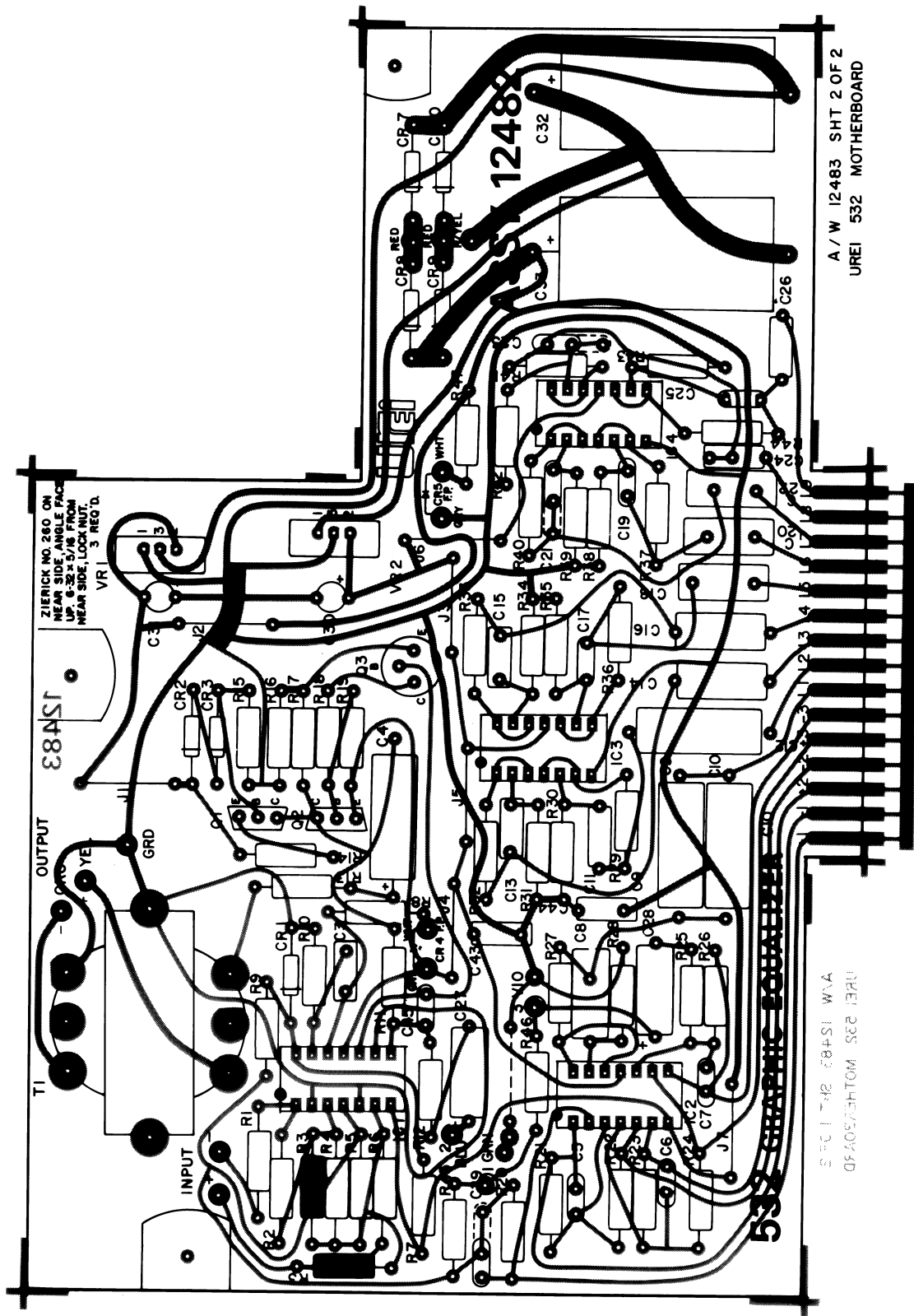
MAINTENANCE

5.1 GENERAL. The Model 532 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 532 is factory warranted to the original purchaser 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.

Because of specially selected components used in this product, field repairs are not authorized during the warranty period and attempts to perform repairs may invalidate the warranty.



CIRCUIT BOARD COMPONENT LAYOUT

