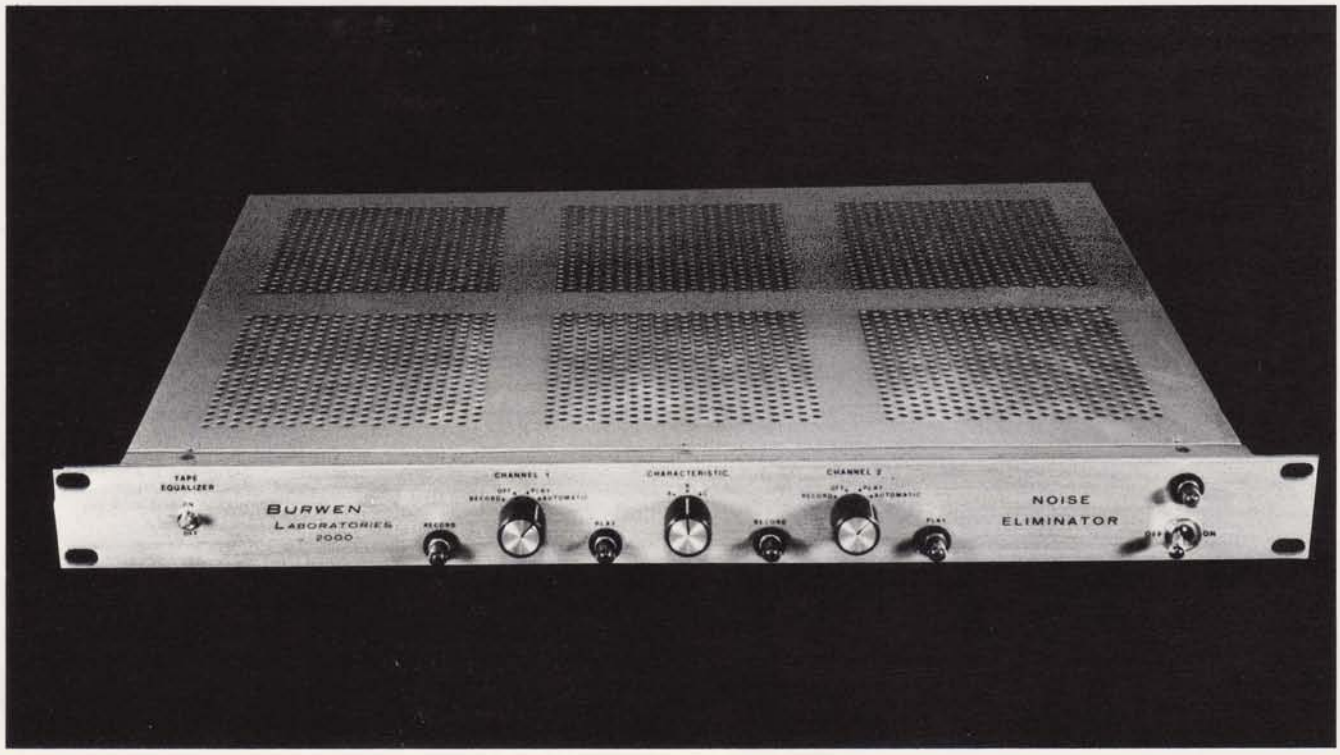
Noise Eliminator
Model 2000



FEATURES

110 dB Dynamic Range @15 ips
105 dB Dynamic Range @7-1/2 ips
35 dB Improvement in FM, Tapes, and Records
Less than .1% Total Harmonic Distortion
RECORD and PLAY Modes for Each Channel
Silent Manual or Automatic Mode Switching
Output DC Coupled, ±11 V Open Circuit
Delivers 18 dBm Into 600 ohms or 16 dBm Into 150 ohms
Response ±.2 dB 20 cps to 20 kc at all times
Compensation for Tape Recorder Response
Equalization for Future High Resolution Tapes
Insensitive to Tape Recorder Errors
1 or 2 Channels Available on 1-3/4" Rack Panel
Plug-in Channel Cards and Modules for Ease of Servicing
Active Transformer Input, 100k or 600 ohms
Highest Quality Materials and Components Guaranteed for Two Years

A record-play signal processor which extends the dynamic range of a studio tape machine or transmission link to as much as 110 dB.

The Noise Eliminator can also be used to produce program material to be played through special consumer equipment with 35 dB improvement in dynamic range or through conventional equipment. It is applicable to prerecorded tapes, cartridges, cassettes, records, and FM.

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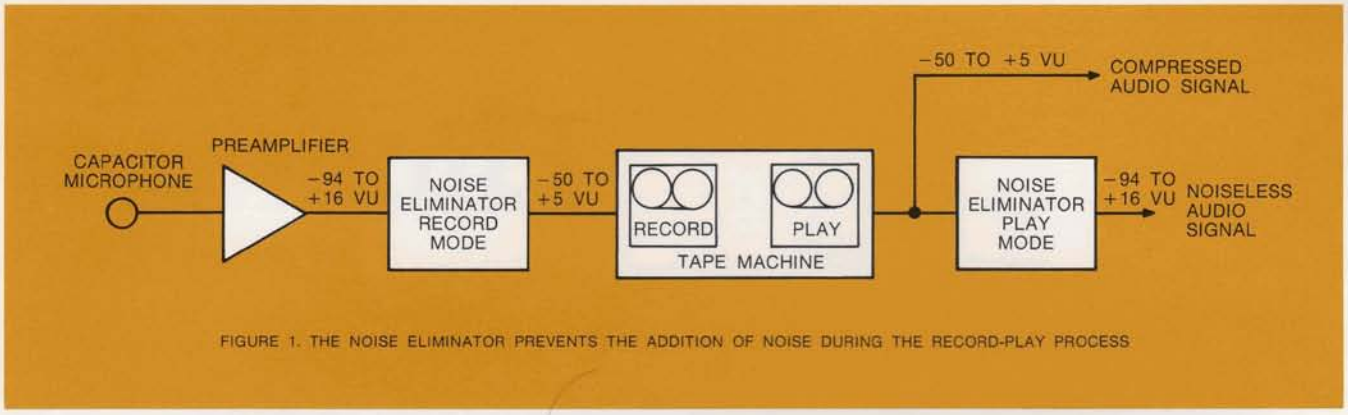


FIGURE 1. THE NOISE ELIMINATOR PREVENTS THE ADDITION OF NOISE DURING THE RECORD-PLAY PROCESS

NOISELESS LIVE RECORDING

Now it is possible to capture on tape with low distortion the full dynamic range of live musical instruments and to reproduce them at their original acoustic levels with no audible tape noise whatsoever. By connecting the Model 2000 Noise Eliminator before and after the tape machine, as shown in Figure 1, the original microphone quality signal can be preserved through the record-playback process with an overall tape noise reduction as great as 50 dB. Noise is overcome by automatically increasing the signal level on the tape when the input signal is small. Upon playback through the Noise Eliminator the original signal levels are restored with high accuracy.

The Noise Eliminator is a complementary system involving high and low frequency preemphasis before recording followed by expansion and deemphasis of the same frequencies after recording. It will not remove noise from an already noisy signal but will preserve its original dynamic range through the recording process.

Each of its two channels may be switched automatically or manually to either the RECORD mode or the PLAY mode.

OTHER USES

The Noise Eliminator may be used to preserve high quality signal transmission through other noisy media such as a microwave link, FM transmission and reception, phonograph records, and cassettes. Unlike other methods of noise reduction there is no frequency response variation and no error resulting from inaccuracy in the gain of the recording or transmission process. The compressed signal, which is nearly always at a fairly high level, is pleasant to listen to and can be used for monitoring while recording and is even suitable for the production of tapes, records, and FM broadcasts for consumers, or for background music service.

110 dB DYNAMIC RANGE

The signal recorded on the tape is compressed in dynamic range so that a 1 dB change in level on the tape represents a 3 dB change in level from the microphone. This characteristic, Figure 10, holds over an 82 dB input range and at lower levels the tape signal is directly proportional to the microphone signal. At minimum signal the increase in level on the tape is 44 dB at 400 cps and is greater at high and low frequencies as shown by the record preemphasis curve, Figure 11.

A tremendous 110 dB input dynamic range from −94 to +16 vu is thus recorded at levels from −50 to +5 vu on the tape, well above the tape noise and below the 1% distortion point for a modern studio machine. Upon playback through the Noise Eliminator complementary expansion and deemphasis accurately restore the original dynamic range from −94 to +16 vu as shown in Figure 9. Although tape noise is present during large signals it has been reduced 8 dB by the playback deemphasis to a level where the signal completely masks the noise.

Not only is the overall record-playback frequency response of the Noise Eliminator system perfectly flat as shown in Figure 12 but also the frequency response through the tape machine itself is improved. In the RECORD mode the Noise Eliminator provides adjustable low frequency compensation for poor response in the tape machine. The system can also benefit from the increased high frequency output of new and future high resolution recording tapes by means of an adjustable high frequency equalizer used in the PLAY mode. Both compensations are shown in Figure 13.

CHARACTERISTICS A, B, AND C

Three different record characteristics are provided to optimize the system performance for various recording or transmission conditions and the differences are shown in Figures 10 and 11.

Characteristic A is optimized for studio recording @ 15 ips. The total dynamic range is 110 dB and compression occurs over an 82 dB input range. The frequency response is +5.4 dB @ 20 cps and +13.0 dB @ 20 kc. Because the preemphasis occurs before the compressor, overload of the tape is avoided.

Characteristic B is optimized for recording @ 7-1/2 ips and takes into account the increased high frequency preemphasis in the tape machine. The record compression is the same as in Characteristic A but the high frequency preemphasis has been reduced to 4.0 dB @ 20 kc. The overall dynamic range attainable is 105 dB.

Characteristic C is optimized for tape recording @ 3-3/4 or 1-7/8 ips, for FM broadcasting, for records, and for background music service. The record preemphasis is the same as in Characteristic B but the record compression has been limited to avoid the extreme amplification of background noise in the input signal when the music ceases. In stereo operation the gain controllers in two or four channels are linked together to provide the same instantaneous gain on all channels and thereby preserve the stereo effect.

COMPATIBLE PROGRAM MATERIAL FOR CONSUMERS

The use of Characteristic C can produce over 35 dB improvement in dynamic range for FM, records, reel to reel tapes, and cassettes. The Noise Eliminator makes it practical to record classical music on cassettes and to extend the effective coverage of FM stations. It is equally applicable to one, two, or four channels, or to matrixed four channel stereo.

Compressed program material produced by the Noise Eliminator in Characteristic C, while differing from the original, makes pleasant listening even without expansion. Both loud and soft passages can be plainly heard at moderate listening levels; yet the dynamic effect of the music remains, partly as a result of the slightly augmented bass and treble.

The principal problem in creating pleasant sounding compressed music is the increase in background noise at low signal levels. Live microphone material is generally acceptably quiet but existing tapes and records are frequently too noisy. This problem can be solved by passing the noisy material through the Burwen Laboratories Model 1000 Dynamic Noise Filter before feeding it to the Noise Eliminator. Alternatively or in addition a potentiometer on the studio console can be connected to the Noise Eliminator to manually adjust the maximum gain in the record mode when using Characteristic C.

CONSUMER EQUIPMENT

Burwen Laboratories manufactures only the professional Noise Eliminator. Engineering assistance can be provided to licensees who may wish to incorporate a simplified version of the Noise Eliminator in their own consumer products.

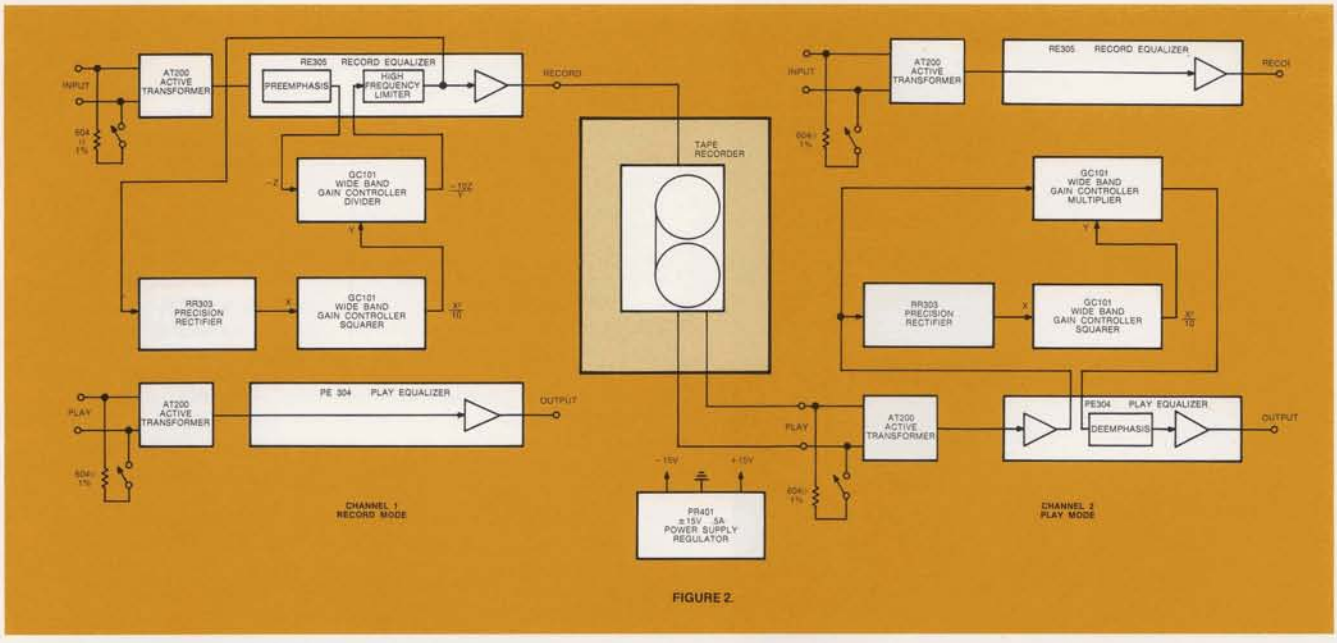


FIGURE 2.

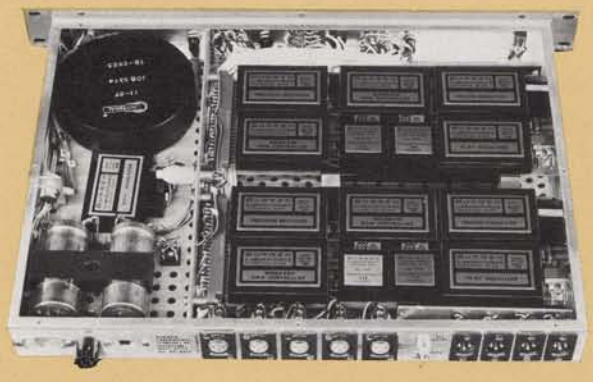


FIGURE 3.

MODULAR SYSTEM

Each of the two plug-in channels consists of a plug-in circuit card containing seven encapsulated modules which provide record and play functions and two unity gain amplifiers for monitoring and tape recorder calibration. Three of the modules are shared between the record and play modes. Normally, when recording, the compressed playback signal is monitored via a unity gain amplifier. By using channel 1 in the record mode and channel 2 in the play mode as shown in Figure 2 the expanded signal can be monitored while recording.

Record Mode

The input signal is converted from balanced to single ended in the Active Transformer and fed to the Record Equalizer. The Record Equalizer preemphasizes the high and low frequencies before the signal is passed through the Wideband Gain Controller and then limits high frequency overshoot to within the capabilities of the tape recorder. At the output of the limiter the signal level is measured in the Precision Rectifier and converted to dc. The dc voltage is then squared in another Wideband Gain Controller used to provide the gain control signal. The limiter output is thus controlled by a feedback loop and the record signal following a buffer amplifier is proportional to the cube root of the input signal. While not shown, tape monitoring of the compressed signal can be via the Active Transformer and buffer amplifier in the Play Equalizer below.

Play Mode

In channel 2 which is shown in the PLAY mode the two Wideband Gain Controllers and the Precision Rectifier have been switched to the Play Equalizer. The upper Wideband Gain Controller is used as a multiplier instead of a divider and as such it reduces gain in the range from 0 to −60 dB. Its gain is open loop controlled from the play signal which is converted to dc in the Precision Rectifier and then squared. The output signal after deemphasis of the high and low frequencies in the Play Equalizer is then proportional to the cube of the play signal. The unused upper portion of channel 2 can be used for delivering signals to the tape recorder at unity gain.

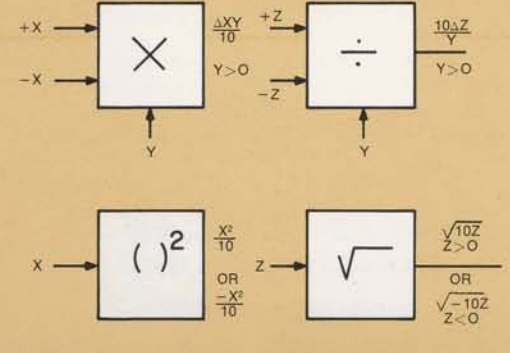


FIGURE 4.

FIGURE 4

GC101 WIDEBAND GAIN CONTROLLER

The GC101 is a unique dc to 10 mc amplifier whose gain is controllable over a 60 dB range with .1 dB accuracy and low noise. Utlizing the variable transconductance of dual monolithic transistors it performs the functions of two quadrant multiplication, division, squaring, and square rooting. Unlike a conventional four quadrant device the GC101 has low harmonic distortion at all values of gain and as a divider provides 70 kc bandwidth at a gain of 60 dB. Differential X and Z inputs offer considerable flexibility.

Brief specifications: Output ±11 V into lk; 1 kc harmonic distortion, .05 at X = 2 V rms, Y = +5V; gain accuracy ±.1 dB from 0 to −60 dB as a multiplier or 0 to +60 dB as a divider; and noise output 6 uV rms from 20 cps to 20kc at −60 dB gain.

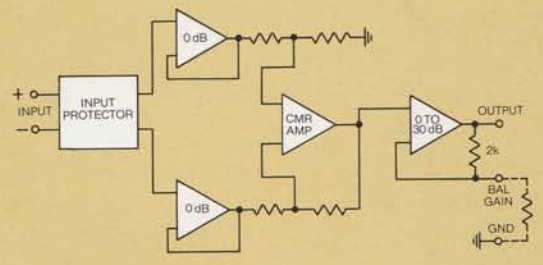


FIGURE 5

MODULAR COMPONENTS
AT200 ACTIVE TRANSFORMER

The passive audio input transformer is obsolete. Burwen Laboratories uses the Active Transformer—a differential input dc amplifier that overcomes the frequency response, distortion, and hum pickup limitations of the common audio transformer. The AT200 consists of an input over-voltage protector that feeds a pair of unity gain followers and then a bridge connected amplifier for common mode rejection. An output buffer amplifier provides 0 to 30 dB voltage gain selected by an external resistor.

Brief specifications: Input impedance 100k, output impedance .1 ohms, distortion .01%, output ±11 V into 10k, +18 dBm into 600 ohms, and CMRR 85 dB min.

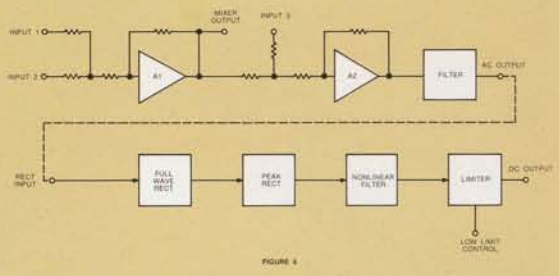


FIGURE 6

RR303 PRECISION RECTIFIER

The RR303 converts an audio input to a dc control signal in the range from 0 to +10 V with an accuracy of 1% of the output over a 30 dB range. The ac portion is used in the Noise Eliminator to combine the record or play signals from two or four channels so that the outputs from the Precision Rectifiers in the stereo channels will be identical.

In two channel stereo operation the record or play signals from channels 1 and 2 are mixed at inputs 1 and 2 and then amplified by A1 and A2 and passed through a 10 kc low pass filter whose ac output is available. The mixer output can feed a second Noise Eliminator and its corresponding mixer output can be added in at input 3.

The dc section is separate and consists of a precision full wave rectifier, a peak rectifier, and a multistage nonlinear filter. After rectification and filtering upper and lower bounds are set so that the dc output is clamped in the range of either +316 mV to +10 V or +1 V to +10 V.

Brief specifications: Output +10 V into 2K, rectifier sensitivity 3.5 V, output ripple .05% p-p at 20 cps.

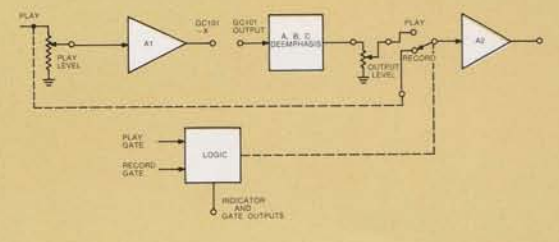


FIGURE 7

PE304 PLAY EQUALIZER

The PE304 consists of an input buffer amplifier A1 which delivers its output to a Wideband Gain Controller and Precision Rectifier. The expanded signal from the Wideband Gain Controller is fed back into the GC101 output terminal where it passes through a deemphasis network which provides curves complementary to those in Figure 11. After external adjustment of the output level the signal is amplified in an output amplifier A2. Internal FET switches cascaded for low crosstalk select either the processed signal or the play signal to be delivered to A2. TTL or relay compatible logic designed for slow silent switching actuates the FET switches, provides record and play indicator lamp outputs, and delivers ±12 V gates for switching in the Record Equalizer.

Brief specifications: Output 11 V peak into 10k, 18 dBm into 600 ohms, 1 kc harmonic distortion .01%, A1 gain 12 dB, deemphasis gain 14 dB at 400 cps, A2 gain 6 dB, gate inputs 0 to +1 V or +2 to +30 V into 40 K.

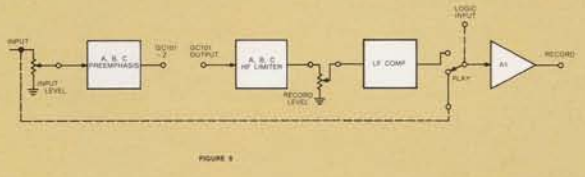


FIGURE 8

RE305 RECORD EQUALIZER

The RE305 provides the record preemphasis as shown in Figure 11 and delivers a signal to the −Z input of the GC101 Wideband Gain Controller. The output of the GC101 is delivered to the high frequency limiter which limits at +11 vu at low frequencies and at lower levels at high frequencies corresponding to the input capabilities of the tape recorder at 15, 7-1/2, and 3-3/4 ips. After external adjustment of the record level the low frequency compensation shown in Figure 13 is added and either the processed signal or the input signal is selected by FET switches and delivered to an output amplifier A1.

Brief specifications: Output 11 V peak into 10k, 18 dBm into 600 ohms, 1 kc harmonic distortion, .01%, preemphasis gain − 4 dB at 400 cps, limiter gain 0 dB inverting, A1 gain 6 dB, logic inputs ±12 V.

IMPROVED TRANSIENT REPRODUCTION

With today's close microphone techniques and the use of the standard vu meter many master tapes are badly overloaded during peaks. Oscilloscope measurements show that the instantaneous peaks produced by such instruments as the drum, cymbal, or cow bell may be as high as 24 dB above the reading of a standard vu meter depending upon the microphone placement. Operation with peaks reaching 0 on the meter produces very substantial distortion because the distortion reaches 1% at only +6 vu in a typical studio machine equipped with a linearizer. High frequency preemphasis in the record amplifier adds to the problem. Reducing the signal level to avoid distortion of the peaks can result in a completely intolerable signal-to-noise ratio.

The Noise Eliminator solves this problem by holding the signal level in the low distortion region for all but the first few hundred microseconds of a transient. As the harmonics die out the level automatically increases to overcome the tape noise. Distortion is reduced by the high frequency deemphasis during playback. Thus the Noise Eliminator is able to considerably improve the reproduction of percussive instruments as well as other types.

PEAK VU METER OUTPUT

Peak record or play levels of each channel may be monitored with a standard vu meter by means of dc voltages made available at the rear of the instrument. The voltages are derived from the RR303 Precision Rectifiers. A 20 vu range at the tape corresponds to a 60 vu range of input level.

STEREO OPERATION

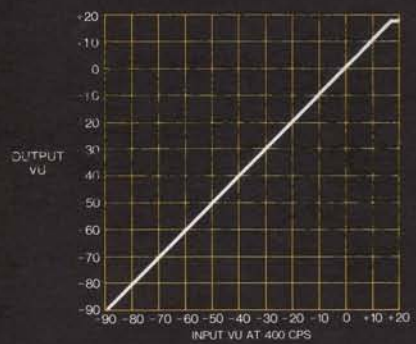
In Characteristic C, used for the production of consumer program material, the Precision Rectifiers' signals are ganged together for channels 1 and 2 if both channels are in the RECORD mode or in the PLAY mode. By means of a rear connector two Noise Eliminators can be connected together for four channel stereo operation. This connector also provides for the use of an external potentiometer on the control console which can raise or lower the limit on the record compression or the play expansion for two or four channels simultaneously. A higher limit is used with voice and noisy program material.

SILENT SWITCHING

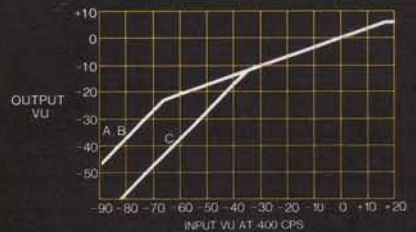
Switching from record RECORD to PLAY may be done manually or by remote control from the tape recorder. Slow acting FET switches cascaded for low crosstalk in the Record Equalizer and the Play Equalizer change modes silently with about .4 seconds gap between. This silent period is useful in allowing the tape recorder to come up to speed when changing to record. Crosstalk from one signal or channel to another is typically—75 dB at 10kc and less at lower frequencies.

POWER SUPPLY

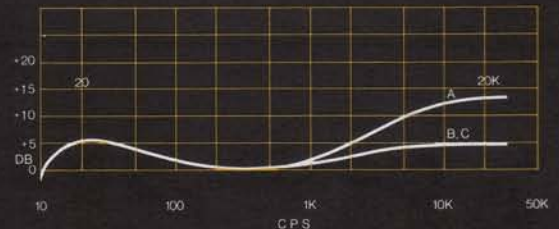
The power supply consists of a large toroidal power transformer designed to eliminate magnetic interference with adjacent equipment, oversized rectifiers and computer grade filter capacitors, and a precision regulator module Model PR401. The supply delivers ±15 V ±5%, ±500 mA regulated to .01%. All components are highly derated, and interlocking and overvoltage protection prevents damage to other modules in the event of a power supply failure.



OUTPUT VS INPUT
FIGURE 9

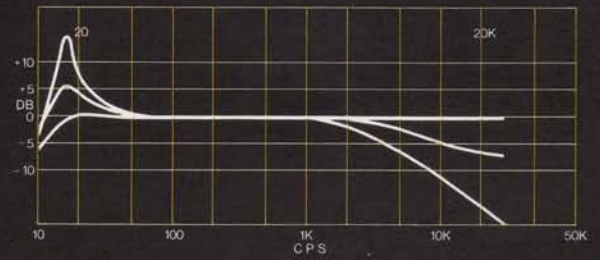


RECORD COMPRESSION
FIGURE 10



RECORD PREEMPHASIS
FIGURE 11

OVERALL FREQUENCY RESPONSE
FIGURE 12



COMPENSATION FOR RECORDER AND HIGH RESOLUTION TAPES
FIGURE 13

SPECIFICATIONS

Typical @ 25%C with 10k load unless otherwise specified.

CHANNELS— Prewired for one or two. Each channel is switchable manually or by remote control from record to play. In the RECORD mode the play signal is passed at unity gain. In the PLAY mode the record signal is passed at unity gain. The channels are completely independent except in Characteristic C when both are in the RECORD mode or in the PLAY mode. Channel cards containing 7 modules may be plugged into either channel and operated without modification or adjustment.

INPUT: 0 vu: +4 dBm normal, internally adjustable from −6 to + 9 dBm

Maximum: +20 dBm

Impedance: 100k bridging • 600 ohms ±1% termination available via rear panel switch

Common Mode Rejection: 85 dB minimum, dc to 1 kc • 65 dB minimum with 600 ohm source unbalance • 70 dB minimum at 10 kc

Common Mode Impedance: 2 Mohm each input to ground

Overload Input: ±25 V dc or rms

OUTPUT—Open Circuit: + 20 dB, 11 V instantaneous peak

600 ohm Load: +18 dBm, 9 V instantaneous peak

150 ohm Load: +16 dBm, 3.4 V instantaneous peak

Output Impedance: <.5 ohm dc to 100 cps • 10 ohms @ 20 kc

Short Circuit Protection: included

Connections: Single ended, common grounded to chassis

FREQUENCY RESPONSE— Record Preemphasis: See Figure 11 • Characteristic A, ±.1 dB, 20 cps to 20 kc • Characteristics B and C, ±.2 dB

Record-Play: Characteristic A, ±.2 dB max. 20 cps to 20 kc @ 0 vu • ±.3 dB @ −60 vu • Characteristics B and C ±.4 dB max. @ 0 vu

Low Frequency Compensation: See Figure 13 • adjustable 0 to +15 dB @ 16 cps

Playback Tape Compensation: See Figure 13 • corner frequency and level adjustments 3 kc to 20 kc

RECORD-PLAYBACK NOISE— Characteristic A: −94 vu, 20 cps to 20 kc • Characterisitic B, −90 vu • Characteristic C, −89 vu

COMPRESSION CHARACTERISTIC: See Figure 10. Accuracy ±.3dB from −80 to +16 vu @ 400 cps

GAIN-OFF MODE: Input-Record, 0 dB ±.1 dB at any load from 150 ohms to open circuit • Play-Output, 0 dB ±.1 dB

HARMONIC DISTORTION—Record-Play: .1% @ +18 dBm input and output into 600 ohms @ 400 cps • OFF mode .02%

STEREO OPERATION: Characteristic C only, two channels or four channels provide the same instantaneous gain • maximum gain remotely adjustable

PEAK VU OUTPUT: Tape record or play signal produces +3.9 V dc @ 0 vu

REMOTE MODE SWITCH INPUT: Record mode, 2 channels: Relay contacts to ground or to +2 to +30 V • logic levels, 0 to +1 V or +2 to +30 V selected by internal switch

CONTROLS-RECORD, OFF, PLAY, AUTOMATIC • separate for channels 1 and 2 • Characteristic A, B, C, 2 channels ganged • EQUALIZER, ON-OFF, 2 channels ganged • Power, ON-OFF

POWER INPUT: 115 V or 230 V ±10%, 50 to 60 cps, 25 W per 2 channels

MECHANICAL: Single 19" x 1-3/4" rack panel for 1 or 2 channels. Depth behind panel 14". Panel gold anodized.

Input Connectors: D3F Switchcraft • mating connectors required (2 per channel) A3M Switchcraft or XLR3-12C Cannon

Output Connectors: D3M Switchcraft • mating connectors required (2 per channel) A3F Switchcraft or XLR3-11C Cannon

Pin Connections: 1, shield and shell • 2, common • 3, high 4 Channel, Peak VU Meter, and Gain Limit: D5F Switchcraft • mating connector required A5M Switchcraft

Record Relay Input: UG 1094/U • mating connector type BNC

MODEL 2000 NOISE ELIMINATOR

SYSTEM ERRORS

Every part of the Model 2000 Noise Eliminator system that contributes to the frequency response or gain accuracy uses precision components together with internal trimming to reduce the cumulative errors. Individual modules are generally accurate to within .1 dB and except for the GC101 gain control element typically produce less than .01% harmonic distortion. In Characteristic A the Frequency response of the entire record-play system excluding the tape machine is flat within ±.2 dB from 20 cps to 20 kc and additional compensation is provided for the tape machine. Because a single wideband compression system is used gain and frequency response errors in the tape machine do not cause additional errors in the Noise Eliminator.

As long as the program content is contained within the 3 dB/1 dB compression range the change in output level resulting from a gain error in the tape machine is constant and there is no change in the linearity of the output vs input.

Highly important to the accuracy of the system when reproducing percussive music are the attack and fall times of the Precision Rectifier and the accuracy of the reproduction of transients within the tape recorder. With the record output of channel 1 in the RECORD mode connected to the play input of channel 2 in the PLAY mode the Precision Rectifiers in each channel measure closely identical signals. The typical instantaneous error over the entire dynamic range is ± 1 dB for transient signals and ±.5dB for steady signals. Over the narrower range occupied by most program material the errors are even less.

A severe tilt in the frequency response of the tape recorder through the middle frequency region may result in slight expansion or compression of orchestral crescendos depending upon their spectral content. Such effects, however, are usually undetectable to the ear. Clipping in the tape machine which would cause the Noise Eliminator to compress transients has been avoided by limiting the signal level inside the Record Equalizer to within the capabilities of the tape machine at all frequencies. In addition the Precision Rectifier has been made insensitive to high frequency phase shift and attenuation in the tape recorder by choosing a medium attack time constant of 1 ms.

OPERATION

Operation is extremely simple and, because the Noise Eliminator is built with stable components, it needs no calibration or adjustment after initial installation. The tape recorder should be standardized at 0 vu input and output at 400 cps. A gain error, however, can be corrected without resulting linearity error simply by adjusting the playback volume.

T2000 DEMONSTRATION TAPE

A 7-1/2 ips Noise Eliminator demonstration tape recorded in four tracks compatible with 1/4 and 1/2 track two channel stereo machines is available for a $10.00 deposit which will be refunded upon return of the tape, postage prepaid, within 15 days.

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