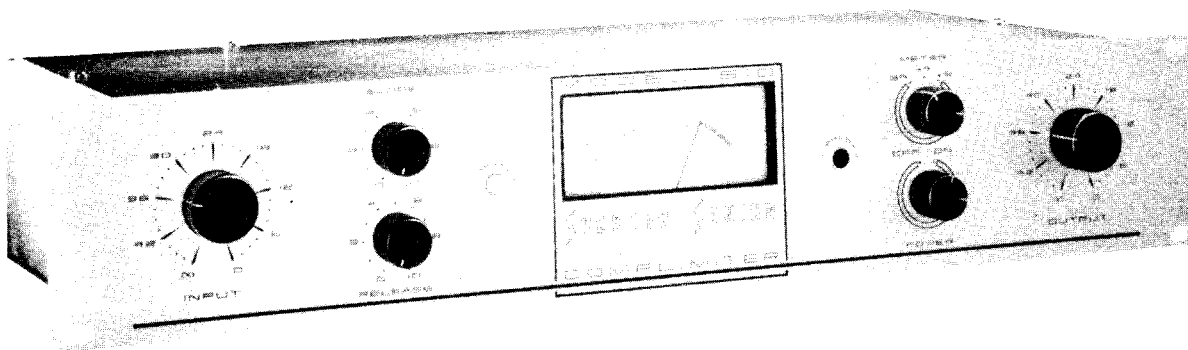




MODEL 610 "COMPLIMITER"™*



GENERAL DESCRIPTION

SPECTRA SONICS introduces the Model 610 "COMPLIMITER"™: the newest proven concept in a rack-mounting compressor/limiter system with performance both measurably and audibly discernable as "beyond the state of the art". This unit performs the functions of peak-limiting and volume-compression, either independently or simultaneously, as a direct function of the type of program input, with performance that is unequalled by most linear amplifiers! The extremely low noise characteristics of this unique, self-contained system provide a very low threshold of -40 dBm, thus allowing the greatest input sensitivity and compatibility with audio equipment and accessories used in the professional recording, broadcasting, motion picture and sound-reinforcement industries.

As the fastest of all peak-limiting devices (100 nanoseconds to 2 microseconds), peak-limiting can be employed with no audible distortion of any kind, thus allowing undistorted recordings, transmissions, etc. at average levels significantly higher than conventional "O" VU ($+4$ dBm or $+8$ dBm) while simultaneously providing maximum amplitude protection. A white threshold attack indicating lamp provides the audio engineer - for the first time - a representation of the peak-limiting taking place without the task of monitoring an auxiliary oscilloscope. A separate red overload indicating lamp forewarns the operator, in advance of overload, exactly when to check his control adjustments without requiring his undivided attention. The continuously variable compression/limiting ratio assures the widest range of slope control available - from 1.1:1 (approximately linear amplification) to approximately 100:1 (flat slope, maximum amplitude protection line). Coupled with a constant threshold attack level of -40 dBm, the need to continually reset input levels during operation for each new compression/limiting ratio is eliminated. Variable release time control allows selection of the smoothest dynamic action commensurate with minimum distortion (typically less than 5/100ths of 1%). The uniform frequency response of this unit negates the need for "de-ess"/roll-off of all high frequencies.

During actual listening, the absence of noise, distortion, and frequency discrimination is readily apparent. The Model 610 "COMPLIMITER"™ is particularly effective in controlling sibilant sounds, restricting extreme ranges, and providing the smoothest dynamic action.

ARCHITECTS' AND ENGINEERS' SPECIFICATIONS

The amplifier shall be a self-contained solid-state device in standard $3\frac{1}{2}'' \times 19''$ rack-mount form. The amplifier shall be capable of independent limiting and compression functions up to 30dB, while not exceeding total harmonic distortion of 1/10th of 1%, 30Hz to 20KHz, at $+16$ dBm (release time set so as not to allow attack and release on each successive cycle of lowest frequency). The signal-to-noise ratio shall be not less than 80dB below $+4$ dBm output with -40 dBm input (threshold), 20Hz to 20KHz, unweighted. The compression ratio shall be continuously variable from 1.1:1 to approximately 100:1. Frequency response shall be within ± 5 dB, 20Hz to 20KHz, at $+16$ dBm, and the release time of the amplifier shall be variable. The compressor/limiter shall contain threshold attack indicating lamp and overload indicating lamp systems to additionally monitor the signals. The amplifier shall be SPECTRA SONICS Model 610 "COMPLIMITER"™.

SPECIFICATIONS

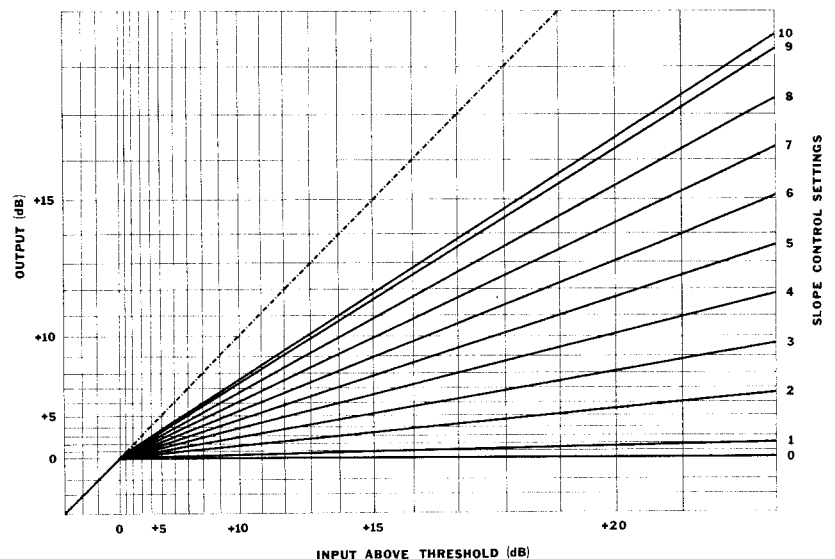
INPUT IMPEDANCE	600 ohms, floating
OUTPUT IMPEDANCE	Approximately 120 ohms (1 kHz), floating
OUTPUT LOADING	600 ohms to INFINITY, balanced or unbalanced
MAXIMUM GAIN	56 dB
INPUT LEVEL	Typically -50dBm to +10dBm
THRESHOLD ATTACK LEVEL	-40dBm
OUTPUT LEVEL	Typically +4dBm or +8dBm
SIGNAL-TO-NOISE RATIO	Not less than 80dB below +4dBm output with -40dBm input (threshold), 20Hz to 20KHz, unweighted.
FREQUENCY RESPONSE	± 1 dB, 10Hz to 40KHz, at +16dB (High Z load) ± 5 dB, 20Hz to 20KHz, at +16dBm (600 ohm load)
HARMONIC DISTORTION	Less than 1/10th of 1%, 30Hz to 20KHz, at +16dBm, up to 30dB compression, with release time such that attack and release does not occur on successive peaks of the lowest frequency utilized (Typically less than 5/100ths of 1%).
COMPRESSION/LIMITING RATIO	Continuously variable from approximately 1.1:1 to 100:1
ATTACK TIME	Automatically variable
LIMITER	100 nanoseconds to 2.0 microseconds
COMPRESSOR	100 nanoseconds to 1.2 milliseconds
RELEASE TIME	For 90% Recovery
LIMITER	Less than 90 nanoseconds
COMPRESSOR	Continuously variable from 50 milliseconds to > 10 seconds
MAXIMUM TEMPERATURE	(140°F) 60°C
POWER REQUIREMENT	105-125 VAC, 50/60Hz, 6 watts, 210-250 VAC 50/60Hz
PHYSICAL DIMENSIONS	8.89cm (3½") High x 49.20cm (19") wide x 21.80cm (8½") deep for standard rack mounting
WEIGHT	Net 4.3Kg (9½ pounds); shipping 6.2Kg (14 pounds)
STEREOPHONIC INTERCONNECTION	Two units are easily coupled. Requires Model 610 SI Accessory.

OPERATING APPLICATIONS

The separate and distinct limiting and compression functions, available only with the Model 610 "COMPLIMITER"™, make possible an inaudible "limiting only" mode of operation. Peak monitoring for this mode is provided by threshold attack and overload indicating lamps. A maximum amplitude protection line and sustained maximum average level may be established with this mode, thus providing an invaluable advancement "beyond" conventional limiters which quickly reduce and slowly restore average level for peak inputs exceeding a predetermined level. In tape recording alone, this "limiting only" mode eliminates the need for the 10 dB (or more) margin conventionally set aside for tape overload protection (of peaks). The significant increase in S/N and power output, resulting from this one application of the Model 610 "COMPLIMITER"™ is self-evident.

The following additional modes of operation are automatically available for control: limiting and compression, compression only, limiting and compression with additional fixed amplitude protection, and normal linear amplification.

VARIABLE COMPRESSION/LIMITING CURVES



SPECTRA SONICS

LEADER IN ADVANCED TECHNOLOGY



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MODEL 610

COMPLIMITER™

OPERATING

INSTRUCTIONS

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UNPACKING AND INSPECTION

Before accepting the Model 610 "COMPLIMITER"TM from the shipper, inspect the shipping carton for external damage. Any sign of external damage must be noted by both customer and shipper, and should be called to the attention of the insurance investigator.

After the equipment is unpacked, inspect the unit for any damage in shipment. Check for scratches or dents, damaged knobs, or connectors. If damage is noted, do not use the unit unless instructed by the insuring agency.

NOTICE

When removing the top or bottom cover plates with the AC power connected, do not touch the AC power lines on the main PC board.

Prior to any termination and operation of the unit, READ THE INSTRUCTION MANUAL.

Do not insert plug-in cards with the power on, since misalignment while inserting the cards into the connector may damage the plug-in cards.

INTRODUCTION

The Model 610 "COMPLIMITER"TM is a rack-mounting compressor/limiter system with performance both measurably and audibly discernable as "beyond the state of the art". The completely self-contained unit is compatible with the audio equipment and accessories used in the professional recording, broadcasting, motion picture and sound-reinforcement industries.

Because of the extremely low noise characteristics of the design, the system has a very low threshold of -40 dBm, thus providing the greatest input sensitivity and compatibility with the widest range of system levels on the professional audio market. Depending on the program content, the Model 610 "COMPLIMITER"TM will accept an input signal of from -50 dBm to -40 dBm just prior to beginning compression, as well as standard line level input signals.

Control functions are provided on the front panel for input level to threshold, continuously variable compression slope (ratio), release time, VU meter monitoring, power, and output level. For the first time, visual lamp indicators for both the essentially instantaneously peak-limiting and also for system overload are provided, in addition to VU meter monitoring, only on the Model 610 "COMPLIMITER"TM.

This manual is provided to aid the operator in obtaining maximum performance from the Model 610 "COMPLIMITER"TM. READ THE INSTRUCTION MANUAL, especially the "MODES OF OPERATION" and "INSTALLATION/TERMINATION" portions, before using the unit.

SPECIFICATIONS

Input Impedance	600 ohms
Output Impedance	Approximately 120 ohms (1 kHz), floating
Output Loading	600 ohms to Infinity, balanced or unbalanced
Maximum Gain	56 dB
Input Level	Typically -50 dBm to +10 dBm
Threshold Attack Level	-40 dBm
Output Level	Typically +4 dBm or +8 dBm
Signal-to-Noise Ratio	Not less than 80 dB below +4 dBm output with -40 dBm input (threshold), 20 Hz to 20 kHz, unweighted
Frequency Response	$\pm .1$ dB, 20 Hz to 40 kHz, at +16 dB (High Z load) $\pm .5$ dB, 20 Hz to 20 kHz, at +16 dBm (600 ohm load)
Harmonic Distortion	Less than 1/10th of 1%, 30 Hz to 20 kHz, at +16 dBm, up to 30 dB compression, with release time such that attack and release does not occur on successive peaks of the lowest frequency utilized. (Typically less than 5/100ths of 1%)
Compression/Limiting Ratio. . .	Continuously Variable from approx. 1.1:1 to 100:1
Attack Time	Automatically Variable
Limiter	100 nanoseconds to 2.0 microseconds
Compressor	100 nanoseconds to 1.2 milliseconds
Release Time	For 90% Recovery
Limiter	Less than 90 nanoseconds
Compressor	Continuously variable from 50 milliseconds to more than 10 seconds
Maximum Temperature	140° F
Power Requirement	105-125 VAC, 60 Hz, 6 watts
Physical Dimensions	3 1/2" high x 19" x 8 1/2" deep for standard rack mounting
Weight	Net, 9 1/2 pounds; Shipping, 14 pounds
Stereophonic Interconnection .	Two units are coupled easily. Requires Model 610 SI Accessory for interconnection.

MODES OF OPERATION

Principle of Operation

The Model 610 "COMPLIMITER"TM is the first and only compressor/limiter that allows the professional audio engineer the widest range of separate and distinct modes of operation. The attainment of this flexibility is based upon being able to set, easily and accurately, the input and output level controls. This is a result of interaction among the following principles of operation:

1. Accurate monitoring of peak vs. average input signal levels using visual LED indication and VU meter, respectively.
2. Constant threshold attack level for any compression slope setting.
3. Separate limiting and compression functions for peak and average material, respectively, may be activated either independently or simultaneously.
4. No audible overload on the Model 101 Audio Amplifier for 1000% overload.

The following modes of operation result from interaction of the above principles and are recommended for actual use to demonstrate the simplicity of obtaining both maximum performance and maximum versatility with the Model 610 "COMPLIMITER"TM:

1. Normal linear amplification
2. Peak limiting only (maximum level below a fixed amplitude without affecting dynamic range)
3. Compression and limiting simultaneously
4. Compression only
5. Limiting and Compression with Additional Fixed Amplitude Protection (maximum percent modulation)

Thus, for the first time, through variations and modifications of these separate and distinct modes of operation, innumerable program production combinations are obtainable. For each mode of operation there follows an explanation of the interaction of the principles of operation, control settings and typical applications.

Normal Linear Amplification

This mode of operation always occurs when both the average and peak level of the signal waveform are below the threshold attack level of -40 dBm. Since neither the compression or limiting functions of the Model 610 "COMPLIMITER"TM will be activated, the slope control and release time settings will have no effect on the output, and 20 dB of normal linear amplification will be provided. In addition, whenever the slope control is set to the minimum compression/limiting ratio of 1.1 to 1 ("10" slope control setting = fully clockwise), approximately normal linear amplification also occurs for all input signal levels above the -40 dBm threshold attack level. This latter condition of operation above the threshold attack level provides the maximum signal-to-noise ratio.

Control Settings: For very low signal levels (e.g. Microphone, etc.) no attenuation of the input signal would be required and the amber threshold attack LED will occasionally flash whenever input levels are above threshold. For higher signal levels (e.g. Line, etc.) it is preferable to operate above the point of threshold and thus maximize the signal-to-noise ratio of the system.

The slope control is set to approximately normal linear amplification ("10" slope control setting), the release control setting is not critical and may be set at maximum time, and the input level control is adjusted so the white threshold attack lamp is continually illuminated. For either of these two conditions, adjust the output level control to obtain the level required.

Typical Application: This mode provides amplification for input signal levels below the -40 dBm threshold attack level, such as when normal microphone output levels (-50 dBm) are fed directly into the Model 610 "COMPLIMITER"TM. For higher level input signals, setting the slope control to approximately normal linear amplification has the practical equivalent of switching the Model 610 "COMPLIMITER"TM out of the circuit.

Peak Limiting Only

For all levels of the input signal waveform where peak signals are above threshold, and average level is below threshold, peak limiting occurs.

Since peak waveforms or transients, by definition, are high amplitude, short time-base, they have essentially no integrated power. Thus, the independent compression function will not activate, whereas, the independent limiting function will attack, essentially instantaneously, to provide complete peak protection. The limiting curve approximately follows the compression curve and thus, a continuously variable limiting curve is obtainable. For positive amplitude protection, a flat compression slope provides a flat limiting protection line.

Control Settings: Increase the input level control until the white threshold attack lamp just occasionally begins to flash, thus indicating peaks just beginning to cross threshold. This control setting will approximately represent the maximum amplitude of the peak material for this program selection. The approximate amount of peak limiting in dB may be determined by noting the change in dial setting as the input level is increased further. The maximum amount of peak limiting will occur just prior to the point where the VU meter begins to indicate gain reduction. The slope control is set for minimum (flat) slope of the limiting (and compression) curve (fully counterclockwise). Since compression is not being activated, the release control setting is not critical and would be set for maximum release time (fully clockwise). Adjust output control for required level.

Typical Applications: Maximum power output without affecting dynamic range is obtained with maximum peak limiting. An application that has received little attention - primarily because no adequate equipment has been available for such use - is the employment of an extremely flat compression (and limiting) ratio of about 100:1. This implies extreme compression to the recording oriented engineer. If, however, with no intent to compress a program source, the engineer were to be provided with a positive amplitude protection line (above which no peak program material could pass) he obviously, for the first time, would be able to predict and guarantee the highest voltage level that could be passed, for example, to a tape machine. This knowledge, in turn, would allow him to enter that margin below tape overload that, heretofore, has been reserved and set aside for peak excursions above average level. Since this margin is normally 10 dB, the increase in recorded tape signal-to-noise ratio resulting from such practice is self evident.

Compression and Limiting Simultaneously

This mode of operation occurs when the average level continually alternates above and below the constant threshold attack level.

When the program waveform first crosses threshold, the limiter will attack and hold until the compression function takes over. The cycle will repeat each time the average level crosses threshold. The compression slope does not change the threshold attack level or the threshold indication. The release time, of course, will determine how long the function will hold.

Control Settings: Increase the input level control until the VU meter begins to indicate compression. The white threshold attack indicator will be illuminated continuously since the average signal level will now be above threshold. The amount of additional compression is dependent upon the input level control setting. When the release control is set for the shortest release time, maximum average level will be obtained with some increase in level changes and distortion. Longer release times, however, will provide the smoothest action with minimum level changes, minimum distortion and an average level slightly lower than the maximum. Adjust the output control for desired output level.

Typical Applications: The mode is used whenever a small or intermediate amount of compression is desired.

Compression Only

When the average level of the input signal to the compressor/limiter is continually above the threshold attack level, this mode occurs.

Control Settings: Increase the input level control until the VU meter continually reads compression and the threshold lamp is continually on. Generally, longer release times should be used.

Typical Applications: Wherever a large amount of compression is required, operate in this mode.

Limiting and Compression with Additional Output Limiting

This mode is the same as the previous "Compression and Limiting Simultaneously" mode except that additional amplitude protection at a fixed level is provided by driving the output amplifier to maximum output (peak clipping).

This system provides "limiting-on-limiting" which assures maximum power output or maximum percent modulation. When utilized in this manner, an external pad after the Model 610 "COMPLIMITER"TM is needed to reduce the higher output level down to line level.

The red overload lamp indicator is set to illuminate for output amplifier signals of approximately +17 dBm, well in advance of the actual output amplifier limiting of +18 dBm or greater. Under normal circumstances, this is the preferred operation. However, for this particular mode, additional precise laboratory lamp indication at the exact point of output amplifier limiting may be preferred. Calibration of the overload lamp is covered in the CALIBRATION section of this manual.

Control Settings: Set the controls in the same manner as described in the previous "Compression and Limiting Simultaneously" mode except that the output level control should be set so the red overload lamp begins to flash. This indicates that peak material is being limited as a result of the outstanding overload protection in the output Model 101 Audio Amplifier plug-in module in the Model 610 "COMPLIMITER"TM system. Thus, a final fixed amplitude protection line is provided to prevent subsequent overload distortion, over-modulation, etc.

Typical Applications: This mode is particularly applicable to broadcast situations where maximum % modulation is required. A resistance in series (eg. 600 ohms, 1000 ohms potentiometer, etc.) with signal output is sufficient to pad the signal positive down to standard +8 dBm broadcast line (eg. 600 telephone line, etc.) level. This mode may be used for any application where maximum level is to be obtained without crossing above a maximum amplitude protection line.

CONTROL AND MONITOR FUNCTIONS

Constant Threshold Operating Advantages

The constant threshold attack level provides a significant operating advantage by eliminating the need to continually reset the input level for each new variation of compression ratio. Thus, comparison analysis on simplified "A-B" basis is possible and the selection of the desired slope of the compression curve is easier, more accurately determined and requires less time.

No "De-Ess" Roll-Off

The need for "de-ess" or "de-emphasis" has been eliminated through the advanced design dual function, independent compression and limiting of the Model 610 "COMPLIMITER"TM. Conventional single function systems are not capable of reacting in time to protect against higher frequency sibilant sounds without markedly sacrificing the performance of all lower frequency program material. To compensate for lack of considerable engineering design effort required to develop a sophisticated dual function system, a "de-ess" or "de-emphasis" control or function is necessary. Unfortunately, it produces a roll-off of all the high frequencies irrespective of whether or not transients or sibilant peaks are present. The professional audio engineer is thus no longer in control of the final program output from such conventional units because he is forced to accept either a "roll-off" of all high frequencies to avoid sibilant distortion from only a few high frequencies, or he has to tolerate sibilant distortion from high frequency overload.

The extensive engineering design effort on the Model 610 "COMPLIMITER"TM has specifically freed the professional audio engineer from the hapless "de-ess" and "de-emphasis" restriction. The engineer is no longer at the mercy of the equipment and thus allowed to process (eg. equalize, filter, single capacitor roll-off, etc.) the final frequency spectrum as he personally wishes. The frequency response of the Model 610 "COMPLIMITER"TM does not change under any condition of normal linear amplification, limiting and/or compression!

Input and Output Level Controls

Reference Symbols: R32 and R31

The input control regulates the amount of compression/limiting desired. The system is capable of receiving input signals 30 dB above the constant threshold attack level without deterioration in performance. The output control regulates the system output level and is located after the compression/limiting plug-in module and before the final amplifier plug-in module.

Continuously variable control of the input and output signal levels is provided to allow any value of attenuation without the restriction of steps. The VU meter may be used to monitor accurately this attenuation.

Detent input and output level controls are available by special order if desired. There is a 6 dB insertion loss for each detented control used in place of a continuously variable control. In addition, the Model 601 Compressor/Limiter plug-in module should be the 600 ohm input impedance configuration (rather than 10 kohms used in the non-detented version) for proper tracking. The front panel is calibrated to exactly match the detented control with 30 steps, 1½ dB per step and cut-off to infinity through the last three steps.

Slope (Compression/Limiting Ratio) Control

Reference Symbol: R30

For the first time in any compressor/limiter, the Model 610 "COMPLIMITER"™ provides both:

1. The widest range of compression/limiting ratios - from approximately 1.1:1 (approaching linear amplification) to 100:1 (flat slope).
2. Continuously variable selection of compression ratios - which may be changed during use to obtain any desired slope of the compression curve without fear of producing transients, pops, clicks, etc. or changing the threshold attack level.

For inputs up to the point of threshold (-40 dBm) the compressor/limiter provides 20 dB of gain. Thereafter, the output is dependent upon the compression/limiting ratio selected. The unit restricts/limits any program material from exceeding, in amplitude, the selected compression/limiting ratio curve. Distortion and gain change effects decrease as the compression/limiting ratio is decreased from the extreme flat condition.

When the slope control is set to the maximum compression/limiting ratio of approximately 100 to 1 ("0" slope control setting = fully counterclockwise), the compression/limiting curve is flat. Hence, the maximum amplitude output is held to a constant -20 dBm for any input level up to 30 dB above threshold. This extremely flat slope is very useful whenever a positive protection line is required.

Conversely, when the slope control is set to the minimum compression/limiting ratio of approximately 1.1:1 ("10" slope control setting = fully clockwise), the slope of the compression curve approaches the linear amplification curve. The Model 610 "COMPLIMITER"™, then, approximates the operation of a normal linear amplifier, and provides approximately 20 dB of gain for inputs above threshold.

For typical intermediate slope control settings, refer to Figure 1, Compression Curve Slope vs. Slope Control Settings. For slope control settings of approximately "5" (50% open), a signal input increase, of 15 dB above threshold, will increase the output approximately 7.5 dB, which is a 2:1 compression/limiting ratio.

Release Control

Reference Symbol: R29

The continuously variable release time control regulates only the compressor release function. Distortion is a function of release time and the amount of compression/limiting.

Maximum release time ("10" on the panel, fully clockwise) will slowly restore gain back to its original level. For lowest distortion and smoothest action, the release time should be at least an order of magnitude greater than the time of one cycle of the lowest frequency to be reproduced. Longer release time settings are often used for multiple source program material, main program channel material, mastering, or very slow music from a single source.

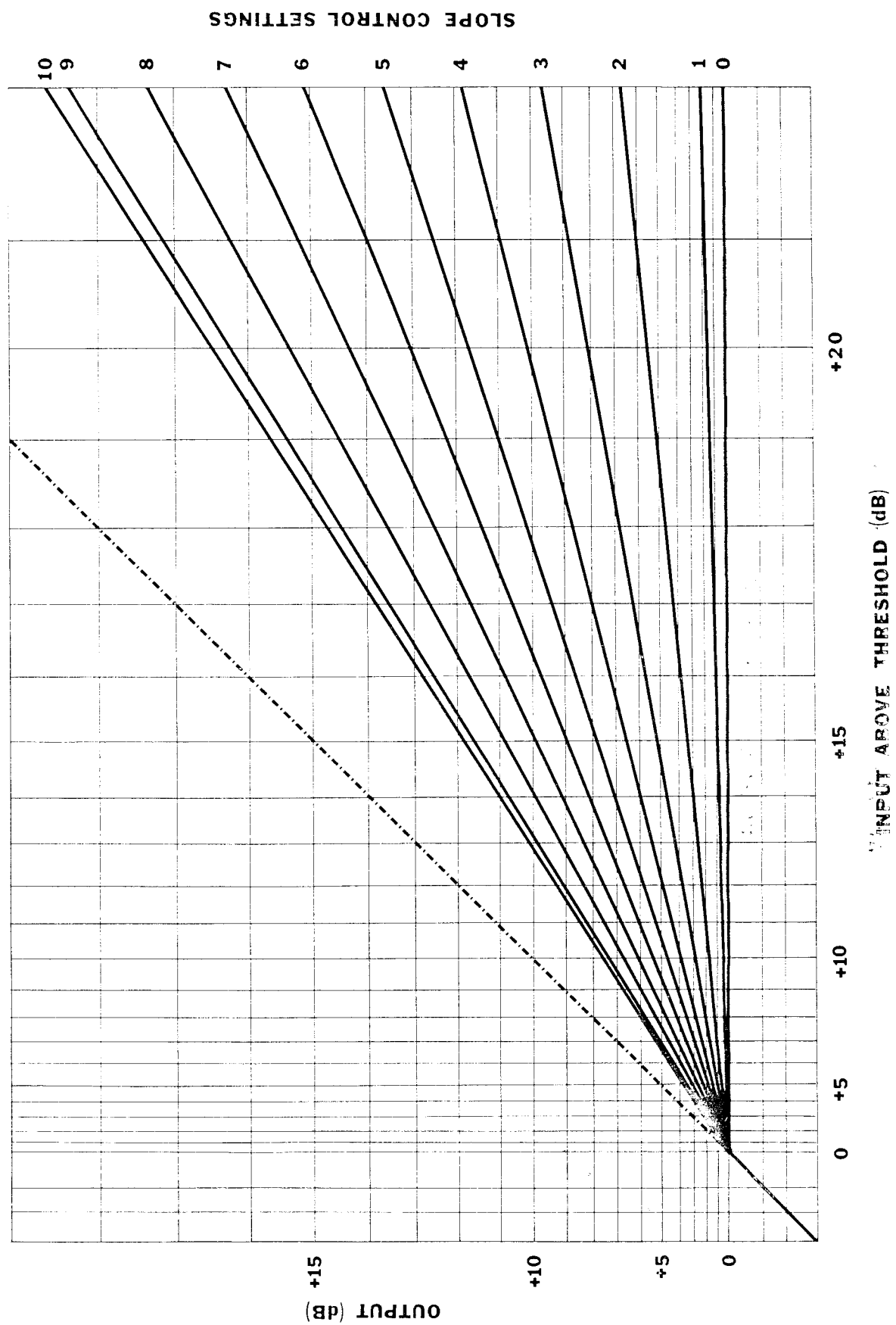


FIGURE 1
COMPRESSION CURVE SLOPE
VS. SLOPE CONTROL SETTINGS

Minimum settings of release time ("0" on the panel, fully counterclockwise) will quickly restore gain back to its original level. For maximum average level below a fixed amplitude output, the release control should be set at the shortest time, however, distortion and level change effects will be greater. Minimum release times are often used for single source, vocal or solo source material with low background noise or low background program. As the background level increases, the quick release to normal level (short release time) would eventually be audibly detectible as a rapid change in background level.

Figure 2, Actual Release Time (90% recovery) vs. Release Control Settings, illustrates the wide degree of continuous release time variation available. The data is approximate due to component variations from unit to unit. In addition, all the release times may be considerably shortened if the release adjustment potentiometer (R34 as described in the calibration section) is set to zero resistance (fully counterclockwise).

		Release Control Settings (Panel Markings)					
		0	2	4	6	8	10
Actual Release Time (Seconds)	5 dB Comp.	0.05	0.4	0.7	1.2	3.5	5.5
	10 dB Comp.	0.08	0.6	1.0	3.0	5.7	8.5
	15 dB Comp.	0.14	0.7	1.4	3.5	6.2	9.2
	20 dB Comp.	0.16	0.9	1.8	4.5	10.0	10
	25 dB Comp.	0.18	1.5	2.8	6.0	10	10

FIGURE 2
ACTUAL RELEASE TIME
VS. RELEASE CONTROL SETTINGS

In summary, the optimum release control setting for maximum level below a fixed amplitude will be the shortest possible release time commensurate with the minimal amount of distortion and/or level changes one is willing to accept. Judicious listening and selection of release times for various program selections is recommended, using this information as an approximate guide only.

Threshold Attack Indicator Lamp

Reference Symbol: L1

Due to inertia inherent in a mechanical indicating device such as a VU meter, the VU meter needle mechanism cannot react in time to detect the essentially instantaneous attack action of the Model 610 "COMPLIMITER"TM system on high amplitude, short time base transients. Practically, a VU meter is capable only of indicating higher power, longer time duration signals within its ballistic characteristics. When illuminated, the white threshold attack lamp indicates that some signal voltage (eg. transients, peak program material, etc.) has crossed the constant -40 dBm threshold attack level of the Model 610 "COMPLIMITER"TM.

The frequency of the white illumination (eg. flash, flashing, steady, etc.) from the lamp indicator gives the audio engineer - for the first time - an approximate representation of the peak limiting taking place, without the task of monitoring an auxiliary oscilloscope.

If the input signal remains above threshold for a longer time, the white threshold attack indicator lamp will remain lighted and the VU meter (meter switch set to "GR") will indicate the amount of gain reduction (compression) that will automatically occur.

Overload Indicator Lamp

Reference Symbol: L2

The red overload indicator lamp will illuminate whenever:

1. The Model 601 Compressor/Limiter is overloaded (Excessive average input signal to Model 601 plug-in module)
2. The Model 101 Audio Amplifier is limiting.

This red indicator is the first practically available device to insure optimum and maximum balance of the systems functions. Flashing of the red forewarns the operator exactly when to check his control adjustments without requiring his complete and undivided attention. In some instances it is particularly desirable to utilize the overload indicator lamp as a guide to obtaining additional limiting with the Model 101 Audio Amplifier.

Meter Switch

Reference Symbol: S3

A three position rotary switch is provided for selection of the VU metering between gain reduction and two output levels. When set to "GR" the VU meter indicates the amount of gain reduction (compression) occurring. When set to "+4" or "+8" and the VU meter is monitoring the output signal level, 0 VU on the VU meter corresponds to +4 dBm or +8 dBm, respectively.

Power Switch

Reference Symbol: S1

A two position rotary switch is used to turn the compressor/limiter system either "on" or "off". When turned "on", transients are normal during the first few seconds of warm up before reaching equilibrium. The system electronics are then ready for operation. The VU meter, however, is temperature sensitive to the heat from its illumination. This heat, and not the system electronics, will cause the meter zero set to vary until after about 30 minutes of warm up to allow the meter to reach a temperature equilibrium.

INSTALLATION/TERMINATION

Identification Plate and Barrier Terminals

The identification plate (Figure 3) is mounted above the terminal strip on the back of the Model 610 "COMPLIMITER"TM and identifies the barrier terminals. A standard approved AC power cord is installed proximate to the plate shown below.

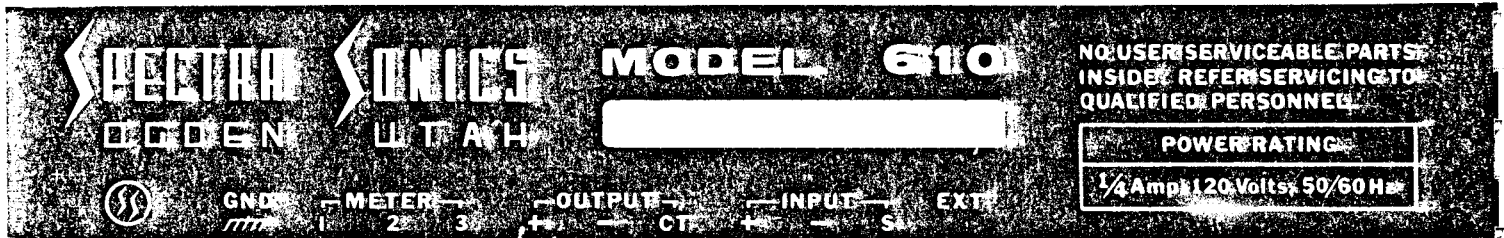


FIGURE 3

IDENTIFICATION PLATE AND BARRIER TERMINALS

Power Terminals (+ -)

The Model 610 "COMPLIMITER"TM is designed to operate from 120 VAC $\pm$ 10%, 60 Hz power source. There is provision (export version) for a transformer substitution and an internal switch (reference symbol: S2) to be mounted on the master printed circuit board allowing use of a 120 or 240 VAC, 50-60 to 400Hz AC power source. When this internal switch is in the "up" position the unit operates from the 120 VAC $\pm$ 10% source. Positive/negative orientation of the power source is not required. Power required to operate the unit is approximately 6 watts. Do not connect the unit to a power source with incorrect voltage or inadequate current rating.

Ground Terminal ()

It is important that these grounding instructions plus the grounding instructions in the following paragraphs, "input terminals" and "output terminals" be carefully followed for successful operation. The unit should be grounded by only one electrical path to the system ground in order to prevent ground loops, hum and maximize the signal-to-noise ratio of the system. When rack-mounted and the rack itself is connected to the system ground, the unit is grounded when it is placed in the rack and the chassis ground terminal must not be used. When the unit is mounted in an insulated rack, then the ground terminal must be connected to the central system ground.

Meter Terminals (1, 2, 3)

Normally the VU Meter in the Model 610 "COMPLIMITER"TM is used for monitoring, and meter terminals 1 and 2 must be externally strapped together. If an external meter is desired, the external strapping must be removed and the external meter is connected to terminals 1 and 3. Only one meter, internal or external, may be utilized at any one time.

Output Terminals (+, -, CT)

The output may be loaded with from 600 ohms to infinity. The output impedance is 6 ohms and thus minimizes, by two orders of magnitude, the high frequency capacitive attenuation and hum pick-up in cable runs from the compressor/limiter. Both balanced and unbalanced termination are illustrated in Figure 4.

Input Terminals (+, -, S)

The source impedance may vary from 0 ohms to infinity. The input impedance is 600 ohms. Unbalanced input termination is recommended and illustrated in Figure 4.

Unbalanced and Balanced Termination

Figure 4 illustrates the correct unbalanced or balanced termination of the Model 610 "COMPLIMITER"TM with the most common configuration of source or load cables and equipment. To assure optimum performance, complete shielding and grounding termination should be utilized exactly as shown.

The input and output terminals of the Model 610 "COMPLIMITER"TM are isolated, in order to be compatible with the widest range of equipment. The signal negative and shield of the source or load equipment should be grounded as shown in Figure 4. The CT terminal on the output of the Model 610 "COMPLIMITER"TM is only used when the balanced line cannot be grounded at the load transformer. The source ground, Model 610 "COMPLIMITER"TM ground and load ground must be individually connected to the system ground point.

External Terminal (EXT)

This terminal is utilized only with the special order optional part, 610-SI, Stereophonic Interconnection Network Accessory. The terminal and network provide combined stereo operation between two Model 610 "COMPLIMITER"TM units.

Dimensions and Mounting

The Model 610 "COMPLIMITER"TM is designed to fit a standard 19 inch electronics equipment rack, cabinet or console, and requires $3\frac{1}{2}$ inches of vertical rack space. The unit may be mounted in any position. The 4 oval cutouts on the ends of the front panel are provided for mounting. The front panel is $1\frac{1}{8}$ " x $3\frac{1}{2}$ " x 19". Behind the front panel, the unit is $3\frac{1}{2}$ " high, 17" wide and $8\frac{1}{2}$ " deep. The net weight is 10 pounds. The unit is completely self contained and does not require forced air cooling.

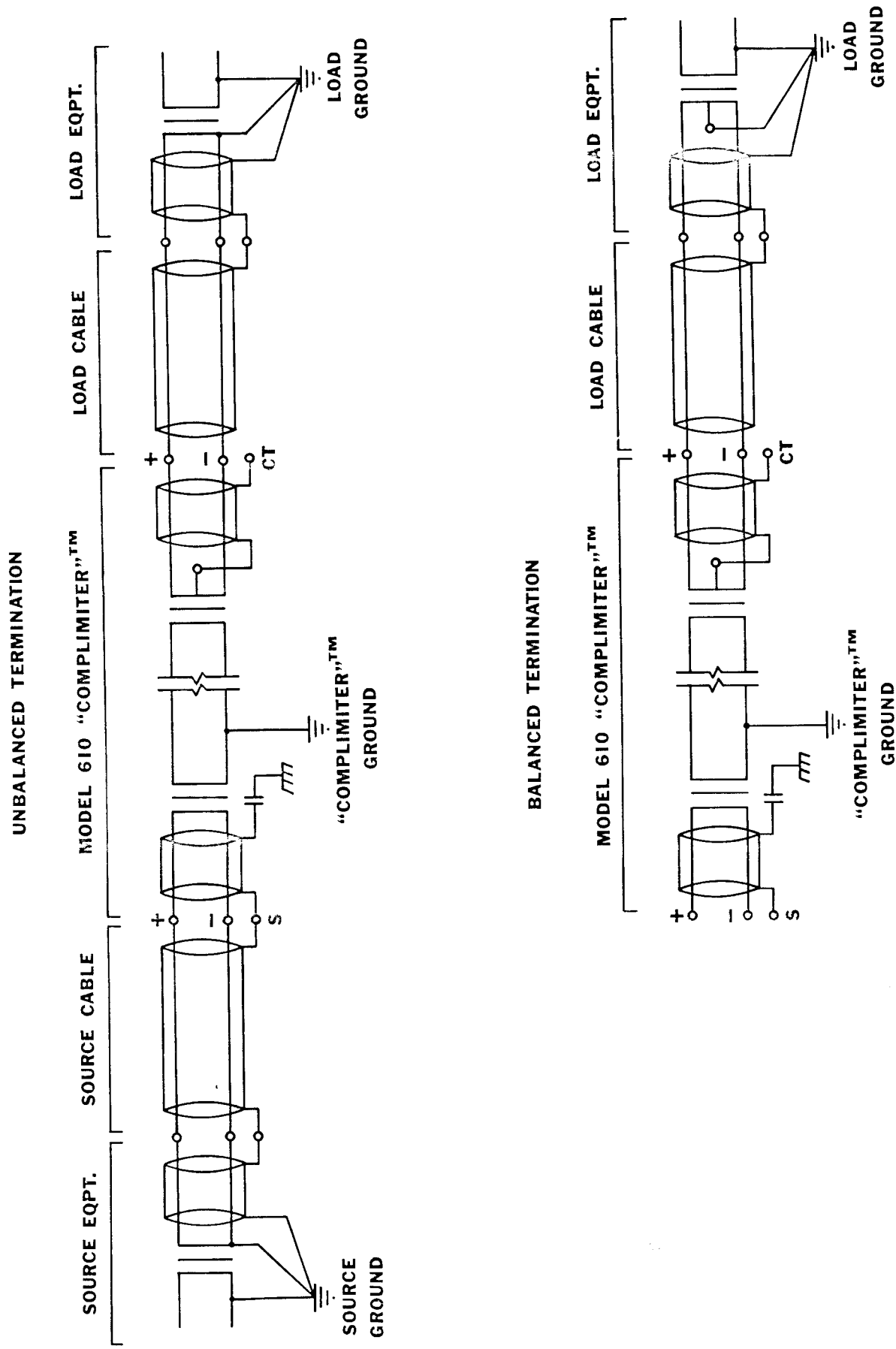


FIGURE 4

UNBALANCED AND BALANCED TERMINATION
SCHEMATIC FOR SOURCE/LOAD, EQUIPMENT/CABLING

ELECTRONIC DESIGN

General

This section is provided to give a better understanding of the internal system components and their design.

Design Schematics and Physical Layout

The Model 610 "COMPLIMITER"TM Block Schematic System Design (Figure 5) is presented first and followed by the circuit designs of the Model 605 Attack Indicator (Figure 6), Model 606 Overload Indicator (Figure 7) and Power Supply (Figure 8) sub-systems. The Physical Layout of the Master Printed Circuit Board (Figure 9) and the Correlation of Physical Layout Numbers with Reference Symbol/Description (Figure 10) are given for ease in locating the system and sub-system parts. All illustrations are labeled with reference symbols which correlate with prior discussions, and the following PARTS LIST section.

In the event of malfunction or failure due to some unavoidable damage, this design section may be used as a maintenance guide for the main system. However, it is recommended that the Model 101 Audio Amplifier, Model 601 Compressor/Limiter and Model 603A Gain Reduction Meter Amplifier plug-in modules be repaired only at the factory because of the precise and critical parameter requirements of the components utilized. Arbitrary insertion of standard components can cause catastrophic failure of the plug-in modules and should not be attempted. It is for this reason that the plug-in module schematics are not provided. Repaired products are tested to original operating specifications on the day received and returned immediately.



FIGURE 5

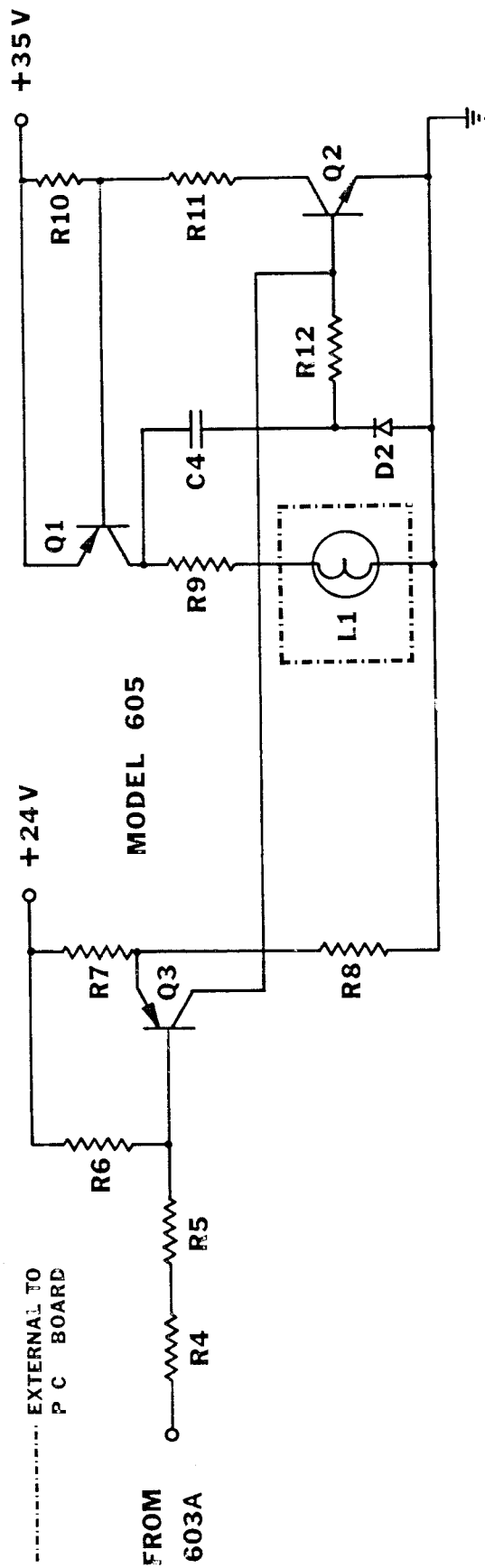


FIGURE 6
MODEL 605 ATTACK INDICATOR SCHEMATIC DESIGN

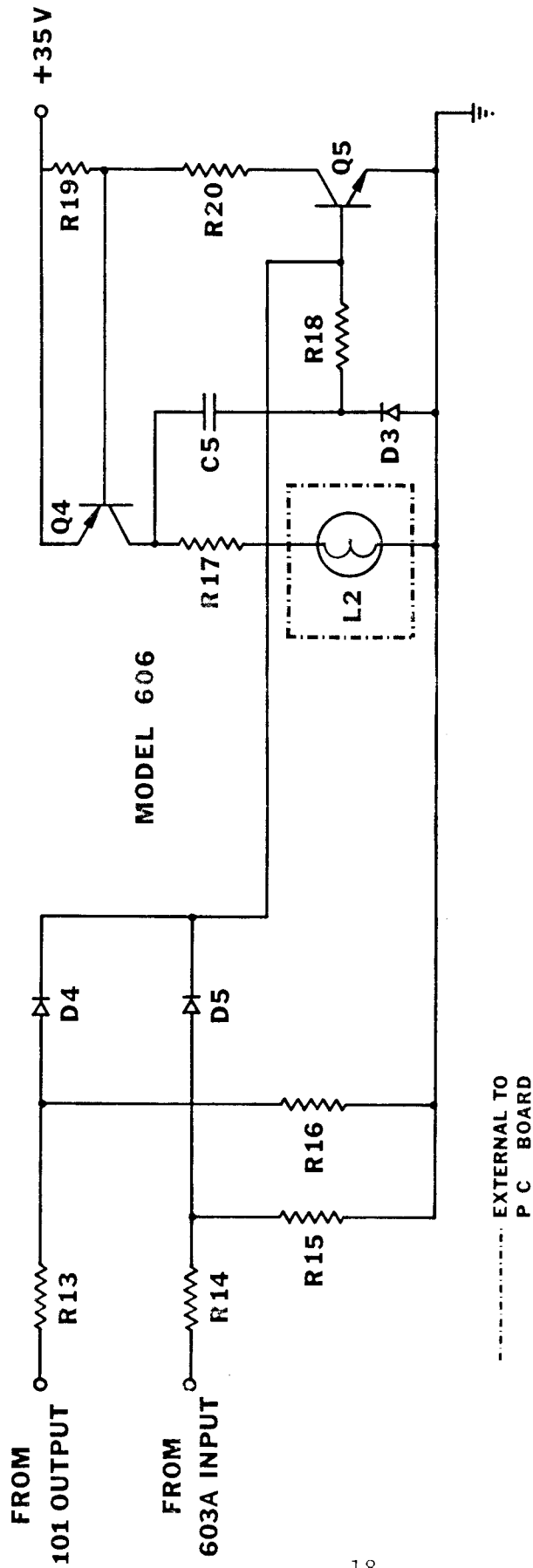


FIGURE 7
MODEL 606 OVERLOAD INDICATOR SCHEMATIC DESIGN

19

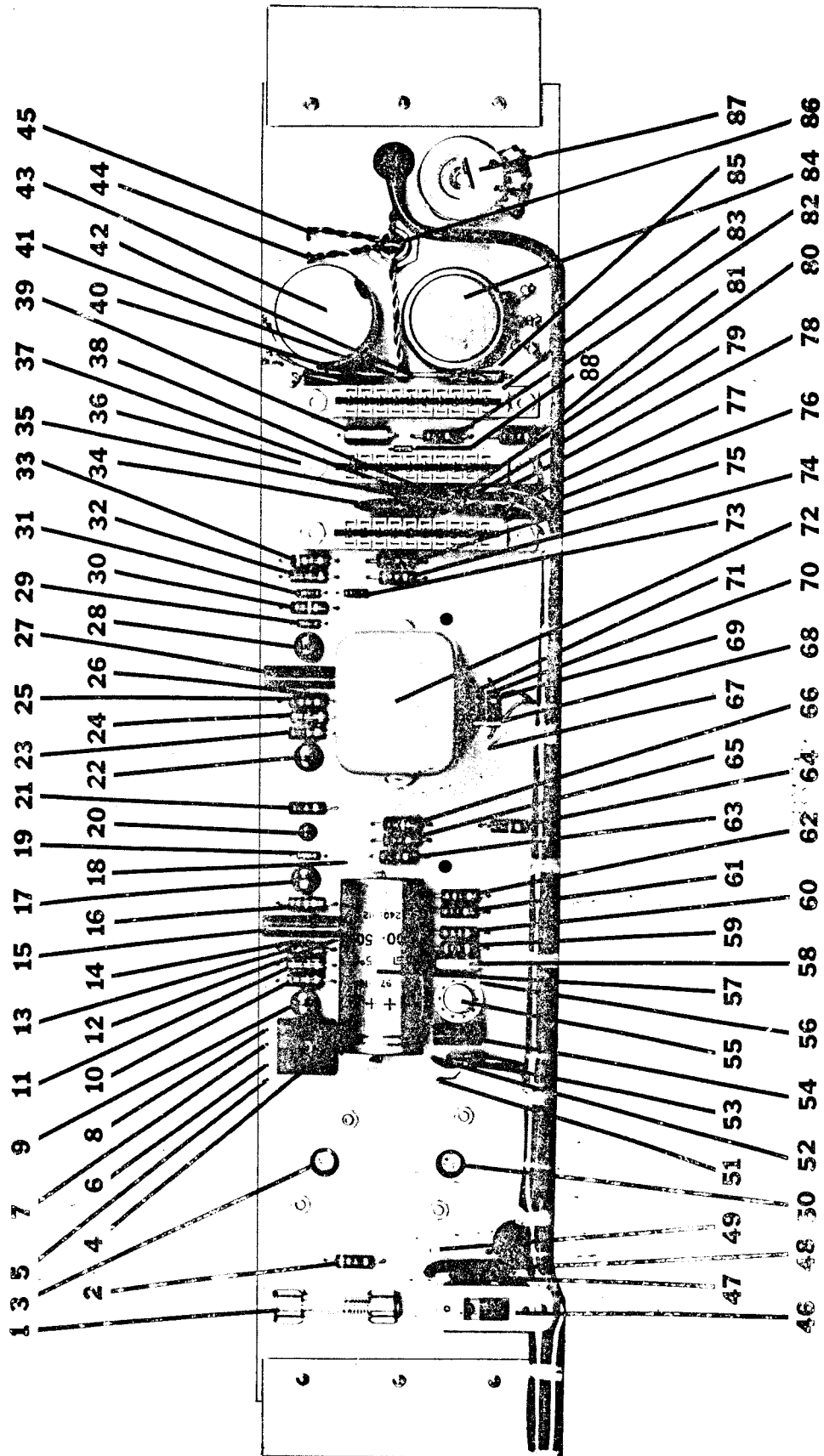


FIGURE 9
 PHYSICAL LAYOUT
 OF MASTER PRINTED CIRCUIT BOARD

LAYOUT NUMBER	REFERENCE SYMBOL DESCRIPTION	LAYOUT NUMBER	REFERENCE SYMBOL DESCRIPTION	LAYOUT NUMBER	REFERENCE SYMBOL DESCRIPTION
1	F1	31	D5	61	R25
2	R24	32	R15	62	R23
3	S3	33	R14	63	R7
4	D1	34	C6	64	R4
5	To VU Meter Lamp	35	Mod. 101 Input, +	65	R6
6	T3 Secondary	36	Model 601 Connector	66	R5
7	T3 Secondary	37	Model 101 Input, -	67	Output (T2) Terminal, Shield
8	To VU Meter Lamp	38	Model 101 Input, Shield	68	Output (T2) Terminal, +
9	O1	39	C7	69	Output (T2) Terminal, -
10	R10	40	To Model 603	70	R27
11	R11	41	Mod. 601 Input, Black & White	71	R26
12	To L1	42	Model 601 Input, Green	72	T3
13	R9	43	R30	73	D4
14	To L1	44	T2 Pri. CT, Orange & Green, Black	74	R13
15	C4	45	T2 Sec. CT, Blue & White, Red	75	R16
16	R12	46	S2 Export Models Only	76	Model 101 Connector
17	Q2	47	110 V AC Term, to T3	77	R28
18	To L2	48	110 V AC Term, to T3	78	Model 601 Output, +
19	D2	49	110 V AC from Bar. Terminal	79	Model 601 Output, -
20	O3	50	S1	80	Model 601 Output, Shield
21	R8	51	Meter Terminal 3, Shield	81	R22
22	Q4	52	Meter Terminal 1, -	82	R21
23	R19	53	Meter Terminal 2, +	83	Model 603 Connector
24	R20	54	C3	84	R29
25	R17	55	Model 410	85	R34
26	To L2	56	#10 Pin Locating Hole, Model 410	86	T2
27	C5	57	C1	87	R33
28	Q5	58	C2	88	R35
29	D3	59	R3		
30	R18	60	R2		

FIGURE 10
CORRELATION OF PHYSICAL LAYOUT NUMBERS
WITH REFERENCE SYMBOL/DESCRIPTION

PARTS LIST

General

To properly identify all parts utilized in the Model 610 "COMPLIMITER"TM, the following list is provided. Both physical and schematic identification of all major parts are additionally illustrated in the previous ELECTRONIC DESIGN section of this manual. Cross-reference is provided by the reference symbol.

Replacement Ordering Information

Should the unit become damaged in some manner, replacement parts may be ordered directly from the factory as per the EQUIPMENT WARRANTY section of this manual. Specify the part reference symbol, product model number and serial number, plus the quantity being ordered. For example, to order one replacement for the amber threshold LED indicator assembly, the order should read as follows:

L1, Model 610, S. N. XXX, 1 Required

Parts List

Reference Symbol	Description	Reference Symbol	Description
C1	Capacitor, 500uF, 50V	PCB-1	Printed Circuit Board, Master
C2	Capacitor, 6.8uF, 35V	PCB-2	Printed Circuit Board, VU Ill.
C3	Capacitor, .0047uF, 400V		
C4	Capacitor, .15uF, 50V	Q1	Transistor
C5	Capacitor, .15uF, 50V	Q2	Transistor
C6	Capacitor, .47uF, 12V	Q3	Transistor
C7	Capacitor, 6.8uF, 35V	Q4	Transistor
C8	Capacitor, .47uF, 12V	Q5	Transistor
C9	Capacitor, .047uF, 400V		
D1	Diode Bridge, 200V	R1	Resistor, 47 ohm
D2	Diode	R2	Resistor, 15kohm
D3	Diode	R3	Resistor, 6.2 kohm
D4	Diode	R4	Resistor, 510 kohm
D5	Diode	R5	Resistor, 510 kohm
F1	Fuse, ¼ Amp, 3AG	R6	Resistor, 3.9 Mohm
F2	Fuse Clips	R7	Resistor, 10 kohm
M410	Integrated Circuit	R8	Resistor, 20 kohm
ICS	Spreader for IC, 10 Terminal	R9	Resistor, 270 ohm
ICHS	Heat Sink for IC	R10	Resistor, 1 kohm
L1	LED, amber, Threshold	R11	Resistor, 10 kohm
L2	LED, red, Overload	R12	Resistor, 510 kohm
M1	VU Meter, 3½" X 2"	R13	Resistor, 75 kohm
MS	Spacers, 1"	R14	Resistor, 4.3 kohm
ML	Lamps, VU Meter Illumination	R15	Resistor, 10 kohm
		R16	Resistor, 10 kohm
		R17	Resistor, 270 ohm
		R18	Resistor, 510 kohm
		R19	Resistor, 1 kohm
		R20	Resistor, 10 kohm

Reference Symbol	Description	Reference Symbol	Description
R21	Resistor, 10 ohm	T1	Transformer, power, 110VAC, 60Hz
R22	Resistor, 15 kohm	T2	Transformer, Input
R23	Resistor, 3.6 kohm	T3	Transformer, Output, HS66
R24	Resistor, 4.3 kohm		
R25	Resistor, 10 ohm	610 MC	Main Chassis, cadmium plated
R26	Resistor, 910 ohm	610 C	Cover, cadmium plated
R27	Resistor, 910 ohm	610 B	Bracket, cadmium plated
R28	Resistor, 10.7 kohm		
R29	Potentiometer, 5 Mohm	610 FP	Front Panel, anodized
R30	Pot., Dual, 5 kohm, 50 kohm	610 K1	Small Knob, w/silver insert
R31	Potentiometer, 2.5 kohm	610 K2	Large Knob, w/silver insert
R32	Potentiometer, 600 ohm	610 IDP	Identification Plate, anodized
R33	Potentiometer, 2.5 kohm	610 BT	Barrier Terminal Strip
R34	Resistor, 8.2 kohm	610 CS	Card Holder/Stop
R35	Resistor, 1.2 kohm		
R36	Resistor, 3.9 ohm	Model 230	Card Connector, bifurcated 10 term.
		Model 101	Audio Amplifier
S1	Switch, Rotary, SP, 2 Pos.	Model 601	Compressor/Limiter
S3	Switch, Rotary, DP, 3 Pos.	Model 603A	Gain Reduction Meter Amplifier

Miscellaneous Items:

Machine Screws, Sheet Metal Screws, Nuts,
Internal Lock Washers, Miniature Shielded
Audio Cable, Connecting Wire, Soldering
Lugs, Grommets.

Optional Parts:

Reference Symbol	Description
610 SI	Stereophonic Interconnection Network Accessory

RELIABILITY

The Model 610 "COMPLIMITER"TM is manufactured to the highest quality standards and receives numerous intermediate quality control checks. A final inspection of each and every completed unit is then performed. If properly used, in accordance with the instructions in this manual, the Model 610 "COMPLIMITER"TM will meet your most exacting requirements.

Prompt warranty service is available from SPECTRA SONICS should you experience any difficulty in the operation of the equipment or should servicing of any kind be necessary. In addition, only the plug-in modules may need to be removed should damage be suspected.

EQUIPMENT WARRANTY

Model 610 "COMPLIMITER"TM

SPECTRA SONICS warrants the Model 610 "COMPLIMITER"TM against defective materials or workmanship for a period of one year from date of shipment to the original buyer as established by the purchase order and subject to the following provisions:

1. The liability of Seller under this warranty is limited, at Seller's option, solely to repair or replacement with equivalent SPECTRA SONICS equipment, at an appropriate credit adjustment not to exceed the original equipment sales price of equipment returned to the Seller, provided that: (a) Seller is promptly notified in writing by Buyer upon discovery of defects, (b) upon receipt of written authorization from Seller the defective equipment is returned to Seller, transportation charges prepaid by Buyer, and, (c) Seller's examination of such equipment discloses to its satisfaction that defects were not caused by negligence, misuse, improper installation, accident, or unauthorized repair or alteration by the Buyer.

2. This warranty does not include mechanical parts failing from normal usage nor does it cover limited life electrical components which deteriorate with age, such as lamps, etc.

Model 101 Audio Amplifier

As a direct result of time proven operational success in both performance and reliability, the Model 101 Audio Amplifier plug-in module is now unconditionally guaranteed by SPECTRA SONICS for a minimum period of two full years. If the Model 101 Audio Amplifier should become damaged, it will be repaired at no cost to the using Buyer and shipped on the same day received.

CALIBRATION

General

Each Model 610 "COMPLIMITER"TM is accurately quality checked and calibrated prior to shipment and is ready for operational use without additional adjustment.

The following adjustment procedures are provided for optimum accuracy should individual substitution of parts or other variations occur after the unit leaves the factory. As an example:

- a. For Model 603A substitution, Model 603A calibration steps 1,2,3,4,8 and 9 should be performed.
- b. When using an external VU meter, Model 603A calibration steps 1 and 3 should be performed.
- c. For Model 601 substitutions, all 9 of the Model 603A calibration steps should be performed.
- d. For Model 101 substitutions, Overload Lamp Calibration procedures may be performed if desired.
- e. When ambient temperatures significantly differ from approximately 75°F (factory calibration temperature), the Release Adjustment Control may have to be reset, following the Model 603A calibration procedure, steps 1, 4, 5 and 6. If the signal generator output level at threshold in step 6 is the same as previously determined in step 4, then the Model 603A is still calibrated, otherwise, steps 8 and 9 must also be performed.

Model 603A Gain Reduction Meter Amplifier and Release Adjustment Control Calibration

The Model 603A is one of three plug-in cards connected to the main printed circuit board and is mounted furthest from the meter. It contains three miniature rotary potentiometers (blue), numbered directly on the plug-in card (1, 2 and 3):

- Potentiometer #1 correlates VU meter first indication of gain reduction (compression) with actual Model 601 threshold point.
- Potentiometer #2 controls dc bias to "zero set" VU meter.
- Potentiometer #3 provides linearity adjustment to correlate VU meter readings with actual amount of gain reduction.

The Release Adjustment Control (R34) is a potentiometer located internally on the lower left of the main printed circuit board of the Model 610 "COMPLIMITER"TM. The bottom chassis cover must be removed to reach this control easily.

If extremely flat slope settings and fast release times are necessary, the release adjustment control may be set to zero resistance (fully counterclockwise when directly facing the system). For zero resistance the maximum slope will be approximately 100:1 and the minimum compressor release time will be approximately 5 milliseconds. Other settings will slightly increase the slope and increase the release time, and are preferred for most applications. For this latter case the release adjustment control is calibrated according to the procedure to follow.

Test equipment required for this calibration procedure consists of: 1. Signal generator to produce a 50 Hz sine wave with output level of 0.1 volt RMS,

(approximately -20 dB or more); 2. A VTVM meter to monitor the signal generator output; and 3. An oscilloscope or distortion analyzer. This last item may be omitted if step 5, the Release Adjustment Control setting, is not performed.

Step procedures for calibrating the Model 603A Gain Reduction Meter Amplifier and Release Adjustment Control are as follows:

1. Model 610 set up: Strap the Model 610 floating terminals (GND, input -, input shield, output -) together. Set the front panel controls as follows:
 - a. Power: On
 - b. Meter: GR
 - c. Slope: 0 (fully counter c.w., flat slope)
 - d. Release: 0 (Fully counter c.w. min. rel. time)

If the Release Adjustment Control (R33) is already calibrated, do not change the setting, otherwise set the control for zero resistance (fully counter c.w. when directly facing the stem).

2. B+ Voltage Check: The B+ voltage to the plug-in printed circuit cards should be approximately 23 to 25 VDC. The B+ is bussed for all three plug-in connectors and is the third connector terminal from the bottom.

3. GR VU meter "zero set" with no signal input: The VU meter requires about 30 minutes to temperature stabilize due to heat generated by its illumination. After the VU meter has stabilized, and with no signal input to the Model 610, set Model 603A Potentiometer No. 2 for a "0" dB gain reduction reading on the VU meter

4. Setting signal generator output level at threshold: In order to monitor the Model 610 signal output level with the VU meter on the unit (or external), reset the meter switch on +4 and set the output level control to a dial setting of approximately 18 (12 on detented versions). Using a signal generator, apply a 50Hz signal at 0.1 volt (-20 dB) or greater to the input terminals of the Model 610. Increase the 50Hz input signal (with either the generator control or the model 610 input level control) until the output signal, as monitored by the Model VU meter, stops increasing (threshold of Model 601 Compressor/Limiter plug-in card within Model 610). Note the reading and reduce the input signal level until the meter starts decreasing slightly. Again increase the input signal level until the meter reads 0.1 dB below the threshold point noted previously. Since the Model 603A is not yet completely calibrated, the threshold attack lamp may only approximately be used to indicate threshold.

The signal generator output level is now referenced to the exact threshold of the Model 610, and will be used as a reference for the remainder of the calibration steps. Caution: In the following steps, do not change Model 610 input level control. A VTVM or VU meter is needed to monitor this signal generator output level and it is important that this meter does not change the signal generator output after the threshold point is determined.

5. Release Adjustment Control setting to eliminate distortion: Increase the signal generator output level exactly 7.0 dB, thus providing a signal input to the Model 610 which is exactly 7.0 dB above threshold.

Using an oscilloscope or distortion analyzer on the output of the Model 610, increase the release adjustment control (clockwise rotation facing the stem) until the point of minimum distortion is reached. Then return the release adjustment potentiometer (counterclockwise rotation) to the point just before a rapid increase in distortion occurs (threshold of distortion). With an oscilloscope, the threshold of distortion is viewed as a flat spot, irregularity, etc. on or near the peaks of the sine wave. The release adjustment potentiometer shall be adjusted until this distortion just disappears. To maximize the system performance, the release adjustment potentiometer must not be set for minimum distortion, but for the threshold of distortion.

6. Resetting signal generator output level at threshold: Repeat step 4.

7. Slope and Release Control check: Decrease the signal generator output level exactly 3.0 dB, thus providing a signal input to the Model 610 which is 3.0 dB below threshold. The Model 610 VU meter (or external VU meter) should be set up (same as previous step) to monitor the Model 610 output.

Adjust the release control through its entire range while monitoring the Model 610 VU meter. If any downward change in excess of 0.5 dB is evident, the Model 601 Compressor/Limiter plug-in card should be replaced. With the unit covered, allow at least 5 minutes for any change to take place.

After setting the meter switch to GR, adjust the slope control through its entire range while monitoring the Model 610 VU meter. If a change in excess of 0.5 dB is evident, the Model 603A Gain Reduction Meter Amplifier plug-in card should be replaced.

8. GR VU meter "threshold set" with actual threshold point and linearity adjustment:

a. Increase signal generator output level to provide a signal input to the Model 610 which is exactly 1.0 dB above the threshold point determined in step 6 (this will also be 4.0 dB above the signal generator setting previously used in step 7 or 6.0 dB below the level used in step 8.b.) Set Model 603A Potentiometer #1 so the Model 610 VU meter (meter switch set on GR) indicates -1.0 dB (1.0 dB compression).

b. Increase signal generator output to provide a signal input to the Model 610 which is exactly 7.0 dB above the threshold point determined in step 6 (this will be 6.0 dB above the signal generator setting previously used in step 8.a.) Set Model 603A potentiometer #3 so the Model 610 VU meter (meter switch set on GR) indicates -7.0 dB (7.0 dB compression).

Repeat steps 8.a. and 8.b. until VU meter calibrates with the 1.0 dB and 7.0 dB input signal levels above threshold and then proceed to step 9.

9. GR VU meter "zero set" with no signal input: Repeat step 3. If the Model 603A Potentiometer #2 needed adjustment repeat step 8. If no adjustment was required and the meter was still "zero set" then the Model 603A Gain Reduction Meter Amplifier plug-in card is calibrated.

Overload Lamp

For the "Limiting and Compression with Additional Output Limiting" mode, the red overload lamp indication may be calibrated to exactly indicate the point of output amplifier limiting.

In this application, resistor R13 is removed from the master printed circuit board and approximately a 43 kohm resistor in series with a 100 kohm potentiometer is substituted in its place. Preferably using program material, the output is monitored with an oscilloscope to visually detect the exact level at which output amplifier limiting occurs and the 100 kohms potentiometer is adjusted so that the red overload lamp first illuminates at this peak limiting level. The indicating lamp must be set to turn on just slightly below the actual clipping point otherwise the lamp will not illuminate.

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