LPB

S-2 LIMITER-COMPRESSOR

INSTRUCTION BOOK

LPB

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520 Lincoln Highway
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INSTRUCTION MANUAL
S-2 COMPRESSOR/LIMITER

The LPB S-2 is a combined audio Compressor and Limiter designed for conditioning voice and music for transmission over media having limited dynamic range, such as recording tape, audio loops and AM and FM broadcasting. The LPB S-2 Compressor/Limiter compresses the dynamic range of the program material, thus elevating low signal passages above the background noise. The S-2 also limits the peak program power, thus preventing overmodulation distortion and enabling the use of higher average audio levels. Advanced state-of-the-art circuit design achieves this signal conditioning with almost imperceptible signal distortion.

Two or more LPB S-2 Compressor/Limiter units may be strapped together for high-quality two or four channel stereo recording or broadcasting operations.

The following discussions of audio compression and limiting, including several practical considerations and typical applications, should be of great value to the user in gaining a clear understanding of the unit and of how to apply it to maximum advantage.

APPLICATIONS OF AUDIO COMPRESSION

The perception of sound intensity by the human ear is logarithmic. This means that the difference in perceived intensity between tones of relative power 1 and 10 is the same as between tones of relative power 10 and 100.

To produce a wide range of stimulus, therefore, the dynamic range of music must be very large. Classical music easily has a dynamic range in excess of 80 db (100,000,000 to 1!). Semi-classical, folk and progressive rock music may have a dynamic range in the vicinity of 40 to 60 db (10,000 to 1 and 1,000,000 to 1), while popular, background and top-forty music has a dynamic range usually held to less than 30 db (1,000 to 1).

For the accurate reproduction of music, a dynamic range of between 1,000:1 to greater than 100,000,000:1 is clearly required. The inherent noise and distortion limitations of typical transmission and recording techniques limit their dynamic range to the lower end of this spread. Audio compression techniques can yield a very attractive solution to this dilemma by reducing the dynamic range of the program material being transmitted. Advanced circuits and components allow this dynamic range reduction of typical program material with very minimum degradation in quality. Several properties of sound perception can be utilized to successfully achieve this objective.

The human ear is very sensitive in the perception of sound intensity. This means that it is a very poor judge of absolute sound level or of slow changes in sound level. For this reason, most of the intensity information of music is contained in the envelope of individual notes and in the short term dynamics of individual phrases. The dynamic range found within these structures is also considerably less than the long term range in level within a particular composition. These long term shifts in level can be significantly attenuated with minimal perceptible degradation in the music being evident to the listeners.

The compressor portion of the LPB S-2 observes the envelope of the incoming program material, reproduces the short term dynamics unchanged, and attenuates the long term dynamic range by one half. Because we are referring to logarithmic quantities, this 50% attenuation of dynamic range can represent significant increase in effective signal power. For example, consider a composition with 55 db dynamic range. Approximately 40 db of this might represent the long term dynamics which will be attenuated by the compressor. The compressor output will have a dynamic range on the order of 35 db, which is 20 db less than that of the original signal. Otherwise stated, this is a change of dynamic range from 316,000:1 to 3,160:1 which is much more impressive than one half (in db). The lowest passages will have 20 db (or 100 times) more signal power with which to combat background noise through the system.

To more fully understand the application of compressor amplifiers, let us compare their characteristics to those of automatic level control amplifiers, which also reduce the dynamic range of program material. The objective of automatic level control amplifiers is the complete removal of all long term program level shifts. This tends to greatly attenuate long term dynamics of musical program material, leaving it to sound somewhat flat. (ALC amplifiers, such as those used in the recording circuits of small tape recorders, are generally oriented towards strictly voice material.) In

order to make their more severe attenuation of program dynamics more acceptable, the rate of level correction is kept very low. Most of the program dynamics are not significantly attenuated, thus little reduction in dynamic range is actually achieved.

Compressor amplifiers cannot remove program level errors. For example, if the level of a particular program source is incorrectly set 6 db below the nominal programming level (such as 0 VU on the console), the S-2 compressor will boost the incorrect level by only 3 db. Because of the action of the limiter section of the S-2, this level will probably be boosted somewhat more, as described later. However, this will also result in degraded limiter performance. The S-2 cannot be depended upon to remove program level (operator) errors or shifts.

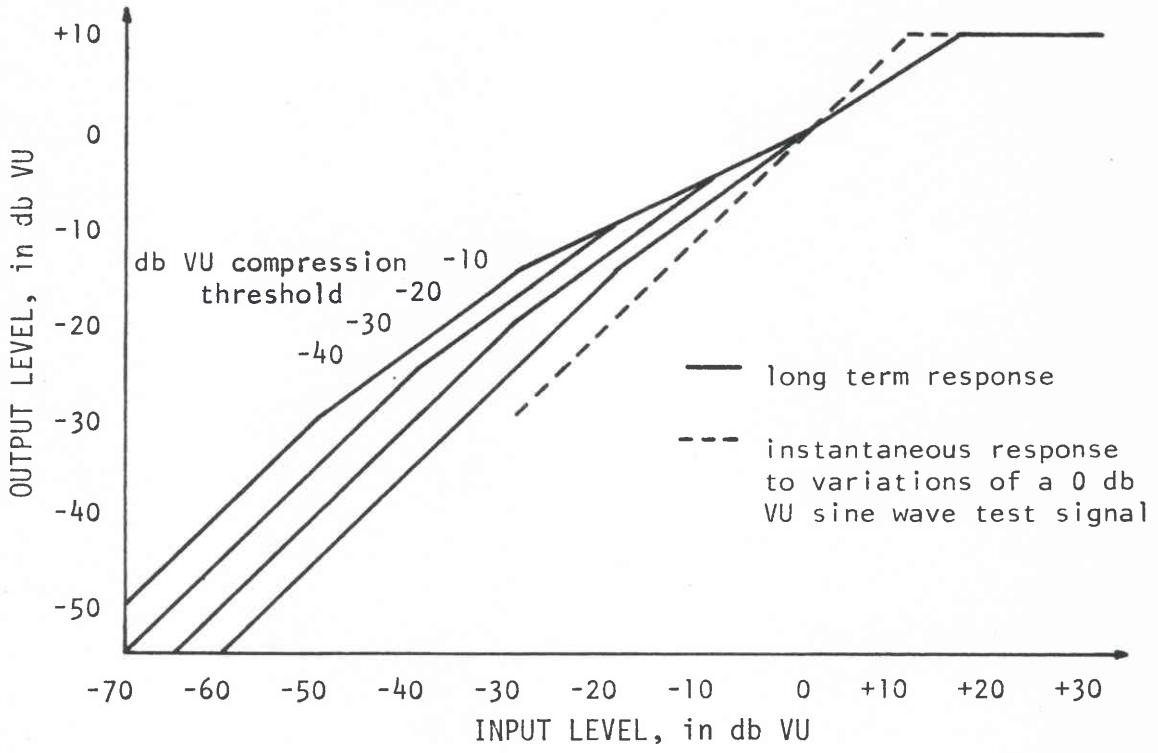
One inherent limitation of compressors is their propensity for increasing the background noise level of the programming source. In the preceeding discussion we have assumed that all of the background noise was introduced after the compressor. In practice this is not the case. Consider the example of a compressor being fed by program material from a magnetic tape deck. The nominal signal-to-noise ratio might be 50 db. During long silent periods, or very low level passages in the program material, the compressor would bring up the source background noises to as high as 25 db below the nominal program level. In almost all broadcasting situations, this noise level would be well above that of the transmission medium and would be intolerable.

To combat the problem of uncontrolled source noise enhancement, the LPB S-2 has a variable compression threshold. This threshold sets an input signal level below which further reduction in input will result in equal reduction of output. Above this threshold, normal compression takes place as described above. That is, any long term input level shift will produce only one half that shift in output. Let us now re-examine the previous example of a 50 db source signal-to-noise ratio and assume 0 db VU nominal signal levels. If the S-2 compression threshold is set at -40 db VU, the minimum output signal-to-noise ratio would be 40 db. Minimum output signal-to-noise ratios for other input signal-to-noise ratios and compression threshold settings can be obtained from the solid line curves of Figure One. For optimum operation, the compression threshold should be set so that the expected minimum output signal-to-noise ratio is equal to the ratio of signal-to-noise introduced into the program material after the compressor. If the program is being transmitted, this noise level should include the noise introduced in transmission.

The LPB S-2 compressors have provision for strapping several units together for multi-channel operation, such as two-or four-channel stereo FM broadcasting or recording. Strapping is achieved by connecting the strapping terminal of each channel's compressor together with a shielded cable. The shield braid should be grounded at each compressor. Once strapped, all compressors will introduce identical compression on each other's signal. Many circuit components are of high precision to insure this identical operation. This prevents shift in signal balance during compression. For multi-channel operation, the input level, output level and compression threshold settings should be identical on all compressors.

Figure One

S-2 TRANSFER CHARACTERISTICS



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APPLICATIONS OF AUDIO LIMITING

Limiting can be used to advantage in several ways when conditioning audio signals. Perhaps the most important application is the prevention of overload of the transmission equipment. In AM transmission, the resulting overmodulation produces obvious listener distortion and splattering of the signal into adjacent broadcast channels. In magnetic tape recording and long distance radio transmission circuits, the overload generally appears as severe intermodulation distortion. Normally this overload is prevented by adjusting the signal level to a conservative value so that the occasional high signal peaks do not distort. With limiting, the requirement of this safety margin can be eliminated, hence the signal level can be run 3 to 5 db higher without fear of overload distortion.

Limiting is particularly important when audio compression is used. Compressors occasionally get fooled into boosting the level of peak signal passages, thus producing more possibilities for overload. If the LPB S-2 compressor did not have a built-in limiter, it's compression range would have to be appreciably reduced to protect the user who might not also be utilizing a limiter.

Limiting can be further applied to clip the level of normal audio peaks. In this manner, an additional 2 to 4 db increase in the average signal level can be achieved without danger of overload and with a very acceptable minimum of quality degredation. The amount of increase in average level which can be achieved by limiting depends upon the program content. Speech is very tolerant of limiting, making as much as a 6 db increase in average level quite possible. In part, this accounts for the apparent increase in volume level of some broadcast stations during the voice commercials and announcements. Percussive instruments, such as cymbals, are least tolerant to limiting. Limiting of 6 db would noticably dull the crash of a cymbal and cause an imbalance in comparison with instruments having fewer overtones. In any case, the increase in average signal level achieveable with high quality limiters, such as incorporated in the LPB S-2, is aurally plainly evident.

The S-2 limiter prevents the peak power of it's output signal from exceeding +11 db VU. It does this by instantaneously reducing gain until the peak signal amplitude does not exceed +11 db. A single swift reduction in gain produces a minimum of perceptable signal degradation. After the peak passes, the gain is returned to normal at a constant rate of 10 db per second. This is the fastest recovery rate which can be used without producing excessive and noticable signal distortion.

A limiting level of +11 db VU was chosen for the LPB S-2 because this is approximately the peak-to-average signal power ratio of speech or music with an average content of overtones. If the input signal level to the S-2 were slowly increased until the signal peaks were just reaching the 0 db VU level, no limiting action would take place unless an abnormally high signal peak occured. If the input level were decreased by 6 db, the average power of the signal peak coming out of the compressor section would be +3 db VU. The limiter section of the S-2 would then limit the signal peaks to an average level of 0 db VU, resulting in 3 db limiting.

EXAMPLES OF APPLYING THE LPB S-2 COMPRESSOR/LIMITER

Perhaps the best way to fully understand the application of the LPB S-2 Compressor/Limiter is to review several specific applications. The application to the conditioning of signals for AM transmission, magnetic tape recording and automatic announcer talk-over are considered.

AM TRANSMISSION:

When conditioning program material for AM transmission, the transmitter input gain control and/or the S-2 output level control should be adjusted so that 100% modulation occurs at the point of limiting. This can best be done by applying a 1 kHz test tone to the input of the S-2 with sufficient level (approximately +18 db VU) to cause the S-2 to limit. If this is not convenient, a test tone level of only 0 db VU can be used if the compression threshold is set to -40 db VU and the compressor strap terminal is temporarily grounded. The transmitter gain controls can now be adjusted for 100% modulation.

The AM broadcast medium has an inherently poor signal-to-noise ratio, perhaps in the order of 30 db. To offset this, a large amount of compression can be used. If the program content is predominantly classical, and if the studio signal is very clean, a -40 db compression threshold can advantageously be used. On the other extreme, if the program content is predominantly top 40, the program content already has little dynamic range, but is more amenable to limiting. The average transmission signal level could be advantageously increased by the following procedure. Adjusting the studio output level and/or the S-2 nominal input level control, set a 0 db VU studio signal at approximately +8 db VU input level at the S-2. This would produce 4 db of limiting which should be quite acceptable under most situations. The compressor threshold should be set to -10 db to minimize the enhancement of studio background noise.

MAGNETIC TAPE RECORDING:

When conditioning program or live material for magnetic tape recording, the situation is considerably different. Tape has typical signal-to-noise ratios in excess of 50 db. This is usually only slightly more noisy than the best studio or program sources so that compression thresholds of -10 db or at most -20 db should be used. With a live recording in a very quiet studio, a compression threshold of -40 db is perhaps useful.

The tape saturation level across most of the low and medium frequency band is +12 db VU recording level for most tape recorders. Hence, proper peak limiting can be achieved by adjusting the tape recorder input and/or the S-2 output level control, so that 0 db VU output from the S-2 equals 0 db VU recording level. Because of the protection against peak distortion afforded by the limiter, an average S-2 input level of a full 0 db VU can be safely used.

ANNOUNCER TALK-OVER:

The limiter can be used to advantage in a different way in an automated announcer talk-over system. The object of such a system is the reduction of the music or other program material level by 8 db when the announcer speaks. This can be achieved, using the LPB S-2, by running the average program material input level to the S-2 at 0 to -2 db VU. The signal will not be limited, and can be compressed as desired. The announce microphone gain is now set for an announcer level 8 db higher than the program signal. By a combination of limiting and compression, the S-2 will reduce the announcer level to 0 db VU, and at the same time instantaneously reduce the program material level by 8 db. The 3 or 4 db of limiting applied to the announcer's voice signal is generally advantageous. When the announcer stops talking, the program signal level is brought up to normal level at a near optimum rate.

S-2 INSTALLATION

The LPB S-2 Compressor/Limiter is designed to mount in a standard 19" relay rack and requires 3 1/2" vertical rack space. Mounting screws and plastic cup washers are provided. Input and output connections are clearly marked on the rear of the unit. For a high impedance bridging input, connect the input to INPUT R and BR terminals. For a 600 ohm input, place a strap between INPUT T and BR and connect to INPUT R and T. The output is connected to OUTPUT R and T and is 600 ohms balanced. Input and output cable shields should be connected to the GND terminal. The COMP STRAP terminal is used to strap two or more units together for multi-channel operation as described previously. The power cord must be plugged into a standard grounding three-wire duplex receptacle providing 117 volts 50-60Hz AC.

EQUIPMENT GUARANTEE

Upon receipt of this equipment, we guarantee that you will find the appearance, workmanship and standards of material and construction in keeping with the application and with good standards of commercial practice. For a period of one year from date of delivery, we guarantee this equipment against any form of failure, provided that, in the opinion of the manufacturer, no improper use of or modification to this equipment is at fault. During that period, we will furnish the labor and materials in our shops to correct any malfunction without charge. Shipping charges are not included in this guarantee.

If need for service arises, contact the manufacturer for permission and instructions to return the equipment BEFORE shipping. We assume no liability for damage which may occur in the return of equipment for repairs as a result of faulty packing. It is clearly wise to retain the original shipping carton.

Prompt delivery of replacement components for out-of-warranty equipment is always available from the factory, as is service.

S-2 SPECIFICATIONS

Input	Type	Balanced or bridging
	Impedance, terminated	600 ohms
	" bridging	greater than 13K ohms
	Nominal (0 VU) level	+8, 6, 4, 2, 0 or -2 dbm
	Maximum level	+32 dbm
	Max. common mode signal	+28 dbm (see notes 1, 2 & 3)
	Equiv. hum and noise	less than -70 dbm (see 1, 2 & 4)
Limiter	Attack time	Instantaneous
	Recovery rate	10 db per second
	Limiting point	+11 db VU peak above nominal output
Compressor	Compression slope	2:1 in db
	Compression threshold	-40, -30, -20 or -10 db relative nominal input (see 5)
	Attack time constant	660 msec.
	Recovery rate	2 db per second
	Multichannel operation	No limit

Response	30Hz to 10kHz	+0, -0.25 db (see 2 & 6)
	20Hz to 20kHz	+0, -1.0 db (see 2 & 6)
Distortion	at 0 db VU output	less than 0.2% @ 1kHz
	at +6 db VU output	less than 0.2% @ 1kHz (see note 1 for both)
Output	Type	Balanced
	Impedance	600 ohms
	Nominal (0 db VU) level	+8, 6, 4, 2, 0 or -2 dbm

Level monitoring — 3 1/2" VU meter across output attenuator.

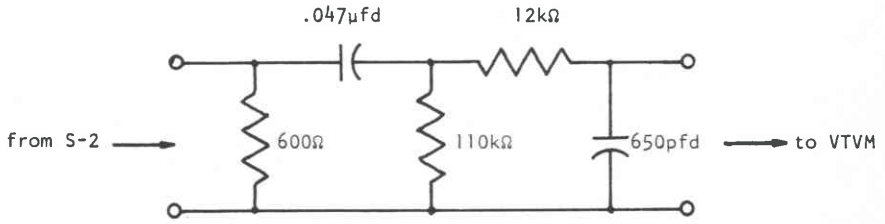
Controls — Nominal input level, compression threshold and nominal output level, on front panel.

Size — Standard 19" rack panel, 3 1/2" high and 4 1/4" deep behing panel.

Power input — 105 to 135 volts AC at 60Hz, 6 watts.

Notes:

(1) Measured using the following terminating/band limiting network between output terminals and a high impedance floating input wide-bandwidth VTVM:



(2) Compression inhibited by shorting compressor strapping terminal to ground; limiting inhibited by maintaining less than +6 db VU output level.

(3) Source impedance unbalance to ground less than 300 ohms.

(4) Input terminals shorted to ground at terminal board.

(5) Below this threshold the compression slope reverts to 1:1 to avoid increasing input or background noise during quiet passages.

(6) Gain relative to 1kHz gain.

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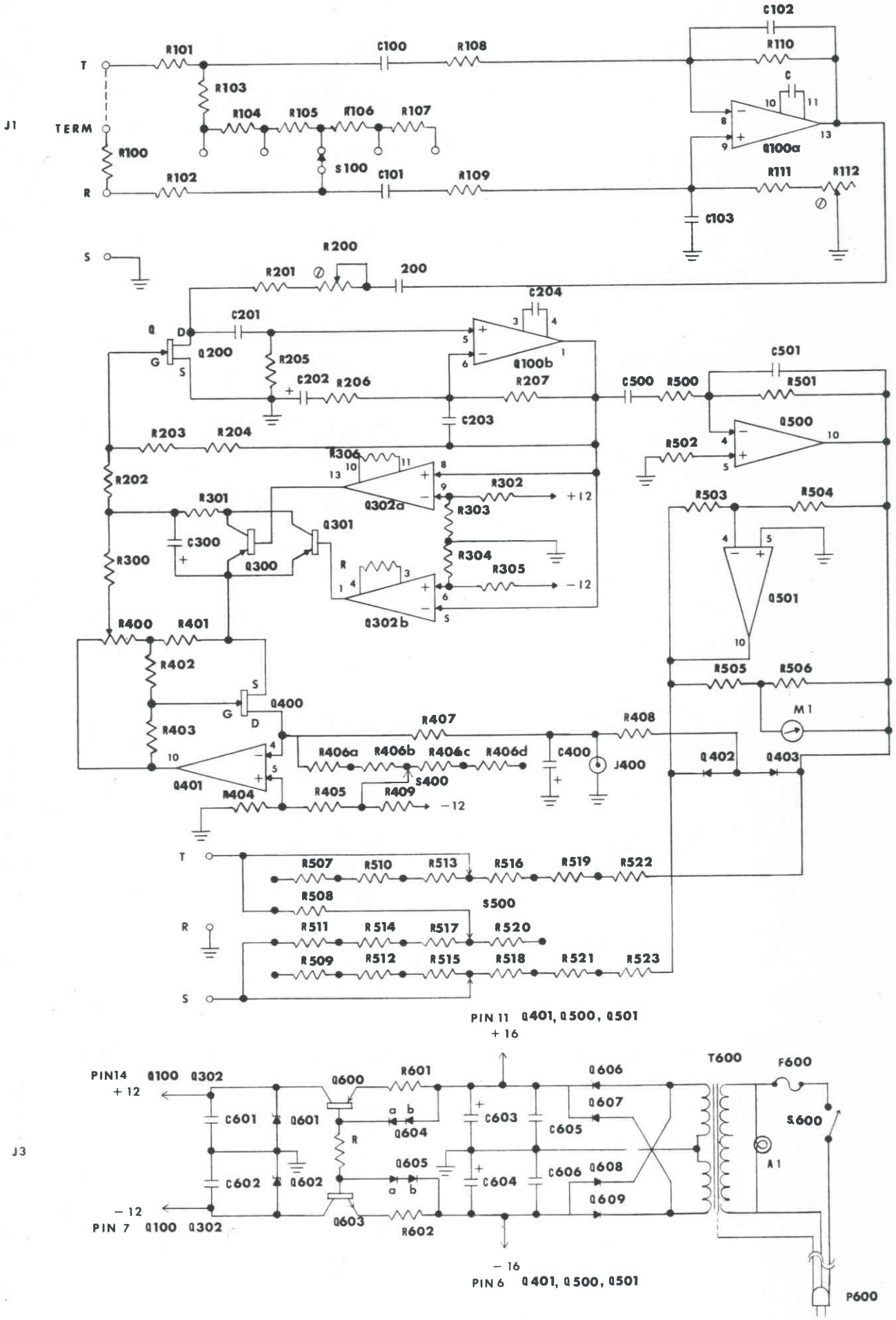
S2 AUDIO COMPRESSOR/LIMITER



S-2 AUDIO COMPRESSOR/LIMITER

PARTS LIST

R100	620 Ω, 1/4 w., 5% car.
R101	4530 Ω, 1/4 w., 1% MF
R102	4530 Ω, 1/4 w., 1% MF
R103	4220 Ω, 1/4 w., 1% MF
R104	1800 Ω, 1/4 w., 5% car.
R105	3300 Ω, 1/4 w., 5% car.
R106	6200 Ω, 1/4 w., 5% car.
R107	20K Ω, 1/4 w., 5% car.
R108	221K Ω, 1/4 w., 1% MF
R109	221K Ω, 1/4 w., 1% MF
R110	71.5K Ω, 1/4 w., 1%MF
R111	69.8K Ω, 1/4 w., 1% MF
R112	5K Ω, 1/4 w., 20% cer. pot.
R200	100K Ω, 1/4 w., 20% cer. pot.
R201	68K Ω, 1/4 w., 10% car.*
R202	51.1K Ω, 1/4 w., 1% MF
R203	5.1M Ω, 1/4 w., 5% car.
R204	5.1M Ω, 1/4 w., 5% car.
R205	330K Ω, 1/4 w., 5% car.
R206	3320 Ω, 1/4 w., 1% MF
R207	332K Ω, 1/4 w., 1% MF
R300	820K Ω, 1/4 w., 5% car.
R301	470 Ω, 1/4 w., 10% car.
R302	9310 Ω, 1/4 w., 1% MF
R303	2740 Ω, 1/4 w., 1% MF
R304	2740 Ω, 1/4 w., 1% MF
R305	9310 Ω, 1/4 w., 1% MF
R306	4700 Ω, 1/2 w., 5% car.
R307	4700 Ω, 1/2 w., 5% car.
R400	100K Ω, 1/4 w., 20% cer. pot.
R401	47K Ω, 1/4 w., 10% car.
R402	33K Ω, 1/4 w., 10% car.
R403	68K Ω, 1/4 w., 10% car.
R404	100 Ω, 1/4 w., 5% car.
R405	1910 Ω, 1/4 w., 1% MF
R406A	162K Ω, 1/2 w., 1% MF
R406B	127K Ω, 1/2 w., 1% MF
R406C	221K Ω, 1/2 w., 1% MF
R406D	392K Ω, 1/2 w., 1%MF
R407	40.2K Ω, 1/4 w., 1% MF
R408	40.2K Ω, 1/4 w., 1%MF
R409	10K Ω, 1/4 w., 1% MF
R500	49.9K Ω, 1/4 w., 1% MF
R501	124K Ω, 1/4 w., 1% MF
R502	120K Ω, 1/4 w., 5% car.
R503	10K Ω, 1/4 w., 1% MF
R504	10K Ω, 1/4 w., 1% MF
R505	11300 Ω, 1/4 w., 1% MF
R506	5230 Ω, 1/4 w., 1% MF
R507	200 Ω, 1/4 w., 5% car.
R508	887 Ω, 1/4 w., 1% MF
R509	200 Ω, 1/4 w., 5% car.
R510	154 Ω, 1/4 w., 1% MF
R511	110 Ω, 1/4 w., 5% car.
R512	154 Ω, 1/4 w., 1% MF
R513	124 Ω, 1/4 w., 1% MF
R514	200 Ω, 1/4 w., 5% car.
R515	124 Ω, 1/4 w., 1% MF
R516	97.6 Ω, 1/4 w., 1% MF
R517	430 Ω, 1/4 w., 5% car.
R518	97.6 Ω, 1/4 w., 1% MF
R519	76.8 Ω, 1/4 w., 1% MF
R520	1300 Ω, 1/4 w., 5% car.
R521	76.8 Ω, 1/4 w., 1% MF
R522	301 Ω, 1/4 w., 1% MF
R523	301 Ω, 1/4 w., 1% MF
R601	2700 Ω, 1 w., 10% car.
R602	15 Ω, 1/4 w., 5% car.
R603	15 Ω, 1/4 w., 5% car.

C100	0.15 µf 10%, 200 v., mylar
C101	0.15 µf, 10% 200 v., mylar
C102	27 pf, 5% mica
C103	27 pf, 5% mica
C104	.01 µf, disc
C200	1 µf, 10%, 50 v., tant.
C201	0.15 µf, 10%, 200 v., mylar
C202	15 µf, 15 v., ±10%, tant.
C203	12 pf, 10%, disc
C204	2200 pf, disc
C300	1 µf, 10%, 50 v., tant.
C400	33 µf, 10%, 6 v., tant.
C500	1 µf, 10%, 50 v., tant.
C501	8 pf, 5% mica
C601	0.1 µf, 25 v., disc
C602	0.1 µf, 25 v., disc
C603	1000 µf, 25 v., electrolytic
C604	1000 µf, 25 v., electrolytic
C605	0.1 µf, 25 v., disc
C606	0.1 µf, 25 v., disc

* Nominal value, actual value chosen at factory to meet system requirements.

Q100	Dual op-amp MC1303L
Q200	Volt. controlled res. 2N5459
Q300	Switch 2N3906
Q301	Switch 2N3906
Q302	Dual op-amp MC1303L
Q400	Volt. controlled res. 2N5459
Q401	Op-amp MC1741G
Q402	Diode, GE 1N100
Q403	Diode, GE 1N100
Q500	Op-amp MC1741G
Q501	Op-amp MC1741G
Q600	Transistor, MPS-U52
Q601	Diode, Zener, 1N4742A, 12 v.
Q602	Diode, Zener, 1N4742A, 12 v.
Q603	Transistor, MPS-U02
Q604A	Rectifier 1N4002, 1A/100 v.
Q604B	Rectifier 1N4002, 1A/100 v.
Q605A	Rectifier 1N4002, 1A/100 v.
Q605B	Rectifier 1N4002, 1A/100 v.
Q606	Rectifier 1N4002, 1A/100 v.
Q607	Rectifier 1N4002, 1A/100 v.
Q608	Rectifier 1N4002, 1A/100 v.
Q609	Rectifier 1N4002, 1A/100 v.

S100	1 pole 6 pos. shorting, 3126J Mallory
S400	1 pole 4 pos. shorting, 3134J Mallory
S500	3 pole 6 pos. shorting, 3136J Mallory
S600	1 pole 2A 250 v. toggle

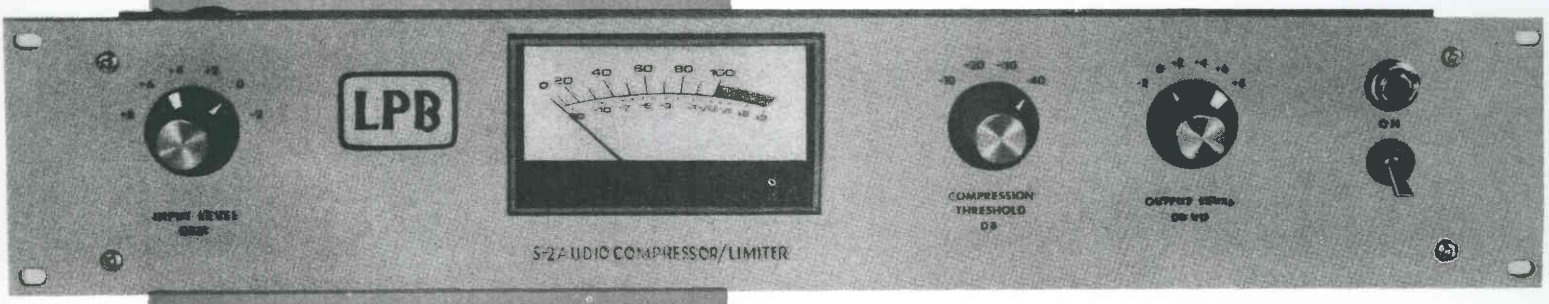
F600	1/8 A, 250 v., 3AG-1/8

M500	ASA Std. VU meter, Modutec

T600	120 v./25.6 v., 150 MA Jensen C10122

B600	Drake indicator light

THE NEW LPB S-2 AUDIO COMPRESSOR/ LIMITER



...the two-in-one unit for about half the price you'd expect to pay

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The LPB S-2 Audio Compressor/Limiter is exactly what its name says: a combination compressor and limiter designed for conditioning both voice and music signals for transmission over media having limited dynamic range. With the capability to compress the dynamic range of the program material, thus elevating low level passages above the background noise, and with the capability to limit the peak program power, thus preventing over-modulation distortion and enabling the use of higher average audio levels, LPB's S-2 achieves two important companion objectives in a single package.

SPECIFICATIONS

LIMITER

Attact time constant . . . instantaneous
Recovery time 10dB/second
Absolute limiting point . +11dB VU peak power

COMPRESSOR

Attact time constant . . . 0.66 seconds
Recovery rate 2dB/second
Compression rate . . . . . 2:1 dBΔPin/ΔPout
Compression threshold . variable −40 to −10dB VU

Specifications on the LPB S-2 Audio Compressor/ Limiter

Maximum input signal .....+24dB VU

Output noise .....at least −65dB with no input

Distortion at max. output ..less than 0.25%

Frequency response .....−0.7dB at 20Hz and 20kHz

Common mode rejection ..minimum of 60dB

Input impedence .....600 Ω balanced or 13k ohms bridging

Output impedence .....600 Ω balanced

Input attenuator .....variable, +8dBm to −2dBm

Output attenuator .....variable, −2dBm to +8dBm

Electronics .....all silicon solid state with regulated power supply and precision resistors in critical circuits.

Power requirements .....10 watts, 105-135 VAC, 60Hz

Size .....3½ inch standard relay rack, 4 inch depth

The above specifications may be changed at the discretion of the manufacturer as long as performance is not degraded.

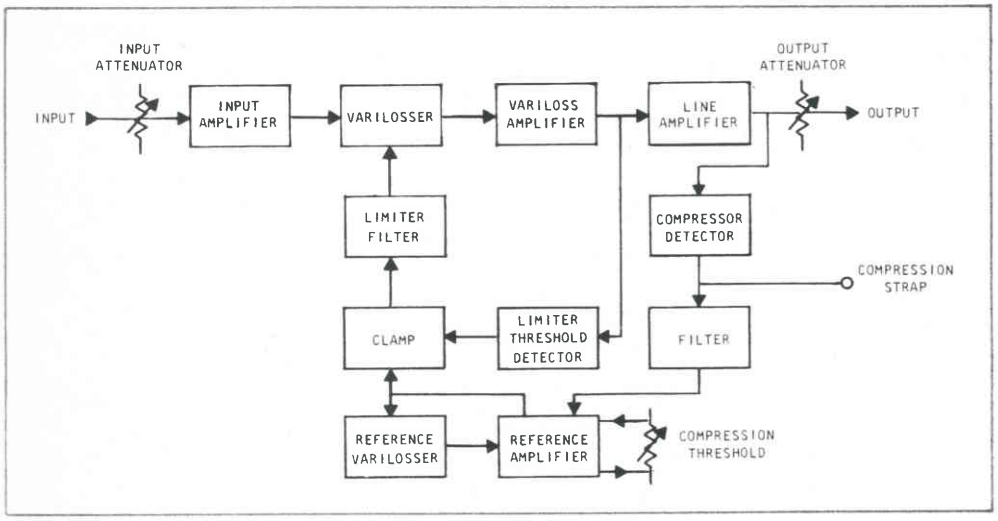
OPTIONS (no charge):

1. Internal pre-emphasis and de-emphasis for more realistic compression and limiting with FM broadcasting.

2. Internal asymmetrical peak limiting to permit 120% AM modulation on positive peaks.

multi-channel operation strapping provision in all S-2's.

The S-2 Audio Compressor/Limiter is just one of the many products manufactured for and distributed to the Broadcast profession by LPB Inc. For a complete product list, as well as additional information on the S-2, call or write LPB at the address shown below. All LPB products are available immediately from stock. All prices F.O.B. Frazer, Pa.



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