SMP-900
STEREO MATRIX PROCESSOR

INSTALLATION AND OPERATION MANUAL

Circuit Research Labs, Inc.
2522 W. Geneva Drive
Tempe, Arizona 85282 U.S.A.
602-438-0888

SMP-900

AM STEREO MATRIX PROCESSOR

INSTALLATION AND OPERATION MANUAL

CIRCUIT
RESEARCH
LABS. INC. 2522 W. Geneva Drive, Tempe, AZ 85282 1-602-438-0888

P/N 10140 DWNG 11-9000-01

TABLE OF CONTENTS

LIST OF ILLUSTRATIONS

Figure

SECTION 1 - INSTALLATION

1.1 INTRODUCTION

This manual provides information on the theory of operation, installation, and alignment for the CRL AM-2S and AM-4S STEREO MATRIX processing systems which use "stereo-strapped" 2 band AGCs, independent "non-strapped" monaural support 4 band compressors (AM-4S only), and the SMP 900 matrix processor which provides monaural support and a combination of limiting and clipping.

NOTE: This entire section of the manual should be read carefully before attempting to install this unit. AM Stereo concepts are not the same as FM Stereo. Experience has shown that if the following procedures are not followed in exact order, the installation will end up in failure and frustration. Many of the techniques employed in the design of this equipment are entirely new. READ THIS ENTIRE MANUAL BEFORE ATTEMPTING INSTALLATION.

1.2 AM STEREO THEORY

PROCESSING REQUIREMENTS EXPLAINED

First, it is important to understand the reason for matrix type limiting and what it specifically means to AM STEREO broadcasting. It is used to improve AM STEREO versus AM MONAURAL compatibility. AM STEREO/MONAURAL transmission is NOT REALLY as COMPATIBLE as compared to their FM counterparts when separate left and right FM type limiting is employed.

Much of the following information has been obtained with the invaluable help of the kind people at the research laboratories of Magnavox and Motorola. However, the findings and viewpoints expressed herein are only based on the research for CRL.

FM STEREO AND LIMITING

In FM stereo transmission, the left and right channel information can be fundamentally described as sent via the same transmission path during equal and alternate time periods. At any instant in time, the total modulation is equal to the summation of the audio channel being transmitted and the fixed amplitude stereo pilot. When properly balanced, this system results in the 100% left channel only, 100% right channel only, and 100% both channels (monaural during stereo) audio limits being equal to each other. This has formed the basis for the separate left and right channel limiting requirements which limit both channels to the same amplitude.

AM STEREO/MONAURAL COMPATIBILITY

AM STEREO broadcasting has brought about a need for a different form of stereo audio limiting. It is called stereo "matrix" limiting because the processing action has been shifted to the matrixed sum and difference axis of the stereo sound field. This method significantly differs from the previous FM "conventional" types which operate on the left and right channel axis.

It is important to understand why matrix processing is needed for AM stereo broadcasting. Its use is essential in achieving monaural versus stereo transmission compatibility. In AM stereo, the algebraic sum and difference of left and right channels occur PRIOR to the points of the modulation. This difference as compared to FM stereo transmissions is what makes conventional audio processing incompatible and matrix processing necessary.

AM STEREO LIMITING PATTERNS

The diagrams presented on page 6 are in a form which can easily be seen on an oscilloscope when monitoring the X-Y lissajous patterns produced at the right and left outputs of the station's limiters or stereo modulation monitor. If the limiters have L+R and L-R outputs instead, the patterns at these outputs will be shifted counter clockwise by 45 degrees from those illustrated. Field experience has shown that once familiarity with these patterns is gained, they are often more helpful in checking for proper processing alignment and show more information about what is being transmitted than any modulation monitoring system.

CONVENTIONAL LIMITING

Figure 1-1 illustrates the oscilloscope X-Y display of the right and left limiter outputs of conventional stereo limiting. When applied to AM stereo transmissions, the amplitude limit levels of the left and right channels must be set equal to each other for proper stereo balancing. As shown, the limit levels are perpendicular to the right and left channel axis and intersect with each other to form the L+R and L-R modulation limits. They form the perimeter of the "box" in the illustration. The L+R axis represents the main monaural component transmitted by the AM envelope of the transmitter and the L-R axis represents the main stereo information component transmitted by the phase modulation of the carrier frequency. As long as the program input is mostly monaural, this limiting system produces nearly full 100% envelope modulation with almost a straight line along the L+R axis and monaural reception remains normal.

However, the figure also demonstrates such limiting creates

serious monaural transmission and reception problems during varying stereo conditions. When stereo inputs temporarily shift to the full left only (vertical) or right only (horizontal) modulation axis, stereo reception is acceptable but monaural is not. The L+R modulation component is forced to drop to 50% as is shown by the dotted line intersection of the lower right modulation scale with the tips of the left channel or right channel limit levels. This indicates an immediate 6 db drop in loudness in monaural reception. Obviously this is an unacceptable condition to AM broadcasters since the existing monaural coverage as well as the monaural loudness is reduced. Although most stereo program material does not contain significant amounts of single channel passages, this form of limiting causes significant losses of monaural loudness and coverage on nearly all stereo program material. The losses are usually directly proportional to the stereo content and become greater as separation increases.

FULL MATRIX LIMITING

Figure 1-2 represents the oscilloscope X-Y display of the right and left limiter outputs of full monaural support matrix limiting. With this system, the output levels of the L+R and L-R are adjusted for equal modulation levels which is the point of maximum separation. As shown, the amplitude limit levels are perpendicular to the L+R and L-R axis and intersect with each other at the left channel and right channel axis. They form the perimeter of "diamond" in the illustration. When stereo inputs temporarily shift to the full left only or the right only axis, these limit levels allow the L+R component to remain at a 100% modulation which maintains full monaural reception compatibility during such transmissions. The dotted area shown in the illustration shows the increased areas of monaural support modulation produced by this system as compared to the earlier conventional left and right limiting which is illustrated by the un-dotted area of the "box" in the center.

Unfortunately, further analysis shows that stereo reception will have a 6 db INCREASE in the single channel receptions. While this obviously is going to be noticeable to listeners, critical listening tests have demonstrated this to be far more acceptable than the LOSS of 6 db in monaural loudness. Also, remember that the majority of stereo program contents do not contain full single channel transmissions.

CRL MODIFIED MATRIX LIMITING

Under light and moderate amounts of limiting, full matrix processing produces outstanding results in both monaural and stereo. Heavy amounts of limiting or processing can produce different results. Heavy or extreme levels of audio processing as demanded by many existing AM radio stations may

cause certain types of overloads in present stereo decoding and reception techniques. In an effort to reduce the chances of these problems, a modified full matrix processing has been developed by Circuit Research Labs, Inc.

Figure 1-3 represents the oscilloscope X-Y display of the right and left limiter outputs of the CRL modified monaural support matrix limiting system. The significant difference between this limiting pattern and the one shown in figure 2 is visible in the left and right bottom corners of the pattern. Here, the corners formed by the L+R and L-R axis are removed by an adjustable single channel limiting network. This system allows full monaural compatibility during most stereo conditions, but causes a reduction of L-R and negative peak L+R modulation levels during left only or right only stereo conditions. In the illustration, the single channel limits are shown set for a left or right only L+R negative limit of 70% instead of the 100% level which would occur without such limiting.

This modified matrix system is designed to reduce the potential problem areas associated with stereo transmissions. At the removed corners shown in the figure, both L+R and L-R modulations are at maximum and can cause decoding difficulties. If high density negative peak L+R modulations are allowed to consistantly reduce the transmitter carrier, the L-R decoding process has little or no carrier to demodulate. The result can be that either stereo decoding returns to monaural or produces distortions. Depending upon the degree of processing used and maximum L+R modulation depth, the single channel limiting network can be adjusted to the level which prevents or greatly reduces such stereo receiving problems. If the feature is not desired, it can also be adjusted totally out of circuit as well.

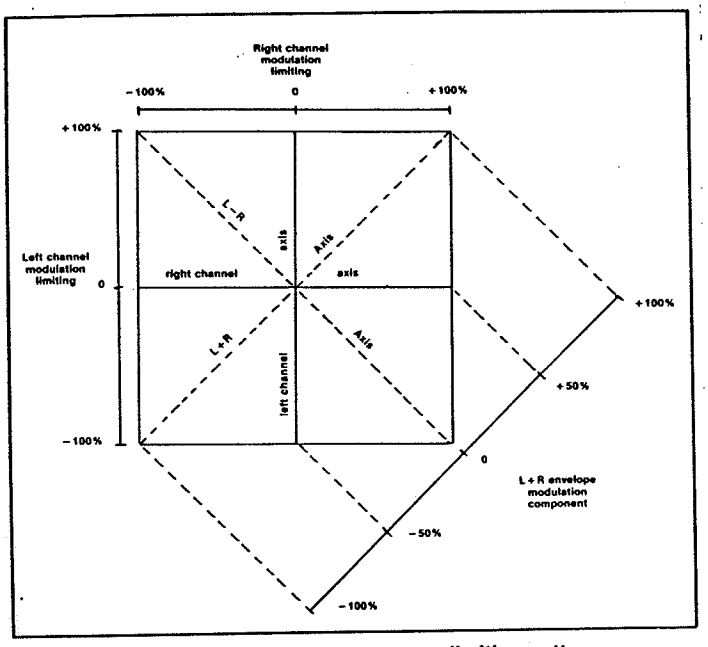


Figure 1. Conventional left and right stereo limiting pattern.

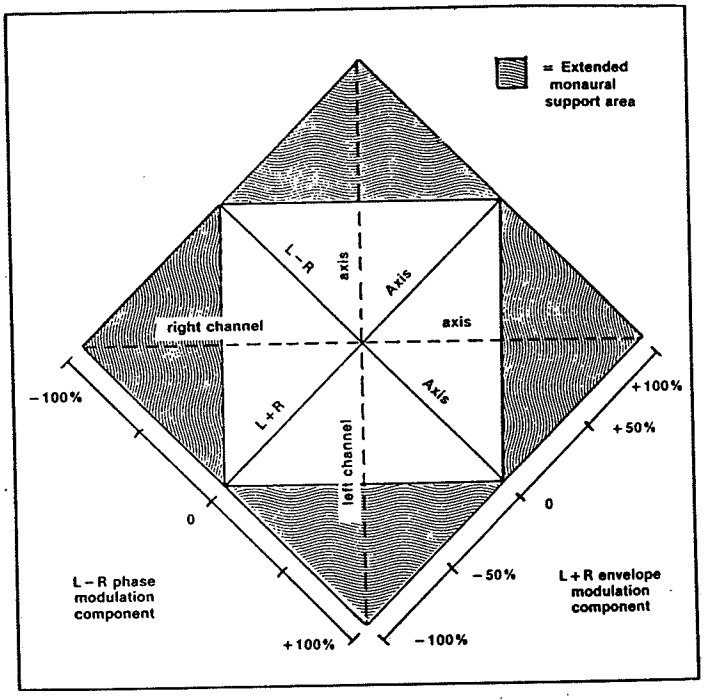


Figure 2. Full monaural support matrix stereo limiting pattern.

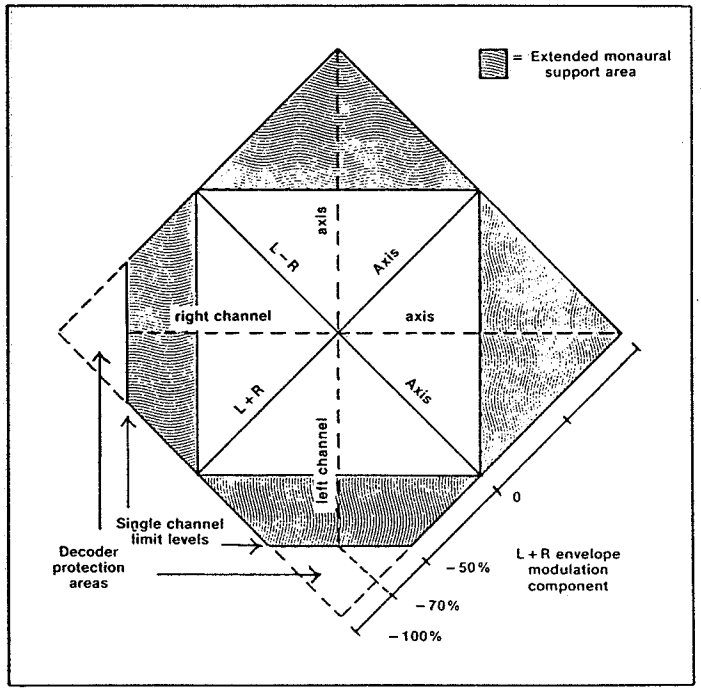


Figure 3. CRL monaural support matrix stereo limiting pattern with adjustable decoder protection.

SECTION 2 - INSTALLATION

2.1 INSTALLATION PROCEDURE

The CRL AM-2S and AM-4S MATRIX Stereo Processing systems have been sent carefully pre-calibrated between units so that only the inputs to the stereo AGC SPP-800 and the outputs from the matrix limiter-clipper SMP-900 are all that have to be adjusted by the station if all of the system is installed in one location.

If separate studio and transmitter locations make it necessary to separate the system into two parts then it should be separated so that the SPP-800 AGC is at the studio and the rest of the system is at the transmitting site as shown in the TYPICAL INSTALLATION BLOCK DIAGRAMS and SIMPLIFIED BLOCK DIAGRAM sections of this manual. Refer to the SEP-400A or SPP-800 manuals for re-alignment details if phone lines or an STL separate the two units.

2.2 INPUT AND OUTPUT CONNECTIONS

Refer to any of the enclosed manuals for proper electrical installation details. The general rules are quit simple. Both the input and output circuits are active operational amplifier balanced configurations. This means that these terminals HAVE TO BE GROUND REFERENCED to the source or load equipment in order to work properly. Cable shields should be connected at BOTH ends (which is contrary to earlier philosophies) to prevent hum problems. If UNBALANCED OUTPUTS are desired, or UNBALANCED TEST PROBES are used in testing this equipment, ONLY THE "+" TERMINALS AND CHASSIS GROUND SHOULD BE USED. The "+" or "-" output terminals of any of the equipment should never be connected to the chassis ground permanently as this will short the associated output operational amplifiers. CAREFULLY FOLLOW THE GROUNDING TECHNIQUES RECOMMENDED TO PREVENT HUM AND OSCILLATIONS FROM POSSIBLY OCCURRING.

2.3 INITIAL CONTROL SETTINGS

Carefully set the system controls to the levels in the chart on the following page. If this is not done, the following alignments will ALL be in error and the entire procedure will have to be repeated.

INITIAL CONTROL SETTINGS

SPP-800 (2 band stereo AGC)

G/R control:	-9
E.Q. control:	2:00 o'clock (1 turn)
GATE switch:	OFF (for following pink noise setup)
OPERATION control:	M
(Rear Panel)	
PROOF/OPERATE switch:	OPERATE
PINK NOISE/OPERATE switch:	OPERATE (turns on pink noise for alignment and transmitter input adjustment)

SEP-400A (4 band Compressors in AM-4S Systems only)

Dep PROCESS switch:	+6
Dep DENSITY switch:	+6
L,M1,M2,H controls:	12:00 o'clock
Pep PROCESS switch:	0
Pep DENSITY switch:	+6
(Rear Panel)	
PROOF/OPERATE switch:	OPERATE
GATE switch:	-12

SMP-900 (stereo MATRIX Limiter/Clipper)

MONO SUPPORT G/R switch:	-6	
HI FREQ EQUALIZATION control:	2:00 o'clock	(1 turn)
STEREO ENHANCE control:	Fully CCW	(1 turn) *
LIMITING switch:	+3	
L+R OUTPUT control:	Fully CCW	(20 turn)
L-R OUTPUT control:	Fully CCW	(20 turn)
TILT CORRECT control:	OFF	(1 turn)
ASYMMETRY control:	Fully CW	(20 turn)
(Rear Panel)		
OPERATE switch:	OPERATE	
SGL CH LIMITERS control:	Fully CCW	(20 turn) *
B.W. 11KHZ/9KHZ switch:	11KHZ	

*
NEVER FORGET to set these control settings or all subsequent alignments and adjustments will be in ERROR.

2.4 SET UP PROCEDURE, PREFERRED

The following is a description of 2 different methods for properly obtaining ACCURATE L+R AND L-R OUTPUT LEVELS. This is absolutely essential in order to insure that proper L+R Amplitude and L-R Phase Modulation Limits are accurately controlled internally in the AM Stereo Exciters and that the maximum transmitted separation is not degraded.

NOTE: ABOVE ALL, ALWAYS FOLLOW THE BELOW INSTALLATION SUMMARY SEQUENCE OR PROBLEMS WILL SUDDENLY BEGIN APPEARING FROM NO WHERE.

This is the preferred set up method since it does not rely on the various AM Stereo Modulation monitors as the alignment tool. Experience has shown that while the various AM Stereo Modulation monitors indicate extremely useful information, they tend to respond ambiguously on pink noise and program material and the following adjustments of the L-R to L+R modulation levels may not accurate.

NOTE: A MONITOR IS NOTHING MORE THAN AN INDIRECT INDICATING DEVICE THAT SHOWS PEAKS, BALANCES, AND ASSOCIATED NULLS. ALL OF THESE MAY BE DIRECTLY DISPLAYED ON AN OSCILLOSCOPE IN INSTANTANEOUS DISPLAYS.

********** INSTALLATION SUMMARY **********

1 - Align AM Stereo Exciter & Monitors
2 - Set CRL equipment controls & pink noise
3 - Set L+R modulation to operate level (pg. 2-3)
4 - Set L-R modulation by Right channel nulling (pg. 2-4)
5 - Set CRL single channel limiting if used (pg. 2-5)
6 - Return system to normal operate condition & set `sound'

****

Assuming that both the proper AM STEREO EXCITER calibrations and the STEP 2 equipment settings have been done properly, a balanced left and right monaural pink noise feed is being sent through the system to its output in order to proceed as follows:

WARNING!: Note if the L-R indicator on the SMP-900 is flashing while the L+R indicator is not. If it is, the input leads are connected out of phase somewhere in front of the SMP-900, reverse one of the input channel "+" and "-" polarities to the system BEFORE PROCEEDING!

L+R MODULATION ADJUSTMENT

CAREFULLY adjust the L+R output control of the unit for the desired TOTAL envelope negative peak modulation as indicated

by the station's monaural Modulation Monitor or as referenced by an Oscilloscope operating at 2mS or 5mS horizontal sweep rate monitoring the RF envelope.

L-R MODULATION ADJUSTMENT

TEMPORARILY switch the SMP-900 rear panel OPERATE switch to it's LEFT ONLY position. Connect an Oscilloscope to the "+" RIGHT output terminal and chassis ground of the SMP-900 and adjust it's Vertical gain for a full screen peak to peak deflection. While observing the Total envelope modulation on the monitor, adjust the L-R output control slowly CW until the scope indicates the best "NULL" or MINIMUM OUTPUT at the RIGHT output of the SMP-900. Do not continue increasing the L-R output control of the unit beyond this point. Temporarily turn off the transmitter for this adjustment if RF "fuzz" prevents proper nulling and turn it back on after nulling is completed. THIS ADJUSTMENT METHOD INSURES PERFECT MATCHING OF THE L-R TO L+R MODULATION LIMIT LEVELS SINCE IT MAXIMIZES SEPARATION WHEN THE RIGHT CHANNEL OUTPUT IS NULLED.

INITIAL MODULATION CHECK

Switch the OPERATE switch back to OPERATE on the SMP-900 and observe that the total PEAK MODULATION as indicated on the Peak Flasher or Oscilloscope is the same level as previous obtained. It should be noted that BECAUSE of MODULATION DENSITIES being different for BOTH channels as compared to a SINGLE channel, the AVERAGE peak meter readings on some monaural modulation monitors may show as much 10% greater for BOTH channels as compared to the LEFT ONLY reading but the PEAK indicator should remain comparatively equal if the transmitter is in good condition.

FINAL MODULATION CHECK

Next, switch the rear panel PINK NOISE/OPERATE switch to OPERATE on the SPP-800 stereo AGC and apply MONAURAL program material at the stations "normal operating level" into it. Adjust the SMP-900 input controls until both Left and Right amber "0" input indicators flash brightly on program peaks and the red "Ovld" indicators just occasionally light.

FINE TUNING

For best results "fine tune" either input control for a maximum "NULL" as shown on the "L-R" Stereo Modulation Monitor position if it is possible. If not, equal peak flashes on the "0" input indicators should be quite sufficient.

MODULATION RE-ADJUSTMENT

If additional Total Envelope Modulation is desired, the above procedure should be repeated using first the SMP-900 "L+R"

output control to set the envelope modulation and next using the "L-R" output control to maximize the stereo separation as described above and as shown on the STEREO Modulation Monitor.

2.5 ALTERNATE SET UP WITH MODULATION MONITOR

This method requires an AM Stereo Modulation Monitor with an L-R position for L+R and L-R Output Alignment. We highly recommend that method "A" described previously be used for the setup. However, if you wish to use this method be sure to read the material above, since it will help in understanding this procedure.

L+R MODULATION ADJUSTMENT

Initially adjust the L+R output control of the CRL SMP-900 AM STEREO Matrix Processor for a total NEGATIVE peak flasher modulation to the desired maximum level as referenced by the station's monaural Modulation monitor while taking care to note as accurately as possible that the readings between left and right channels are equal as represented by the Stereo Modulation Monitor, they should be if the stereo monitor and exciter are functioning properly.

L-R MODULATION ADJUSTMENT

Next switch the Stereo Modulation Monitor to it's "L-R" position and switch the rear panel SETUP switch on the SMP-900 to LEFT ONLY and adjust the L-R output control for an L-R "+" or "-" peak flasher reading equal to the L+R "-" peak flasher value as indicated on the Stereo Monitor. Then, "fine tune" the L-R control for a minimum modulation indication in the right channel modulation.

FINE TUNING (AM4S system only)

Now turn the rear panel setup switch back to OPERATE and using a pink noise or other monaural source; "fine tune" the four band output controls (L,M1,M2,H) on ONE of the SEP 400A units for MINIMUM L-R level as indicated by the AM Stereo Monitor. This usually provides some improvement over visual control settings. The final numeric figure will vary with Monitor and Exciter type, but should represent no less than -20db from 100% modulation if everything is properly aligned.

2.6 SET UP OF SINGLE CHANNEL NEGATIVE LIMITING SYSTEM

The following is a description of the method for properly obtaining an ACCURATE setting of SINGLE CHANNEL LEFT and RIGHT NEGATIVE LIMIT LEVELS. A careful reading of the first five pages of this SMP 900 manual is necessary to understand this procedure. Pay particular attention to the description of the lissajous patterns and check the diagrams on Page 1-5 again. It is recommended that the negative single channel

limit levels be restricted to 75% to 70% for the Motorola AM Stereo Transmission System and possibly other unconfirmed levels for the other Stereo Transmission Systems to protect the RECEIVER decoding process from creating potential distortion during accidental SINGLE CHANNEL TRANSMISSIONS. It should be noted that this limiting normally does NOT cause MONAURAL or STEREO LOUDNESS LOSSES for normal program content and is intended as ONLY a protection device which is optional to the user. It should be utilized ONLY IF apparent receiver distortion (either Monaural or Stereo) becomes audible to the listeners because of heavy stereophonic transmissions.

SINGLE CHANNEL LIMIT ADJUSTMENT

With the SMP-900 rear panel OPERATE switch still switched to it's LEFT ONLY position, perform the following:

Adjust the 20 turn rear panel SGL CH LIMITERS control of the unit CW until the TOTAL envelope NEGATIVE peak modulation is reduced to 75% or 70% as indicated by the station's normal Modulation Monitor, Stereo Monitor's L+R NEGATIVE peak flasher, or as referenced by an Oscilloscope operating at 2mS or 5mS horizontal sweep rate.

NOTE: SET THE REAR PANEL OPERATE SWITCH BACK TO OPERATE AS THE CALIBRATION IS NOW COMPLETE.

CAUTION!: The negative peak monaural or L+R indication on the Modulation Monitor will now vary anywhere from a maximum modulation (caused by pure mono L+R) indication initially set by the L+R control to a minimum modulation (caused by pure single channel) indication just established by the SGL CH LIMITERS control. This action will be dependent on "how much stereo" is present in the program content being transmitted and will be a NORMAL action. It should be noted however, that the positive modulation will tend to be little unaffected by the single channel limiting.

NOTE: ATS MODULATION CONTROL SYSTEMS WILL NOT WORK WITH THIS TYPE LIMITING AND SHOULD BE DISABLED! IF ATS MODULATION CONTROL ABSOLUTELY HAS TO BE USED, THE SINGLE CHANNEL LIMITING PRINCIPLE CANNOT BE USED. THIS MAY CAUSE DISTORTION IN THE DECODING CIRCUITS OF RECEIVERS.

2.7 INTERNAL OPTIONS, JUMPERS AND ALIGNMENTS

Several Internal Options should be looked into for additional improvements in stereo processing performance after the above adjustments have been successfully completed. If you have an `older' transmitter, have a Harris Stereo exciter, or notice `too much Bass Punch', you should turn immediately to page 18 and review these features.

2.8 SYSTEM INITIAL SOUND SETTINGS

The following chart should be followed for the INITIAL settings after the previous alignments have been completed. The rest of the chart should only be used for reference to insure that the final combination of "sound" settings which you arrive at are within the recommended ranges on the next page.

NOTE: SETTINGS BEYOND THESE LISTED RANGES MAY INDICATE IMPROPER ALIGNMENT SOMEWHERE ELSE IN THE SYSTEM.

SPP-800 STEREO PREPARATION PROCESSOR (2 band stereo AGC)
Setting Guide

	INITIAL	LIGHT	MEDIUM	HEAVY
G/R control:	-9	-3 to -6	-9	-12
E.Q. control:	2:00 o'clock	1:00	2:00	3:00
GATE switch:	ON	ON	ON	ON
OPERATION control:	M	S	M	F
(Rear Panel)				
PROOF/OPERATE:	OPERATE	--	--	--
PINK NOISE/ OPERATE :	OPERATE	--	--	--

SEP-400A SPECTRAL ENERGY PROCESSORS (4 band Compressors in AM-4S ONLY)
Setting Guide

	INITIAL	LIGHT	MEDIUM	HEAVY
Dep PROCESS:	+6	+3 to +6	+6 to +9	+9
Dep DENSITY:	+6	0	+3	+6
L,M1,M2,H controls:	12 o'clock	1,12,12,11	1,12,1,12	1,12,2,11
(Any setting Between 9 o'clock and 3 o'clock as desired)				
Pep PROCESS:	0	0	0	+3
Pep DENSITY:	+6	0	+6	+3
(Rear Panel)				
PROOF/OPERATE:	OPERATE	--	--	--
GATE switch:	-12	-22	-12	-12

SMP-900 STEREO MATRIX PROCESSOR (MATRIX Limiter/Clipper)
Setting Guide

	INITIAL	LIGHT	MEDIUM	HEAVY
MONO SUPPORT G/R:	-6	-4	-6	-8
HI FREQ E.Q.:	1 o'clock	9:00	12:00	3:00
	(As desired for Received Brightness)			
STEREO ENHANCE:	OFF	10:00	12:00	2:00
	(As desired for Received Stereo Separation)			
LIMITING control:	+2	+0 to +1	+2	+3 to +4
TILT CORRECT:	OFF (For all PDM, PWM, & WELDON TYPE transmitters)			
ASYMMETRY control:	150	110	120	135
	(Rear Panel)			
OPERATE switch:	OPERATE	--	--	--
SGL CH LIMITERS:	(See Page 2-5, STEP 4 for details)			
Output Band Width				
11KHZ/9KHZ switch:	11KHZ	--	--	--
	(As desired for transmitter, antenna, and best received sound)			

SECTION 3 - OPERATION

3.1 CONTROL FEATURES LISTING (SMP-900)

The purpose of this section is to describe the control features of the SMP-900, their operation theory, and anticipated useage. The listing is in the order of their appearance first, on the front panel, then on the rear panel, and then internally on the circuit board.

Front Panel

1-Mono Support G/R Switch
2-Input LED Indicators
3-Hi Freq Equalization Control (1 turn)
4-Stereo Enhance Control (1 turn)
5-L+R & L-R LED Indicators
6-Limiting Switch
7-L+R Output Control (20 turn)
8-L-R Output Control (20 turn)
9-Asymmetry Control (20 turn)
10-Tilt Correct Control (1 turn)

Rear Panel

11-Input/Output Terminal Buss
12-Mono Out Jack & Level Control (20 turn)
13-SGL CH LIMITERS Control (20 turn)
14-Input Calibrate LED Indicators and Pots (20 turn)
15-B.W. 11KHZ/9KHZ Switch
16-Operate Switch

Internal Options Jumpers

17-Power Supply Disconnect Jumpers (On/Off)
18-Output Mode Select Jumpers (L & R, or L+R & L-R)
19-Bass Pre-emphasis In/Out Jumpers
20-Bass Tilt Correct In/Out Jumpers

3.2 FRONT PANEL CONTROLS

1-Mono Support G/R Switch:

For this feature to work properly, the unit inputs must be properly calibrated with standard operating input levels. When the inputs are at the proper level the rear panel input calibrate and front panel 0 input LEDs will flash brightly. The OVLD LEDs should occasionally light on loud passages. The 2 db per step G/R control is then used to increase the amount of gain reduction of the following L+R controlled left and right AGC compressors. Since the left and right AGC amplifiers ARE L+R controlled, this tends to support MONAURAL

loudness during heavy stereophonic transmissions. Care should be used in the amount this stage is used since the amount of compression action will vary 6 db between monaural and single channel inputs and may cause additional compression of the output sound if used excessively under normal left and right input conditions.

2-Input LED Indicators:

The input LED indicators form a simplified input level indicating system. This is used to maintain proper monitoring of the audio input level and to assure the unit is being driven at its proper operating level. Proper calibration of the unit's input level is achieved when its input controls are set to the point which causes the red input OVLD (overload) indicators to just occasionally light on loud program passages similar to the flashing rate allowed for the -100% peak modulation flashes.

3-Hi Freq Equalization Control:

The single turn Equalization control provides a simple continuously variable high frequency pre-emphasis of the input program content which ranges from "flat" to a maximum of 80 microseconds time constant. This is only the final portion of the multiple time constant equalization system of the unit and thus the end resultant curve is far more complex in nature. This control allows primary control of the total curve by the user in order to provide easy adjustment of the station's overall high frequency equalization. It is recommended that the boost used for monaural reception improvements be kept to a minimum both for listener `tuneability' and for high quality stereo reception purposes.

4-Stereo Enhance Control:

The single turn Stereo Enhance control is a variable gain L-R amplifier inserted prior to the matrix L-R limiting network. Positioned at this point, it has the potential of increasing the L-R gain by as much as 6 db. While extreme settings may tend to create a "hole in the center", we know that FM stations are already using special "stereo enhancement" equipment in attempts to "increase" the present day stereo effects in program material. In AM stereo, it can be used for an exciting "competitive edge" against other stations as it allows an `undistorted' increase in received STEREO loudness because of the greater matrix modulation area as graphically demonstrated earlier in the AM STEREO THEORY - PROCESSING REQUIREMENTS EXPLAINED section of this manual. It also allows the station to simply "sound more stereo" than a competing station. While we do not advocate its useage in excess, we do believe that it can be used to effectively offset some of the separation deficiencies which are present both in the existing AM transmission and receiver technologies.

5-L+R & L-R LED Limiting Indicators:

The L+R LED indicator in this unit is used to show the arbitrary amount of clipping activity in the L+R channel low pass output clipping filter. This indicator references the amounts of average clipping activity and does not necessarily indicate whether clipping distortions are audible in the output.

The L-R LED indicator is complimentary to the L+R LED and indicates any similar activity occurring in the L-R channel low pass output clipping filter. It should be noted that this indicator is EXCELLENT in indicating ANY -180 out of phase program content as it will be almost constantly on while the L+R indicator will remain OFF during such events.

6-Limiting Switch:

The Limiting control is a 1 db per step attenuator to the inputs of the L+R and L-R multi-band clipping/limiters and following low pass clipping filters. This control is used to achieve the final "on the air" LOUDNESS versus DISTORTION trade off desired by the particular radio station.

7-L+R Output Control:

The L+R output control is a 20 turn potentiometer which adjusts the Amplitude Modulated Envelope level feeding the normal transmitter input via the L and R inputs of the AM Stereo Exciter.

8-L-R Output Control:

The L-R output control is a 20 turn potentiometer similar to the L+R output control which generally controls the "Difference Information" or "Stereo" Modulated Envelope level feeding the transmitter input via the L and R inputs of the AM Stereo Exciter.

9-Asymmetry Control:

The Asymmetry control is a 20 turn potentiometer used in the main L+R channel only, and will provide the capability for 125% positive peak modulation of the L+R component. While producing greater received stereo crosstalk distortions which may at times be audible (only during full single channel transmission), it is felt that the majority of AM broadcasters will DEMAND this feature because of their concern for MONAURAL "compatibility". Contrary to the degradations associated with the useage of asymmetry by other manufactured limiter devices, listening tests clearly indicate that asymmetrical output of CRL's limiting system produces LESS audible distortions than does symmetrical operation (provided the transmitting system is capable of doing so without distortion).

10-Tilt Correct Control:

The single turn "Tilt Correct" control is a CRL pioneered Low Frequency Gain/Phase Equalizer which is now copied by other manufacturers and is used ONLY for older High Level Plate Modulated transmitters which tend to over-modulate (Amplitude Modulation) because of their non-linearities on audio bass notes or low frequencies. This control when properly adjusted is used to allow low frequency Square Wave type modulations of bass frequencies to occur without causing carrier pinch off. An "older" transmitter can therefore be made to modulate nearly as well as the newer PWM, PDM, or Weldon type transmitters which can be as much as 2db to 3db more than they normally can without such correction. NOTE: some stereo exciters tend to already correct for this, check your envelope and look at Addendum 1 on pages 25 and 26 for further details on correction.

3.3 REAR PANEL CONTROLS

11-Input/Output Terminal Buss:

The input and output terminal buss is located on the rear panel and is designed to connect to standard 600 ohm balanced source and load devices as commonly found in broadcast audio applications. SPECIAL CARE on grounding techniques should be adhered to as described in the other enclosed unit manual sections because of the transformerless active balanced input and output configurations.

12-Mono Out Jack & Level Control:

The Mono Out Jack and 20 turn Level control provides an additional balanced monaural output for feeding an auxiliary or stand-by transmitter. These provide an independent control and feed of the L+R signal to the TIP,RING, and SLEEVE of the Stereo Phone Jack on the rear panel in a balanced "+", "-", and "shield" configuration. The advantages of having an already accessible, independently controlled monaural output that is directly derived from the stereo program content has proven to be of immense benefit for stand-by operation.

13-SGL CH LIMITERS Control:

The SGL CH LIMITERS Control is a 20 turn potentiometer which adjusts the NEGATIVE peak limit level of SINGLE CHANNEL audio sound field levels INDEPENDENT of the L+R and L-R Limit levels. These are controlled separately from the L+R and L-R planes in order to provide a protection system which will prevent accidental Single Channel Transmissions (One Channel Dead) from creating possible distortion in the RECEIVER decoding processes such as recommended by several of the AM Stereo Transmission System manufacturers. It should be noted that this is an optional limiting system and is left to the discretion of the end user as more RECEIVER DECODERS become

available for actual evaluation of their limitations.

14-Input Calibrate LED Indicators and Pots:

The Input Calibrate LED indicators are used to obtain proper input level adjustment of their associated 20 turn input pots. They begin illuminating regularly on program peaks when proper input levels are achieved. These are shipped carefully pre-aligned to the previous CRL units and should not need ANY adjustment unless they are for some reason not connected directly to the other CRL units.

15-11KHZ/9KHZ Bandwidth Switch:

The B.W. 11KHZ/9KHZ switch controls the break point of the CRL patented L+R and L-R low-pass output clipping filters which limits the audio output bandwidth energy and thus the overall transmission bandwidth of the broadcast facility. These insure that even with the higher amounts of high frequency Pre-Emphasis, the station's bandwidth meets the minimum F.C.C. bandwidth requirements for adjacent channel interference levels.

The 9KHZ position is for international stations and for U.S. stations which have either severe transmitter and/or antenna bandwidth problems which would otherwise degrade their received transmissions when using heavy pre-emphasis. While not a cure to the problem, it has been field proven that such stations can actually sound both "cleaner and louder" when using more limited bandwidth audio inputs. The high VSWR's of higher audio modulation frequencies in antennas can create radical impedance shifts and resultant sideband distortions. High VSWR caused distortions of audio is sometimes used as `negative' feedback by transmitters which in turn creates additional distortions.

16-Operate Switch:

The Operate switch is used in the Proof Mode to defeat all of the equalization and L+R, L-R matrix processing elements such that proper Stereo AM Proof of Performances may be run in order to meet current F.C.C. requirements. However, the SGL CH LIMITERS are not bypassed and must be temporarily turned FULLY CCW during proof measurements or the single channel measurements may be affected. During normal transmission, the switch must ALWAYS BE IN OPERATE.

The Operate switch is also designed to be a very useful tool for proper setup of the L+R and L-R levels necessary for the best stereo separation transmissions. With monaural inputs to the CRL processing system and the switch set to REVERSE, -180 degree phase information (or Full L-R modulation) can be obtained for proper adjustment of the L-R output level feeding the AM Stereo Exciter. With the switch in the LEFT ONLY position, an additional overall system check of the

transmitted Separation can be made as mentioned earlier in the Installation Section.

3.4 INTERNAL OPTIONS AND JUMPERS

17-Power Supply Disconnect Jumpers (On/Off):

Two sets of jumpers on the printed circuit board allow the +15 volt and -15 volt power supplies to be disconnected from all circuitry in the SMP-900. This feature is very handy should field service ever be required on the power supplies. One jumper is for the +15 volt supply, while the other is for the -15 volt supply. When the jumpers are in the "ON" position (connecting the circuitry to the power supplies), two red LEDs located next to the jumpers will light.

18-Output Mode Select Jumpers (L & R, or L+R & L-R):

Two sets of jumpers on the printed circuit board allow the output of the SMP-900 to be programmed for either Left and Right channel audio out, or matrixed L+R and L-R audio out. One jumper selects either Left channel decoded audio or L+R, and another selects either Right channel decoded audio or L-R. Normally, the factory ships with Left and Right out unless requested otherwise.

It is recommended to bypass the audio input card filters and encode matrix circuits on all Harris type AM Stereo Exciters as confirmed by Mr. David Herschberger, system designer of the Harris Corporation. With these exciters, it is recommended to operate the audio processing system with L+R and L-R outputs in order to bypass these circuits. Call Harris or CRL for further details on this matter. This is strongly recommended because these filters cause significant `un-limiting' of the audio input waveforms since they are very sharp filters.

19-Bass Pre-emphasis In/Out Jumpers:

The Bass Pre-emphasis circuit adds a small amount of bass boost. While actually used to remove very low frequency program material, this filter has been uniquely designed to cause an equalization peak near 100 HZ which significantly increases the apparent BASS PUNCH on car and small sized portable radios. Low frequency filtering helps reduce interference to the AM stereo pilots and greatly reduces the transmitter power supply strain associated with sub-audible envelope modulations. Two sets of jumpers on the printed circuit board allow this feature to be bypassed Out as it is factory shipped In circuit. One jumper is for the Left channel and another is for the Right channel.

20-Bass Tilt Correct In/Out Jumpers:

Two sets of jumpers on the printed circuit board allow this feature to be programmed In or Out. One jumper is for L+R, and another is for L-R. Normally, it is factory shipped Out of circuit unless requested otherwise. See "10-Tilt Correct Control" earlier for a discussion of this control.

3.5 INTERNAL ALIGNMENT

It should be noted that the internal alignment controls in the SMP-900 AM Stereo Matrix Processor are for production alignment only and are not intended for any field service reasons. They affect only the resistive tolerances of the matrix encoders and decoders and it is not recommended that any field servicing on them be performed. If a separation problem with the unit is suspected, make certain the front panel `Stereo Enhance' control is fully CCW, and carefully listen to the input and the output of the unit by itself before concluding the existence of alignment problems. If you then conclude there is a problem, give us a call and we will help you.

SECTION 4 - MAINTENANCE

4.1 PREVENTIVE MAINTENANCE

A minimum amount of preventive maintenance is required to insure optimum performance of this processor unit. If you do not have a regular preventive maintenance schedule in existence, Circuit Research Labs suggests the following check list be performed on a periodic basis such as once a month or at least quarterly.

1. Check to insure that the input and output cables are secured tightly to their respective terminals and are not frayed (FRAYED SHIELD WIRES CAN SHORT OUT INPUT AND OUTPUT TERMINALS AND CAUSE INTERMITTENT FAILURES).

2. Check to insure that all knobs, switches, and indicators are secure and in good working condition. If they become physically loose, tighten them as this could also cause intermittent operating results.

3. Check to insure that there is not an excessive build up of dirt or dust around the unit. While this may not immediately affect the unit, long term exposure may.

4. NOTE: Keep all liquids away from the units. Accidental spillage can result in serious damage to the unit and will void the warranty.

4.2 TROUBLESHOOTING

When trouble is reported with this equipment never assume that the SMP-900 is at fault. In many cases the trouble is with other equipment used in combination with the SMP-900. It is recommended that you write down the control settings you normally use with this equipment. Before troubleshooting the equipment you should verify that the SMP-900 is properly set-up.

Years of experience has demonstrated to us that our equipment is generally the first to be suspected of causing distortion or loudness problems which occur from time to time with a station`s sound quality. This is only natural since the main function of our equipment is to improve loudness and quality by processing the audio.

However, the overwhelming majority of equipment which is returned to us for servicing is usually found to be working properly. In many cases the trouble is later traced to station equipment BEFORE or AFTER the processor.

This does not mean that CRL equipment never fails. But if problems do occur, don't forget to perform basic input and output tests on each piece of equipment before assuming that the processor is at fault. It is a good idea to write down all switch settings. Disc jockeys have been known to change the settings to suit their own taste without telling anyone.

The items listed below should be checked before troubleshooting the SMP-900.

1. Check for input and output levels causing overloads to the equipment under test or the equipment following it. Make certain any additional equipment which may be connected to unit is not being over-driven.

2. Check for failures in monitoring or other test equipment if measurements are erratic. Strong RF fields can make some test equipment give strange results. Poor equipment grounds and incorrect grounding of balanced line interconnects will cause problems that are not faults within the SMP-900. It is a good idea to use an oscilloscope to verify your testing.

3. Since this is audio equipment, don't be afraid to use your ears. LISTEN to each unit of the equipment while they are in actual operation. A pair of good quality, 600 ohm or higher headphones can be used to "bridge" across the input and output. Listening can quickly locate a bad unit or clear a suspected unit.

4.3 FACTORY SERVICE

In the event this unit must be returned to the factory for repair, IN or OUT of warranty, Circuit Research Labs requires that a RETURN AUTHORIZATION (RA) NUMBER be obtained from the CUSTOMER SERVICE department. Call CRL prior to shipment at 602-438-0888 for this number or the equipment will be returned to you without being serviced. In order to insure prompt service, the following information must also be included with the returned unit:

1. The Return Authorization Number CLEARLY MARKED ON THE OUTSIDE of the shipping container.

2. Description of Trouble which includes:
   A. The symptom description
   B. The unit control settings when the trouble was detected
   C. A short description of the facility in which the unit is used, for example: radio station (AM or FM), recording studio, etc.

3. Approximate date of purchase and the serial number of the unit - This will aid in the determination of billing for warranty or out of warranty repairs.

   All repairs must be shipped PRE-PAID via United Parcel Service when shipped in the USA to:

   Circuit Research Labs, Inc.
   2522 W. Geneva Drive
   Tempe, Arizona 85282 USA
   Att: CUSTOMER SERVICE
   RA #_____

SECTION 5 - APPENDIX

5.1 LOW FREQUENCY, TILT CORRECTION CIRCUIT

This circuit is designed to improve the low frequency response of plate modulated transmitters. It is not used with transmitters that have no plate modulation transformer, such as the Harris PDM, the Powerock, or the Continental using the Doherty circuit. THIS SHOULD BE DONE AFTER ALL OTHER SET UP IS COMPLETED. THE UNIT WILL WORK FINE WITHOUT THIS PROCEDURE, BUT BETTER SOUND WILL RESULT IF THIS ADJUSTMENT IS PROPERLY MADE.

1. Move the small blue plastic jumper on the circuit board marked BASS TILT COR. to enable this circuit. Units are normally shipped with this circuit disabled. Jumper is located near front of board behind red LED's marked L+R and L-R. Do not confuse with bass pre-emphasis jumper.

2. Bridge the input of the modulation monitor to obtain an oscilloscope display similar to the figures on the next page.

3. Disconnect the audio input to the SMP 900 and connect an audio generator to the audio input terminals. Feed the unit a 100 Hz tone and set the mono support G/R switch to -8 and the clipping switch to +4 to display a highly clipped waveform similar to those on the next page.

4. Turn up the L+R output control to obtain 70 to 80% modulation as observed on the oscilloscope or modulation monitor. THIS SHOULD BE DONE FOR A SHORT PERIOD OF TIME ONLY TO AVOID DAMAGE TO TRANSMITTER.

5. The display on the scope should look like Figure 1 with no tilt in the waveform. If tilt is present as shown in Figure 2 adjust the tilt correct control to obtain a waveform similar to Figure 1. Overcorrection will resemble Figure 3 and cause poor performance. Turn control counter-clockwise to correct.

6. If you have trouble obtaining the results indicated, turn the tilt correction control counterclockwise to oft and call the factory for assistance.

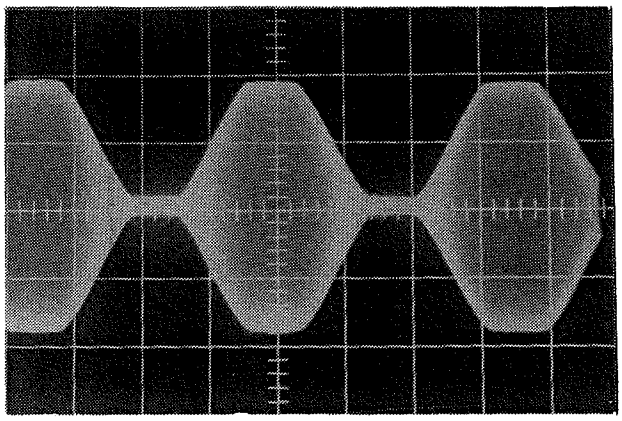


FIGURE 5-1 NORMAL MODULATION ENVELOPE

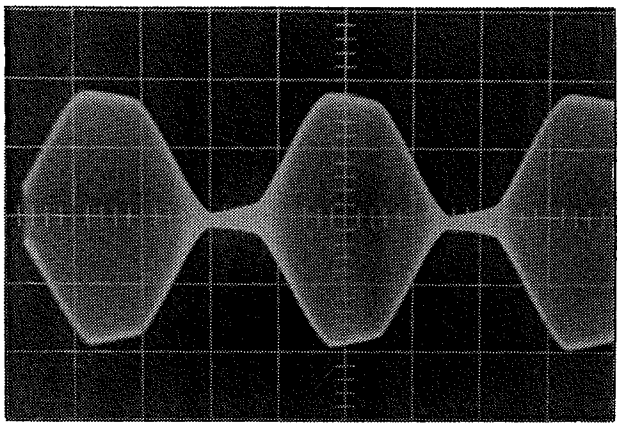


FIGURE 5-2 UNDER CORRECTED MODULATION ENVELOPE

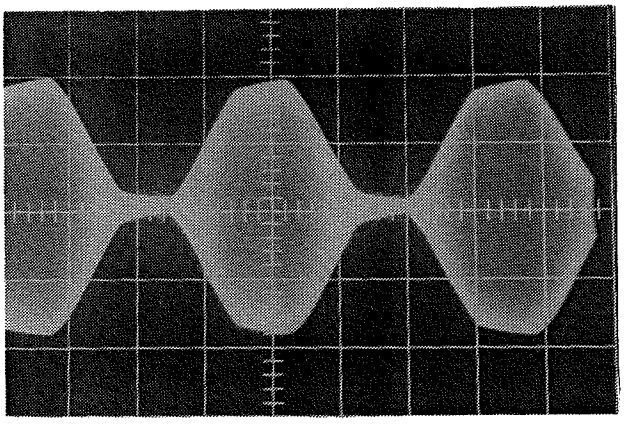


FIGURE 5-3 OVER CORRECTED MODULATION ENVELOPE

5.2 AM4S SYSTEM INFORMATION

1. SPP800. This is a split band AGC amplifier that maintains a constant level and tonal balance into the following unit. It contains a pink noise generator for system set up and an optional phase rotator for removing asymmetry from voices.
2. SEP800. This is a stereo 4 band compressor with gating in each band. It provides a very dense, controlled signal that results in improved stereo coverage and loudness. The output of each of the 4 bands has a control that allows the "mix" of lows, mid-range, and highs to be adjusted to create a specific sound to suit the stations format. It dynamically equalizes program material for a consistant sound balance.
3. SMP900. This is a MATRIX processor. L+R and L-R are processed separately. It is designed to support mono loudness and prevent any loss of coverage.

SUGGESTED INITIAL SETTINGS

SPP800:	G/R: -9		EQ:	12 to 2 o'clock
	GATE: Off		OPERATION:	M

This unit is connected between the console and the phone lines or aural STL with the other units at the transmitter site. The YELLOW LED should flash on peaks and the RED LED should not flash with normal program material.

SEP800:	G/R:	-6	OPERATION:	M
	LIMIT/COMPRESS:	Compress	WIDE/MULTI:	Multi
	GATE:	-20	BAND CONTROLS:	12:00

This unit is connected to the phone lines or dual channel STL receivers at the transmitter site. The YELLOW LED should flash on peaks about 10 to 20 percent of the time. The RED LED will flash on peaks +10dbm above the YELLOW LED.

SMP900:	G/R:	-4	LIMITING:	+1
	EQUALIZATION:	12:00		

The statement above concerning the flashing of the YELLOW & RED LED's applies here also. This unit is quite different from most limiters. PLEASE READ THE MANUAL CAREFULLY, and call us it you need help at 602-438-0888.

NOTE: This equipment is designed to sound good on typical consumer radios. It may sound overly bright on studio monitors. Use various types of radios to judge the right "sound" for your format. Change only one control at a time and PLEASE READ THE MANUAL.

5.3 USING THE SMP900 STEREO MATRIX PROCESSOR IN MONO

When the SMP-900 is connected to a mono program console you will need to make a pad using 150 ohm 5% 1/2 watt resistors as illustrated in Figure 1. The pad is connected as per the same figure. When a stereo program console is used, other processing equipment between the console and the SMP-900 input is connected as per the equipment manual (for stereo operation).

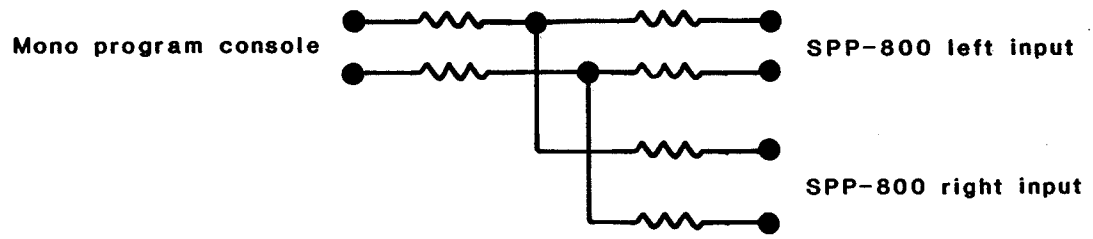
The output of the SMP-900 is then connected using the "MONO OUTPUT" on the rear panel, which is 600 ohms balanced using a 1/4 inch stereo phono jack. Connect this output to the transmitter in use. Use the "MONO OUTPUT LEVEL" to adjust the required modulation. This output has all the AGC processing and asymmetry circuitry. However, the tilt correction circuit is not included in this configuration and should only be used in plate modulated transmitters, as described below.

If you are using a plate modulated transmitter and want to utilize the tilt correction circuitry, do the following:

A. Remove the top cover from SMP900.
B. Move the L+R & L-R jumpers to the "ENCODE" position as illustrated in figure 2. Note that in the encode position the LEFT output is now L+R and the right output is now L-R.
C. Be sure that the "BASS TILT CORRECTION" jumpers are located in the "IN " position. See figure 2.
D. Replace the top cover.
E. Use the LEFT (L+R) output and connect it to the audio input of your transmitter.
F. Use the (L+R) output level control on the front panel to adjust the modulation as required. The L-R control on the front panel has no effect on operation in this configuration.

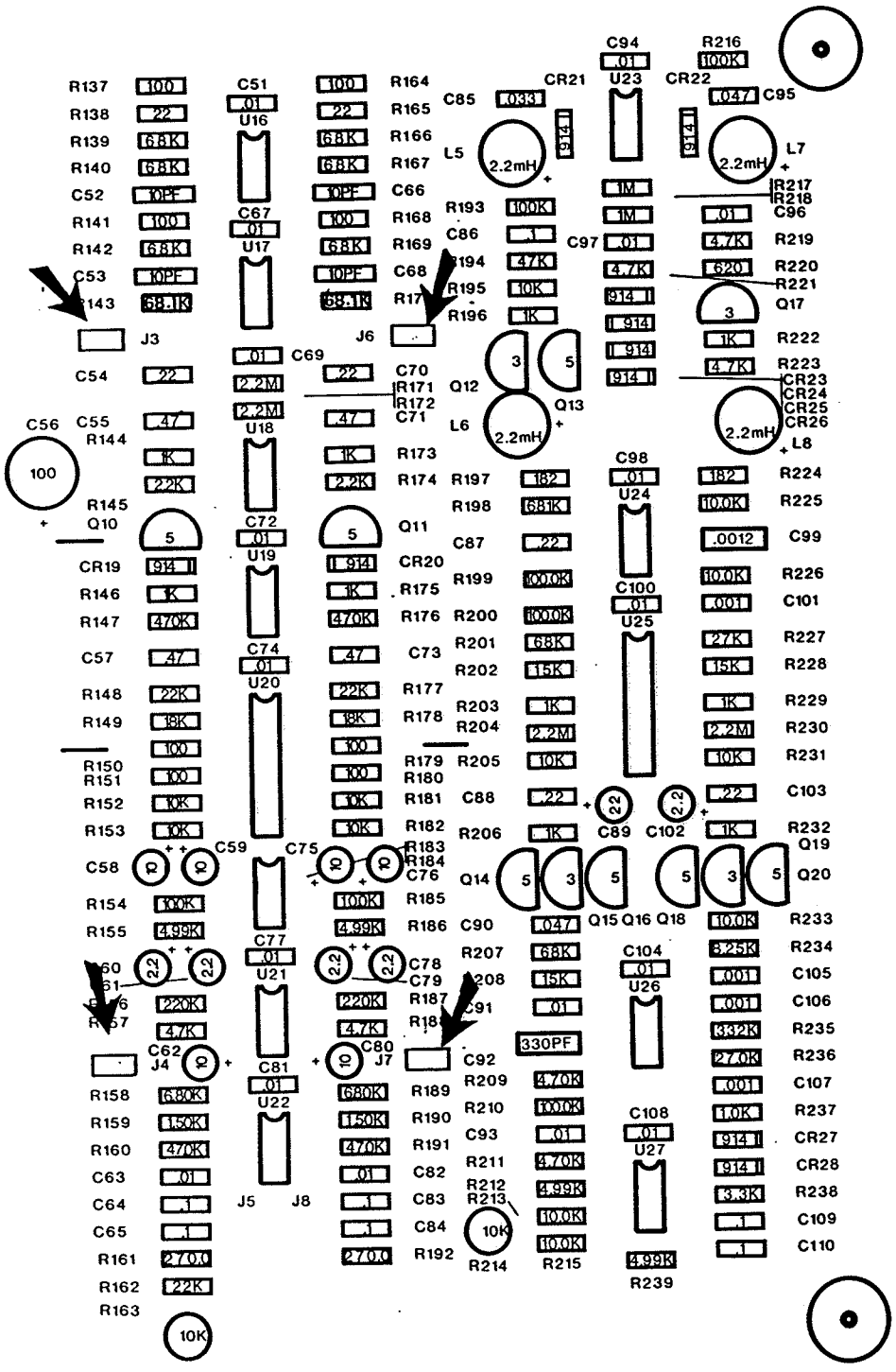
This concludes the procedure for mono operation of the SMP900.

FIGURE 5-4 MONO INPUT PAD



All resistors 150 ohms 5% 1/4 watt

FIGURE 5-5 SMP-900 PCB JUMPER LOCATIONS FOR MONO OPERATION



5.4 SMP900 PARTS LIST

DES.	DESCRIPTION
(VALUES IN MICROFARADS UNLESS NOTED)	
C01	2.2 TANTALUM 20% 25V
C02	2.2 TANTALUM 20% 25V
C03	2.2 TANTALUM 20% 25V
C04	10 ELECTROLYTIC 16V
C05	2.2 TANTALUM 20% 25V
C06	10 ELECTROLYTIC 16V
C07	470 ELECTROLYTIC 50V
C08	470 ELECTROLYTIC 50V
C09	.01 POLYESTER FILM 5% 63V
C10	.1 POLYESTER FILM 5% 63V
C11	.1 POLYESTER FILM 5% 63V
C12	10 PF CERAMIC 1KV
C13	470 pF SILVER MICA 5% 500V
C14	.1 POLYESTER FILM 5% 63V
C15	.47 POLYESTER FILM 5% 63V
C16	.01 PF CERAMIC 1KV
C17	.01 POLYESTER FILM 5% 63V
C18	.01 POLYESTER FILM 5% 63V
C19	.01 POLYESTER FILM 5% 63V
C20	.01 POLYESTER FILM 5% 63V
C21	470 pF SILVER MICA 5% 500V
C22	.1 POLYESTER FILM 5% 63V
C23	.47 POLYESTER FILM 5% 63V
C24	.01 POLYESTER FILM 5% 63V
C25	.033 POLYESTER FILM 5% 63V
C26	.1 POLYESTER FILM 5% 63V
C27	.22 POLYESTER FILM 5% 63V
C28	.22 POLYESTER FILM 5% 63V
C29	22 TANTALUM 20% 16V
C30	.047 POLYESTER FILM 5% 63V
C31	.01 POLYESTER FILM 5% 63V
C32	330 PF POLYSTYRENE 5% 160V
C33	.01 POLYESTER FILM 5% 63V
C34	.01 POLYESTER FILM 5% 63V
C35	.047 POLYESTER FILM 5% 63V
C36	.01 POLYESTER FILM 5% 63V
C37	.01 POLYESTER FILM 5% 63V
C38	.0012 POLYSTYRENE 5% 160V
C39	.01 POLYESTER FILM 5% 63V
C40	.001 POLYESTER FILM 5% 63V
C41	2.2 TANTALUM 20% 25V
C42	.22 POLYESTER FILM 5% 63V
C43	.01 POLYESTER FILM 5% 63V
C44	.001 POLYESTER FILM 5% 63V
C45	.001 POLYESTER FILM 5% 63V
C47	.001 POLYESTER FILM 5% 63V
C48	.01 POLYESTER FILM 5% 63
C49	.1 POLYESTER FILM 5% 63V
C50	.1 POLYESTER FILM 5% 63V

DES.	DESCRIPTION
C51	.01 POLYESTER FILM 5% 63V
C52	10pF CERAMIC 1KV
C53	10pF CERAMIC 1KV
C54	.47 POLYESTER FILM 5% 63V
C55	.22 POLYESTER FILM 5% 63V
C56	100 ELECTROLYTIC 35V
C57	.47 POLYESTER FILM 5% 63V
C58	10 ELECTROLYTIC 16V
C59	10 ELECTROLYTIC 16V
C60	2.2 TANTALUM 20% 25V
C61	2.2 TANTALUM 20% 25V
C62	10 ELECTROLYTIC 16V
C63	.01 POLYESTER FILM 5% 63V
C64	.1 POLYESTER FILM 5% 63V
C65	.1 POLYESTER FILM 5% 63V
C66	10pF CERAMIC 1KV
C67	.01 POLYESTER FILM 5% 63V
C68	10pF CERAMIC 1KV
C69	.01 POLYESTER FILM 5% 63V
C70	.47 POLYESTER FILM 5% 63V
C71	.22 POLYESTER FILM 5% 63V
C72	.01 POLYESTER FILM 5% 63V
C73	.47 POLYESTER FILM 5% 63V
C74	.01 POLYESTER FILM 5% 63V
C75	10 ELECTROLYTIC 16V
C76	10 ELECTROLYTIC 16V
C77	.01 POLYESTER FILM 5% 63V
C78	2.2 TANTALUM 20% 25V
C79	2.2 TANTALUM 20% 25V
C80	10 ELECTROLYTIC 16V
C81	.01 POLYESTER FILM
C82	.01 POLYESTER FILM 5% 63V
C83	.1 POLYESTER FILM 5% 63V
C84	.1 POLYESTER FILM 5% 63V
C85	.033 POLYESTER FILM 5%
C86	.1 POLYESTER FILM 5% 63V
C87	.22 POLYESTER FILM 5% 63V
C88	.22 POLYESTER FILM 5% 63V
C89	22 TANTALUM 20% 16V
C90	.047 POLYESTER FILM 5% 63
C91	.01 POLYESTER FILM 5% 63V
C92	330pF POLYSTYRENE 5% 160V
C93	.01 POLYESTER FILM 5% 63V
C94	.01 POLYESTER FILM 5% 63V
C95	.047 POLYESTER FILM 5% 63
C96	.01 POLYESTER FILM 5% 63V
C97	.01 POLYESTER FILM 5% 63V
C98	.01 POLYESTER FILM 5% 63
C99	.0012 POLYSTYRENE 5% 160V
C100	.01 POLYESTER FILM 5% 63V

DES.	DESCRIPTION
C101	.001 POLYESTER FILM 5% 63V
C102	2.2 TANTALUM 20% 25V
C103	.22 POLYESTER FILM 5% 63V
C104	.01 POLYESTER FILM 5% 63V
C105	.001 POLYESTER FILM 5% 63V
C106	.001 POLYESTER FILM 5% 63V
C107	.001 POLYESTER FILM 5% 63V
C108	.01 POLYESTER FILM 5% 63V
C109	.1 POLYESTER FILM 5% 63V
C110	.1 POLYESTER FILM 5% 63V
C111	.01 POLYESTER FILM 5% 63V
C112	.001 FEEDTHRU (L-IN)
C113	.001 FEEDTHRU (L+IN)
C114	.001 FEEDTHRU (R-IN)
C115	.001 FEEDTHRU (R+IN)
C116	.022 POLYESTER 10% 100V
C117	.022 POLYESTER 10% 100V
C118	.001 FEEDTHRU (L-OUT)
C119	.001 FEEDTHRU (L+OUT)
C120	.001 FEEDTHRU (R-OUT)
C121	.001 FEEDTHRU (R+OUT)

DIODES

CR01	1N4001
CR02	1N4001
CR03	1N4001
CR04	1N4001
CR05	1N4001
CR06	1N4001
CR07	1N914
CR08	1N914
CR09	1N914
CR10	1N914
CR11	1N914
CR12	1N914
CR13	1N914
CR14	1N914
CR15	1N914
CR16	1N914
CR17	1N914
CR18	1N914
CR20	1N914
CR21	1N914
CR22	1N914
CR23	1N914
CR24	1N914
CR25	1N914
CR26	1N914
CR27	1N914
CR28	1N914

DES.	DESCRIPTION

LEDS

DS01	MV55A
DS02	MV55A
DS03	MV55A
DS04	2190M94 (POWER)
DS05	2190M94 (OVLD L)
DS06	2190M96 (0 CAL FNT <L>)
DS07	2190M95 (-15 L)
DS08	2190M94 (OVLD R)
DS09	2190M96 (0 CAL FNT <R>)
DS10	2190M95 (-15 R)
DS11	2190M94 (L+R LIMITING)
DS12	2190M94 (L-R LIMITING)
DS13	2190M96 (0 CAL REAR L)
DS14	2190M96 (0 CAL REAR R)

FUSES

F01	1/10 AMP SLO-BLOW

COILS

L01	2.2 MH
L02	2.2 MH
L03	2.2 MH
L04	2.2 MH
L05	2.2 MH
L06	2.2 MH
L07	2.2 MH
L08	2.2 MH
L09	1.0 MH
L10	1.0 MH
L11	1.0 MH
L12	1.0 MH
L13	1.0 MH
L14	1.0 MH
L15	1.0 MH
L16	1.0 MH

TRANSISTORS

Q01	2N4125
Q02	MPS404A
Q03	2N4123
Q04	2N4125
Q05	2N4125
Q06	2N4123
Q07	2N4125
Q08	2N4123
Q09	2N4125
Q10	2N4125
Q12	2N4123
Q13	2N4125

DES.	DESCRIPTION
Q14	2N4125
Q15	2N4123
Q16	2N4125
Q17	2N4123
Q18	2N4125
Q19	2N4123
Q20	2N4125

RESISTORS IN OHMS 1% 1/4 WATT

DES.	DESCRIPTION
R01	10K
R02	10K
R03	390
R04	390
R05	390
R06	390
R07	27K
R08	27K
R09	470K
R10	47K
R11	82K
R12	27K
R13	27K
R14	470K
R15	47K
R16	82K
R17	249
R18	2.21K
R19	1K DUAL POT
R20	1K DUAL POT
R21	2.21K
R22	249
R23	1K
R24	39K
R25	39K
R26	100
R27	27K
R28	22K
R29	150K
R30	4.7M
R31	47K
R32	100
R33	27K
R34	22K
R35	180K
R36	10K CERMET POT
R38	4.7M
R39	47K
R40	100
R41	68K
R42	68K
R43	1K
R44	10K

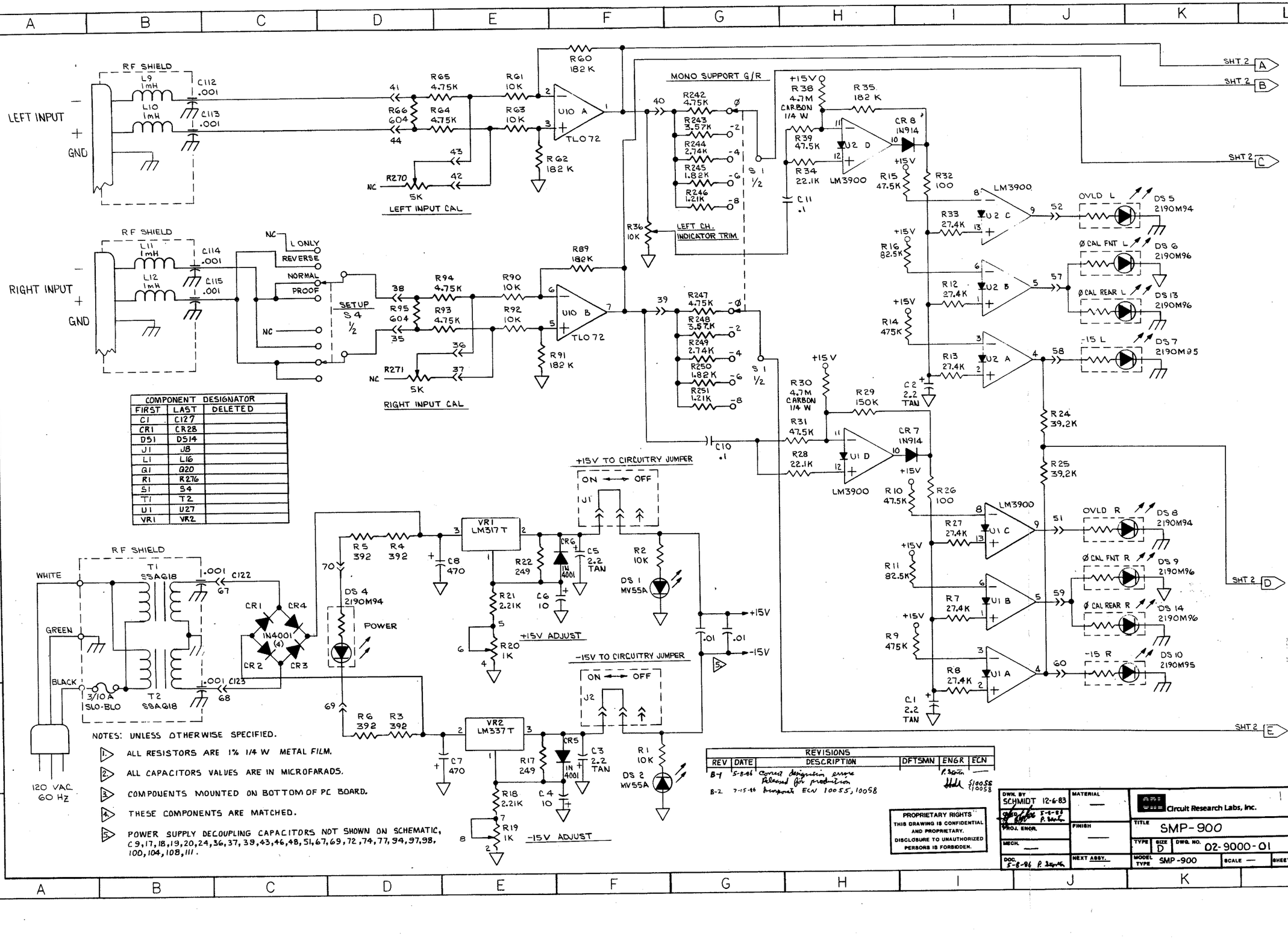
DES.	DESCRIPTION
R45	10K
R46	10K
R47	681K
R48	47.0K
R49	47.0K
R50	10K
R51	10K
R52	15K
R53	1K
R54	2.2M
R55	10K
R56	33.2K
R57	1K
R58	4.7K
R59	4.7K
R60	180K
R61	10K
R62	180K
R63	10K
R64	4.7K
R65	4.7K
R66	620
R67	100
R68	22
R69	68K
R70	39K
R71	10K
R72	33K
R73	10K
R74	10K
R75	33K
R76	681K
R77	47.0K
R78	47.0K
R79	15K
R80	1K
R81	2.2M
R82	10K
R83	10K DUAL POT
R84	10K DUAL POT
R85	33.2K
R86	1K
R87	10K
R88	10K
R89	180K
R90	10K
R91	180K
R92	10K
R93	4.7K
R94	4.7K
R95	620
R96	47K

DES.	DESCRIPTION
R97	10K
R98	1K
R99	182
R100	681K
R101	100K
R102	100K
R103	68K
R104	15K
R105	1K
R106	2.2M
R107	10K
R108	4.7K
R109	68K
R110	15K
R111	4.7K
R112	100K
R113	4.7K
R114	10K
R115	10K
R116	4.7K
R117	604
R118	4.7K
R119	1K
R120	1.5K
R121	6.8K
R122	150
R123	10K
R124	10K
R125	27K
R126	15K
R127	1K
R128	2.2M
R129	10K
R130	10K
R130	4.7K
R132	8.25K
R133	332K
R134	27.4K
R135	1K
R136	3.3K
R137	100
R138	22
R139	68K
R140	39K
R141	100
R142	68K
R144	1K
R145	2.2K
R146	1K
R147	470K
R148	22K
R149	18K

DES.	DESCRIPTION
R150	100
R151	100
R152	10K
R153	10K
R154	10K
R155	8.25K
R156	220K
R157	4.7K
R158	6.8K
R159	1.5K
R160	47K
R161	270
R162	22.1K
R163	10K CERMET POT
R164	100
R165	22
R166	68K
R167	39K
R168	100
R169	68K
R170	68K
R171	2.2M
R172	2.2M
R173	1K
R174	2.2K
R175	1K
R176	470K
R177	22K
R178	18K
R179	100
R180	100
R181	10K
R182	10K
R183	10K DUAL POT
R184	10K DUAL POT
R185	10K
R185	4.7K
R186	8.25K
R187	220K
R189	6.8K
R190	1.5K
R191	47K
R192	270
R193	100K
R194	47K
R195	10K
R196	1K
R197	182
R198	681K
R199	100K
R200	100K
R201	68K

DES.	DESCRIPTION
R202	15K
R203	1K
R204	2.2M
R205	10K
R206	1K
R207	68K
R208	15K
R209	4.7K
R210	100K
R211	4.7K
R212	2.21K
R213	4.7K
R214	10K CERMET POT
R215	4.7K
R216	100K
R217	1M
R218	1M
R219	4.7K
R220	604
R221	4.7K
R222	1K
R223	4.7K
R224	150
R225	10K
R226	10K
R227	27K
R228	15K
R229	1K
R230	2.2M
R231	10K
R232	1K
R233	10K
R234	8.25K
R235	332K
R236	27.4K
R237	1K
R238	3.3K
R239	4.99K
R240	5K MULTITURN POT
R241	5K MULTITURN POT
R242	4.7K
R243	3.6K
R244	2.7K
R245	1.8K
R246	1.2K
R247	4.7K
R248	3.6K
R249	2.7K
R250	1.8K
R251	1.8K
R252	2.2K
R254	1.5K

DES.	DESCRIPTION
R255	1.2K
R256	1.0K
R257	2.2K
R258	1.8K
R259	1.5K
R260	1.2K
R261	1.0K
R262	10K DUAL POT
R263	5K POT
R264	2.74K
R265	2.74K
R266	47K
R267	47K
S01	SWITCH ROTARY
S02	SWITCH ROTARY
S03	SWITCH DPDT
S04	SWITCH ROTARY
T1	TRANSFORMER, POWER
T2	TRANSFORMER, POWER
U1	IC LM3900
U2	IC LM3900
U3	IC TL072
U5	CRL MODULE 901
U4	IC TL072
U6	IC TL072
U7	IC TL072
U8	IC LM13600
U9	IC TL072
U10	IC TL072
U11	IC TL072
U12	IC LM13600
U13	IC TL072
U14	IC TL072
U15	IC TL072
U16	IC TL072
U17	IC TL072
U18	IC TL072
U19	IC TL072
U20	IC LM13600
U21	IC TL072
U22	IC TL072
U23	IC TL072
U24	IC TL072
U25	IC LM13600
U26	IC TL072
U27	IC TL072
U28	IC LM377T
U29	IC LM317T



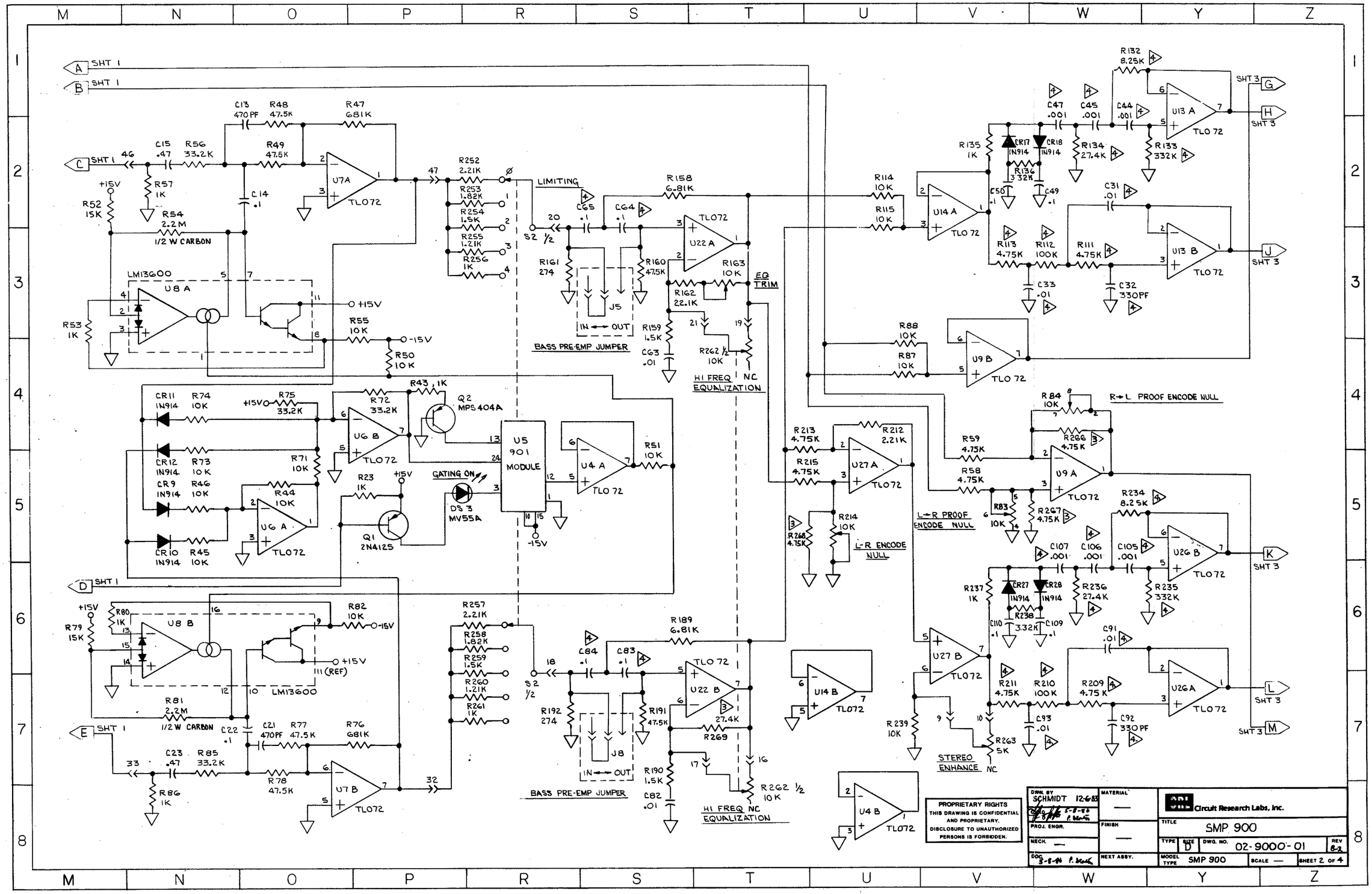
COMPONENT DESIGNATOR		
FIRST	LAST	DELETED
C1	C127	
CR1	CR28	
DS1	DS14	
J1	J8	
L1	L16	
Q1	Q20	
R1	R276	
S1	S4	
T1	T2	
U1	U27	
VR1	VR2	

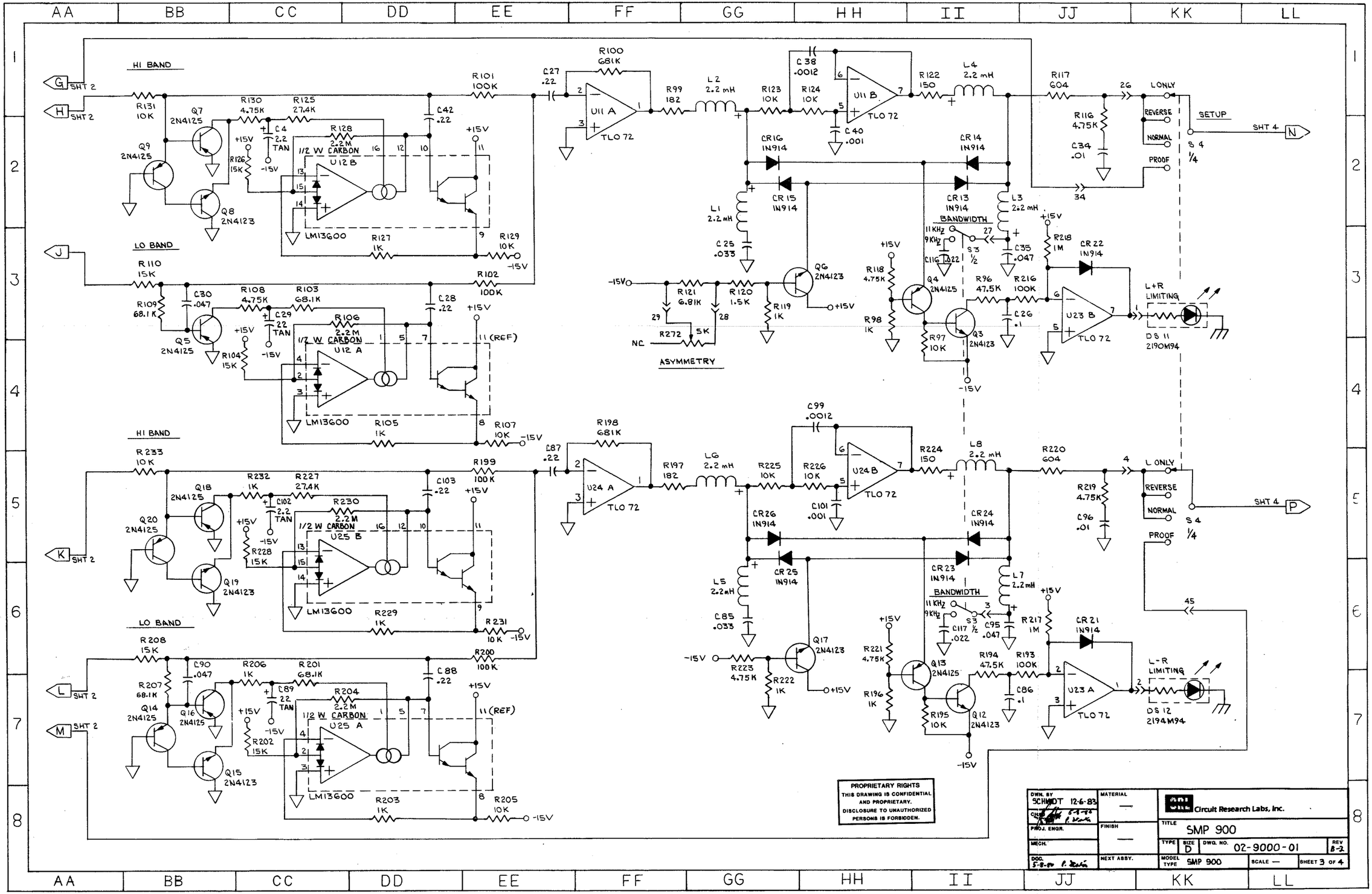
REVISIONS					
REV	DATE	DESCRIPTION	DFTSMN	ENGR	ECN
B-1	5-8-86	Correct designation error Released for production	P. Stein	—	
B-2	7-15-86	Released per ECN 10055, 10058			10055 10058

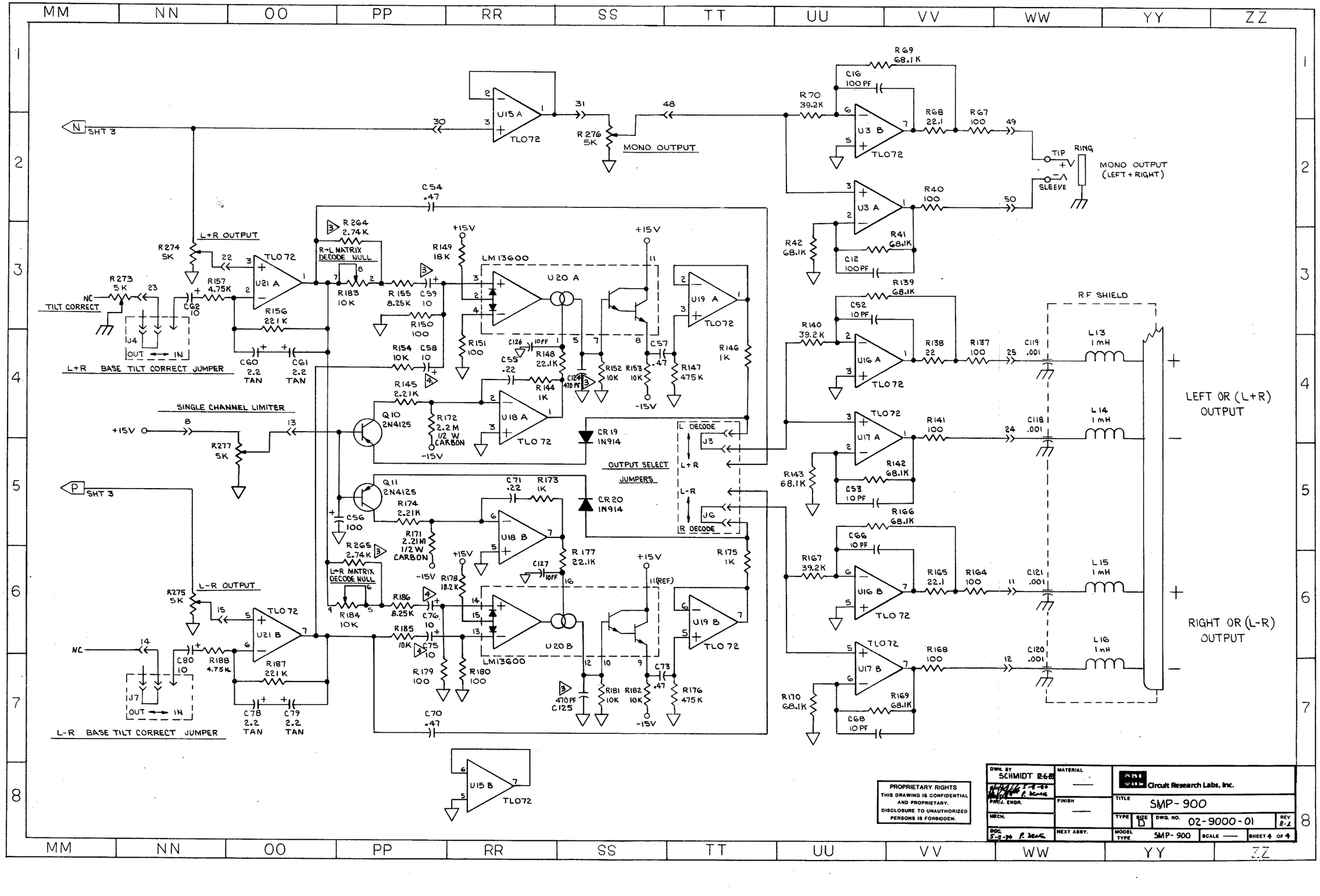
DWN. BY SCHMIDT 12-6-83
CHKD. P. Stein 5-8-86
PROJ. ENGR.
MECH. —
DOC. 5-8-86 P. Stein

MATERIAL —
FINISH —
NEXT ASSY.

Circuit Research Labs, Inc.
TITLE SMP-900
TYPE D SIZE D DWG. NO. 02-9000-01 REV B-2
MODEL TYPE SMP-900 SCALE — SHEET 1 OF 4


A SHT 1
B SHT 1
C SHT 1
D SHT 1
E SHT 1
C13 470PF
R48 47.5K
R47 681K
C15 .47
R56 33.2K
R49 47.5K
U7A TL072
R57 1K
R52 15K
+15V
R54 2.2M
1/2 W CARBON
C14 .1
R252 2.21K
R253 1.82K
R254 1.5K
R255 1.21K
R256 1K
LIMITING
S2 1/2
CG5 .1
CG4 .1
R158 6.81K
TL072 U22 A
R161 274
R160 47.5K
J5
IN OUT
BASS PRE-EMP JUMPER
R163 10K
EQ TRIM
R162 22.1K
R159 1.5K
CG3 .01
R262 1/2 10K
HI FREQ EQUALIZATION
NC
LM13600 U8 A
R53 1K
R55 10K
-15V
R50 10K
CR11 IN914
R74 10K
R75 33.2K
R72 33.2K
R43 1K
Q2 MPS 404A
U6 B TL072
CR12 IN914
CR9 IN914
R73 10K
R46 10K
R71 10K
R44 10K
U6 A TL072
CR10 IN914
R45 10K
R23 1K
Q1 2N4125
GATING ON
DS 3 MV55A
U5 901 MODULE
U4 A TL072
R51 10K
R80 1K
U8 B
R79 15K
R82 10K
+15V
111 (REF)
LM13600
R81 2.2M
1/2 W CARBON
C22 .1
C21 470PF
R77 47.5K
R76 681K
C23 .47
R85 33.2K
R78 47.5K
R86 1K
U7 B TL072
R257 2.21K
R258 1.82K
R259 1.5K
R260 1.21K
R261 1K
S2 1/2
C84 .1
C83 .1
R189 6.81K
TL072 U22 B
R192 274
R191 47.5K
J8
IN OUT
BASS PRE-EMP JUMPER
R269 27.4K
R190 1.5K
C82 .01
R262 1/2 10K
HI FREQ NC EQUALIZATION
R114 10K
R115 10K
U14 A TL072
R135 1K
CR17 IN914
CR18 IN914
R136 3.32K
C50 .1
C49 .1
R132 8.25K
C47 .001
C45 .001
C44 .001
U13 A TL072
R134 27.4K
R133 332K
SHT 3 G
H SHT 3
C31 .01
R113 4.75K
R112 100K
R111 4.75K
U13 B TL072
C33 .01
C32 330PF
J SHT 3
R88 10K
R87 10K
U9 B TL072
R213 4.75K
R212 2.21K
R215 4.75K
U27 A TL072
R214 10K
L-R ENCODE NULL
R268 4.75K
L-R PROOF ENCODE NULL
R84 10K
R→L PROOF ENCODE NULL
R59 4.75K
R58 4.75K
R266 4.75K
U9 A TL072
R83 10K
R267 4.75K
R234 8.25K
C107 .001
C106 .001
C105 .001
U26 B TL072
K SHT 3
R237 1K
CR27 IN914
CR28 IN914
R238 3.32K
C110 .1
C109 .1
R236 27.4K
R235 332K
C91 .01
U27 B TL072
R211 4.75K
R210 100K
R209 4.75K
U26 A TL072
L SHT 3
C93 .01
C92 330PF
R263 5K
M SHT 3
R239 10K
STEREO ENHANCE
U14 B TL072
U4 B TL072
PROPRIETARY RIGHTS
THIS DRAWING IS CONFIDENTIAL AND PROPRIETARY. DISCLOSURE TO UNAUTHORIZED PERSONS IS FORBIDDEN.
DRN. BY SCHMIDT 12-6-83
CHK. 5-8-84 P. Beck
PROJ. ENGR.
MECH. —
DOC 5-8-84 P. Beck
MATERIAL —
FINISH —
NEXT ASSY.
Circuit Research Labs, Inc.
TITLE SMP 900
TYPE D SIZE DWG. NO. 02-9000-01 REV B-2
MODEL TYPE SMP 900 SCALE — SHEET 2 OF 4


HI BAND
LO BAND
G SHT 2
H SHT 2
J
K SHT 2
L SHT 2
M SHT 2
R131 10K
Q7 2N4125
Q9 2N4125
Q8 2N4123
R130 4.75K
R125 27.4K
C4 2.2 TAN
R128 2.2M 1/2 W CARBON
U12 B
LM13600
R126 15K
R127 1K
R129 10K
R101 100K
C42 .22
R110 15K
R109 68.1K
Q5 2N4125
C30 .047
R108 4.75K
R103 68.1K
C29 22 TAN
R106 2.2M 1/2 W CARBON
U12 A
R104 15K
R105 1K
R107 10K
R102 100K
C28 .22
11 (REF)
R233 10K
Q18 2N4125
Q20 2N4125
Q19 2N4123
R232 1K
R227 27.4K
C102 2.2 TAN
R230 2.2M 1/2 W CARBON
U25 B
R228 15K
R229 1K
R231 10K
R199 100K
C103 .22
R208 15K
R207 68.1K
Q14 2N4125
Q16 2N4125
Q15 2N4123
C90 .047
R206 1K
R201 68.1K
C89 22 TAN
R204 2.2M 1/2 W CARBON
U25 A
R202 15K
R203 1K
R205 10K
R200 100K
C88 .22
R100 681K
C27 .22
U11 A
TLO 72
R99 182
L2 2.2 mH
R123 10K
R124 10K
C38 .0012
C40 .001
U11 B
R122 150
L4 2.2 mH
R117 604
R116 4.75K
C34 .01
26
LONLY
REVERSE
NORMAL
PROOF
SETUP
S4 1/4
SHT 4 N
34
CR16 IN914
CR14 IN914
CR15 IN914
CR13 IN914
L1 2.2 mH
C25 .033
L3 2.2 mH
BANDWIDTH
11 KHz
9 KHz
S3 1/2
C116 .022
C35 .047
R218 1M
CR22 IN914
R121 6.81K
R120 1.5K
R119 1K
Q6 2N4123
R272 5K
NC
ASYMMETRY
R118 4.75K
R98 1K
Q4 2N4125
R97 10K
Q3 2N4123
R96 47.5K
R216 100K
C26 .1
U23 B
TLO 72
L+R LIMITING
DS 11 2190M94
R198 681K
C87 .22
U24 A
TLO 72
R197 182
L6 2.2 mH
R225 10K
R226 10K
C99 .0012
C101 .001
U24 B
R224 150
L8 2.2 mH
R220 604
R219 4.75K
C96 .01
4
L ONLY
REVERSE
NORMAL
PROOF
SETUP
S4 1/4
SHT 4 P
45
CR26 IN914
CR24 IN914
CR25 IN914
CR23 IN914
L5 2.2mH
C85 .033
L7 2.2mH
BANDWIDTH
11 KHz
9 KHz
S3 1/2
C117 .022
C95 .047
R217 1M
CR21 IN914
R221 4.75K
R196 1K
Q13 2N4125
R195 10K
Q12 2N4123
R194 47.5K
R193 100K
C86 .1
U23 A
TLO 72
L-R LIMITING
DS 12 2194M94
R223 4.75K
R222 1K
Q17 2N4123
+15V
-15V
PROPRIETARY RIGHTS
THIS DRAWING IS CONFIDENTIAL AND PROPRIETARY.
DISCLOSURE TO UNAUTHORIZED PERSONS IS FORBIDDEN.
DWN. BY SCHMIDT 12-6-83
CHK'D
PROJ. ENGR.
MECH.
DOC. 5-8-84
MATERIAL —
FINISH —
NEXT ASSY.
Circuit Research Labs, Inc.
TITLE SMP 900
TYPE D
SIZE
DWG. NO. 02-9000-01
REV B-2
MODEL TYPE SMP 900
SCALE —
SHEET 3 OF 4



PROPRIETARY RIGHTS
THIS DRAWING IS CONFIDENTIAL AND PROPRIETARY. DISCLOSURE TO UNAUTHORIZED PERSONS IS FORBIDDEN.

DWN. BY SCHMIDT 12-6-88	MATERIAL —	Circuit Research Labs, Inc.	
PROJ. ENGR. 5-9-90 P. Sears	FINISH —	TITLE SMP-900	
MECH.	NEXT ASSY.	TYPE B · DWG. NO. 02-9000-01 · REV B-1	
BOM 5-9-90 P. Sears		MODEL TYPE SMP-900 · SCALE — · SHEET 4 OF 4	