

Operating Manual

OPTIMOD-TV

Model 8180A

orban

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U.S. Patents #4,208,548 and #4,249,042, other patents pending

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Registration Card

The original purchaser should have received a postpaid Registration Card packed with this manual.

Registration is of benefit to you because it enables us to tell you of new applications, possible performance improvements, service aids, etc., which may be developed over the life of the product. It also provides us with the date of sale so that we may more promptly respond to possible claims under Warranty in the future (without having to request a copy of your Bill of Sale or other proof of purchase).

Please fill in the Registration Card and return it to us.

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Fig. 1: REGISTRATION CARD

Warranty

The Warranty, which applies only to the first end-user of record, is stated on the Warranty Certificate on a separate sheet packed with this manual. Save it for future reference.

Details on obtaining factory service are provided in **Part C**.

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Preface

Despite its weight, this Manual is intended to be concise and easy to use. It is organized into two major sections. The first contains information on how to plan your installation, how OPTIMOD-TV interfaces with other station equipment, how to set up and adjust OPTIMOD-TV, how to do a Proof of Performance, and brief comments on routine maintenance. You should read Parts 1, 2, and 3 before attempting to install OPTIMOD-TV.

The second section contains Appendices which provide useful information that you may need at some time during the life of OPTIMOD-TV. This is primarily reference material, and you do not need to digest it to install, set up, or operate your unit.

There is no Index, so the TABLE OF CONTENTS should be used to help you find the information you want. The TABLE OF CONTENTS provides an overview of the organization of the manual, and lists in some detail the topics discussed.

Packing Material: The carton in which your OPTIMOD-TV was shipped was carefully designed to prevent shipping damage. You may wish to save the carton and all packing material in case you ever have to re-ship the OPTIMOD-TV chassis.

Security (Keys and Locks): To control access to the setup controls, the access door is fitted with a lock. Two keys are supplied. These can be duplicated as desired.

The dealer from whom your OPTIMOD-TV was purchased can supply additional keys, as can the factory. In either case, your Registration Card must be on file at the factory, and you must supply your serial number to obtain replacement keys.

If all keys are lost, you can obtain access by removing the three hex-socket screws from the top of the front panel with a 5/64" hex wrench (one was supplied with the unit). The panel will then tilt downward.

If you wish to make the unit's adjustments more secure, obtain similar splined-socket or aircraft tri-point screws (and tools), and use these in place of the hex-socket screws supplied. (Tools for these are not commonly found in hardware stores.) The screws are 6-32 x 3/8" 82 degree Flat-Head, nickel-plated steel.

Part I: Introduction

1

Function of OPTIMOD-TV: OPTIMOD-TV is an integrated signal-processing system which replaces conventional compressors, limiters, and clippers. It is an adaptation of the OPTIMOD-FM Model 8100A to TV audio, and offers the TV broadcaster the same superb audio quality that has made the 8100A so popular among FM radio broadcasters.

Briefly, the OPTIMOD-TV system performs the following functions:

1. It rides gain over a range of as much as 25dB, compressing dynamic range and compensating for gain riding errors on the part of operators. The amount of dynamic range reduction ordinarily produced is adjustable. When OPTIMOD-TV is operated at its optimum release time setting, gain riding and compression are virtually undetectable because of advanced program-controlled time constants, level-dependent gating, and multiband compression.
2. It controls potential interference to video and/or future stereo services by means of bandwidth-limiting 15kHz lowpass filters incorporating full overshoot compensation. OPTIMOD-TV thus provides extremely tight control over peak modulation, preventing overmodulation and controlling its output spectrum simultaneously.
3. The OPTIMOD-TV compressor is a dual-band design which can be operated with the bands independent of each other ("independent"), or such that the bands are coupled and ordinarily track each other ("wideband"). When operated in "independent" mode, OPTIMOD-TV can make audio quality more consistent by correcting frequency balances between bass and midrange material. When operated in "wideband" mode, OPTIMOD-TV will preserve frequency balances and will produce an output which sounds like its input.
4. OPTIMOD-TV prevents peak overload and overmodulation due to the effects of the preemphasis curve.

Each part of the OPTIMOD-TV system has been precisely engineered to be compatible with all other parts to achieve optimum performance. The basic OPTIMOD-TV is a stereo unit with active balanced +10dBm outputs. Internal jumpers determine if the output is to be flat or preemphasized.

In general, OPTIMOD-TV should be fed unprocessed audio. However, additional compression and/or other audio processing may be desirable if applied to individual microphone channels in a live production environment, or to other sources requiring special processing.

OPTIMOD-TV as ordinarily sold is fully equipped for stereo operation in anticipation of the approval of stereo standards. Little cost would be saved by eliminating components for the second channel, and future conversion would be somewhat inconvenient. In addition, the second channel provides a certain measure of redundancy and permits utilization of card-swapping techniques to diagnose problems.

An accessory port is available to interface the noise reduction encoder which will probably be required as a part of any multiplex TV stereo system. In addition, an external TV stereo generator will be required.

Comparison With OPTIMOD-FM: OPTIMOD-TV (Model 8180A) is conceptually similar to OPTIMOD-FM (Model 8100A). If you are familiar with the 8100A, this comparison may be of interest. If you are not, no reference to the 8100A is required; this Manual accurately describes the features and circuitry of OPTIMOD-TV, beginning with the **Simplified System Description**, below.

The following characteristics are different:

- The stereo generator (Card #7) has been replaced with a two-channel audio output buffer card, as the stereo generator to be used for TV stereo is expected to be significantly different than the stereo generator required for the current FM standards. The TV stereo generator will be purchased as a separate chassis upon approval of a TV stereo system.
- The output wiring (including the RFI filter card) has been changed to accommodate stereo audio.
- Since the stereo generator is omitted, the STEREO/MONO mode switch and indicator lamp have been excluded. The rotary switch controlling the diagnostic VU meter excludes positions relating to the stereo generator but has new monitor points for the system outputs.
- The compressor gating circuitry has been altered to prevent the compressor's gain from recovering beyond -10dB in absence of program. This prevents noise rush-up, especially when the audio source is 16mm optical film.

(The gain of the 8100A was permitted to slowly recover to 0dB since source material used in FM is typically much quieter.)

To avoid operator confusion, three of the four Gain Reduction meters (Total Master G/R, Compressor Master G/R, and Total Bass G/R) have new scales where 10dB gain reduction is represented as "0dB".

Split Configuration: An alternate, dual-chassis system configuration permits the Dual-Band Compressor to be operated separately from the remainder of the circuitry. This permits placing the Dual-Band Compressor at the studio side of the STL (telephone line, dual microwave, or FM subcarrier on a video STL) to protect the STL from overmodulation.

This configuration consists of an OPTIMOD-TV Model 8180A in conjunction with an Accessory Chassis (with power supply) and two jumper cards. Cards #3, #4, and #5 are removed from the 8180A (Main) Chassis and placed in the Accessory Chassis. Card slots #3 and #4 in the Main Chassis are then fitted with the jumper cards. The Accessory Chassis is known as the Model 8180A/ST.

If the gain between the output of the Accessory Chassis and the input of the Main Chassis cannot be maintained within a 0.75dB window, we recommend using the full single-chassis OPTIMOD-TV at the transmitter, and using an Orban Compressor/Limiter at the studio side of the STL to protect against STL overload. The studio compressor/limiter is adjusted so that gain reduction is not produced unless excessive levels are output from the switcher or console.

Simplified System Description: OPTIMOD-TV consists of six basic blocks:

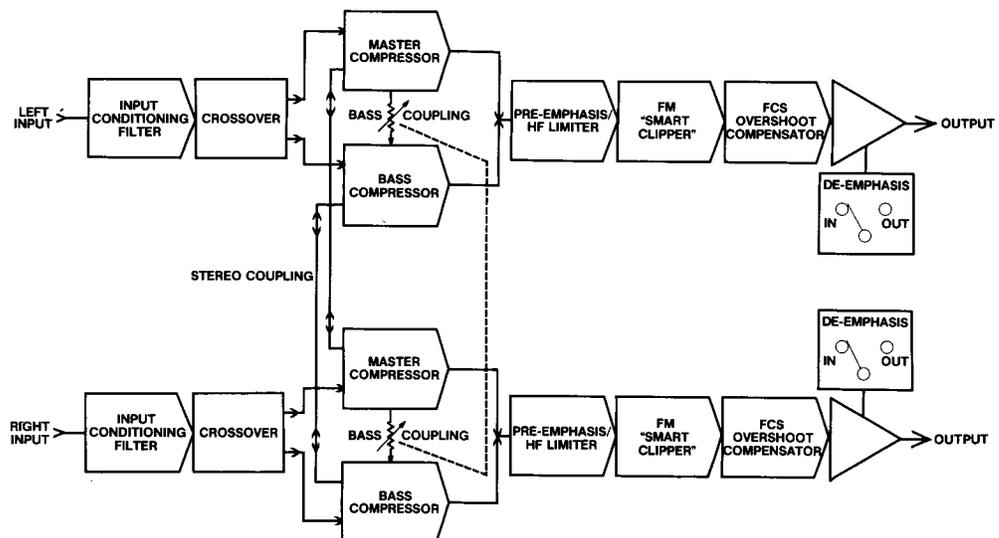


Fig. 1-2: BLOCK DIAGRAM

1. Input Conditioning Filter: This consists of an allpass phase scrambler to make peaks more symmetrical (thus reducing clipping distortion and permitting higher loudness), and a 30Hz 18dB/octave highpass filter to prevent subsonic information from disturbing the operation of the audio processing or exciters' AFC's. Even if an AFC doesn't unlock, it can attempt to "track" subsonic information, thus producing IM distortion. The 30Hz highpass filter can be defeated (although we have purposely made it slightly inconvenient to do so); the phase scrambler is an essential part of the system and is non-defeatable.

2. Dual-Band Compressor: This consists of two compressors in parallel: "Bass" which processes audio below 200Hz (12dB/octave crossover), and "Master" which processes above 200Hz. A BASS COUPLING control adjustable by the user determines if the two bands will operate discriminately ("independent" mode), or if the "Bass" band will be forced to track the "Master" band ("wideband" mode), thus preserving frequency balances. Intermediate bass coupling settings are also available.

Even in "wideband" mode, the bass control loop is still active. Therefore, heavy bass will cause a momentary reduction in the gain of the "Bass" band rather than forcing gain reduction of the entire signal (as in a true wideband system), thus avoiding pumping.

Time constants and other parameters of the Dual-Band Compressor have been adjusted so that the summed and preemphasized output of the two bands can be directly applied to the FM "Smart Clipper" (TM). No further gain reduction is required for distortion control, and maximum naturalness is preserved.

The release time of the "Master" band only is adjusted with the RELEASE TIME control, thus permitting loudness/fatigue tradeoffs according to your needs.

Gain reduction in both "Master" and "Bass" compressors is metered by edgewise-reading meters calibrated with a dB-linear scale. To indicate that the normal gain reduction is 10dB, this point has been calibrated as "0dB gain reduction" on the meters, with the scale extending from +10 to -15dB gain reduction.

No attempt has been made to make these meters extremely accurate. Their readings may disagree with the actual gain reduction by as much as ±2dB. This accuracy is fully adequate for the purpose, since the amount of gain reduction varies widely with variations in program material and operator gain riding.

A GATING function is provided which prevents noise rush-up during program pauses (particularly with noisy 16mm optical sound tracks) and makes the 25dB gain reduction range usable. The GATING function is designed such that the gain does not get "stuck" forever in the 0 to 15dB gain reduction region, so low-level program material is eventually increased in level. Since gain recovery is slow in GATED mode, the gradual increase in level is essentially imperceptible.

In GATED mode (GATE lamp illuminated) and "wideband" mode, it is normal for the meters to drift slowly to "0". In "independent" mode under GATED conditions, the TOTAL BASS G/R meter normally drifts slowly to between "0" and "+10". (See **Release Time And Amount Of Gain Reduction** in Part 5 for a complete explanation.)

The meters will recover towards "+10" when the program material is above the gate threshold but of a level insufficient to produce 10dB G/R.

The output level of the compressor is determined by the CLIPPING control. This control sets the drive level to the subsequent high-frequency limiter and clipper, thus determining the amount of limiting and clipping.

3. Preemphasis And High Frequency Limiter: The summed outputs of the two compressors are applied to a phase corrector, 24dB/octave 15kHz lowpass filter, preemphasis network, and high-frequency limiter. The purpose of the lowpass filter is to prevent out-of-band components from affecting the operation of the high-frequency limiter and to avoid intermodulation between out-of-band frequency components and in-band frequency components in the clipper. Phase correction reduces the peak level increase caused by filter ringing and preemphasis to the theoretical minimum, thus reducing the amount of clipping.

The high-frequency limiter is controlled by high frequencies only (rather than by the peak level of the preemphasized signal), thus eliminating any possibility of modulation of high frequency content by low frequency material.

The threshold of limiting of the high-frequency limiter is user-adjustable over a 3dB range, permitting brightness and high frequency distortion to be traded off according to your needs. Because the FM "Smart Clipper" incorporates IM distortion cancellation, substantially more clipping can be accomplished without objectionable distortion than in conventional systems, and significantly improved high frequency power handling capability is achieved.

4. FM "Smart Clipper" (TM): The "Smart Clipper" provides the peak limiting function, and contains filters to assure that the clipping does not introduce out-of-band frequency components above 19kHz.

The output of the high frequency limiter is applied to a clipper with automatically-varying threshold. This clipper performs the basic peak limiting function. The output of the clipper is subtracted from its input, thus deriving the distortion added by the clipper. This distortion component is lowpass filtered at 2.2kHz (the knee of the 75us preemphasis curve), and then added to the clipped signal. This "smoothing signal" cancels all clipper-induced distortion below 2.2kHz by 30dB or more, and is particularly effective in eliminating the effects of high-frequency IM, such as sibilance splatter.

The 2.2kHz distortion-cancelling lowpass filter has a time delay. To assure proper distortion cancellation, the main clipped signal must be delayed by an equal amount before the main signal and distortion-cancelling signal are added. The main signal is delayed by a phase-corrected 15kHz lowpass filter, which also removes all out-of-band harmonics caused by the clipping process.

5. Frequency-Contoured Sidechain (FCS) Overshoot Corrector: The output of the "Smart Clipper" contains overshoots due to the addition of the distortion-cancelling signal, and to unavoidable overshoots in the 15kHz filter. These overshoots must be eliminated without adding out-of-band frequency components. This is done in the FCS Overshoot Corrector.

The FCS circuit first derives that part of the signal exceeding the 100% modulation point by means of a "center-clipper". If these overshoots were then subtracted from the input signal, the overshoots would be cancelled — in fact, doing so would be equivalent to simple clipping. Unfortunately, this can't be done because the overshoots contain out-of-band frequency components.

The overshoots are therefore lowpass filtered to eliminate out-of-band components. If the overshoot filter had a flat response to its cutoff frequency, this filtering action would reduce the amplitude of high-frequency overshoots (by removing out-of-band harmonics which make the overshoots "spikey"). This would result in incomplete cancellation of the overshoots after subtraction. The overshoot filter is therefore designed to have a rising response at 15kHz, effectively increasing the gain of the fundamentals of the higher-frequency overshoots and compensating for the fact that their harmonics have been removed. The overshoot extractor and this filter are the "Frequency-Contoured Sidechain".

The overshoot filter has phase shift. Phase shift networks are therefore included in the main path to make sure that the overshoot subtraction process works correctly, and that the overall FCS system has constant time delay.

The rising response of the overshoot filter means that essentially no extra subtraction gain (compared to the system operated without the filter as a simple differential clipper) is required. Any low frequency IM introduced by the FCS circuit is therefore no worse than the low-frequency IM caused by a simple clipper.

Because the FCS circuit is an instantaneous system and uses no gain reduction or dynamic filtering, it causes neither pumping nor dulling of program material.

6. Output Amplifier/Deemphasis: At the output of the Overshoot Corrector, the signal is peak-controlled and preemphasized. This output is applied to a balanced transformerless line amplifier with strappable deemphasis.

Best system peak control is obtained by defeating exciter preemphasis and applying the preemphasized signal from OPTIMOD-TV to the flat exciter. However, in some systems it is extremely inconvenient to defeat the exciter's preemphasis, and the exciter must be supplied with a "flat" (i.e., deemphasized) signal from OPTIMOD-TV.

The outputs of the line amplifiers are interfaced to the outside world through non-overshooting RFI filters effective from approximately 500kHz to 1GHz.

VU Meter: The front-panel VU meter can monitor the audio level at several different points in the circuitry as selected by the METER switch. (See **Block Diagram** in **Appendix J** for metering points.)

Summary: OPTIMOD-TV is an integrated "system approach" to ride gain, perform compression as desired, and control peaks by high-frequency limiting, distortion-cancelling clipping, and bandlimited overshoot correction. This optimizes technical parameters to their practical limit while producing a sound at the viewer's ear which is perceived as natural, pleasant, and free from the processing artifacts that often plague other signal processing approaches.

This concludes the **Introduction and Simplified System Description**. The next part of this Manual (**Application**) should now be read carefully to assure that your installation produces optimum results.

Part 2: Applications

This Part of the Manual provides essential information on how OPTIMOD-TV fits in with the rest of the equipment at your station.

2

Studio/Transmitter Links: There are five types of studio/transmitter links (STL's) in common use internationally in TV audio service, whether single- or multi-channel. These are:

- 1) Analog land-lines (telephone lines);
- 2) 50-15,000 Hz microwave STL's (single or dual);
- 3) Composite baseband microwave STL's (stereo service);
- 4) Composite video/audio microwave STL's; and
- 5) PCM (Pulse-Code Modulation) links.

All except (3) carry the audio either directly or in some encoded form other than the stereo baseband to be found in TV multiplex stereo service (once approved). These links are ordinarily fed audio in non-encoded form, and their receiver output is audio. In the case of (4), the audio is placed on an FM subcarrier above the video baseband.

The composite STL (3) carries the multiplexed stereo baseband, and is therefore fed from the output of a stereo generator. The receiver output of the composite STL is the stereo baseband signal, which is applied directly to wideband input of the TV transmitter's aural exciter.

In general, highest quality is obtained by use of a composite microwave STL (3) or video/audio microwave STL (4) provided that a line-of-sight transmission path of less than 10 miles or so exists between studio and transmitter. If not, RF signal-to-noise ratio, multipath distortion, and diffraction effects can cause serious quality problems.

The 50-15,000Hz microwave system (2) provides more noise immunity than composite systems. However, problems include gain- and phase-matching of the left and right channels in stereo service, preemphasis-induced overloads, and a requirement that the audio applied to the microwave transmitters be processed to prevent their overmodulation.

Land-line (1) quality is extremely variable, ranging from excellent to atrocious. The decision on whether to employ land-lines depends a great deal on the line quality locally available. However, even the best land-lines tend to slightly veil audio quality due to line equalizer characteristics, phase shifts, and repeaters of indifferent quality.

PCM links (5) are generally unavailable in the USA as of this writing, although they are widely used in Europe. They achieve good noise performance and consistency at the expense of a very sharp high-frequency cutoff, rapid changes in group delay around cutoff (unless elaborate phase equalization is used), and quantization distortion. At the moment, there is considerable disagreement over how elaborate the coding must be to render quantization distortion inaudible to critical listeners, and no PCM system should be accepted without critical listening tests.

OPTIMOD-TV is available in either single- or dual-chassis configurations. The dual-chassis splits the system at a point between the output of the Dual-Band Compressor and the input of the high-frequency Limiter.

The dual-chassis (split) configuration is ordinarily used with STL's of types (1), (2), (4), and (5) of modest performance characteristics. By performing initial compression before the STL input, the dual-chassis version can prevent STL overload and can aid in achieving superior STL signal-to-noise ratio. (See the **Introduction** for further information.)

Locating the high-frequency limiter and peak limiting sections at the transmitter can minimize the potential for peak level increases caused by subsequent passage of the peak-limited signal through transformers, filters, and other devices with non-linear group delay. Modulation is thus more tightly controlled and higher average levels can be obtained, optimizing receiver signal-to-noise ratios and minimizing the audible effects of such problems as intercarrier buzz and incidental phase modulation in CATV and MATV systems.

The single-chassis configuration is suited for any microwave STL whose group delay is essentially constant from 50-15,000Hz, whose -3dB low frequency cutoff point is below 5Hz, and whose response above 15,000Hz rolls off in an approximately Gaussian manner. In many ways, the requirements are similar to the requirements for high-quality video transmission with the exceptions that much narrower bandwidth is required and more stringent limits are placed on noise and non-linear distortion.

While many audio frequency microwave STL's do not have these characteristics as delivered from their manufacturers, modifications to achieve them are often trivial, involving increasing the size of coupling capacitors and eliminating input and output transformers, replacing them with modern active input and output stages.

The single-chassis configuration is also suited for installations where studio and transmitter are at the same site or are connected by short, high-quality lines. Because it is less expensive than the dual-chassis version, the single-chassis version is also suited for use with any STL having extremely wide dynamic range (80dB or better) such that unprocessed audio can be passed to the compressor without danger of noise build-up when the compressor's gain increases towards its maximum.

It is important to note that the compressor section alone does not control peak levels accurately, and does not compensate for overloads caused by preemphasis. (Peak limiting and high frequency limiting are performed later in the system.) It is therefore necessary to allow headroom in the STL to accommodate compressor overshoots. If the STL is preemphasized at 50 or 75us (as is the case with many 50-15,000Hz microwave systems), further headroom must be allowed to accommodate the peak level increases caused by the preemphasis. Precise STL setup recommendations are provided in **Part 4 (Setup)** of this Manual.

If STL preemphasis can be readily modified, use of 25us preemphasis will match headroom to the typical spectral distribution of contemporary program material, thus achieving optimum STL signal-to-noise ratio.

Exciters: OPTIMOD-TV will interface with all TV aural exciters, whether direct-FM or phase modulation. However, it is important to realize that modern solid-state direct-FM aural exciters provide both vastly improved reliability and audible improvements in sound quality when compared to older designs (particularly phase modulators), and such older exciters should be retired if at all possible. In addition, phase-modulator exciters will almost certainly be unsuited to stereo TV broadcasting.

The discussion above regarding microwave STL performance requirements (to correctly handle the peak-limited OPTIMOD-TV output without increasing peak levels uncontrollably) applies also to aural exciters. While the output of OPTIMOD-TV is supplied strapped for "flat" (requiring use of the exciter's internal preemphasis network), far more accurate results are obtained if the exciter's input transformer, preemphasis network, and any bandwidth-limiting filters are entirely bypassed, and the preemphasized output of OPTIMOD-TV is introduced as close to the modulator stage as practical. Some exciters have an auxiliary or "test" input available for this purpose.

Instructions on how to restrap the OPTIMOD-TV output for preemphasized operation are provided in **Part 3 (Installation)** of this Manual.

Noise Reduction: OPTIMOD-TV can be interfaced to a noise reduction encoder to produce the encoded broadcasts which will probably be required in future stereo service.

To interface a noise reduction encoder, stations with single-chassis OPTIMOD-TV's should order the "Dolby Interface Connector Kit" from Orban. This can be supplied factory-installed if ordered at time of OPTIMOD-TV purchase. Stations using the dual-chassis OPTIMOD-TV do not need a special interface, as the noise reduction encoder is connected to the output of the Accessory 8180A/ST Chassis, and the encoder's output is connected to the STL.

Additional Aural Subcarriers: OPTIMOD-TV operates well with subcarriers because OPTIMOD-TV provides excellent baseband spectrum control, thus protecting that part of the baseband occupied by the subcarrier. No special subcarrier precautions need be taken; the subcarrier should be implemented according to the instructions of the exciter manufacturer.

Older aural exciters may not have separate subcarrier inputs. In most cases, one can be added simply by passively summing into the modulated oscillator through a resistor and small capacitor. Note, however, that such older exciters often suffer from narrow RF bandwidths which may cause subcarrier "birdies" due to intermodulation.

Stereo: All OPTIMOD-TV mainframes are fully equipped for stereo.

It is important to note that OPTIMOD-TV has only one control circuit which adjusts the gain reduction of both stereo channels based on the higher of the two. It is therefore unsuited for dual-mono operation (such as biligual programming).

Part 3: Installation

Registration Card: If you have not already done so, please fill out the Registration Card fully and mail it to the factory. (See Preface.)

Unpacking And Initial Inspection: You are now ready to proceed with unpacking and installation of your OPTIMOD-TV.

Sometime during the life of your OPTIMOD-TV, you may wish to re-ship or return it. Since it is expensive and heavy, it is advisable to ship it only in the original packing materials which have been carefully designed to protect it. For this reason, it is wise to mentally note the method of packing and to save all packing materials.

Sage advice for repacking and reshipping your unit is contained at the end of **Appendix F**.

Various items are packed with OPTIMOD-TV:

- (1) Line Cord
- (4) 10-32x3/4" Rack Screws
- (1) 3-wire AC Adapter
- (1) Operating Manual
- (1) 5/64" Allen Wrench (for front panel screws)
- (2) Keys For Adjustment Door
- (2) 620 ohm $\pm 5\%$ 1/4 watt carbon film resistors (for input termination if required)

Physical Examination: Perform a general inspection of the perimeter of the unit to check for obvious damage.

DAMAGE CLAIMS MUST BE MADE BY YOU AGAINST THE CARRIER IMMEDIATELY UPON DISCOVERY. Save packing and other evidence of damage for the carrier's inspector.

Set the unit on a flat, soft surface. Remove the three hex-socket screws at the top of the front panel using the wrench provided. The front panel, which is hinged at the bottom, will then tilt downward and reveal the interior. Look for IC's or other loose parts which may have fallen out during shipment.

Remove the subpanel through which the controls protrude by twisting the four DZUS fasteners 1/4 turn counterclockwise. Tilt the panel to remove it. This reveals the "card cage".

Various components are mounted in sockets for servicing convenience. It is possible that a component could be dislodged by heavy shocks in shipment.

Starting at the left, using the card ejector tabs, carefully remove each card in turn, examine it, and replace it. Make sure that all components are properly seated in their sockets. Check with particular care to make sure that none of the IC's are held in their sockets by one row of leads only.

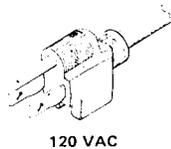
Power Considerations: OPTIMOD-TV will operate on 115/230V $\pm 15\%$ 50-60Hz AC power. Due to the conservative design of the power supply, it should also operate properly on 208 volt service.

Without applying power to the line cord, turn the power switch ON and check the position of the LINE VOLTAGE SELECTOR switch. All units are shipped with this switch in the "115 Volt" position. Adjust the selector switch so that the appropriate voltage is indicated. (If OPTIMOD-TV is installed within a transmitter, 208/230V may be the only power available.) Check the fuse, and replace with the following values if necessary:

115 VOLT: 1/2 amp SLO-BLO, 3AG-type (as supplied);
 208/230 VOLT: 1/4 amp SLO-BLO, 3AG-type.

AC connection to the chassis is made through an RF filter with IEC-standard mains connector. This filter is designed to meet the standards of all international electrical safety authorities, and leaks less than 0.5mA to the chassis when operated from 230V mains.

A U.S.A.-standard "U-ground" power cord is supplied to connect to the IEC socket. Users in other countries should be able to obtain a power cord compatible with their country's standard. If you choose to cut the "U-Ground" plug from the cord and replace it with a plug appropriate to your standards, refer to Fig. 3-1 below.



Power Cord Conductor Identification		
Conductor	Color	Alternate Color
Ungrounded (Line)	Brown	Black
Grounded (Neutral)	Blue	White
Grounding (Earthing)	Green-Yellow	Green

Fig. 3-1: POWER CORD COMPATIBILITY

Initialization Options: The section describes how to change certain operating characteristics of OPTIMOD-TV to suit your needs. If your needs correspond to the "factory-standard" characteristics, then no modifications need to be made, and you may skip to **Reassembly** below.

All modifications are made on the plug-in circuit cards. If the steps above regarding physical inspection have been followed, the cards are now readily accessible.

1) **Output Preemphasis:** OPTIMOD-TV is shipped to provide a flat output, requiring use of the preemphasis network built into your aural exciter. As mentioned in **Exciters in Part 2 (Applications)**, better peak control is obtained if the exciter's input transformer, preemphasis network, and any filtering are bypassed, since OPTIMOD-TV can provide these functions with greatly improved peak-control accuracy.

Note that OPTIMOD-TV is shipped with either 75us or 50us preemphasis, depending on government requirements in the Region to which it is shipped unless ordered otherwise. Even if you are operating "flat", the HF limiter is still operating on either a 50 or 75us preemphasis curve, and "flat" operation is obtained by complementary deemphasis after the processing. Thus even with "flat" operation, this internal preemphasis and deemphasis must complement that used in the aural exciter.

Changing from 75 to 50us preemphasis or vice-versa is non-trivial, and requires changing the values of a substantial number of components. If you wish to change preemphasis in the field, please request the appropriate application bulletin from Orban Customer Service at the address on the title page.

To restrap for preemphasized output, move jumpers on Card #7 according to Fig. 3-2. Card #7 contains two active balanced output amplifiers (for stereo); thus, two jumpers must be moved.

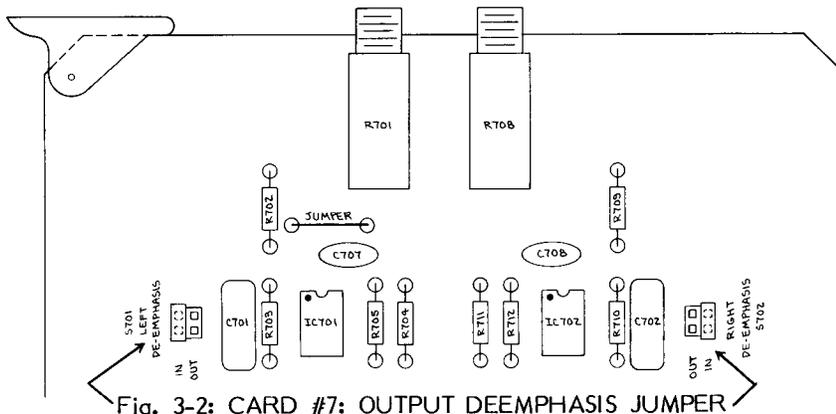


Fig. 3-2: CARD #7: OUTPUT DEEMPHASIS JUMPER

2) **Input Attenuator Pads:** OPTIMOD-TV is shipped with 20dB pads ahead of the input buffer amplifiers. These are located on Card #3 (left channel) and Card #4 (right channel), and are suited for nominal input levels from -10 to +10dBm. If lower input levels (from -30 to -10dBm) are present, the pads must be defeated. To do this, remove Cards #3 and #4. Reposition the jumper straps according to Fig. 3-3.

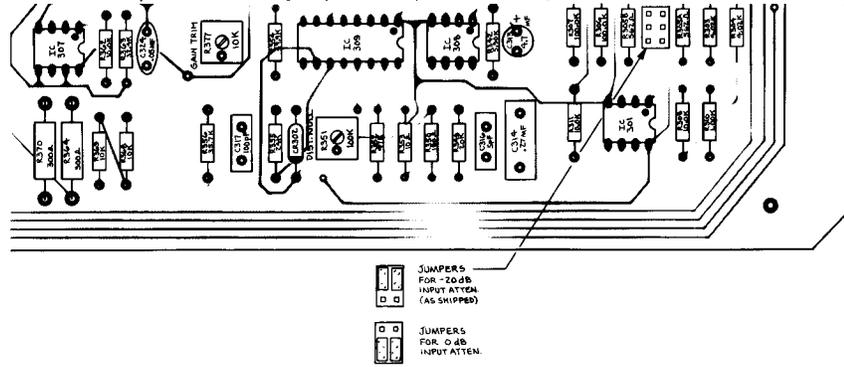


Fig. 3-3: INPUT ATTENUATOR JUMPER

3) **Defeating The 30Hz Highpass Filters:** There is no jumper plug for defeating these filters because we feel that the overall broadcast system will work better with the filters operative for reasons discussed in detail in paragraphs 1.b and 1.c of Appendix A. We recognize that there are those who will disagree. Those who wish to defeat the filters can do so by soldering a jumper wire between pins 3 and 7 of IC302 (Card #3) and IC402 (Card #4).

Reassembly: When the physical examination, line voltage adjustment, and optional initialization procedures are completed, replace the subpanel. The subpanel, besides carrying knob identification and calibrations and holding the cards in place, also provides RF shielding for the cards. So, all four DZUS fasteners should be engaged by turning 1/4-turn clockwise.

The front panel may now be closed and fastened using the three hex-socket screws. Normally, all access required from now on can be achieved through the smaller access door (equipped with a key lock).

Initial Electrical Checkout: Plug the power cord into an outlet whose voltage corresponds to the setting of the internal LINE VOLTAGE SELECTOR switch. The unit should spring to life. Check to make sure that the following events occur:

- A) The green POWER LED is illuminated;
- B) The red GATE LED is illuminated (provided that the COMPRESSOR PROOF/OP switch is in OP);
- C) Both yellow HF LIMIT LED's are off;

- D) The TOTAL MASTER, COMPRESSOR, and TOTAL BASS G/R meters drift slowly to "0", while the LIMITER G/R meter reads "0" immediately.
- E) All VU meter positions read "0%" except for "+15VDC" and "-15VDC", whose readings should correspond approximately to those printed on your "Final Factory Qualification Test Results" inserted in the front of this manual.

If anything is abnormal, repeat the **Physical Inspection** described above to make sure that you didn't miss anything. A preliminary diagnosis should be made, and, if necessary, the factory should be consulted.

If you wish to perform a more rigorous and complete checkout before installation, **Appendix D (Field Audit-Of-Performance Procedure)** provides complete instructions.

Equipment Location: OPTIMOD-TV is supplied in either single-chassis or dual-chassis versions. The dual-chassis version splits the system at the output of the Compressor. The studio chassis may be located in any convenient rack space in the studio. It is important to bear in mind that its RFI suppression is modest because it was assumed that the unit would be operated at a considerable distance from high-powered transmitters.

The main chassis, which is highly RFI-suppressed, is ordinarily located reasonably close to the transmitter's aural exciter or phase-linear STL transmitter. The chassis requires 4 units (7"/17.8cm) in a standard 19" rack.

Although a good monitoring loudspeaker system seems rare at transmitter sites, such a system which can be easily heard from the location in which OPTIMOD-TV is mounted will facilitate subjective adjustments.

Difficult Environments:

1. Where humidity is typically high, the environment should be controlled to prevent moisture from condensing on circuit cards of all plant equipment, including OPTIMOD-TV, as this can degrade performance. Using some of the exhaust from the transmitter to heat the building slightly above ambient temperature is often sufficient to prevent problems.
2. If electrical storms are frequent, it may be advisable to add suitable Varistors or other protection between each incoming wire (AC, remote control, and audio) and a solid earth ground as indicated by local experience.
3. OPTIMOD-TV has been carefully designed to operate in high-energy VHF/UHF environments and no special placement precautions need be observed unless RFI is encountered in operation.
4. Please remember that the reliability of any electronic equipment is enhanced by maintaining moderate operating temperatures. OPTIMOD-TV should never be operated in ambient above 50 degrees C (122 degrees F).

Mounting And Grounding: As a matter of good engineering practice, it is desirable that the OPTIMOD-TV chassis be properly connected to a good earth ground. Wire is totally ineffective at VHF and above; the best way to ground the OPTIMOD-TV chassis is to mount it solidly in a well-grounded rack (or the transmitter cabinet). The rack or cabinet must be connected to earth through a wide, thin copper ground strap.

To assure good electrical contact between the OPTIMOD-TV chassis and the rack, it may be necessary to scrape the paint from the rack and/or the OPTIMOD-TV mounting flanges. Measure the resistance between the OPTIMOD-TV chassis and rack, and verify that it is less than 0.5 ohm.

Input Signal Connections: These instructions apply to the audio inputs of single-chassis OPTIMOD-TV's, and to the audio inputs of both Accessory and Main Chassis' in dual-chassis OPTIMOD-TV's.

If you are operating in mono, output signal connections may be made to the left or right channels since OPTIMOD-TV is symmetrical. However, use of the left channel is customary, and later setup instructions are written assuming that the left channel is used.

IMPORTANT

3

Regardless of whether the left or right output is used, both inputs should be driven in parallel during mono operation, and both INPUT ATTEN controls should be set approximately equal. If this is not done, the range of the GATE THRESH control will be approximately 6dB higher than normal and compressor dynamic performance will suffer slightly.

It may be desirable to wire the unused output to a patch bay or even to a remote-controlled switching facility to make the unused channel available in case of a failure of the ordinarily-used channel, and to facilitate troubleshooting by the "card swap" method described in **Appendix F**.

In a high RF field, the audio input to OPTIMOD-TV must be fully-balanced, and should be run in 100% foil-shielded cable like Belden 8451. The shield should be connected to earth (chassis) ground at both ends. In addition, you should make sure that the telephone line termination box or STL receiver is properly grounded to earth.

In low-RF environments, the shield should be grounded at one end only. Audio may be run balanced for long distances, or unbalanced over distances of less than 20 feet (6m).

OPTIMOD-TV should be operated with its integral 20dB input pad for levels between -10 and +10dBm, and without the pad for levels between -30 and -10dBm. Instructions for restrapping the pads are found above in **Initialization Options**.

The OPTIMOD-TV input is balanced bridging, and its impedance is 200K with the 20dB pad defeated and 11.2K with the 20dB pad operative. If the source requires a 600 ohm termination (such as a telephone line), connect a 620 ohm $\pm 5\%$ 1/4 watt carbon film resistor across each audio input. Two such resistors are provided for your convenience.

In stereo installations, it is important that both left and right audio inputs be in phase.

This is ordinarily assured simply by connecting the red and black wires within all shielded cables symmetrically and consistently when wiring the two stereo channels. If a phasing error occurs, it will be indicated in on-air testing by the stereo monitor's indicating more L-R than L+R level.

Accessory Chassis Output Connections: In the dual-chassis configuration of OPTIMOD-TV, the output of the Accessory Chassis presents a 600 ohm pure-resistive source impedance, balanced to ground, with a nominal output level of +10dBm when loaded by 600 ohms. It is thus suited for driving a land-line directly, or for driving the balanced input of a microwave STL transmitter.

If you wish to drive an unbalanced input, connect such an input between the Accessory Chassis "+" output and circuit ground. **Do not ground the "-" output;** while no damage will occur, it will short the output of the "-" line amplifier to ground through a 300 ohm resistor.

Output Signal Connections: The outputs of OPTIMOD-TV are balanced to ground from an active source. They are designed to be loaded by an essentially resistive load of 600 ohms

$\pm 10\%$ to assure correct frequency and transient response. Some high-quality transformers are suitable. However, most transformers will degrade the pulse response of the system, and use of active input stages at the aural exciter or stereo generator is advised, as discussed in Part 2 under **Exciters**. (The output RFI suppression network was designed to have no overshoot or ringing when properly terminated).

The output should be run in 100% foil-shielded cable (like Belden 8451). See the comments on grounding in **Input Signal Connections** above.

If bypassing the exciter's input transformer, preemphasis network, and any filtering (as recommended above for best peak level control) requires that the exciter be driven unbalanced, this driving signal should be taken between the (+) output and circuit ground on the rear-panel barrier strip. Total load impedance should be 300 ohms, $\pm 10\%$. Usually, the exciter presents a reasonably high impedance when operated in this configuration, and the load must be provided by an external 300 ohm resistor (not supplied).

IMPORTANT

Do not ground the (-) output in an attempt to get an unbalanced output; you will short the output of the (-) amplifier to ground through the RFI suppression filter. Just leave the (-) output floating.

If the exciter modification results in very high input sensitivity, then the input may have a tendency to pick up noise due to RFI. If this occurs, operate the OPTIMOD-TV output at a higher level, and build an "L" pad at the exciter. This "L" pad can be designed to have an input impedance of 300 ohms, correctly loading the OPTIMOD-TV output.

Interfacing The Dolby 334 Broadcast Encoder: Instructions for interfacing and aligning the Dolby 334 to OPTIMOD-TV are found in **Appendix G**.

Although the details may differ slightly, this **Appendix** will serve as a useful reference for interface of any noise reduction encoder required in stereo service.

Remote Gain Reduction Meter: A negative DC voltage approximately proportional to the Total Master Gain Reduction is available between the OPTIMOD-TV rear-panel G/R terminal and circuit ground. The voltage scale is approximately $-0.33V$ per dB of gain reduction, and the source impedance is 8.87K. A standard 0-25dB Orban gain reduction meter can be connected directly between this terminal (-) and ground (+).

The Orban meter has a sensitivity of 1mA f.s. and a DC resistance of about 950 ohms. Full-scale corresponds to 30dB G/R. Because only 25dB G/R can be achieved, the last 5dB of the scale is colored red. (The purpose of this is to match the scale to that of the BASS G/R meter, which is capable of, and fully calibrated to, 30dB G/R.)

If an external meter with different characteristics is used, it is easy to calculate the required additional multiplier resistor for a 0-30dB scale by the formula: $M=(9.75/F)-(8870+R)$, where

M is the required multiplier resistor in ohms,

F is the full scale meter sensitivity in amps, and

R is the internal DC resistance of the meter in ohms.

If M is negative, the meter you wish to use is not sensitive enough, or has too high an internal resistance.

If you wish to interface the G/R output to a remote control for telemetry, bear in mind that the input impedance of the remote control will load down the G/R output and reduce the voltage according to the gain factor: $G=X/(X+8870)$, where X is the input resistance of the remote control in ohms. The scaling of the remote control should therefore be $-0.33 \times G$ volts per dB gain reduction.

Part 4: Initial Setup Procedure

If you have a single-chassis OPTIMOD-TV, skip to II. **Single-Chassis Alignment** below.

If you have a dual-chassis OPTIMOD-TV, you must first align the gain of your STL and the Main (Transmitter) Chassis to a standard to assure that both STL and Main Chassis are driven at correct levels and are properly gain-matched. (The dual-chassis configuration is described in Part I (Introduction).)

Instructions are provided for both stereo and mono installations. In mono operation, the left and right inputs must be driven in parallel (or by identical audio from redundant sources); the output may be taken from either the left or the right channel.

Before beginning the dual-chassis alignment, remove the #3, #4, and #5 cards from the Main Chassis, and substitute the #3TX and #4TX cards per instructions supplied with the Accessory Chassis (8180A/ST).

I. DUAL-CHASSIS ALIGNMENT

In a mono installation, the procedure depends on whether a redundant STL is available. If a redundant STL is available, treat the two STL's as "LEFT" and "RIGHT" and follow the stereo instructions. If only one STL is available, follow the mono instructions. Do not parallel the left and right inputs until the procedure instructs you to do so.

In a stereo installation, the procedure is repeated twice, once for the left channel and once for the right.

In all cases, it is assumed that the STL is a pair of land-lines, a pair of microwave STL's, or a PCM link.

There are four steps:

- 1) **Stereo Or Mono Installation:** Adjust the operating controls on the Accessory Chassis as follows:

Proof/Operate Switch:	OPERATE
L and R Input Attenuators:	0
Clipping:	+2
Release Time:	10
Bass Coupling:	10
Gate Threshold:	0
HF Limiting:	10

- 2) **Stereo Or Mono Installation:** Connect an audio oscillator to the LEFT INPUT of the Accessory Chassis. Set its frequency to 1kHz, and its output level to produce "0dB" ± 3 dB as indicated on the Accessory Chassis MASTER TOTAL G/R meter.

(This establishes a standard level at the output of the Accessory Chassis of 1.17Vrms (+3.6dBm) ± 0.5 dB when the balanced output is loaded by 600 ohms. This level is 3.4dB below nominal 100% modulation in a 75us preemphasis system, although compressor overshoots will produce peaks substantially above this level.)

If the STL is un-preemphasized, adjust the Studio Chassis OUTPUT ATTEN until the STL is modulated 8dB below its nominal 100% modulation level. In the case of a microwave STL, refer to the modulation meter on the STL transmitter. In the case of a U.S.A.-standard land-line requiring a nominal drive level of +8dBm, simply turn the Studio Chassis OUTPUT ATTEN fully clockwise.

If the STL is preemphasized at 50 or 75us, adjust the Studio Chassis OUTPUT ATTEN until the STL is modulated 12dB below its nominal 100% modulation level.

Stereo Installation Only: Repeat Step (2) for the RIGHT CHANNEL of the Accessory Chassis, using the RIGHT CHANNEL STL.

Mono Installation Only: If you have two STL's for redundancy, repeat Step (2) using the RIGHT CHANNEL of the Accessory Chassis and the redundant STL. If you have only one STL, proceed to the next step.

- 3.a) **Stereo Installation Only:** Reconnect the oscillator to the LEFT Accessory Chassis input, and drive it with a 1kHz tone at a level which produces a "0" reading on the TOTAL MASTER G/R meter. Connect the output of the LEFT STL receiver to the LEFT INPUT of the OPTIMOD-TV Main Chassis. Place the VU meter FUNCTION switch in L COMPR OUT. Adjust the LEFT INPUT ATTEN on the OPTIMOD-TV Main Chassis to make the VU meter read 100%.

NOTE:

Jumper Cards #3TX and #4TX are shipped with 20dB pads ahead of the input amplifiers. If the readings in the COMPRESSOR OUT position of the Main Chassis meter are too low with the INPUT ATTEN fully CW and the input pads are strapped for 20dB attenuation, restrap them for 0dB attenuation. This is done by removing Cards #3TX and #4TX from the chassis according to the instructions on p. C-1 of **Appendix C**, and by moving the jumpers according to Fig. 3-3. The cards and subpanel are then replaced.

If the reading is too high with the INPUT ATTEN fully CCW, and the input pads on Cards #3TX and #4TX in the Main Chassis are strapped for 0dB attenuation, follow the same instructions to restrap the pads for 20dB attenuation.

Turn the Main Chassis LEFT OUTPUT ATTEN fully counterclockwise. Turn on the aural transmitter, and advance the Main Chassis LEFT OUTPUT ATTEN until your TV stereo monitor indicates a left-channel modulation of 60%. Record the reading of the Main Chassis LEFT SYS OUT meter.

Disconnect the oscillator from the LEFT Accessory Chassis input, and connect it to the RIGHT Accessory Chassis input. The MASTER TOTAL G/R meter should still read "0".

Connect the output of the RIGHT STL receiver to the RIGHT INPUT of the OPTIMOD-TV Main Chassis. Place the VU meter FUNCTION switch in R COMPR OUT. Adjust the RIGHT INPUT ATTEN on the OPTIMOD-TV Main Chassis to make the VU meter read 100%.

Advance the Main Chassis RIGHT OUTPUT ATTEN control until your TV Stereo Monitor indicates a right channel modulation of 60%.

Check the reading of the Main Chassis RIGHT SYS OUT meter. It should be very close to the reading obtained on the LEFT SYS OUT meter immediately above. If not, there is a left/right gain imbalance in the system beyond OPTIMOD-TV which should be corrected.

NOTE

The "60% modulation" figure is somewhat arbitrary, as the appropriate figure will depend not only upon the stereo system chosen by Government authorities, but also upon whether the aural exciter is being used with or without its internal preemphasis. In the latter case, modulation is better controlled and a higher percentage of modulation can be chosen when aligning with a 1kHz tone in the procedure above.

The "60% modulation" figure must therefore be modified in your individual installation according to experience.

- 3.b) **Mono Installation Only:** Continue to drive the LEFT Accessory Chassis input with a 1kHz tone at a level which produces a "0" reading on the TOTAL MASTER G/R meter. Connect the output of the STL receiver to the LEFT AND RIGHT INPUTS of the OPTIMOD-TV Main Chassis in parallel. Place the VU meter FUNCTION switch in L COMPR OUT. Adjust the LEFT INPUT ATTEN on the OPTIMOD-TV Main Chassis to make the VU meter read 100%. Then place the VU meter FUNCTION SWITCH in R COMPR OUT and adjust the RIGHT INPUT ATTEN on the Main Chassis to make the VU meter read 100%.

Connect the LEFT Main Chassis output to the aural exciter. Turn on the aural transmitter, and advance the Main Chassis LEFT OUTPUT ATTEN until your Aural Modulation Monitor reads 60% modulation.

Turn off the aural transmitter, and connect its input to the Main Chassis' RIGHT OUTPUT. Turn on the aural transmitter, and advance the Main Chassis RIGHT OUTPUT ATTEN until your Aural Modulation Monitor reads 60%. (See the NOTE immediately above.)

The LEFT SYS OUT and RIGHT SYS OUT meters on the Main Chassis should read identically.

- 4.a) **Stereo Installation Only:** Connect the LEFT and RIGHT program lines from the console or switcher to the LEFT and RIGHT inputs of the Accessory Chassis. Proceed to **Program Tests** below.
- 4.b) **Mono Installation Only:** Connect the program line to both LEFT and RIGHT Accessory Chassis inputs in parallel.

If your installation is fully redundant, you may wish to connect a redundant audio source to the Accessory Chassis RIGHT INPUT instead of paralleling. Be sure that both audio sources are at the same level, and are in-phase. Proceed to **Program Tests** below.

II. SINGLE-CHASSIS ALIGNMENT

In a mono installation, do not parallel the left and right inputs until the procedure instructs you to do so.

In a stereo installation, the procedure is repeated twice, once for the left channel and once for the right.

There are three steps:

- 1) **Stereo Or Mono Installation:** Adjust the operating controls on the Main Chassis as follows:

Proof/Operate Switches:	OPERATE
L and R Input Attenuators:	0
Clipping:	+2
Release Time:	10
Bass Coupling:	10
Gate Threshold:	0
HF Limiting:	10
Output Attenuators:	fully counterclockwise

- 2.a) **Stereo Installation Only:** Connect an audio oscillator to the LEFT INPUT of OPTIMOD-TV. Set its frequency to 1kHz, and its output level to produce "0dB" \pm 3dB as indicated on the MASTER TOTAL G/R meter. Turn on the aural transmitter, and advance the LEFT OUTPUT ATTEN until your TV stereo monitor indicates a left-channel modulation of 60%. Record the reading of the LEFT SYS OUT meter.

Disconnect the oscillator from the LEFT OPTIMOD-TV input, and connect it to the RIGHT input. The MASTER TOTAL G/R meter should still read "0".

Advance the RIGHT OUTPUT ATTEN control until your TV Stereo Monitor indicates a right channel modulation of 60%.

Check the reading of the RIGHT SYS OUT meter. It should be very close to the reading obtained on the LEFT SYS OUT meter immediately above. If not, there is a left/right gain imbalance in the system after OPTIMOD-TV which should be corrected.

NOTE

The "60% modulation" figure is somewhat arbitrary, as the appropriate figure will depend not only upon the stereo system chosen by Government authorities, but also upon whether the aural exciter is being used with or without its internal preemphasis. In the latter case, modulation is better controlled and a higher percentage of modulation can be chosen when aligning with a 1kHz tone in the procedure above.

The "60% modulation" figure must therefore be modified in your individual installation according to experience.

- 2.b) **Mono Installation Only:** Connect an audio oscillator to the LEFT INPUT of OPTIMOD-TV. Set its frequency to 1kHz, and its output level to produce "0dB" \pm 3dB as indicated on the MASTER TOTAL G/R meter. Connect the LEFT OPTIMOD-TV OUTPUT to the input of the aural exciter. Turn on the aural transmitter, and advance the LEFT OUTPUT ATTEN until your Aural Modulation Monitor indicates 60% modulation.

Turn off the aural transmitter. Disconnect the oscillator from the LEFT OPTIMOD-TV input, and connect it to the RIGHT input. The MASTER TOTAL G/R meter should still read "0".

Disconnect the LEFT OPTIMOD-TV OUTPUT from the aural exciter input, and connect the aural exciter input to the RIGHT OPTIMOD-TV OUTPUT. Turn on the aural transmitter.

Advance the RIGHT OUTPUT ATTEN control until your Aural Modulation Monitor indicates 60% modulation. (See the NOTE immediately above.)

The LEFT SYS OUT and RIGHT SYS OUT meters on the Main Chassis should read identically.

- 3.a) **Stereo Installation Only:** Connect the LEFT and RIGHT program lines from the console or switcher to the LEFT and RIGHT inputs of OPTIMOD-TV. Proceed to **Program Tests** below.
- 3.b) **Mono Installation Only:** Connect the program line to both LEFT and RIGHT OPTIMOD-TV inputs in parallel.

If your installation is fully redundant, you may wish to connect a redundant audio source to the RIGHT INPUT instead of paralleling. Be sure that both audio sources are at the same level and are in-phase. Proceed to **Program Tests** below.

4

III. PROGRAM TESTS

From this point on, the procedure is identical for single- and dual-chassis units. "OPTIMOD-TV INPUT" means the input of the Accessory Chassis in dual-chassis systems, and the main input in single-chassis systems.

These listening tests are made with OPTIMOD-TV set up according to our **Recommended Initial Control Settings** in Fig. 4-5. They are intended to detect obvious problems with audio quality which must be resolved before final adjustments are made. Once initial listening tests are passed, you can proceed to adjust OPTIMOD-TV setup controls according to subjective requirements.

These instructions apply to either a stereo or mono installation except as noted.

- a) Adjust OPTIMOD-TV controls according to Fig. 4-5. Do not adjust the INPUT ATTEN or OUTPUT ATTEN controls at this time. If you have a dual-chassis system, DO NOT READJUST THE MAIN CHASSIS INPUT ATTEN CONTROLS UNDER ANY CIRCUMSTANCES!

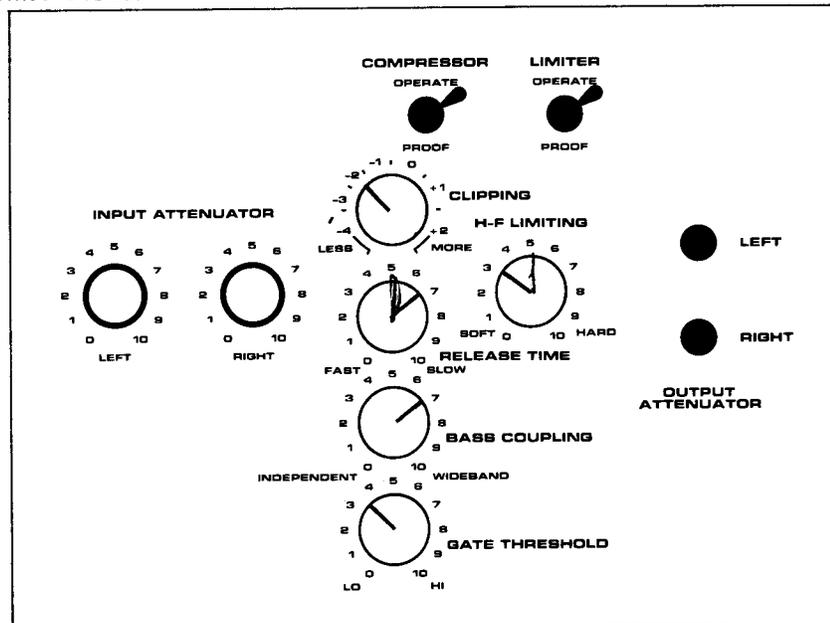


Fig. 4-5: RECOMMENDED INITIAL CONTROL SETTINGS

- b) Drive OPTIMOD-TV with typical audio at your usual operating level. Set your console in MONO mode, such that both channels are putting out identical levels. Peak the console VU meters at 0VU.

- c) Adjust the OPTIMOD-TV INPUT ATTEN controls (in a dual-chassis installation, on the ACCESSORY CHASSIS) to "0". Advance the LEFT INPUT ATTEN until the MASTER TOTAL G/R meter reads approximately "0dB" ± 3 dB.

Stereo Installation Only: Observe the L-R meter on your stereo monitor and advance the OPTIMOD-TV RIGHT INPUT ATTEN until the meter nulls.

Mono Installation Only: Either load both outputs with equal impedances, or temporarily disconnect both outputs from the system. Connect a sensitive AC voltmeter between the OPTIMOD-TV (+) LEFT OUTPUT and (+) RIGHT OUTPUT. Advance the OPTIMOD-TV RIGHT INPUT ATTEN until the meter nulls. Reconnect the outputs to the system as necessary.

- d) **Stereo Installation Only:** Place the console in STEREO mode. Observe the TOTAL MODULATION meter and peak flasher on your Aural Modulation Monitor. Make slight adjustments to the the COMPOSITE OUTPUT ATTEN of your stereo generator as necessary to achieve desired modulation levels.

Mono Installation Only: Observe the TOTAL MODULATION meter and peak flasher on your Aural Modulation Monitor. Assuming that the OPTIMOD-TV LEFT OUTPUT is driving the aural exciter, make slight adjustments to the LEFT OUTPUT ATTEN as necessary to achieve desired modulation levels.

As in the step above, either load both outputs with equal impedances or temporarily disconnect both outputs from the system. Connect a sensitive AC voltmeter from the (+) LEFT OUTPUT to the (+) RIGHT OUTPUT, and adjust the OPTIMOD-TV RIGHT OUTPUT ATTEN until the meter nulls. Reconnect the outputs to the system as necessary.

- e) Listen to the audio quality of the air sound on a good monitor system, and verify that it sounds natural and free from noise and distortion. Comparing "AIR" and "PROGRAM" should reveal very little difference in tonal balance due to the quasi-wideband operation of OPTIMOD-TV as initially set up.
- f) You may now proceed to **Part 5 (Operating Instructions)** of this Manual, and adjust OPTIMOD-TV's setup controls to your specific requirements and tastes.

Part 5:

Operating Instructions

This part describes how to adjust the OPTIMOD-TV setup controls to achieve a sound appropriate to your taste, programming, and competitive situation. Although primarily engineering-oriented, it is written so that others interested in your station's sound can also benefit.

Best results will be achieved if both Engineering and other interested parties go out of their way to communicate with one another regarding the "sound" that best suits the station's needs and objectives. It is especially important that Engineering explain to others that there are significant tradeoffs among the three prime processing parameters: Loudness, Brightness, and Distortion. Maximizing one invariably results in some deterioration of one or more of the others — a tasteful, effective compromise must be made.

Audio Quality And OPTIMOD-TV: Due to the proliferation of new video services such as videodisk and pay-cable, TV audio is in a rapidly-changing state of flux. Formerly, the sound desired for TV was one that was extremely uniform and unobtrusive. However, the processing necessary to achieve this (and to control excessive commercial loudness) often has a very deleterious effect upon the quality of demanding program material such as musical variety shows and rock concerts.

It is becoming clearer and clearer that in order to successfully compete with non-broadcast video, broadcast TV must cast off its "business as usual" attitude regarding audio quality and audio processing. Fortunately, the 50-15,000Hz FM audio channel is fully up to the task of transmitting higher quality audio. Your OPTIMOD-TV can process the audio with perceived quality an order-of-magnitude higher than the audio processing customarily used in TV audio. Since the processing problem has been solved by OPTIMOD-TV, and since the basic transmission channel is capable of very high quality, achieving improved quality depends upon the quality of the audio section in the home receiver, upon the quality of the source material feeding OPTIMOD-TV, and upon the quality of the transmitter (particularly its aural exciter), all of which are rapidly improving.

The source quality logjam was finally broken by the availability of 50-15,000Hz diplexed or digital links in network audio feeds, by the increasing use of 1" helical-scan video tape recorders (whose intrinsic audio quality substantially exceeds the quality of 2" quad machines), and upon the use of audio tape machines synchronized (by means of SMPTE time code) to video for highest-quality playback of more demanding program material. In most stations, much more work remains to be done in the areas of cleaning up DA's, audio switchers, STL's, and the like. However, the potential for high audio quality is finally at hand.

As this is written, it seems that stereo audio for TV is imminent. Your OPTIMOD-TV is ready for stereo operation with the addition of an external stereo generator and, most probably, noise reduction encoder, as specified by the forthcoming stereo standards. In addition, modification of the station's facilities so that stereo audio can be handled will provide a golden opportunity for a general upgrading and modernization of plant audio equipment which cannot help but have a beneficial effect upon the general audio quality, apart from any multichannel considerations.

Processing Philosophy: The station which orients its programming towards an audience which tends to view the station with sets having small speakers and low-powered amplifiers may want to achieve a more uniform, highly-compressed sound than the station whose audience tends to have the new consumer receivers now available with improved audio sections, larger speakers, and even pseudo-stereo.

As will be discussed below, the control which has the most effect upon the amount of compression and uniformity of the sound is the RELEASE TIME control. It should be adjusted towards faster settings to achieve more uniformity and density, and towards slower settings to achieve more accurate musical reproduction, a more "open" sound, and a more pleasing sound on receivers with good-quality audio sections.

You will find that OPTIMOD-TV is remarkably free from the traditional pumping and modulation effects even as the RELEASE TIME is shortened (within reason, of course). This permits considerable freedom in achieving the sound that you want without unpleasant side-effects.

On Loudness: In radio, most stations want to be as loud as possible to stand out on the dial. In TV, loudness is a two-edged sword, since excessive loudness vis-a-vis other stations can be an annoyance factor when channels are changed.

OPTIMOD-TV is capable of unusually high loudness for a given degree of distortion and high frequency loss. In TV it seems possible (in fact, very desirable) to trade some of this loudness for pristine cleanliness and superior high frequency response.

Functions Of The Setup Controls:

Below, we present a condensed description of the functions of the setup controls, followed by a detailed discussion of each one. Techniques for trading off loudness against quality are discussed in detail. This information is basic to all further discussions, and must be well-understood if you are to succeed in getting the sound you want.

See Fig. 4-5 for recommended initial setup.

1) **Input Attenuators** (Left and Right): Determine the amount of gain reduction (for a given audio level going into the processor), and therefore how much the loudness of soft program material is increased. OPTIMOD-TV has been designed to work best with a nominal gain reduction of 10dB (corresponding to "0" on the G/R meter).

(In a mono installation with both channels driven in parallel, it is important that both channels be in balance. After the LEFT INPUT ATTEN is adjusted for the desired amount of gain reduction, and assuming that the OUTPUT ATTENUATORS have been correctly balanced by following the instructions in Part 4, balance can be achieved by connecting a sensitive AC voltmeter between the LEFT (+) OUTPUT and the RIGHT (+) OUTPUT, and by adjusting the RIGHT INPUT ATTEN until the meter nulls.)

2) **Release Time:** Determines how fast the gain of the "Master" compressor increases when the program material gets soft. Mostly, this control affects the density of the sound, which is a fundamental fatigue-determining factor. There is a clearly "optimum" setting ("7") which gives the most natural sound and least detectable compression — although not the most loudness or greatest uniformity.

3) **Clipping:** Determines how much of the signal is peak-limited by clipping — a distortion generating process. The loudness/distortion tradeoff is primarily determined by this control.

4) **High Frequency Limiting:** Determines a tradeoff: the degree to which the highs are controlled by filtering (which can make them dull), or by clipping (which can make them distorted).

5) **Bass Coupling:** Determines if the compressor will operate "wideband", completely "independent", or somewhere in between. In "wideband" mode, the air sound is most faithful to the sound of the original program material; in "independent" mode, bass

balances are more uniform and bass is often increased. To avoid pulling up stage rumble and other low frequency noise, OPTIMOD-TV is ordinarily operated towards the "wideband" mode.

6) **Gate Threshold:** Determines what input level the system considers "noise". Below this level, the release time of the compressor is slowed by a factor of 10 or so to prevent "breathing", and the compressor releases towards 10dB gain reduction ("0" on the G/R meter).

A reference chart relating control adjustments to desired sonic characteristics is found at the end of this Part.

DETAILED DISCUSSION OF THE SETUP CONTROLS

Start at the BASS COUPLING control: Everything else depends on how you decide to adjust it.

— "WIDEBAND" mode (BASS COUPLING close to "10") makes the output sound most like the input. Because it minimizes the amount of pump-up of low frequency noise (like hum or stage rumble), OPTIMOD-TV is usually operated favoring this mode. However, it is not suited for very fast release times and ultimate loudness. As long as you use the "optimum" release time ("7"), it sounds good even with large amounts of compression.

Because setting the BASS COUPLING control at "10" will sometimes cause a bass loss (because the "Bass" compressor can never take more gain than the "Master" compressor, and will sometimes take less), the most accurate frequency balance will often be obtained with this control between "7" and "10". The setting depends of the amount of gain reduction and the setting of the RELEASE TIME control. The control is most readily adjusted by watching the BASS G/R and COMPRESSOR G/R meters, and adjusting the control until the meters track as closely as possible.

-- "INDEPENDENT" mode (BASS COUPLING at "0") is most appropriate for pop music:

With the "optimum" release time ("7"), it sounds very open, natural, and non-fatiguing. It will provide a bass boost on some program material which is bass-shy. It may be desirable to temporarily "retune" OPTIMOD-TV to this mode for programming like "Rock Concert".

With fast release times (close to "0"), the INDEPENDENT mode provides maximum uniformity and density on smaller sets with underpowered amplifiers and small speakers. Even with potential bass noise pump-up problems, INDEPENDENT mode will usually create a more pleasing sound than WIDEBAND mode when a very fast release time is used. However, a fast release time may fatigue listeners with high-quality receivers, and such a release time requires more careful operator gain riding than slower release times do. In addition, hiss from 16mm optical sound tracks may be noticeably pumped up and down.

— HYBRID WIDEBAND/INDEPENDENT mode (BASS COUPLING between "2" and "7") compromises between the two sounds. This mode is useful if you feel that the INDEPENDENT mode provides too much bass for your taste — you can use the BASS COUPLING control to adjust the balance between bass and the rest of the spectrum. This mode is ordinarily used with the "optimum" release time setting ("7").

Adjusting The Other Controls: Once you have chosen your adjustment of the BASS COUPLING control, you must adjust the rest of the controls to finish "customizing" your sound. MAKE ADJUSTMENTS JUDICIOUSLY, AND LISTEN CAREFULLY TO ALL TYPES OF AUDIO TYPICAL OF YOUR PROGRAMMING.

Clipping: This is the prime control over the loudness/distortion tradeoff. In our opinion, "0" is the best setting, giving results that sound "undistorted" even on high quality receivers — provided that input program material is clean and that the "optimum" release time setting ("7") is used. If faster release time settings are used, or if input program material is somewhat distorted, the CLIPPING control should be turned down.

Particularly in WIDEBAND mode, the CLIPPING control can sometimes be turned up if you are operating with small amounts of gain reduction, slow release times, and ultra-clean program material.

Because inconsistent loudness from one station to the next could be an annoyance to a viewer who is forced to adjust his volume control each time he switches to your signal, it is usually desirable to set the CLIPPING control very conservatively (in the "-" section) to control excessive loudness compared to other stations. This will also result in cleanest sound and best high frequency response.

Release Time And Amount Of Gain Reduction: The action of the RELEASE TIME control has been optimized for resolution and adjustability. When the "optimum" release time setting ("7") is used, the amount of gain reduction is surprisingly non-critical. (The amount of gain reduction is controlled both by the setting of the INPUT ATTENUATOR controls and average levels from the console or switcher.)

The GATING feature, which essentially "freezes" the gain, prevents noise rush-up during program pauses (particularly with noisy 16mm optical sound tracks) and makes the 25dB gain reduction range usable. This function was designed such that the gain does not get "stuck" forever in the 0 to 15dB gain reduction region, so low-level program material is eventually increased in level. Since gain recovery is slow in GATED mode, this gradual increase in level is essentially imperceptible.

Since pumping does not occur even at high levels of G/R, the primary danger of using large amounts of G/R is that the level of soft portions of wide-dynamic-range input material may eventually be increased unnaturally, and optical sound track hiss may be increased to unpleasant levels in presence of signal above the GATING threshold.

The MASTER G/R and COMPRESSOR G/R meters are calibrated from +10 to -15dB G/R; the BASS G/R meter is calibrated from +10 to -20dB G/R. If the GATE were defeated, both "Master" and "Bass" compressors would recover to +10dB in the absence of signal. Thus "+10dB" on the meters is actually no gain reduction.

However, if the GATE is activated in the ordinarily-used "wideband" mode, the release time is slowed by a factor of 10 or so, and the gain slowly drifts toward 10dB gain reduction. Because the gain reduction meters will therefore sit at 10dB gain reduction in absence of signal, we have calibrated the meters so that this point is "0" to avoid confusing operators who might otherwise think that the compressors were faulty.

Because of this design feature, smoothest performance is obtained when average levels out of the console or switcher are made to cause 10dB gain reduction (i.e., to indicate approximately "0" on the G/R meters). This way, noise will neither increase nor decrease during pauses in the audio.

The normal reading of the TOTAL BASS G/R meter in GATED mode is affected by the setting of the BASS COUPLING control. To understand why, recall that the gain control voltage of the "Master" compressor drifts slowly towards -10dB (which appears on the GAIN REDUCTION meters as "0") in GATED mode. The "Bass" control voltage is also gated, but in a different way: Under GATED conditions, the gain control voltage produced by the "Bass" control loop starts drifting very slowly towards maximum gain (which would be indicated as "+10" on the meters).

In the "wideband" mode usually employed, the gain of the "Bass" compressor is the sum of the "Master" and "Bass" gain control voltages. In "wideband" mode, the gains of both "Master" and "Bass" compressors will eventually reach -10dB because the -10dB "Master" gain control voltage is summed into the "Bass" compressor. This will be indicated by both G/R meters' reading "0".

Conversely, in "independent" mode, the gain of the "Bass" compressor is determined primarily by the control voltage developed in the "Bass" control loop. Since the "Bass" control loop recovers very slowly toward 0dB gain, the gain of the "Bass" compressor will eventually become higher than the gain of the "Master" compressor in this case. This will result in a slight bass boost if the unit remains gated for a long period of time (30 seconds or more). Because the gating function is primarily useful in preventing audible hiss pump-up, this slight bass boost (which does not exaggerate hiss) causes no audible problem even in the seldom-used "independent" mode. We explain this behavior to avert the confusion which might otherwise result if the operator observed the MASTER G/R and BASS G/R meters gating to different gain reductions during "independent" operation.

Release becomes faster as gain reduction is increased between "+10" and "0"dB on the G/R meter, making the program progressively denser and creating a sense of increasing loudness. This preserves some feeling of dynamic range, even though peak levels are not increasing. In the "-" region of the G/R meter, there is no change in short-term density regardless of the amount of gain reduction. This avoids the unnatural, fatiguing sound often produced by processors at high gain-reduction levels, and makes OPTIMOD-TV resistant to operator gain-riding errors.

It is important to realize that the processing in OPTIMOD-TV was designed to perform both a compression and limiting function. Full loudness is not achieved until approximately 10dB of gain reduction is used (i.e., until you enter the "-" side of the G/R meter) because of the gradual transition that occurs between no gain reduction and 10dB gain reduction.

When OPTIMOD-TV is operated with fast release times, the sound will change substantially as more gain reduction is used. This means that operator gain riding is more critical, and also that you must decide on the basis of listening tests how much gain reduction gives you the dense sound you want without a feeling of overcompression and fatigue.

Unlike the metering on some familiar processors, the red in the OPTIMOD-TV gain reduction meter means business! When the meter is in the red, it means that the compressor has run out of gain reduction range, that the circuitry is being overloaded, and that nastiness is likely to commence. Because the compressor has 25dB of gain reduction range, this problem should never occur if OPTIMOD-TV has been set up for a sane amount of gain reduction under ordinary program conditions. But beware the different peak factors on voice and music — if voice and music are peaked identically on a VU meter, voice may cause up to 10dB more peak gain reduction than does music!

High Frequency Limiting: This control trades off distortion against high frequency loss. When the control is moved toward "soft" (more HF limiting), the sound will become duller but less "gritty". When the control is moved toward "hard", the sound will become brighter, but more gritty and "smeared".

Because the clipper in OPTIMOD-TV cancels distortion at low frequencies, the HF LIMITING control will have a different effect on clipping distortion than you might expect. Gross breakup (principally sibilance splatter) will not occur, and you must listen to the upper midrange and the highs to hear the effect of the clipper.

When the CLIPPING control is operated at "0" or below and the "optimum" release time setting is used, it is possible to operate the HF LIMITING control at "10" (full hard) without objectionable distortion, provided that the program material is super-clean. If the CLIPPING control is operated beyond "0" and/or faster release times are used (such that greater level and density is produced), it is usually necessary to readjust the HF LIMITING control closer to "soft" to avoid objectionable distortion. Fortunately, the HF limiter "knows" that greater density and level have been produced when these other controls are operated more aggressively, and most of the necessary increases in HF limiting will occur automatically. In fact, you will clearly hear a loss of highs when you adjust any control to produce greater loudness and density — this is an automatic response to the loudness/brightness/distortion tradeoff discussed above. (Engineering aside: the main reason for readjusting the HF LIMITING control is to compensate for the HF limiter's relatively low compression ratio.)

Because excessive loudness in TV audio is usually not desired (as discussed above), the CLIPPING control will ordinarily be operated low enough to permit operation of the HF LIMITING control at "10" (full "hard") without difficulty.

Gate Threshold: The GATE THRESHOLD control is adjusted so that noise is not brought up during short pauses.

As discussed in more detail in **Release Time and Amount Of Gain Reduction** above, in GATED mode, the gain drifts slowly towards 10dB gain reduction ("0" on the G/R meters).

For most stations, the noisiest program material is 16mm optical sound. The GATE THRESHOLD control should be adjusted until quieter parts of 16mm sound tracks do not permit compressor recovery (which would result in an approximate 10dB increase in hiss levels underneath the desired audio). Determining what "quieter parts" means is a subjective decision. The tradeoff is excessive dynamic range versus audible hiss pump-up.

In general, the faster the RELEASE TIME, the higher the GATE THRESHOLD must be set to avoid problems, as faster RELEASE TIMES will pump up hiss more quickly.

On Excessive Commercial Loudness

You may find that optimization of processing for program segments tends to cause agency spots to be unacceptably loud or unpleasant-sounding. This is because some agencies employ extreme amounts of midrange boost and/or compression and limiting in order to attempt to make the spots "stand out" against the programming. These practices have caused broadcasters considerable difficulty due to the FCC's rule prohibiting excessive and annoying commercial loudness.

Fortunately, these practices seem to be changing rapidly because of increasing sophistication on the part of the agencies and the realization that the automatic loudness controllers in use at many stations automatically "push down" such material, making it sound in its most extreme form not only without impact but almost ludicrously tinny and distorted.

If this problem is observed, it may be desirable to re-equalize the individual spots upon transfer to video tape or cart, subduing an unnaturally boosted midrange by reducing 2kHz to 4kHz energy as necessary to achieve more natural frequency balances. The Orban 672A (mono) and 674A (stereo) equalizers are good choices for such work (and other audio production as well) because they are extremely flexible, yet easily used by only modestly experienced station personnel.

OPTIMOD-TV cannot compensate for the problem of severe limiting and compression on such material, and such material may still be noticeably louder than the surrounding program. If this proves to be annoying to viewers, you may wish to use an external loudness controller after the OPTIMOD-TV output. Over the years, a considerable amount of research has been done in an attempt to measure and control subjective loudness. At least one automatic loudness controller has been marketed, and improved designs are expected in due time.

Such a loudness controller can be connected between the OPTIMOD-TV output and the input of the aural exciter. The decision to use such a device should not be made lightly, since any device (no matter how perfectly it performs its appointed task of controlling loudness) must inevitably compromise the dynamic integrity and dramatic impact of program material. From an artistic point of view, not all program material is supposed to be at the same loudness! Thus, any effort to pre-process annoyingly loud commercials to "tame them down" (avoiding the need for an external loudness controller), cannot help but improve the overall audio quality of the station.

Orban Associates is not convinced that, given contemporary agency practices, the "loudness problem" is currently significant, and we welcome feedback from all of our customers as to whether excessive commercial loudness is in fact a problem in their operations.

Summary

The basic TV audio medium is capable of very high quality. More and more viewers are equipped to receive and appreciate such quality when it is broadcast. In addition, many people are now being exposed to the excellent quality of the "Laservision" videoedisk stereo sound tracks.

OPTIMOD-TV is capable of an outstandingly advantageous tradeoff between loudness, brightness, and distortion. This tradeoff is fundamental, and must be made in a wise and artistic way.

The OPTIMOD-TV setup controls are functionally independent. However, changing one usually requires that others be readjusted to rebalance the loudness/brightness/distortion tradeoff. An explanation of how this is done was provided above.

Bear in mind that poor-quality program material automatically forces a poorer tradeoff than could otherwise be obtained. So any effort expended in cleaning up the audio chain prior to OPTIMOD-TV will pay extra dividends.

The idea that excessive loudness can be an annoyance factor in television can pay quality dividends, since reducing loudness automatically results in more open, dynamic highs and lower distortion.

CATALOG OF OPERATING OBJECTIVES AND SOLUTIONS

ALWAYS START WITH OUR SUGGESTED INITIAL SETTINGS (BELOW) AND WORK FROM THERE.

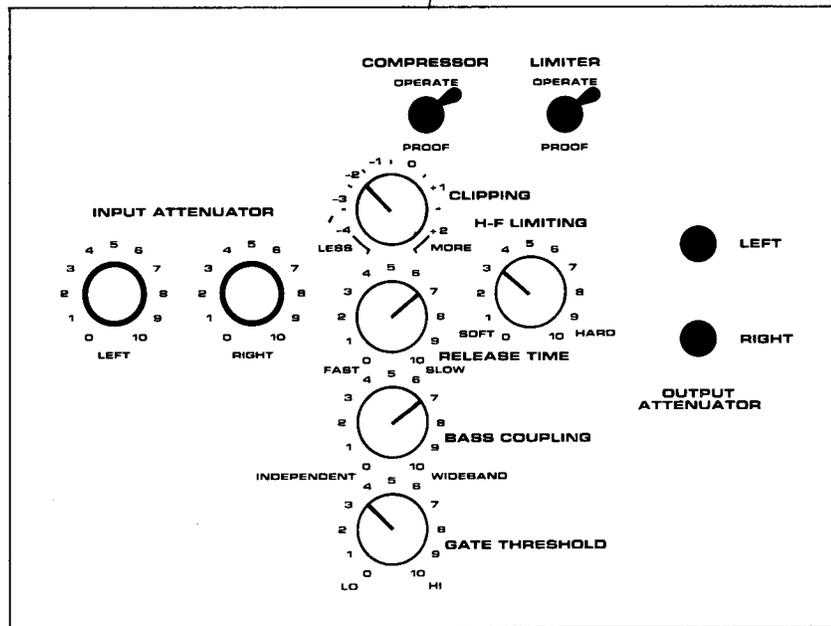


Fig. 5-1: INITIAL CONTROL SETTINGS

-- To control loudness

1. Adjust the CLIPPING control to obtain the loudness desired. The INPUT ATTEN must then be slightly readjusted to achieve the desired amount of gain reduction.

-- To obtain more consistent levels

1. Operate "multiband" (BASS COUPLING at "0") with fast release times. Turn down CLIPPING and HF LIMITING as necessary to avoid objectionable distortion.
2. Clean up audio. Super-clean audio can be processed harder without objectionable side-effects.

-- To obtain more brightness

1. Turn the HF LIMITING CONTROL fully clockwise (full hard). To avoid objectionable distortion with fast RELEASE TIME, you may have to turn down the CLIPPING control. This will further increase brightness at the expense of loudness.
2. Be sure that program material is properly equalized, and that the STL is flat to 15kHz.

-- To obtain more bass

1. Operate the BASS COUPLING control towards "0".

-- To obtain less bass (retaining original program material balance)

1. Operate the BASS COUPLING control towards "10".

-- To make "Air" sound most like "Program"

1. Operate with the BASS COUPLING close to "10". (Adjust the control to make the BASS and COMPRESSOR G/R meters track as closely as possible.)
2. Operate with the RELEASE TIME at "7" (optimum).
3. Use approximately 10dB of gain reduction ("0" on the G/R meter) by adjusting the INPUT ATTENUATOR as necessary.
4. Minimize the amount of clipping and HF limiting by operating HF LIMITING at "10" (full hard), and backing off the CLIPPING as far as required to avoid audible distortion on difficult material like male voice or piano.

-- To obtain "open" sound with no audible compression

1. Operate the RELEASE TIME control at "7".
2. Do not pre-compress program material in production.

-- To obtain a "heavily-processed" sound

1. Operate the RELEASE TIME control at "0" and the BASS COUPLING control at "0". (You may have to back off the CLIPPING and HF LIMITING controls to avoid objectionable distortion. Operator gain riding will also become more critical.)

-- To avoid "noise pump-up"

1. Operate with 10dB of gain reduction ("0" on the meter) with normal levels out of the console or switcher.
2. Adjust the GATE THRESHOLD more clockwise.
3. Use slower RELEASE TIME.

-- To achieve more subtle gain riding in wide-dynamic range material

1. Critically adjust the GATE THRESHOLD control so that medium- to low-level passages cause the GATE lamp to flash on and off, thus slowing down the release time as the program gets softer.

-- To avoid excessive sibilance (particularly on women's voices)

1. Use an Orban Dynamic Sibilance Controller on speech inputs only. (While OPTIMOD-TV will not distort sibilance, its excellent high frequency power handling capability will result in its passing high-energy sibilance present at its input instead of limiting it.)

Part 6: Proof of Performance

Mono Proof: Proof of Performance (U.S.A. standard) is straightforward. Switch both PROOF/OPERATE switches to PROOF and drive the input with test signal. Sufficient headroom exists to modulate well beyond 100% at all frequencies, 50-15,000 Hz.

With single-chassis units, the only potential difficulty involves STL signal-to-noise ratio. The PROOF mode disables the gate and permits the compressors to recover to 0dB gain reduction ("+10" on the meters). If the system is usually operated with 10dB gain reduction as recommended, the additional 10dB of system gain in PROOF mode may amplify the noise in a marginal STL to the point where system noise does not meet specification. In this case, we suggest either inserting a 10dB pad into the input line of the OPTIMOD-TV, or temporarily turning down the OPTIMOD-TV INPUT ATTEN by 10dB, thus returning system gain to its nominal value. (If the INPUT ATTEN controls are operated close to fully counterclockwise, it may be impossible to turn them down 10dB, and inserting a 10dB pad may be the only practical solution.)

This difficulty will probably not occur in a dual-chassis unit unless the signal-to-noise ratio of the switcher or audio console is very poor by contemporary standards.

NOTE

OPTIMOD-TV frequency response falls off extremely rapidly above 15.0kHz. If the test oscillator is miscalibrated, OPTIMOD-TV may appear not to meet proof at 15kHz. Before blaming OPTIMOD-TV, measure the output frequency of the oscillator with an accurate counter to make sure that it is actually producing 15.0kHz, and not some slightly higher frequency.

Stereo Proof: As this Manual is written, no stereo standards have been approved by the FCC (U.S.A.). We can therefore provide no instructions at this time.

It is highly probable that stereo performance measurements will require defeating compression and limiting action while leaving all active circuitry unbypassed. The existing PROOF/OPERATE switches provide this function. (See **Mono Proof** immediately above.)

Part 7:

Routine Maintenance

OPTIMOD-TV is a highly stable device which uses solid-state circuitry throughout. Recommended routine maintenance is minimal.

- 1) Particularly in humid or salt-spray environments, check periodically for corrosion around metal-to-metal contacts such as the audio and control wiring, and those places where the OPTIMOD-TV chassis contacts the rack. Check for loss of grounding due to corrosion or loosening of rack mounting screws.
- 2) Familiarize yourself with the normal VU meter readings, and with the normal performance of the G/R meters. If any meter reading becomes abnormal, refer to **Appendix F (Trouble Diagnosis)**.
- 3) A good ear will pick up many failures. Familiarize yourself with the "sound" of OPTIMOD-TV as you have set it up, and be sensitive to changes or deteriorations. But if problems arise, please don't blame OPTIMOD-TV by reflex. Refer to **Appendix F** for systematic troubleshooting instructions which will also help you determine if the problem is in OPTIMOD-TV or is somewhere else in the station's equipment.
- 4) To clean the panel, wash it with a mild household detergent and water. Stronger solvents may damage plastic parts, paint, or the silkscreened lettering, and should not be used.

Routine Performance Verification

This procedure can be performed very quickly, and provides tests of some of the more important OPTIMOD-TV performance parameters. A much more thorough and rigorous procedure is provided in **Appendix D (Field Audit-of-Performance Procedure)**.

Audio Processing: There are no effective, quick instrument tests that can be made using ordinary program material. Your ear is the best test instrument here.

If a minute or so can be spared from normal programming, the "standard level" test can be made using a sinewave input. This is done as follows:

- 1) Record the settings of the CLIPPING, BASS COUPLING, RELEASE TIME, and HF LIMITING controls so that they can be restored when you have completed the test.
- 2) Set the OPTIMOD-TV controls to the following "standard" settings:

PROOF/OPERATE SWITCHES:	OPERATE
CLIPPING:	+2
RELEASE TIME:	10
BASS COUPLING:	10
HF LIMITING:	10

- 3) Drive the OPTIMOD-TV left channel (probably through a console input) with a 1kHz sinewave. Adjust the oscillator level until the OPTIMOD-TV TOTAL MASTER G/R meter reads "0".
- 4) Verify that the OPTIMOD-TV L COMPR OUT position on the VU meter switch causes the meter to read 0VU, ± 0.5 VU, and that the OPTIMOD-TV L FILTER OUT meter position causes the meter to read 0VU, ± 1.0 VU.
- 5) Repeat steps (3) and (4) for the RIGHT channel.
- 6) Restore the OPTIMOD-TV setup controls to their normal settings.

Failure to produce these standard levels indicates a failure somewhere within the audio processing circuitry. Refer to **Appendix F (Trouble Diagnosis)**.

Appendix A: System Description

The purpose of this Appendix is to provide the installing engineer with an overview of system design, to answer questions and deal with uncertainties about various unconventional aspects of the design, and to provide the service technician with a moderately detailed overview of the system.

Each card is numbered. Reference will be made in each section to the number of the card on which the described circuitry is located.

The paragraphs in **Appendix B (CIRCUIT DESCRIPTION)** that correspond with topics in this Appendix have identical numbers and titles in order to expedite access to further information on a topic of interest.

REFER TO THE BLOCK DIAGRAM (p. J-21)

I.a) Input Amplifier: (on Cards #3 and #4)

The audio is applied to an RFI suppression network and pad, the latter strappable for 0 or 20dB attenuation. The RFI-suppressed audio is then applied to a low-noise true instrumentation amplifier, whose "+" and "-" inputs are symmetrical and high impedance. The gain of this amplifier is adjustable from 0.88 to approximately 10.5 (a 21.5dB range). If this range does not yield the desired amount of gain reduction, the input pad should be restrapped.

In order to avoid distortion due to imperfections in the large-value coupling capacitors that would be necessary, the input is DC-coupled. Therefore, only small amounts of differential DC should be applied to the input. Ordinarily, the input is fed by the output of a transformer or capacitively-coupled amplifier, and no difficulty should arise. Slight amounts of DC offset are eliminated in the 30Hz highpass filter following the input amplifier.

I.b) 30Hz Highpass Filter: (on Cards #3 and #4)

The output of the input buffer is applied to a third-order Chebychev highpass filter with 30Hz cutoff frequency (0.5dB down) and 0.5dB ripple. This filter is not conveniently bypassable. It was felt that the advantages of this filter (i.e., elimination of modulation-wasting subsonic energy from stage rumble and other sources, elimination of subsonic energy's introducing distortion by modulating the compressor control voltages, and prevention of destabilization and/or distortion introduction in exciters' AFC's) merited the filter's inclusion as a standard part of the system.

The cutoff frequency of the filter is sufficiently low that the only commonly-found musical instrument producing lower fundamental frequencies is the pipe organ. Most records cut off at 30Hz, and no rock-and-roll instruments have fundamentals below 40Hz.

The ringing introduced by the filter is insignificant. The ear is very insensitive to ringing in this frequency range. Further, the ringing is comparable to that introduced by a well-designed vented box loudspeaker with 30Hz cutoff.

If there seems to be an on-air problem with bass response, please don't blame this filter! First investigate such problems as obviously measurable bass rolloff in the chain up to OPTIMOD-TV, excess numbers of transformers in the audio chain, non-linear group delay in phone lines, and rising bass harmonic and IM distortion at program levels

(which are, in general, at least 14 dB higher than tone level at "0" VU). The 30Hz highpass filter does not cause significant loss of bass "tightness", and certainly does not introduce "thinness".

1.c) Allpass Phase Scrambler And Preemphasis/Deemphasis (on Cards #3 and #4)

The TV aural carrier has symmetrical positive and negative overload points ($\pm 100\%$ modulation). Some music, and voice in particular, have highly asymmetrical waveforms. Therefore, maximum loudness and minimum distortion consistent with the overload constraints of the TV aural carrier are achieved by processing waveforms to make their peaks more symmetrical.

In OPTIMOD-TV this is achieved by a combination of the crossover network in the master/bass multiband compressor and a third-order non-minimum-phase filter. This crossover is 12dB/octave, and when its outputs are summed, it provides a single-order phase shift to complete the phase scrambler function.

The frequency response of the second stage of the phase scrambler is slightly peaked, and provides preemphasis into the multiband compressor to improve its accuracy. A deemphasis stage after the bands are summed restores flat response.

The phase scrambler is a low "Q" circuit which does not introduce ringing. Its audible effect is extremely subtle. It can be heard as a very slight change in the "sound" of some voices. Music, in general, is audibly unaffected. Despite the fact that square waves emerging from the scrambler no longer look like square waves, the purist should not fear that it is degrading audio quality. It is in fact significantly improving subjective distortion performance of the system.

2.a) Dual-Band "Master/Bass" Compressor:

(audio on Cards #3 and #4; control on Card #5)

The major part of the 8180A compressor is the "Master" channel. This carries all program material above 200Hz. It is a feedback compressor, and its control voltage can be summed in a dB-linear manner (U.S. patent #4,249,042) with the control voltage developed by the "Bass" compressor to control the gain of the "Bass" VCA, which passes frequencies between 30 and 200Hz.

The summation is variable from none at all (in which case the "Master" and "Bass" bands operate independently, as in a conventional triband compressor) to unity gain (in which case the "Bass" channel always takes as much gain reduction as the "Master" channel). In the latter "quasi-wideband" case, the feedback compressor control loop in the "Bass" channel is still active, and causes further gain reduction in the "Bass" VCA when program material with excessive bass energy is present. This avoids the pumping which would occur in a fully-wideband system if excess bass were to force gain reduction of the entire program.

We feel that operating the third band of a conventional triband compressor independently of the rest of the bands yields very unnatural high frequency response when auditioned on high quality receivers. In addition, operating the low frequency band independently may result in unnatural frequency balances with certain program material. For this reason, the multiband compressor in the 8180A is quite dissimilar to other triband units, and offers unprecedented versatility in combination with very natural, unfatiguing sound.

2.b) Crossover and Bass Clipper: (on Card #3 and #4)

OPTIMOD-TV employs a 12dB/octave crossover. The 12dB/octave configuration is simply two identical 6dB/octave filters in series, with the polarity of the "Bass" band

inverted. It can be shown that the sum of the two outputs has a perfectly flat magnitude response, but exhibits an overall phase shift. This phase shift is purposely used as part of the "phase scrambler" to make peaks more symmetrical.

In OPTIMOD-TV, this crossover is realized as a "distributed crossover" (U.S. patent #4,249,042). This means that the first 6dB/octave section is before the VCA, and the second 6dB/octave section is after the VCA and the control voltage rectifier. The control voltage circuitry is therefore fed from a 6dB/octave crossover only.

The advantage of this configuration is that it permits insertion of a soft clipper immediately after the "Bass" VCA to eliminate overshoots which would otherwise intermodulate with the output from the "Master" VCA when the sum of "Bass" and "Master" is preemphasized and clipped. The second part of the "Bass" crossover is after the "Bass" clipper, thus lowpass-filtering the clipper output and rolling off harmonics and out-of-band IM introduced by the clipping process. In-band IM is negligible because of the relatively narrow bandwidth processed by the "Bass" channel.

The sum of the "Bass" and "Master" channels is applied to a deemphasis network to "undo" the preemphasis introduced in the phase scrambler circuitry (see 1.c)

2.c) Voltage-Controlled Amplifier (VCA) Operation:

The voltage-controlled gain block used throughout OPTIMOD-TV is a proprietary Class-A VCA which operates as a two-quadrant analog divider with gain inversely proportional to a current injected into the gain-control port. A specially-graded Orban IC contains two matched non-linear gain-control blocks with differential inputs and current outputs. The first of these is employed in the feedback loop of an opamp to perform the gain control function. The inputs of the first and second gain-control blocks are connected in parallel, and the output of the second block is a distortion-corrected current which is transformed into the desired gain-controlled voltage by means of an opamp current-to-voltage converter. For most gains, levels, and frequencies, THD is well under 0.1%. Overload-to-noise ratio (noise measured in a 20-20,000Hz band) is typically 90dB, and is constant with respect to gain and level.

2.d) Compressor Control Circuitry: (on Card #5)

Each compressor (left and right "Master" and left and right "Bass") feeds its own rectifier with threshold. The drive to the clippers following the compressors and preemphasis/high-frequency limiters is determined by the setting of the CLIPPING control, which simultaneously adjusts all rectifier thresholds (and thus the average compressor output level). Left and right rectifier pairs (which have current-mode high-impedance outputs) are "OR"ed into individual timing circuitry for "Master" and "Bass" channels.

This timing circuitry is proprietary, and is located within sealed modules. The "Master" timing circuitry is most critical to achieving natural sound. It performs the following functions:

- 1) A peak limiting function with very fast recovery time for transient material;
- 2) A slower compression function whose recovery time is a function of gain reduction; and,
- 3) A recovery-delay function which provides extra smoothing of the gain control voltage to avoid low frequency distortion even with fast release times.

The recovery time of the compression function is adjustable in the "Master" band only by means of the RELEASE TIME control. In addition, a gating circuit slows the recovery time of the compression function if the input program level drops below a threshold adjustable by the GATE THRESHOLD control, thus preventing "noise swish-up" during pauses or during low-level material. In GATED mode, recovery occurs toward -10dB gain instead of 0dB, thus avoiding noise pump-up on very noisy material like 16mm optical sound tracks.

The "Bass" timing circuitry is similar to the "Master" timing circuitry, and performs all of the same functions. Its time constants are optimized for most natural, dynamic sound.

Both timing circuits process the signal in logarithmic form, and have low-impedance outputs. The timing circuits drive exponential converters which provide control-current outputs for the "Master" and "Bass" VCA's. The BASS COUPLING control provides the ability to sum a controlled amount of the "Master" timing circuit output into the "Bass" exponential converter, where it sums with the output of the "Bass" timing circuit in a dB-linear manner.

Extensive gain reduction metering is provided. Since the outputs of the timing circuits are dB-linear, the gain reduction meters are provided with dB-linear scales.

The output of the "Master" timing module is applied to a peak detector which "holds" the fast-limiting component of the control voltage until the gain reduction meter ballistics have a chance to "catch up". The output of this peak detector drives the "Master" gain reduction meter, which shows the true peak value of the gain reduction.

The output of the "Master" timing module also drives a slewrate-limited amplifier which removes the fast limiting spikes from the voltage, and which drives the "compressor" meter to show the amount of slow compression occurring.

By subtracting the output of the slewrate-limited amplifier from the peak detector, the fast peaks only are derived. This difference signal feeds the "Limiting" meter.

The output of the "Bass" timing circuitry contains a much smaller fast peak limiting component than does the output of the "Master" timing circuitry. No peak detection is necessary to assure accurate metering, and the output of the "Bass" timing circuitry thus drives its gain reduction meter directly.

Except for the "Limiting" meter, all G/R meters are calibrated from -15dB to +10dB gain reduction. "0" thus corresponds to the normal gain of the system in its quiescent, gated state. In this state, the VCA gains are in fact 10dB below maximum.

The LIMITING meter is calibrated from 0 to 5dB for best resolution. When the RELEASE TIME control is operated in the slow part of its range, the LIMITING meter will ordinarily show little activity. However, as the release time is speeded up, the LIMITING meter will become more active, typically reading full-scale on transient material.

3) Phase-Corrected Lowpass Filter/Preemphasis: (on Card #6)

After the outputs of the "Master" and "Bass" channels have been summed, they are passed to a filter which performs three functions:

- 1) It lowpass-filters the signal at 15kHz and 24dB/octave to prevent frequencies beyond the bandwidth of the system from unnecessarily activating the high frequency limiter or causing unnecessary IM distortion in the clipper;

- 2) It provides a standard preemphasis (75us or 50us, depending on region); and,
- 3) It provides phase correction to make the delay of the lowpass filter plus preemphasis approximately constant, thus minimizing the unavoidable increases in peak level resulting from the preemphasis and filtering functions.

The lowpass filter is designed to partially equalize the frequency response variations in the main 15kHz lowpass filter following in the "FM Smart Clipper", thus providing flatter overall frequency response. The preemphasis is created by summing a second-order bandpass filter with the flat signal. The rising side of the filter slope provides the preemphasis; the falling side provides part of the lowpass filter function. The phase corrector is a fourth-order allpass filter, and is physically placed before the lowpass filter and preemphasis.

4) High Frequency Limiter: (on Card #6)

In order to perform the high-frequency limiter function, a variable-gain stage is placed between the output of the bandpass filter creating the preemphasis (see 3 immediately above) and the amplifier which sums the bandpass filter output with the main signal. Thus high frequency limiting is effected by dynamically reducing the preemphasis as required.

The variable gain stage is realized by a junction FET operating as a voltage-controlled resistor, instead of by a VCA as in other processing functions within OPTIMOD-TV. This simplification is possible because the high frequency limiters in the left and right channels are entirely independent, and need not track accurately together.

Each channel has its own rectifier and timing module. The timing in the high-frequency limiter is considerably simpler than in the compressor sections because only fast dynamic filtering occurs; there is no "compression" function.

It should be noted that the OPTIMOD-TV high-frequency limiter is activated by high frequency energy only. The high-frequency limiter therefore cannot be activated by, for example, low frequency overshoot components from the previous multiband compressor. This design is possible because OPTIMOD-TV's "FM Smart Clipper" permits considerably greater amounts of clipping than other clipping schemes without introducing audible distortion, thus rendering the high-frequency limiter function far less critical and permitting substantial increases in perceived high frequency power output. The high-frequency limiter need not "know" about the actual peak level of the preemphasized signal — only approximately how much HF energy is present.

An HF LIMITING control available to the user adjusts the threshold of high-frequency limiting over a range of approximately 3dB. The lowest threshold results in very little clipping on sinusoidal tone; the +3dB threshold results in moderate clipping of tone above approximately 2kHz. In most cases, users prefer operating this control in full "hard", which moves the threshold to the "+3dB" point and results in minimum high-frequency limiting and maximum high frequency control by clipping, while still limiting high frequency energy which would otherwise cause disturbing distortion if it were clipped.

Operation of the high-frequency limiter is metered by a simple comparator circuit which lights the appropriate front-panel high-frequency limit lamp if any high-frequency limiting at all occurs. It is primarily useful to verify that the high-frequency limiter circuit is operating properly.

5) "FM Smart Clipper": (on Cards #8 and #9)

The OPTIMOD-TV "FM Smart Clipper" (U.S. Patent #4,208,548) is a clipper circuit in which the threshold of clipping is varied dynamically as a function of the high

frequency energy in the program, and in which a distortion-cancelling sidechain permits all clipping distortion below 2.2kHz to be reduced by at least 30dB. This results in cleanest sound on both high and low frequencies, and controls the classic distortion problems in preemphasized clippers, the most significant one being sibilance splatter.

It should be noted that it is normal for sinewaves to modulate less than 100% when applied to OPTIMOD-TV in its normal OPERATE mode. There are two principal reasons for this:

- 1) Some headroom is left between the threshold of the "FM Smart Clipper" and the threshold of the subsequent overshoot corrector in order to accommodate the distortion corrector signal. With sinewaves, no distortion corrector signal is produced. Thus, the headroom is not used, and full 100% modulation does not occur.
- 2) Sinewaves have a very low peak-to-average ratio and high loudness potential compared to program material of identical peak levels. The audio processing, in order to maintain natural sound quality, pushes sinewaves down in level as it would any other similar program material with low peak-to-average ratio. In general, any audio processor which produces 100% modulation on sinewaves tends to sound somewhat unnatural because this psychoacoustic factor has not been accounted for.

5.a) Clipper With Dynamic Threshold: (on Cards #8 and #9)

The clipper is a straightforward shunt clipper which is ordinarily biased with ± 1.5 volts, thus providing a somewhat "soft" characteristic (but not nearly as soft as a pair of back-to-back unbiased diodes). The characteristic was chosen to obtain the best compromise between harmonic and IM distortion induced by clipping, when the IM-cancelling circuitry is considered.

The output of the bandpass filter in the high frequency limiter (see 4 above) feeds a rectifier with threshold. When high frequency energy exceeds this threshold, the clipper bias voltage is reduced to reduce the clipping threshold by approximately 1.0dB. The purpose of this threshold reduction is to provide headroom between the clipper threshold and the subsequent overshoot corrector threshold. This headroom accommodates the distortion corrector signal (see 5.c below) which is needed to correct the IM distortion produced when large amounts of HF energy are clipped. If this headroom were not provided, the overshoot corrector would clip off the distortion corrector signal, thus negating its effect. On the other hand, when the input signal to the clipper contains predominantly low frequency energy, the distortion corrector loop is essentially ineffective. In this case, the absolute amount of clipping is minimized by raising the clipping threshold to approximately the threshold of the overshoot corrector.

5.b) 15kHz Phase-Corrected Lowpass Filter: (on Cards #8 and #9)

The main clipped signal is applied to a 15kHz phase-corrected fifth-order Cauer lowpass filter to remove energy above 15kHz, particularly that induced by clipping. (Bear in mind that the unclipped signal was already filtered in the preemphasis lowpass filter.) The signal is also passed through a shelving deemphasis to help match the frequency response of this main signal path to the frequency response of the distortion-cancelling sidechain.

The delay of the 15kHz filter is equalized by means of a fourth-order allpass network to achieve minimum filter overshoot, and also to add sufficient delay to the main path so that the delay of the distortion-correcting sidechain can be matched.

5.c) Distortion-Cancelling Sidechain: (on Cards #8 and #9)

The clipper's output is subtracted from its input to derive the distortion introduced by the clipper. This distortion signal is applied to a 2.2kHz lowpass filter which matches both the frequency response and time delay of the main-path filter extremely closely throughout the 2.2kHz passband.

The output of this distortion-cancelling sidechain filter is summed into the output of the main-path filter. Distortion below 2.2kHz is cancelled by adding the filtered distortion signal to the main path. (Because the clipper's output was subtracted from its input, the actual distortion component — which appears at the clipper's output — is out-of-phase and thus cancels properly). The output of the 2.2kHz filter can be considered a smoothing signal. This signal increases the peak level of the summed signal somewhat. If the level increases beyond the 100% point, it is clipped by the subsequent overshoot corrector. In most cases, the level buildup is not very large because the distortion signal contains mostly high frequencies, and these are filtered out by the 2.2kHz lowpass filter, thus greatly reducing the level of the distortion signal before it is summed with the main signal.

The sum of the main-path and distortion signals is passed through a shelving preemphasis which is precisely complementary to the shelving deemphasis introduced in the main path, thus restoring overall flat response.

6) Frequency-Contoured Sidechain (FCS) Overshoot Compensator: (on Cards #8 and #9)

A

The FCS overshoot compensator (patent pending) is best thought of as a "bandlimited safety clipper". That is, it performs the function of clipping off overshoots from the earlier "FM Smart Clipper", but does not produce out-of-band frequency components as a simple clipper would. If such components were produced, they would cause "aliasing distortion" when applied to a (future) stereo generator and then decoded in a stereo receiver. Simultaneously, the FCS overshoot compensator does not significantly increase low frequency IM products when compared to a simple clipper performing the same function — a problem particularly characteristic of competing overshoot compensation circuits.

Briefly, the FCS overshoot compensator functions by deriving the overshoots from its input with a "center clipper" circuit, lowpass-filtering the overshoots with a fifth-order passive LC filter to remove out-of-band frequency components, and then mixing the filtered overshoots out-of-phase with a delayed version of the input signal. This delay, created by an encapsulated active allpass network, is identical to the delay in the overshoot filter, thus assuring that the input signal and filtered overshoots arrive in the same place at the same time.

If no filter were used, this process would be identical to clipping the input signal, and would create a "differential clipper". However, the overshoot filtering process reduces the peak level of the high frequency components of the overshoot by removing harmonics. To compensate for this loss of peak level (which would cause less than full cancellation of overshoot), the frequency response of the overshoot filter rises at 15kHz — thus increasing the level of the high-frequency fundamental to compensate for the loss of harmonics. This is why the system is called "Frequency-Contoured Sidechain".

The final sum of input and out-of-phase filtered overshoot is passed through a third-order lowpass filter to provide further attenuation of unwanted high frequency energy. Phase correction is applied to the combination of this filter and the overshoot filter. (The phase response of the overshoot filter is identical to its matched main-path delay network — thus the phase correction also corrects the response of the main-path delay network.) This phase correction makes the overall time delay through the entire FCS

overshoot compensator approximately constant, and assures that the various filters within the compensator do not upset carefully controlled peak levels in unpredictable ways.

If any very unusual waveforms cause residual overshoots, these are dealt with in a safety clipper at the output of the FCS overshoot compensator system. However, the basic FCS overshoot compensator is so effective that this safety clipper is rarely active.

7) Balanced Line Amplifier and Deemphasis: (on Card #7)

The line amplifier is totally straightforward. It consists of a pair of inverting opamps. These are 5532 devices which can drive 600 ohm loads directly. The feedback resistor of the first opamp can be shunted by a capacitor (selected by a plug-in jumper) to effect deemphasis if desired.

The second opamp is a unity-gain inverter driven by the first opamp. The outputs of the two opamps thus provide an output balanced to ground which drives a non-overshooting EMI filter to interface to the outside world. The balanced driving capability of the circuit is approximately +20dBm into 600 ohms.

8) Power Supplies:

Primary power for the OPTIMOD-TV circuitry comes from a highly regulated ± 15 volt power supply. The main supply is +15 volts. This is controlled by means of a 723C IC regulator with current-boosted output, current limiting, and overvoltage protection using a zener diode and fast-blo fuse.

The -15 volt supply is essentially a current-boosted opamp in a unity-gain inverting configuration which "amplifies" and inverts the +15 V supply, thus "tracking" it. The -15 volt supply is also current-limited and overvoltage protected. Both +15 and -15 supplies are located on a non-plug-in card mounted on the inside of the rear chassis apron. This apron is also used as a heat sink for the regulator power transistors.

The 711C comparators used in the stereo generator require +12/-6 volt sources. These are developed by locally dropping the main +15 volt supply through three forward-biased silicon diode junctions (to create the +12), and by means of local resistive voltage dividers from -15 to ground (to create the -6). In addition, a number of local ± 14 volt sources exist. These are developed by means of single diode drops from the ± 15 volt main power supply, with local capacitive decoupling. Their purpose is to decouple noise from the main power supply.

Bias sources are also required for the diode clippers in the audio processing. There are two such sources; the first creates approximately ± 1.2 volts (for Cards #3 and #4), while the second creates ± 4.2 volts (for Cards #8 and #9). Both sources employ a pair of opamps. The first is a unity-gain voltage-follower whose input is a temperature-compensated voltage created by a resistor/diode network; the second is a unity-gain inverter which creates the complementary negative voltage.

This concludes **APPENDIX A (SYSTEM DESCRIPTION)**.

Appendix B: Circuit Description

The following section provides an extremely detailed description of the circuitry used in OPTIMOD-TV on the component level.

It may be wise to read **Appendix A** first, and to consult the block diagram on p. J-21. Referring to the appropriate Schematics and Parts Locator Drawings in **Appendix J** will help you to follow the text and will aid component-level troubleshooting.

In those cases where the circuitry is duplicated in the left and right channels, only the left channel circuit and component designators will be discussed.

I.a) Input Amplifier: (on Cards #3 and #4)

The input is applied to the RF filter chamber, and there encounters an RF filter and 10K bridging pad R303, R304, R305. Strapping R305 into the pad introduces 20dB loss, which is the normal condition of the pad.

The output of the pad is connected to a low-noise true instrumentation amplifier consisting of IC301A, IC301B, IC302A, and associated resistors. R306, R307 provide bias current for IC301, which is a low-noise bipolar-input dual IC opamp. R308, R311 are feedback resistors for the two sections of IC301. The differential gain is controlled by the series resistance of R310 and GAIN control R309. The common-mode gain of the IC301 pair is 1.

The differential output of IC301A and IC301B is converted to a single-ended output and the common mode component of the output is nulled by means of differential amplifier IC302A and associated resistors. R316 adjusts the balance of the resistor network to assure maximum common-mode 60Hz rejection.

NOTE:

Nearby lightning strikes may induce sufficient energy into OPTIMOD-TV's audio input wiring to pass through the RFI protective networks and destroy IC301 or IC401. If OPTIMOD-TV is installed in a lightning-prone location, it is advisable to keep spare NE5532's in stock.

Installation of Varistors or other protective devices between each side of the audio input line and earth may help prevent such problems. (IC301 is socketed, and is thus easily replaced.)

I.b) 30Hz Highpass Filter: (on Cards #3 and #4)

The non-bypassable 30Hz highpass filter IC302B, C303, C304, C305, R317, R318, R319 is a third-order Chebychev filter with 0.5dB passband ripple (nominal) and a ripple bandwidth (i.e., -0.5dB frequency) of 30Hz. It is realized as a unity gain Voltage-Controlled Voltage-Source (VCVS) active filter. This filter is non-inverting, has a gain of exactly 0dB in the passband, and uses positive feedback to "sharpen up" the response around the cutoff frequency. Most modern books on active filters extensively discuss this type of filter. (See for example — Wong and Ott: Function Circuits. New York, McGraw-Hill, 1976, pp. 230-231.)

I.c) Allpass Phase Scrambler and Preemphasis/Deemphasis: (on Cards #3 and #4)

This filter contains a single-order allpass filter IC303A, R320, R321, R322, C306 followed by a second-order non-minimum-phase peaking equalizer IC303B, R323, R324,

R325, R326, R327, C307, C308. The phase response of the first section varies from 0 to 180 degrees as a function of frequency, while the phase response of the second section varies from 0 to 360 degrees as a function of frequency. The amplitude response of the first section is flat; the amplitude response of the second section is broadly peaked at approximately 200Hz.

To restore flat response, a complementary dipping-equalizer section is inserted after the two bands of the dual-band compressor have been recombined. This circuit consists of IC307A, R359, R360, R361, R362, R363, C319, C320. Its gain far from 200Hz is -1.76dB, and it exhibits a second-order dip centered at 200Hz.

2.a) Dual-Band "Master/Bass" Compressor (General): (on Cards #3, #4, and #5)

The dual-band compressor consists of an audio path and control circuitry. We will first discuss the audio path generally. Details of the VCA operation and control circuitry operation are found immediately below in sections 2.c, 2.d, and 2.e.

2.b) Crossover and Bass Clipper (on Cards #3 and #4)

The crossover consists of 12dB/octave sections. The first 6dB/octave filter is located before the VCA, the second after. Since the input to the control rectifiers is taken from the VCA outputs, the control-voltage crossover is 6dB/octave.

The first 200Hz highpass section for the "Master" compressor is filter C309, R328. The second 200Hz highpass section is C318, R357. The first 200Hz lowpass section for the "Bass" channel is R342, R343, C314. The second lowpass section for the "Bass" channel is R367, R366, R365, C321.

A clipper, consisting of biased diodes CR303, CR304, and resistors R367, R366, is located before the second lowpass section. Thus the second lowpass section rolls off harmonics created by clipping. (NOTE: This "distributed crossover with embedded clipper" system is protected by U.S. patent # 4,249,042.)

In order to force the "Master" and "Bass" channels to add correctly, the polarity of the "Bass" VCA is inverted by using the appropriate inputs of IC309B (compare with IC305B).

2.c) Voltage-Controlled Amplifier VCA Operation:

NOTE

This section contains a general description of the voltage-controlled amplifier circuitry used through OPTIMOD-TV. The "Master" VCA will be specifically described.

The basic operation of the VCA depends on a precisely-matched pair of gain-control blocks with differential voltage inputs and current-source outputs. The gain of each block is controlled by means of a control current.

If used alone, one such gain-control block would introduce considerable distortion. Therefore, the first of the two matched blocks IC305A is used as the feedback element in a high-quality operational amplifier, IC304. The second of the matched blocks IC305B is then driven by the predistorted output of IC304. To provide more detail: The output of IC304 is first attenuated by R334, R335, C311, and then applied to the input of the feedback element IC305A. The output of IC304 is predistorted as necessary to force the current output of IC305A to precisely and linearly cancel the audio input into the "virtual ground" summing junction of IC304. This same predistorted voltage is also

connected to the input of IC305B. Thus the output of IC305B is an undistorted current, which is converted to a voltage in current-to-voltage converter IC306A, R341, R376, C312. The output of IC306A is the output of the VCA.

Because IC305A is in the feedback loop of IC304, the gain of the VCA is inversely proportional to the gain of IC305A. Thus if the control current is applied to the control port of IC305A (through R333), then the VCA behaves like a two-quadrant analog divider.

In the case of the "Master" VCA, a fixed current is applied to the control port of IC305B through R339, R340, CR301 to fix the gain of IC305B. CR301 provides temperature compensation.

Second-harmonic distortion is introduced by differential offsets in either IC305A or IC305B. This distortion is cancelled by applying a nulling voltage directly to the input of IC305B by means of resistor network R336, R337, R338.

If the VCA is not perfectly balanced, "thumps" due to control current feedthrough can appear at the output. These are equivalent to multiplying the control current by DC. If a correct DC offset is applied to the VCA input, then this equivalent DC multiplication can be nulled to zero and the "thumps" eliminated. Such an adjustable DC offset is provided by R331, R332.

R329, R330, C310 are frequency-compensation components to prevent the VCA from oscillating supersonically.

2.d) Compressor Control Circuitry: (on Card #5)

The output of the "Master" VCA is applied to a voltage in/current out fullwave rectifier-with-threshold, IC503A, IC504, R505, R506, R507, C502, CR502. This is essentially an opamp with discrete class-B output stage. A bias voltage of -12V on the "+" input of IC503A holds the voltage at this opamp's "-" input at -12V by feedback and provides appropriate bias conditions for the rectifier to prevent saturation. R507 determines the rectifier's transconductance. C502 provides DC blocking between the nominal ground potential of the input side of R507 and the -12 volts at IC503A's "-" input.

A negative-going voltage at the input side of R507 pulls current away from the "AC virtual ground" at IC503A's "-" input. An equal current must therefore flow into "-" input by turning on the NPN transistor whose base is connected to the output of IC503A. Because of the class-B biasing, this assures that the PNP whose base is connected in parallel to the NPN is off.

A collector current essentially equal to the NPN's emitter current flows into the NPN from the output terminal of the rectifier. Part of this current comes from the rectifier load; part comes from the fixed collector current of the top PNP transistor. This PNP creates the threshold of limiting by saturating and diverting all class-B output stage collector current away from the load until the output stage current exceeds the nominal PNP collector current. When the output stage current exceeds the PNP collector current, the PNP comes out of saturation, and the difference between the PNP collector current and the rectifier output current is delivered to the rectifier's load. The PNP transistor's collector current is fixed by its emitter resistor R505, and by its base voltage (determined by the setting of the CLIPPING control, R542). The CLIPPING control thus varies the collector current of the PNP, and therefore the threshold of limiting. In PROOF mode, CR502 and R506 parallel R505, increasing the collector current, and raising the limiting threshold by approximately 14dB.

If the voltage at the input side of R507 goes positive, then the bottom PNP transistor turns on, and its neighboring NPN turns off. The collector current of the PNP is inverted by the dual NPN current mirror, and the current mirror output is summed into the output port of the rectifier, where it is also subject to the action of the PNP threshold transistor as described immediately above.

The output of the left "Master" rectifier is "OR"ed with the output of the right "Master" rectifier by means of two diodes: CR501 & CR504. Because the output of each rectifier is in the form of a current, voltage drops across the "OR"ing diodes do not affect the accuracy of the rectifier. Any number of rectifier outputs could be "OR"ed to this point, and an input is provided for a possible future loudness controller.

The output of the "OR" circuit is applied to a proprietary circuit which computes the VCA control voltage. Release time control for the slow "compressor" function is provided by R508, R509. A JFET switch Q501 is provided to slow the compression release when ordered to do so by the gating circuitry (described immediately below). In the case of the "Master" compressor, a pair of resistors whose Thevinin equivalent voltage is approximately -3.2VDC are connected to one side of Q501. When Q501 is ON, these resistors are swamped out by a low impedance drive on the other side of the FET. When Q501 is OFF, these resistors pull a small current from the timing module, forcing the gain reduction voltage slowly towards -3.2V (corresponding to 10dB G/R).

In the case of the "Bass" compressor, gating FET Q502 is bridged by 22 meg resistor R551. Thus very slow recovery toward 0dB gain reduction occurs even when Q502 is OFF.

The output of the control voltage module varies between 0 volts (maximum gain) and approximately -10 volts (minimum gain=maximum gain reduction). Thus release is inhibited by applying a voltage of greater than +10 volts to the anode of CR503 which forces Q501 off. Release is enabled by applying a voltage of less than -10 volts to the anode of CR503. This reverse-biases CR503, and Q501 is forced on by R510's forcing Q501's gate to be at the same potential as its source.

The output of the release time module is a low impedance voltage source. It is applied to exponential converter circuit IC501, IC502, R501, R502, C501 through pad R503, R504. The collector current of either matched transistor in IC502 is an almost perfect exponential function of its base-emitter voltage. The scaling factor of the converter is stabilized by forcing a constant current through the left-hand transistor by means of IC501. This current is determined by the current injected into IC501's "-" input through R502. The base of the left-hand transistor is grounded; the emitters of the matched transistors are connected. Thus, assuming a perfect match between transistors, the collector currents of the two transistors will be equal if the base of the right transistor is grounded. Varying the base voltage on the right-hand transistor varies its collector current exponentially about the nominal current in the left-hand transistor. This nominal current determines the quiescent (no-gain-reduction) gain in the VCA's.

The current output at the collector of the right-hand transistor is connected to a matched pair of resistors, one of which feeds the gain control port of the left VCA, and the other of which feeds the gain control port of the right VCA. This is a "current divider" and is analogous to the familiar resistive voltage divider.

The operation of the "Bass" control loop is similar to the operation of the "Master" control loop. There are two essential differences. First, the "Master" control loop gates to -10dB gain, while the "Bass" control loop gates to 0dB gain (as discussed above). Second, provision is made to mix "Master" control voltage into the input of the "Bass"

exponential converter through BASS COUPLING control R521, and R518. When R521 is fully clockwise, the "Bass" exponential converter is being fed as much "Master" control signal as the "Master" exponential converter. In the absence of output from the "Bass" release time module, "Bass" and "Master" VCA's will thus track exactly.

Because the "Bass" rectifier is always connected to the output of the "Bass" VCA, exceptionally strong bass will exceed the threshold of bass limiting and cause an output from the "Bass" release time module, thus momentarily decreasing the gain of the "Bass" VCA below that of the "Master" VCA. This is the low-frequency equivalent of familiar high frequency limiting.

(NOTE: The "multiband feedback compressor with crosscoupling into dB-linear VCA's" concept is protected by U.S. patent # 4,249,042.)

2.e) Gain Reduction Metering:

Gain reduction metering in the "Master" band is provided by three meters.

The first, TOTAL G/R, is driven by a peak detector IC512, R530, C508, CR511. C508 captures negative-going peaks and discharges slowly through R530. To avoid being loaded by the meter, C508 is buffered by voltage-follower IC512B. The discharge time of C508 is sufficiently slow to permit the mechanical movement of the TOTAL G/R meter to rise to the actual peak level of the gain control voltage, thus accurately displaying it.

COMPRESSION is indicated by passing the output of the release time module through a grossly overcompensated 301A opamp IC511 connected as a voltage follower. The 2.2uF compensation capacitor C507 so limits the slew rate of IC511 that only the slow component of gain reduction is permitted to drive the COMPRESSION meter.

The LIMITING meter is connected differentially between the outputs of IC511 and IC512B. It thus indicates the fast component of gain reduction as the difference between the slow component and the peak-held TOTAL component.

"Bass" band gain reduction metering reads the sum of the "Master" and "Bass" control voltages through R519, R520, in the same proportions that are applied to the input of the "Bass" exponential converter. In the interests of simplicity, the "Bass" TOTAL G/R metering signal is not electronically conditioned.

2.f) Gating Circuitry: (on Card #5)

The gating detector consists of a peak detector followed by a comparator. IC opamps are employed for both functions.

The left and right input signals are summed in R538, R539, and lowpass-filtered at 3kHz by means of C510. The lowpass-filtered sum is amplified by means of non-inverting amplifier IC513B, whose gain is variable from 0 to approximately 40dB by means of R537, the GATE THRESHOLD control. Low frequency response of IC513B is rolled off with C511 to prevent low-frequency noise from inhibiting the gate.

The positive peak output of IC513B is detected by CR514 and C503. R536 determines the recovery time of this peak detector.

The output of the peak detector is applied to comparator IC513A. R533, R534 create a reference voltage of +1.9 volts. If the output of the peak detector exceeds this value, then the output of IC513A is driven towards the negative power supply, and the gate is inhibited. Otherwise, the output of IC513A rests close to the positive power supply, and the gate is enabled. In this condition, the GATE LED is lit by current supplied through R531, CR512.

Hysteresis to assure clean switching is provided by positive feedback through R532.

In PROOF mode, CR513 applies +15 volts to the "-" input of IC513A to inhibit the gate, thus permitting all VCA's to recover to full gain.

3) Phase-Corrected Lowpass Filter/Preemphasis: (on Card #6)

Phase correction for the preemphasis and fourth-order lowpass filter associated with it is provided by a fourth-order allpass filter IC601, R601, R602, R603, R604, R605, R606, R607, R608, R609, C601, C602, C603, C604. The overall magnitude response of the filter between the card input and the filter output at IC601B is flat, gain is 0dB, and the phase response varies from 0 to 720 degrees. The operation of the filter is difficult to explain in words, and is best left to a mathematical analysis.

The fourth-order lowpass filter is in fact quasi-fourth-order. The first section of the filter is generated by a conventional second-order multiple-negative feedback active lowpass filter IC602A, R610, R611, R612, C605, C606. (See, for example, Wong and Ott: Function Circuits, op. cit.). However, the second section has been combined with the preemphasis, and transformed from a purely lowpass form to a peaking bandpass equalizer.

To understand this, imagine first a preemphasis cascaded with a 12dB/octave lowpass filter. As frequency is increased, the response will first rise at 6dB/octave, following the preemphasis. However, when the cutoff frequency of the lowpass filter is encountered, the response will reverse itself and fall at 6dB/octave indefinitely.

This is similar to the response of a peaking equalizer. However, when the response of the peaking equalizer falls, it does not fall indefinitely, but only until it reaches unity gain again. Nevertheless, we can choose a peaking equalizer whose rising side matches the rising side of our original preemphasis-plus-lowpass-filter to very close tolerances.

The falling side, after deemphasis, represents the stopband of the filter. Thus, when considered as a totality, the response of the entire fourth-order filter will, instead of falling indefinitely at 24dB/octave, fall for approximately 20dB after cutoff at 24dB/octave, and at 12dB/octave thereafter.

4.a) Differential Preemphasis and High Frequency Limiter: (on Card #6)

The advantage of transforming the lowpass filter as described in the previous section is that it permits us to create the preemphasis differentially, by summing the output of bandpass filter IC602B, R614, R615, R617, C607, C608 with the filter's input. The summation occurs in IC605A. The output of IC602B is passed through a variable-gain stage, realized with FET IC603A, and low-noise non-inverting amplifier IC604. By varying the gain with which the output of IC602B is summed with its input, a high frequency limiter is realized.

Ordinarily, IC603A is pinched off, thus producing maximum gain and full preemphasis. However, as the gate voltage on IC603A is reduced toward ground, the resistance of IC603A decreases, thus decreasing the gain of voltage divider R619, R620, IC603A and reducing the preemphasis.

The polarity reversal in IC602B requires that a compensating polarity reversal occur in the summing process. IC605A is thus non-inverting for the bandpass signal, and inverting for the main signal. In addition, R616 feeds some of the output of IC602B around the variable-gain stage out-of-phase. This permits complete cancellation of the preemphasis despite the inability of the FET variable-gain stage to achieve total cutoff.

4.b) High Frequency Limiter Control Circuitry: (on Card #6)

The high frequency limiter control circuitry is very similar to the compressor control circuitry described in 2.d above. The output of the bandpass filter only is applied to the rectifier-with-threshold, which is identical to the ones used in the compressor control circuitry. Similarly, the output of the rectifier is connected to a proprietary release-time module, and the threshold-of-limiting adjustment and PROOF mode G/R defeat are also substantially identical to previously described circuits.

The output of the module, unlike the outputs of the release time modules in the compressor control circuitry, is high impedance. It drives the high impedance gate of FET IC603A through R625.

Gain reduction is indicated by a simple ON/OFF LED indicator, driven by IC606A. FET BIAS adjustment R626 determines the quiescent gate voltage of IC603A, assuring pinchoff under conditions of no limiting. This voltage is applied through release time resistor R627 to the "-" input of IC606A. This input will be pulled in the negative direction when gain reduction occurs.

The output of R626 is also applied to the "+" input of IC606A through R628. R629 pulls this "+" input slightly more negative than the output of R626 to hold the output of IC606A negative during conditions of no gain reduction. However, as soon as the "-" input of IC606A is pulled slightly less positive by the occurrence of gain reduction, the output of IC606A goes positive and lights the HF LIMIT lamp through R630 and Q601, used as a zener diode.

5.a) Clipper With Dynamic Threshold: (on Cards #8 and #9)

The threshold of the first clipper CR801, CR802 is varied dynamically to make best use of the distortion-cancelling circuitry. When the clipper input signal contains substantial high frequency energy, then the threshold of clipping is lowered approximately 1.0dB to permit the difference-frequency IM distortion-cancelling signal to sum with the output of the main 15kHz lowpass filter without excessive clipping in the subsequent overshoot corrector. However, when the clipper input signal contains predominantly low frequencies, then the clipper threshold is raised to minimize the amount of low frequency clipping which occurs.

This is achieved by using the rectified output of IC602B (the high frequency bandpass filter employed differentially in the preemphasis filter) to control the clipper threshold. The output of IC602B feeds a rectifier-with-threshold IC806B, IC807 (and associated circuitry) whose operation is identical to the rectifier-with-threshold already described in 2.d. This rectifier feeds an RC filter R844, R847, R848, CR807, C826. R844 determines the attack time of the circuit in conjunction with C826. The recovery time is determined by the series combination of R847 and R848.

If the high frequency energy present at the input to the rectifier is insufficient to overcome its threshold, then the "+" input of IC808A is held at ground by R847, R848. If output current flows into the rectifier, then C826 is pulled negative through CR807. If the voltage across C826 attempts to go more negative than approximately -13 volts, the rectifier will saturate and limit the voltage swing to this value. The voltage divider R847, R848 attenuates this 13 volt variation such that it causes a voltage variation of -0.2v at the output of IC808A, thus changing the threshold of clipping by approximately 1.0dB.

A 1.5 volt quiescent bias for the clipper diodes is provided by passing the output of a voltage divider through CR808 to R846. IC808A then acts as a unity-gain inverting amplifier for the voltage at CR808's anode. CR808 temperature-compensates the

B

threshold of clipping by reducing the clipper bias voltage as the voltage drop across the diodes increases (with temperature variation). The final diode bias voltage at the output of IC808A is thus the sum of the quiescent voltage contributed by the circuitry connected to the "-" input of IC808A, and the voltage variation contributed by the circuitry connected to the "+" input of IC808A.

IC808B is connected as a unity-gain inverting amplifier, and provides a complementary negative bias for CR802.

It is important to understand that this scheme results in sinewaves not hitting 100% modulation in OPERATE mode. This occurs for two reasons. First, the dynamic response of the previous multiband compressor section is such that steady-state 1kHz sinewaves reach about 60% modulation if the CLIPPING control is adjusted to 12:00. This is a direct consequence of the natural loudness balances produced by this processing. Because sinewaves have a very low peak-to-average ratio compared with speech or music, their peak level must be reduced to prevent them (or similar program material) from being unnaturally loud and giving the processing an artificial, strained quality.

Second, a certain amount of headroom is left between the threshold of the first clipper and the threshold of the overshoot compensator to accommodate the distortion corrector signal and overshoots in the 15kHz lowpass filter without performing excessive, non-distortion-cancelling clipping in the overshoot corrector.

Because of the previously mentioned characteristics of the multiband compressor, sinewaves below about 2.5kHz are not ordinarily clipped; thus, no distortion-corrector signal is produced. However, varying the clip threshold does make better use of available headroom than would be the case if the clipper were always left at the "-1.0dB" threshold to which it switches in the presence of substantial high frequency energy.

It is important to note that despite (in reality, because of) this behavior with sinewaves, extremely high loudness is obtainable with speech or music because the processor's behavior is optimized for these signals.

5.b) 15kHz Phase-Corrected Lowpass Filter: (on Cards #8 and #9)

The signal from the HF limiter is applied through R801 to clipper CR801, CR802. The clipper output is applied to inverting amplifier IC801A through R802.

The output of IC801A (the clipped signal) is filtered by fifth-order Cauer lowpass filter R806, R807, C801, C802, C803, C804, C805, C806, C807, L801, L802. This lowpass filter is realized as a "passive ladder" for maximum stability. The filter's response is nominally +0, -0.6dB from 0 to 15.4kHz, with a sharp rolloff thereafter. There are notches at approximately 19kHz and 26.6kHz.

The load resistor for the filter, R807, is connected not to true ground, but to the "virtual ground" of the summing junction of IC801B. IC801B is an inverting, frequency selective amplifier, whose feedback network R808, R809, C808 provides a 2dB shelving rolloff. The purpose of this rolloff is to match the gentle rolloff of the 2.2kHz sidechain filter (see 5.c) so that the distortion is correctly cancelled.

The output of IC801B feeds a differential sidechain which creates a fourth-order allpass function when its output is correctly summed with the output of IC801A (i.e., the main signal). This allpass function does not change the frequency response of the 15.4kHz lowpass filter, but does add phase shift as necessary to make the overall time delay of the 15.4kHz filter plus allpass network more constant than the time delay of the 15.4kHz filter alone.

Basically, this phase corrector sidechain consists of a pair of active inverting bandpass filters built around IC802A, IC802B. The IC802A filter is driven by the output of IC801B through R815. Its output is summed into summing amplifier IC803B through R817.

The second bandpass filter (associated with IC802B) is driven by both the main signal (through R814) and the output of the first bandpass filter IC802A (through R818). The output of IC802B sums into IC803B through R820.

The third input to IC803B is the main signal (through R810). The fourth (and final) input is the output of the 2.2kHz sidechain distortion-cancelling filter (through R822).

To restore flat response, the frequency response of this summation is boosted by passing the signal through a shelving filter complementary to the one realized in the feedback network of IC801B. The shelving boost is created by the R811, R812, R813, C809 in the feedback network of IC803B.

The output of IC803B is the output of the "Smart Clipper". Because it contains substantial overshoots, it is connected to the FCS overshoot compensator (see 6 below).

5.c) 2.2kHz Distortion-Cancelling Filter Sidechain: (on Cards #8 and #9)

The distortion-cancelling sidechain takes the difference between the input and output of the clipper (which is the distortion added by the clipper). It then lowpass-filters this difference at 2.2kHz (thus substantially reducing the peak level), and finally sums the difference back into the main signal (at IC803B) to cancel clipping-induced distortion below 2.2kHz.

If no clipping occurs, the signal at the input side of R801 is equal and opposite to the signal at the output of inverting amplifier IC801A and no differential signal is produced. Because of the polarity reversal in IC801A, the difference between the input signal and the clipped output is derived by a simple summation through R804, R805.

This signal (our desired difference signal) feeds filter C814, L803, A1, whose magnitude and phase, when cascaded with additional rolloff R821, R822, C815, match the magnitude and phase of the phase-corrected 15.4kHz lowpass filter (see 5.b above) from 0 to 2.2kHz. IC803A is a unity-gain buffer to drive this final rolloff network, the output of which is directly summed into IC803B.

6) Frequency-Contoured Sidechain (FCS) Overshoot Compensator: (on Cards #8 and #9)

Overshoots are derived from the input signal by center clipper IC804A, R823, R824, R825, R826, CR803, CR804. This circuit is a differential amplifier which subtracts the output of a clipper from the clipper's input. This clipper consists of Schottky diodes biased with approximately $\pm 4.2\text{v}$, and is therefore substantially "harder" than the first clipper (associated with IC801A).

If the output of IC804A were simply added to its input, the sum would be a clipped signal; a "differential clipper" would be created. However, the output of IC804A contains clipper-induced high frequencies which could cause "aliasing" in a stereo generator or possible interference to the video. The output of IC804A is therefore lowpass-filtered by passive 15kHz ladder filter R828, R829, C816, C817, C818, L804, L805, before being added back into the input signal to cancel overshoots. This filter has a response that rises 4dB at 15kHz. This makes up for the loss of high frequencies which would otherwise reduce the peak level of the overshoots emerging from the filter. To compensate, the fundamental levels around 15kHz are increased by the frequency-contouring.

(NOTE: Patent claims are pending on this "Frequency-Contoured Sidechain" overshoot compensation scheme.)

The filter has phase shift. To assure correct addition of the filtered overshoot, the input signal is delayed in a modular phase shift network, A1, whose amplitude response is flat, but which accurately matches the phase response of the sidechain filter throughout its passband. A1 is also equipped with a summing input for the overshoot signal, which appears at the output of IC804B.

The time delay of this network is not constant at all frequencies. The output of A1 is thus passed through allpass network IC805A, R831, R832, R833, R834, C819, C820 to create constant time delay from the input of the overshoot compensator system to its output. The allpass network has a flat amplitude response, but frequency-dependent phase response. (This network is designed to also compensate for the non-constant group delay of the following third-order lowpass filter).

The output of IC805A is passed through a composite capacitor (consisting of two aluminum electrolytics back-to-back, bypassed by a polycarbonate) to remove accumulated DC offsets. Recent research has indicated that this sort of composite structure minimizes the audible degradation caused by passing audio signals through polar capacitors with high dielectric absorption.

The signal then passes through a third-order active 15kHz lowpass filter IC805B, R836, R837, R838, R839, C822, C823, C824 to provide further reduction of any remaining out-of-band energy above 19kHz.

Finally, to catch any slight errors made by the overshoot compensator, the signal is applied to safety clipper R840, R841, CR805, CR806. The basic overshoot compensator is extremely effective; thus, the safety clipper is virtually never active and no additional filtering is included after its output. The output of the safety clipper is buffered by IC806A.

7) Balanced Line Amplifier With Deemphasis: (on Card #7)

Card #7 contains two identical balanced line amplifiers with provision for jumpering deemphasis in or out. The operation of this circuit is completely straightforward, and no further information beyond that found in **Appendix A** is necessary for understanding.

8.a) Unregulated Power Supply: (on chassis outside RF-tight enclosure)

The unregulated power supply is wholly conventional. It consists of a dual-primary transformer T101, two full-wave rectifiers CR101, CR102 and CR103, CR104, and two energy storage capacitors C101, C102.

T101's primary may be switched for 115 volt operation by paralleling its two primaries, or for 230 volt operation by connecting its two primaries in series. RF filtering is provided on the AC line by means of FL101. In addition, VHF and UHF RF is filtered from the unregulated DC supply lines as they enter the main chassis by means of C103, C104, C105, C106, C107, L101, L102. The RF suppression scheme divides the chassis into three major sections. The section to the left (unregulated power supply chamber) contains the AC wiring and the unregulated power supply, and is assumed to contain some RF. The card cage, to the right, uses RF suppression on each line entering or leaving the area, and is thus RF-free. (The RF filter box, on the rear panel, interfaces the audio input and output lines with the outside world. It contains the input pads. Its connections to the main RF-tight compartment are all RF-filtered.)

8.b) +15 Volt Regulator: (on Card #1 — rear chassis apron)

The +15 volt regulator is the main reference for all other voltages in the OPTIMOD-TV system. It employs a 723C IC voltage regulator IC101 in conjunction with an external series-pass transistor Q101. This transistor is mounted on the rear apron of the chassis, which serves as a heat sink.

The 723C contains a reference voltage source, an opamp (externally compensated by means of C109 to prevent oscillation), and a current limiting transistor. The reference voltage (nominally +7.15 volts) is developed at pin 6. C108 filters high frequency noise from the reference voltage. The reference voltage is directly connected to the non-inverting input of the internal opamp, pin 5. Voltage divider R105, R106, R107 develops a precise fraction of the output voltage of the regulator at the wiper of R106. R106 adjusts this fraction. The wiper of R106 is connected to the inverting input of IC101's internal opamp. Negative feedback thus forces the voltage at the wiper of R106 to be equal to the reference voltage. Thus the output voltage of the regulator is always the reference voltage divided by the voltage divider gain.

The output current flowing through Q101 develops a voltage drop across R103. When the current exceeds approximately 3/4 amp, said voltage drop is sufficient to turn on the current-limit transistor inside IC101, whose base-emitter junction is connected to pins 2 and 3 of IC101. The current-limit transistor then shunts base drive current from the external series-pass transistor Q101 and prevents damage due to overheating.

If a catastrophic failure in the +15 volt regulator causes it to lose control over its output voltage, the rest of the circuitry must be protected against the full unregulated voltage, or the entire system will be severely damaged. This protection is provided by zener diode VR101, CR105, and 1 amp fast-blo fuse F102.

In the event that the regulator loses control of the output voltage, VR101 will conduct and limit the output voltage to approximately 16.5 volts, which will not damage the system. Extremely large amounts of current will flow in VR101. However, before VR101 is damaged, this current will blow F102, thus disconnecting the circuitry from the unregulated supply. VR101's clamping action will also prevent the negative tracking supply from going any higher than -16.5 volts. If the regulator is operating properly, the current limiting circuitry will prevent F102 from blowing even if the regulator output is short-circuited.

Under certain unusual circumstances, the regulator may lose control of its output voltage, yet the current limiting circuit may still work. If this occurs, F102 will not blow, and VR101 will overheat and burn out. Fortunately, its failure mode is a short-circuit. It will therefore still protect the OPTIMOD-TV circuitry even in this exceptional circumstance.

8.c) -15 Volt Regulator: (on Card #1 — on rear chassis apron)

The -15 volt regulator is an operational amplifier containing a discrete power-booster output stage with current limiting. It "amplifies" the output of the +15 volt regulator by -1, thus producing a -15 volt tracking supply. Shutdown of the +15 volt supply (due to current limit conditions or to a fault which blows F102) will also result in the -15 volt supply's shutting down.

The basic opamp is IC102; its input resistor R109 and feedback resistor R108 are equal-valued, resulting in a gain of -1 \pm 2%. IC102's negative supply comes from the unregulated -22 volt supply. The common-mode range of the 301A opamp includes its positive power supply, thus permitting operation with IC102's positive supply at ground. Under normal operating conditions, the "+" input of IC102 is grounded, and its "-" input is within 10mV of ground.

Q103 and Q102 form a conjugate emitter follower which can boost the output current of IC102 to more than 3/4 amp. The basic emitter follower is Q103; Q102 is connected in a 100% negative feedback configuration to boost the current output capability of Q103.

Q104 is a current-limit transistor. If the -15 volt supply is called upon to deliver more than 3/4 amp, sufficient voltage drop (approximately 0.6 volts) will occur across R104 to turn on Q104, thus shunting drive current away from Q103 into the load and protecting Q102/Q103 from burnout. Under these conditions, IC102 is protected by internal current limiting circuitry.

C113 frequency-compensates the -15 volt supply to protect it against high frequency oscillations. R102 increases the circuit's immunity to leakage in Q103.

The rest of the circuitry is protected against a catastrophic failure of the -15 volt regulator by means of zener clamp VR102, CR106, and fuse F103. The operation of this circuit is identical to the operation of the corresponding circuit in the +15 volt regulator (see 8.b).

8.d) Miscellaneous Voltage Supplies:

The operation of these supplies is extremely straightforward. No further explanation beyond that given in **Appendix A** is required.

This concludes **Appendix B (CIRCUIT DESCRIPTION)**.

Appendix C: User Access

The first part of this Appendix describes how to access those parts of OPTIMOD-TV ordinarily involved in setup, adjustment, or alignment.

The second part of the Appendix provides information on the disassembly techniques necessary to access the balance of the circuitry.

I. ROUTINE ACCESS

a) User Adjustments: To access the user adjustments, open the small access door using the key furnished. This will reveal all user-adjustable controls.

b) Line Fuse, Power Switch, and Line Voltage Selector: These are accessed by swinging down the entire front panel, which is hinged at the bottom. To avoid damage, this should be done only with the small access door locked. Using the 5/64" hex wrench supplied, remove the three hex-socket screws at the top of the front panel and carefully swing the panel out and down.

c) Circuit Cards: First, swing the front panel down (see b). You must then remove the subpanel by first loosening four DZUS fasteners by turning each one-quarter turn counterclockwise with a long 3/16" or 1/4" slotted-blade screwdriver. Taking care not to stress the flat cable beneath it, tilt the top of the subpanel outward and leftward to clear the upper chassis lip and the door support bail at the right. The PC cards may now be removed from their slots.

**** This procedure is directly reversible with cautions:

- The subpanel should always be replaced to protect the cards from RFI.
- DZUS fasteners turn only 1/4-turn. Don't force them, lest they be damaged in a way that is very time-consuming to repair.

NOTE

OPTIMOD-TV shares chassis components with other Orban products. The first available card slots are not used, and there is no Card #2. The power supply regulator card is Card #1 (which is mounted on the rear panel).

2. SERVICE ACCESS

General Cautions: These apply to all the procedures described below.

- For best RFI protection, replace all screws and tighten normally to achieve firm contact.
- If screws are lost, replace them with screws of the same length, since longer screws may cause mechanical interference or internal short circuits.
- Most screws used in OPTIMOD-TV are binding head to achieve secure fastening without lockwashers. If a pan head screw is substituted, use an internal star lockwasher to retain this security.
- Plating on all screws is Cadmium type II. Almost any other plating is acceptable unless corrosive atmosphere is present.

a) Cover Removal: Removing the top or bottom covers is tedious because thirty screws must be removed. (The large number of screws is necessary to achieve an RF-tight seal.) Luckily, most service access can be achieved without removing either cover! Specific instructions for doing this are found further below.

If you wish to remove either cover, simply remove all thirty screws.

**** This procedure is directly reversible with cautions:

- When replacing a cover, align it as closely as possible with the corresponding holes, and start all screws. After all screws have been started, tighten all screws to normal tightness, "inland" screws first.

b) Access To Area Behind Rear Panel: If the covers are still in place, they needn't be removed.

Remove eight screws holding the top cover to the flange of the rear panel. Remove the corresponding eight screws from the bottom cover. The rear panel will remain solidly in place.

Set the chassis, bottom cover down, on a pad on a table. Allow 6" (15cm) between the rear panel of the chassis and the table edge. Unplug the power cord.

Now remove three groups of three screws which are circled in black on the rear panel.

VERY carefully and slowly, pull the rear panel about 3/4" (2cm) toward you, and tilt the top edge down until the rear panel is horizontal and resting on the table.

CAUTION

Watch for snags in the internal wiring, and for any stress on the ceramic feedthrough capacitors on the divider wall or RF filter box. These capacitors are very fragile and difficult to replace.

**** This procedure is directly reversible with cautions:

- When positioning the rear panel over the corresponding holes, make sure that no wires are pinched under the flanges. Start, but do not tighten all nine screws. Observe the areas where the flanges on the rear panel meet the flanges on the side panels. Adjust the rear panel so that the flanges line up in order to provide a flat mounting surface for the cover when tightened.

c) Access To RF Filter Card: First open the rear panel (procedure **b** above).

Remove the four screws holding the RF filter box to the rear panel. **VERY** carefully and slowly, tilt the metal box back to vertical, taking care to avoid snagging the internal wiring and stressing the ceramic feedthrough capacitors.

This will reveal the internal circuit card, which is attached to the rear panel by four #4-40 screws. While this card can be removed for component replacement, it is easier (though less workmanly) to clip out the defective component from the topside and to install its replacement by tack-soldering to the old leads.

**** This procedure is directly reversible with cautions:

- If components have been replaced, make sure that reassembly will not result in crushing of the component against the rear panel.

- Tilt the box back to horizontal (so it rests against the rear panel) very slowly and carefully. Watch for wire snags and dress wires appropriately. Make sure that no wires are crushed under the flange.

d) Access To Unregulated Power Supply Chamber: If the covers are not already removed, remove the five cover screws which attach the top cover to the flange of the side panel. Remove the corresponding five screws from the bottom cover.

Open the front panel.

Remove the shoulder screw that attaches the door-support bail to the left chassis wall. Note that there is a nylon washer between the bail and chassis wall to prevent scraping.

Turn the chassis so that the left wall is facing you. Remove the left rack flange by removing the six unrecessed screws.

Remove the three screws that attach the rear panel to the main (steel) side panel.

Remove the remaining six screws and gently lift off the side panel by pulling outward.

**** This procedure is directly reversible with cautions:

- Position the steel side panel and start, but do not tighten, all nine screws. Observe the areas where the flanges meet the rear panel and internal bulkhead, and align the flanges so that the covers will seat on a flat mounting surface.

e) Removal Of Card #1 (The DC Regulator) From Rear Panel And Power Transistor Replacement: Because the removal procedure is complex, this card was designed to permit many servicing operations to be performed without removing the card from the chassis.

IC's are conventionally socketed. Many unsocketed components can be replaced from the topside by tack-soldering the new component to the lead stubs of the old clipped-out component.

If the card must be removed, do it as follows:

CAUTION

The rear panel serves as a heat dissipator for the power transistors. Proper contact is necessary to insure sufficient transistor cooling. Please follow instructions carefully.

Remove the four press-fit plastic plugs on the power transistor covers with a pair of chain-noise pliers. This will reveal the transistor mounting screws. Remove the four screws holding the power transistors.

VERY carefully and slowly pull each transistor from its socket. If, as you do this, the silicone rubber insulator tends to stick to the panel, release it from the panel such that it sticks to the bottom of the transistor instead. After you remove each transistor, press its insulator back in close contact with it pending reinstallation.

NOTE

These insulators form themselves to the bottom surface of each transistor. Since they take a "set", they should not be interchanged or reversed. If you have to replace a power transistor, you may re-use the

insulator if it is in good condition. With care, it will re-form itself as necessary. Otherwise, use a conventional mica insulator and white silicone heat-conducting compound.

Open the rear panel (procedure **b**). With the transistors removed, it is possible to release the circuit card from its plastic post mounts by squeezing the tangs in each of the four corners to permit pulling the card off the posts.

**** This procedure is directly reversible with cautions:

- See the discussion above regarding heat-conduction insulators
- The power transistor sockets must be correctly aligned with the rear-panel holes to prevent short circuits.
- The screws mounting the transistors should be tightened evenly. For best thermal contact, tighten each screw a small amount, alternating between screws. Tighten securely, but not enough to damage the threads in the sockets.
- Note that there must be a split lockwasher under each screwhead to accomodate thermal cycling.
- The Thermalloy (TM) plastic cover does not attach in a conventional or readily obvious way. It rides on the circumference of the special split lockwasher and does not (and should not) become captured under the head of the screw. Consequently, the cover may be slightly loose even after screws are tightened securely. This is normal, and should not (and cannot) be corrected.
- Be sure to reinstall the press-fit plugs that cover the screwheads.

Appendix D:

Field Audit-of-Performance Procedure

General

This Appendix provides instructions enabling OPTIMOD-TV users to check the performance of their units using test equipment likely to be found in a well-equipped TV station. This procedure is a starting point for detecting and diagnosing a problem that you believe is caused by OPTIMOD-TV. It is also useful in routine maintenance, and can be used at Proof time to check routine equipment performance, thus providing more data than the Proof alone provides. By its nature, it is limited in scope to discovering static problems. A dynamic problem in the AGC circuitry (caused by the failure of a timing module on Card #5, for example) would not tend to be discovered by performing these tests.

For this reason, measurements must always be complemented by listening. If you are well-acquainted with the "sound" of OPTIMOD-TV as adjusted to your tastes, then faults that develop will ordinarily be readily detectable by ear.

If audio problems develop, many engineers immediately blame their processing. However, as is the case with any processing, faults in the audio equipment preceding OPTIMOD-TV will be magnified by the action of the processing. Program material that is marginally distorted at the OPTIMOD-TV input, for example, is likely to be unlistenable by the time it emerges from the output when aggressive processing is used. In addition, be sensitive to possible defects in the monitoring equipment; verify that a problem can be observed on at least two receivers before pushing the panic button.

Required Equipment

- a) Audio Oscillator. An ultra-low-distortion type like the Sound Technology 1710B is preferred. However, a Heathkit or Eico-type oscillator (such as Heath IG-72) can be used to obtain approximate results, provided that residual distortion has been verified to be below 0.1%.
- b) Noise and Distortion (N&D) Test Set. Once again, a high-performance type like the Sound Technology is preferred, but not required.
- c) General-Purpose Oscilloscope. DC-coupled, dual-trace, with at least 5mHz vertical bandwidth. This is used to monitor the output of the N&D Test Set.

Audio Processing

It is often more convenient to make measurements on the bench away from high RF fields which could affect results. For example, in a high RF field it is very difficult to accurately measure the very low THD produced by a properly-operating OPTIMOD-TV at most frequencies. However, in an emergency situation (is there any other kind?!), it is usually possible to do measurements under high-RF conditions which will reveal many of the grosser faults which could develop in the OPTIMOD-TV circuitry.

The rear-panel TEST JACKS serve as a convenient source of preemphasized audio when the adjacent NORM/TEST switch is in NORM. By strapping deemphasis IN on Card #7 (see **Part 3: Installation**, Fig. 3-2), an unbalanced deemphasized output is simultaneously available between the (+) audio output and circuit ground on the rear-panel barrier strip. To assure correct response from the output RFI suppression network, load the main output with a 300 ohm $\pm 5\%$ resistor between the (+) input and circuit ground.

a) **Standard Control Setup:** Record the normal settings of the controls so that they can be reset after the measurements have been completed. Then set the controls as follows:

L and R Input Attenuators:	0
Clipping:	+2
Release Time:	10
Bass Coupling:	10
Gate Threshold:	0
HF Limiting:	0

b) **Skeleton Proof:** This should be performed for both left and right channels.

1) Place both PROOF/OPERATE switches in PROOF.

2) Connect a low-distortion audio oscillator to the OPTIMOD-TV input. Set the frequency to 50Hz, and adjust the oscillator output level to produce 3.3V rms at the OPTIMOD-TV TEST JACK.

3) Adjust the appropriate OPTIMOD-TV OUTPUT ATTEN until 3.3V rms is also produced at the MAIN OUTPUT (between (+) and circuit ground, as described above).

The TEST JACK now serves as the PREEMPHASIZED OUTPUT, and the MAIN OUTPUT serves as the DEEMPHASIZED OUTPUT.

4) **Frequency Response:** Reduce the oscillator output level by 20dB (to avoid overloading the OPTIMOD-TV circuitry at high frequencies because of preemphasis). Connect the N&D set to the OPTIMOD-TV MAIN (DEEMPHASIZED) OUTPUT. Without changing the oscillator output level, measure the frequency response at 50, 100, 400, 1000, 5000, 10,000, and 15,000 Hz. The response should be better than $\pm 0.75\text{dB}$ with reference to 1kHz.

(A more accurate frequency response evaluation can be performed by sweeping the system with a test set like the Tektronix 5L4N Spectrum Analyzer/Tracking Generator. If the station has such equipment, see paragraph 6.c of **Appendix E** for further information.)

5) **Distortion:** The deemphasized THD should now be measured at 100% modulation (corresponding to 3.3V rms at the TEST JACK). If you wish to set the 100% modulation exactly, first move your test probe to the TEST jack, and adjust the oscillator OUTPUT ATTEN to produce 3.3V rms for each frequency measured. Then move the test probe back to the OPTIMOD-TV MAIN OUTPUT and measure the THD.

Alternately, if you do not wish to move the test probe for each new frequency to be measured and you are satisfied with slightly less accurate settings of the 100% modulation levels, you can adjust the oscillator at each frequency to produce the level at the MAIN OUTPUT tabulated in TABLE D-1 below.

TABLE D-1

50Hz	3.30V
100Hz	3.30V
400Hz	3.24V
1kHz	2.99V
5kHz	1.29V
10kHz	0.685V
15kHz	0.462V

The deemphasized THD+Noise should not exceed 0.05% at all frequencies except 15kHz, where up to 0.07% is acceptable. (The 15kHz measurement will consist almost entirely of noise.) In many cases, results will be determined entirely by the quality of oscillator and distortion analyzer available, and/or by the presence of RF fields which might affect the instruments.

6) **Noise:** Short both OPTIMOD-TV inputs, and measure the deemphasized noise at the OPTIMOD-TV MAIN OUTPUT. It should not exceed -63dBm. (Note that hum or buzz due to test equipment grounding problems and/or high RF fields may result in falsely high readings. If the output of the N&D set is monitored with a scope, problems like this should be immediately apparent.)

c) **Operate-Mode Measurements:** These measurements evaluate certain static characteristics of OPTIMOD-TV in its normal OPERATE mode. Normal measurements given herein are provided for service guidance only and are not guaranteed. As in the PROOF mode measurements above, these measurements should be repeated for both left and right channels.

1) Reconnect the audio oscillator to the OPTIMOD-TV input. Switch both PROOF/OPERATE switches to OPERATE. Be sure that operating controls are standardized as described in (a) above. Set the oscillator frequency to 1kHz, and adjust the oscillator output level until the MASTER G/R meter on the front panel reads "0" dB.

2) Verify that the OPTIMOD-TV VU meter reads 0 VU \pm 0.5VU in the COMPRESSOR OUT position.

3) Measure the OPTIMOD-TV output level and THD at the MAIN OUTPUT for each frequency indicated in the table below, and compare your results with the typical readings provided.

Table D-2

50Hz	2.05Vrms	less than 0.1% THD
500Hz	2.08Vrms	less than 0.1% THD
3kHz	1.44Vrms	approx. 2.0% THD
12kHz	0.401Vrms	less than 0.1% THD

The increase in THD at 3kHz is caused by a combination of factors, including the "standard" control settings (which are atypical of operating settings), and the fact that this distortion is the result of slight clipping permitted by the "Smart Clipper" circuitry. The distortion-cancelling clipper exploits the fact that the ear is quite insensitive to very high frequency harmonic distortion (the major distortion component in the 3kHz test is third-harmonic at 9kHz), and is far more disturbed by low-frequency IM distortion. At 12kHz, all clipper-induced harmonic distortion is filtered out by the 15kHz lowpass filters.

Excessive THD at 50Hz not present in the PROOF-mode test is usually caused by problems in the bass timing module on Card #5. Excessive THD at 500Hz is often caused by problems in the master timing module on Card #5. (See paragraph 2.d of **Appendix B**).

Typical THD at 3kHz can be caused by several factors. Excessively high THD can be caused by a failure in the high-frequency limiter on Card #6 (see paragraphs 4.a and 4.b in **Appendix B**). Excessively low THD can be caused by excessive action of the high-frequency limiter, or by failure in the dynamic clipper-threshold adjustment circuitry (see paragraph 5.a of **Appendix B**).

4) Now turn the HF LIMITING control to 10. Sweep the oscillator frequency up from 1kHz, and determine what frequency first turns the front-panel HF LIMITING lamp ON. This frequency is typically 1.6kHz.

Steps (5) and (6) below provide a first-order test of the dynamics of the timing circuitry in the compressor. However, there are many possible faults which these tests will not detect. These must be diagnosed by more sophisticated tests at the factory.

5) Turn the BASS COUPLING control to "0". Set the oscillator frequency to 5kHz, and adjust the oscillator output level until the MASTER G/R meter reads "-5dB". Switch the COMPRESSOR PROOF/OPERATE switch to PROOF and measure the time required for the MASTER G/R meter to fall from "-5dB" to "+5dB" indicated G/R. This time should be 6 seconds, ± 1.5 seconds.

6) Change the oscillator frequency to 50Hz and turn the oscillator's output level control all the way down. Restore the COMPRESSOR PROOF/OPERATE switch to OPERATE, and advance the oscillator output level until the BASS G/R meter reads "-5dB" G/R. Switch the COMPRESSOR PROOF/OPERATE switch to PROOF, and measure the time required for the BASS G/R meter to fall from "-5dB" to "+5dB" indicated G/R. This time should be 3 seconds, ± 0.75 second.

For a comprehensive discussion of **Trouble Diagnosis and Correction**, see **Appendix F**.

This concludes the **Field Audit Of Performance procedure**.

Appendix E: Field Alignment Procedure and Specification

1) General

The following section describes how to align and calibrate OPTIMOD-TV in the field. It is included primarily for purposes of reference as routine alignment is neither necessary nor desirable due to the high stability of the circuitry.

WARNING!

IF CALIBRATION IS NECESSARY, WE STRONGLY RECOMMEND THAT THE CARD IN QUESTION BE RETURNED TO THE FACTORY FOR CALIBRATION BY OUR EXPERIENCED TECHNICIANS, WHO HAVE ACCESS TO SPECIAL TEST FIXTURES AND A SUPPLY OF EXACT-REPLACEMENT SPARE PARTS. ONLY IN AN EMERGENCY SITUATION SHOULD AN ATTEMPT BE MADE TO ALIGN AND CALIBRATE OPTIMOD-TV IN THE FIELD.

The factory aligns each card independently to a standard, so that cards will be completely interchangeable. However, the user does not have access to the special test fixtures necessary to complete independent alignment of the cards. The user thus must use his own OPTIMOD-TV chassis as a test fixture, and align the entire unit as a system.

This section is organized on a card-by-card basis. Cards should be calibrated in the same order as their order in the signal path, from input to output. This will occur naturally if the instructions in this section are followed in order from beginning to end. If a card later in the signal path is aligned while an earlier card is misaligned, the later card may not be correctly aligned, even if the instructions for that card are followed conscientiously.

Before commencing alignment, remove OPTIMOD-TV from its normal rack mounting location and place it on the test bench away from RF fields. Jumper the chassis and circuit grounds together on the rear-panel barrier strip.

E

2) Required Test Equipment And Materials

The following test equipment (or close equivalents) is required. It is assumed that the technician is thoroughly familiar with the operation of this equipment.

- a) Digital Voltmeter, accurate to $\pm 0.1\%$
- b) Oscilloscope, DC-coupled, dual-trace, triggered-sweep, with 5MHz or better vertical bandwidth
- c) Ultra-Low Distortion Sinewave Oscillator/THD Test Set/AC VTVM (Sound Technology 1700B or 1710B)
- d) Low Frequency Spectrum Analyzer with Tracking Generator (Tektronix 5L4N plug-in with 5111 Bistable Storage Mainframe)
- e) A 137K 1% resistor
- f) A 243K 1% resistor
- g) Six 6" alligator-to-alligator jumper leads
- h) A 1uF $\pm 20\%$ film capacitor (voltage unimportant)

REFER TO THE FOLD-OUT SCHEMATICS AND PARTS LOCATOR IN **APPENDIX J**.

3) Card #1 (Power Supply)

- a) Measure the voltage across C111 (or other convenient point on the +15 volt bus) with the DVM. Adjust R106 until the DVM reads +15.00 volts.
- b) Measure the voltage across C112 (or other convenient point on the -15 volt bus). Make sure that the voltage is between -14.85 and -15.15 volts. If it is not, refer to Appendix B (CIRCUIT DESCRIPTION), paragraph 8.c for troubleshooting hints.

BEFORE ALIGNING EACH CARD AS DESCRIBED IN THE INSTRUCTIONS BELOW, REMOVE THE CARD OF INTEREST FROM ITS SLOT AND PLUG THE EXTENDER INTO THE EMPTY CARD SLOT. PLUG THE CARD INTO THE CARD EXTENDER. THIS WILL ALLOW ACCESS TO THE ALIGNMENT TRIMMERS AND TEST POINTS.

4) Cards #3 and #4 (Input Buffer/Input Conditioning Filter/Compressor Audio Path)

- a) Remove Cards #3, #4 and #5 from their slots. Plug the extender board into the Card #3 slot. Cards #3 and #4 will both be aligned on this extender, one at a time, without moving it from the Card #3 slot.
- b) Plug Card #3 into the extender board.
- c) Connect one side of a 137K 1% resistor, and one side of a 243K 1% resistor to a convenient ground point (like the chassis) by means of jumper leads. Using two more jumper leads, connect the other side of the 137K resistor to the side of R333 away from IC305, and connect the other side of the 243K resistor to the side of R348 away from IC309. These external resistors now force reference gain-control currents into IC305A and IC309A respectively: 97 μ A into the "Master" VCA and 55 μ A into the "Bass" VCA. (Short clip leads will minimize hum and noise pickup.)
- d) Connect the chassis ground of the oscillator and the low side of the oscillator output to the chassis of OPTIMOD-TV. Using a pair of jumper leads, connect the high side of the oscillator output to both the "+" input of IC301A and the "+" input of IC301B. This provides common-mode excitation for the input differential amplifier.
- e) Set the oscillator frequency to 60Hz, and the oscillator output to 0 dBm. Observe TPI (pin D at the card connector) with the AC VTVM adjusted so that the common-mode feedthrough is readily observed. Adjust R316 (CMRR) to null it. The nulled level of the 60Hz should be less than -60dBm.
- f) Connect the low side of the oscillator output to the "-" terminal of the left-channel audio input of OPTIMOD-TV. Connect the high side of the oscillator output to the "+" terminal. Set the oscillator output frequency to 5kHz and the oscillator output level to produce -15dBm at the output of IC302B (pin V of the card connector).
- g) Observe the output of IC307A (pin K of the card connector) with the AC VTVM, and adjust R376 (MASTER VCA GAIN) to produce +2.0dBm at this point.
- h) Readjust the oscillator frequency to 35Hz. If necessary, readjust the output level of the oscillator until it is identical to the oscillator output level produced at 5kHz.
- i) Adjust R377 (BASS VCA GAIN) until the AC VTVM indicates +2.0dBm. The gains of both "Master" and "Bass" VCA's are now standardized, assuring card interchangeability.

NOTE: The following distortion and balance adjustments are made without disturbing the resistors jumpered into place in the steps above.

j) Without disturbing the oscillator output level, set its frequency to 5kHz. Switch the AC VTVM into its distortion-measuring mode, and measure the THD. Adjust R336 (MASTER DIST NULL) to null the THD. It should not exceed 0.04% if a noise-limiting 80kHz lowpass filter is employed in the measurement.

CAUTION!

Any stray audio picked up on the leads of the 137K jumper resistor will cross-multiply with the desired signal in the VCA, and will produce second-harmonic distortion which cannot be nulled with the MASTER DIST NULL control. It may be necessary to bypass the R333 side of the 137K resistor to ground with a tantalum capacitor larger than 5uF and 15VDC. Ground the "+" terminal of the capacitor.

k) Set the oscillator frequency to 50Hz. Measure the THD as above, and adjust R351 (BASS DIST NULL) to null it. It should not exceed 0.04%.

l) Remove the oscillator from the OPTIMOD-TV input. Ground the low side of the oscillator output to the OPTIMOD-TV chassis and, using a pair of jumper leads, connect the high side of the oscillator output through a 1uF film capacitor to the side of R333 away from IC305. (The 137K resistor is already connected to this point. Don't disturb it.) Set the output frequency of the oscillator to 100Hz, and its level to produce approximately 0.55V rms at its output. Observe the output of IC307A with the AC VTVM at high gain. You will see a distorted feedthrough component from the oscillator. Adjust R331 (MASTER VCA BALANCE) to null the feedthrough.

m) Move the lead from the 1uF capacitor from R333 to the corresponding side of R348. Do not disturb the resistor already connected to this point. Set the oscillator output to approximately 0.35V rms. Continue to observe the output of IC307A, and adjust R346 (BASS VCA BALANCE) to null the feedthrough component observed.

n) Remove all jumper leads connected to Card #3, and remove Card #3 from the extender.

o) Insert Card #4 in the extender (still in slot #3), and repeat steps c through n.

5) Card #5 (Compressor Control/Gating Detector)



IMPORTANT

Before embarking on this procedure, be sure that Cards #3 and #4 have been standardized according to the alignment procedure above, or are in their original factory-aligned condition.

a) Connect the oscillator to the OPTIMOD-TV's left input, high side to "+", low side to "-".

b) Pull Card #3 halfway out and connect the AC VTVM to TP1. TP1 may be readily accessed at the end of R323 closest to the edge of the board.

Reinsert Card #3. Make sure that Card #4 is also in its slot. (If only one card is inserted, all gain control current will be diverted to the VCA's in that card, reducing the gain 6dB below its correct value.)

c) Extend Card #5 on the extender.

- d) Set the oscillator frequency to 5kHz; set its output level to produce -15dBm at Card #3 TPI.
- e) Switch the Compressor PROOF/OPERATE switch (on Card #5) to PROOF and allow the gain to settle for at least one minute.
- f) While you are waiting, reconnect the AC VTVM to the output of IC307A on Card #3. This point can be readily accessed at the upper end of R364 by pulling the card halfway out, and reinserting it as above.
- g) Adjust R501 (MASTER GAIN CAL) on Card #5 until +2.0dBm is observed on the AC VTVM.
- h) Set the oscillator frequency to 35Hz. Be sure that the oscillator output level is the same as it was at 5kHz.
- i) Adjust R514 (BASS GAIN CAL) on Card #5 until the AC VTVM reads +2.0dBm.
- j) Remove Card #5 from the extender, and restore Card #5 to its slot.

6) Card #6 (Preemphasis/HF Limiter)

This card serves both left and right channels. The procedure below is performed twice; once for the left channel and once for the right. When the reference designator of an alignment trimmer is specified, the reference designators for both left and right channel trimmers will be given in order, with the right in parentheses.

- a) Extend Card #6. Place both PROOF/OPERATE switches in PROOF. Turn R626 and R660 (FET BIAS) fully clockwise to guarantee that the FET's in IC603 will be fully pinched-off.
- b) Connect the output of the tracking generator in the 5L4N spectrum analyzer to the left (right) audio input of OPTIMOD-TV.
- c) The PREEMPHASIS trimmers are used to adjust the entire OPTIMOD-TV for best conformance to the standard FM preemphasis. Place the rear-panel NORMAL/TEST slide switch in NORMAL. This connects the output of the audio processing to the rear-panel TEST JACKS. Now connect the TEST JACK corresponding to the channel which you are aligning to a precision 75us (or 50us) deemphasis network. Connect the output of the deemphasis network to the input of the 5L4N spectrum analyzer.

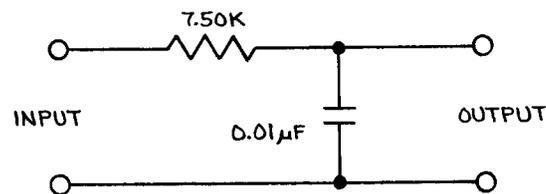


Fig. E-1: DEEMPHASIS NETWORK

- d) Set the 5L4N for a 0-20kHz sweep (2kHz/div). Set its input sensitivity to -10dBV in dB mode. Set the vertical sensitivity to 2dB/division, and set the output level of the tracking generator to obtain an on-screen trace. (You may have to readjust the OPTIMOD-TV INPUT ATTEN if gain is insufficient.)

e) You are now sweeping the entire OPTIMOD-TV system, including the complex filters in Cards #8 and #9. Adjust R618(652) to achieve maximally flat response, similar to Fig. E-2. The response should be $\pm 0.75\text{dB}$ or better, 50-15,000Hz.

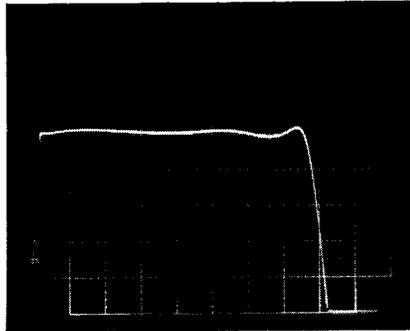


Fig. E-2: OVERALL DEEMPHASIZED RESPONSE

f) Now turn R626(660) (FET BIAS) slowly counterclockwise until the swept response just begins to roll off. Back off until no rolloff is observed, and go a little further for safety.

g) Repeat steps (d) through (f) for the right channel.

h) Connect the oscillator to the OPTIMOD-TV input.

i) Observe the output of IC605A(611A) with the distortion meter. Set the oscillator frequency to 10kHz, and the oscillator level to produce +10dBm at the output of IC605A(611A).

j) Turn R678 (HF LIMITING--front-panel control) fully CW. Turn the LIMITER PROOF/OPERATE switch (on Card #6) to OPERATE. The 10kHz level should go down to approximately +6dBm. Now adjust R631(665) (DIST NULL) to minimize THD. Bear in mind that you are observing a preemphasized signal, and that THD will be even lower after deemphasis. Even without deemphasis, THD is typically less than 0.1%.

k) Repeat steps (i) and (j) for the right channel.

l) Observe the junction of R669 and R670 with a high-impedance (10 megohm or greater) DC DVM. Adjust R671 (OVERSHOOT COMPENSATION THRESHOLD) until the DVM reads +4.50VDC.

m) Return Card #6 to its slot.

7) Cards #8 and #9 (FM Smart Clipper/FCS Overshoot Corrector)

This procedure is performed twice — once for Card #8, and once for Card #9. Only Card #8 will be referenced.

a) Extend Card #8.

b) Connect the oscillator to the left OPTIMOD-TV input. Place both PROOF/OPERATE switches in PROOF. Connect the AC VTVM to the input of Card #8 (input side of R801). Set the oscillator frequency to 100Hz, and adjust the oscillator output level until -4.3dBm is observed on the VTVM.

c) Observe the left rear-panel TEST JACK with the AC VTVM with the rear-panel NORMAL/TEST switch in NORMAL. Adjust R841 (SAFETY CLIPPER THRESH) to produce 0dBm at the TEST JACK. This sets a standard gain of +4.3dB through the card.

d) **OPTIONAL PERFORMANCE VERIFICATION** Of Filters In FM "Smart Clipper"

1) Connect the output of the 5L4N tracking generator to TPI of Card #8 (pin L on the card connector). Connect the input of the 5L4N to the left rear-panel TEST JACK. Observe the swept response with the 5L4N vertical span at 10dB/div, with 20-20kHz log frequency sweep. The swept response shows the response of the "Smart Clipper" to clipping-induced distortion components only. Note the high amount of rejection below 2.2kHz, and the very steep slope at 2.2kHz (see Fig. E-3).

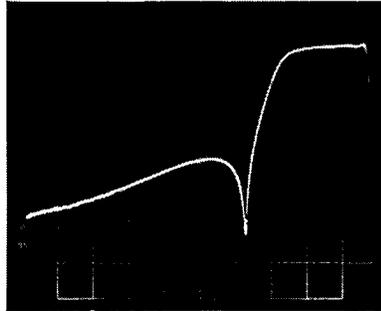


Fig. E-3: DISTORTION CANCELLATION RESPONSE

If this swept response does not resemble Fig. E-3, then there is a fault in either the filters or phase correctors between the card input and the output of IC803B. This test is both fast and sensitive because accurate cancellation demands accurate matching of the phase and amplitude responses of both the phase-corrected 15kHz lowpass filter and the distortion-cancelling filter. If any circuitry is faulty, then the cancellation will not occur accurately.

2) Measure the clipper bias voltages at the outputs of IC808A and IC808B. These should be approximately $\pm 1.5\text{VDC}$ with no signal. (NOTE: The temperature-compensation circuitry will cause this bias voltage to change slightly with temperature to keep the clipping threshold constant.)

e) **OPTIONAL PERFORMANCE VERIFICATION** Of FCS Overshoot Corrector

1) Connect the oscillator to the junction of R806 and L801 (this provides a convenient injection point that bypasses the first clipper).

2) Place the LIMITER PROOF/OPERATE switch (on Card #6) in OPERATE.

3) Observe the left rear-panel TEST JACK with a scope. Set the oscillator frequency to 100Hz, and advance the oscillator output level until clipping just barely occurs. Measure the oscillator output, and verify that it is approximately 0.63V rms. (The "clipping" is the action of the overshoot corrector. If this clipping doesn't occur, then there is a fault in the overshoot corrector sidechain.)

4) Increase the oscillator output 4dB. Substantial clipping should occur. Now sweep the oscillator frequency upward, and verify that the peak level of the output waveform never exceeds the "flat-top" level of the 100Hz clipped sine wave by more than 0.7dB, and that this 0.7dB peak occurs at approximately 4.4kHz. At this frequency, the waveform should resemble a filtered square wave with two equal cycles of ringing on the top and bottom of the wave (Fig. E-4). If substantially more than 0.7dB overshoot occurs, particularly if the ringing is not symmetrical, then suspect problems in the filters or phase-shift networks associated with the FCS circuit.

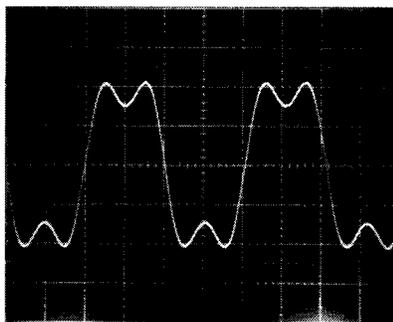


Fig. E-4: 5kHz OVERDRIVEN FCS OUTPUT

This concludes the Field Alignment Procedure for the entire OPTIMOD-TV system. Insert the extender board in its slot, and replace the subpanel, being sure that all four DZUS fasteners are fully tightened for RF suppression. Close the front door, and fasten with its three screws. Remove the jumper between chassis and circuit grounds, unless it is ordinarily used in your installation.

OPTIMOD-TV is now ready for reinstallation in the station.

E

Appendix F:

Trouble Diagnosis and Correction

This Appendix is the first place you should go to obtain information on what to do if OPTIMOD-TV develops a fault.

Many problems experienced in the field can be resolved or conclusively diagnosed with the following diagnostic routines. Even if the repair cannot be done in the field, the information provided by these diagnostic routines can speed the work of the factory service department in making the repair. Please perform these routines and make notes if you observe anything exceptional or unusual.

1) Use systematic troubleshooting techniques to positively determine that the problem is in fact being caused by OPTIMOD-TV and not by other equipment. If a standby processor is available, it should be substituted for the supposedly faulty unit to see if the problem vanishes. If a standby processor is not available, audio quality at the OPTIMOD-TV audio input terminals should be checked with a high-quality monitor system. Note that even slight distortion can be seriously exaggerated by "heavy" processing, and that this sort of processing can only be successful if the input audio is extremely clean. A relatively minor problem which develops in the station's audio chain or STL can therefore be magnified by the action of OPTIMOD-TV, even if the unit is in no way defective. This is a further argument for adjusting the OPTIMOD-TV controls conservatively to produce low distortion and superior high frequency response.

If the audio is clean going into OPTIMOD-TV, problems can still arise in the aural exciter. If a standby exciter is available, it should be substituted to see if the problem vanishes. If no standby exciter is available, you can connect the audio output of OPTIMOD-TV directly into a high-quality amplifier and loudspeaker to see if the problem can still be heard. If you ordinarily operate un-deemphasized, then you should first remove Card #7 and move the jumpers to the deemphasized position (see **Part 3: Installation**) in order to hear flat sound from the audio monitor. If the problem vanishes when you observe the output of OPTIMOD-TV directly, then the exciter (or phase-linear STL, if used) is strongly suspect.

Changes in or deterioration of grounding and/or exterior lead dress can sometimes cause RFI or hum problems to appear in a correctly-operating OPTIMOD-TV.

If it seems impossible to conclusively isolate the problem to OPTIMOD-TV, yet no other definite cause is found, then performing the **Field Audit-Of-Performance** procedure in **Appendix D** may help diagnose a problem.

2) If the fault has been positively isolated to OPTIMOD-TV, the **Problem Localization Routine** described below should be performed to identify the faulty PC card.

PROBLEM LOCALIZATION ROUTINE

General Principles: The most powerful and general technique for localizing a problem within OPTIMOD-TV is signal tracing. This simply means that the signal is observed at various points as it passes from OPTIMOD-TV's input to its output. If the signal is normal at some point "A" in the circuit, and is abnormal at a point "B" further towards the output, then the problem clearly lies in circuitry between points "A" and "B".

Signal tracing in OPTIMOD-TV is facilitated by the fact that much of the circuitry is duplicated for stereo, and is arranged so that the bad channel can be readily compared with the good one, which serves as a "normal" reference.

Power Supply Tests: Some circuitry is common to both channels, and failures will therefore affect both channels in a symmetrical way. In particular, problems in the power supply may affect many circuits simultaneously. For this reason, the first step in any troubleshooting procedure is to check the power supply for normal output. Gross changes in power supply voltage can be detected with the "+15VDC" and "-15VDC" positions on the VU meter. Normal readings are 0VU ± 0.5 VU. If normal readings are obtained, skip to the next section on **VU Meter Techniques**.

If either "+" or "-" power supply output is significantly low, it could indicate a defect in the supply itself. But it is more likely to indicate a shorted IC or capacitor somewhere in the circuit that is overloading the supply and causing it to current-limit.

The power supply is electronically protected against excessive current demand by other parts of the circuitry. If a failure causes a high current demand on the power supply, its output voltage will drop as far as necessary to reduce output current to approximately 0.75A. If the power supply voltage is observed to be abnormally low, unplug each circuit card in turn and check if the power supply recovers by observing the "-15VDC" meter position. (The negative regulator tracks the +15V supply. So the -15V supply will go down if the +15V supply does, even if the -15V supply or load is completely normal. A normal "-15VDC" reading thus assures a normal "+15VDC" reading.) If recovery occurs, then troubleshoot the unplugged board. Ordinarily, the defective component will become very hot, and is easily detected by touch. (Wet your finger first to avoid burns!)

If all cards are removed and an undervoltage problem does not disappear, examine the meter card, motherboard, and chassis wiring before suspecting the supply itself. (A wiring problem will be indicated by an ohmmeter's indicating very low resistance between the "+15V" or "-15V" power busses with AC power OFF.)

Even if power supply voltages appear normal on the VU meter, subtle problems such as hum, noise, or oscillation may still exist with the supply. To check for this, test the regulated DC with a well-calibrated DVM, scope, and AC VTVM with 20-20kHz bandpass filter. Voltages should be +15.00V ± 0.075 V, -15.00V ± 0.375 V. Ripple must be less than 2mV r.m.s., 20-20,000Hz. There must be no high frequency oscillation.

VU Meter Technique: If one channel goes dead, the VU meter provides a means for fast signal tracing. Note, however, that problems other than gross gain changes or total failure to pass signal may not be detected by the meter alone.

First, switch through the first eight VU meter functions (which monitor the audio processing) to see where the signal disappears (or the VU meter pegs, implying that a defective IC opamp has latched up to the power supply rail.) Refer to the block diagram (p. J-21) to locate the exact points in the signal path monitored by the meter.

If the signal is normal at the input terminals and abnormal in either INPUT BUFFER position, then the problem lies with Card #3 (left channel) or Card #4 (right channel), or with the incoming audio circuitry prior to these cards.

If the signal is normal at the INPUT BUFFER positions but abnormal in the COMPRESSOR OUT position, then the problem probably lies with Card #3 (left channel), with Card #4 (right channel), or, if both channels are equally affected, with Card #5.

If the signal is normal at the COMPRESSOR OUT positions, but abnormal in either FILTER OUT position, then the problem may lie with Card #6 (which contains both channels), Card #8 (left channel), or Card #9 (right channel).

If the signal is normal at both FILTER OUT positions, but abnormal at either SYSTEM OUT position, then the problem lies in Card #7 (line amplifiers).

The **Card Swap Technique** (below) may be used to localize the problem more precisely.

The instructions below provide more detailed information on troubleshooting at the "card exchange" level. Servicing on the "component replacement" level requires more profound understanding of OPTIMOD-TV circuit operation, which is provided by **Appendix A (SYSTEM DESCRIPTION)** and **Appendix B (CIRCUIT DESCRIPTION)**. If the technician wishes to troubleshoot at the component level, he should first use **Appendix A** to help track down the fault to a given subsystem, and then refer to **Appendix B** for an extremely detailed explanation of the circuitry at the component level.

Card Swap Technique: If the defective card has not yet been conclusively identified and if the fault appears on one channel only, the next step involves a card swap technique. The PC cards in OPTIMOD-TV have been specifically configured to aid troubleshooting if a fault appears in one stereo channel only. Cards #3 and #4 are identical, as are Card #8 and #9. Therefore, these card pairs can be interchanged one pair at a time to see if the problem moves from one channel to the other (implying that the fault is with one of the cards just moved), or stays the same (implying that the problem lies elsewhere in the system).

If interchanging these card pairs fails to affect the location of the problem, then Card #6 should be investigated. This card passes both left and right audio. To aid troubleshooting, a jumper is provided at the output of the card to interchange the outputs of the left and right channels (See Fig. F-1). If this jumper is moved and the fault moves from one channel to the other, then Card #6 is probably faulty.

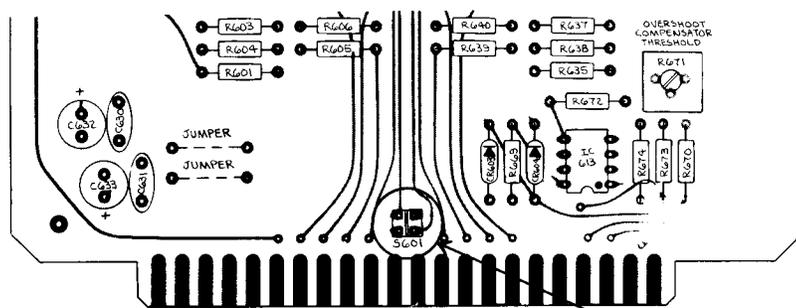


Fig. F-1: CARD #6 OUTPUT JUMPERS

Problems in Card #7 (Line Amplifiers) are unlikely because the circuitry is so simple. If one channel of Card #7 is bad, audio will be normal at the rear-panel TEST JACK corresponding to that channel, and abnormal at that channel's MAIN AUDIO OUTPUT.

Cards Common To Both Channels: Cards #1 (Power Supply) and #5 (Compressor Control Circuitry) are common to both channels. Card #6 contains the common $\pm 4.2V$ clipper bias supply used by Cards #8 and #9.

Diagnosis of power supply problems was discussed above.

A failure in Card #5 (the common processing control card that controls both Card #3 and #4) can manifest itself on both channels as distortion (too little gain reduction), low loudness (too much gain reduction), pumping or other dynamic problems (failure in the timing circuitry), or failure of the gating circuitry (which is usually indicated by abnormal behavior of the front-panel GATE lamp). First-order problems in card #5 are often indicated by a failure to produce the "standard level" under "standard control setup" conditions. (See c.1 and c.2 in **Appendix D** for instructions on how to make this test.)

Failures Which Cannot Be Diagnosed By Card-Swapping

Phase Corrector Failures: One possible problem which is difficult to diagnose by means of a card swap is failure of a phase corrector on Cards #6, #8, or #9. Some failures can grossly change the phase response of a given channel without significantly affecting the frequency response. While each channel sounds normal by itself, the mono sum will exhibit gross frequency response aberrations due to phase cancellations. If OPTIMOD-TV is driven by mono material, the "L-R" meter on your (forthcoming) TV stereo monitor will fail to null.

The principal difficulty is determining which channel is abnormal, since phase corrector failures will cause audible problems (most often increased distortion) only with certain types of program material. The following describes listening tests to detect phase corrector failures. If the ear can detect the usually subtle effect of the corrector failure by listening to one channel only, then the card-swap technique can be successfully applied to isolate the problem. In these tests, it is important to drive both channels with identical program material, as the usual differences between the left and right channels can totally mask any differences due to phase corrector failure. The easiest way to assure identical L and R drive is simply to drive both L and R inputs in parallel from a single signal.

A phase corrector failure on Card #6 will cause slightly more high frequency clipping than would otherwise be expected, so the failed channel may sound slightly grittier when program material containing large amounts of high frequency energy is processed.

A phase corrector failure in the "Smart Clipper" (first part of Cards #8 and #9) will cause the distortion cancellation function to work incorrectly, and will result in sibilance distortion (splattered "ess" sounds on voices).

A phase corrector failure in the FCS Overshoot Compensator (second part of Cards #8 and #9) will result in inaccurate overshoot cancellation. This will result in overdriving the safety clipper when significant high frequency energy is present, which will in turn cause out-of-band frequency components to be generated. These components will cause aliasing distortion when decoded in a stereo receiver, and could conceivably cause interference with the video.

If you have a spectrum analyzer which covers 0-50kHz or so, the easiest way to test for this is to observe the spectrum of the signal at the left and right TEST JACKS when both channels are driven by pink noise at a level sufficient to cause the TOTAL MASTER G/R meter to read "0". Once this G/R meter indication is obtained, switch the COMPRESSOR PROOF/OP switch to PROOF to grossly overdrive the clippers and overshoot compensator, thus stressing the system highly. If one channel shows much more "trash" beyond 15kHz than the other channel, the channel showing the excess "trash" is suspect.

Catalog of Typical Symptoms and Probable Causes

This troubleshooting guide is a catalog of some possible failure modes in OPTIMOD-TV. It should be used in conjunction with **Appendices A** and **B** to aid troubleshooting at the component level.

ALWAYS BE SURE THAT THE PROBLEM IS NOT IN THE SOURCE MATERIAL FEEDING OPTIMOD-TV.

Whistle is heard on air.

1. Power supply oscillation. Suspect C111, C112, IC101, IC102.
2. Whistle on one stereo channel only probably due to oscillating IC. Use signal tracing techniques to isolate defective IC.

Buzz or hum.

1. Improper grounding. Chassis not properly grounded to rack. Circuit and chassis grounds connected through excessively long path. No direct connection between OPTIMOD-TV circuit ground and circuit ground of exciter with balanced input.
2. RFI. Improve grounding scheme. Relocate OPTIMOD-TV chassis. Change length of input or output cables to retune them.
3. Low line voltage causing regulator to drop out and pass ripple.
4. C101, C102 in unregulated power supply failed, resulting in extremely high ripple. Power supply regulator drops out on each ripple cycle which instantaneously goes lower than 17.5 volts.

Loss of modulation control.

1. Make sure LIMITER PROOF/OPERATE switch (on Card #6) is in OPERATE.
2. Check for tightly-controlled peak levels at rear-panel TEST jacks. If levels not well-controlled, check $\pm 4.2V$ supply on Card #6.
3. If levels are well-controlled, check connection to aural exciter, including STL (if used). Inadequate phase linearity and/or frequency response in the circuit path after OPTIMOD-TV can change peak levels, causing overshoots and loss of modulation control. This problem will ordinarily appear immediately upon installation.

Bass incorrectly balanced.

1. It is normal when operating OPTIMOD-TV "independent" to have it accentuate bass on many different types of program material. If you want the frequency balance between "Air" and "Program" to be substantially identical, operate the BASS COUPLING control closer to "wideband".
2. Possible misalignment or failure in exponential converter circuitry for either "Master" or "Bass" compressors. This will cause frequency response to be non-flat even in PROOF mode. If this is the case, check circuitry associated with IC501, IC502, IC506, IC507.
3. Failure in Input Conditioning Filter (on Cards #3 and #4). This will be revealed in PROOF mode.
4. Failure in either "Bass" or "Master" VCA, causing gain shift.

Insufficient high frequency response.

1. Due to the preemphasis curve, some high frequency loss is inevitable when OPTIMOD-TV is operated aggressively for maximum loudness (i.e., large amounts of clipping, and fast release time). To obtain more highs, back off both the CLIPPING and RELEASE TIME controls.
2. In "independent" mode, the increase in bass response with certain program material may cause an apparent loss of highs. Try operating "wideband" temporarily to see if the highs are then balanced like the input material.
3. R626 (left channel) or R660 (right channel) misadjusted, such that IC603A (left channel) or IC603B (right channel) is always turned ON, thus partially defeating the preemphasis.

4. HF limiter working too hard. Check IC605B, IC607 (left channel); IC611B, IC612 (right channel) for correct rectifier action and correct HF limiting threshold. (These circuits are independent. Thus, the bad channel can be compared to the good channel with a mono source.)

Gross distortion.

1. Power supply voltage low. (Check AC power line voltage first.)
2. IC opamp failure. This must be diagnosed by signal tracing.
3. Failure in clipper-diode bias supplies. Low bias voltage will cause excessive clipping, and will also result in abnormally low modulation. Check IC806B, IC808 and associated circuitry (on Cards #8 and #9) to make sure that the output is approximately $\pm 1.5\text{VDC}$ under no-signal conditions, and approximately $\pm 1.35\text{VDC}$ when a 5kHz sine wave at level sufficient to cause gain reduction is applied to the input of the appropriate channel. Check IC613 and associated circuitry (on Card #6) to make sure that the output is approximately $\pm 4.2\text{VDC}$ under all OPERATE conditions.
4. Gross failure in a sidechain, such as IC latchup. This will either misbias the main signal path, or add distortion to the main signal, without causing the main signal to disappear. IC's in sidechains include IC601A, IC608A, IC602B, IC609B, IC604, IC610 (on Card #6); IC802A, IC802B, IC803A, IC804A, IC804B (on Card #8 and Card #9).
5. Exponential converter(s) IC501, IC502, IC506, IC507, or timing module(s) A1, A2 (on card #5) defective, causing very low (or no) control current to VCA's on Cards #3 and #4, thus causing these VCA's to take very high gain. Timing module failure will be indicated by MASTER COMPRESSOR G/R or BASS G/R meter's pegging at the top of the scale (beyond "+10").

Moderate to Subtle Distortion.

1. Distorted program material and/or distortion problems in studio or STL.
2. Check points listed in "Gross Distortion" (immediately above), for moderate deviations from normal parameters.
3. CLIPPING control misadjusted.
4. Failure in rectifiers IC503A, IC504, IC503B, IC505, IC508A, IC509, IC508B, IC510, or in timing modules A1, A2 on card #5. These problems will usually be indicated by failure to produce standard level under standard conditions (see c.1 and c.2 in **Appendix D**).
5. Safety clipper misalignment (R841). This alignment is most unlikely to drift by itself from its factory-adjusted condition. But humans with alignment tools sometimes do strange things. If you are in doubt about this alignment, it can be checked (and readjusted if necessary) by performing Part 7 of **Appendix E**.
6. Phase corrector failure. See "Phase Corrector Failures" earlier in this Appendix for a further discussion.
7. Failure in distortion-cancel sidechain on Cards #8 and #9. This is indicated by a "gritty" high end with severe sibilance splatter.

L-R does not null on mono material.

1. This is caused by gain, frequency response, or phase response differences between the left and right channels. So before assuming that the problem is internal to OPTIMOD-TV, make sure that the feed is really 100% mono. This can be reliably assured by driving both left and right OPTIMOD-TV inputs in parallel from a single signal source.
2. If L-R will not null in PROOF mode, then the problem is static, and is caused by abnormal frequency and/or phase response in one channel. If the frequency response is normal, suspect the phase correctors on Cards #6, #8, and #9 (including A1, the phase delay network module).
3. If L-R will null in PROOF mode, then the left and right VCA's or high frequency limiter circuitry are failing to track dynamically under gain reduction conditions. In the case of the VCA's, the dual gain block (IC305, for example) is suspect. In the case of the HF limiter, the rectifiers or timing modules are suspect.

Sibilance Distortion.

1. Source material at OPTIMOD-TV input terminals distorted.
2. Failure of distortion-cancelling sidechain on Cards #8 or #9.
3. Failure of the HF limiter. If the HF limiter isn't working at all, then even a properly-operating distortion-cancelling clipper may generate some audible distortion.

Factory Assistance

Orban Associates Inc., maintains a Customer Service Department to help Orban product users who experience difficulties. Orban Customer Service is supplied at two levels. The first is telephone consultation. Often, a problem is due to misunderstanding, or is relatively simple and can be fixed by the customer aided by phone advice from the factory. Telephone consultation should always be the first step in any factory service transaction. Units will be accepted for factory service (the second level) only after consultation, and only after a Return Authorization (RA) code number has been provided by phone or letter. The RA number flags the returned unit for priority treatment when it arrives on our dock, and ties it to the appropriate information file.

The purpose of this formality is to save both the customer and the factory time and trouble by attempting to weed out problems which are caused by equipment other than OPTIMOD-TV, misapplication, or environment, and to identify those problems that lend themselves to quick field repair.

Before calling Customer Service, be prepared to give the model number (8180A) and serial number of your unit. If the unit is in its warranty period and the Registration Card was never returned, we will also need the name of the dealer from which the unit was bought, the invoice number, and the invoice date.

Be prepared to accurately describe the the problem. What is the complaint? Is it constant or intermittent? If it is intermittent, can it be correlated to environmental conditions like line voltage, temperature, humidity, electrical storms, vibration, etc? Do problems only occur with certain program material (live voice, very bright music, music with heavy bass transients, etc.)? What about source: network, VTR, film chain, cart, disk, reel-to-reel tape, live microphone?

Be prepared to describe any unusual observations made during the **Problem Localization Routine** you performed using the instructions above.

Then, contact the Customer Service Department by telephone, letter, or Telex (see title page for numbers). A Customer Service Engineer is ordinarily available during local business hours, Monday through Friday. The Customer Service Engineer will do everything practical to help correct the fault and have your OPTIMOD-TV up and running again as quickly as possible.

In many cases, field repairs can be effected by merely exchanging a single PC card, rather than by returning the entire OPTIMOD-TV chassis for repair. The factory ordinarily maintains a small number of "loaner cards". One of these may be provided as a spare PC card for use while the customer's card is being repaired at the factory. In most cases, factory service of defective cards is preferable to field service by the customer because the factory maintains a supply of exact-replacement spare parts, and has the experienced technicians and special test fixtures necessary to assure that the repaired card meets factory specifications in all respects. Instructions for packing and shipping cards or the complete chassis are found at the end of this Appendix.

DIAGNOSIS AT THE COMPONENT LEVEL

After following the above diagnostic procedure to localize the problem to a single card, you may want to troubleshoot the card on the component level instead of returning the card to the factory for service.

Here are some suggestions....

Troubleshooting IC Opamps

IC opamps are operated such that the characteristics of their associated circuits are essentially independent of IC characteristics and dependent only on external feedback components. The feedback forces the voltage at the "-" input terminal to be extremely close to the voltage at the "+" input terminal. Therefore, if the technician measures more than a few millivolts between these two terminals, the IC is probably bad.

Exceptions are IC's used without feedback (as comparators) and IC's whose outputs have been saturated due to excessive input voltage because of a defect in an earlier stage. However, if an IC's "+" input is more positive than its "-" input, yet the output of the IC is sitting at -14 volts, this almost certainly indicates that it is bad. The same holds if the above polarities are reversed. Because the characteristics of OPTIMOD-TV are essentially independent of IC opamp characteristics, an opamp can usually be replaced without need for recalibration.

NOTE

THE DUAL CURRENT-CONTROLLED GAIN BLOCKS EMPLOYED IN THE VCA's(IC 305, 309, 405, & 409) ARE NOT OPAMPS. IF THEY ARE REPLACED, RECALIBRATION IS ABSOLUTELY NECESSARY.

A defective opamp may appear to work, yet it may have extreme temperature sensitivity. If parameters appear to drift excessively, freeze-spray may aid in diagnosing the problem. Freeze-spray is also invaluable in tracking down intermittent problems. But, use sparingly, because it can cause resistive short circuits due to moisture condensation on cold surfaces.

Selecting And Ordering Replacement Parts

Nearly all parts used in Optimod-TV have been very carefully chosen to make best use of both major and subtle characteristics. For this reason, parts should always be replaced with exact duplicates as indicated on the Parts List. It is very risky to make "close-equivalent" substitutions because of the possibility of materially altering performance and/or compliance with FCC requirements. The Factory is ordinarily able to supply any replacement part rapidly at an uncommonly reasonable price.

Specifically, such parts include all FET's and precision metal-film resistors, almost all capacitors, trimmer resistors, and integrated circuits, most transistors, and certain diodes.

Certain cards contain potted modules which, if diagnosed as defective, must be replaced as a unit. Ordinarily, this requires return of the entire card to the factory.

Certain parts are selected by the factory to tighter than normal specifications in order to obtain circuit performance which meets our exacting standards. Such parts are footnoted in the Parts Lists.

Certain parts, if replaced, require partial recalibration which may or may not be practical in the field. Such parts are footnoted in the Parts Lists. The recalibration requirements are outlined in the appropriate section of **Appendix B (Circuit Description)** and/or **Appendix E (Alignment)**.

Service in areas involving selected parts or recalibration is best referred to the factory, which, as a result of training, experience, availability of special equipment, and availability of exact replacement parts, is generally far better qualified to perform repairs efficiently and correctly.

Ordering Parts From The Factory: If parts are ordered from the factory, we require all of the following information:

- The Orban part number, if ascertainable from the Parts List
- The Reference Designator (e.g., R503)
- A brief description of the part
- And, from the serial label on the rear of the unit
 - the exact Model Number
 - the Serial Number
 - the "M" number, if any

Replacement Of Components On Printed Circuit Cards

It is important to use the correct technique for replacing components mounted on PC cards. Failure to do so may result in circuit damage and/or intermittent problems.

Many components, if replaced, will cause a change in calibration which will require returning the affected circuit card to the factory for recalibration. Also, some components are selected for characteristics which are not indicated by the manufacturer's part number. Most of these components are listed as "selected" on the parts list, but not all. In addition, the selection criteria are not generally described. It is therefore almost always wiser to return the defective card to the factory for service.

Most circuit cards used in OPTIMOD-TV are of the double-sided plated-through variety. This means that there are traces on both sides of the card, and that the through-holes contain a metallic plating in order to conduct current through the card. Because of the plated-through holes, solder often creeps 1/16" up into the hole, requiring a sophisticated technique of component removal to prevent serious damage to the card.

If the technician has no practical experience with the elegant and demanding technique of removing components from double-sided PC cards without card damage, it is wiser to cut each of the leads of an offending component from its body while the leads are still soldered into the card. The component is then discarded, and each lead is heated independently and pulled out of the card with a pair of long nose pliers. Each hole may then be cleared of solder by carefully heating with a low-wattage soldering iron and sucking out the remaining solder with a spring-activated desoldering tool. THIS METHOD IS THE ONLY SATISFACTORY METHOD OF CLEARING A PLATED-THROUGH HOLE OF SOLDER IN THE FIELD!

The new component may now be installed by following the directions below starting with step (4).

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Otherwise, use the following technique to replace a component:

- 1) Use a 30 watt soldering iron to melt the solder on the solder side (underneath) of the PC card. Do not use a soldering gun or a high-wattage iron! As soon as the solder is molten, vacuum it away with a spring-actuated desoldering tool like the Edsyn "Soldapullit". AVOID OVERHEATING THE CARD; overheating will almost surely damage the card by causing the conductive foil to separate from the card base.

Even with care, you are likely to blister the enamel solder-mask coating on the card, which, in most cases, is no cause for concern. The coating exists mainly to prevent moisture from condensing between the traces and to simplify wave-soldering.

- 2) Repeat step (1) until each lead to be removed has been cleared of solder and freed.

3) Now release the component by gently wiggling each of the leads to break solder webs. Then lift the component out.

4) Bend the leads of the replacement component until they will fit easily into the appropriate PC card holes. Using a good brand of rosin-core solder, solder each lead to the bottom side of the card with a 30 watt soldering iron. Make sure that the joint is smooth and shiny. If no damage has been done to the plated-through hole, soldering of the topside pad is not necessary. However, if the removal procedure did not progress smoothly, it would be prudent to solder each lead at the topside as well in order to avoid potential intermittent problems.

5) Cut each lead of the replacement component close to the solder (underneath) side of the PC card with a pair of diagonal cutters.

6) Remove all residual flux with a cotton swab moistened with a solvent like 1,1,1 trichloroethane, naphtha, or 99% isopropyl alcohol. The first two solvents are usually available in supermarkets under the brand name "Energine" fire-proof spot remover and regular spot remover, respectively. The alcohol, which is less effective, is usually available in drug stores. Rubbing alcohol is highly diluted with water and is ineffective.

It is good policy to make sure that this defluxing operation has actually removed the flux and has not just smeared it so that it is less visible. While most rosin fluxes are not corrosive, they can slowly absorb moisture and become sufficiently conductive to cause progressive deterioration of performance.

Shipping Instructions

Circuit Cards: A circuit card is best shipped in the special Orban Associates shipping carton used to supply loaner cards. If you wish to ship a card without this carton, cut two pieces of 1" or thicker soft foam to 6.5" x 9" (17cm x 23cm) or larger. Sandwich the card between the two foam pieces, and ship the foam "sandwich" in a rigid cardboard carton.

A "JIFFY-BAG" OR SIMILAR SOFT MAILING BAG DOES NOT PROVIDE SUFFICIENT PROTECTION FOR THE CARD, AND MUST NOT BE USED!

Shipping The Complete Chassis: If the original packing material is available, it should be used. Otherwise, a sturdy, double-wall carton of at least 200 pounds bursting test and no smaller than 22" x 15" x 12" (56 x 38 x 31 cm) should be employed.

OPTIMOD-TV should be packed so that there is at least 2" of packing material protecting every point. A plastic wrap or bag around the chassis will protect the finish. Cushioning material such as Air-Cap, Bubble-Pak, foam "popcorn", or thick fibre blankets are acceptable. Folded newspaper is not suitable. Blanket-type materials should be tightly wrapped around OPTIMOD-TV and taped in place to prevent the unit from shifting out of its packing and contacting the walls of the carton.

The carton should be packed evenly and fully with the packing material filling all voids such that the unit cannot shift in the carton. Test for this by closing but not sealing the carton and shaking vigorously. If the unit can be felt or heard to move, use more packing. The carton should be well-sealed with 3" (8 cm) reinforced fibreglass or polyester sealing tape applied across the top and bottom of the carton in an "H" pattern. Narrower or parcel-post type tapes will not stand the stresses applied to commercial shipments.

The package should be marked with the name of the shipper, and the words in red: DELICATE INSTRUMENTS, FRAGILE!. Even so, the freight people will throw the box around as if it were filled with junk. The survival of the unit depends almost solely on the care taken in packing!

After a formal Return Authorization (RA) number is obtained from the factory, units should be shipped to the Service Manager at the address shown on the title page.

YOUR RETURN AUTHORIZATION NUMBER MUST BE SHOWN ON THE LABEL, OR THE PACKAGE WILL NOT BE ACCEPTED!

INSURE YOUR SHIPMENTS APPROPRIATELY!

SHIP PREPAID -- DO NOT SHIP COLLECT!

DO NOT SHIP PARCEL POST!

(Otherwise, have a nice day.)

F

Appendix G: Interfacing and Aligning Dolby 334 to Optimod-TV

Introduction: This Appendix provides specific instructions for interfacing and aligning the Dolby 334 to OPTIMOD-TV. The 334 is a Dolby-B encoder, which will probably not be used in television audio. However, a compandor-type noise reduction system will almost certainly be specified as part of the forthcoming TV stereo standards. While the exact type of noise reduction encoder to be used is not known at the time of this writing, the instructions below should be easily extendable by analogy to apply to any such encoder.

Interfacing: If you have a dual-chassis OPTIMOD-TV, then no special hardware is necessary to interface the Dolby 334. The 334 is simply connected between the output of the studio unit and the input of the STL's.

If you have a single-chassis OPTIMOD-TV, the Dolby 334 is interfaced through a rear-panel connector. A kit containing this connector, a jumper plug, and the interconnecting cable may be ordered from the factory as a retrofit kit. Or you can make up the kit yourself by referring to the drawing at the end of this Appendix.

NOTE

In a dual-chassis OPTIMOD-TV installation, no Dolby port is required because the Dolby 334 is inserted between the output of the OPTIMOD-TV studio chassis and the STL input. If you have a dual-chassis installation, you must install a hard-wire bypass around the Dolby 334 when the instructions call for installation of a "jumper plug". In practice, this means that step (2) of the procedure below should be performed before the Dolby 334 is installed.

Alignment Concept: This procedure aligns the Dolby 334 such that Dolby Level produces 50% modulation, and such that the overall input/output gain of the Dolby 334 (with noise reduction defeated) is precisely unity. The procedure is performed on-the-air in STEREO mode using the station's aural modulation monitor and stereo monitor, and assumes that OPTIMOD-TV has already been installed and is correctly adjusted and operating in non-Dolby mode.

Alignment Procedure

- 1) **Required Equipment:** The Procedure requires only a sinewave oscillator and the station's stereo monitor.
- 2) **Level Standardization:** Install the jumper plug in the Dolby connector on the rear OPTIMOD-TV panel. Connect the oscillator to the LEFT OPTIMOD-TV audio input. (You may use the console, if this is more convenient.) Do not drive the RIGHT OPTIMOD-TV input. With OPTIMOD-TV in its normal OPERATE mode, set the oscillator frequency to 400Hz and advance the oscillator OUTPUT ATTEN until the OPTIMOD-TV MASTER TOTAL GAIN REDUCTION METER indicates "0". Read the percentage modulation indicated on the stereo monitor LEFT meter, and write it down, labeling it as "L".
- 3) Repeat step (2) above for the RIGHT channel. Label the reading obtained from the RIGHT stereo monitor meter as "R".

Do not change this right channel setup; it will be used again in Step (5) below.

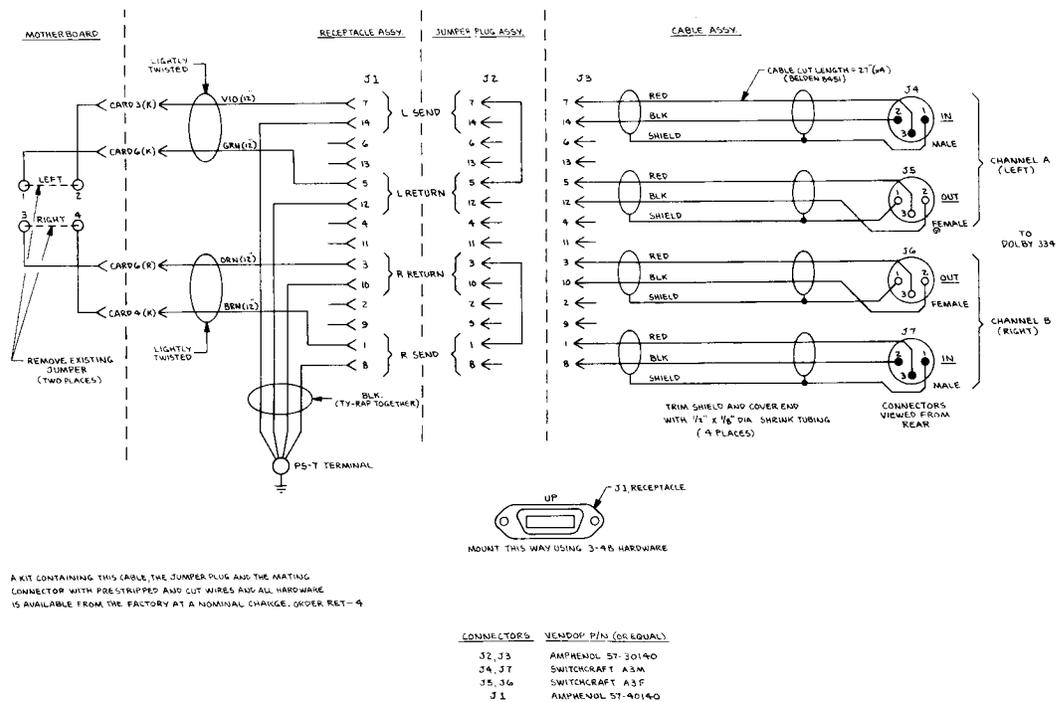
- 4) **Dolby Level:** Remove the jumper plug, and plug the Dolby 334 into the OPTIMOD-TV Dolby port. Turn all Dolby 334 ATTENUATOR controls all the way down. Depress both NR IN and DOLBY TONE buttons on the Dolby 334. Advance the Dolby 334 LEFT OUTPUT ATTEN control until the LEFT meter on the stereo monitor reads 50%.

Advance the Dolby 334 RIGHT OUTPUT ATTEN control until the RIGHT meter on the stereo monitor also reads 50%.

5) **Unity Gain Adjustment:** Release both NR IN and DOLBY TONE buttons on the Dolby 334. Assuming that the oscillator is still connected to the OPTIMOD-TV RIGHT input, and that no changes have been made to oscillator or OPTIMOD-TV, turn the Dolby 334 RIGHT INPUT ATTEN control CW until the RIGHT meter on your stereo monitor reads the same as reading "R" (step 2, above).

Move the oscillator to the LEFT OPTIMOD-TV input, and readjust the oscillator level if necessary to produce "0" on the OPTIMOD-TV TOTAL MASTER G/R meter. Advance the Dolby 334 LEFT INPUT ATTEN control until the LEFT meter on your stereo monitor reads the same as reading "L" (step 2).

This concludes the alignment procedure. Dolby mode may now be entered by depressing the NR IN button on the Dolby 334.



G-1: Dolby Connector and Jumper Plug; Dolby Cable

Appendices H and I have been intentionally omitted.

Appendix J: Schematics, Assembly Drawings and Parts Lists

The documents in this Appendix reflect the actual construction of your unit as accurately as possible. If changes are made, they will be found in an Addendum inserted in the front of this Manual. If there is a disagreement between these drawings and your actual unit, it more likely reflects an error in documentation than an error in the construction of your unit.

If you intend to replace parts, please consult the section in **Appendix F** on **Selecting And Ordering Replacement Parts**.

Schematic drawings for the major cards face the corresponding Parts Locator Drawing.

Schematic Drawings and Parts Locator Drawings for miscellaneous assemblies and the chassis interwiring follow.

TABLE OF CONTENTS

SCHEMATICS WITH PARTS LOCATOR

Card #1	POWER SUPPLY REGULATOR (includes AC and unregulated DC)
Card #2	(not used in system)
Card #3/4	L & R COMPRESSORS
Card #5	COMMON PROCESSING CONTROL (for Cards #3 & #4)
Card #6	PREEMPHASIS AND H-F LIMITERS (both L and R)
Card #7	LINE AMPLIFIERS
Card #8/9	FILTERS, CLIPPERS, AND OVERSHOOT COMPENSATOR
IF	INPUT FILTER (on rear panel)
MR	METER RESISTOR (on front panel)
MB	MOTHERBOARD

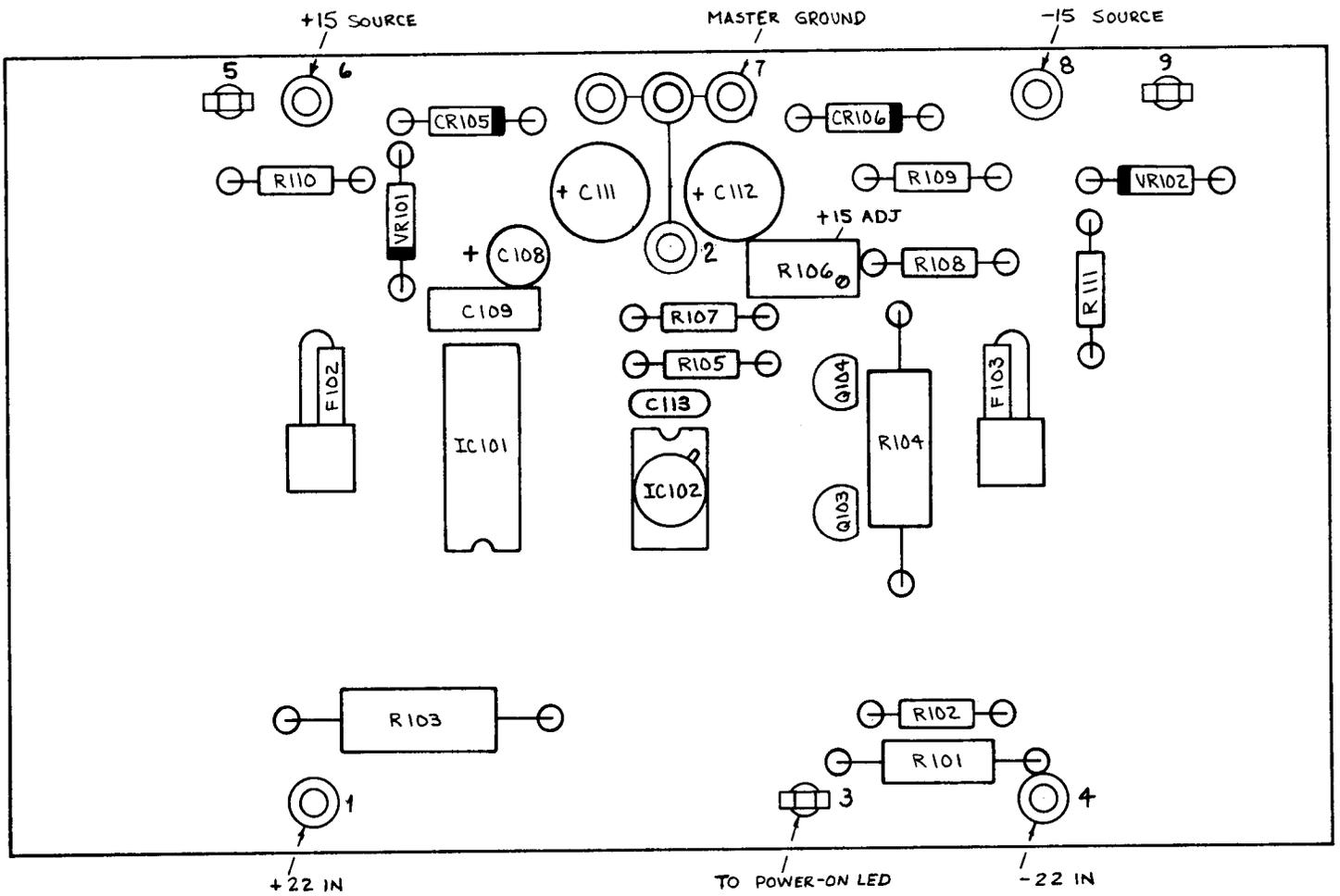
LOCATOR FOR CHASSIS-MOUNTED COMPONENTS

- 1) Raw DC Section

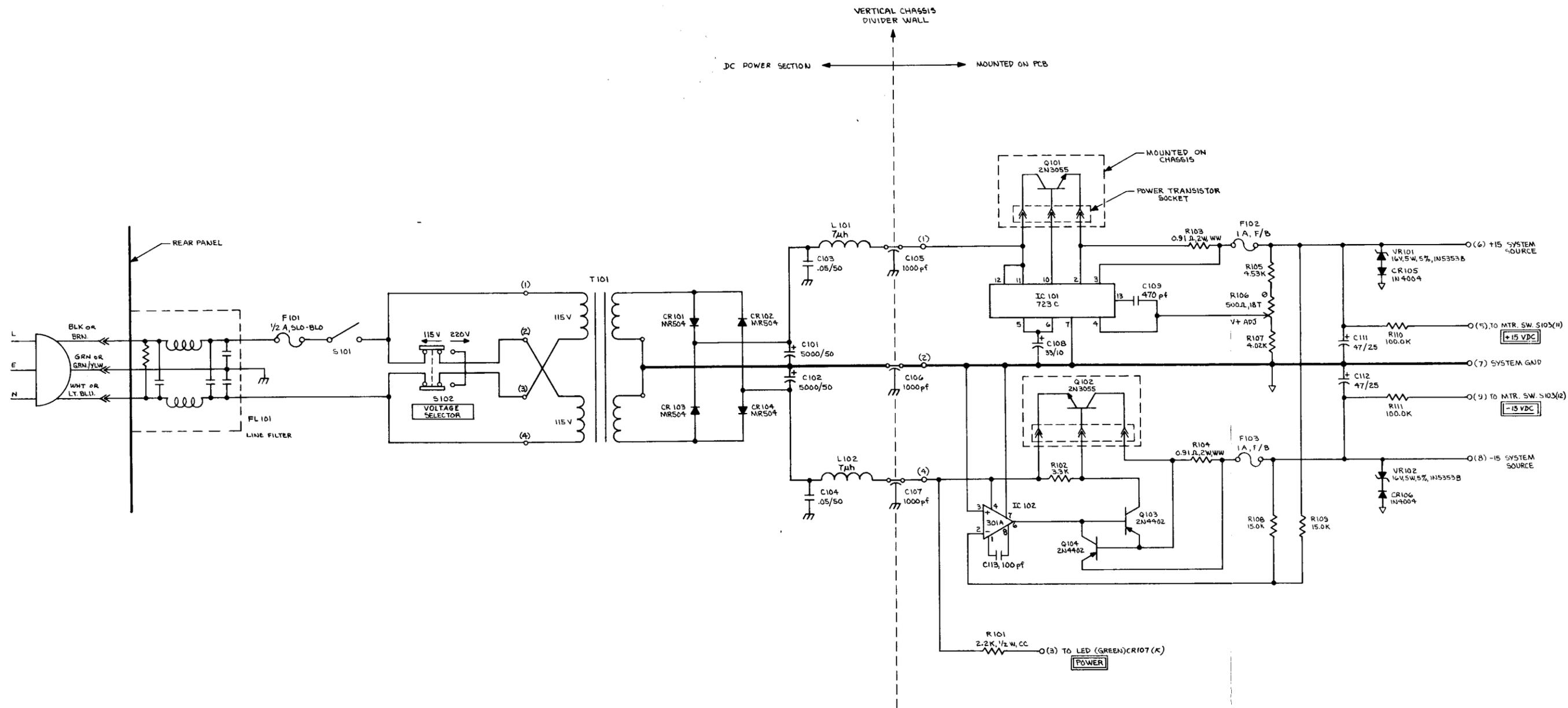
Notes

- 1) Chassis interwiring is indicated on the Schematics for the interconnected cards.
- 2) Complete information on the Accessory Chassis (Model 8180A/ST) and on the #3/4TX cards is found in a separate Manual shipped with the 8180A/ST.
- 3) Connections for the Dolby connector and other such accessories are shown either in an Appendix of this manual or in a separate Supplemental Manual for the accessory.

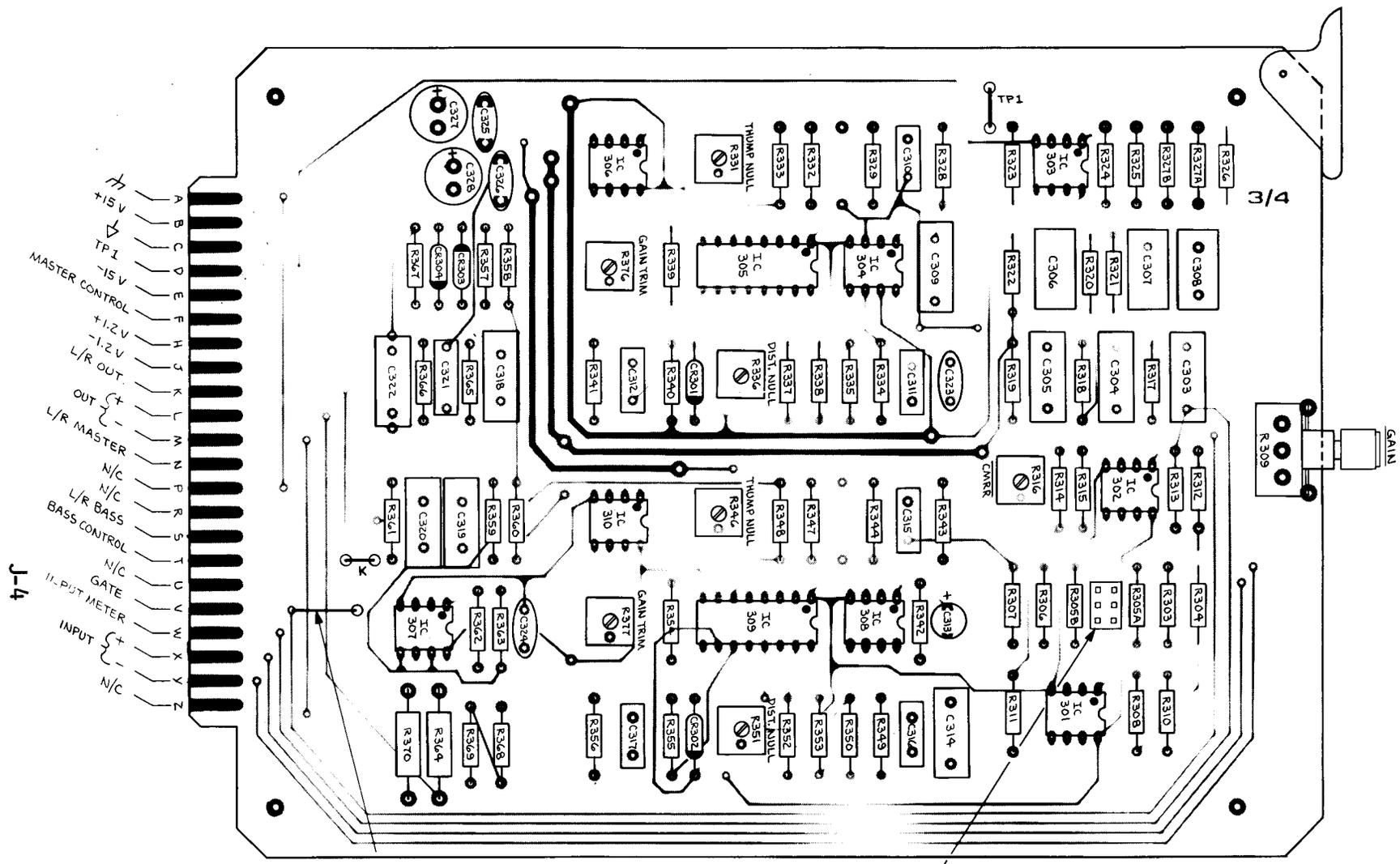
J



orban	Orban Associates Inc.
	TITLE: ASSEMBLY DRAWING POWER SUPPLY 30310-000-05



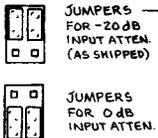
orban	Orban Associates Inc.
	TITLE: SCHEMATIC POWER SUPPLY 60021-000-04



J-4

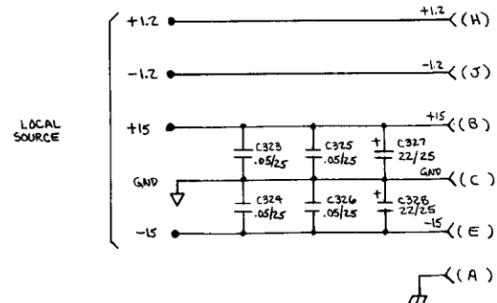
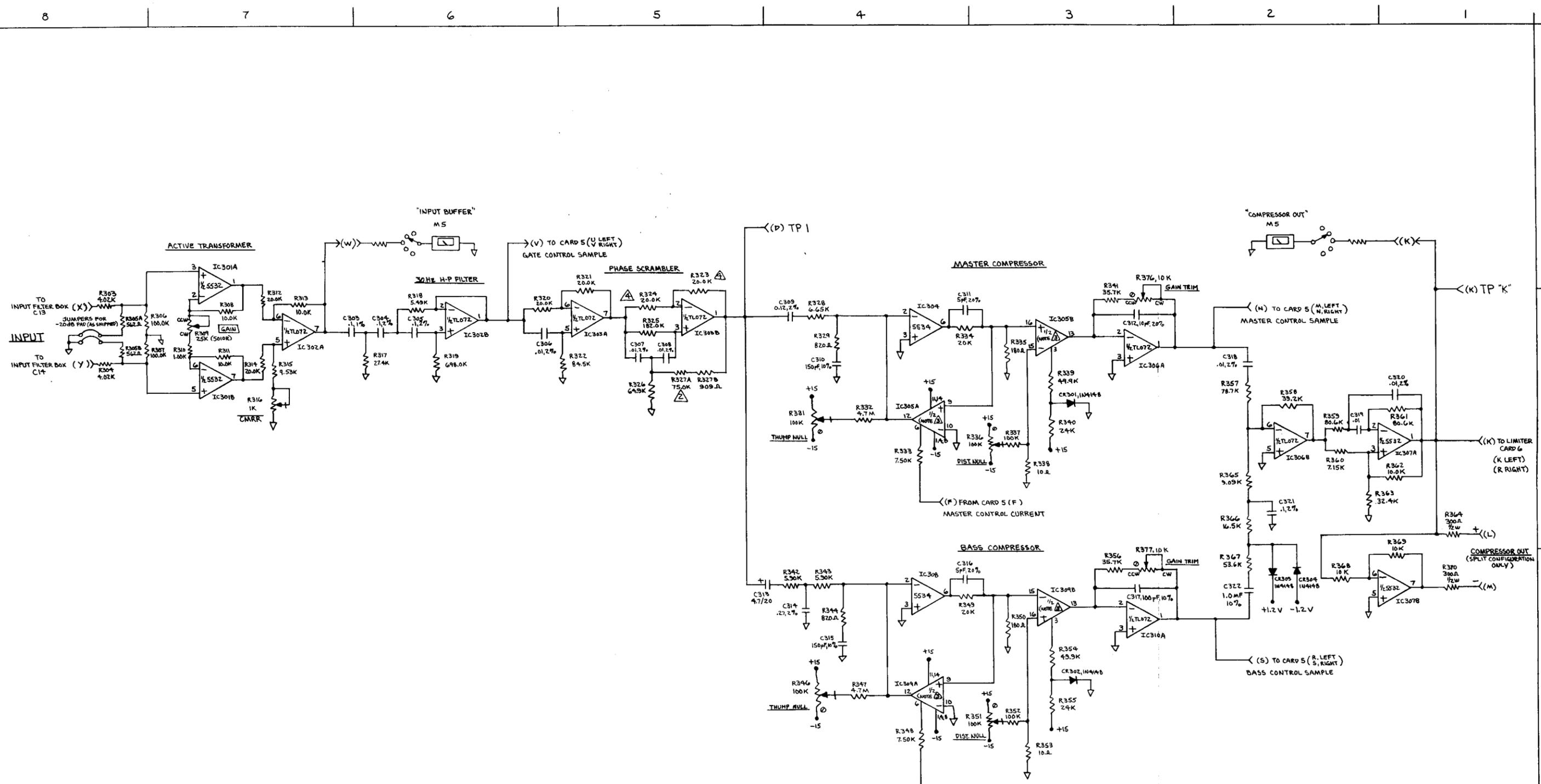
- A +15V
- B TP1
- C -15V
- D MASTER CONTROL
- E
- F
- G
- H +1.2V
- I -1.2V
- J L/R OUT
- K
- L OUT { +
- M -
- N L/R MASTER
- O N/C
- P N/C
- Q L/R BASS
- R BASS CONTROL
- S
- T N/C
- U GATE
- V INPUT METER
- W
- X INPUT { +
- Y -
- Z N/C

JUMPER FOR CARD 3/4 TX ONLY



2. VERSION CODE: -001 = *3 CARD, -002 = *4 CARD.
 1. REFERENCE DESIGNATORS SHOWN FOR *3 CARD ONLY (LEFT). *4 CARD(RIGHT) IS 400 SERIES.
 NOTES:

Orban Associates Inc.
orban
 TITLE: ASSEMBLY DRAWING
 L&R COMPRESSORS, CARD #3/4
 30430-VER-03



- ⚠ R323, R324 20.0K MATCHED PAIR.
- ⚠ IC 305, 309 IS ORBAN P/N 2420B-303
- ⚠ SELECTED

1. REFERENCE DESIGNATORS SHOWN FOR #3 (LEFT) CARD ONLY. #4 CARD IS 400 SERIES
NOTES:

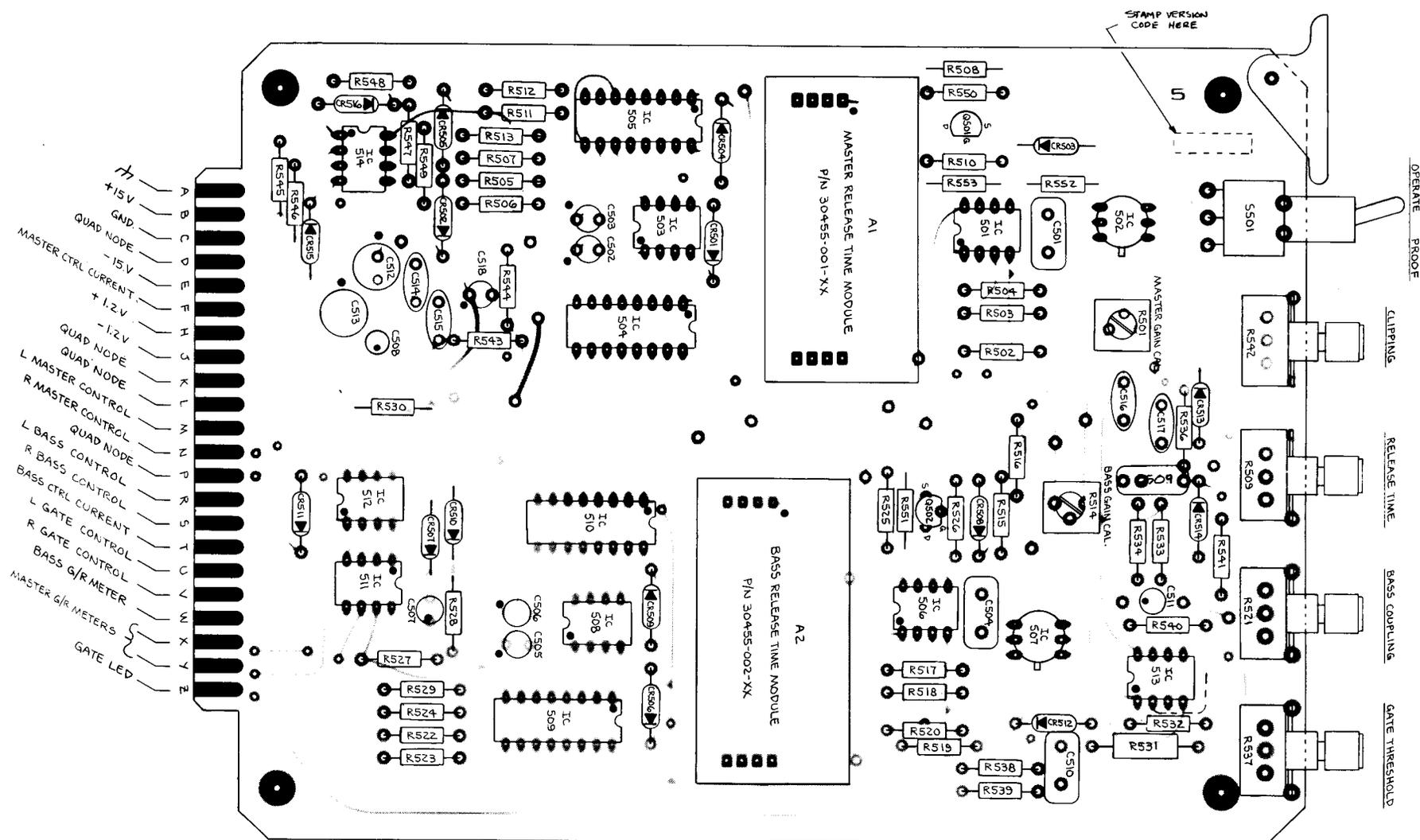
REF. DES. USED

IC	LAST #	SKIP
CR	304	-
C	326	301, 302
R	377	301, 302, 311-375

IC POWER PINS

DEVICE	+V	-V	GND
5532	8	4	
5534	7	4	
TL072	8	4	

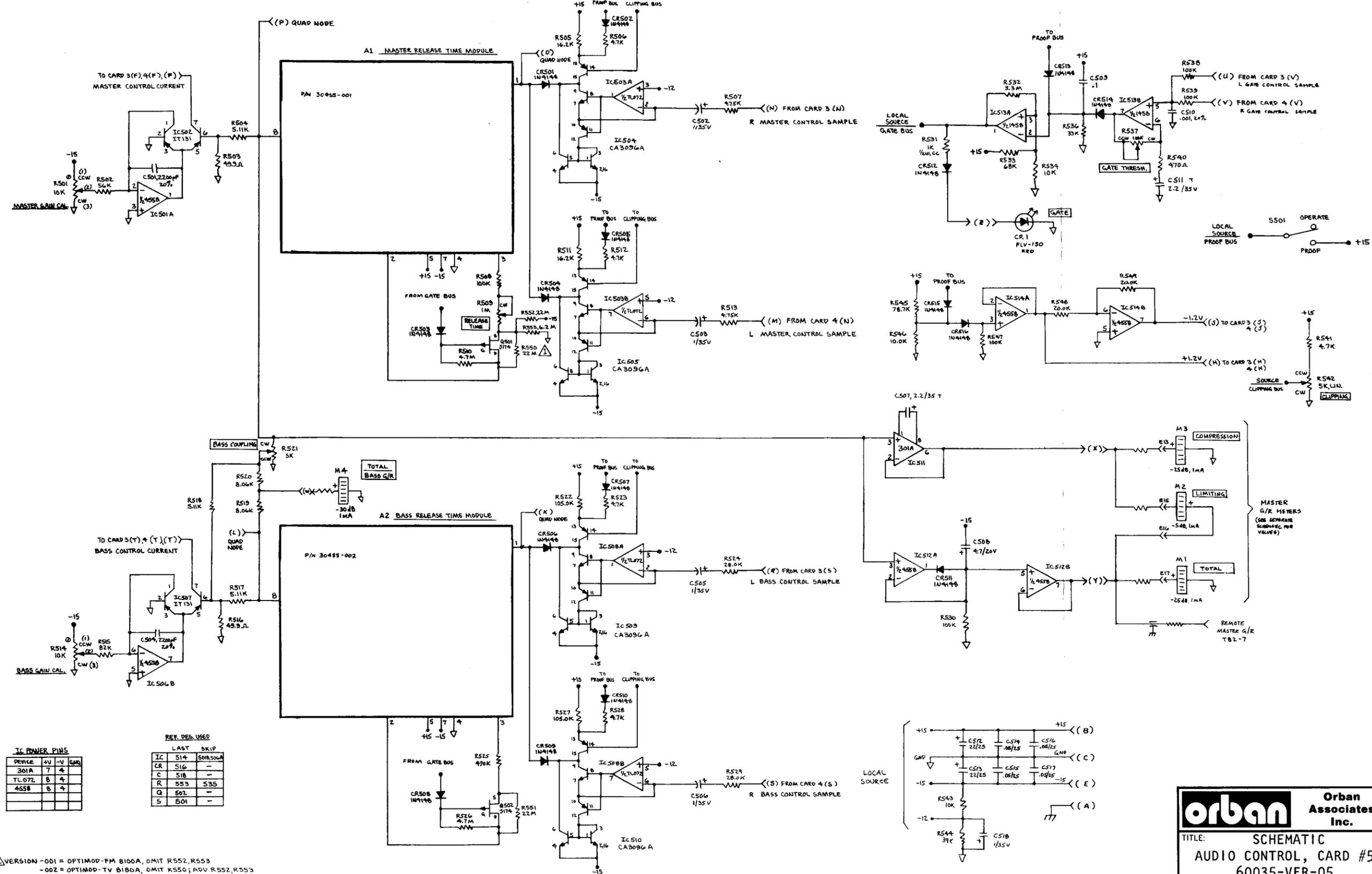
Orban Associates Inc.
 TITLE: SCHEMATIC
 L&R COMPRESSORS, CARD #3/4
 60034-000-03



1. VERSION -001 = OPTIMOD-FM, 8100A OMIT R552,553
 -002 = OPTIMOD-TV, 8180A OMIT R550; ADD R552,R553

NOTES:

orban Orban Associates Inc.
 TITLE: ASSEMBLY DRAWING
 AUDIO CONTROL, CARD #5
 30450-VER-05



IC POWER PINS

DEVICE	+V	-V	QND
301A	7	4	
TL072	8	4	
455B	8	4	

REF. DES. USED

IC	S14	S01S04M
C	S16	-
R	S18	-
Q	S53	S35
S	S02	-

VERSION -001 = OPTIMOD-FM B100A, OMIT R552, R553
 -002 = OPTIMOD-TV B100A, OMIT R550; ADD R552, R553

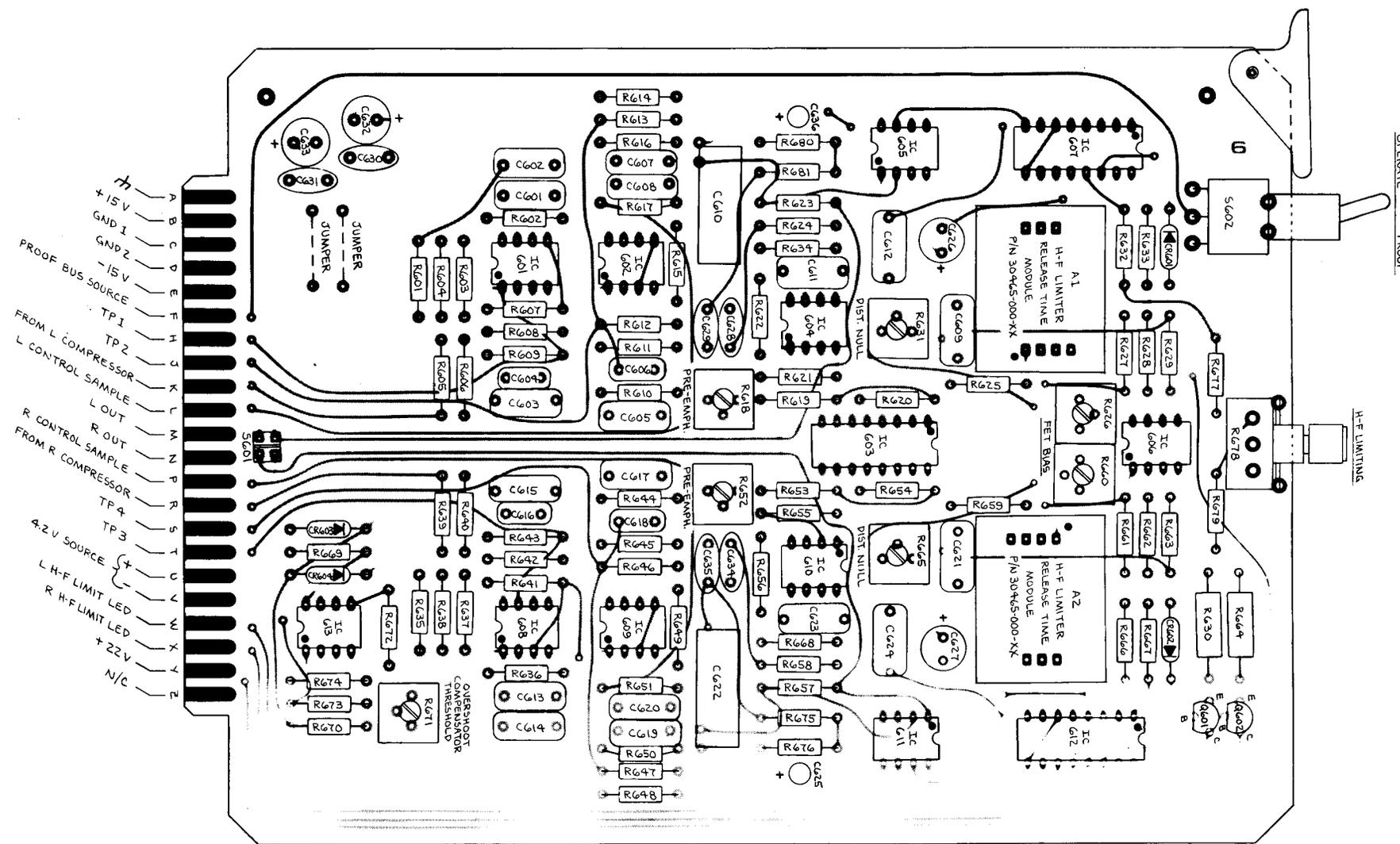
NOTES:

Orban Associates Inc.

TITLE: SCHEMATIC
 AUDIO CONTROL, CARD #5
 60035-VER-05

OPERATE PROOF

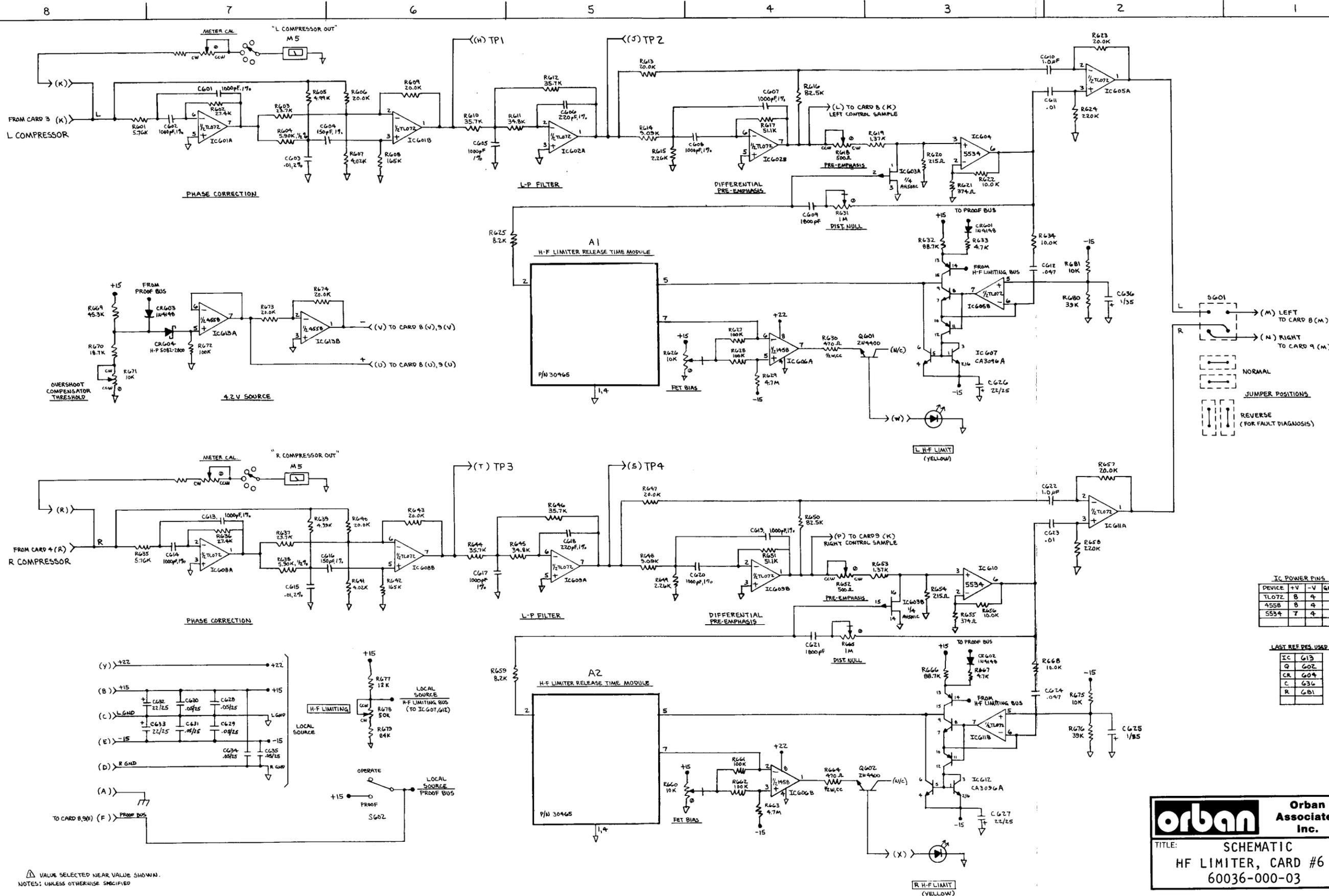
H-F LIMITING



J-8

orban Orban Associates Inc.

TITLE: ASSEMBLY DRAWING
 HF LIMITER, CARD #6
 30460-000-03



△ VALUE SELECTED NEAR VALUE SHOWN.
 NOTES: UNLESS OTHERWISE SPECIFIED

IC POWER PINS

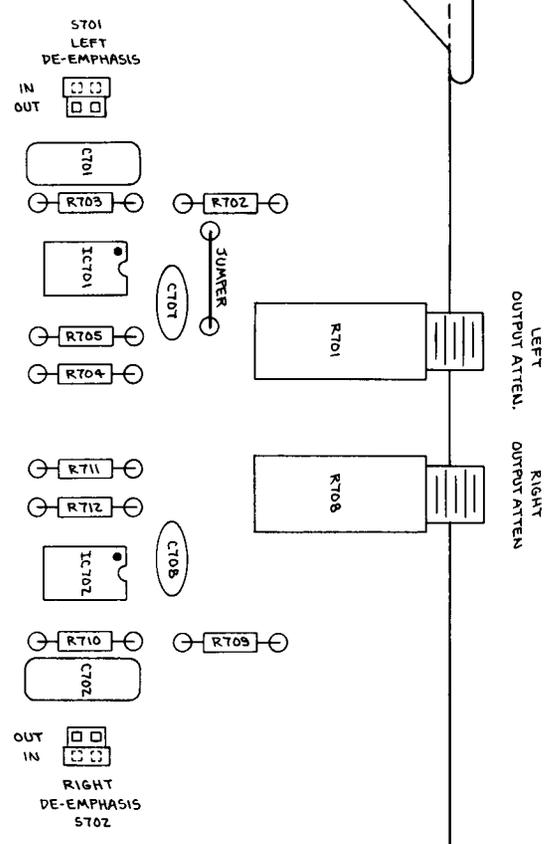
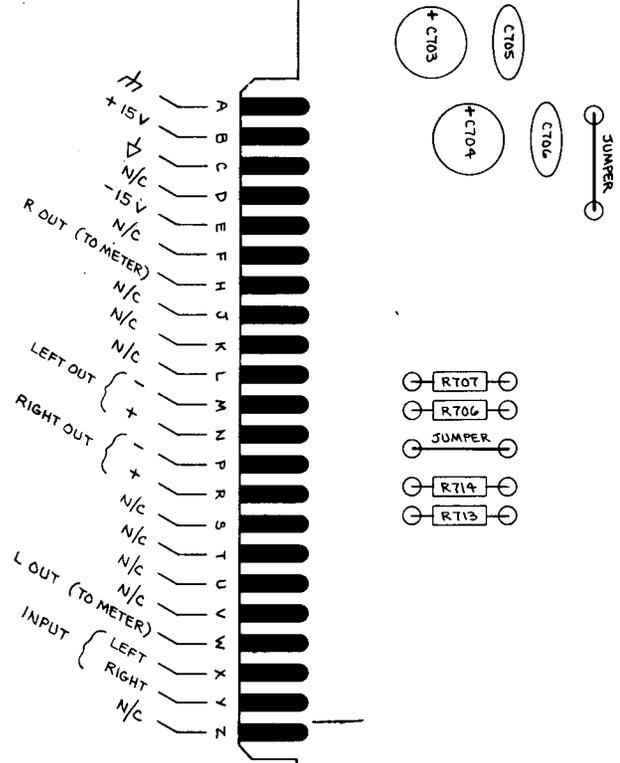
DEVICE	+V	-V	GND
TL072	8	4	
4558	8	4	
5534	7	4	

LAST REF DES USED

IC	G13
Q	G02
CR	G04
C	G36
R	G01

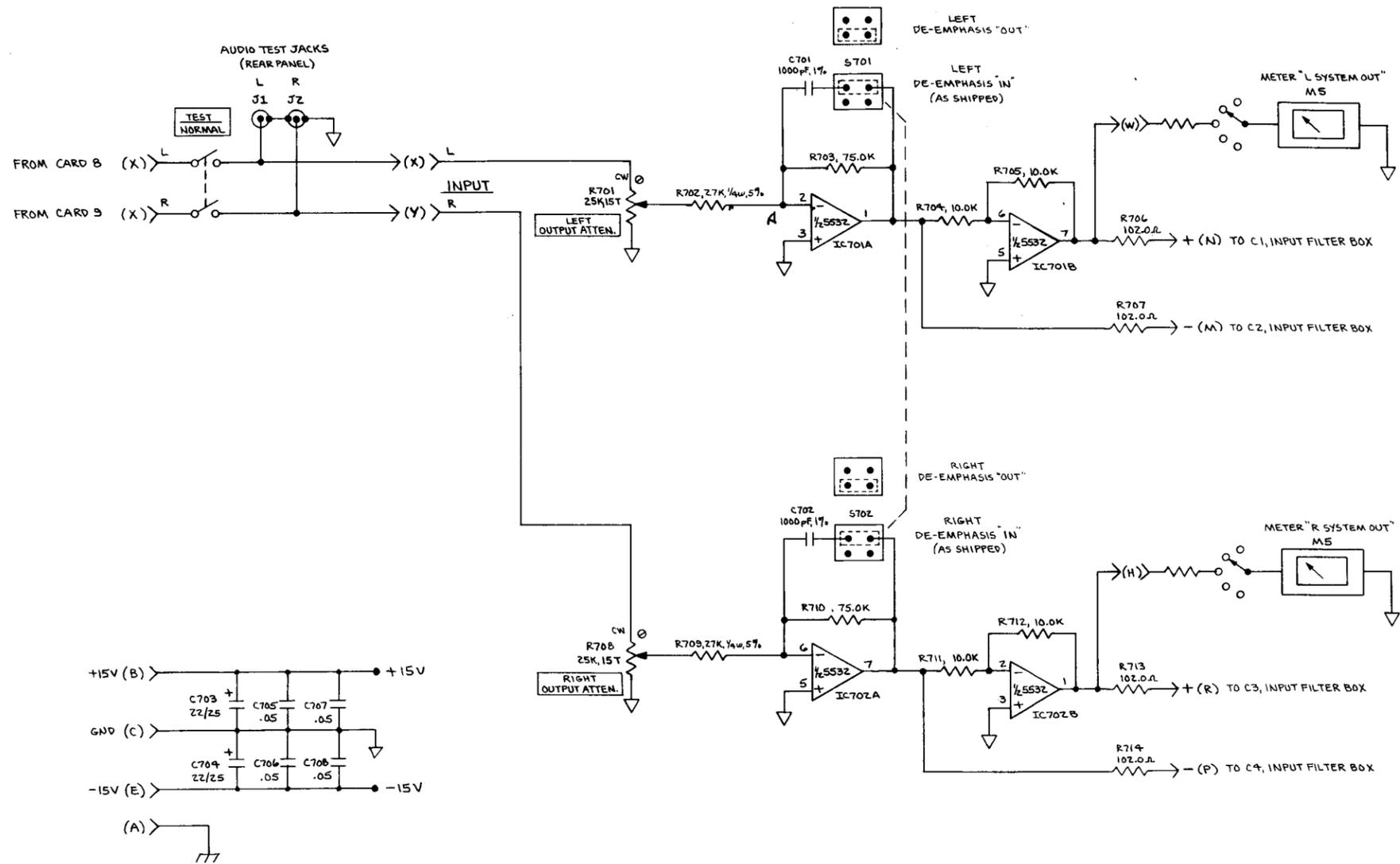
orban Orban Associates Inc.
 TITLE: SCHEMATIC
 HF LIMITER, CARD #6
 60036-000-03

J-10



orban Orban Associates Inc.

TITLE: ASSEMBLY DRAWING
OUTPUT, CARD #7
30570-000-01



2. ALL CAP'S ARE IN MICROFARADS
 1. ALL RESISTORS ARE 1/8W, 1%, MF (KN550)
 NOTES: UNLESS OTHERWISE SPECIFIED

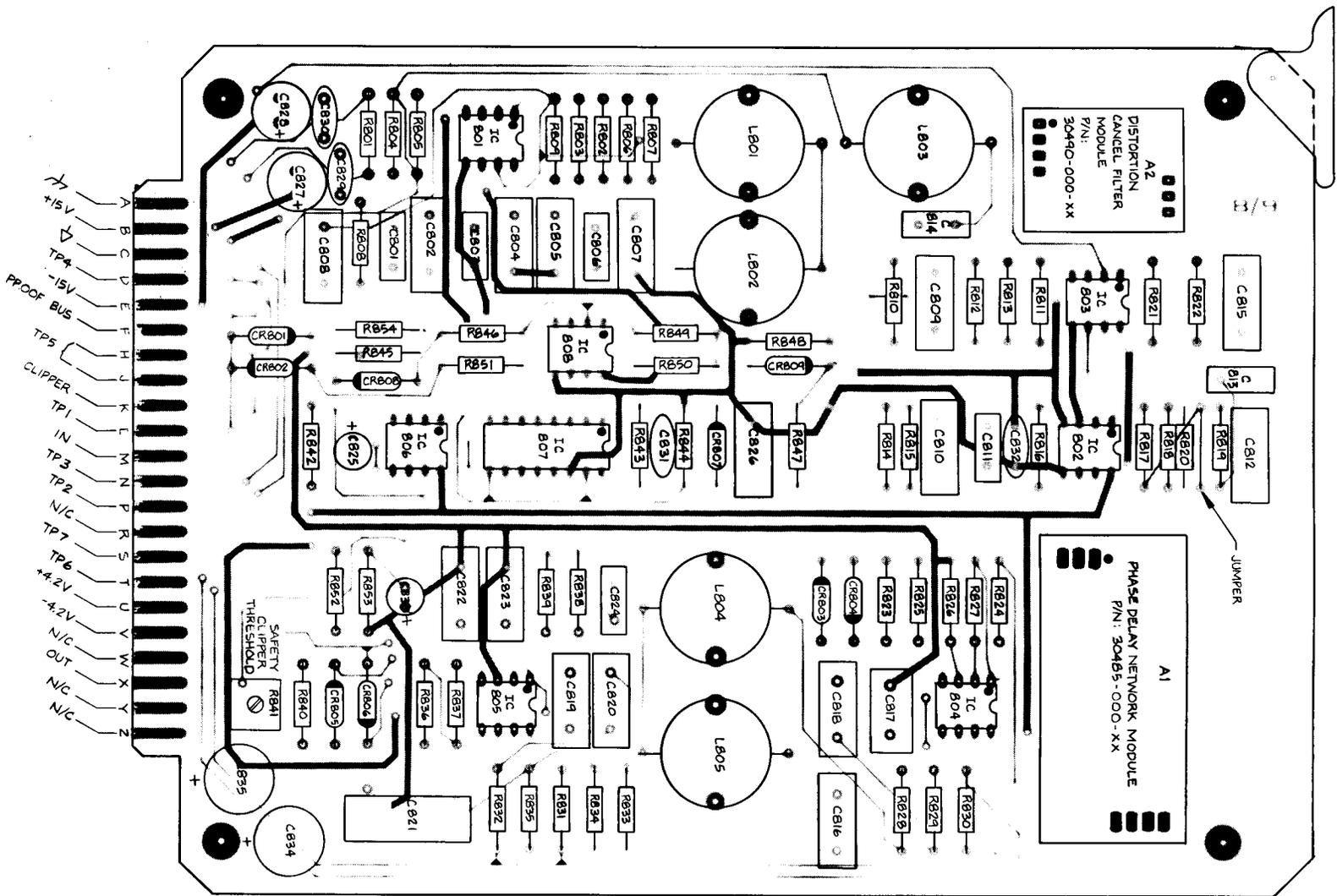
REF. DESIGNATORS

ITEM	LAST USED	NXT USED
IC	702	
C	708	
R	714	
S	702	

IC POWER PINS

DEVICE	+V	-V	GND
5532	8	4	-

orban Orban Associates Inc.
 TITLE: SCHEMATIC
 OUTPUT, CARD #7
 60045-000-01

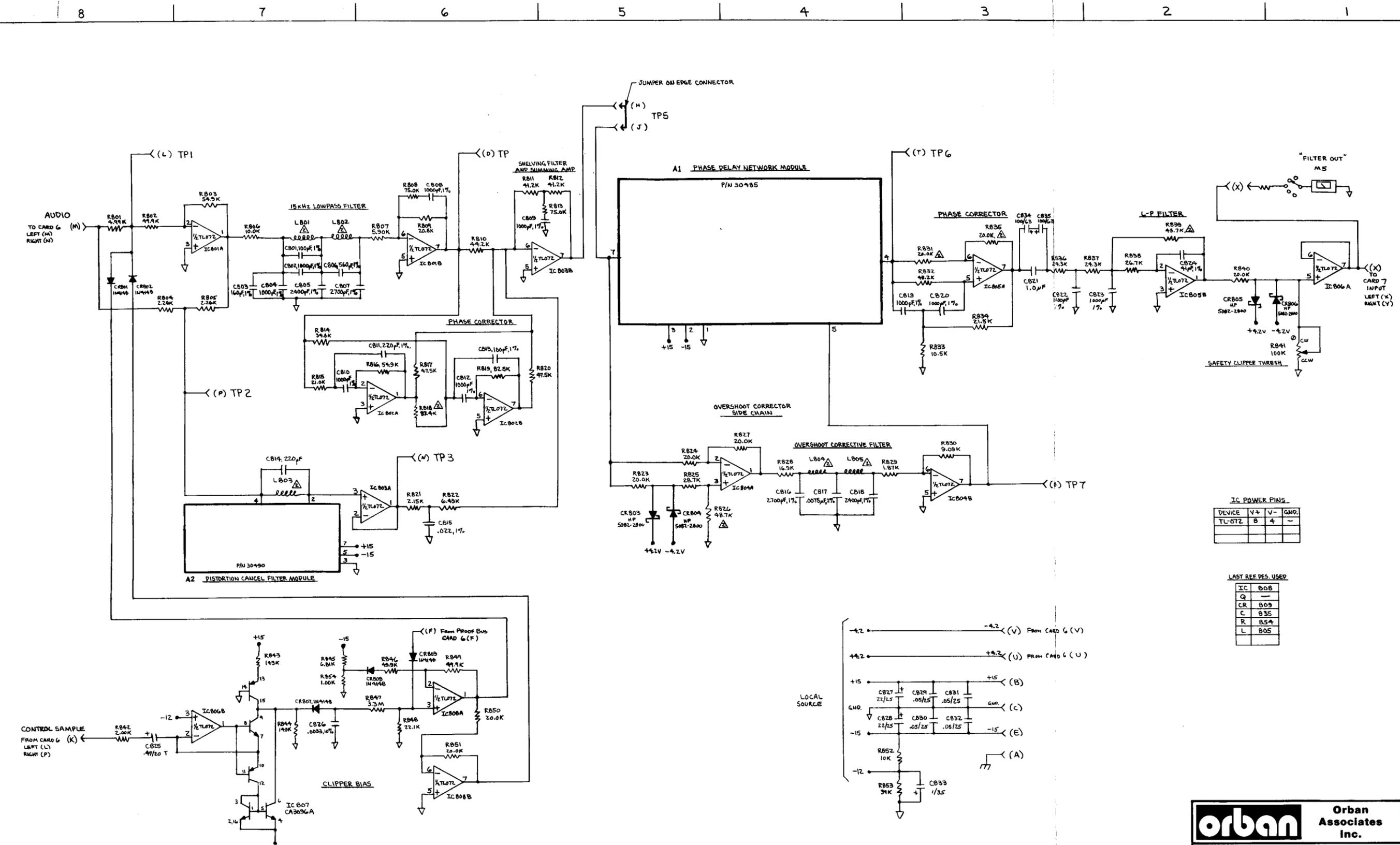


J-12

Orban Associates Inc.

orban

TITLE: ASSEMBLY DRAWING
 L&R FILTERS, CARD #8/9
 30480-000-02



IC POWER PINS

DEVICE	V+	V-	GND.
TL-072	B	4	-

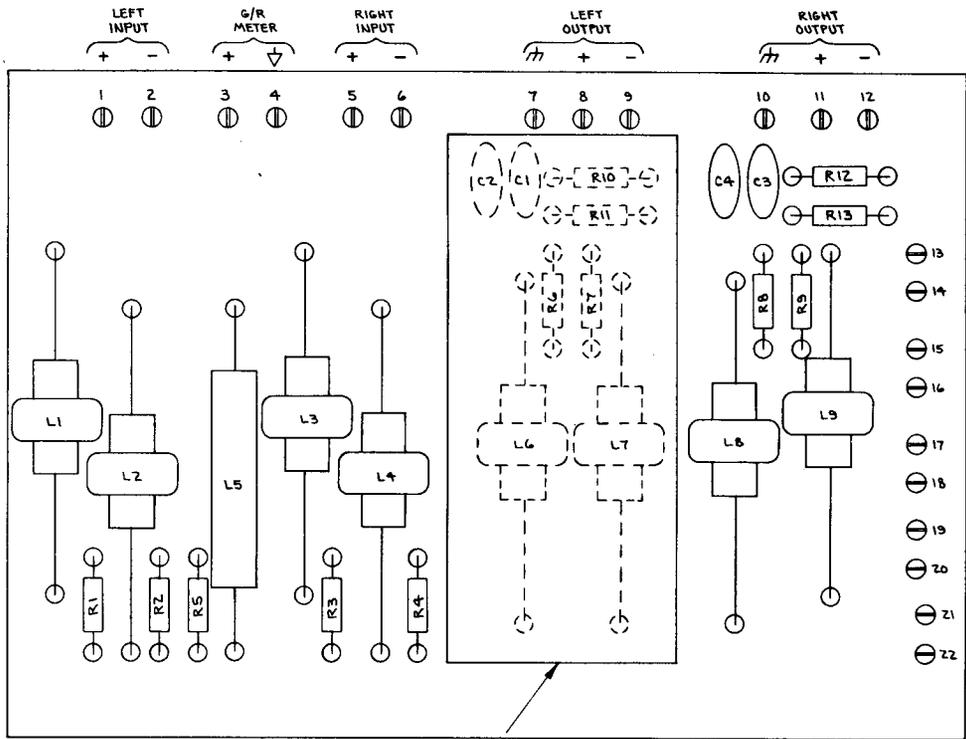
LAST REF. DES. USED

IC	B08
Q	-
CR	B09
C	B35
R	B54
L	B05

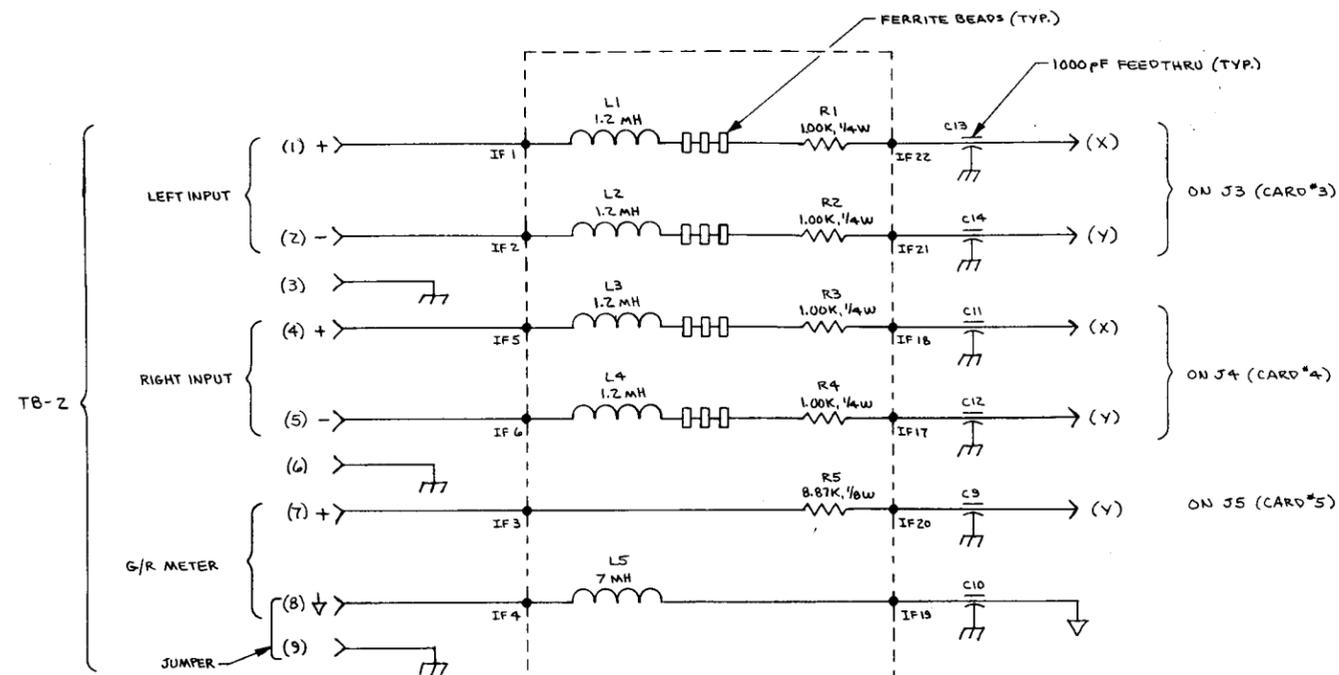
△ SELECTED
 1. REFERENCE DESIGNATORS SHOWN FOR *B (LEFT) CARD ONLY. *9 CARD IS 900 SERIES.
 NOTES: UNLESS OTHERWISE SPECIFIED

urban Orban Associates Inc.
 TITLE: SCHEMATIC
 L&R FILTERS, CARD #8/9
 60038-000-03

J-14

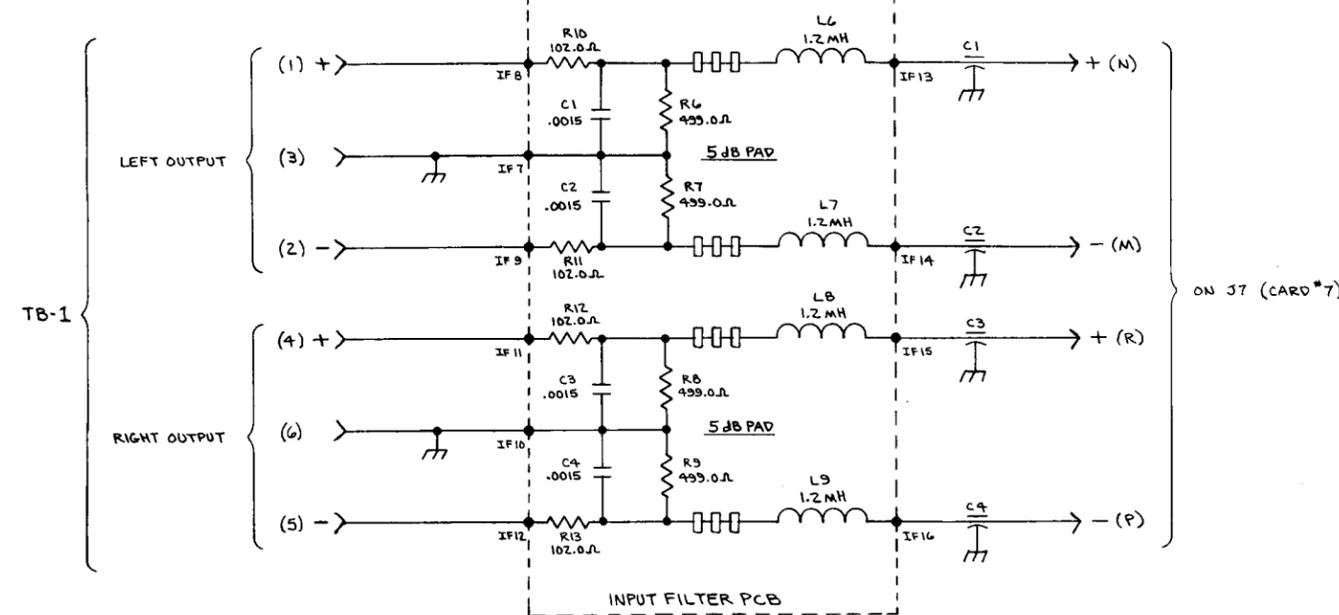


orban	Orban Associates Inc.
	TITLE: ASSEMBLY DRAWING INPUT FILTER 30565-000-01



LAST REF. DES.

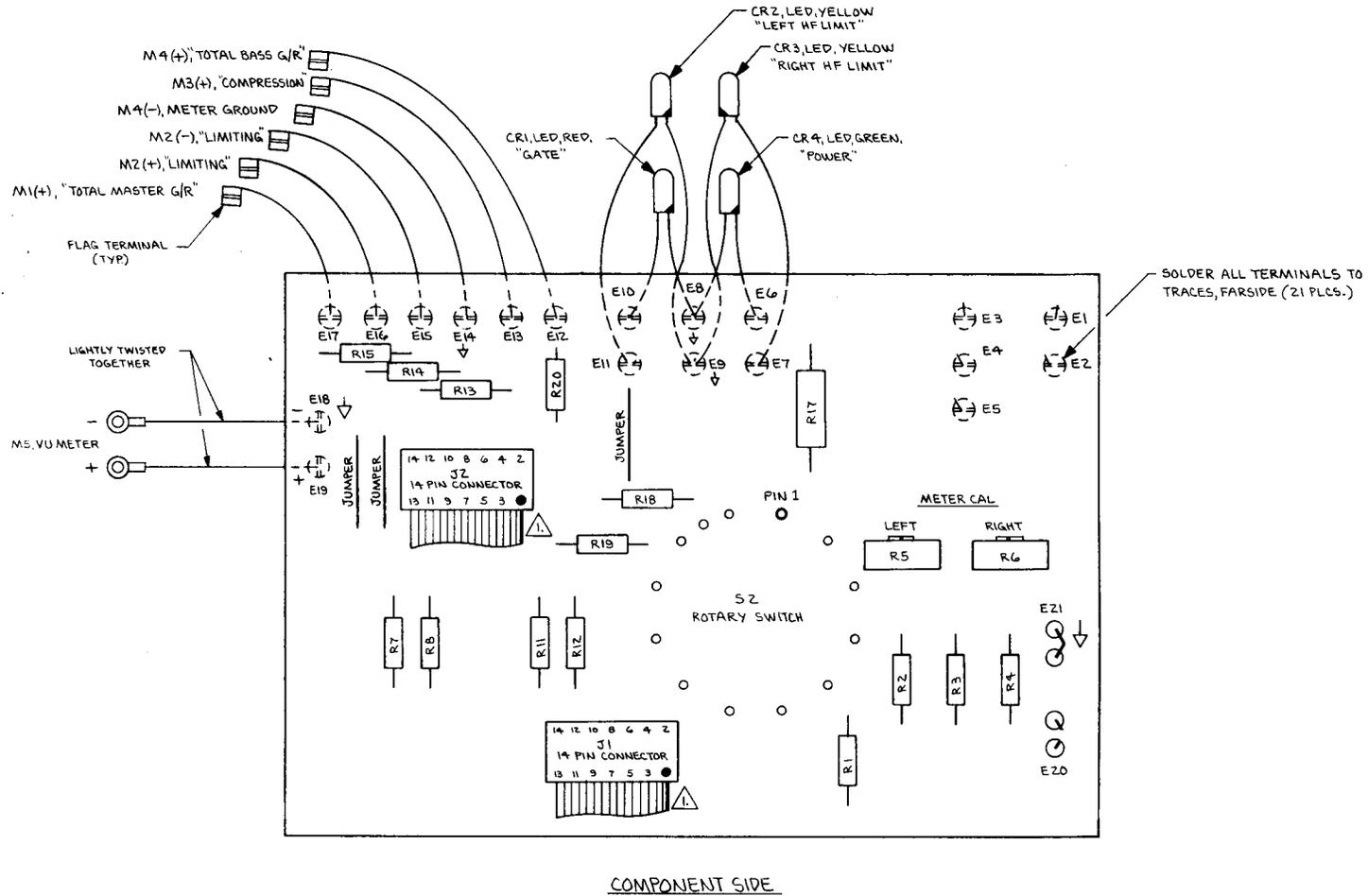
ITEM	USED	SKIP
C	14	5-8
R	13	
L	9	



orban Orban Associates Inc.

TITLE: SCHEMATIC
INPUT FILTER
60046-000-01

J

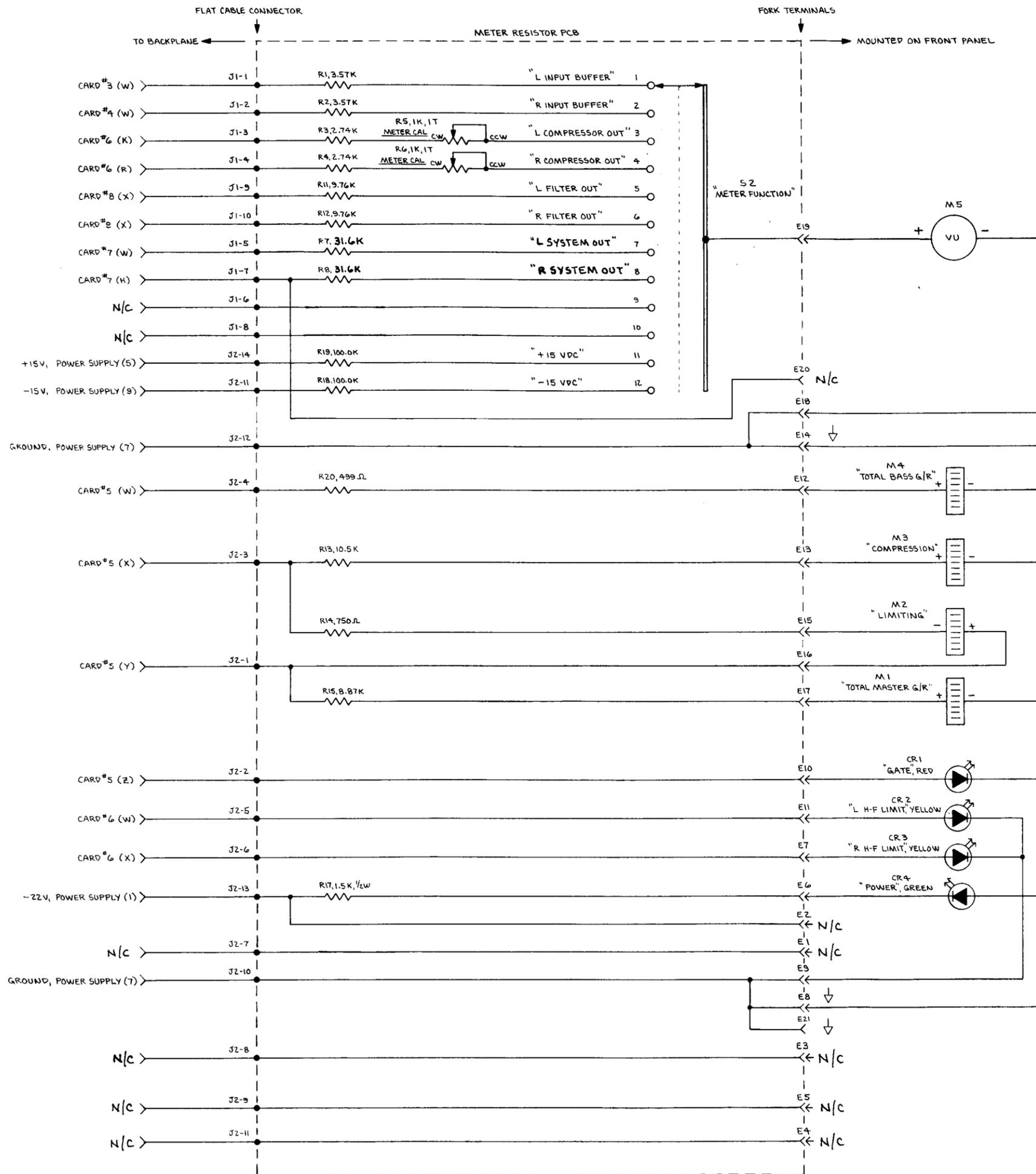


▲ DARK BLUE LINE ON EDGE OF BERG RIBBON CABLE TO BE TOWARD PIN 1 ON 14 PIN CONNECTOR.

NOTES:

orban Orban Associates Inc.

TITLE: ASSEMBLY DRAWING
METER RESISTOR BOARD
30440-VER-04

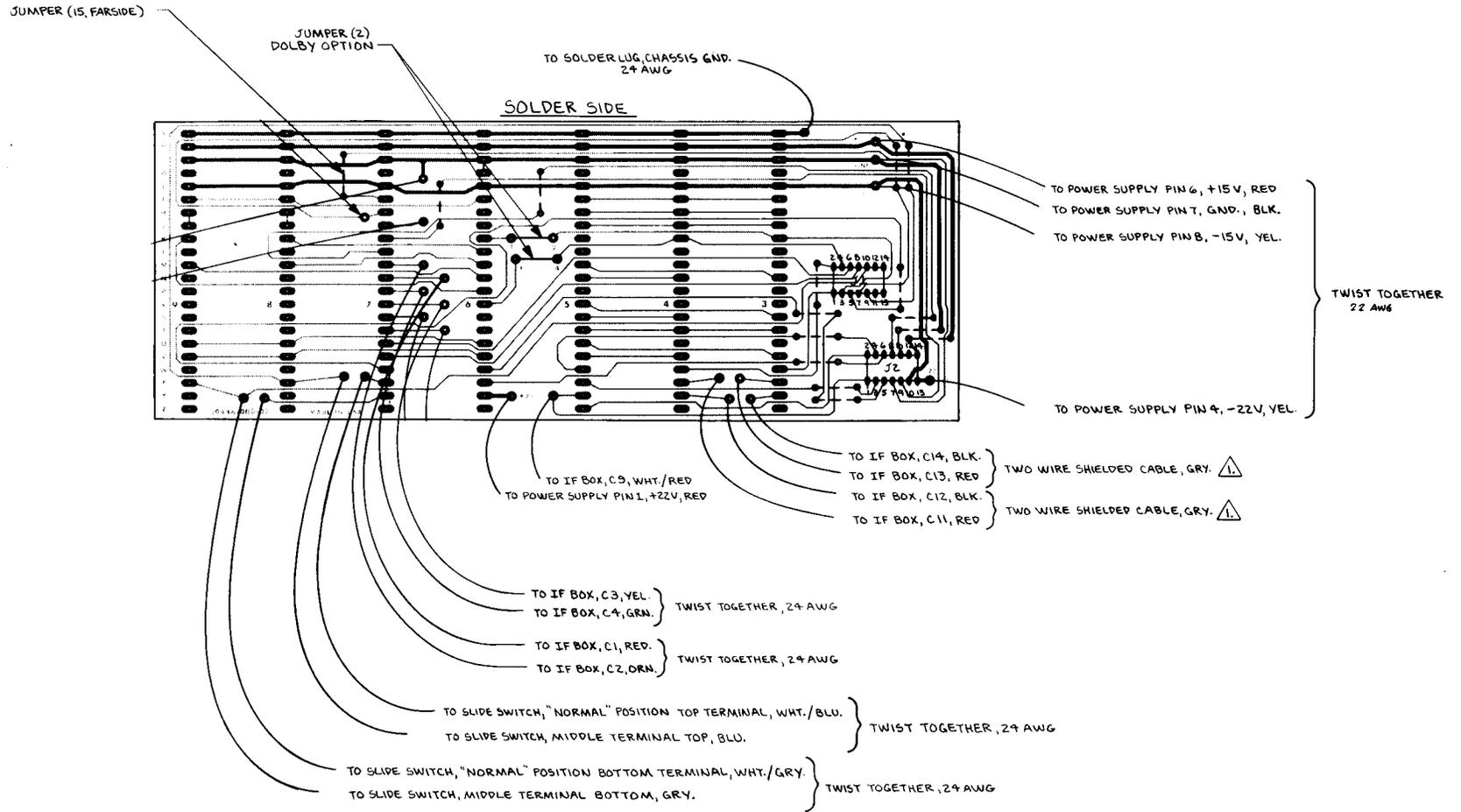


LAST REF DES. USED

CR	5
R	20
M	5
S	2

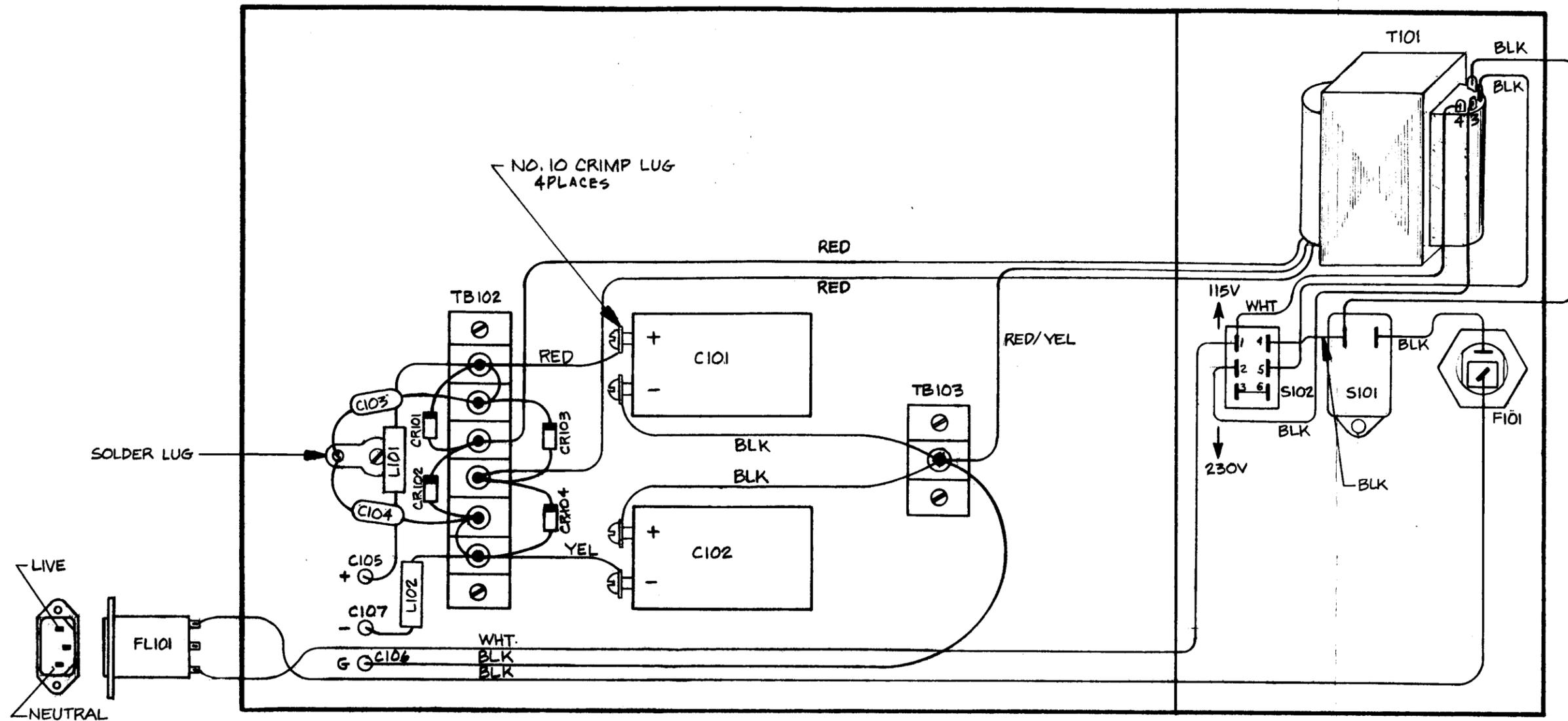
Orban Associates Inc.

TITLE: SCHEMATIC
METER RESISTOR BOARD
60040-000-05



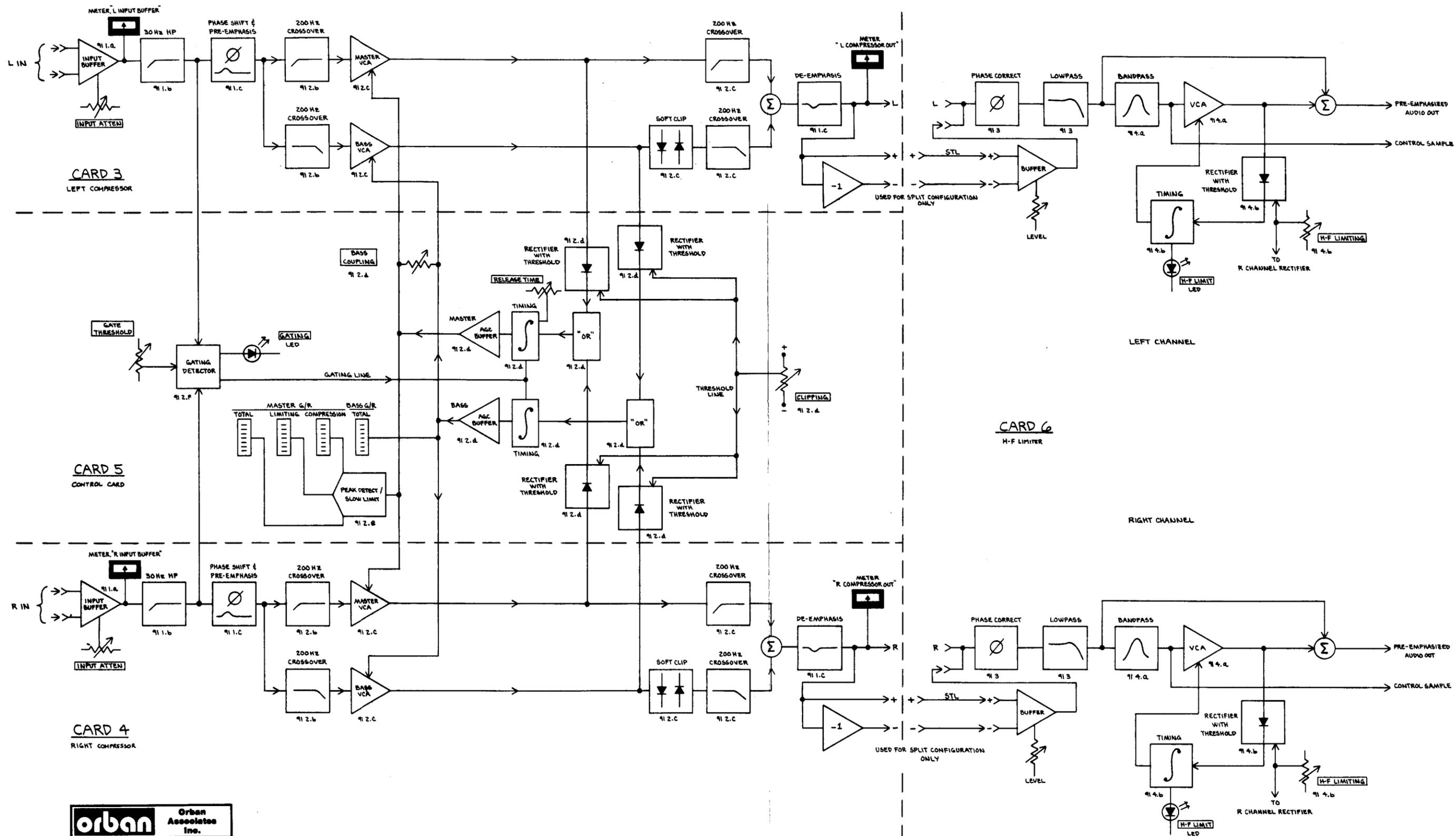
⚠ WIRE: SHIELDED CABLE, BELDEN 8451, ALL OTHER WIRE: 22 AWG
 NOTES: UNLESS OTHERWISE SPECIFIED.

orban	Orban Associates Inc.
	TITLE: ASSEMBLY DRAWING MOTHERBOARD 30445-000-01



ALL WIRE USED IS 18 AWG UL1015 ONLY, 16/30 STRAND.

orban Orban Associates Inc.
 TITLE: WIRING DIAGRAM
 DC POWER SUPPLY
 60106-000-05



CARD 3
LEFT COMPRESSOR

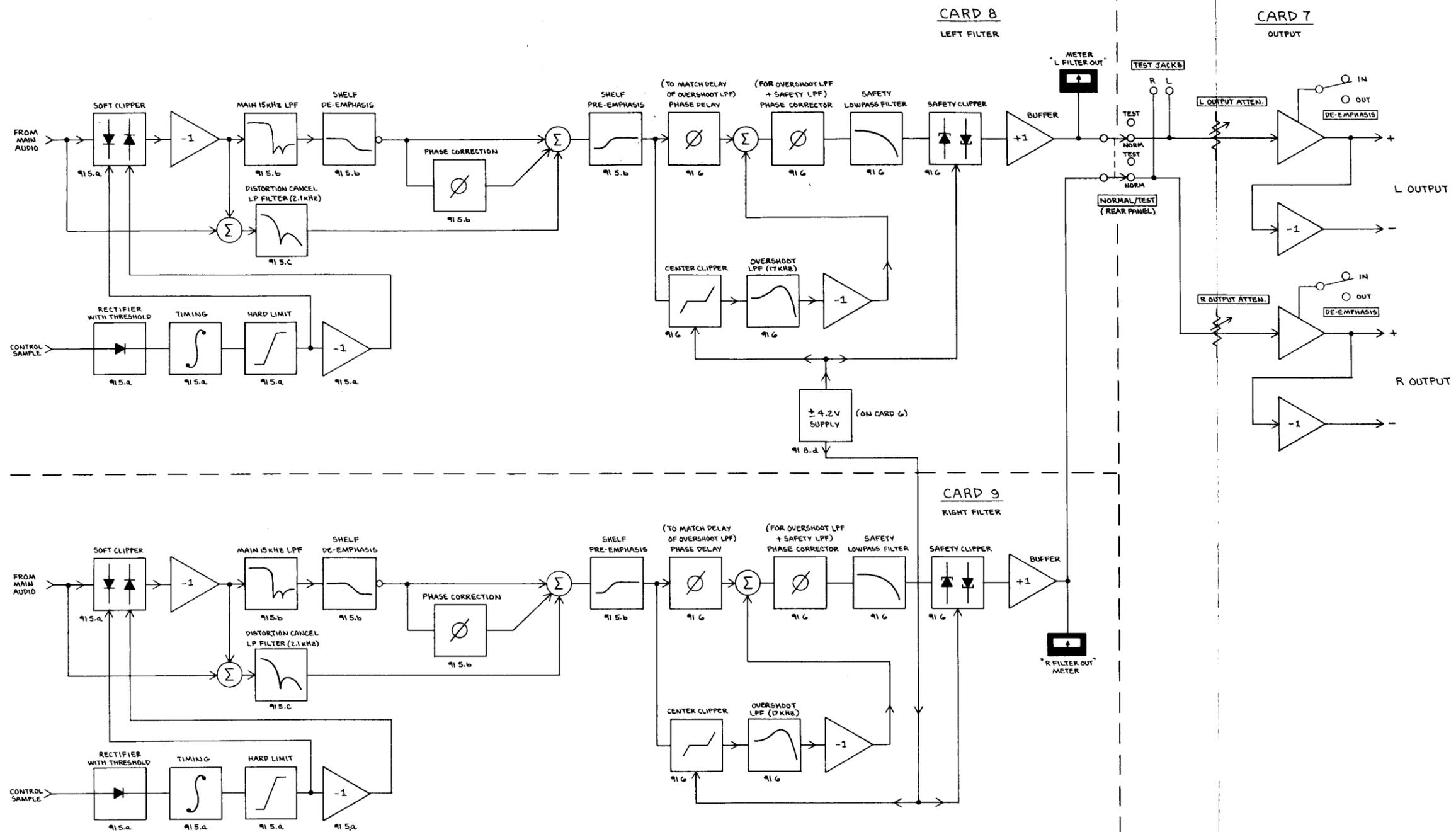
CARD 5
CONTROL CARD

CARD 4
RIGHT COMPRESSOR

CARD 6
H-F LIMITER

Orban Associates Inc.
TITLE: BLOCK DIAGRAM
60117-002-01

1. VERSION CODE: -001 = 8100A, SHEETS 1 AND 2
-002 = 8180A, SHEETS 1 AND 3
NOTES:



orban Orban Associates Inc.
 TITLE:
 BLOCK DIAGRAM
 60117-002-01

Parts List

Parts are listed by part class by assembly in Reference Designator order except for certain widely used common parts such as:

Fixed Resistors
3/8" Square Trimmer Resistors
Signal Diodes

which are described generally under the appropriate heading and which must be examined to determine the exact value.

If your installation employs the separate "Studio Chassis" accessory in order to perform the compression function at the studio end of an STL, the #3 and #4 cards have been replaced in the main chassis by special "jumper" cards identified as #3/4TX. The Parts List for these cards is printed in a separate manual supplied with the "Studio Chassis".

OBTAINING SPARE PARTS

Because special or subtle characteristics of certain components are exploited in order to produce an elegant design at a reasonable cost, it is unwise to make substitutions for listed parts. It is also unwise to ignore notations in the Parts List indicating "Selected" or "Realignment Required" when replacing components. In such cases, the factory should be consulted if optimum performance is to be maintained.

Orban normally maintains an inventory of tested, exact replacement spare parts to supply any present or normal future demand quickly at nominal cost.

When ordering parts from the factory, we will need all of the following information:

- The Orban Part Number, if ascertainable
- The Reference Designator for a defective component
- A brief description of the part
- From the Serial Label on the rear:
 - The exact Model Number
 - The Serial Number
 - The "M" number, if any

Orban can supply standardized Spare Parts Kits for this product during its production life. Consult your dealer or the factory for the consist of such kits and their prices.

Parts for this unit have been chosen from the catalogs of well-known manufacturers for ease in future maintenance. The U.S. headquarter addresses are listed at the end of the Parts List. Most manufacturers have extensive distribution facilities throughout the world and may often be contacted through local offices.

J

REF DES	DESCRIPTION	ORBAN P/N	VEN (1)	VENDOR P/N	ALTERNATE VENDORS (1)	QUAN/ SYS.	NOTES
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MODULES

Card #5

A1	Module Assy, Master Release Time	30455-001-xx*				1	*Add suffix printed on part
A2	Module Assy, Bass Release Time	30455-002-xx*				1	*Add suffix printed on part

Card #6

A1	Module Assy, H-F Limiter Release Time	30465-000-xx*				2	*Add suffix printed on part
A2	Same as A1						

Card #8/9

A1	Module Assy, Phase Delay Network	30485-000-xx*				2	*Add suffix printed on part
A2	Module Assy, Distortion Cancel Filter	30490-000-xx*				2	*Add suffix printed on part

CAPACITORS

Chassis (Filter Box)

C1-14	Feedthrough, 1000pF	21118-210	ERE	2404-000 Series		17	
-------	---------------------	-----------	-----	-----------------	--	----	--

Chassis (Back Panel)

.E1-4	Ceramic, 1000V, 10%, .0015uF	21112-215	CRL	DD-152		4	
-------	------------------------------	-----------	-----	--------	--	---	--

Power Supply and Regulator Board

C101	Aluminum Electrolytic, 40V, 5000uF	21250-850	CD	5000-40-A2	Many	2	
C102	Same as C101						
C103	Ceramic Disc, 50V, .05uF	21107-350	CRL	UK50-503	Many	2	
C104	Same as C103						
C105	Same as Chassis C1						
C106	Same as Chassis C1						
C107	Same as Chassis C1						
C108	Tantalum, 10V, 33uF	21303-633	SPR	196D336X9010KA1	Many	1	
C109	Mica, 500V, 470pF, ±5%	21020-147	CD	CD15FD471J03	Many	1	
C110	Not used						
C111	Aluminum Electrolytic, 50V, 47uF	21208-647	SPR	502D476G050CD	Many	2	
C112	Same as C111						
C113	Same as C117						

Card #3/4

C301	Not used						
C302	Not used						
C303	Metallized Polycarb., 100V, 0.1uF, ±1%	21601-410	EC1	652A1B104F	IMB	2	
C304	Metallized Polycarb., 100V, 0.1uF, ±2%	21602-410	EC1	652A1B104G	IMB	6	
C305	Same as C304						

FOOTNOTES:

- (1) See last page for abbreviations
 (2) No Alternate Vendors known at publication
 (3) Actual part is specially selected from part listed, consult Factory
 (4) Realignment may be required if replaced, see Circuit Description and/or Alignment Instructions

SPECIFICATIONS AND SOURCES FOR REPLACEMENT PARTS

OPTIMOD-TV MODEL 8180A
 Rev. 01 12/81
 MODULES/CAPACITORS

REF DES	DESCRIPTION	ORBAN P/N	VEN (1)	VENDOR P/N	ALTERNATE VENDORS (1)	QUAN/ SYS.	NOTES
C306	Polystyrene, 50V, 0.01uF, ±2%	21504-310	SPR	287P1032R5A3	(2)	16	
C307	Same as C306						
C308	Same as C306						
C309	Metallized Polycarb., 100V, 0.12uF, ±2%	21602-412	ECI	652A1B124G	IMB	2	
C310	Mica, 500V, 150pF, 5%	21020-115	CD	CD15FD151J03	Many	4	
C311	Mica, 500V, 5pF, ±½pF	21017-005	CD	CD15CD050D03	Many	4	
C312	Mica, 500V, 10pF, ±½pF	21017-010	CD	CD15CD100D03	Many	2	
C313	Tantalum, 35V, 4.7uF	21307-547	SPR	196D475X9035JA1	Many	3	
C314	Metallized Polycarb., 100V, 0.27uF, ±2%	21602-427	ECI	652A1B274G	IMB	2	
C315	Same as C310						
C316	Same as C311						
C317	Mica, 500V, 100pF, ±5%	21020-110	CD	CD15FD101J03	Many	3	
C318	Same as C306						
C319	Same as C306						
C320	Same as C306						
C321	Same as C304						
C322	Metallized Polyester, 50V, 1.0uF, +10%	21441-510	PLE	160-60H105J100	(2)	2	
C323	Ceramic Disc, 25V, .05uF, ±20%	21106-350	CRL	UK25-503	Many	32	
C324	Same as C323						
C325	Same as C323						
C326	Same as C323						
C327	Aluminum Electrolytic, 25V, 22uF	21206-622	SPR	502D226G025BB1C	Many	18	
C328	Same as C327						
C4xx	Subtract 100 and refer to C3xx series						
Card #5							
C501	Ceramic Disc, 1kV, .0022uF, ±20%	21113-222	CRL	DD-222	Many	2	
C502	Tantalum, 35V, 1uF, 10%	21307-510	SPR	196D105X9035HA1	Many	13	
C503	Same as C502						
C504	Same as C501						
C505	Same as C502						
C506	Same as C502						
C507	Tantalum, 35V, 2.2uF, ±10%	21307-522	SPR	196D225X9035JA1	Many	2	
C508	Same as C313						
C509	Metallized Polyester, 100V, 0.1uF, +10%	21441-410	PLE	160-60C104J100	Many	2	
C510	Ceramic Disc, 1kV, .001uF, ±10%	21112-210	CRL	DD-102	Many	1	
C511	Same as C507						
C512	Same as C327						
C513	Same as C327						
C514	Same as C323						
C515	Same as C323						
C516	Same as C323						
C517	Same as C323						
C518	Same as C502						

J-25

FOOTNOTES:

- (1) See last page for abbreviations
- (2) No Alternate Vendors known at publication
- (3) Actual part is specially selected from part listed, consult Factory
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SPECIFICATIONS AND SOURCES FOR
REPLACEMENT PARTS

OPTIMOD-TV MODEL 8180A
Rev. 01 12/81

CAPACITORS



REF DES	DESCRIPTION	ORBAN P/N	VEN (1)	VENDOR P/N	ALTERNATE VENDORS (1)	QUAN/ SYS.	NOTES
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Card #6

C601	Mica, 500V, 1000pF, ±1%	21022-210	CD	CD19FD102F03	Many	32	
C602	Same as C601						
C603	Same as C306						
C604	Mica, 500V, 150pF, ±1%	21018-115	CD	CD15FD151F03	Many	2	
C605	Same as C601						
C606	Mica, 500V, 220pF, ±1%	21018-122	CD	CD15FD221F03	Many	6	
C607	Same as C601						
C608	Same as C601						
C609	Mica, 500V, 1800pF, ±5%	21024-218	CD	CD19FD182J03	Many	2	
C610	Metallized Polycarb., 50V, 1.0uF, ±10%	21604-510	ECI	652A1B105K	1MB	4	
C611	Same as C306						
C612	Polyester, 100V, .047uF, ±10%	21401-347	SPR	225P47391WD3	Many	2	
C613	Same as C601						
C614	Same as C601						
C615	Same as C306						
C616	Same as C604						
C617	Same as C601						
C618	Same as C606						
C619	Same as C601						
C620	Same as C601						
C621	Same as C609						
C622	Same as C610						
C623	Same as C306						
C624	Same as C612						
C625	Same as C502						
C626	Same as C327						
C627	Same as C327						
C628	Same as C323						
C629	Same as C323						
C630	Same as C323						
C631	Same as C323						
C632	Same as C327						
C633	Same as C327						
C634	Same as C323						
C635	Same as C323						
C636	Same as C502						

Card #7

C701	Mica, 500V, 1000pF, 1%	21022-210	CD	CD19FD102F03		2	
C702	Same as C701						
C703	Aluminum, 22/25V	21206-622	SPR	502D226G025BB1C		2	
C704	Same as C703						
C705 - C708	Ceramic, .05/25V	21106-350	CRL	UK25-503		4	

FOOTNOTES:

- | | |
|---|--|
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| (2) No Alternate Vendors known at publication | |
| (3) Actual part is specially selected from part listed, consult Factory | |

SPECIFICATIONS AND SOURCES FOR
REPLACEMENT PARTS

OPTIMOD-TV MODEL 8180A
Rev. 01 12/81

CAPACITORS

REF DES	DESCRIPTION	ORBAN P/N	VEN (1)	VENDOR P/N	ALTERNATE VENDORS (1)	QUAN/ SYS.	NOTES
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Power Supply and Regulator Board

CR101-							
CR104	Diode, Rectifier, 400PIV, 3A	22203-400	MOT	MR504	Some	4	
CR105	Diode, Rectifier, 400PIV, 1A	22201-400	MOT	1N4004	Many	2	
CR106	Same as CR105						

Meter Resistor Board

CR1	LED, Red	25103-000	FSC	FLV-150	Many	1	
CR2	LED, Yellow	25105-000	FSC	FLV-450	Many	2	
CR3	Same as CR2						
CR4	LED, Green	25104-000	FSC	FLV-355	Many	1	

Card #6

CR604	Schottky Hot-Carrier	22102-001	HP	5082-2800	(2)	9	
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Card #8/9

CR803-							
CR806	Same as CR604						
CR9xx	Subtract 100 and refer to CR8xx series						

INTEGRATED CIRCUITS

Power Supply and Regulator Board

IC101	Regulator, Voltage	24301-302	NAT	LM723CN		1	
IC102	Same as IC511						

Card #3/4

IC301	Dual Opamp	24207-402	SIG	NE5532FE	TI,EXR	4	
IC302	Dual Opamp	24206-402	TI	TL072CJG	NAT(LF353H)	31	
IC303	Same as IC302						
IC304	Single Opamp	24014-402	SIG	NE5534FE	TI,EXR	7	
IC305	Dual Variable Gain Block	24208-303	ORB	24208-303	(2)	4	(3) (4)
IC306	Same as IC302						
IC307	Same as IC301						
IC308	Same as IC304						
IC309	Same as IC305						
IC310	Same as IC302						
IC4xx	Subtract 100 and refer to IC3xx series						

FOOTNOTES:

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SPECIFICATIONS AND SOURCES FOR
REPLACEMENT PARTS

OPTIMOD-TV MODEL 8180A
 Rev. 01 12/81
 DIODES/INTEGRATED CIRCUITS

REF DES	DESCRIPTION	ORBAN P/N	VEN (1)	VENDOR P/N	ALTERNATE VENDORS (1)	QUAN/ SYS.	NOTES
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Card #5

IC501	Dual Opamp	24202-402	RAY	RC4558DE	TI, Many	6	
IC502	Dual PNP Transistor, Matched Pair	24407-101	INS	IT 131	(2)	2	(4)
IC503	Same as IC302						
IC504	Transistor Array	24406-302	RCA	CA3096AE	(2)	8	
IC505	Same as IC504						
IC506	Same as IC501						
IC507	Same as IC502						(4)
IC508	Same as IC302						
IC509	Same as IC504						
IC510	Same as IC504						
IC511	Single Opamp	24003-402	TI	LM301AJG	Many	4	
IC512	Same as IC501						
IC513	Dual Opamp	24203-201	MOT	MC1458CP1	Many	2	
IC514	Same as IC501						

Card #6

IC601	Same as IC302						
IC602	Same as IC302						
IC603	QUAD FET	24405-303	NAT	AH5011CN	INS	1	(4)
IC604	Same as IC304						
IC605	Same as IC302						
IC606	Same as IC513						
IC607	Same as IC504						
IC608	Same as IC302						
IC609	Same as IC302						
IC610	Same as IC304						
IC611	Same as IC302						
IC612	Same as IC504						
IC613	Same as IC501						

Card #7

IC701	Dual Opamp, 5532	24207-402	SIG	NE5532FE		2	
IC702	Same as IC701						

Card #8/9

IC801-							
IC806	Same as IC302						
IC807	Same as IC504						
IC808	Same as IC302						
IC9xx	Subtract 100 and refer to IC8xx series						

FOOTNOTES:

- | | |
|---|--|
| (1) See last page for abbreviations | (4) Realignment may be required if replaced, see |
| (2) No Alternate Vendors known at publication | Circuit Description and/or Alignment |
| (3) Actual part is specially selected from part listed, consult Factory | Instructions |

SPECIFICATIONS AND SOURCES FOR
REPLACEMENT PARTS

OPTIMOD-TV MODEL 8180A
Rev. 01 12/81
INTEGRATED CIRCUITS



REF DES	DESCRIPTION	ORBAN P/N	VEN (1)	VENDOR P/N	ALTERNATE VENDORS(1)	QUAN/ SYS.	NOTES
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INDUCTORS

Input Filter Board

L1-L4	Inductor, 1.2mH	29503-000	MIL	73F123AF	(2)	8	
L5	Inductor, 7mH	29501-004	OHM	Z-50	(2)	1	
L6-L9	Same as L1-L4						

Power Supply and Regulator Board

L101	Same as Input Filter L5						
L102	Same as Input Filter L5						

Card #8/9

L801	Inductor	29702-801			(2)	2	
L802	Inductor	29702-802			(2)	2	
L803	Inductor	29702-803			(2)	2	
L804	Inductor	29702-804			(2)	2	
L805	Inductor	29702-805			(2)	2	

L9xx Subtract 100 and refer to L8xx series

TRANSISTORS

Power Supply and Regulator Board

Q101	Transistor, Power	23601-501		RCA 2N3055	Many	2	
Q102	Same as Q101						
Q103	Silicon, PNP	23002-101		FSC 2N4402	Many	2	
Q104	Same as Q103						

Card #5

Q501	J-FET, P-Channel	23407-101		NAT J174	SIL	2	
Q502	Same as Q501						

Card #6

Q601	Silicon, NPN	23202-101		FSC 2N4400	Many	4	
Q602	Same as Q601						

FOOTNOTES:

- | | |
|---|--|
| (1) See last page for abbreviations | (4) Realignment may be required if replaced, |
| (2) No Alternate Vendors known at publication | see Circuit Description and/or Alignment |
| (3) Actual part is specially selected from | Instructions |
| part listed, consult Factory | |

SPECIFICATIONS AND SOURCES FOR
REPLACEMENT PARTS

OPTIMOD-TV MODEL 8180A
Rev. 01 12/81
INDUCTORS/TRANSISTORS

REF DES	DESCRIPTION	ORBAN P/N	VEN (1)	VENDOR P/N	ALTERNATE VENDORS (1)	QUAN/ SYS.	NOTES
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RESISTORS

ALL COMMON RESISTORS NOT LISTED ARE GENERALLY SPECIFIED THUS: Replace resistors only with the same style and with the exact value as marked on the resistor body, lest performance or stability be compromised. If the resistor is damaged, consult the factory or refer to the Schematic to obtain the value.

Metal Film Resistors

Body: conformally-coated
 I.D.: five color bands or printed value
 Orban P/N: 20040-XXX
 Power Rating: 1/8 Watt @ 70°C
 Tolerance: 1%
 Temperature Coefficient: 100 PPM/°C
 U.S. Military Spec.: MIL-R-10509, Style RN55D
 Manufacturers: R-Ohm (CRB-½FX), TRW/IRC, Beyschlag, Dale, Corning, Matsushita

Carbon Composition Resistors

Body: molded phenolic
 I.D.: four color bands
 Orban P/N: 20011-XXX
 Power Rating: (70°C) ¼ Watt (Body 0.090" x 0.250")
 ½ Watt (Body 0.140" x 0.375")
 Tolerance: 5%
 U.S. Military Spec.: MIL-R-11, Style RC-07 (¼W) or RC-20 (½W)
 Manufacturers: Allen-Bradley, TRW/IRC, Stackpole, Matsushita

Carbon Film Resistors

Body: conformally-coated
 I.D.: four color bands
 Orban P/N: 20001-XXX
 Power Rating: ¼ Watt @ 70°C
 Tolerance: 5%
 Manufacturers: R-Ohm (R-25), Piher, Beyschlag, Dale, Phillips, Matsushita

Cermet Trimmer Resistors

Body: 3/8" square (9mm)
 I.D.: printed marking on side
 Orban P/N: 20510-XXX
 Power Rating: ½ Watt @ 70°C
 Tolerance: 10%
 Temperature Coefficient: 100 PPM/°C
 Manufacturers: Beckman (72PR-series), Spectrol, Bourns, Matsushita

Power Supply and Regulator Board

R103	Wirewound, 2W, 0.91 OHM ±5%	20028-891	IRC BWF Series	(2)	2
R104	Same as R103				
R106	Trimpot, 18 turn, 500 OHM ±20%	20511-150	BEK 68WR500	Many	1

Meter Resistor Board

R5	Trimpot, Vertical, 1K ±20%	20509-210	BEK 72XR1K	Many	2
R6	Same as R5				

Card #3/4

R309	Control, 10% CCW Log, 25K ±20%	20734-000	CTS 270 Series	AB, BRN	2
R409	Same as R309				

Card #5

R509	Control, 20% CW Log, 1 MEG ±20%	20737-000	CTS 270 Series	AB, BRN	1
R521	Control, Linear, 5K ±20%	20735-000	CTS 270 Series	AB, BRN	2
R537	Control, 20% CCW Log, 100K ±20%	20736-000	CTS 270 Series	AB, BRN	1
R542	Same as R521				

Card #6

R678	Control, Linear, 50K ±10%	20727-000	CTS 270 Series	AB, BRN	1
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Card #7

R701	Trimpot, 15 turn, 25K ±20%	20512-325	BEK 89PR25K	Many	2
R708	Same as R701				

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FOOTNOTES:

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SPECIFICATIONS AND SOURCES FOR REPLACEMENT PARTS

OPTIMOD-TV MODEL 8180A
 Rev. 01 12/81
 RESISTORS



REF DES	DESCRIPTION	ORBAN P/N	VEN (1)	VENDOR P/N	ALTERNATE VENDORS (1)	QUAN/ SYS.	NOTES
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SWITCHES

Meter Resistor Board

S2 Switch, Rotary, 1P12T(non-short) 26078-306 CTS 212 Series (2) 1

Card #5

S501 Switch, SPDT 26037-009 CK 7101SYA Many 3

Card #6

S602 Same as S501

MISCELLANEOUS

Chassis

Connector, Card Edge, 22 Pos. 27035-004 SAE SAC 22S/2-3 Many 7

Power Supply and Regulator Board

F101 Fuse, 3AG SLO-BLO, 1/2A 28005-001 LFE 313.500 BUS 1

F102 Fuse, PICO 1A 28011-210 LFE 275001 BUS 2

F103 Same as F102

FL101 Filter, Line 28015-000 COR 3EF1 Many 1

T1 Transformer, Power 38VCT 1A 29004-000 1

VR101 Diode, Zener, 5W, 16V ±5% 22005-160 MOT 1N5353B Many 2

VR102 Same as VR101

Other

Line Cord, IEC 28102-002 BEL 17500 Many 1

PCB Extender Board Assy 30315-000 1

P/L REVISIONS:

- 30565-000-01 INPUT FILTER
- 30310-000-05 PS
- 30430-VER-03 3/4 CARD
- 30450-002-05 5 CARD
- 30460-000-03 6 CARD
- 30570-000-01 7 CARD
- 30480-VER-02 8/9 CARD
- 30440-002-03 METER RESISTOR
- 40022-000-01 FRONT PANEL
- 40023-000-01 REAR PANEL

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<p>FOOTNOTES:</p> <p>(1) See last page for abbreviations</p> <p>(2) No Alternate Vendors known at publication</p> <p>(3) Actual part is specially selected from part listed, consult Factory</p>		<p>(4) Realignment may be required if replaced, see Circuit Description and/or Alignment Instructions</p>	
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SPECIFICATIONS AND SOURCES FOR
REPLACEMENT PARTS
OPTIMOD-TV MODEL 8180A
Rev. 01 12/81
SWITCHES/MISCELLANEOUS

Vendor Codes

AB	Allen-Bradley Co. 1201 South Second St. Milwaukee, WI 53204	COR	Corcom, Inc. 2635 North Kildare Ave. Chicago, IL 60639	MIL	J. W. Miller Division Bell Industries 19070 Reyes Avenue P. O. Box 5825 Compton, CA 90224	RCA	RCA Solid State Division Route 202 Somerville, NJ 08876
AD	Analog Devices, Inc. Route 1, Industrial Park P.O. Box 280 Norwood, MA 02062	CTS	CTS Corporation 905 N. West Blvd. Elkhart, IN 46514	MON	Monsanto Commercial Products Co. Electronics Division 3400 Hillview Ave. Palo Alto, CA 94304	SAE	Stanford Applied Engineering 340 Martin Avenue Santa Clara, CA 95050
AM	Amphenol North America A Division of Bunker-Ramo 2122 York Road Oak Brook, IL 60521	ECI	Electrocube 1710 South Del Mar Avenue San Gabriel, CA 91776	MOT	Motorola, Inc. P. O. Box 20912 Phoenix, AZ 85036	SCH	ITT Schadow, Inc. 8081 Wallace Road Eden Prairie, MN 55343
BEK	Beckman Instruments, Inc. Helipot Division 2500 Harbor Blvd. Fullerton, CA 92634	EMI	EMICO Division Sheller-Globe Corp. P. O. Box 368 Dublin, PA 18917	NAT	National Semiconductor Corp. 2900 Semiconductor Drive Santa Clara, CA 95051	SIE	Siemens Components Division 186 Wood Avenue, South Iselin, NJ 08830
BEL	Belden Corporation Electronic Division Richmond, IN 47374	ERE	Erie Technological Products, Inc. 644 West Twelfth Street Erie, PA 16512	NOB	Noble Teikoku Tsushin Kogyo Co. Ltd. 335, Kariyado, Nakahara-ku Kawasaki 211, JAPAN	SIG	Signetics Corporation A Subsidiary of U.S. Philips Corp. P. O. Box 9052 Sunnyvale, CA 94086
BRN	Bourns, Inc. Trimpot Products Division 1200 Columbia Ave. Riverside, CA 92507	EXR	Exar Integrated Systems, Inc. P. O. Box 62229 Sunnyvale, CA 94088	OHM	Ohmite Manufacturing Company A North American Philips Co. 3601 Howard Street Skokie, IL 60076	SPR	Sprague Electric Company 125 Marshall Street North Adams, MA 01247
BUS	Bussmann Manufacturing Div. McGraw-Edison Company P. O. Box 14460 St. Louis, MO 63178	FSC	Fairchild Camera & Instr. Corp. 464 Ellis Street Mountain View, CA 94042	ORB	Orban Associates Inc. 645 Bryant Street San Francisco, CA 94107	STK	Stackpole Components Company P. O. Box 14466 Raleigh, NC 27620
CD	Cornell-Dubilier Electric Corp. Div. of Federal Pacific Electric 150 Avenue "L" Newark, NJ 07101	HP	Hewlett-Packard Corporation 1501 Page Mill Road Palo Alto, CA 94304	PAK	Paktron Div. of Illinois Tool Works Inc. 900 Follin Lane, S.E. Vienna, VA 22180	SYL	GTE Sylvania Inc. Connector Products Operation Box 29 Titusville, PA 16354
CK	C & K Components Inc. 103 Morse Street Watertown, MA 02172	INS	Intersil, Inc. 10710 N. Tantau Avenue Cupertino, CA 95014	PLE	Plessey, Inc. 5334 Stierling Ctr. Dr. Westlake Village, CA 91361	TI	Texas Instruments P. O. Box 225012 Dallas, TX 75265
CRL	Centralab Electronics Div. Globe-Union Inc. 5757 North Green Bay Ave. Milwaukee, WI 53201	IRC	TRW/IRC Resistors 401 North Broad Street Philadelphia, PA 19108	RAY	Raytheon Semiconductor Division 350 Ellis Street Mountain View, CA 94042		
		LFE	Littelfuse A Subsidiary of Tracor 800 East Northwest Highway Des Plaines, IL 60016				
		MAL	P. R. Mallory & Company, Inc. 3029 East Washington Street Indianapolis, IN 46206				



Appendix K has been intentionally omitted.

Appendix L: Specifications

Frequency Response (System in PROOF mode)

Follows standard 75us preemphasis curve $\pm 0.75\text{dB}$, 50-15,000 Hz. 50us preemphasis available on special order. Deemphasis jumper on line amplifier card permits flat output $\pm 0.75\text{dB}$ 50-15,000Hz for use with external preemphasis. All preemphasis networks include a fourth-order lowpass filter and fourth-order phase corrector prior to the high-frequency limiter and clipper to prevent these elements from processing out-of-band program material and to minimize overshoot, thus minimizing the amount of high-frequency limiting and clipping.

Input Conditioning

Highpass Filter: Third-order Chebychev with 30Hz cutoff and 0.5dB passband ripple. Down 0.5dB at 30Hz; 10.5dB at 20Hz; 31.5dB at 10Hz. Protects against infrasonic destabilization of certain exciters' AFC's, as well as infrasonic gain modulation in the compressor.

Phase Scrambler: Allpass network makes peaks more symmetrical to best utilize the symmetrical peak overload characteristics of the FM medium.

Noise

-75dB below 100% modulation, 50-15,000 Hz maximum; -81dB typical.

Total System Distortion (PROOF Mode; deemphasized; 100% Modulation)

Less than 0.05% THD, 50-15,000Hz (0.02% typical); less than 0.05% SMPTE Intermodulation Distortion (60/7000Hz; 4:1).

NOTE

"THD" is defined as the root-sum-square (R.S.S.) sum of all harmonics, 50-30,000Hz. Noise (which is unavoidably included in the reading on a typical THD analyzer) is specifically excluded from this specification. The R.S.S. sum of all harmonics and noise may be as high as 0.07% at 15kHz.

"Master" Band Compressor Characteristics

Attack Time: approximately 1ms

Release Time: program-controlled — varies according to program dynamics and amount of gain reduction (see text). Process can be scaled fast or slow by means of continuously variable RELEASE TIME control. Employs delayed release for distortion reduction.

Total Harmonic Distortion (measured at VCA output, OPERATE mode, RELEASE TIME control centered): Less than 0.1%, 200-15,000Hz, +10 to -15dB gain reduction
Available Gain Reduction: 25dB

Metering: Three dB-linear edgewise-reading gain reduction meters —

MASTER is true peak-reading with electronic acceleration and peak-hold (+10 to -15dB);

COMPRESSOR indicates slow compression component of gain reduction (+10 to -15dB)

LIMITER indicates fast peak limiting component of gain reduction (0-5dB)

Gain Control Element: True VCA. Proprietary Class-A design eliminates crossover notch distortion, modulation noise, and slewrate limiting found in competitive Class-AB designs.

"Bass" Band Compressor Characteristics

Attack Time: program-controlled; not adjustable

Release Time: program-controlled; not adjustable. Incorporates delayed-release distortion reduction.

Total Harmonic Distortion (at VCA output, OPERATE mode): Less than 0.1% THD, 50-200Hz, +10 to -20dB gain reduction

Available Gain Reduction: 30dB

Metering: single dB-linear edgewise-reading gain reduction meter (+10 to -20dB).

Gain Reduction Element: Proprietary Class-A true VCA

Crosscoupling (U.S. patent #4,249,042): Enables gain of "Bass" band to track gain of "Master" band to any degree, from identical tracking to fully independent operation. Adjustable with BASS COUPLING control.

Crossover Characteristics

Control: 6dB/octave @200Hz;

Program: 12dB/octave @200Hz in unique "distributed crossover" configuration (U.S. patent #4,249,042)

High Frequency Limiter Characteristics

Attack Time: approximately 5ms

Release Time: approximately 20ms. Delayed release included for distortion reduction.

Mode: Left and right channels operate independently to avoid high frequencies in one channel causing audible timbre modulation of opposite channel.

Control Element: Junction FET

Metering: Two LED's indicate HF limiting in L and R channels.

Threshold of HF Limiting: User-adjustable over 3dB range to meet format requirements

FM "Smart Clipper" Output Processor Characteristics

Nominal Bandwidth: 15.4kHz

Distortion Cancellation: Clipping distortion (below overshoot compensator threshold) cancelled better than 30dB (40dB typical), 0-2200 Hz (U.S. patent #4,208,548).

Delay Correction: Fourth-order allpass

Amount of Clipping: User-adjustable over 6dB range to match format requirements.

Frequency-Contoured Sidechain (FCS) Overshoot Compensator Characteristics (patent pending)

System Overshoot: The FCS circuit is best thought of as a "bandlimited safety clipper". It operates like a hard clipper, but does not produce out-of-band frequency components as a simple hard clipper would. Because the audio processing will sometimes limit steady-state material with high average energy (like sinewaves) or with very little high-frequency energy to levels below the threshold of clipping, it is difficult to state a clear and meaningful specification for the system overshoot performance of the FCS circuit.

The FCS circuit is followed by a safety clipper. The overshoot specification could be slightly improved if this safety clipper were set up to clip more frequently. However, the system is aligned at the factory such that the safety clipper is almost never active, thus fully preserving the bandlimiting provided by the FCS circuit. With this safety clipper alignment, the peak modulation will be controlled $\pm 3.5\%$ on arbitrary waveforms clipped to any degree by the FCS circuit (acting as a bandlimited safety clipper); peak modulation will not exceed this level on other material. With typical program material, peak modulation uncertainty is less than 2%.

Sinewave Modulation Ability: 93% modulation (i.e., 0.6dB below maximum overshoot level) at all sinewave frequencies, assuming sinewaves are applied to FCS input.
Dynamic Separation: better than 45dB

Difference-Frequency Intermodulation: FCS circuit causes no more audible IM (such as sibilance splatter) than would a simple hard clipper clipping to the same depth. The entire OPTIMOD-TV processing system is specifically configured to prevent the FCS circuit from audibly degrading the difference-frequency distortion-cancellation properties of the earlier FM "Smart Clipper".

System Separation

Greater than 50dB, 50-15,000Hz; 60dB typical

Input

Impedance: greater than 10K ohms, electronically balanced by means of true instrumentation amplifier. Requires balanced source.

Common Mode Rejection: Greater than 60dB @60Hz

Sensitivity: -10dBm produces 10dB "Master" Band gain reduction @1kHz. Removal of internal 20dB pad permits -30dBm to produce same effect.

Connector: Cinch-Jones 140-style barrier strip (#5 screw).

Output

Source Impedance: 370 ohms, independent of OUTPUT ATTEN setting, balanced.
Level: variable -infinity dBm to greater than +20dBm by means of 15-turn OUTPUT ATTEN controls.

Connector: Cinch-Jones 140-style barrier strip (#5 screw). RF suppressed.

Auxiliary Input/Output (for Test use only)

Provides L and R lowpass filter output or L and R line amplifier input depending upon setting of rear-apron NORMAL/TEST switch. Connectors are RCA phono-type, unbalanced.

Operating Controls

VU Meter Selector: switches ASA-standard VU meter to read:

- L or R Input Level
- L or R Compressor Output
- L or R Filter Out
- L or R Line Amplifier Output
- ±15 V Power Supply Voltages

Setup Controls (front-panel, behind lockable swing-down door -- see Fig. 4-5)

Compressor:

- Left and Right Input Attenuators
- "Master" Band Release Time
- Gate Threshold
- Bass Coupling
- Clipping
- High-Frequency Limiter Threshold

General:

Left and Right Output Attenuators

PROOF/OPERATE Switches (to defeat gain reduction, HF limiting, clipping, and gating)

Power ON/OFF

115V/230V Selector Switch

Power Requirement

115/230VAC, $\pm 15\%$, 50-60Hz, approx. 19VA. IEC mains connector with detachable 3-wire "U-Ground" power cord supplied. Leakage to chassis less than 0.5uA. AC is RF-suppressed.

Dimensions

19"(48.3cm)W x 7"(17.8cm)H x 12.5"(31.2cm)D -- 4 rack units

Environmental

Operating Temperature Range: 0-50 degrees C (32-122 degrees F).

Humidity: 0-95% R.H., non-condensing

Warranty

One year, parts and labor. Subject to limitations set forth in our Standard Warranty.

All specifications subject to change without notice.