Section 6
Technical Data

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Specifications

It is impossible to define the listening quality of even the simplest limiter or compressor with the usual specifications because they cannot adequately describe the crucial *dynamic* processes which occur with program material. We evaluate these dynamic processes at the factory and control them to close tolerances. These measurements require special test fixtures, cannot be readily duplicated by measurements with standard test equipment in the field, and cannot be described in familiar terms.

The 9105A is the result of computer-aided design, high-precision components, careful testing, and extensive burn-in. When the 9105A's PROCESSOR switch is set to AGC/CLIPPER DEFEAT, clipping and gain reduction are defeated *without bypassing any circuitry* — unlike equipment produced by some other manufacturers. (Separate switches defeat receiver and transmitter equalization.) Because of this, the following specifications truly reflect the accuracy and transparency of the 9105A's signal path.

Performance

Frequency response: If ordered with 4.5kHz bandwidth (4.0, 5.0, 5.5, 6.0kHz also available), ±1.0dB, 50–4500Hz (PROCESSOR switch set to AGC/CLIPPER DEFEAT).

Total harmonic distortion: <0.2% at 100% modulation, 200–4500Hz (PROCESSOR switch set to AGC/CLIPPER DEFEAT).

Band 1 in the multi-band limiter has been designed to clip at approximately 5dB below 100% modulation even when the PROCESSOR switch is set to AGC/CLIPPER DEFEAT. Therefore full-bandwidth THD measurements are only valid below approximately 50% modulation. This limitation does not apply when the PROCESSOR BYPASS switch is in BYPASS, so there is no problem in performing transmission system measurements through OPTIMOD-HF.

RMS noise: >65dB below 100% modulation, 30–20,000Hz (PROCESSOR switch set to AGC/CLIPPER DEFEAT).

Installation

Audio Input

Impedance: >10K ohms, electronically balanced.

Sensitivity: –30dBm or greater nominal line levels.

Controlled by INPUT ATTEN control. 20dB input attenuation pad can be defeated by repositioning jumpers.

RFI suppressed: Yes.

Connector: Barrier strip (#6 screws).

Audio Output

Configuration: Single output for one transmitter.

Impedance: <35Ω, electronically-balanced and floating (simulates true transformer output).

Level: >+20dBm into 600 ohms.

RFI suppressed: Yes.

Connector: Barrier strip (#6 screws).

Power

Power requirement: 115/230V AC (±15%), 50/60Hz, 30VA.

Connector: IEC mains connector.

Protection: Leakage to chassis <0.25mA at 115V, <0.5mA at 230V. AC power input is RFI-suppressed.

Fuse: Slo-Blo, 3AG ½-amp for 115V operation, or "T" type 250mA for 230V operation.

Physical

Dimensions: 19 inches (48.3 cm) wide, 7 inches (17.8 cm) high, 12.5 inches (31.2 cm) deep. Requires 4 EIA rack units.

Operating temperature range: 0–50°C (32–122°F).

Circuitry

Input Conditioning

High-pass filter: −0.5dB at 50Hz, with >30dB/octave roll-off below 50Hz. Includes deep notches at 34 and 23Hz to protect transmitter power supplies.

Low-pass filter: Rolls off frequencies above 5kHz at >24dB/octave.

Phase scrambler: All-pass network makes peaks more symmetrical to best utilize the capabilities of the processing.

Broad-band Compression

Range of compression: 25dB.

Compression ratio: >10:1.

Attack time: Approximately 200ms (when TIME CONSTANT switch set to SINGLE) *or* program-controlled (when TIME CONSTANT switch set to MULTI).

Release rate: Approximately 3dB/second (when TIME CONSTANT switch set to SINGLE) *or* program-controlled (when TIME CONSTANT switch set to MULTI).

Total harmonic distortion: Does not exceed 0.05% at any amount of gain reduction, 50–10,000Hz.

Noise: >85dB below output clipping level.

Gating: Gain reduction will slowly change to 10dB if input level drops below a user-adjusted threshold.

Receiver Equalization

Bass: Bell-shaped curve provides ±6dB symmetrical boost/cut. Peak frequency is 100Hz. Q is 0.7.

High-frequency: Four plug-in "personality modules" supplied.

The GREEN, YELLOW, and RED modules each provide a family of third-order shelving curves with adjustable (by HF EQ control) ultimate high-frequency boost. The BLUE module provides standard North American National Radio Systems Committee (NRSC) "modified 75µs" pre-emphasis.

Multi-band Limiting

Filters: 150Hz low-pass; 420Hz, 700Hz, 1.6kHz, and 3.7kHz; 6.2kHz high-pass. 18dB/octave selectivity, parallel topology.

Outputs of all filters combine to yield a static frequency response of ±0.5dB, 50–10,000Hz (disregarding other bandwidth-limiting filters elsewhere in the processor). Phase interaction between filters under program conditions will not cause audible dips in the frequency response.

Range of gain reduction: 25dB.

Attack time: Program controlled; adjusted according to band frequency.

Release time: Program controlled; adjusted according to band frequency.

Total harmonic distortion (each limiter): ≤0.1% for any frequency in the limiter's passband with any amount of gain reduction, provided signal is below the multiband clipper threshold.

Distortion cancellation: All clipper-induced distortion in upper three bands is canceled by >30dB below 1.8kHz. Additional distortion reduction is provided as a function of frequency in each band.

Noise (each limiter): >85dB below VCA output clipping level.

Hilbert-Transform Clipping

Harmonic Distortion: <2% THD introduced with single sinewave input 0–6dB clipping, 50–4,500Hz.

Attack Time: <10 µsec.

Release Time: essentially instantaneous.

Output Filtering

Filter characteristics: 4kHz, 4.5kHz, 5kHz, 5.5kHz, and 6kHz low-pass filters as ordered.

The spectrum at the output of the processor is guaranteed to meet the requirements of CCIR 328-5 regarding occupied bandwidth for a given specified cutoff frequency. Regardless of which filter is fitted, the spectrum is guaranteed to meet FCC 73.756(b) (U.S.A.).

Transmitter Equalization

Low-frequency tilt equalizer: Proprietary phase/magnitude compensation introduces adjustable positive-slope tilt to the output waveform to cancel normal negative-slope tilt in older transmitters. Independent control of very-low-frequency compensation avoids saturation and non-linear effects in transmitters with limited low-frequency power handling capacity.

High-frequency shelving equalizer: Adjustable breakpoint shelving equalizer creates controlled undershoots in high-frequency transient waveforms to prevent RF envelope overshoot due to excessive Q in transmitters, phasers, or antenna systems — or due to poor transient response in audio or modulator stages.

High-frequency delay equalizer: Selectively introduces added time delay into the spectrum to compensate for non-linear group delay in the transmitter/antenna system, thus optimizing transient response by creating approximately constant time delay at all frequencies within the audio bandwidth.

Controls: One set of low-frequency transmitter equalizer controls is provided. Eight separate sets of high-frequency transmitter equalizer controls enable switching between eight different high-frequency transmitter equalization set-ups. Switching can be effected by front panel switches or by remote control.

Warranty

One year, parts and labor: Subject to limitations set forth in our Standard Warranty. Factory assistance and service will be available throughout the life of the product.

All specifications subject to change without notice.

Circuit Description

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1. Overview

The block diagram on page 6-47 illustrates the following overview of 9105A circuitry.

The input signal is applied to an **RFI suppression network** and an **attenuation pad** (which can be strapped for 0 or 20dB attenuation). Then, the audio is applied to a low-noise true instrumentation **input amplifier** (gain is set with the INPUT ATTEN control). The level of the signal out of the amplifier determines the amount of gain reduction applied by the broad-band automatic gain control circuitry.

The signal is then applied to a **5kHz low-pass filter** to prevent out-of-band high-frequency energy from being processed, to protect the transmitter, and to minimize any potential intermodulation between in-band and out-of-band components. To make more efficient use of OPTIMOD-HF processing (and help achieve maximum loudness), asymmetrical signal waveforms are made more symmetrical with a **phase scrambler.**

A **50Hz high-pass filter** protects the transmitter, eliminates modulation-wasting subsonic energy from turntable rumble and other sources, eliminates distortion caused by modulation of the compressor control voltages by such subsonic energy, and filters out automation cue tones.

The input-conditioned audio drives the **broad-band automatic gain control** (AGC) circuit. The broad-band AGC helps achieve consistent sound (despite normal production variations and operator sloppiness) by compressing the dynamic range of program material. Because the broad-band AGC is not designed to produce significant augmentation of program density (the multi-band limiter does that), its attack and release times are either slow at all times, or slow except when large changes of level have occurred. Setting the TIME CONSTANT control to SINGLE selects the former (best for music and program with well-controlled levels), while the MULTI setting selects the latter (useful in talk and location material characterized by wide variations in input level).

Gating prevents audible noise pump-up. When the signal level into the broad-band AGC falls below the level set by the GATE THRESH control, the gain of circuit is held approximately constant. If the input level is below the gate threshold for more than a very brief time, the gain of the broad-band AGC will slowly move toward 10dB gain reduction (= 0 on the BROAD-BAND AGC G/R meter). The gating threshold level detector is limited to the 100–3000Hz band to prevent false ungating on noise.

The broad-band AGC's output drives the bass and high-frequency receiver equalizers.

The **bass equalizer** provides control of the amount of equalization (with the BASS EQ control). Range is ±6dB, peak frequency is 100Hz, and Q is 0.7.

The **high-frequency equalization** curve is determined by the pre-emphasis module installed on Card #4. The HF EQ control sets the amount of boost.

All 9105A OPTIMOD-HF units are shipped with the GREEN pre-emphasis module installed. The module produces a third-order pre-emphasis curve which complements the frequency response of an "average" HF radio. As determined by Orban's statistical studies of many representative radios, the "average" radio is well-modeled by a third-order (18dB/octave) Bessel (constant time-delay) low-pass filter with a −3dB frequency of 2.0kHz.

The effective bandwidth of the system (including 9105A and receiver) is adjusted with the HF EQ control. When the HF EQ control is set to its recommended "10dB" setting, the effective system bandwidth is extended from 2kHz to approximately 4kHz, significantly improving speech intelligibility.

Because some broadcasters may have different requirements or preferences, three other modules are supplied with the 9105A: RED, YELLOW, and BLUE. See page 3-12 for a description of these modules.

The **multi-band limiter** divides the signal into six frequency bands. (The gain reduction in band #6 is forced to track the gain reduction in band #5.) Since the average AM receiver is only flat to about 1.5–2kHz, the midrange is far more important in AM than in FM. OPTIMOD-HF's multi-band limiter is designed to give you precise and versatile control over midrange audio. This expanded control makes possible a more consistent, intelligible, and pleasing sound — even with widely varying program material. The multi-band limiter is particularly useful for correcting intelligibility problems with low-grade speech from telephone calls or other actualities.

The multi-band limiter is also an effective high-frequency limiter; the program-controlled release time circuitry permits as much as 25dB compression of a high-frequency band without audible side effects.

To permit large amounts of limiting without interaction and pumping, the multi-band limiter filters have been designed with 12dB/octave slopes. When the filters' outputs are summed after the following multi-band clipper (which contains further filtering), the resulting output is typically flat (±0.25dB) over the frequency range of the 9105A. These filters have been carefully designed to prevent audible "holes" in the frequency response from occurring in dynamic conditions.

Each filter is followed by its own limiter. Because the characteristics of these limiters are *extremely* critical to proper frequency response and inaudible operation, they are not user-adjustable. The DENSITY control sets the level of the signal going into the multi-band limiter. The CLIPPING control adjusts the threshold of limiting of all multi-band limiters simultaneously, which controls their output level and (therefore) the input level for the following multi-band clipper. Together, the DENSITY and CLIPPING controls determine the amount of multi-band limiting: turning the DENSITY control clockwise and/or turning the CLIPPING control counterclockwise will produce more limiting.

> Because it operates in several frequency bands, the multi-band limiter is capable of far more *fast* gain control without audible side-effects than is the broad-band AGC. The multi-band limiter can substantially improve the peak to average ratio of the signal *without* the spectral gain intermodulation effects which would result if only one limiter were used for the entire frequency spectrum.
>
> OPTIMOD-HF is fundamentally different from other multi-band audio processing systems because its multi-band section is primarily a *limiter*, not a *compressor*. Devices which attempt to compress audio with a multi-band AGC run a severe risk of causing unnatural frequency balances if their input levels are not well-controlled. This is because certain bands may exhibit heavy gain reduction while others may exhibit little or none. Heavily reducing the gain of some bands while others are not attenuated at all tends to overemphasize the unattenuated bands. To avoid such problems, average levels into the 9105A's multi-band limiter are controlled by the slow broad-band AGC.

The output of each of the six band-limiters is applied to a separate **distortion-canceling clipper**, followed by filters to reduce the out-of-band harmonic and intermodulation distortion caused by the clipping. In addition, high-frequency harmonic distortion caused by clipping the upper three bands is removed by a 4.5kHz low-pass filter, and is sharply canceled below 2kHz by a parallel feedforward distortion-canceling sidechain.

The distortion filtering and cancellation effectively reduces the peak-to-average ratio of the signal without distortion build-up due to clipping. The result is an extraordinarily favorable trade-off between loudness and distortion. Because the summed outputs of the six clippers can be applied to the Hilbert-Transform clipper for final peak limiting without the need for further broad-band gain control, potential pumping and modulation effects are avoided.

The signal is then applied to the **Hilbert-Transform clipper** to further reduce the peak-to-average ratio and control peaks without excessive distortion on voice.

> The Hilbert-Transform clipper is an analog computer that behaves like a radio-frequency (RF) clipper: it produces no harmonic distortion, only intermodulation distortion. Because speech is most severely degraded by harmonic distortion, not intermodulation distortion, the Hilbert Transform clipper can be driven significantly harder by a speech signal than could a conventional audio clipper before distortion becomes objectionable.

> Unlike a conventional RF clipper, the Hilbert-Transform clipper operates in two frequency bands: above and below 2kHz. Below 2kHz, special processing reduces distortion at the expense of a slight increase in overshoot. This two-band scheme makes the Hilbert-Transform clipper usable on music as well as speech — its subjective distortion on music is approximately the same as a conventional audio-frequency clipper, while its subjective distortion on speech is notably better.
>
> The Hilbert-Transform clipper contains a 5kHz low-pass filter that further improves the occupied bandwidth characteristics of the 9105A.

The Hilbert-Transform clipper is followed by a **safety clipper** to eliminate slight overshoots remaining in the output of the Hilbert-Transform clipper. After the safety clipper, a **supersonic non-overshooting low-pass filter** controls any potential adjacent-channel interference that might be caused by the safety clipper.

> Spectrum analysis confirms that OPTIMOD-HF meets all CCIR 328-5 and FCC 73.756(b) (U.S.A) occupied bandwidth requirements on the most severe program material we could find (certain heavily-equalized rock CDs).

The supersonic low-pass filter drives a three-stage **transmitter equalizer,** which predistorts the shape of the final-clipped waveform to compensate for non-flat response in the transmitter.

The first stage of the transmitter equalizer provides a shelving roll-off which will reduce or eliminate high-frequency roll-off in the vast majority of antenna/transmitter systems that have high-frequency roll-off problems. The second stage is an adjustable all-pass network which can add delay to improve the pulse response of transmitter/antenna systems with non-constant group delay. The third stage provides low-frequency tilt equalization by creating a *positive slope* tilt in the output waveform to cancel the negative-slope tilt introduced by many plate-modulated transmitters.

> There is only one set of low-frequency equalization controls because the low-frequency tilt performance of a given transmitter will not change with variations in antenna load. However, because the high-frequency overshoot and ringing *will* change, eight sets of high-frequency equalizer controls are provided. These define eight different high-frequency transmitter equalization presets, numbered 0 through 7 (shown on a front-panel numeric display). A preset can be chosen from the front panel by stepping sequentially through the presets with the momentary TX EQ PRESET switch, or by applying remote control signals to optically isolated rear-panel terminals. There are eight remote control terminals (plus a COMMON) available, permitting remote random access to the presets.

The **output line amplifier** is driven through the OUTPUT ATTEN control. The output of this balanced amplifier passes through an EMI filter before being presented at the output terminals on the 9105A's rear panel.

2. Input amplifier

Located on Card #4

The audio is applied to an RFI suppression network and to an attenuation pad (which can be strapped for 0 or 20dB attenuation). The RFI-suppressed audio is then applied to a low-noise true instrumentation amplifier with symmetrical, high-impedance + and − inputs. The gain of this amplifier can be adjusted from 0.88 to approximately 47 (a 34.5dB range). If this range does not yield the desired amount of gain reduction, the input attenuation pad should be re-strapped.

Because the input is DC-coupled, only small amounts of differential DC should be applied to the input. Since the input would typically be fed by the output of a transformer or capacitively-coupled amplifier, this should not be a problem. Slight amounts of DC offset are eliminated in the 50Hz high-pass filter that follows the input amplifier.

Component-level description:

The input is RF-filtered, then applied to 10K bridging pad R1, R3. Strapping R2 and R4 into the pad introduces 20dB attenuation (the 9105A is shipped with R2 and R4 strapped in).

The output of the pad is connected to low-noise true instrumentation amplifier IC13a, IC14a, IC14b, and associated resistors. R5, R6 provide bias current for IC14, which is a low-noise bipolar-input dual IC opamp. R7, R10 are feedback resistors for the two sections of IC14. The differential gain is controlled by the series resistance of R9 and INPUT ATTENuator control R8. The common-mode gain of the IC14 pair is 1.

The differential output of IC14a and IC14b is converted to a single-ended output: the common mode component of the output is nulled by differential amplifier IC13a and associated resistors.

Nearby lightning strikes may induce energy into OPTIMOD-HF's audio input that is sufficient to pass through the RFI protective networks and destroy IC14. If OPTIMOD-HF is installed in a lightning-prone location, keep spare NE5532 chips in stock. Installation of varistors between each side of the audio input lead and earth may help prevent such problems.

3. 50Hz High-pass Filter

Located on Card #4

The output of the input buffer is applied to a fifth-order elliptical high-pass filter with a 50Hz cut-off frequency (0.18dB down), 0.18dB ripple, and deep notches at 23 and 34Hz. This filter was not designed to be conveniently bypassed because it protects the transmitter from possible damage due to low-frequency overload, prevents introduction of distortion in transmitters (which could be exaggerated by the transmitter equalizer), eliminates modulation-wasting subsonic energy from turntable rumble and other sources, eliminates distortion caused by modulation of the compressor control voltages by such subsonic energy, and prevents loss of loudness in most receivers (which cannot reproduce audio below 50Hz).

Component-level description:

The 50Hz high-pass filter is an active-RC analog of a passive LC ladder filter, in which gyrators replace inductors. Such a passive filter would have five capacitors, two inductors, and two resistors. Capacitors C1, C2, C3, C5, C6 function exactly as they would in a conventional passive filter. IC12 (and associated circuitry) simulates one inductor and resonates with C3 at 23Hz; IC11 simulates the other inductor and resonates with C5 at 34Hz. R25 is the load resistor; the source resistor is the parallel combination of R15 and R16, which also serve as a voltage divider to reduce the signal level, protecting the opamps in the gyrators from overload. The filter is buffered by IC13b, which also makes up the gain lost in R15, R16.

4. Low-pass input Filter

Located on Card #4

The output of the input amplifier is applied to a fourth-order 5kHz low-pass filter, which prevents out-of-band high-frequency energy from being processed, and minimizes any potential inter-modulation between in-band and out-of-band components. This is particularly important if large amounts of high-frequency boost are employed in the following equalization circuitry.

To ensure maximally flat response from the entire OPTIMOD-HF system, the frequency response of the low-pass input filter has been designed to equalize frequency response losses in the various low-pass filters later in the system.

Component-level description:

The low-pass input filter consists of two cascaded, unity-gain, positive feedback active filters. The first (low-Q) section consists of IC10a and associated components. The second (high-Q) section consists of IC10b and associated components.

This type of active filter is described in many modern texts on active filter design (see, for example, chapter 6 of Wong and Ott: *Function Circuits.* McGraw-Hill, New York).

5. Phase Scrambler

Located on Card #4

The overload points of most HF transmitters are symmetrical — greater than 100% positive modulation is not possible due to government regulation and/or design limitations in high-power transmitters. To make best use of this symmetrical overload characteristic, OPTIMOD-HF phase-shifts asymmetrical input waveforms to make them symmetrical before any processing occurs.

OPTIMOD-HF accomplishes this with a combination of a first-order all-pass filter (phase-shifter) in series with a second-order all-pass filter in the multi-band crossover (see page 6-20). The crossover introduces further phase shift and completes the phase scrambling system.

The phase scrambler is a low-Q circuit that 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.

Component-level description:

The all-pass phase scrambler consists of two unity-gain phase-shift sections in series. Each has a flat frequency response, but a phase response that varies as a function of frequency.

The first section's phase response varies from 0° to 180° as a function of frequency. It consists of IC9a and associated components.

The second section's frequency response varies from 0° to 360° as a function of frequency. It consists of IC9b and associated components. Close matching of R35a and R35b is particularly important to ensure flat frequency response.

6. Broad-band Automatic Gain Control (AGC)

Located on Cards #2 and #6

Broad-band automatic gain control is provided by a feedback compressor, made up of a voltage-controlled amplifier (on Card #2) and associated control circuitry (on Card #6).

OPTIMOD-HF uses proprietary class-A voltage-controlled amplifiers (VCAs), operated as two-quadrant analog dividers 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. The output of the second block is a distortion-corrected *current* which is transfomed into the desired gain-controlled voltage by an opamp current-to-voltage converter. The VCAs produce less than 0.05% harmonic or intermodulation distortion; overload-to-noise ratio is approximately 90dB.

VCA output is applied to a control circuit. If the average output level of the VCA attempts to rise above a predetermined threshold, the control circuit decreases the gain of the VCA.

The output of the rectifier feeds a proprietary timing module which computes a control voltage for the VCA based on the rectified L+R signal. The dB-linear output of this module drives the linear-scale BROAD-BAND AGC G/R meter.

Compressor attack and release time-constants are controlled by the program material when the TIME CONSTANT switch is set to MULTI. When the switch is set to SINGLE, OPTIMOD-HF uses a 200ms attack and a 3dB/second release.

If the input signal falls below the level set by the GATE THRESHold control, release is slowed and re-directed toward 10dB gain reduction (= 0 on the BROAD-BAND AGC G/R meter). This level is detected by a band-limited peak detector circuit followed by a comparator. The output of the comparator activates a switching FET (to enable gating) and lights the GATE indicator on the front panel.

Component-level description:

Although only the broad-band AGC VCA on Card #2 is described here, the following discussion of VCA operation applies to VCA circuitry throughout OPTIMOD-HF.

If used alone, one of the paired gain-control blocks would introduce considerable distortion. Therefore, the first of the two matched blocks (IC12a) is used as the feedback element in a high-quality operational amplifier (IC11). The second of the matched blocks (IC12b) is then driven by the pre-distorted output of IC11.

The output of IC11 is first attenuated by R5, R6, C2, and then applied to the input of the feedback element IC12a. The output of IC11 is pre-distorted as necessary to force the current output of IC12a to precisely and linearly cancel the audio input into the virtual ground summing junction of IC11. This same pre-distorted voltage is also connected to the input of IC12b. The output of IC12b is therefore an undistorted current, which is converted to a voltage in current-to-voltage converter IC10a, R12, R13, C4. The output of IC10a is the output of the VCA.

Because IC12a is in the feedback loop of IC11, the gain of the VCA is *inversely* proportional to the gain of IC12a. So, if the control current is applied to the control port of IC12a (through R14), the VCA will behave like a two-quadrant analog *divider.*

A fixed current is applied to the control port of IC12b through R10 to set the gain of IC12b. R10 is fed by a +1.2V source (R76, CR7, CR8), common to all VCAs on a card (the diodes provide temperature compensation).

Second-harmonic distortion is introduced by differential offsets in either IC12a or IC12b. This distortion is canceled by a nulling voltage applied directly to the input of IC12b by resistor network R7, R8, R9.

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 the correct DC offset is applied to the VCA input, this equivalent DC multiplication can be nulled to zero, eliminating the thumps. An adjustable DC offset is provided by R3, R4.

Frequency-compensation components R2, C1 prevent the VCA from oscillating supersonically.

Because the basic current-controlled gain is inversely proportional to the control current, it must be transformed into a gain that is proportional to the control voltage (in dB). This is done in exponential current converter IC13a and associated components.

IC9a, IC9e, and associated components form a log/antilog multiplier that multiplies the current flowing through R75 by the exponential of the voltage on the base of IC9a. The current gain of the multiplier increases as the voltage on the base of IC9a becomes more positive.

The exponential-converter transistors for all of the VCAs on Card #2 are in monolithic array IC9. One transistor within this array (IC9e) is connected to the emitters of all the other exponential-converter transistors to provide a common reference. This reference (approximately −0.6V) is produced by forcing a constant current through IC9e. The voltage across R75 is held at 15V by the feedback action of IC8, which determines the current through IC9e and thus its base-to-emitter voltage. C16 prevents IC8 from oscillating.

CR5 protects IC9e from a reverse bias latch-up condition, which could zener IC9e's base-emitter junction and cause permanent damage.

The output current of the log/antilog multiplier appears at the collector of IC9a. Since it is the wrong polarity and level to correctly drive the control-current port of IC12a, it is applied to a current inverter (IC13a, Q1, R15, R16, C5) with a gain of 6.66×. A voltage proportional to the current output of IC9a is developed across R16, due to the feedback action of IC13a. C5 stabilizes IC13a against oscillations. Feedback forces IC13a's − and + inputs to the same voltage. Therefore, the voltage across R16 is the same as the voltage across R15, and current flows through R15 in proportion to the ratio between the values of R16 and R15. This current flows out of the + input line of IC13a into the emitter of Q1. Because Q1's base current is small compared to its emitter current, essentially the same current flows out of Q1's collector into the gain-control port of IC12a. Because Q1's base is grounded, its emitter sits at +0.6V. This forces both the + and − inputs of IC13a to sit at +0.6V also, ensuring correct bias voltage for IC9a's collector. CR1 protects Q1 from reverse base-emitter voltage, which could cause junction breakdown, leading to latch-up of the entire current-inverter circuit.

On Card #6, the broad-band VCA output is applied to full-wave precision rectifier IC4a and associated components. This circuit adds twice the inverted output of a precision half-wave rectifier to its input. The rectifier output is integrated by a proprietary timing module, which produces a control voltage for the broad-band AGC VCA on Card #2.

The threshold of compression is determined by R61 for the slow attack circuitry, regardless of the position of the TIME CONSTANT switch. The threshold for the fast attack circuitry (used only when the TIME CONSTANT switch is set to MULTI) is determined by R63.

When the PROCESSOR switch is set to AGC/CLIPPER DEFEAT, the proof bus is forced to +15V, and the thresholds of both the slow and fast attack circuits are raised by paralleling the threshold-determining resistors with resistors of lower value (R62 and R64). When the AGC/CLIPPER DEFEAT switch is set to NORMAL, the proof bus floats, and CR6 and CR7 isolate the circuitry from the proof bus.

The level-dependent gating is controlled by variable-gain amplifier IC12a and associated components. The low-frequency response of the gating level detector is rolled-off by C9; its high-frequency response is rolled-off by C8. Both roll-offs are at 6dB/octave. The output of IC12a is applied to peak detector (CR1, C10, R45), and the output of the peak detector is applied to comparator IC12b. The comparator threshold (and thus the threshold at which gating occurs) is determined by voltage divider R46, R47. Gating occurs when the output of IC12b goes negative, which lights the GATE indicator, and turns off the gate switching FET Q13 through CR3. When this occurs, the integration network within the module is disconnected from the main release circuit. Release is then determined by R48 and R49, which very slowly charge the release circuitry to a voltage corresponding to 10dB gain reduction. In non-gated conditions, the release time is determined by R50.

When the PROCESSOR switch is set to AGC/CLIPPER DEFEAT, the proof bus goes to +15V, forcing the input of IC12b positive and its output negative. This gates the broad-band AGC, forcing it to 10dB gain reduction.

7. Bass Equalizer

Located on Card #4

The bass equalizer provides a symmetrical bell-shaped equalization curve with a range of ±6dB centered at 100Hz with a Q of 0.7. Boost is created by summing the output of a bandpass filter with the filter's input; cut is created by placing the same filter in the feedback loop of the summing amplifier.

Component-level description:

IC4a and associated components are a non-inverting bandpass filter with a peak gain of 24dB at 100Hz. When the BASS EQ control is clockwise from its center detent, the input of the filter is fed directly from the equalizer's input. The output of the filter is summed with the equalizer's input in IC8b through R48, creating peak boost.

When the BASS EQ control is counterclockwise from its center detent, the input of the filter is fed from the output of IC8b. This places the filter in the feedback loop of IC8b, producing a symmetrical peak cut.

8. High-frequency Equalizer

Located on Card #4

To provide accurate equalization of a typical HF radio to a frequency determined by the HF EQ control, the high-frequency equalizer produces an 18dB/octave shelving boost when the GREEN, YELLOW, or RED modules are installed. When the BLUE module is installed, the high-frequency equalizer produces a 6dB/octave boost. A special filter introduces a controlled amount of positive feedback around an opamp to control the amount of boost.

The essential tuning elements are located in a plug-in resistor array.

Component-level description:

High-frequency equalization is realized by applying an adjustable amount of frequency-selective positive feedback around IC8b. Selectivity is provided by active filter IC8a and associated components. Tuning elements for the active filter are located in module R51 to permit simple re-tuning of the equalizer for different broadcast environments.

The amount of high-frequency equalization is adjusted by setting the amount of positive feedback with HF EQ control R50.

It is not possible to easily explain how this circuit generates its equalization curves; this must be left to a mathematical analysis.

9. Multi-band Limiter, Distortion-canceling Multi-band Clipper

(Overview) USA Patent #4,412,100

Because the multi-band limiter is so intimately connected with the multi-band clipper, they will be discussed together. Each limiter/clipper circuit is discussed in detail following these general comments.

OPTIMOD-HF incorporates Orban's patented multi-band limiter and distortion canceling multi-band clipper.

The signal for each channel is first divided into six frequency bands by a pre-compressor crossover. Each crossover filter then drives its own compressor/limiter, which in turn drives a clipper followed by a post-compressor filter. The characteristics of the pre- and post-compressor filters enable a very flat (±0.5dB) final summation of the bands.

The first-order filtered distortion induced by clipping in the upper three bands is derived by subtracting the clipper's output from its input, and then filtering this distortion signal with a filter identical to the post-crossover filter. The sum of these filtered distortion signals from the upper three bands is passed through a 2kHz low-pass filter.

Meanwhile, the clipped, filtered sum of all of the bands is passed through a phase-corrected 4.5kHz filter with a delay that matches that of the 2kHz low-pass filter. By then summing the outputs of the 4.5kHz and 2kHz filters, clipper-induced distortion below 2kHz (the average "flat" passband of an AM radio) is sharply canceled.

This approach reduces distortion much better than could simple first-order filtering after the clippers — effective selectivity is about 36dB/octave. The cancellation is particularly effective in eliminating the "ffff" sound characteristic of heavily clipped sibilance.

It should be noted that it is normal for *sine waves* to modulate less than 100% when the AGC/CLIPPER DEFEAT switch is set to NORMAL. There are two principal reasons for this:

- About 1dB headroom is left between the threshold of the Hilbert-Transform clipper and the threshold of the subsequent safety clipper to accommodate the distortion corrector signal produced by the dynamic operation of the Hilbert-Transform clipper. No distortion corrector signal is produced with sine waves, so the headroom is not used and full 100% modulation does not occur.
- Sine waves have a very low peak-to-average ratio and a high loudness potential compared to program material of identical peak levels. The audio processing, in order to maintain natural sound quality, pushes sine waves 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 sine waves tends to sound somewhat unnatural because it ignores this psychoacoustic factor.

10. Pre-compressor Crossovers

Located on Card #4

The 150Hz (band 1) low-pass crossover is a second-order 420Hz low-pass filter cascaded with a second-order 150Hz low-pass filter.

The 420Hz (band 2) bandpass crossover is a second-order 420Hz low-pass filter cascaded with a third-order 420Hz high-pass filter.

The 700Hz (band 3), 1.6kHz (band 4), and 3.7kHz (band 5) bandpass crossovers each consist of two cascaded, second-order stagger-tuned bandpass filters.

The 6.2kHz (band 6) high-pass crossover is a second-order 6.2kHz high-pass filter.

Bands 3, 4, 5, and 6 are fed from a first-order all-pass filter, which provides phase correction for the crossover summation.

Component-level description:

All filters are built with second-order sections of the type found in any modern text on active filter design (see, for example, chapter 6 of Wong and Ott: *Function Circuits*. McGraw-Hill, New York, 1976). Some filters are basically negative-feedback filters of the "multiple feedback" type; others are positive-feedback "Sallen and Key" type filters. The two types are mixed as necessary to achieve inverting (negative feedback) or non-inverting (positive feedback) responses.

11. Multi-band Limiter VCAs

Bands 1,3,5 located on Card #2; bands 2,4,6 located on Card #3

The VCAs in the multi-band limiter all have a potential gain reduction range of 25dB. See page 6-13 for a detailed discussion of VCA operation.

12. Multi-band Limiter Control

Located on Card #6

The output of each band's VCA feeds a voltage divider which, in turn, feeds a dual comparator IC. If the output of the voltage divider exceeds the threshold set by the CLIPPING control (±0.5V to ±1.0V), the comparator will produce an output pulse. This pulse is smoothed by the timing module to produce a control voltage that reduces the gain of the VCA. Therefore, the drive level to the clippers following the compressors and pre-emphasis/high-frequency limiters is determined by the CLIPPING control. Because the CLIPPING control simultaneously adjusts all comparator thresholds, it governs the average VCA output level in all bands.

Because of the previous 4.5 or 5kHz low-pass filtering, there is very little energy above 6kHz to activate a separate band limiter for the 6.2kHz band. Therefore, there is no separate control circuit for 6.2kHz band. Instead, the gain of the 6.2kHz VCA is made to track the gain of the 3.7kHz VCA.

This proprietary timing circuitry is located within sealed modules. It provides: 1) peak limiting with very fast recovery time for transient material; 2) slower compression with a recovery time that is a function of gain reduction; and, 3) recovery delay for smoothing of the gain control voltage to avoid low-frequency distortion even with fast release times.

The timing circuits process the signal in logarithmic form, and have low-impedance outputs. They drive exponential converters which provide control-current outputs for their respective VCAs.

Component-level description:

Because the control circuits for all multi-bands are identical (except for component values), only the control circuit for the 150Hz band (band 1) will be discussed in detail.

The output of the band 1 VCA is applied to voltage divider R1, R2. If the output of voltage divider R1, R2 exceeds the comparator threshold voltage generated by IC8 and associated circuitry, the NPN output transistor within IC1c, IC1d turns on, also switching Q2 on. (R5 determines Q2's collector current, which in turn determines the attack time.) Two factors thus determine the threshold of limiting : 1) the loss in voltage divider R1, R2 (the more loss, the higher the voltage at the VCA output before IC1c, IC1d turns on); and, 2) the threshold voltage applied to IC1c, IC1d by CLIPPING control R65. R65 adjusts this voltage from ±0.5 to ±1.0V — this changes the threshold of limiting, and thus the average output level of the band VCAs.

The timing module integrates Q2's collector current and produces a voltage which is buffered by unity-gain FET-input opamp IC3a. The output of IC3a is a dB-linear control voltage which determines the gain of the band VCA (in dB).

13. Post-compressor Crossover, Clippers, and Distortion-cancellation

Located on Card #7

The upper three bands are treated differently than the bottom two bands.

The objectionable distortion generated by the upper three (high-frequency) bands is, by and large, difference-frequency intermodulation *below* the frequency of the band in question. This is because *harmonic distortion* caused by clipping is radically rolled off by the "average" radio, which is only flat to about 2kHz. This roll-off also reduces the level of most of the fundamentals in the upper three bands, effectively amplifying the effect of the difference-frequency IM — which is *not* rolled off.

Difference-frequency IM due to clipping is canceled below 2kHz by a patented (USA #4,208,548) feedforward distortion-canceling sidechain. The output of each of the three upper bands is applied to two identical filters (one inverting and one non-inverting) with 6dB/octave slopes. The 6.2kHz band filter is high-pass; the others are bandpass.

A clipper is located before the inverting filter, so that the inverting filter filters the clipped signal, somewhat reducing out-of-band clipper-induced distortion.

The outputs of the inverting and non-inverting filters are added in the distortion-canceling summing amp. If no clipping occurs, the outputs of the inverting and non-inverting filters will cancel, and there will be no output from the distortion-canceling summing amp. If clipping does occur, the distortion-canceling summing amp's output will represent the difference between the clipper's input and output as filtered by the inverting filter. This difference is the distortion added by the clipper, passed through the 6dB/octave filter.

Since the upper three bands are all processed by the distortion-canceling summing amp, the output of this amplifier represents the sum of the filtered clipper-induced distortion produced by the three clippers in these bands. This signal is applied to the distortion-canceling filter, a 2kHz low-pass filter with constant delay.

Meanwhile, the outputs of just the inverting filters (containing the clipped, filtered outputs of the upper three bands) are summed into the band summation amplifier. The output of this amplifier is applied to the input of the 4.5kHz low-pass filter with constant delay.

The outputs of the 4.5kHz filter and 2kHz filter are summed. If only one band is passing signal, the clipper-induced distortion component which that band contributes to the 2kHz filter's output is equal to, and out-of-phase with, the same distortion component in the 4.5kHz filter's output. Thus, the distortion component is canceled by better than 30dB within the 2kHz bandwidth of the distortion-canceling filter. Because the 4.5kHz and 2kHz filters and the summation process are all linear, superposition holds and the distortion component in each of the three top bands is canceled — even when more than one band is active.

The two low-frequency bands are not processed by the distortion-cancellation sidechain because the objectionable distortion in these bands is not IM, but rather *harmonic* distortion *above* the frequency range of the bands. Simple low-pass filtering of the clipped signal can therefore be used to reduce distortion.

The 150Hz band's VCA is forced to clip slightly above the threshold of limiting to remove overshoots. This clipped signal is applied to a pair of cascaded, 6dB/octave low-pass filters before it is summed with the other bands in the band summation amplifier.

No distortion filtering is applied to the 700Hz band because difference-frequency IM distortion and harmonic distortion are more or less equally significant in the distortion spectrum produced by this band's clippers — neither type of distortion dominates the other.

Component-level description:

Band 5 (3.7kHz) is used as an example of a typical high-frequency band in the following.

The output of band 5's VCA is applied to 6dB/octave high-pass filter R19, R21, C11. Clipper diodes (CR5, CR6) embedded between R19 and R21 clip the output of the band VCA before it is applied to the high-pass filter. The clipped signal is also low-pass filtered by the feedback action of R23, C12 in association with IC2a (which inverts the signal). The output of IC2a is therefore the clipped signal, passed through a bandpass (high-pass cascaded with low-pass) filter with 6dB/octave skirts.

The output of band 5's VCA is also applied to passive RC bandpass filter R20, R22, R24, C9, C10. It can be shown that the frequency response of this filter is identical to the frequency response of IC2a and its associated filters. The output of this non-inverting passive filter is summed (through R24) with the output of IC2a (through R26) into the distortion-canceling summing amp (IC8a's) summing bus. When clippers CR5 and CR6 are non-conductive, total cancellation occurs (within the limitation of component tolerances), and no signal appears on the summing bus. When the clippers conduct, all signal is canceled except the distortion added by the clipping process, as filtered by IC2a and associated components. The output of IC2a is also summed (through R25) into the band summation amplifier, IC3a's summing bus.

The output of band 1's VCA is low-pass filtered by R1, R2, C1, and then mixed with the output of band 2 through R3. The sum is low-pass filtered again (through R4, R9, C2) before being applied to the + input of band summation amplifier IC3a.

The output of IC3a feeds a phase corrector (IC3b and associated components) for the following active, fifth-order, 4.5kHz (or other frequency as ordered) elliptical filter IC4, IC5 and associated components. IC3b has a flat magnitude response and a phase response which varies with frequency. The phase response is designed to equalize the phase response of the following low-pass filter to produce approximately constant time delay from 0 to 4.5kHz, thus minimizing overshoots in the 4.5kHz filter.

This filter is an active-RC analog of a passive LC ladder filter. It is realized by means of resistors, capacitors, and Frequency-Dependent Negative Resistors (FDNR's). An FDNR is realized by means of a dual opamp, three resistors, and two capacitors. When the passive LC filter is transformed into an active RC filter, inductors become resistors, resistors become capacitors, and capacitors become FDNR's.

The FDNR's each resonate with a series resistor to create a notch in the frequency response of the filters. (This is analogous to a series L-C circuit to ground.) The notches are located in the "stopband" (beyond approximately 5.8kHz). If the standard 4.5kHz filter is fitted, the circuit associated with IC4 produces a notch at 8.53kHz ±4%, while the circuit associated with IC5 produces a notch at 5.94kHz ±4%. Measuring the frequency of these notches and their depth provides the best way of diagnosing problems with such filters, since problems with a given notch can be associated with a given FDNR in most cases.

To avoid possible clipping, the signal is attenuated by 6.9dB by voltage divider R37, R38 before being applied to the filter. This gain is made up by IC7b to restore unity gain at low frequencies.

Meanwhile, the output of distortion-canceling summing amp IC8a feeds a 2kHz low-pass filter (IC7a, IC8b and associated components) with amplitude and phase response that match those of the fifth-order 4.5kHz low-pass filter and phase corrector IC3b through 2kHz. R54, R55, R56, C24 give IC8a an overall shelving boost which helps match the amplitude and delay of the fifth-order 4.5kHz low-pass filter and phase corrector. The output of the 2kHz distortion-canceling low-pass filter is summed with the output of the main phase corrector in summing amplifier IC7b and associated components.

The output of IC7b is the distortion-canceling sum of the multiple bands. Its bandwidth is limited to 4.5kHz. It contains substantial overshoots which are ordinarily removed in the following Hilbert-Transform clipper.

14. Hilbert-Transform Clipper

USA patent #4,495,643 Located on Card #5

Further peak limiting to achieve most efficient modulation is provided by Orban's exclusive Hilbert Transform Clipper. This circuit behaves like a single-sideband RF clipper, but with distortion cancelation. An RF clipper produces no harmonic distortion — only intermodulation distortion. Thus voice (which is far more degraded by harmonic than by intermodulation distortion) is processed as cleanly as possible. A crossover eliminates almost all distortion of *any* type below 2kHz — at the expense of a certain amount of overshoot, which is eliminated by the subsequent safety clipper.

The signal into the Hilbert Transform Clipper is split into two paths: each path consists of a chain of phase-shift networks. The two chains are designed so that the phase difference between their outputs is 90° from 30Hz to 6kHz.

The outputs of the two chains are each applied to matched frequency-dependent clippers. These clippers act only on low frequencies, constraining them to be several dB below 100% modulation, thus preventing excessive IM between the low frequencies and high frequencies in the Hilbert-Transform clipper's control circuitry, or in the final safety clipper.

The outputs of the two clippers are applied to a vector sum generator, which computes the square root of the sum of the squares of the two outputs. The output of the vector sum generator is applied to the control ports of both a high-frequency VCA and (through a delaying low-pass filter) a low-frequency VCA. The output of the main phase-shifter chain is applied to the audio input of the high-frequency VCA and (through a low-pass filter) to the audio input of the low-frequency VCA. The control voltage and audio to the low-frequency VCA are therefore delayed equally.

If a sine wave is applied to the input of the Hilbert Transform Clipper, the output of the vector sum generator is ideally DC without ripple, the control voltage to the VCAs is constant, and no distortion is produced by the action of the VCAs. However, when more complex waveforms are applied, ripple does occur in the control voltage, producing intermodulation distortion — but no harmonic distortion. (Due to circuit tolerances, the actual sine wave THD produced is typically 1-2% up to 10dB clipping.)

The output of the high-frequency VCA is accurately peak-limited without overshoots regardless of its input spectrum, provided only that the phase difference between the inputs to the vector sum generator is 90° over the frequency range in which both chains have substantial output energy (i.e., below 6kHz). However, the control voltage to the low-frequency VCA is smoothed by the low-pass filter prior to its control port. Accordingly, little audible distortion is produced by this VCA, but smoothing its control voltage does cause some overshoots in its output.

Component-level description:

The main path consists of all-pass filters IC5a, IC4a, and associated components. The other path is made up of all-pass filters IC5b, IC4b, and associated components. The signal at pin 1 of IC4a and the signal at pin 7 of IC4b should have identical levels (±0.2dB) and a 90° phase difference (±2.5°) in the range 30–6000Hz.

(The existence of the 90° phase difference can be checked with a Lissajous pattern displayed on an oscilloscope. If the oscilloscope X and Y inputs are connected to the two pins mentioned above, a circle on the screen indicates an accurate 90° phase relationship between the two chains.)

The outputs of the phase-shifter chains are applied to clipper/filters IC3a, IC2a, and IC3b, IC2b. (We will describe only the IC3a, IC2a circuit, as the IC3b, IC2b circuit is identical.) The output of IC3a represents its input signal filtered at 200Hz (−3dB) with a slope of 6dB/octave. This filtered signal is applied to clipper R21, CR1, CR2. The output of the clipper is applied to a second 200Hz low-pass filter R22, R23, C7 to attenuate harmonics produced by clipping. The output of this second low-pass filter is summed with the output of a 12dB/octave 200Hz high-pass filter (produced by subtracting IC3a's input from its output and applying the difference to C6) in IC2a. It can be shown that the output appearing at pin 1 of IC2 has a flat frequency response. However, its peak level is constrained below 200Hz by the action of CR1, CR2.

The output of IC2a is full-wave rectified by precision rectifier IC1a, IC7b and associated components. The output of the IC2b is full-wave rectified by precision rectifier IC1b and associated components. These two rectified outputs are applied to a vector sum generator using a single log-antilog XY/Z multiplier/divider IC6. The vector sum (i.e., the square root of the sum of the squares of the two rectified inputs) is computed by the "implicit" technique, using feedback (see Wong and Ott: *Function Circuits*. New York, McGraw-Hill, 1976, p. 206).

The vector sum is developed at pin 3 of IC7a. In addition, a threshold voltage (−2 volts when no input signal is present) is added in through R71 and RATIO trimmer R70. IC7a serves as a threshold amplifier. If the instantaneous input level to the Hilbert Transform Clipper is below 2.0V peak, the sum of the output of the vector sum generator and the threshold voltage will drive the output of IC7a (at pin 1) to the negative rail (due to its nominal non-inverting gain of 6.9), and CR9 will be off. In this case, the gain of high-frequency VCA IC14a, IC17, IC18a and associated components, is determined by the *current* flowing through the sum of R64, R65, and R66. This current is constant because IC7a has been effectively disconnected when CR9 is off.

When the input to the Hilbert Transform Clipper exceeds 2V peak, the voltage on pin 5 of IC7a becomes more positive than −1.45V, and IC7a comes out of saturation, turning CR9 on and taking control of the high-frequency VCA control current. This current is determined by the voltage drop across R66. Normally, pin 6 of IC17b sits at approximately −13.5V, so the control current is determined by the voltage at the cathode of CR9. Proof mode is entered by turning Q3 on, which parallel R71 and RATIO trimmer R70 with R72 to increase the threshold.

The output voltage of IC7a (at the cathode of CR9) is buffered by IC12a and applied to second-order unity-gain constant-delay low-pass filter IC13b and associated components. IC13b drives R69, which has a value equal to that of R66. This ensures equal currents flow through R69 and R66 under steady-state conditions, so that R69 and R66 apply equal gain-control currents to the high-frequency VCA and to the low-frequency VCA IC14b, IC8, IC9b, and associated components. For a description of the operation of the high-frequency and low-frequency VCAs, see page 6-13. The input to the low-frequency VCA is processed by low-pass filter IC13a, IC9a and associated components. This filter is normally down 3dB at approximately 2kHz and exhibits a deep notch at 5.0kHz.

The output of the high-frequency VCA drives a constant-delay band-pass filter which is created by subtracting the output of a 2kHz low-pass filter IC18b, IC19b, and associated components from the output of a 4.5kHz low-pass filter IC10, IC15, IC19a, and associated components. (The 2kHz low-pass filter is identical to the IC13a, IC9a low-pass filter associated with the low-frequency VCA.) The 4.5kHz low-pass filter is phase-corrected with IC16b and associated components. It is an active RC analog, created with FDNRs, of a passive LC filter (see page 6-20). The notch associated with IC10 is at 9.02kHz ±4%; the notch associated with IC15 is at 6.56kHz ±4%. The band-pass filter created by the subtraction has a passband from 2kHz to 4.5kHz, thus filtering out any IM distortion below 2kHz that appears at the output of the high-frequency VCA.

Meanwhile, the output of the low-frequency VCA is summed with the output of the high-frequency signal path in IC16a. If the gains of the low-frequency and high-frequency VCAs are identical (which they are in steady state), then the contributions of the two matched 2kHz low-pass filters are equal and opposite, and cancel at IC16a. Under these conditions, the frequency response of the Hilbert-Transform clipper is simply that of the 4.5kHz low-pass filter.

If the gains of the low-frequency and high-frequency VCAs are different (which they usually are under program conditions due to smoothing of the low-frequency VCA control voltage in IC13b), then the contributions of the two 2kHz low-pass filters no longer cancel exactly. The incomplete cancelation adds extra peak level at the Hilbert-Transform clipper output, which can be considered to cancel distortion. This extra level is generally less than 1dB, and is taken into account by leaving 1dB headroom in the following safety clipper.

R130, R131, C41 introduce a shelving roll-off into the 4.5kHz low-pass filter signal path. This helps the amplitude and phase response of the 4.5kHz filter match the response of the 2kHz filter to achieve most effective subtraction. A complementary shelving boost in IC16a restores flat response.

The BYPASS mode turns switching FET Q4 on and, through inverter Q7, turns Q5, IC8a and IC17a off, interrupting the normal signal path and turning on the signal introduced at the BYPASS input of Card #5 (pin 21).

15. Square Wave Generator

Located on Card #5

The square wave generator provides a convenient source of square waves for testing the square wave response of the transmitter and antenna system. See page 2-12 for details.

Component-level description:

When S1 is switched to SQUAREWAVE, it enables squarewave generator IC20 and associated components. The section of S1 associated with IC16a defeats the shelving response of IC16a when S1 is switched to SQUAREWAVE, ensuring that the squarewave will have an accurate shape. IC20a is an integrator charged from the output of IC20b, which acts as a comparator. Positive feedback from the output of IC20a causes the comparator to abruptly change state each time the output of IC20a reaches approximately ±10V. The output of IC20a is thus a triangle wave and the output of IC20b is a squarewave. The frequency of oscillation is adjusted by setting the integrator time constant with R141 (SQUAREWAVE FREQUENCY). R139 (SQUAREWAVE INJECTION LEVEL) is a trimmer that allows the user to change the percentage modulation produced by the squarewave according to his needs.

IC11a is a DC servo amplifier which eliminates any DC offset at the output of the Hilbert-Transform clipper. It works in both the NORMAL and SQUAREWAVE modes.

16. Safety Clipper

Located on Card #7

The safety clipper provides final peak limiting. Realized with biased Schottky diodes, it is an extremely "hard" clipper that produces substantially less intermodulation distortion than the "soft" safety clippers often used in audio processing equipment. Further clipping (particularly soft clipping) should **not** be added to the system after OPTIMOD-HF output — it will cause the sound to become less defined and much more fatiguing, and, by generating spurious harmonics, will also destroy the effective bandwidth-limiting achieved by the OPTIMOD-HF system.

Component-level description:

Clipping is achieved with shunt clippers CR9, CR10, as buffered by IC11a. CR9, CR10 are biased by ±4.1V sources, realized by IC9 and associated circuitry. R70, R71 serve as a reference voltage divider of the +15V power supply. The voltage at the junction of R70 and R71 is equal to the clipping threshold, which is approximately ±4.5V peak.

Temperature compensation for the clipping diodes is supplied by CR11 and R72. The voltage at IC9a's + input varies according to the voltage drop across CR11, thereby achieving a constant threshold of clipping regardless of temperature variations in the turn-on voltage of CR9, CR10.

The −4.1V is created by "amplifying" the +4.1V supply in unity-gain inverter IC9b, R73, R74.

The multi-band clippers are biased by IC10, which has circuitry topologically identical to the ±4.1 supply discussed immediately above.

To defeat clipping when the PROCESSOR switch is set to AGC/CLIPPER DEFEAT, the ±4.1V and ±1.8V are driven to approximately ±14V by CR12 and CR14. These diodes are connected to the proof bus, which floats when the PROCESSOR switch is set to NORMAL, and is connected to the +15V supply in when the PROCESSOR switch is set to AGC/CLIPPER DEFEAT.

17. Supersonic Low-pass Filter

Located on Card #7

The safety clipper ordinarily provides almost no clipping because the peak control in the earlier Hilbert-Transform clipper is highly effective. However, because of the overshoot mechanisms inherent in the Hilbert-Transform clipper, occasional overshoots do reach the threshold of the safety clipper, producing harmonics. Such harmonics must be attenuated to permit correct control of output spectrum. This attenuation is accomplished with the supersonic third-order non-overshooting low-pass filter located after the safety clipper. This filter is down approximately 3dB at 8.3kHz and rolls off smoothly thereafter with an ultimate slope of 18dB/octave. It is realized as a unity-gain, positive feedback, single-amplifier, active filter.

Component-level description:

For further discussion of filter topology, see Wong and Ott's *Function Circuits* (McGraw-Hill, New York, 1976).

18. Transmitter Equalizer, Switching

Located on Card #8

The transmitter equalizer is organized in three stages:

The first stage is an adjustable first-order all-pass network. If the transmitter/antenna system has non-constant group delay, this all-pass network can add delay as necessary to make the delay more constant, thereby improving the pulse response.

The second stage provides a 2.5dB shelving roll-off. The initial frequency of operation can be adjusted from approximately 500Hz to beyond OPTIMOD-HF's passband. This shelving roll-off will reduce or eliminate high-frequency roll-off in the vast majority of antenna/transmitter systems that have high-frequency roll-off problems. The shelving roll-off is created differentially by subtracting the output of an adjustable high-pass filter from the main signal.

The third stage provides low-frequency tilt equalization by creating a *positive slope* tilt in the output waveform to cancel the negative-slope tilt introduced by most transmitters. Control is provided over both the frequency at which the correction first begins to take effect (set by the LF BREAKPOINT control), and the ultimate amount of low-frequency correction (set by the LF BOOST control).

A single TX EQ switch activates or defeats both the low-frequency and high-frequency equalizers.

There is only one set of low-frequency equalization controls because the low frequency tilt performance of a given transmitter will not change with variations in antenna load. However, because the high-frequency overshoot and ringing *will* change, eight sets of high-frequency equalizer controls are provided. These define eight different high-frequency transmitter equalization presets, numbered 0 through 7. A front-panel numeric display shows the preset # in use. A preset can be chosen from the front panel by stepping sequentially through the presets with the momentary TX EQ PRESET switch, or by remote control signals through optically isolated rear-panel terminals. There are eight remote control terminals (plus a COMMON available, permitting remote random access to the presets.

Component-level description:

High-frequency delay equalization is provided by first-order all-pass network IC5a and associated components, which subtract the output of a high-pass filter (formed by C5 and its load resistors R101-R108) from the main signal. The time constant (and thus the frequency at which the phase shift is 90°) is determined by the RC product of C1 and its loading resistors. One of eight different time constants is selected by turning on switching FETs Q101-Q108 by applying 0V to their gates. The FETs are off when −15V is applied.

High-frequency shelving equalization is created through a similar subtraction, but only a fraction of the output of the high-pass filter is subtracted from its input.

Low-frequency tilt equalization is created inside a sealed, proprietary circuit module. It is controlled by the LF BREAKPOINT and LF BOOST controls, which are not switched.

Logic circuits determine which of the eight sets of high-frequency transmitter equalization controls is active. Input to this logic is from the TX EQ PRESET switch, the remote control terminals, or the power-up initialization circuit. The eight remote control lines are applied to Schmitt triggers IC3, IC11 to sharpen-up the logic transitions applied to the input opto-isolators. Current-limiting and RF suppression are provided by resistors and feed-through capacitors within the filter box; rectification for AC control signals is provided by CR1.

The outputs of the Schmitt triggers are applied to an 8-bit priority encoder IC8 which translates the eight inputs into a 3-bit binary word (if more than one input is active, the lowest-numbered input takes control). When any input to IC8 is active, it forces the PRESET ENABLE input of IC4 HIGH, reading the output word from IC8 into IC4. Delay lines R9, R10, R11, C1, C2, C3 hold IC4's output word valid until the PRESET ENABLE function in IC4 turns off, following removal of an input signal to IC8. IC12 decodes the output word of IC4 to eight lines which drive the eight TX EQ preset switching FETs.

R12, C4, IC3 are a circuit that resets the equalizer preset to "0" on power-up.

The rest of the TX EQ logic circuitry is on the meter card. IC1 decodes the output word of IC8 (on Card #8) and drives the front-panel seven-segment LED display. IC2 is an RS flip-flop that de-bounces front-panel TX EQ PRESET control and provides a clock pulse at pin 1 each time the TX EQ PRESET is toggled. Each such clock pulse forces the output word of IC4 up by one count. If S5 (NORMAL/LOCKOUT) is in the LOCKOUT position, it removes drive voltage from all front-panel logic-setting switches.

The SYSTEM NORMAL/BYPASS and PROCESSING PRESET switching is also driven by logic circuits on Card #8. Because the SYSTEM NORMAL/BYPASS and PROCESSING PRESET logic circuits are identical, only the SYSTEM NORMAL/BYPASS circuit will be detailed.

NAND gates IC17a and IC17b are cross-coupled to form a bistable multivibrator (flip-flop). This bistable changes state when the SYSTEM NORMAL/BYPASS switch is flipped or the transistor in one of the input optoisolators turns on and pulls its collector down to −15V. The NORMAL (high) output of the bistable is the output of IC17b. IC18a is an inverting buffer, which buffers the NORMAL and BYPASS LED drive circuit. IC18b inverts and buffers the NORMAL line to provide a BYPASS logic drive to Card #5.

Remote control pulses applied to the rear-panel terminals are routed through opto-isolators IC19 (NORMAL) and IC20 (BYPASS). Current-limiting and RF suppression are provided by resistors and feed-through capacitors within the filter box; rectification for AC control signals is provided by CR3.

Initialization circuit CR4, C9, R45, R46 ensures that the system always powers up in NORMAL mode. Upon power-up, the transition of the negative power supply from 0V to -15V is coupled through C11 and CR2 to IC17b. In steady-state conditions, R45 pulls the cathode of CR4 up to 0V. CR4 then effectively disconnects the power-up circuitry.

19. Balanced Line Amplifier

Located on Card #8

The line amplifier consists of a OUTPUT ATTENUATOR control, buffered by a non-inverting amplifier which drives **an output module.** This module converts the unbalanced single-ended signal to a balanced, floating output. Output impedance is 30 ohms, ±5%.

Simpler "electronically-balanced to ground" output stages can cause problems because grounding one side of their outputs to unbalance them will short an output amplifier to ground. In contrast, the 9105A output stage is balanced and *floating*, so it simulates a **true transformer output**. Because the output is floating, either side can be grounded to obtain an unbalanced output. When either side is grounded, the overall output level changes very little (less than 0.5dB), and no ill effects occur. The output of the 9105A can be freely connected to a **patch bay** without concern that problems may occur if one side of the output is grounded.

Component-level description:

The 411 opamp used in the balanced output module is a **low-offset servo amplifier** which centers the DC level at the output of the module around ground. The floating characteristic is achieved by complex cross-coupled positive and negative feedback between two 5532 opamps, and its operation is not readily explainable except by a detailed mathematical analysis. Opamps may be replaced; resistors are specially matched and should not be replaced (see page 5-12).

The output amplifiers are isolated from the outside world by LC RFI filters, which are effective at both AM and FM frequencies. When properly loaded, these filters will not introduce ringing or overshoot.

20. Power Supplies

Mostly located on Card #PS

Most power for 9105A circuitry comes from a highly regulated ±15-volt power supply. The main supply is +15 volts, created by a 723C IC regulator with current-boosted output, current limiting, and over-voltage protection using a zener diode and fast-blow fuse.

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

Component-level description:

The unregulated power supply (mounted inside the chassis, but outside of the RF-tight enclosure) is wholly conventional. It consists of dual-primary transformer T101, two full-wave rectifiers (CR101, CR102 and CR103, CR104), and two energy storage capacitors (C101 and C102).

T101's primary can be configured for 115-volt operation by paralleling its two primaries, or for 230-volt operation by connecting its two primaries in series (with a switch). RF filtering is provided on the AC line by FL101. In addition, C103, C104, C105, C106, C107, L101, L102 filter RF from the unregulated DC supply lines as they enter the chassis. The chassis is divided into three major sections to facilitate RF suppression. 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 free from RF. The RF shielding box on the rear panel, which interfaces the audio input and output lines with the outside world, contains the input pads — its connections to the main RF-tight compartment are all RF-filtered.

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

IC101 contains a reference voltage source, an opamp (externally compensated by C109 to prevent oscillation), and a current-limiting transistor. The reference voltage (nominally +7.15V) is developed at pin 6. C108 filters high-frequency noise from the reference voltage, which is directly connected to the non-inverting input (pin 5) of the internal opamp. Voltage divider R105, R106, R107 develops a precise fraction of the output voltage of the regulator at the wiper of +15V ADJUST trimmer R106. The wiper of R106 is connected to the inverting input of IC101's internal opamp. Negative feedback forces the voltage at R106's wiper to be equal to the reference voltage, so 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 ¾-amp, the voltage drop is sufficient to turn on the current-limiting transistor inside IC101. Since this transistor's base-emitter junction is connected to pins 2 and 3 of IC101, it 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-blow fuse F102. If 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. Ordinarily, this current will blow F102 and disconnect the circuitry from the unregulated supply before VR101 is damaged. VR101's clamping action will also prevent the negative tracking supply from exceeding −16.5

volts. When the regulator is operating properly, the current-limiting circuitry will prevent F102 from blowing even if the regulator output is short-circuited. (In certain unusual circumstances, the current-limiting circuit may still work, even though the regulator has lost control of its output voltage. If this occurs, F102 will not blow, and VR101 will overheat and burn out. Because its failure mode is a short-circuit, VR101 will still protect the OPTIMOD-HF circuitry even in this exceptional circumstance.)

The −15-volt regulator (located on Card #PS) is an opamp that contains a discrete power-booster output stage with current-limiting. It "amplifies" the output of the +15-volt regulator by −1 to produce a −15-volt tracking supply. Shutdown of the +15-volt supply (due to current-limiting conditions or to a fault which blows F102) will also result in shutdown of the −15-volt supply. The basic opamp is IC102. Its input resistor R109 and feedback resistor R108 are of equal valued, resulting in a gain of −1 ±2%. IC102's negative supply comes from the *unregulated* −22-volt supply. The common-mode range of IC102 includes its positive power supply, which permits operation with the chip's positive supply at ground. In normal operating conditions, the IC102's +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 ¾-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-limiting transistor. If the −15-volt supply is called upon to deliver more than ¾-amp, a 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 burn-out (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.

Zener clamp VR102, CR106, and fuse F103 protect the rest of the circuitry from a catastrophic failure of the −15-volt regulator. The operation of this circuit is identical to the operation of the corresponding circuit in the +15-volt regulator.

Parts List

Because special or subtle characteristics of certain components have been exploited to produce an elegant design at a reasonable cost, *it is unwise to make substitutions for listed parts*. Consult with Orban Customer Service (see page 5-14) if the parts list indicates that a part is specially selected, or that realignment is required when the part is replaced.

Orban maintains an inventory of tested, exact replacement parts that can be supplied quickly at nominal cost. Spare parts kits are also available. When ordering parts from Orban, please be ready to supply the following information:

Orban part number
Reference designator (e.g., C3, R78, IC14)
Description of part
Model, serial, and M number of unit — see rear-panel label
    (not all units have M numbers)

Parts are listed by card or assembly (except for widely used common parts, which are described on the following page), and the parts on each card are grouped by type. See the assembly drawings for locations of components.

To facilitate future maintenance, we have used components from well-established manufacturers with worldwide distribution whenever possible. The abbreviations used for manufacturers are listed on page 6-44, along with their USA headquarters addresses.

Widely used common parts:

Diodes: Unless specified by reference designator in the following, all signal diodes are 1N4148 (Orban part number 22101-000). This is a silicon, small-signal diode with ultra-fast recovery and high conductance. It may also be replaced with 1N914 (BAY-61 in Europe). (BV: 75V min. @ I_r = 5V, I_r: 25nA max. @ V_r = 20V, V_f: 1.0V max. @ I_f = 100mA t_{rr}: 4ns max.)

Resistors: Resistors should only be replaced with the same style and with the *exact* value marked on the resistor body. If the value marking is not legible, check the schematic or contact Orban Customer Service (see page 5-14). Performance and stability will be compromised if you do not use exact replacements.

Unless specified by reference designator in the following, the resistors in this unit are:

Metal film resistors with conformally-coated bodies, value identified with five color bands or printed on body; rated ⅛-watt @ 70°C, with a ±1% tolerance, and with a temperature coefficient of 100 PPM/°C; Orban part numbers 20038-xxx through 20045-xxx, USA Military Specification MIL-R-10509 style RN55D, manufactured by R-Ohm (CRB-1/4FX), TRW/IRC, Beyschlag, Dale, Corning, Matsushita,

Carbon film resistors with conformally-coated bodies, value identified with four color bands; rated ¼-watt @ 70°C, with a tolerance of ±5%; Orban part numbers 20001-xxx, manufactured by R-Ohm (R-25), Piher, Beyschlag, Dale, Phillips, Spectrol, Matsushita,

Carbon composition resistors with molded phenolic bodies, value identified with four color bands; rated 1/4-watt for the 0.09 × 0.25-inch (2.3 × 6.4mm) size, and rated 1/8 watt for the 0.14 × 0.375-inch (3.6 × 9.5mm) size @ 70° C, with a tolerance of ±5%; Orban part numbers 2001x-xxx, USA Military Specification MIL-R-11 style RC-07 or RC-20, manufactured by Allen-Bradley, TRW/IRC, Matsushita,

Cermet trimmer resistors with 3/8-inch (9mm) square bodies, value printed on side; rated 1/2-watt @ 70°C, with a tolerance of ±10%, and a temperature coefficient of 100 PPM/ °C; Orban part numbers 20510-xxx and 20511-xxx, manufactured by Beckman (72P, 68W-series), Spectrol, Matsushita.

CARD #2/3

Capacitors

REF DES	DESCRIPTION	ORBAN P/N	VEN (1)	VENDOR P/N	ALTERNATE VENDORS (1)	NOTES
C1	Mica, 500V, 5%; 150pF	21020-115	CD	CD15-FD151J03	SAN	Not loaded on Card #3
C2	Mica, 500V, +1/2pF -1/2pF; 5pF	21017-005	CD	CD15-CD050D03	SAN	Not loaded on Card #3
C3	Met. Polyester, 100V, 10%; 0.1uF	21441-410	WIM	MKS-4100V5.0.1	WES,SIE	Not loaded on Card #3
C4	Mica, 500V, 1%; 100pF	21018-110	CD	CD15-FD101F03	SAN	Not loaded on Card #3
C5	Mica, 500V, +1/2pF -1/2pF; 10pF	21017-010	CD	CD15-CD100D03	SAN	Not loaded on Card #3
C6	Met. Polyester, 100V, 10%; 0.1uF	21441-410	WIM	MKS-4100V5.0.1	WES,SIE	
C7,8	Mica, 500V, +1/2pF -1/2pF; 10pF	21017-010	CD	CD15-CD100D03	SAN	
C9	Met. Polyester, 100V, 10%; 0.1uF	21441-410	WIM	MKS-4100V5.0.1	WES,SIE	
C10,11	Mica, 500V, +1/2pF -1/2pF; 10pF	21017-010	CD	CD15-CD100D03	SAN	
C12	Mica, 500V, +1/2pF -1/2pF; 5pF	21017-005	CD	CD15-CD050D03	SAN	
C13	Met. Polyester, 100V, 10%; 0.1uF	21441-410	WIM	MKS-4100V5.0.1	WES,SIE	
C14,15	Mica, 500V, +1/2pF -1/2pF; 10pF	21017-010	CD	CD15-CD100D03	SAN	
C16	Met. Polyester, 100V, 10%; 0.0022uF	21441-222	WES	160C 222K1000	SIE,WIM	
C17,18	Alum., Radial, 25V, -20% +100%; 100uF	21206-710	PAN	ECE-A1EV101S		
C19,20	Monolythic Ceramic, 50V, 20%; 0.1uF	21123-410	SPR	1C25 Z5U104M050B	KEM	
C21,22	Monolythic Ceramic, 50V, 20%; 0.1uF	21123-410	SPR	1C25 Z5U104M050B	KEM	Not loaded on Card #3

Integrated Circuits

REF DES	DESCRIPTION	ORBAN P/N	VEN (1)	VENDOR P/N	ALTERNATE VENDORS (1)	NOTES
IC1	Linear, Dual Opamp	24206-202	TI	TL072CP	MOT	
IC2	Linear, Dual Opamp	24208-303	ORB	CA3280AG Selected		3
IC3	Linear, Dual Opamp	24209-202	NAT	LF412CN		
IC4	Linear, Dual Opamp	24206-202	TI	TL072CP	MOT	
IC5	Linear, Dual Opamp	24208-303	ORB	CA3280AG Selected		3
IC6	Linear, Dual Opamp	24207-202	SIG	NE5532N	TI,EXR	
IC7	Linear, Dual Opamp	24208-303	ORB	CA3280AG Selected		3
IC8	Linear, Dual Opamp	24209-202	NAT	LF412CN		
IC9	Multiple FET	24402-302	NAT	LM3046N	RCA	
IC10	Linear, Dual Opamp	24206-202	TI	TL072CP	MOT	Not loaded on Card #3
IC11	Linear, Single Opamp	24014-202	SIG	NE5534N	TI	Not loaded on Card #3
IC12	Linear, Dual Opamp	24208-303	ORB	CA3280AG Selected		3, Not loaded on Card #3
IC13	Linear, Dual Opamp	24209-202	NAT	LF412CN		

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-HF Model 9105A
Card 2/3 - Capacitors, IC's

REF DES	DESCRIPTION	ORBAN P/N	VEN (1)	VENDOR P/N	ALTERNATE VENDORS (1)	NOTES
Resistors						
R4	Trimpot, Cermet, 1 Turn; 100K	20524-410	BRN	3329H-1-104		Not loaded on Card #3
R7	Trimpot, Cermet, 1 Turn; 100K	20524-410	BRN	3329H-1-104		Not loaded on Card #3
R21	Trimpot, Cermet, 1 Turn; 100K	20524-410	BRN	3329H-1-104		
R24	Trimpot, Cermet, 1 Turn; 100K	20524-410	BRN	3329H-1-104		
R35	Trimpot, Cermet, 1 Turn; 100K	20509-410	BEK	72XR100K	BRN	
R39	Trimpot, Cermet, 1 Turn; 100K	20524-410	BRN	3329H-1-104		
R42	Trimpot, Cermet, 1 Turn; 100K	20524-410	BRN	3329H-1-104		
R53	Trimpot, Cermet, 1 Turn; 100K	20509-410	BEK	72XR100K	BRN	
R57	Trimpot, Cermet, 1 Turn; 100K	20524-410	BRN	3329H-1-104		
R60	Trimpot, Cermet, 1 Turn; 100K	20524-410	BRN	3329H-1-104		
R71	Trimpot, Cermet, 1 Turn; 100K	20509-410	BEK	72XR100K	BRN	
Transistors						
Q1	Transistor, Signal, PNP	23002-101	MOT	2N4402	FSC	Not loaded on Card #3
Q2-4	Transistor, Signal, PNP	23002-101	MOT	2N4402	FSC	
CARD #4						
Capacitors						
C1	Polypropylene, 50V, 2.5%; 0.015uF	21702-315	NOB	CQ15P1H153GPP	WES	
C2	Polypropylene, 50V, 2.5%; 0.01uF	21702-310	NOB	CQ15P1H103GPP	WES	
C3	Met. Polyester, 100V, 5%; 0.1uF	21440-410	WES	160C 104J100	SIE,WIM	
C4	Polypropylene, 50V, 2.5%; 0.01uF	21702-310	NOB	CQ15P1H103GPP	WES	
C5	Met. Polyester, 100V, 5%; 0.033uF	21440-333	WES	160C 333J250	SIE,WIM	
C6	Polypropylene, 50V, 2.5%; 0.020uF	21702-320	NOB	CQ15P1H203GPP	WES	
C7	Polypropylene, 50V, 2.5%; 0.01uF	21702-310	NOB	CQ15P1H103GPP	WES	
C8	Polypropylene, 50V, 1%; 4700pF	21701-247	NOB	CQ15P1H472FPP	WES	
C9	Polypropylene, 50V, 2.5%; 0.01uF	21702-310	NOB	CQ15P1H103GPP	WES	
C10	Mica, 500V, 1%; 560pF	21022-156	CD	CD19-FD561F03	SAN	
C11	Polypropylene, 50V, 1%; 0.015uF	21701-315	NOB	CQ15P1H153FPP	WES	
C12-14	Polypropylene, 50V, 2.5%; 0.01uF	21702-310	NOB	CQ15P1H103GPP	WES	
C15,16	Polypropylene, 50V, 2.5%; 0.022uF	21702-322	NOB	CQ15P1H223GPP	WES	
C17	Polypropylene, 50V, 1%; 0.01uF	21701-310	NOB	CQ15P1H103FPP	WES	
C18,19	Mica, 500V, 1%; 1000pF	21022-210	CD	CD19-FD102F03	SAN	
C20	Met. Polyester, 100V, 5%; 0.033uF	21440-333	WES	160C 333J250	SIE,WIM	
C21	Met. Polycarb., 100V, 2%; 0.01uF	21602-310	ECI	652A 1B103G	IMB	
C22	Mica, 500V, 1%; 1000pF	21022-210	CD	CD19-FD102F03	SAN	
C23	Met. Polycarb., 100V, 2%; 0.01uF	21602-310	ECI	652A 1B103G	IMB	
C24	Polypropylene, 50V, 2.5%; 3300pF	21702-233	NOB	CQ15P1H332GPP	WIM	

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-HF Model 9105A
Cards 2/3 - Resistors, Transistors
Card 4 - Capacitors

REF DES	DESCRIPTION	ORBAN P/N	VEN (1)	VENDOR P/N	ALTERNATE VENDORS (1)	NOTES
C25	Polypropylene, 50V, 2.5%; 0.033uF	21702-333	NOB	CQ15P1H333GPP	WIM	
C26	Alum., Radial, 63V, -20% +100%; 33uF	21209-633	SPR	502D 336G063CC1C	PAN	
C27	Polypropylene, 50V, 2.5%; 0.01uF	21702-310	NOB	CQ15P1H103GPP	WES	
C28-37	Met. Polycarb., 100V, 2%; 0.01uF	21602-310	ECI	652A 1B103G	IMB	
C38-43	Mica, 500V, 1%; 1000pF	21022-210	CD	CD19-FD102F03	SAN	
C44,45	Alum., Radial, 25V, -20% +100%; 100uF	21206-710	PAN	ECE-A1EV101S		
C46	Mica, 500V, +1/2pF -1/2pF; 47pF	21017-047	CD	CD15-CD470D03	SAN	
C47-49	Not Used	-----				
C50-63	Monolythic Ceramic, 50V, 20%; 0.1uF	21123-410	SPR	1C25 Z5U104M050B	KEM	
Integrated Circuits						
IC1-13	Linear, Dual Opamp	24206-202	TI	TL072CP	MOT	
IC14	Linear, Dual Opamp	24207-202	SIG	NE5532N	TI,EXR	
Resistors						
R8	Pot, Single; 25K (5010R)	20742-000	ORB			10% CCW Log
R18a,b	Resistor Set, MF; 10.0K	28520-004	ORB			3
R22a,b	Resistor Set, MF; 10.0K	28520-004	ORB			3
R35a,b	Resistor Set, MF; 20.0K	28521-001	ORB			3
R41	Pot, Single; 10K (5050)	20756-000	ORB			Linear
R50	Pot, Single; 500K (5010R)	20746-000	ORB			10% CCW Log
R51	Module, Sub-Assy, Equalizer, Green	40042-000	ORB			3
R57,58	Pot, Single; 100K (5020)	20726-000	ORB			20% CW Log
Switches						
S1,2	Switch, Toggle, Min.; SPDT	26041-102	CK	7101SYABE		
Transistors						
Q1	Transistor, Signal, NPN	23202-101	MOT	2N4400	FSC	
Q2,3	Transistor, JFET/N	23406-101	NAT	J113	SIL	

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-HF Model 9105A
Card 4 - IC's, Resistors, Switches, Transistors

REF DES	DESCRIPTION	ORBAN P/N	VEN (1)	VENDOR P/N	ALTERNATE VENDORS (1)	NOTES
CARD #5						
Capacitors						
C1-9	Polypropylene, 50V, 1%; 0.01uF	21701-310	NOB	CQ15P1H103FPP	WES	
C10,11	Polypropylene, 50V, 1%; 4700pF	21701-247	NOB	CQ15P1H472FPP	WES	
C12-14	Polypropylene, 50V, 1%; 0.01uF	21701-310	NOB	CQ15P1H103FPP	WES	
C15-17	Met. Polyester, 100V, 10%; 0.0047uF	21441-247	WES	160C 472K630	SIE,WIM	
C18	Mica, 500V, +1/2pF -1/2pF; 5pF	21017-005	CD	CD15-CD050D03	SAN	
C19	Polypropylene, 50V, 1%; 0.01uF	21701-310	NOB	CQ15P1H103FPP	WES	
C20	Polypropylene, 50V, 1%; 4700pF	21701-247	NOB	CQ15P1H472FPP	WES	
C21-24	Polypropylene, 50V, 1%; 0.01uF	21701-310	NOB	CQ15P1H103FPP	WES	
C25	Mica, 500V, 5%; 150pF	21020-115	CD	CD15-FD151J03	SAN	
C26	Mica, 500V, +1/2pF -1/2pF; 5pF	21017-005	CD	CD15-CD050D03	SAN	
C27	Mica, 500V, 5%; 100pF	21020-110	CD	CD15-FD101J03	SAN	
C28	Mica, 500V, 5%; 150pF	21020-115	CD	CD15-FD151J03	SAN	
C29	Mica, 500V, +1/2pF -1/2pF; 5pF	21017-005	CD	CD15-CD050D03	SAN	
C30	Mica, 500V, 5%; 100pF	21020-110	CD	CD15-FD101J03	SAN	
C31-43	Polypropylene, 50V, 1%; 0.01uF	21701-310	NOB	CQ15P1H103FPP	WES	
C44	Met. Polyester, 100V, 10%; 0.1uF	21441-410	WIM	MKS-4100V5.0.1	WES,SIE	
C45	Polypropylene, 50V, 1%; 0.01uF	21701-310	NOB	CQ15P1H103FPP	WES	
C46	Polypropylene, 50V, 2.5%; 0.03uF	21702-330	NOB	CQ15P1H303GPP		
C47,48	Alum., Radial, 25V, -20% +100%; 100uF	21206-710	PAN	ECE-A1EV101S		
C49-59	Monolythic Ceramic, 50V, 20%; 0.1uF	21123-410	SPR	1C25 Z5U104M050B	KEM	
C60	Not Used	-----				
C61,62	Monolythic Ceramic, 50V, 20%; 0.1uF	21123-410	SPR	1C25 Z5U104M050B	KEM	
C63,64	Not Used	-----				
C65-68	Monolythic Ceramic, 50V, 20%; 0.1uF	21123-410	SPR	1C25 Z5U104M050B	KEM	
Integrated Circuits						
IC1-5	Linear, Dual Opamp	24209-202	NAT	LF412CN		
IC6	Multiplier	24705-202	RAY	RC4200NB		
IC7	Linear, Dual Opamp	24207-202	SIG	NE5532N	TI,EXR	
IC8	Linear, Dual Opamp	24208-303	ORB	CA3280AG Selected		3
IC9	Linear, Dual Opamp	24209-202	NAT	LF412CN		
IC10	Linear, Dual Opamp	24206-202	TI	TL072CP	MOT	
IC11-13	Linear, Dual Opamp	24209-202	NAT	LF412CN		
IC14	Linear, Dual Opamp	24207-202	SIG	NE5532N	TI,EXR	
IC15,16	Linear, Dual Opamp	24206-202	TI	TL072CP	MOT	
IC17	Linear, Dual Opamp	24208-303	ORB	CA3280AG Selected		3
IC18,19	Linear, Dual Opamp	24206-202	TI	TL072CP	MOT	
IC20	Linear, Dual Opamp	24207-202	SIG	NE5532N	TI,EXR	

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-HF Model 9105A
Card 5 - Capacitors, IC's

REF DES	DESCRIPTION	ORBAN P/N	VEN (1)	VENDOR P/N	ALTERNATE VENDORS (1)	NOTES
Resistors						
R03	Pot, Single; 10K (5050)	20720-000	ORB			Linear
R06	Pot, Single; 10K (5050)	20720-000	ORB			Linear
R08a,b	Resistor Set, MF; 20.0K	28521-001	ORB			3
R12a,b	Resistor Set, MF; 20.0K	28521-001	ORB			3
R30a,b	Resistor Set, MF; 20.0K	28521-001	ORB			3
R34a,b	Resistor Set, MF; 20.0K	28521-001	ORB			3
R122a,b	Resistor Set, MF; 2.00K	28520-002	ORB			3
R126a,b	Resistor Set, MF; 2.00K	28520-002	ORB			3
R132a,b	Resistor Set, MF; 20.0K	28521-001	ORB			3
R141	Pot, Single; 100K (5020R)	20736-000	ORB			20% CCW Log
Switches						
S1	Switch, Toggle, Min.; DPDT	26041-202	CK	7201SYABE		
Transistors						
Q1,2	Transistor, JFET/N	23406-101	NAT	J113	SIL	
Q3	Transistor, Signal, NPN	23201-101	MOT	2N4123	FSC	
Q4,5	Transistor, JFET/N	23406-101	NAT	J113	SIL	
Q6	Transistor, Signal, NPN	23201-101	MOT	2N4123	FSC	
Q7	Transistor, Signal, PNP	23002-101	MOT	2N4402	FSC	
CARD #6						
Capacitors						
C1-3	Monolythic Ceramic, 50V, 20%; 0.1uF	21123-410	SPR	1C25 Z5U104M050B	KEM	
C4-6	Not Used	-----				
C7	Tantalum, 35V, 10%; 2.2uF	21307-522	SPR	196D 225X9035JA1	MANY	
C8	Ceramic Disc, 1KV, 10%; 0.001uF	21112-210	CRL	DD-102	MUR	
C9	Tantalum, 35V, 10%; 1uF	21307-510	SPR	196D 105X9035HA1	MANY	
C10-12	Met. Polyester, 100V, 10%; 0.1uF	21441-410	WIM	MKS-4100V5.0.1	WES,SIE	
C13	Alum., Radial, 25V, -20% +100%; 100uF	21206-710	PAN	ECE-A1EV101S		
C14	Not Used	-----				
C15	Alum., Radial, 25V, -20% +100%; 100uF	21206-710	PAN	ECE-A1EV101S		
C16-19	Monolythic Ceramic, 50V, 20%; 0.1uF	21123-410	SPR	1C25 Z5U104M050B	KEM	
C20,21	Alum., Radial, 25V, -20% +100%; 100uF	21206-710	PAN	ECE-A1EV101S		

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-HF Model 9105A
Card 5 - Resistors, Switches, Transistors
Card 6 - Capacitors

REF DES	DESCRIPTION	ORBAN P/N	VEN (1)	VENDOR P/N	ALTERNATE VENDORS (1)	NOTES
Integrated Circuits						
IC1	Quad Comparator	24710-302	NAT	LM339		
IC2	Not Used	-----				
IC3,4	Linear, Dual Opamp	24209-202	NAT	LF412CN		
IC5	Quad Comparator	24710-302	NAT	LM339		
IC6	Not Used	-----				
IC7	Linear, Dual Opamp	24209-202	NAT	LF412CN		
IC8	Linear, Dual Opamp	24202-202	RAY	RC4558NB	MOT,FSC	
IC9	Quad Comparator	24710-302	NAT	LM339		
IC10	Not Used	-----				
IC11	Linear, Dual Opamp	24209-202	NAT	LF412CN		
IC12	Linear, Dual Opamp	24202-202	RAY	RC4558NB	MOT,FSC	
Modules						
A1-3	Module Assy, Release Time	30665-001-xx*	ORB			*Add suffix printed on part
A4	Module Assy, Timing	30670-000-xx*	ORB			*Add suffix printed on part
Resistors						
R44	Pot, Single; 100K (5020R)	20736-000	ORB			20% CCW Log
R65	Pot, Single; 10K (5050)	20720-000	ORB			Linear
Switches						
S1	Switch, Toggle, Min.; DPDT	26041-202	CK	7201SYABE		
S2	Switch, Toggle, Min.; SPDT	26041-102	CK	7101SYABE		
Transistors						
Q1	Not Used	-----				
Q2	Transistor, Signal, PNP	23002-101	MOT	2N4402	FSC	
Q3	Not Used	-----				
Q4	Transistor, Signal, PNP	23002-101	MOT	2N4402	FSC	
Q5	Not Used	-----				
Q6	Transistor, Signal, PNP	23002-101	MOT	2N4402	FSC	
Q7	Not Used	-----				
Q8	Transistor, Signal, PNP	23002-101	MOT	2N4402	FSC	
Q9	Not Used	-----				
Q10	Transistor, Signal, PNP	23002-101	MOT	2N4402	FSC	
Q11	Not Used	-----				
Q12	Transistor, Signal, PNP	23002-101	MOT	2N4402	FSC	
Q13	Transistor, JFET/N	23406-101	NAT	J113	SIL	

FOOTNOTES:
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(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-HF Model 9105A
Card 6 - IC's, Modules, Resistors, Switches, Transistors

REF DES	DESCRIPTION	ORBAN P/N	VEN (1)	VENDOR P/N	ALTERNATE VENDORS (1)	NOTES
CARD #7						
Capacitors						
C1-3	Polypropylene, 50V, 1%; 0.01uF	21701-310	NOB	CQ15P1H103FPP	WES	
C4	Polypropylene, 50V, 2.5%; 2200pF	21702-222	NOB	CQ15P1H222GPP	WIM	
C5	Polypropylene, 50V, 1%; 0.01uF	21701-310	NOB	CQ15P1H103FPP	WES	
C6	Polypropylene, 50V, 2.5%; 0.068uF	21702-368	NOB	CQ15P1H683GPP		
C7	Polypropylene, 50V, 2.5%; 2200pF	21702-222	NOB	CQ15P1H222GPP	WIM	
C8	Mica, 500V, 1%; 1000pF	21022-210	CD	CD19-FD102F03	SAN	
C9	Polypropylene, 50V, 1%; 0.01uF	21701-310	NOB	CQ15P1H103FPP	WES	
C10	Polypropylene, 50V, 2.5%; 0.068uF	21702-368	NOB	CQ15P1H683GPP		
C11-14	Mica, 500V, 1%; 1000pF	21022-210	CD	CD19-FD102F03	SAN	
C15,16	Polypropylene, 50V, 2.5%; 4700pF	21702-247	NOB	CQ15P1H472GPP	WIM	
C17-22	Polypropylene, 50V, 2.5%; 0.022uF	21702-322	NOB	CQ15P1H223GPP	WES	
C23-29	Polypropylene, 50V, 1%; 0.01uF	21701-310	NOB	CQ15P1H103FPP	WES	
C30	Mica, 500V, 1%; 1000pF	21022-210	CD	CD19-FD102F03	SAN	
C31	Polypropylene, 50V, 1%; 0.01uF	21701-310	NOB	CQ15P1H103FPP	WES	
C32,33	Alum., Radial, 25V, -20% +100%; 100uF	21206-710	PAN	ECE-A1EV101S		
C34-43	Monolythic Ceramic, 50V, 20%; 0.1uF	21123-410	SPR	1C25 Z5U104M050B	KEM	
Diodes						
CR9-11	Diode, Signal, Hot Carrier	22102-001	HP	HP5082-2800	MANY	
Integrated Circuits						
IC1-5	Linear, Dual Opamp	24206-202	TI	TL072CP	MOT	
IC6	Linear, Single Opamp	24017-202	NAT	LF411CN		
IC7,8	Linear, Dual Opamp	24206-202	TI	TL072CP	MOT	
IC9,10	Linear, Dual Opamp	24202-202	RAY	RC4558NB	MOT,FSC	
IC11	Linear, Dual Opamp	24206-202	TI	TL072CP	MOT	
Resistors						
R33a,b	Resistor Set, MF; 20.5K	28521-008	ORB			3
R41a,b	Resistor Set, MF; 2.00K	28520-002	ORB			3
R45a,b	Resistor Set, MF; 2.00K	28520-002	ORB			3

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-HF Model 9105A

Card 7 - Capcitors, Diodes, IC's, Resistors

CARD #8

Capacitors

REF DES	DESCRIPTION	ORBAN P/N	VEN (1)	VENDOR P/N	ALTERNATE VENDORS(1)	NOTES
C1-3	Mica, 500V, 1%; 470pF	21022-147	CD	CD19-FD471F03	SAN	
C4	Met. Polyester, 100V, 10%; 0.1uF	21441-410	WIM	MKS-4100V5.0.1	WES,SIE	
C5	Mica, 500V, 1%; 1000pF	21022-210	CD	CD19-FD102F03	SAN	
C6	Polypropylene, 50V, 2.5%; 0.0068uF	21702-268	NOB	CQ15P1H682GPP	WES	
C7	Alum., Radial, 50V, -20% +100%; 47uF	21208-647	SPR	502D 476G050CD1C	PAN	
C8-10	Met. Polyester, 100V, 10%; 0.1uF	21441-410	WIM	MKS-4100V5.0.1	WES,SIE	
C11,12	Alum., Radial, 25V, -20% +100%; 100uF	21206-710	PAN	ECE-A1EV101S		
C13,14	Monolythic Ceramic, 50V, 20%; 0.1uF	21123-410	SPR	1C25 Z5U104M050B	KEM	
C15	Mica, 500V, +1/2pF -1/2pF; 30pF	21017-030	CD	CD15-CD300D03	SAN	
C16	Not Used	-----				
C17-21	Monolythic Ceramic, 50V, 20%; 0.1uF	21123-410	SPR	1C25 Z5U104M050B	KEM	

Integrated Circuits

REF DES	DESCRIPTION	ORBAN P/N	VEN (1)	VENDOR P/N	ALTERNATE VENDORS(1)	NOTES
IC1,2	Optoisolator, NPN	25003-000	SIE	SFH-601-1		
IC3	CD40106B	P032-300-000				
IC4	CD4516B	P032-302-000				
IC5	Linear, Dual Opamp	24209-202	NAT	LF412CN		
IC6,7	Optoisolator, NPN	25003-000	SIE	SFH-601-1		
IC8	CD4532B	P032-303-000				
IC9,10	Optoisolator, NPN	25003-000	SIE	SFH-601-1		
IC11	CD40106B	P032-300-000				
IC12	Digital, 1-in-4 Decoder	24506-302	RCA	CD4555BE	SIG	
IC13-16	Optoisolator, NPN	25003-000	SIE	SFH-601-1		
IC17	Digital, NAND Gate	24501-302	RCA	CD4011BE	MOT	
IC18	Digital, Hex Inverter	24505-302	RCA	CD4069UBE	SIG	
IC19,20	Optoisolator, NPN	25003-000	SIE	SFH-601-1		
IC21	Linear, Dual Opamp	24207-202	SIG	NE5532N	TI,EXR	

Modules

REF DES	DESCRIPTION	ORBAN P/N	VEN (1)	VENDOR P/N	ALTERNATE VENDORS(1)	NOTES
A1	Module Assy, Tilt Equalizer	30690-000-xx*	ORB			*Add suffix printed on part
A2	EQ(AUX) Assy	31285-000	ORB			
A3	Module Assy, Output	31160-002-xx*	ORB			*Add suffix printed on part

Resistors

REF DES	DESCRIPTION	ORBAN P/N	VEN (1)	VENDOR P/N	ALTERNATE VENDORS(1)	NOTES
R37	Trimpot, Cermet, 20 Turn; 100K	20512-410	BEK	89PR100K	BRN	

Switches

REF DES	DESCRIPTION	ORBAN P/N	VEN (1)	VENDOR P/N	ALTERNATE VENDORS(1)	NOTES
S1	Switch, Toggle, Min.; DPDT	26041-202	CK	7201SYABE		

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-HF Model 9105A
Card 8 - Capacitors, IC's, Modules, Resistors, Switches

REF DES	DESCRIPTION	ORBAN P/N	VEN (1)	VENDOR P/N	ALTERNATE VENDORS (1)	NOTES
Transistors						
Q1	Not Used	-----				
Q2-9	Transistor, JFET/N	23406-101	NAT	J113	SIL	
Q10,11	Transistor, Signal, NPN	23202-101	MOT	2N4400	FSC	
CHASSIS (FRONT PANEL)						
Meters						
M1	Meter, Edge, 1mA, Cream/Black +10 to -15	28009-107	EMI	132D5		950 Ohms
M2-6	Meter, Edge, 1mA, Cream/Black, 0 to 25	28009-104	EMI	132D5		950 Ohms
M7	Meter, VU, Brown/Tan	28002-007	DIX	330T	HOYT	
Switches						
S2,3	Switch, Toggle, Min.; SPDT	26044-101	CK	7105P3YZQE		
S4	Switch, Toggle, Min.; SPDT	26046-102	CK	7109P3YZQE		
CHASSIS (POWER SUPPLY)						
Capacitors						
C101,102	Alum., Electrolytic, 40V; 5000uF	21250-850	CD	FAH-5000-40-A2	MAL	
C103,104	Ceramic Disc, 50V, 20%; 0.05uF	21107-350	CRL	UK50-503	MUR	
C105-107	Ceramic, Feed-thru; 1000pF	21118-210	ERE	2404-000	MUR	
Diodes						
CR101-104	Diode, Rectifier, 400V, 3A	22203-400	MOT	MR504		
Inductors						
L101,102	Inductor, RF Choke; 7uH	29501-004	OHM	Z-50	(2)	
Miscellaneous						
F101	Fuse, 3AG, Slo-Blo, 1/2A	28004-150	LFE	313.500	BUS	
T101	Transformer, Power; 38VCT, 46VA	55002-000	ORB			
Switches						
S101	Switch, Rocker, Power; DPST	26003-001	MAR	1802-0111		
S102	Switch, Slide, Mains voltage selector	26140-000	SW	EPSI-SLI		

FOOTNOTES:
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SPECIFICATIONS AND SOURCES FOR REPLACEMENT PARTS

OPTIMOD-HF Model 9105A
Card 8 - Transistors
Chassis Front Panel
Chassis Power Supply

REF DES	DESCRIPTION	ORBAN P/N	VEN (1)	VENDOR P/N	ALTERNATE VENDORS (1)	NOTES
CHASSIS (REAR PANEL)						
Capacitors						
C1-22	Ceramic, Feed-thru; 1000pF	21118-210	ERE	2404-000	MUR	
Miscellaneous						
FL101	Filter, Line, 3 Amp	28015-000	COR	3EF1	MANY	
EQ(AUX) BOARD						
Transistors						
Q101-108	Transistor, JFET/N	23406-101	NAT	J113	SIL	
FILTER BOARD						
Capacitors						
C1,2	Ceramic Disc, 1KV, 10%; 0.0015uF	21112-215	CRL	DD-152	MUR	
Inductors						
L1-4	Inductor, RF Choke; 1.2mH	29503-000	MIL	73F123AF		
L5	Inductor, RF Choke; 7uH	29501-004	OHM	Z-50	(2)	
Miscellaneous						
K1,2	Relay, Dip, 15V, 1A	28022-011	PB	JWD-107-7		
METER RESISTOR BOARD						
Capacitors						
C1,2	Monolythic Ceramic, 50V, 20%; 0.1uF	21123-410	SPR	1C25 Z5U104M050B	KEM	
Integrated Circuits						
IC1	CD4511B	P032-301-000				
IC2	Digital, Dual Flip-Flop	24502-302	RCA	CD4013BE		

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-HF Model 9105A
Chassis Rear Panel
EQ AUX Board
Meter Resistor Board - Capacitors, IC's

REF DES	DESCRIPTION	ORBAN P/N	VEN (1)	VENDOR P/N	ALTERNATE VENDORS (1)	NOTES
LEDs						
DS1-3	LED, Green	25106-002	HP	HLMP-1503	GI	
DS4,5	LED, Yellow	25106-001	HP	HLMP-1400	GI	
DS6	LED, Green	25106-002	HP	HLMP-1503	GI	
DS7	LED Display, 0-9, Red	25402-000	HP	5082-7613	GI	
Switches						
S1	Switch, Rotary, 1P12T	26078-306	CTS	212-Series		
S5	Switch, Toggle, Min.; SPDT	26041-102	CK	7101SYABE		
Transistors						
Q1	Transistor, Signal, NPN	23202-101	MOT	2N4400	FSC	
MONITOR ROLLOFF FILTER (ACCESSORY)						
Capacitors						
C1	Met. Polyester, 100V, 5%; 0.034uF	21440-334	WES	160C 343J250	SIE,WIM	
C2	Met. Polyester, 100V, 5%; 0.29uF	21440-429	WES	160C 294J100	SIE,WIM	
C3	Met. Polyester, 100V, 10%; 0.039uF	21441-339	WES	160C 393K250	SIE	
C4a,b	Capacitor Set, Polypro.; 0.27uF	28604-001	ORB			3
C5	Met. Polycarb., 100V, 2%; 0.15uF	21602-415	ECI	652A 1B154G	IMB	
Inductors						
L1	Inductor, Variable	29703-002	ORB			
L2	Inductor, Variable	29706-002	ORB			
Resistors						
R4	Pot, Single; 500 OHM (5050)	20747-000	ORB			Linear
Switches						
S1	Switch, Slide; DPDT (Gold)	26106-000	CW	GF326-0149		Special Plating

FOOTNOTES:

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SPECIFICATIONS AND SOURCES FOR
REPLACEMENT PARTS
OPTIMOD-HF Model 9105A
Meter Resistor Board - LEDs,
Switches, Transistors
Monitor Rolloff Filter

REF DES	DESCRIPTION	ORBAN P/N	VEN (1)	VENDOR P/N	ALTERNATE VENDORS (1)	NOTES
POWER SUPPLY BOARD						
Capacitors						
C108	Tantalum, 10V, 10%; 33uF	21303-633	SPR	196D 336X9010KE3	MANY	
C109	Mica, 500V, 5%; 470pF	21024-147	CD	CD19-FD471J03	SAN	
C111,112	Alum., Radial, 50V, -20% +100%; 47uF	21208-647	SPR	502D 476G050CD1C	PAN	
C113	Mica, 500V, 5%; 100pF	21020-110	CD	CD15-FD101J03	SAN	
C114	Polyester, 100V, 10%; 0.01uF	21401-310	SPR	225P 10391WD3	PAN,PAK	
Diodes						
CR105,106	Diode, Rectifier, 400V, 1A	22201-400	MOT	1N4004	MANY	
VR101,102	Diode, Zener, 5W, 5%; 16V	22005-160	MOT	1N5353B	MANY	
Integrated Circuits						
IC101	D.C. Regulator	24301-302	NAT	LM723CN		
IC102	Linear, Single Opamp	24003-202	NAT	LM301AH	TI,RCA	
Miscellaneous						
F102,103	Fuse, Pico, 1A, Axial	28011-210	LFE	275001	BUS	
Resistors						
R106	Trimpot, Cermet, 18 Turn; 500 OHM	20508-150	BEK	68XR500	BRN	
R108,109	Resistor Set, MF; 20.5K	28521-008	ORB			3
Transistors						
Q101,102	Transistor, Power, NPN; TO-3	23601-501	RCA	2N3055	MANY	Located on Chassis Rear Panel
Q103,104	Transistor, Signal, PNP	23002-101	MOT	2N4402	FSC	

FOOTNOTES:

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SPECIFICATIONS AND SOURCES FOR REPLACEMENT PARTS

OPTIMOD-HF Model 9105A
Power Supply Board

Vendor Codes

AB Rockwell Allen-Bradley
625 Liberty Ave
Pittsburgh, PA 15222-3123

AD Analog Devices, Inc.
One Technology Way
PO Box 9106
Norwood, MA 02062-9106

AKG AKG Acoustics, Inc.
See Orban

AM Amphenol Corporation
358 Hall Avenue
Wallingford, CT 06492

BEK Beckman Industrial Corporation
4141 Palm Street
Fullerton, CA 92635-1025

BEL Belden Electronic Wire & Cable
PO Box 1980
Richmond, IN 47374

BRN Bourns, Inc
Resistive Components Group
1200 Columbia Avenue
Riverside, CA 92507

BUS Bussmann Division
Cooper Industries
PO Box 14460
St. Louis, MO 63178

CD Cornell-Dubilier Electronics
1700 Rte. 23 North
Wayne, NJ 07470

CRL Mepcopal/Centralab
See Mepcopal

CSC Crystal Semiconductor Corporation
4210-T. South Industrial Dr.
Austin, TX 78744

CTS CTS Corporation
907 North West Blvd.
Elkhart, IN 46514

CW CW Industries
130 James Way
Southampton, PA 18966

DBX dbx
A Harman International Company
8760 South Sandy Parkway
Sandy, UT 84107

DEL Delta Products Corp
3225 Laurel View Ct.
Fremont, CA 94538

DUR Duracell, Inc.
Berkshire Industrial Park
Bethel, CT 06801

ELSW Electro Switch
77 King Avenue
Weymouth, MA 02188

EMI Crompton Modutec
920 Candia Rd.
Manchester, NH 03109

EXR Exar Corporation
2222 Qume Dr.
PO Box 49007
San Jose, CA 95161-9007

FR Fair-Rite Products Corp.
PO Box J
Wallkill, NY 12589

FSC Fairchild Camera & Instr. Corp.
See National Semiconductor

GI General Instruments
Optoelectronics Division
See Quality Technologies

HA Harris Semiconductor
1301 Woody Burke Rd.
Melbourne, FL 32901

HO Hoyt Elect. Inst. Works
19 Linden St.
Penacook, NH 03303

HP Hewlett-Packard Co.
Components Group
640 Page Mill Road
Palo Alto, CA 94304

INS Intersil, Inc.
See Harris Semiconductor

ITW ITW Switches
An Illinois Tool Works Co.
6615 W. Irving Park Rd.
Dept. T
Chicago, IL 60634

KEM KEMET Electronics Corporation
Post Office Box 5928
Greenville, South Carolina 29606

KEY Keystone Electronics Corp.
31-07 20th Rd.
Astoria, NY 11105

LFE Littlefuse
A Subsidiary of Tracor, Inc.
800 E. Northwest Hwy
Des Plaines, IL 60016

LT Linear Technology Corp.
1630 McCarthy Blvd.
Milpitas, CA 95035

LUMX Lumex Opto/Components Inc.
292 E. Hellen Road
Palatine, IL 60067

MAL Mallory Capacitor Co.
7545 Rockville Rd.
PO Box 1284
Indianapolis, IN 46241

MAR Marquardt Switches, Inc.
2711-TR Route 20 East
Cazenovia, NY 13035

MAT Matsushita Electric Corp
of America
One Panasonic Way
Secaucus, NJ 07094

ME Mepcopal/Centralab
A North American Phillips Corp.
11468 Sorrento Valley Road
San Diego, CA 92121

MID Hollingsworth/Wearnes
1601 N. Powerline Rd.
Pampano, FL 33069

MIL J.W. Miller Division
Bell Industries
306 E. Alondra
Gardena, CA 90247

MOT Motorola Semiconductor
PO Box 20912
Phoenix, AZ 85036

MUR Murata Erie North America
2200 Lake Park Drive
Smyrna, GA 30080

NAT National Semiconductor Corp.
2900 Semiconductor Drive
PO Box 58090
Santa Clara, CA 95051

NEL Crystal Biotech
75 South Street
Hopkinton, MA 01748

NOB Noble U.S.A., Incorporated
5450 Meadowbrook Industrial Ct.
Rolling Meadows, IL 60008

OKI OKI Semiconductor
785 N. Mary Ave.
Sunnyvale, CA 94086-2909

OHM Ohmite Manufacturing Company
3601 Howard Street
Skokie, IL 60076

ORB Orban
A Harman International Company
1525 Alvarado Street
San Leandro, CA 94577

PAN Panasonic Industrial Company
Two Panasonic Way
7E-2T
Secaucus, NJ 07094

QT Quality Technologies, Inc.
610 North Mary Ave.
Sunnyvale, CA 94086

RAL Raltron Electronics Corp.
2315 NW 107th Ave.
Miami, FL 33172

RAY Raytheon Company
Semiconductor Division
350 Ellis Street
Mountain View, CA 94039

RCA RCA Solid State
See Harris Semiconductor

ROHM Rohm Electronics
3034 Owens Dr.
Antioch, TENN 37013

SAE Stanford Applied Engineering, Inc
340 Martin Avenue
Santa Clara, CA 95050

SAN Sangamo Weston Inc.
Capacitor Division
See Cornell-Dubilier

SCH ITT Schadow, Inc.
8081 Wallace Road
Eden Prairie, MN 55344

SIE Siemens Components Inc.
Heimann Systems Div.
186 Wood Avenue South
Iselin, NJ 08830

SIG Philips Components - Signetics
North American Phillips Corp.
811 E. Arques
Sunnyvale, CA 94088

SPR Sprague Electric Co.
41 Hampden Road
PO Box 9102
Manifold, MA 02048-9102

S.W. Seitchcraft
A Raytheon Company
5555 N. Elation Avenue
Chicago, IL 60630

AT Taiga America, Inc.
700 Frontier Way
Bensenville, IL 60106

TDK TDK Electronics Corporation
12 Harbor Park
Port Washington, NY 11050

TI Texas Instruments, Inc.
PO Box 655012
Dallas, TX 75265

TOS Toshiba America, Inc.
9740 Irvine Blvd.
Irvine, CA 92718

TRW TRW Electronics Components
Connector Division
1501 Morse Avenue
Elk Grove Village, IL 60007

VARO Micro Quality Semiconductor, Inc.
PO Box 469013
Garland, TX 75046-9013

WES Westlake
See Mallory Capacitor Co.

WIM Wima Division
2269 Saw Mill Rd.
Building 4C
PO Box 217
Elmsford, NY 10533

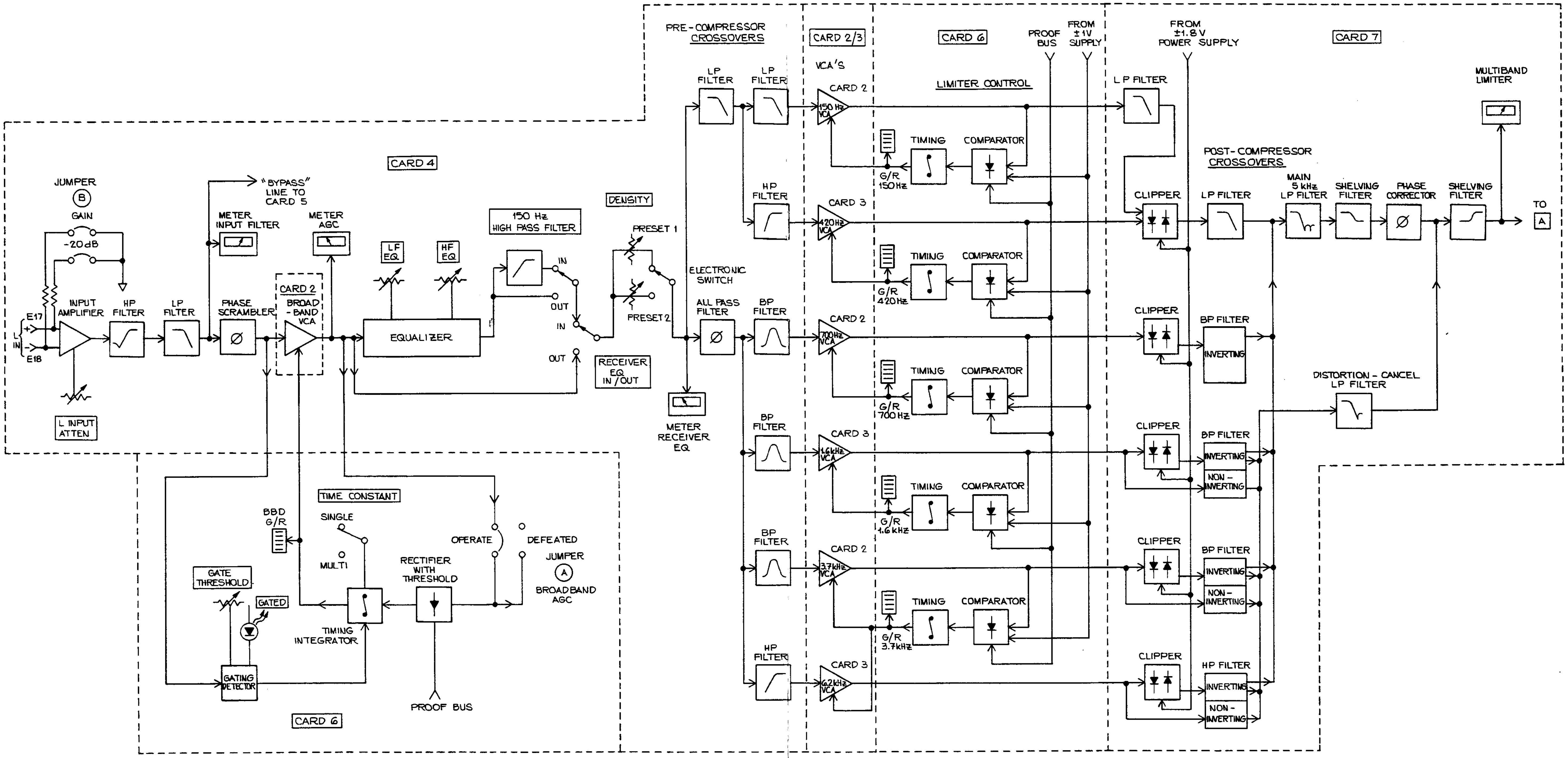
ZI ZILOG Inc.
210 Hacienda Ave.
Campbell, CA 95008

Schematics, Assembly Drawings

The following drawings are included in this manual:

Page	Card #	Function	Drawing
6-46		BLOCK DIAGRAM	
6-48		Motherboard	Assembly Drawing
6-49		DC Power Supply	Wiring Diagram
6-50	PS	Power Supply	Assembly Drawing
6-51			Schematic
6-52		Input Filter	Assembly Drawing
6-53			Schematic
6-54	MR	Meter Resistor	Assembly Drawing
6-55			Schematic
6-56	2, 3	Voltage-Controlled Amplifiers	Assembly Drawing
6-57			Schematic
6-58	4	Buffers, Filters, EQ, Crossovers	Assembly Drawing
6-59			Schematic
6-60	5	Hilbert-Transform Clipper	Assembly Drawing
6-61			Schematic
6-62	6	Compressor Control	Assembly Drawing
6-63			Schematic
6-64	7	Crossovers, Clippers, Filters	Assembly Drawing
6-65			Schematic
6-66	8	Output, Transmitter EQ, Logic	Assembly Drawing
6-67			Schematic
6-68	8-A	Tilt EQ	Assembly Drawing
6-69		Monitor Roll-Off Filter	Assembly Drawing Schematic

These drawings reflect the actual construction of your unit as accurately as possible. Any differences between the drawings and your unit are almost undoubtedly due to product improvements or production changes since the publication of this manual. Major changes are described in addenda located at the front of this manual. If you intend to replace parts, please read page 6-29.



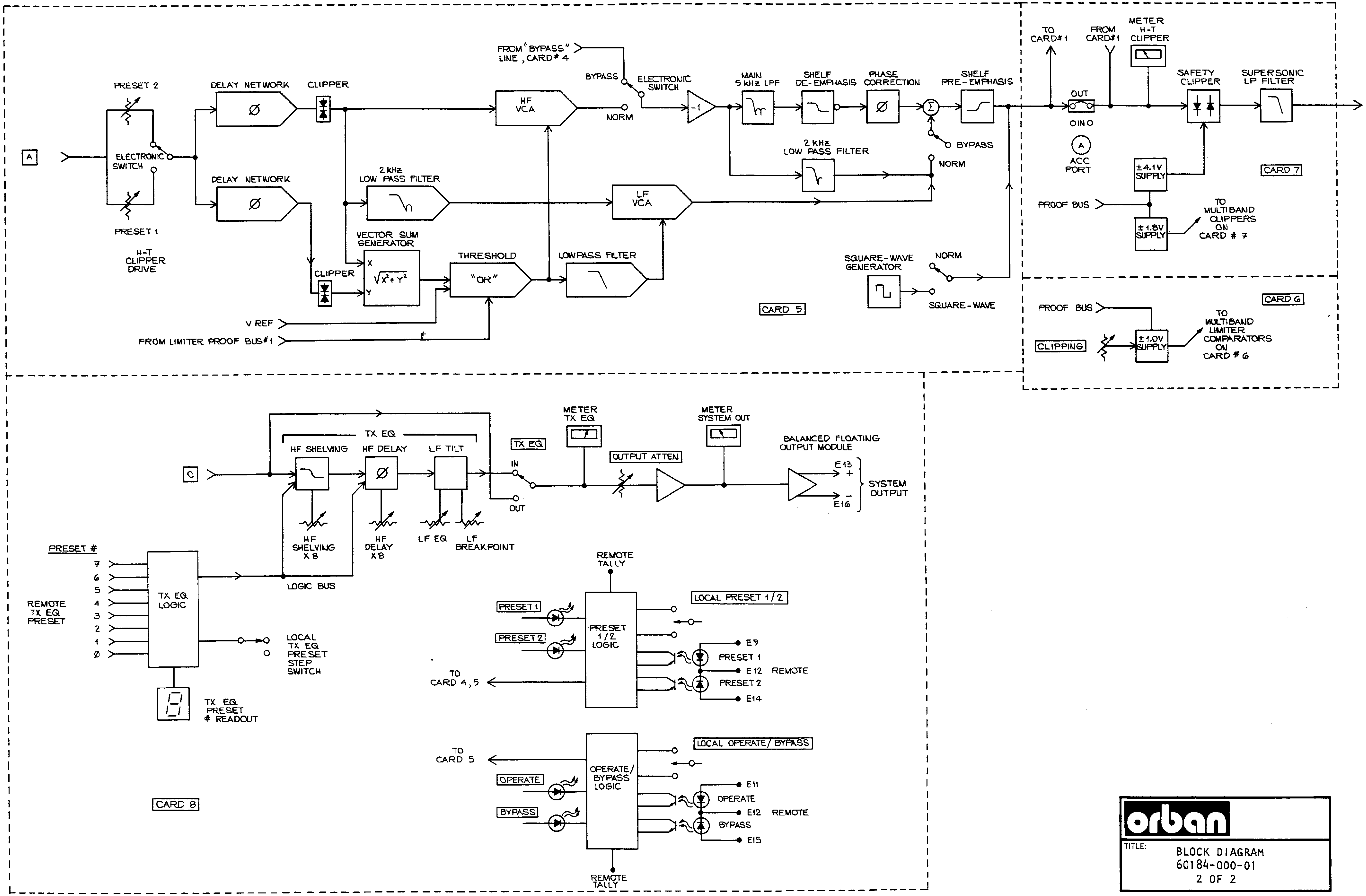
2. Ø MEANS PHASE SHIFTER .

1. ∫ MEANS INTEGRATOR .

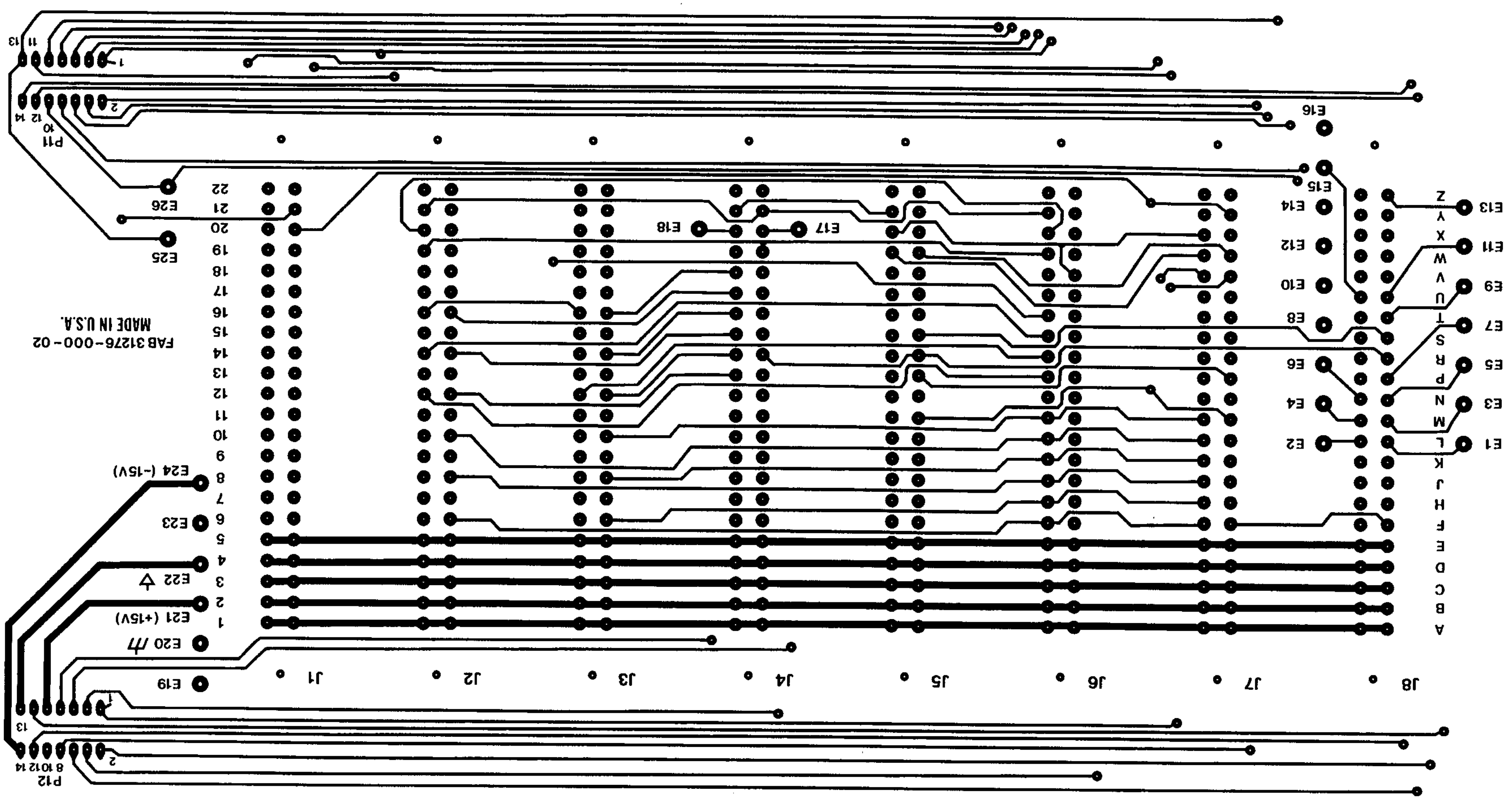
NOTES:

orban

TITLE: BLOCK DIAGRAM
60184-000-01
1 OF 2

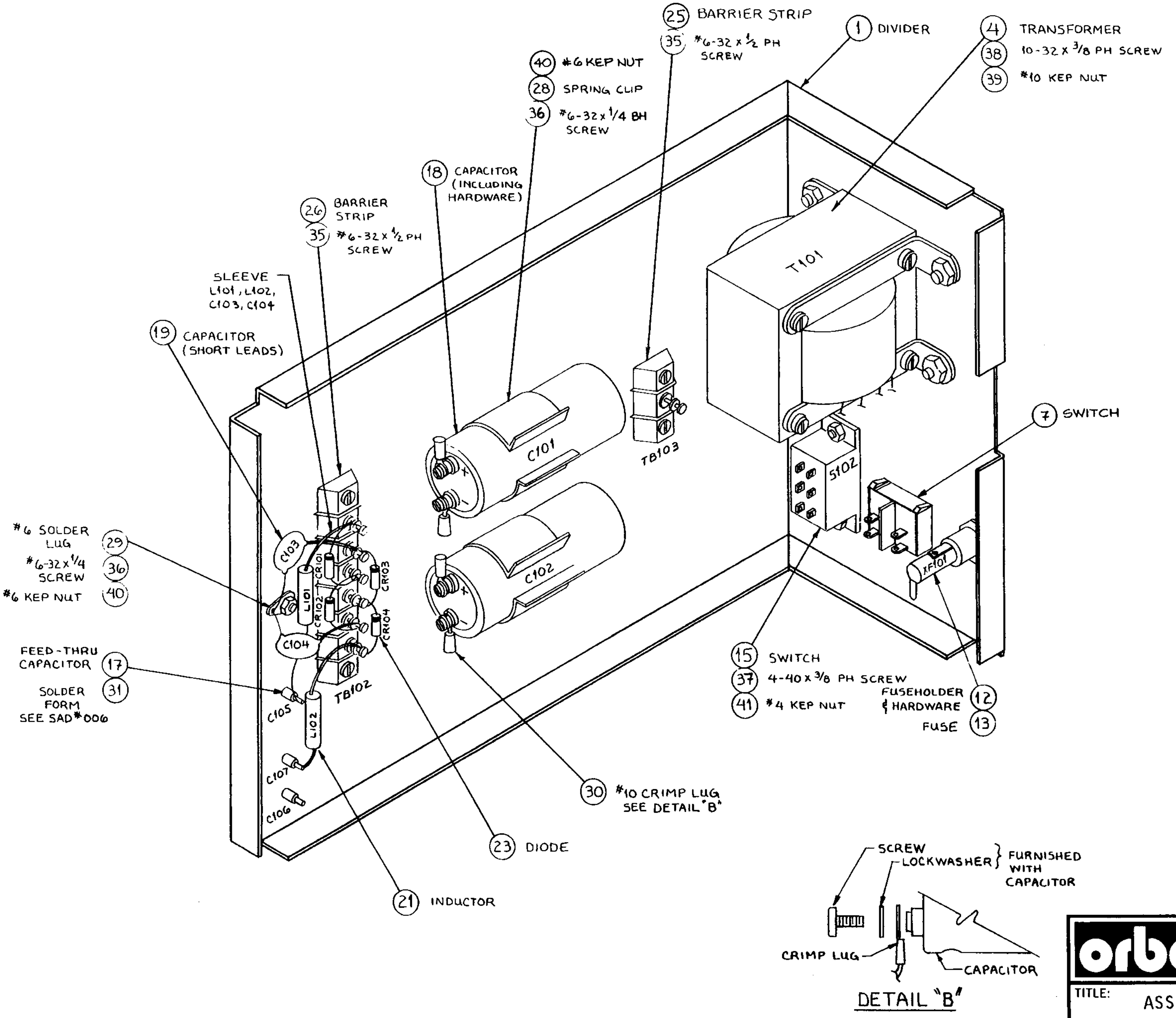


TITLE: BLOCK DIAGRAM
60184-000-01
2 OF 2



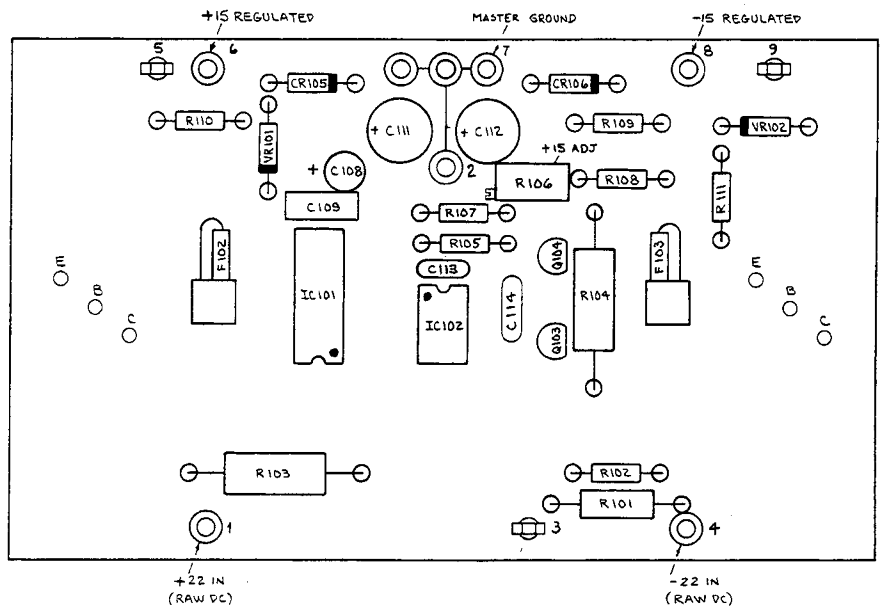
orban

TITLE:
ASSEMBLY DRAWING
MOTHERBOARD
31276-000-02



orban

TITLE: ASSEMBLY DRAWING
DC POWER SECTION
40017-000-07

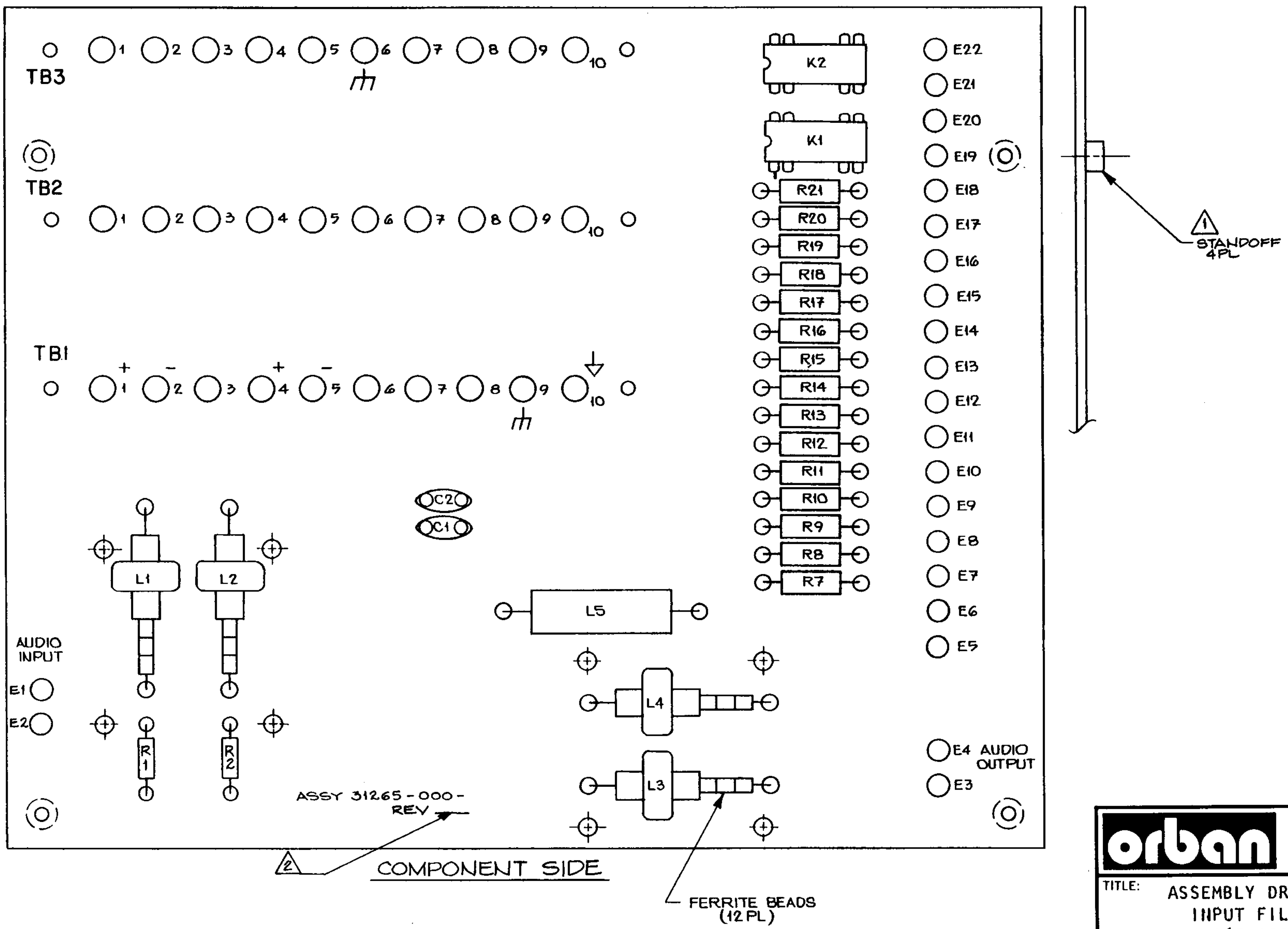


orban

TITLE:
ASSEMBLY DRAWING
POWER SUPPLY
30310-000-07

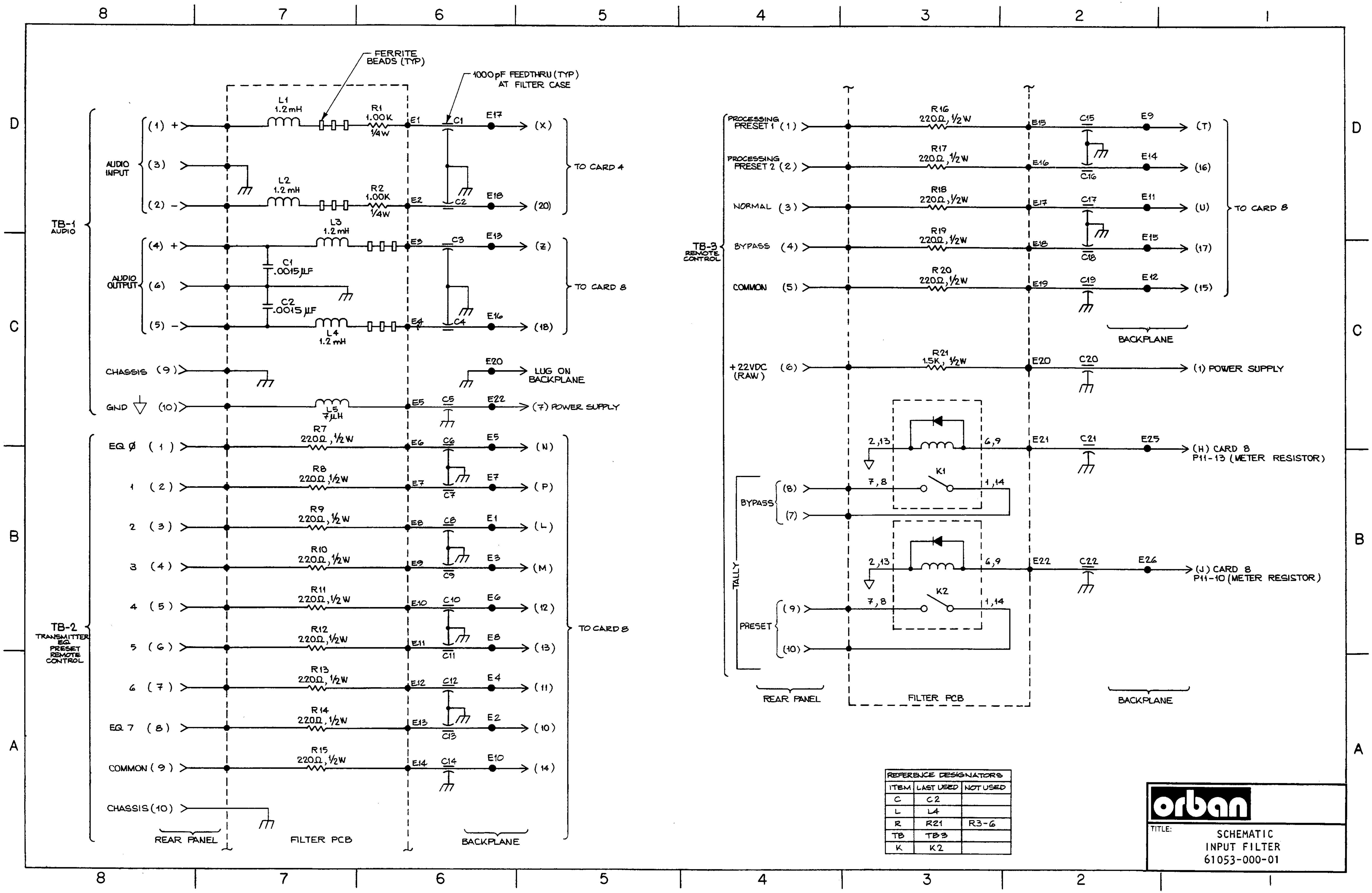
NOTES: (UNLESS OTHERWISE SPECIFIED)

1. MOUNT PCB STANDOFF, PEM KEF 440-4 ON SOLDER SIDE OF BOARD, 4 PLACES.
2. STAMP REVISION LEVEL HERE
3. REFERENCE SCHEMATIC NO. 61053-000



orban

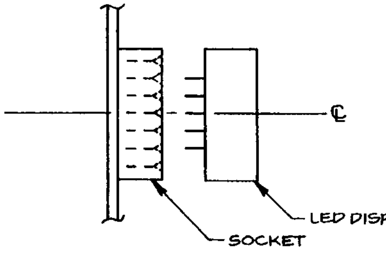
TITLE: ASSEMBLY DRAWING
INPUT FILTER
31265-000-01



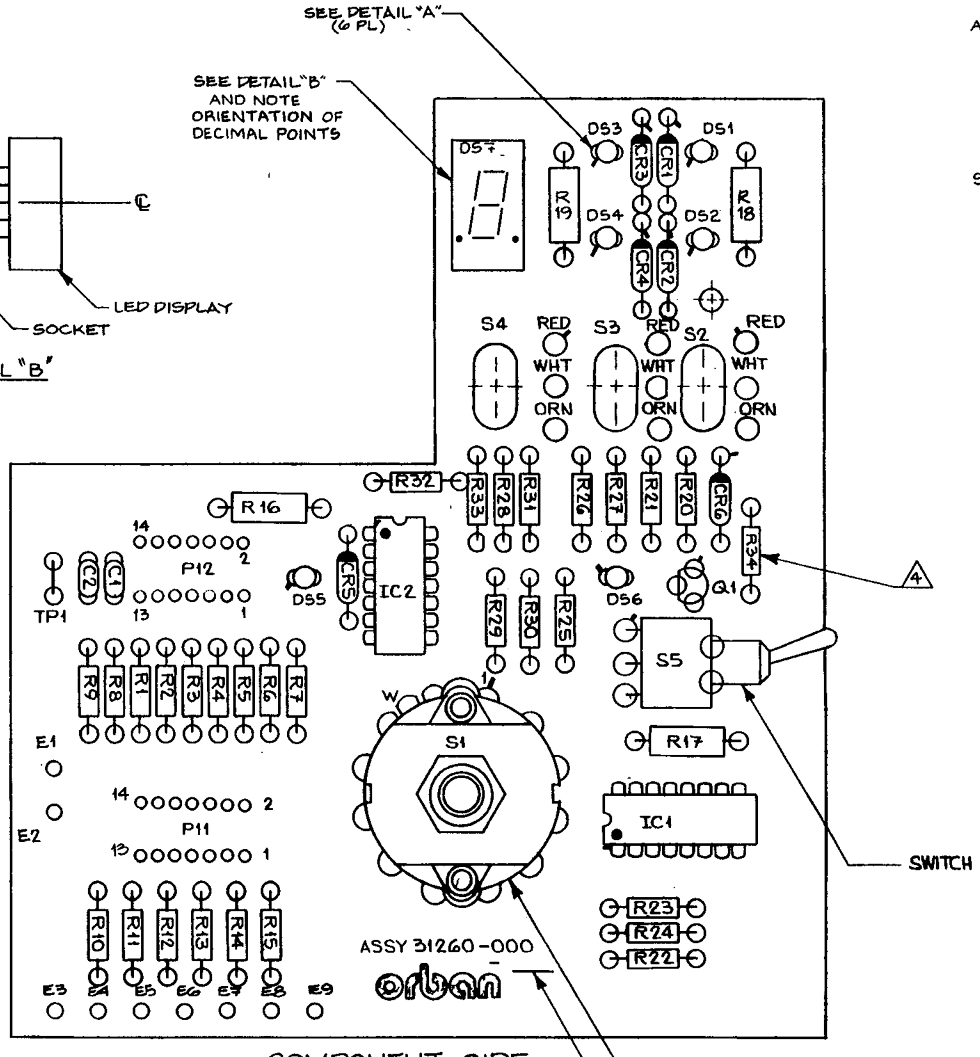
REFERENCE DESIGNATORS		
ITEM	LAST USED	NOT USED
C	C2	
L	L4	
R	R21	R3-6
TB	TB3	
K	K2	

orban

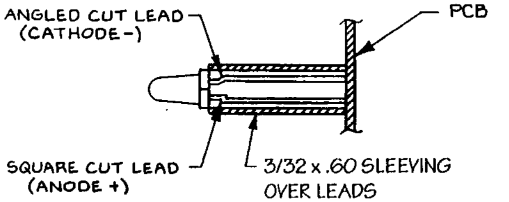
TITLE:
SCHEMATIC
INPUT FILTER
61053-000-01



DETAIL "B"



COMPONENT SIDE



DETAIL "A"

1. INSTALL SLEEVING. DO NOT SHRINK.
2. INSTALL LED INTO BOARD. ANGLED CUT LEAD GOES TO TIC MARK PAD.

△4 FOR ASSYS USING PCB 31261-000-01, TAC SOLDER R34 BETWEEN S2-WHT PAD AND R18-GND.

△3 HAND INSTALL - DO NOT WASH MECHANISM

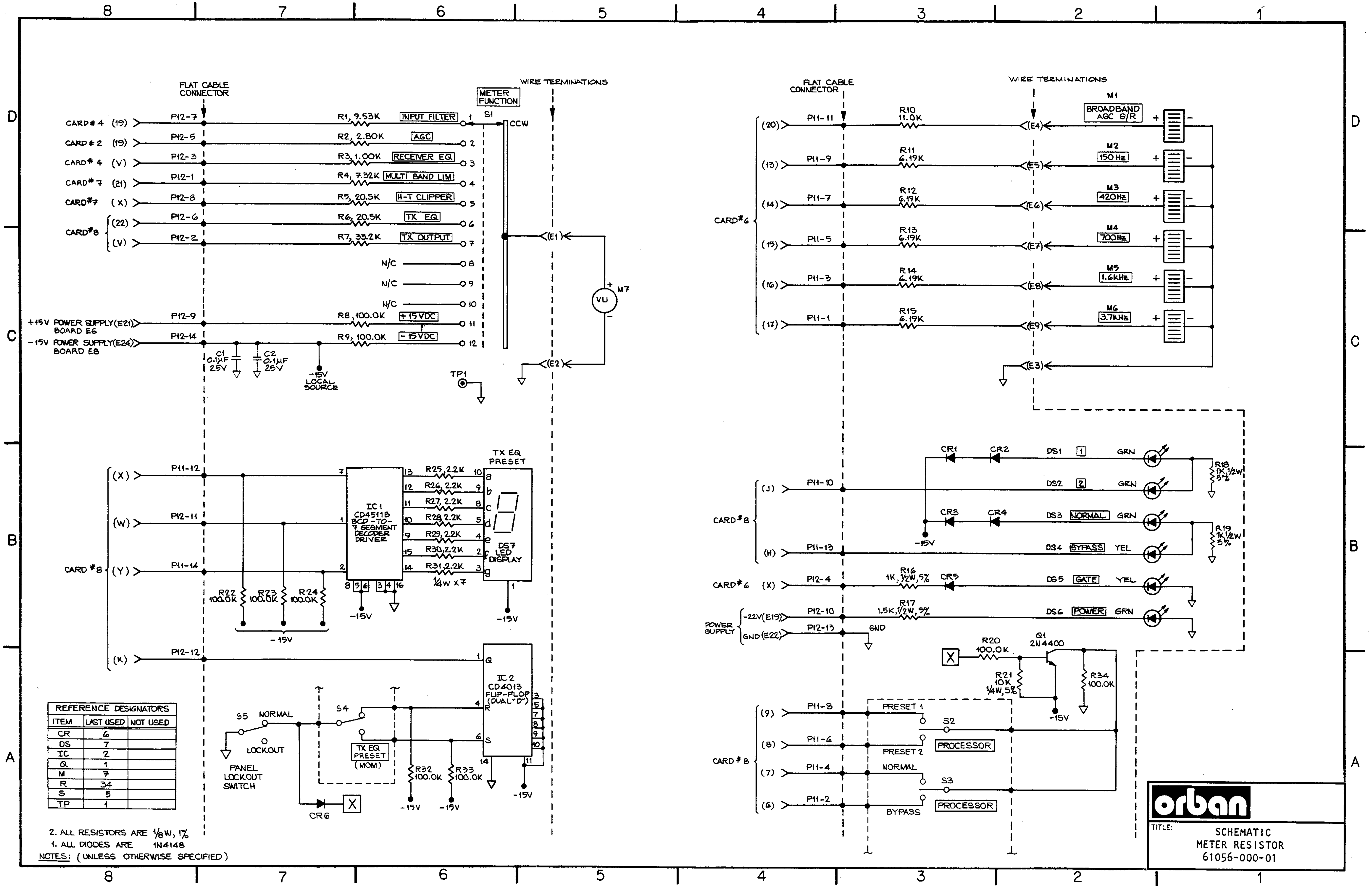
2. TIC MARKS INDICATE PIN 1 OF IC'S, CONNECTORS, CATHODE OF DIODES, EMITTER OF TRANSISTORS, AND PIN 1 OF SWITCHES

1. REFERENCE SCHEMATIC 61056-000.

NOTES: (UNLESS OTHERWISE SPECIFIED)

orban

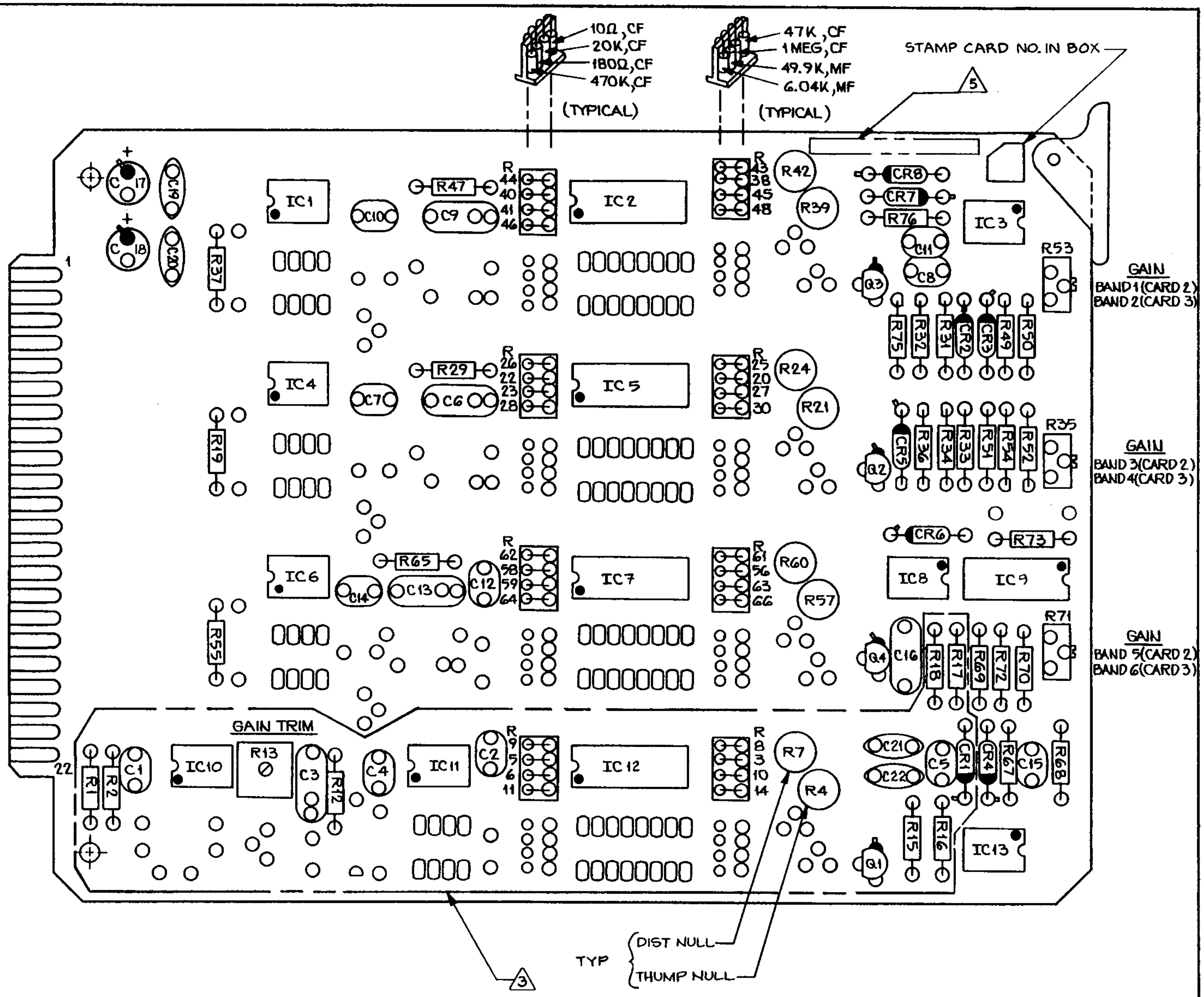
TITLE: ASSEMBLY DRAWING
METER RESISTOR
31260-000-01



REFERENCE DESIGNATORS		
ITEM	LAST USED	NOT USED
CR	6	
DS	7	
IC	2	
Q	1	
M	7	
R	34	
S	5	
TP	1	

2. ALL RESISTORS ARE ⅛W, 1%
1. ALL DIODES ARE 1N4148
NOTES: (UNLESS OTHERWISE SPECIFIED)

TITLE:
SCHEMATIC
METER RESISTOR
61056-000-01



SIDE

	SOLDER		COMPONENT
A	CHASSIS GND	1	—
B	+15V	2	—
C	GND	3	—
D	—	4	—
E	−15V	5	—
F	BAND $\left[\begin{smallmatrix}1\\2\end{smallmatrix}\right]$ AUDIO OUT	6	—
H	—	7	—
J	BAND $\left[\begin{smallmatrix}3\\4\end{smallmatrix}\right]$ AUDIO OUT	8	—
K	—	9	—
L	BAND $\left[\begin{smallmatrix}5\\6\end{smallmatrix}\right]$ AUDIO OUT	10	—
M	—	11	—
N	BAND $\left[\begin{smallmatrix}1\\2\end{smallmatrix}\right]$ AUDIO IN	12	BAND $\left[\begin{smallmatrix}1\\2\end{smallmatrix}\right]$ COMP. CONTROL
P	—	13	—
R	BAND $\left[\begin{smallmatrix}3\\4\end{smallmatrix}\right]$ AUDIO IN	14	BAND $\left[\begin{smallmatrix}3\\4\end{smallmatrix}\right]$ COMP. CONTROL
S	—	15	—
T	BAND $\left[\begin{smallmatrix}5\\6\end{smallmatrix}\right]$ AUDIO IN	16	BAND $\left[\begin{smallmatrix}5\\6\end{smallmatrix}\right]$ COMP. CONTROL
U	—	17	—
V	—	18	—
W	—	19	BBD AGC OUT
X	—	20	BBD AGC CONTROL
Y		21	BBD AGC IN
Z	—	22	—

MNEMONICS IN BRACKETS LISTED ABOVE INDICATE; $\left[\begin{smallmatrix}\text{(2 CARD)}\\\text{(3 CARD)}\end{smallmatrix}\right]$

5\. ADD SERIAL NO. PER SAD 014

4\. TIC MARKS INDICATE PIN ONE OF IC'S, CATHODE OF DIODES, EMITTER OF TRANSISTORS AND POSITIVE SIDE OF CAPACITORS.

3\. NOT LOADED ON #3 CARD. (BROADBAND COMPRESSOR)

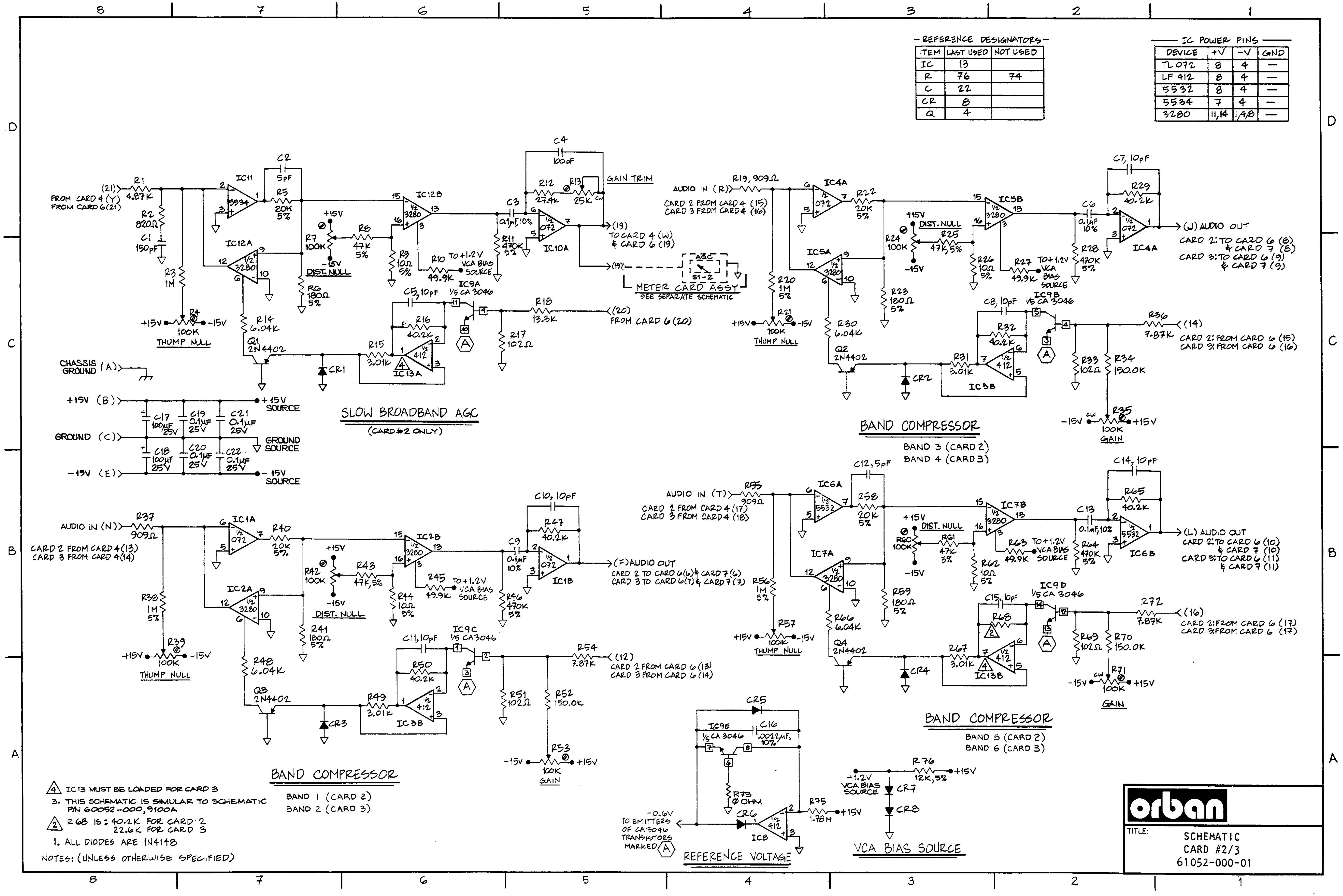
2\. REF. SCHEMATIC NO. 61052-000

1\. VER-001 = 2 CARD
VER-002 = 3 CARD (EXCLUDES BBD COMPRESSOR)

NOTES: (UNLESS OTHERWISE SPECIFIED)

orban

TITLE: ASSEMBLY DRAWING
CARD #2/3
31220-VER- 01



— REFERENCE DESIGNATORS —

ITEM	LAST USED	NOT USED
IC	13	
R	76	74
C	22	
CR	8	
Q	4	

— IC POWER PINS —

DEVICE	+V	−V	GND
TL 072	8	4	—
LF 412	8	4	—
5532	8	4	—
5534	7	4	—
3280	11,14	1,4,8	—

4. IC13 MUST BE LOADED FOR CARD 3

3. THIS SCHEMATIC IS SIMULAR TO SCHEMATIC P/N 60052-000, 9100A

2. R68 IS: 40.2K FOR CARD 2
22.6K FOR CARD 3

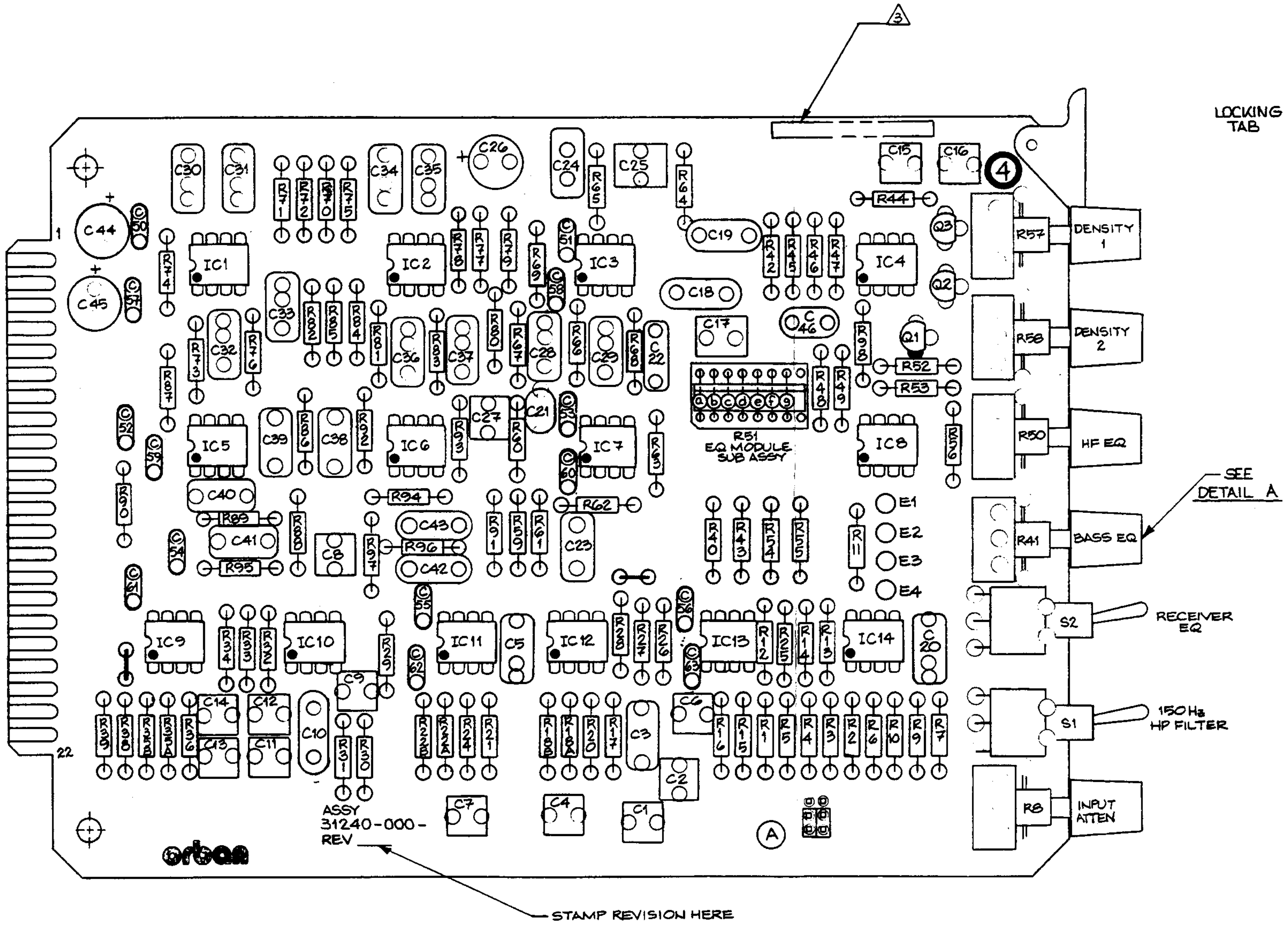
1. ALL DIODES ARE 1N4148

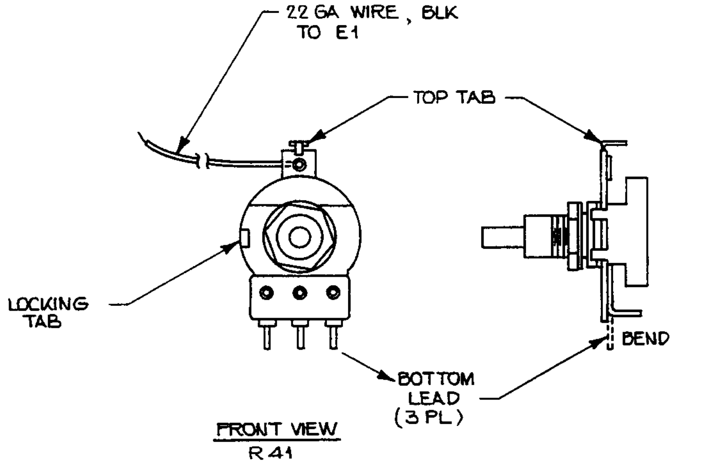
NOTES: (UNLESS OTHERWISE SPECIFIED)

orban

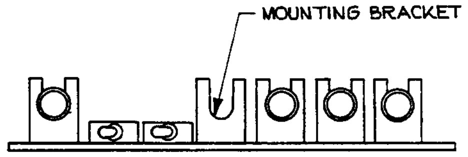
TITLE:
SCHEMATIC
CARD #2/3
61052-000-01

SOLDER SIDE		COMPONENT SIDE	
A	CHASSIS GND	1	———
B	+15V	2	———
C	GND	3	———
D	—	4	———
E	–15V	5	———
F	———	6	———
H	———	7	———
J	———	8	———
K	———	9	———
L	———	10	———
M	———	11	———
N	———	12	———
P	———	13	BAND 1 - 150Hz
R	PRESET 1/2	14	BAND 2 - 420Hz
S	———	15	BAND 3 - 700Hz
T	———	16	BAND 4 - 1.6kHz
U	———	17	BAND 5 - 3.7kHz
V	RECEIVER EQ	18	BAND 6 - 6.2kHz
W	FILTERED AUDIO/ COMPRESSED AUDIO	19	INPUT FILTER
X	AUDIO INPUT/+HI	20	AUDIO INPUT/–LO
Y	FILTERED AUDIO	21	BYPASS IN
Z	———	22	———





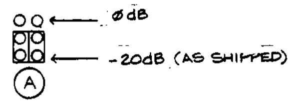
FRONT VIEW
R41



DETAIL A

BEFORE INSTALLING 10K POT, P/N P032-320-000, ON CARD # 4:

1. REMOVE LOCKING TAB.
2. REMOVE TOP TAB.
3. BEND 3 BOTTOM LEADS.
4. SOLDER 22GA, BLK, 3" WIRE (BOTH ENDS TINNED) TO REAR (OTHER END OF WIRE TO E1)
5. FILE MOUNTING BRACKET TO FIT POT BEFORE MOUNTING TO BOARD.



JUMPER A

3 ADD SERIAL NO. PER SAD 014

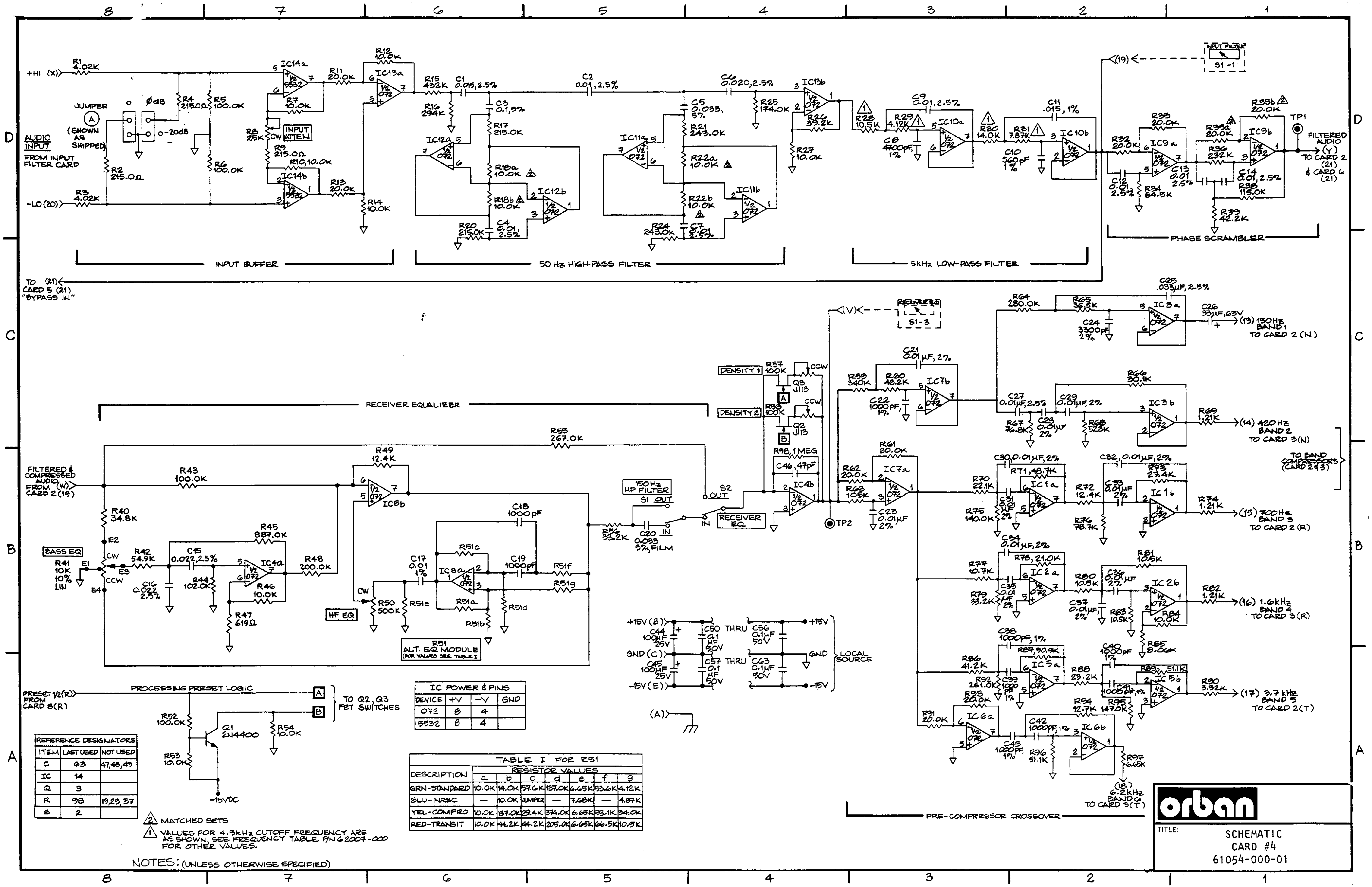
2. TIC MARKS INDICATE PIN ONE OF IC'S, POSITIVE SIDE OF CAPACITORS AND EMITTERS OF TRANSISTORS.

1. REFERENCE SCHEMATIC 61054-000-

NOTES: (UNLESS OTHERWISE SPECIFIED)

orban

TITLE: ASSEMBLY DRAWING
CARD #4
31240-000-01



IC POWER & PINS			
DEVICE	+V	−V	GND
072	8	4	
5532	8	4	

REFERENCE DESIGNATORS		
ITEM	LAST USED	NOT USED
C	63	47,48,49
IC	14	
Q	3	
R	98	19,23,37
S	2	

TABLE I FOR R51

DESCRIPTION	RESISTOR VALUES						
	a	b	c	d	e	f	g
GRN-STANDARD	10.0K	14.0K	57.6K	137.0K	6.65K	53.6K	4.12K
BLU-NRSC	—	10.0K	JUMPER	—	7.68K	—	4.87K
YEL-COMPRO	10.0K	137.0K	29.4K	374.0K	6.65K	93.1K	34.0K
RED-TRANSIT	10.0K	44.2K	44.2K	205.0K	6.65K	66.5K	10.5K

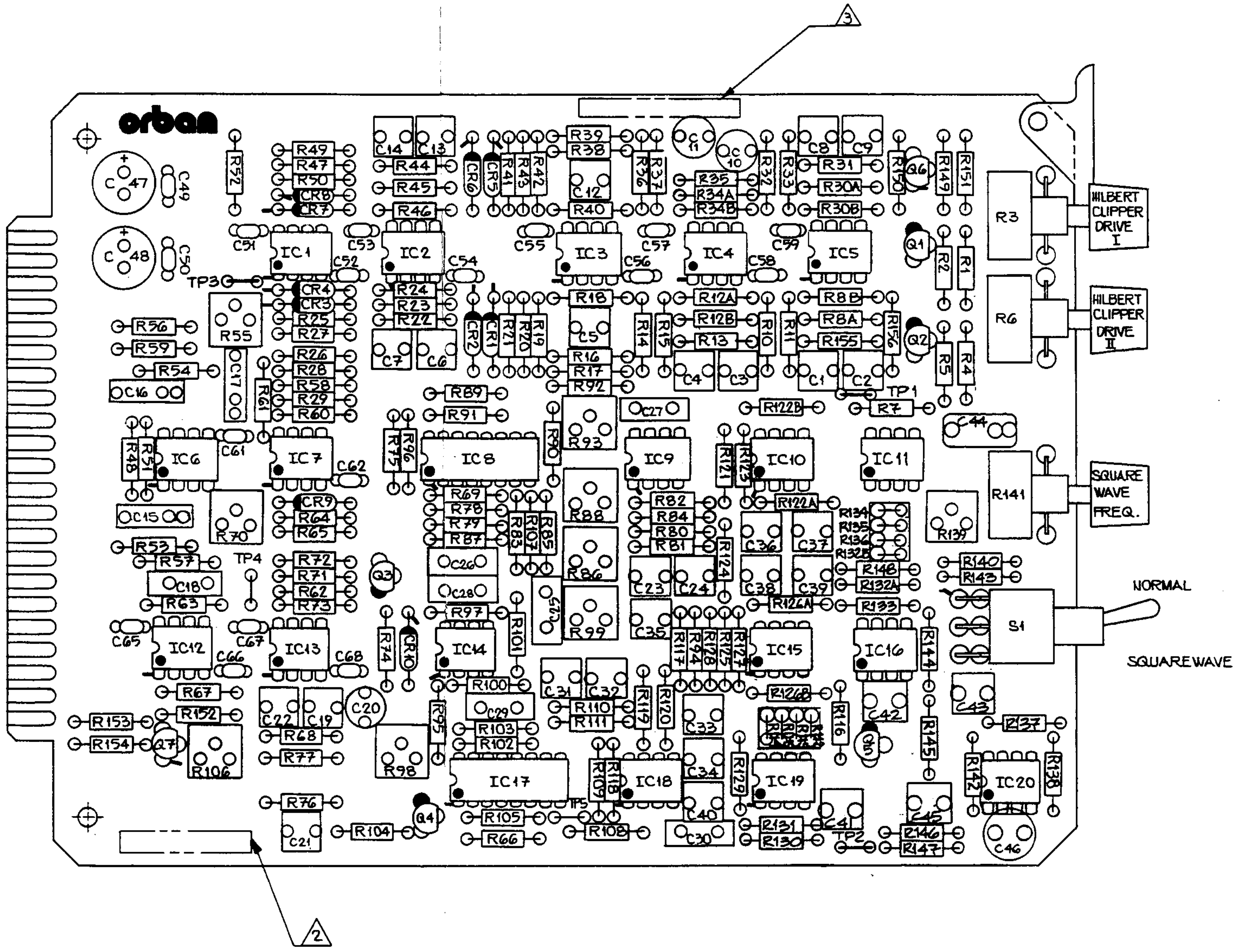
2 MATCHED SETS

1 VALUES FOR 4.5kHz CUTOFF FREQUENCY ARE AS SHOWN, SEE FREQUENCY TABLE P/N 62007-000 FOR OTHER VALUES.

NOTES: (UNLESS OTHERWISE SPECIFIED)

TITLE:
SCHEMATIC
CARD #4
61054-000-01

SOLDER SIDE		COMPONENT SIDE	
A	CHASSIS GND	1	
B	+15V	2	
C	GND	3	
D		4	
E	-15V	5	
F		6	
H		7	
J		8	
K		9	
L		10	
M	INPUT	11	
N		12	
P	OUTPUT	13	
R	PRESET 1/2 CONTROL	14	
S	SYSTEM BYPASS	15	
T		16	
U		17	
V		18	
W	LOCAL SOURCE +1.8V	19	LOCAL SOURCE -1.8V
X		20	PROCESSOR DEFEAT
Y		21	BYPASS AUDIO IN
Z		22	



COMPONENT SIDE

4. REFERENCE SCHEMATIC NO. 61055-000

△3 ADD SERIAL NO. PER SAD 014

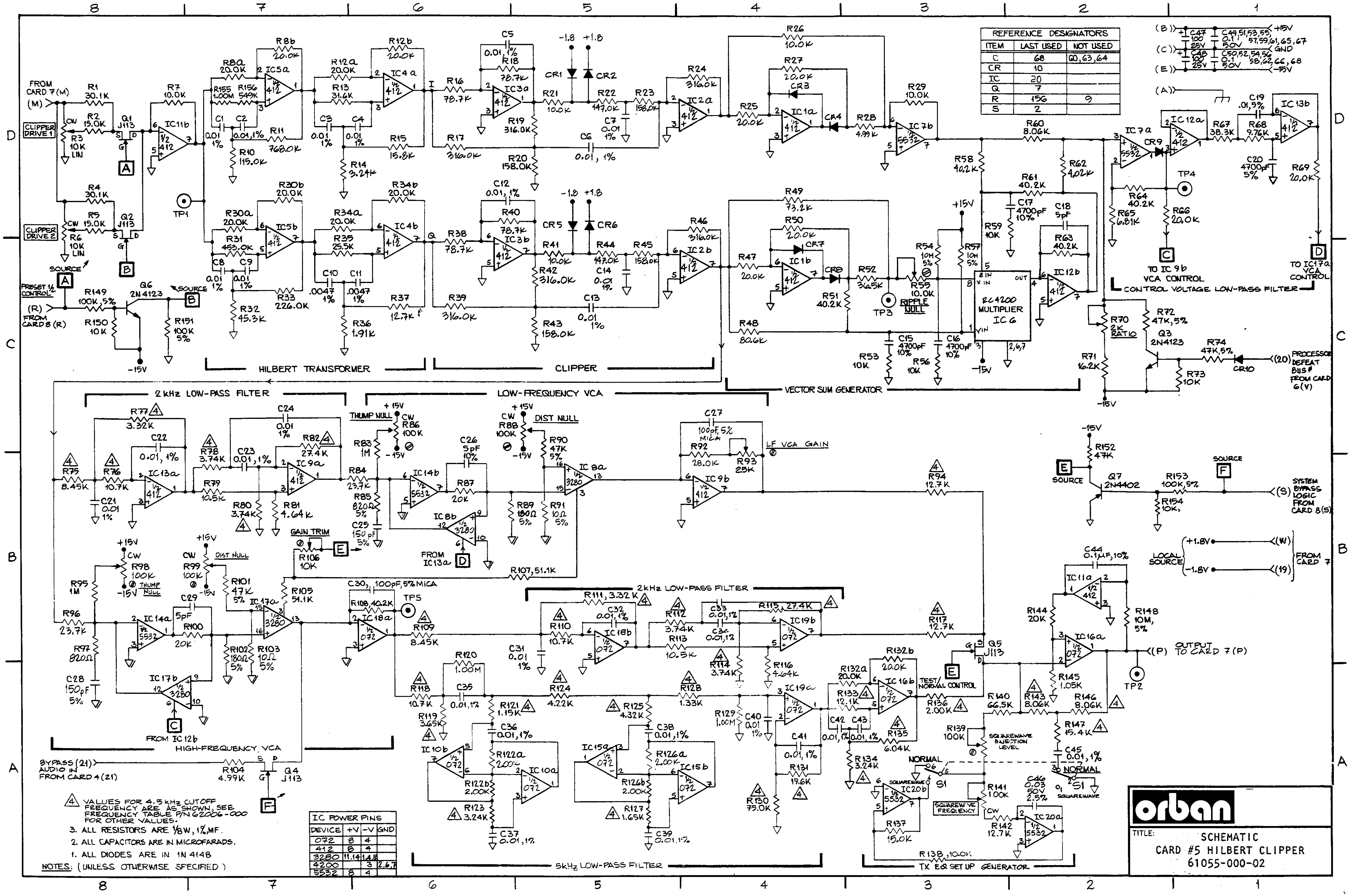
△2 MARK VERSION & REV. LEVEL IN SPACE PROVIDED.

1. TIC MARKS INDICATE PIN 1 OF IC'S, CATHODE OF DIODES, PIN 1 OF SWITCH, EMITTER OF TRANSISTORS, POSITIVE SIDE OF CAPACITORS.

NOTES: (UNLESS OTHERWISE SPECIFIED)

orban

TITLE:
ASSEMBLY DRAWING
CARD #5
31255-000-02



REFERENCE DESIGNATORS		
ITEM	LAST USED	NOT USED
C	68	60,63,64
CR	10	
IC	20	
Q	7	
R	156	9
S	2	

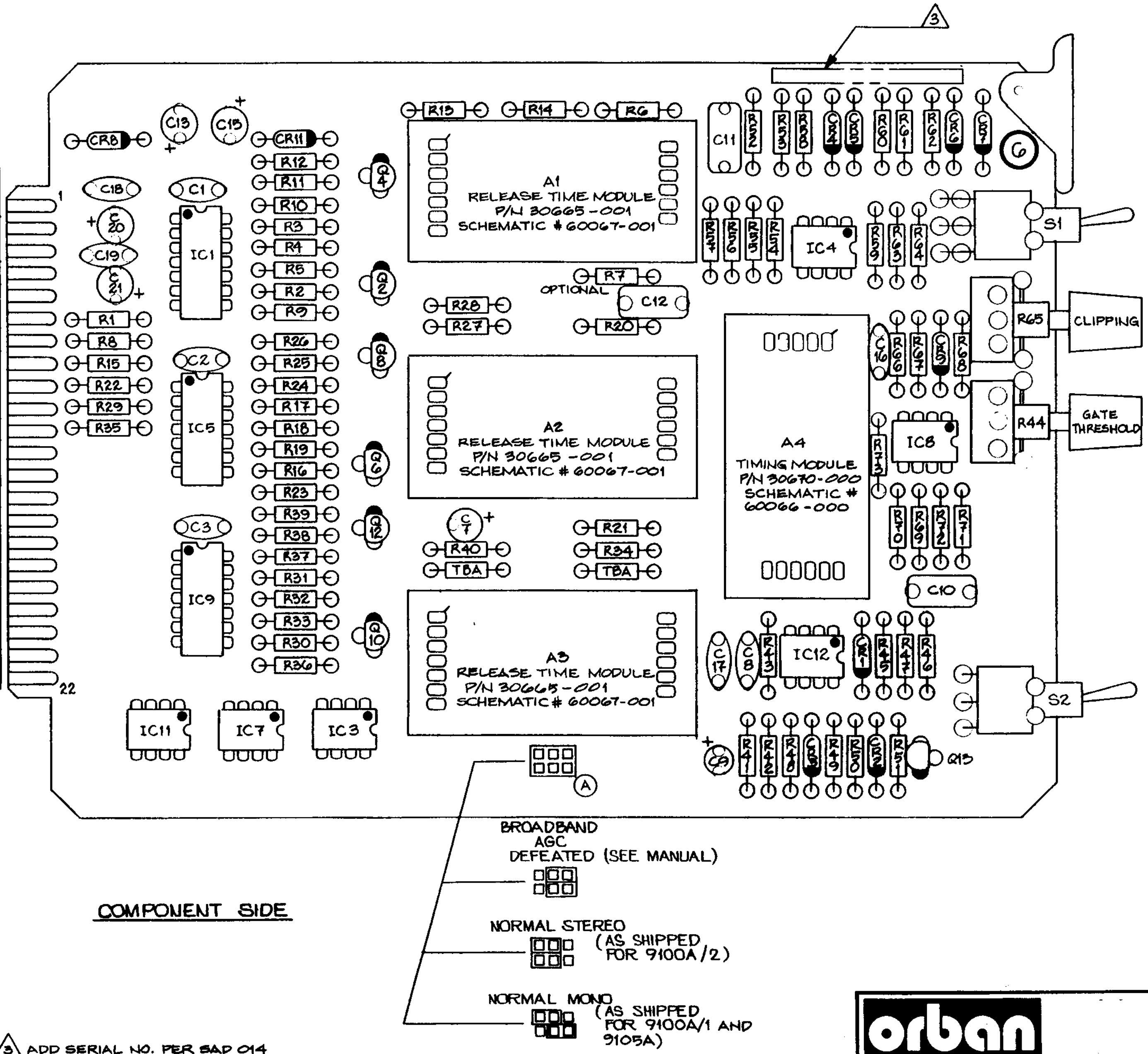
IC POWER PINS			
DEVICE	+V	-V	GND
072	8	4	
412	8	4	
3280	11,14	1,4,8	
4200		3	2,6,7
5532	8	4	

4. VALUES FOR 4.5 kHz CUTOFF FREQUENCY ARE AS SHOWN, SEE FREQUENCY TABLE P/N 62006-000 FOR OTHER VALUES.
3. ALL RESISTORS ARE 1/8 W, 1%, MF.
2. ALL CAPACITORS ARE IN MICROFARADS.
1. ALL DIODES ARE IN 1N 4148

NOTES: (UNLESS OTHERWISE SPECIFIED)

TITLE: SCHEMATIC
CARD #5 HILBERT CLIPPER
61055-000-02

SOLDER SIDE		COMPONENT SIDE	
A	CHASSIS GND	1	——
B	+15	2	——
C	GND	3	——
D	——	4	——
E	-15	5	——
F	——	6	BAND 1/150 Hz
H	——	7	BAND 2/420 Hz
J	——	8	BAND 3/700 Hz
K	——	9	BAND 4/1.6kHz
L	——	10	BAND 5/3.7kHz
M	——	11	BAND 6/6.2kHz
N	——	12	——
P	——	13	"150Hz"(BAND 1)
R	——	14	"420Hz"(BAND 2)
S	——	15	"700Hz"(BAND 3)
T	——	16	"1.6kHz"(BAND 4)
U	——	17	"3.7kHz"(BAND 5)
V	PROCESSOR TEST	18	"6.2"kHz(BAND 6)
W	——	19	COMPRESSED AUDIO
X	"GATE"	20	"BROADBAND AGC"
Y	——	21	FILTERED AUDIO
Z	——	22	——



COMPONENT SIDE

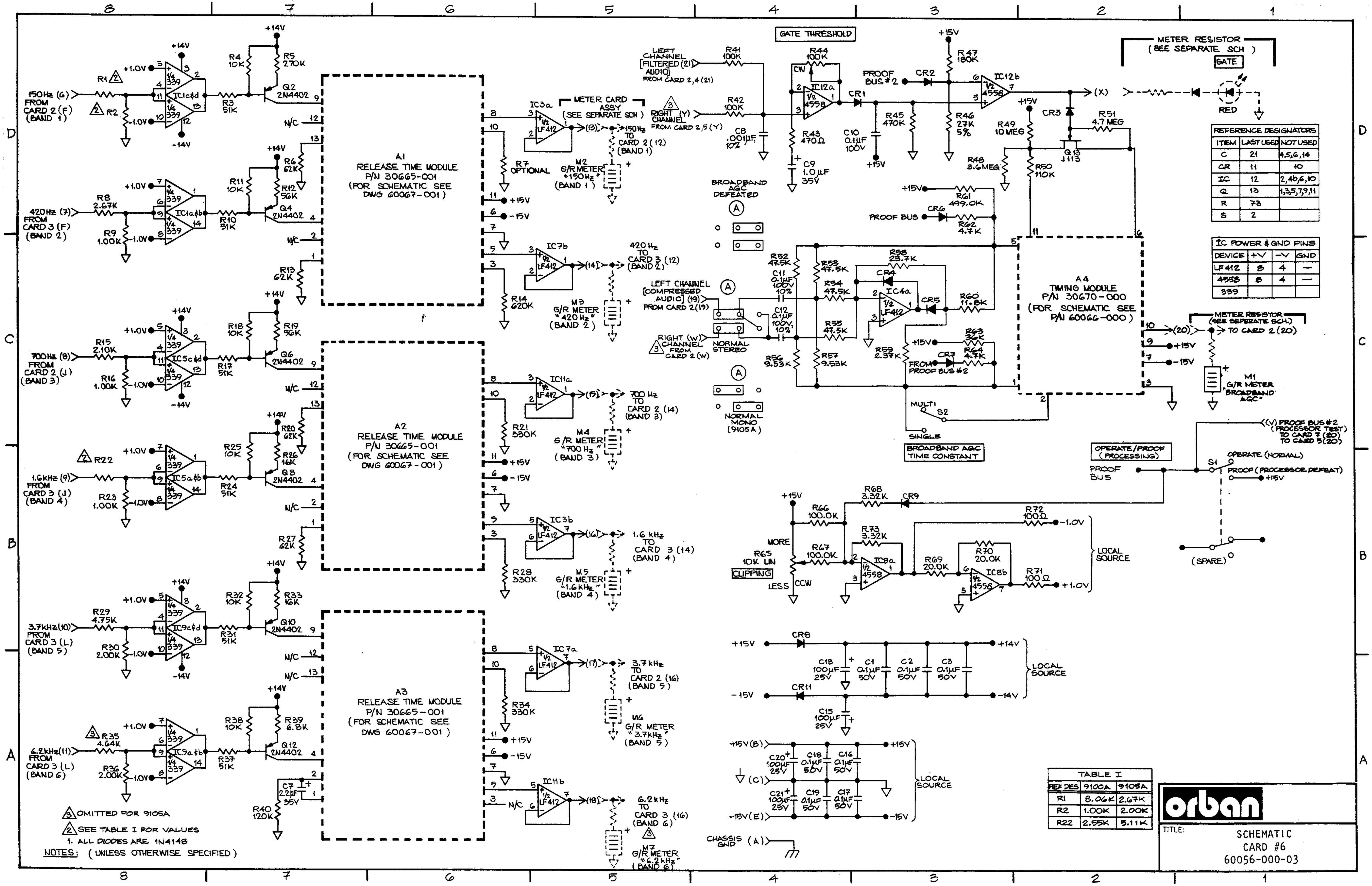
VERSION	CODE
-001	9100A
-002	9105A

NOTES: (UNLESS OTHERWISE SPECIFIED)

1. TIC MARKS INDICATE PIN (1) OF MODULE'S, IC'S, CATHODE OF DIODES, POSITIVE SIDE OF CAPACITORS, AND EMITTERS OF TRANSISTORS
2. REFERENCE SCHEMATIC NO. 60056-000
3. △ ADD SERIAL NO. PER SAD 014

orban

TITLE: ASSEMBLY DRAWING
CARD #6
30660-VER-04



REFERENCE DESIGNATORS		
ITEM	LAST USED	NOT USED
C	21	4,5,6,14
CR	11	10
IC	12	2,4b,6,10
Q	13	1,3,5,7,9,11
R	73	
S	2	

IC POWER & GND PINS			
DEVICE	+V	−V	GND
LF412	8	4	—
4558	8	4	—
339			

TABLE I		
REF DES	9100A	9105A
R1	8.06K	2.67K
R2	1.00K	2.00K
R22	2.55K	5.11K

NOTES: (UNLESS OTHERWISE SPECIFIED)
1. ALL DIODES ARE 1N4148
2 SEE TABLE I FOR VALUES
3 OMITTED FOR 9105A

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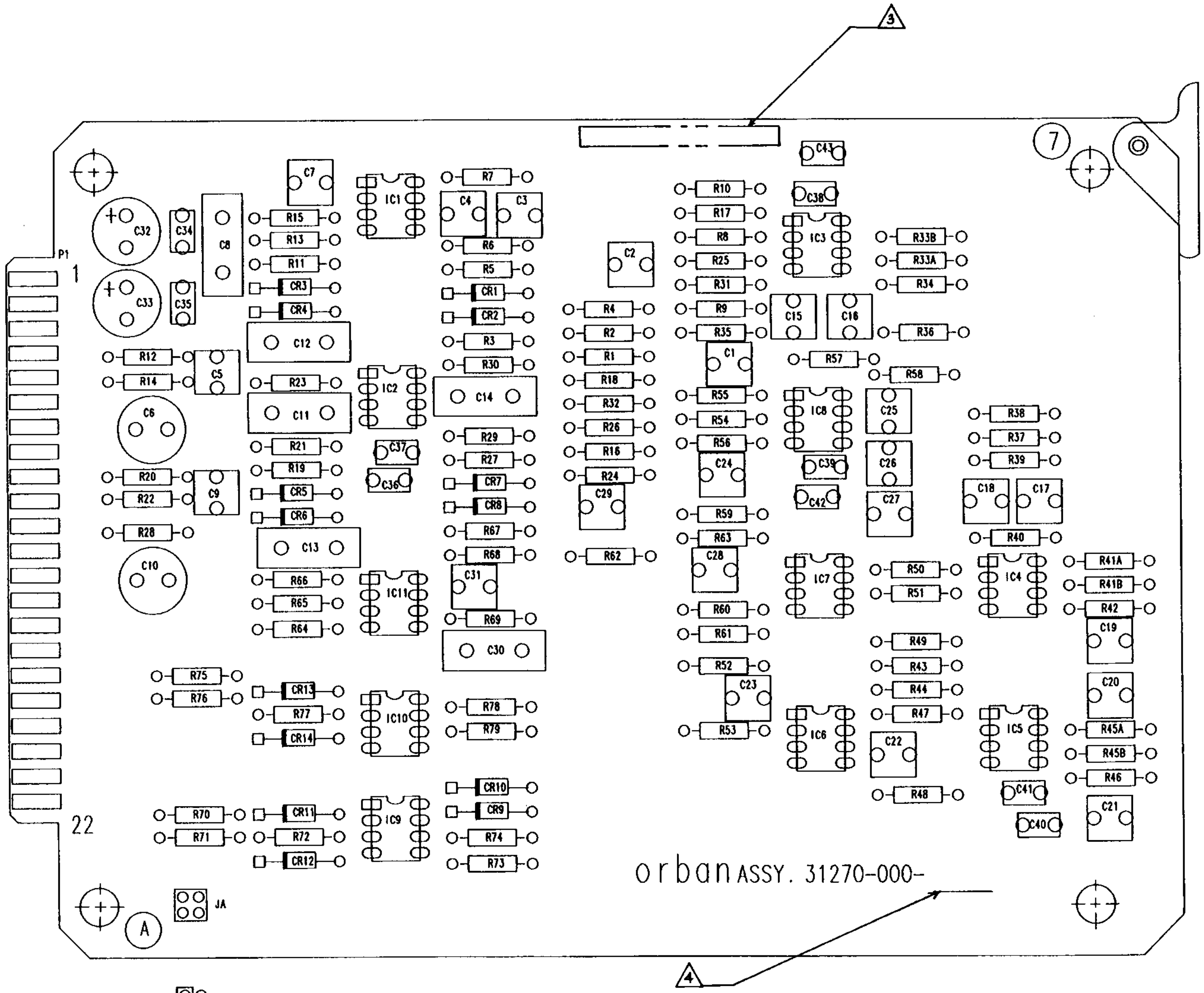
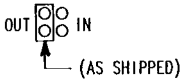
TITLE: SCHEMATIC
CARD #6
60056-000-03

	SOLDER SIDE		COMPONENT SIDE
A	CHASSIS GND	1	————
B	+15V	2	————
C	GND	3	————
D	————	4	————
E	-15V	5	————
F	OUTPUT	6	BAND 1 - 150 Hz
H	————	7	BAND 2 - 420 Hz
J	————	8	BAND 3 - 700 Hz
K	————	9	BAND 4 - 1.6 KHz
L	————	10	BAND 5 - 3.7 KHz
M	CLIPPER DRIVE 1	11	BAND 6 - 6.2 KHz
N	————	12	————
P	FINAL CLIPPER INPUT	13	————
R	————	14	————
S	————	15	————
T	————	16	————
U	————	17	————
V	CLIPPER BIAS (+4.1V)	18	CLIPPER BIAS (-4.1V)
W	CLIPPER BIAS (+1.8V)	19	CLIPPER BIAS (-1.8V)
X	HT CLIPPER	20	PROCESSOR DEFEAT
Y	FROM CARD1 (X)	21	MULTIBAND LIMIT
Z	————	22	————





JUMPER A

4 STAMP REVISION HERE

3 ADD SERIAL NUMBER PER SAD 014

2. SQUARE PADS INDICATE PIN#1 OF IC'S, CATHODE OF DIODES.

1. REFERENCE SCHEMATIC NO. 61057-000

NOTES: (UNLESS OTHERWISE SPECIFIED)

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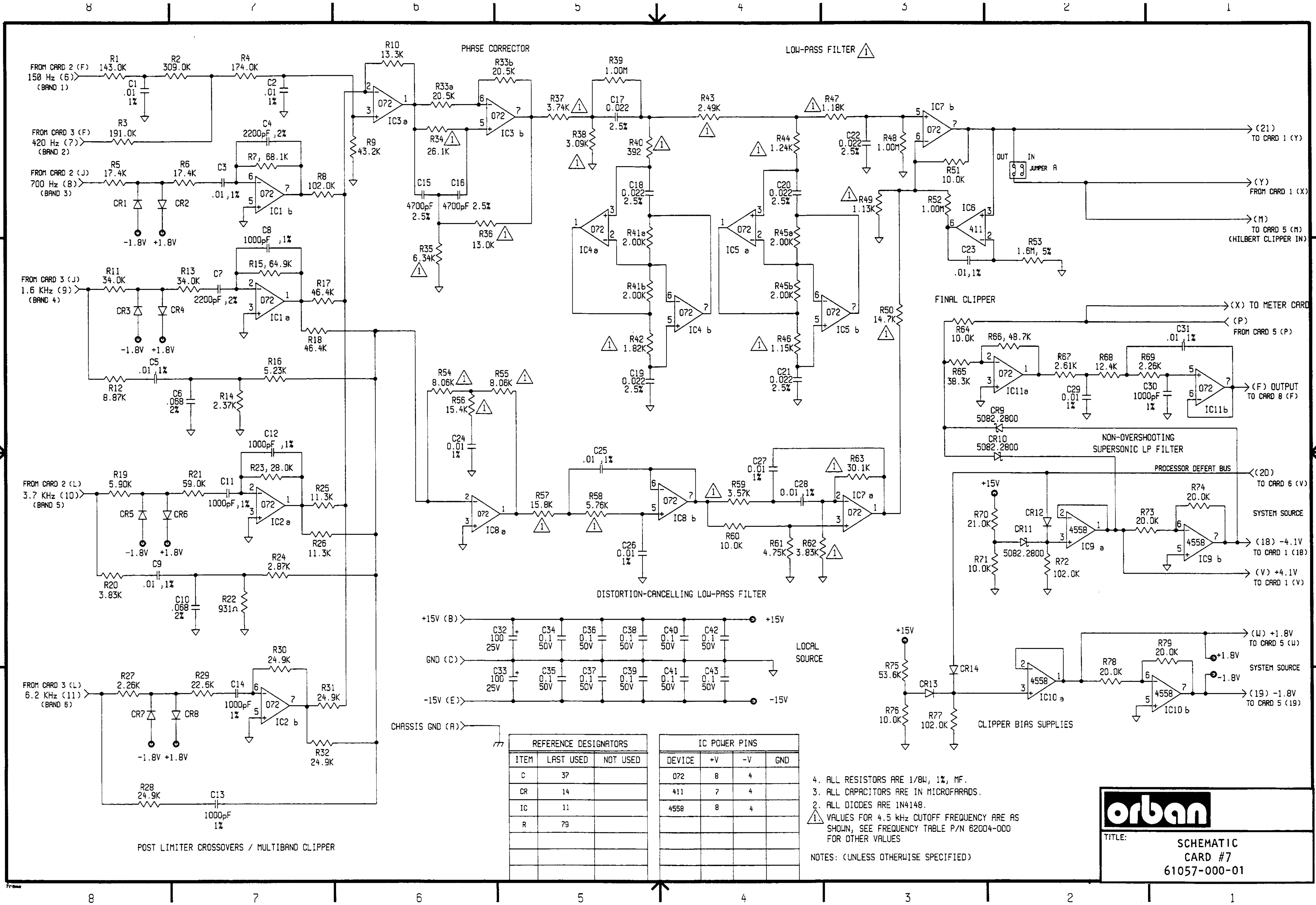
TITLE: ASSEMBLY DRAWING
CARD #7
31270-000-01



REFERENCE DESIGNATORS		
ITEM	LAST USED	NOT USED
C	37	
CR	14	
IC	11	
R	79	

IC POWER PINS			
DEVICE	+V	-V	GND
072	8	4	
411	7	4	
4558	8	4	

4. ALL RESISTORS ARE 1/8W, 1%, MF.
3. ALL CAPACITORS ARE IN MICROFARADS.
2. ALL DIODES ARE 1N4148.
1. VALUES FOR 4.5 kHz CUTOFF FREQUENCY ARE AS SHOWN, SEE FREQUENCY TABLE P/N 62004-000 FOR OTHER VALUES

NOTES: (UNLESS OTHERWISE SPECIFIED)

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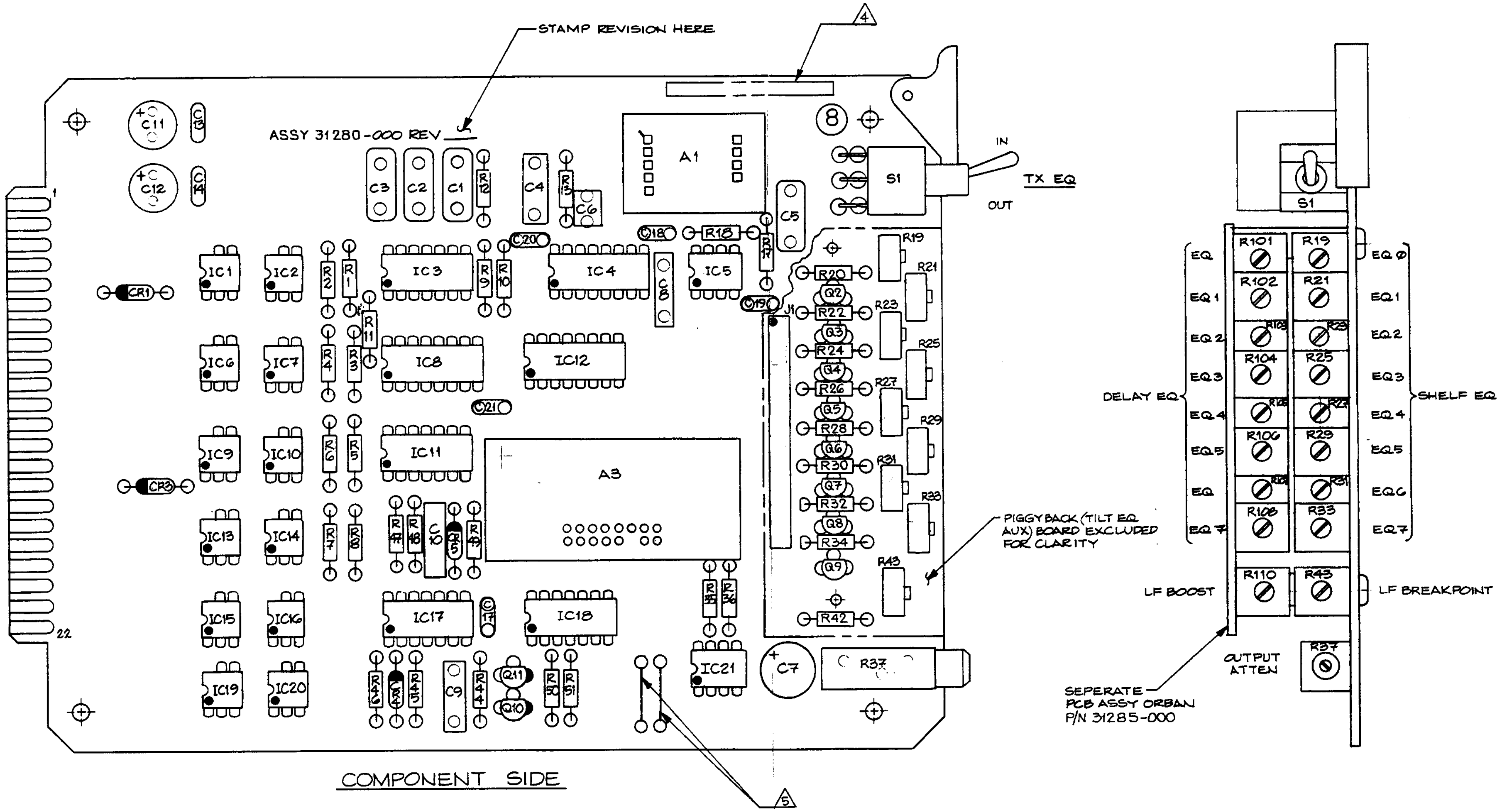
TITLE:
SCHEMATIC
CARD #7
61057-000-01

SOLDER SIDE		COMPONENT SIDE	
A	CHASSIS GND	1	————
B	+15V	2	————
C	GND	3	————
D	LOGIC GND	4	————
E	-15V	5	————
F	AUDIO IN	6	SYSTEM BYPASS NORMAL
H	NORMAL/BYPASS	7	SYSTEM BYPASS BYPASS
J	PRESET 1/PRESET 2	8	PROCESSING PRESET-2
K	TX EQ PRESET	9	PROCESSING PRESET-1
L	EQ 2	10	EQ 7
M	EQ3	11	EQ6
N	EQ0	12	EQ 4
P	EQ 1	13	EQ 5
R	PRESET 1/PRESET 2	14	COMMON (EQ)
S	SYSTEM BYPASS	15	COMMON
T	PRESET 1	16	PRESET
U	BYPASS	17	NORMAL
V	OUTPUT METER	18	SYSTEM OUTPUT-
W	DISPLAY DRIVE Q_1	19	————
X	DISPLAY DRIVE Q_0	20	————
Y	DISPLAY DRIVE Q_2	21	————
Z	SYSTEM OUTPUT +	22	TX EQ



COMPONENT SIDE

△5 NOTE; FOR TEST DEPT. ONLY
CUT TRACES, ADD FERRITE BEADS IF REQUIRED

△4 ADD SERIAL NO. PER SAD 014

3. REFERENCE SCHEMATIC 61058-000-

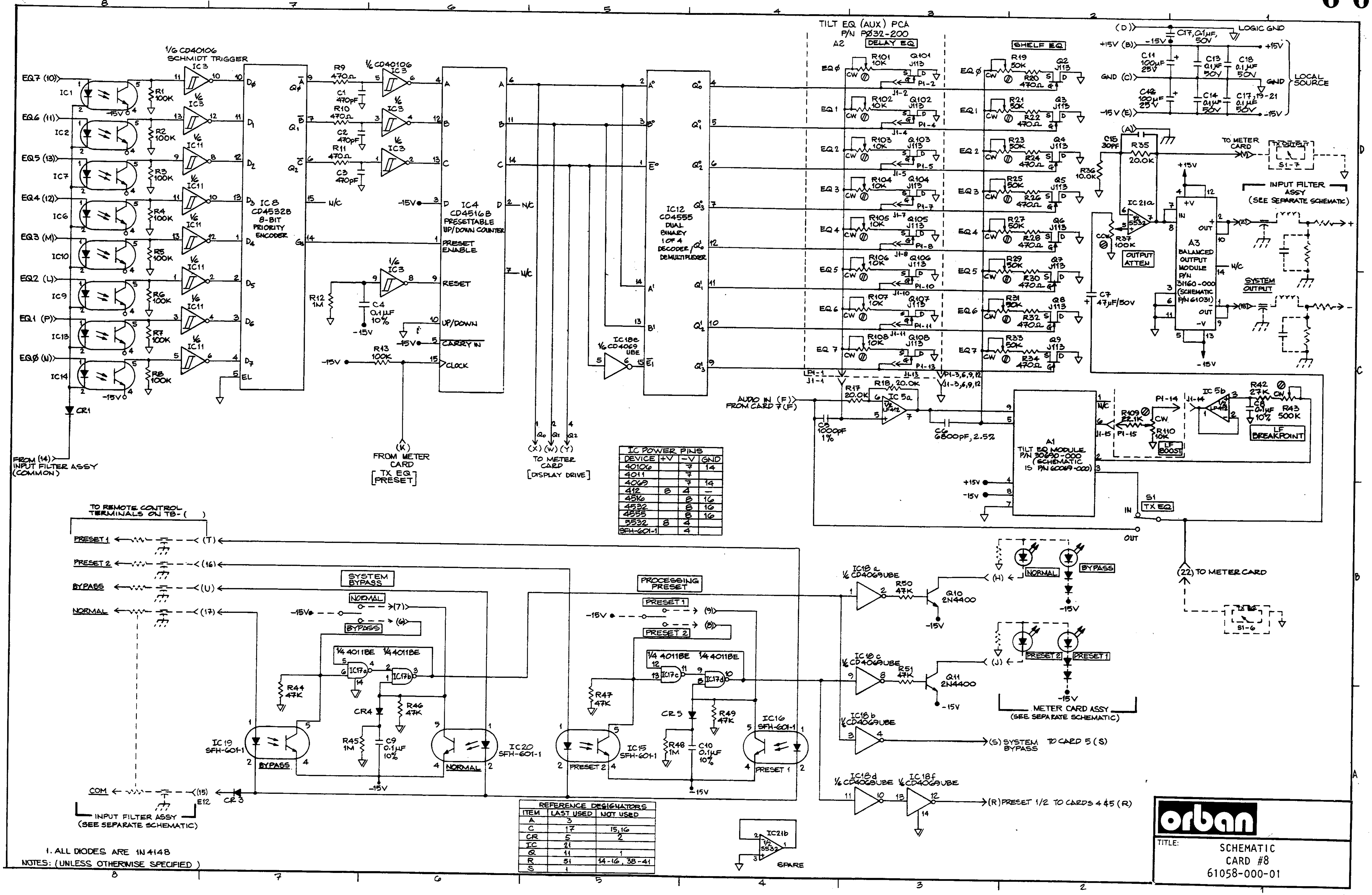
2. CLIP PIN 6 ON IC'S 1,2,6,7,9,10,13,14,15,16,19,20 BEFORE INSERTING

1. TIC MARKS INDICATE PIN (1) OF MODULE, IC'S, CATHODE OF DIODES, POSITIVE SIDE OF CAPACITORS, AND EMITTERS OF TRANSISTORS

NOTES: (UNLESS OTHERWISE SPECIFIED)

orban

TITLE: ASSEMBLY DRAWING
CARD #8
31280-000-01



IC POWER PINS			
DEVICE	+V	-V	GND
40106		7	14
4011		7	
4069		7	14
412	8	4	—
4516		8	16
4532		8	16
4555		8	16
5532	8	4	
SFH-601-1		4	

REFERENCE DESIGNATORS		
ITEM	LAST USED	NOT USED
A	3	
C	17	15, 16
CR	5	2
IC	21	
Q	11	1
R	51	14-16, 38-41
S	1	

NOTES: (UNLESS OTHERWISE SPECIFIED)
1. ALL DIODES ARE 1N4148

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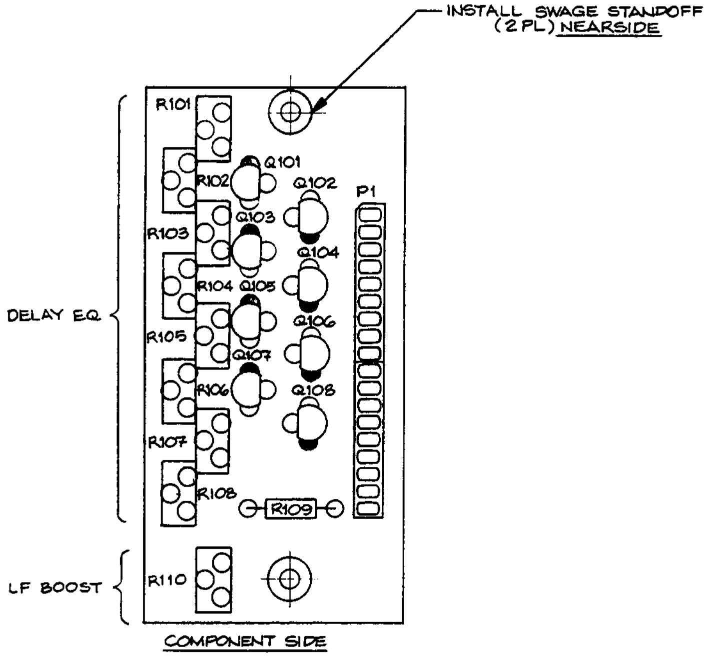
TITLE: SCHEMATIC CARD #8
61058-000-01



3. TIC MARK IS PIN 1 ON CONNECTOR AND GATE OF TRANSISTOR
2. USED ON CARD 8, 31280-000
1. REF SCHEMATIC NO. 61058-000
NOTES:

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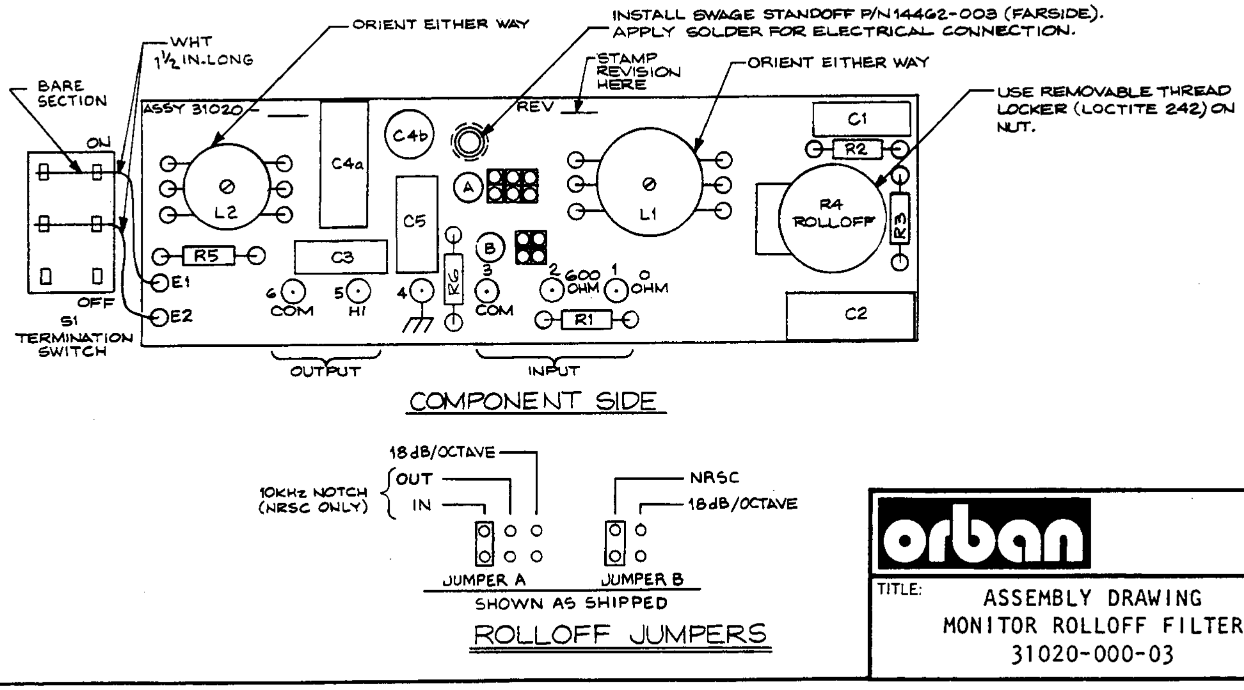
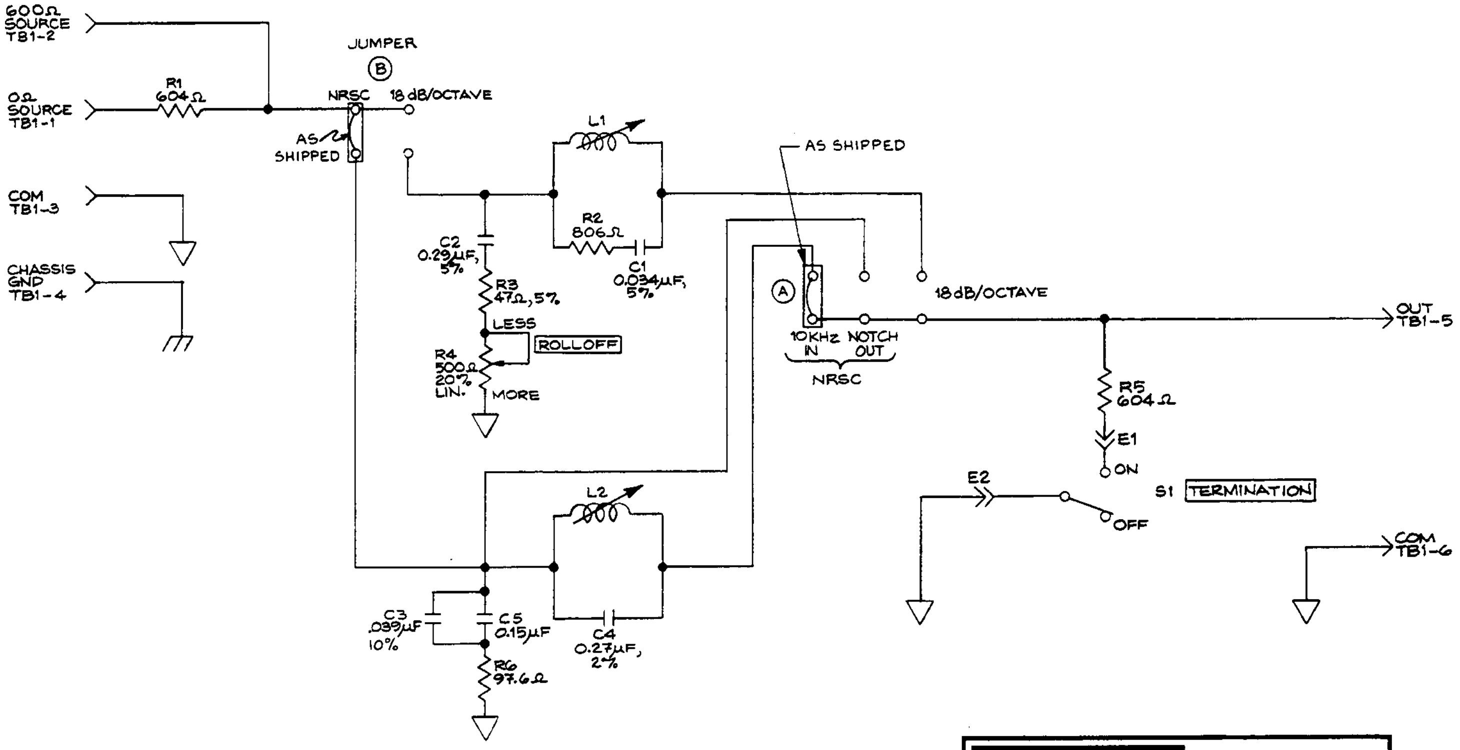
TITLE:
ASSEMBLY DRAWING
TILT EQ (AUX) CARD
31285-000-01



orban

TITLE:
ASSEMBLY DRAWING
MONITOR ROLLOFF FILTER
31020-000-03



NOTES: 1. ALL RESISTORS ARE MF, 1/8W, 1% (UNLESS OTHERWISE SPECIFIED)

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TITLE:
SCHEMATIC
MONITOR ROLLOFF FILTER
61016-000-01

Abbreviations

Some of the abbreviations used in this manual may not be familiar to all readers:

AGC	automatic gain control
CCIF	International Telephone Consultative Committee
CD	Compact disc
DAC	digital-to-analog converter
dBu	0dBu = 0.775Vrms. For this application, the dBm into 600Ω scale on voltmeters can be read as if it were calibrated in dBu.
DJ	disk jockey, an announcer who plays records in a club or on the air
EBS	Emergency Broadcasting System
EBU	European Broadcasting Union
EMI	electromagnetic interference
FCC	Federal Communications Commission (USA)
FET	field-effect transistor
G/R	gain reduction
HF	high-frequency
IC	integrated circuit
IEC	International Electrotechnical Commission
IF	intermediate frequency
IM	intermodulation (or "intermodulation distortion")
ips	inches per second
JFET	junction field-effect transistor
LED	light-emitting diode
LF	low-frequency
NAB	National Association of Broadcasters (USA)
N&D	noise and distortion
NRSC	National Radio Systems Committee
PM	pulse modulation
PPM	peak program meter
RF	radio frequency
RFI	radio-frequency interference
SCA	secondary channel authorization (FCC)
SID	slew-induced distortion
SMPTE	Society of Motion Picture and Television Engineers
S/N	signal-to-noise ratio
STL	studio-transmitter link
THD	total harmonic distortion
VCA	voltage-controlled amplifier

Warranty

United States Warranty

Limited Warranty

Valid only in the United States. We warrant Orban products against defects in material or workmanship for a period of one year from the date of original purchase for use, and agree to repair or, at our option, replace any defective item without charge for either parts or labor.

IMPORTANT: This warranty does not cover damage resulting from accident, misuse or abuse, lack of reasonable care, the affixing of any attachment not provided with the product, loss of parts, or connecting the product to any but the specified receptacles. This warranty is void unless service or repairs are performed by an authorized service center. No responsibility is assumed for any special, incidental or consequential damages. However, the limitation of any right or remedy shall not be effective where such is prohibited or restricted by law.

Simply take or ship your Orban product prepaid to our service department. Be sure to include your sales slip as proof of purchase date. (We will not repair transit damage under the no-charge terms of this warranty). Orban will pay return shipping.

NOTE: No other warranty, written or oral is authorized for Orban products.

This warranty gives you specific legal rights, and you may also have other rights which vary from state to state. Some states do not allow the exclusion of limitations of incidental or consequential damages or limitations on how long an implied warranty lasts, so the above exclusion and limitations may not apply to you.

International Warranty

Bedingungen

Orban gewährt 1 Jahr Garantie ab Verkaufsdatum auf nachweisbare Material- und Fabrikationsfehler. Der Garantieanspruch erlischt bei unsachgemäßer Handhabung, elecktrischer oder mechanischer Beschhädigung durch mißbräuchliche Anwendung sowie bei unsachgemäßer Reparatur durch nichtautorisierte Werkstätten. Voraussetzung für die Garantieleistung ist die Vorlage der ordnungsgemäß durch den Fachhändler ausgefüllten Garantiekarte sowie der Kaufrechnung. Transport- und Portospesen, welche aus der Einsendung des Gerätes zur Garantiereparatur erwachsen, können von Orban nicht übernommen werden, das Risiko der Zusendung trägt der Kunde. Die Garantie wird ausschließblich für den ursprünglichen Käufer geleistet.

Warranty Conditions

Orban warrants Orban products against evident defects in material and workmanship for a period of one year from the date of original purchase for use. This warranty does not cover damage resulting from misuse or abuse, or lack of reasonable care, and inadequate repairs performed by unauthorized service centers. Performance of repairs or replacements under this warranty is subject to submission of this Warranty/Registration Card, completed and signed by the dealer on the day of purchase, and the sales slip. Shipment of the defective item for repair under this warranty will be at the customer's own risk and expense. This warranty is valid for the original purchaser only.

Conditions de garantie

Pour toute mise en œvre de garantie ou de service après-vente, vous devez vous adresser à votre revendeur. Notre société assure au revendeur le remplacement gratuit des pièces détachées nécessaires à la réparation pendant un an, à partir de la date de votre facture, sauf en cas de non respect des prescritions d'utilsation ou lorsqu' une cause étrangère à l'appareil est responsable de la défaillance. Les dispositions stipulées ci-dessus ne sont pas exclusives du bénéfice au profit de l'acheteur de la garantie légale pour défaut et vice cachés qui s'applique, en tout état de cause, dans les conditions des articles 1641 et suivants du Code Civil.

Condizioni di garanzia

L'Orban presta garanzia per un anne dalla data della vendita per difetti di materiale e fabbriccazione che possono essere provati. Il diritto di garanzia cessa in caso di manipolazione impropria, danneggiamento electtrico o meccanico attraverso l'uso non approriato e riparazione inesperta eseguita da officine non autorizzate. E' indispensabile, per la prestazione della garanzia, presentare la carta di garanzia debitamente riempita dal rivenditore autorizzato e la fattura di vendita. Spese di trasporto che risultano dall'invio dell'impianto per la riparazione in garanzia, non possono essere assunte dall'Orban l'invio è a rischio e pericolo del cliente. La garanzia verrà data solo al primo acquirente.

Condiciones de garantia

Orban concede 1 añe de garantia por defectos comprobables de material o de fabricación a partir de la fecha de venta. El derecho de garantia caduca en caso de procederse a uno manipulación inadecuada en caso de producirse daño electrico o mecánico por uso indebido, así como también en caso de reparaciones inadecuados por parte de talleres no autorizados. La prestación de la garantia está sujeta a la presentación de la Tarjeta de Garantia rellenada correctamente por el vendedor autorizado, y de la factura de compra. Orban no assume ningún gasto de transporte o correo incurrido por el envio del aparato defectuoso para la reparación bajo garantia; el riesgo del envio ha de ser asumido por el cliente. La garantia se concede única y exclusivamente al comprador original.