Section 6
Technical Data

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Specifications

Performance

Frequency Response (20-15,000Hz): ±0.25dB below leveler, compressor, and high-frequency limiter thresholds.

RMS Noise: >82dB (83.5dB typical) below 100% modulation with high-frequency limiter strapped for flat output. See the table in step 13-D on page 4-13 for typical noise performance with various high-frequency limiting curves.
Measured in a 20-20,000Hz bandwidth with a true-R.M.S. meter.

Total Harmonic Distortion (TEST mode): <0.05%, 20-15,000Hz.
Measured at level equivalent to 90% peak modulation.

Total Harmonic Distortion (OPERATE mode): <0.05% at 1kHz. Typically <0.2% at 20Hz, <0.1% at 100Hz, <0.05% at 200-15,000Hz.
Measured with 5dB of limiting at 1kHz. (As with any limiter, low frequency distortion will rise as limiting is increased because the limiter acts on each cycle of the low-frequency waveform.)

SMPTE Intermodulation Distortion (TEST mode): <0.075%.
Measured at level equivalent to 90% peak modulation; 60/7000Hz; 4:1.

SMPTE Intermodulation Distortion (OPERATE mode): <0.25%.
Measured with 5dB of limiting.

Interchannel Crosstalk: Better than −90dB, 20-15,000Hz.

Overshoot: 1dB maximum (referred to the low-frequency "clipping threshold" of the FCS Overshoot Compensator).

Spectral Control: See Figure 3-1 on page 3-8.

Installation

Audio Input

Impedance: >10KΩ, active balanced, EMI-suppressed. Input transformer option available (specify OPT-25).

Operating Level: Usable with −30dBu to +10dBu lines.
(0dBu = 0.775V RMS; for this application, the dBm @600Ω scale on voltmeters can be read as if were calibrated in dBu.)

Connectors: XLR-type.

Audio Output

Impedance: 30Ω, electronically balanced and floating to simulate true transformer output. Minimum load impedance is 600Ω. Output can be unbalanced by grounding one output terminal. Output transformer option available (specify OPT-26).

Level: Front-panel controls permit use with −10dBm to +8dBm systems. Output clipping level is >+20dBm @600Ω.

Connectors: XLR-type.

Physical

Pushbuttons: Momentary.

Meter: 10-segment LED bargraph display shows limiting, 0 to 15dB.

Indicators: Two LEDs light to show operation of gating and high-frequency limiting.

Dimensions: 19" (48.3 cm) wide, 11.25" (28.6 cm) deep, 3½" (8.9 cm) high.

Operating Temperature Range: 32-113°F (0-45°C)

Humidity: 0-90% RH (non-condensing)

Power Requirements: 115/230 volts AC ±10%, 50-60Hz, 16VA (9VA for 4000A1). IEC mains connector with detachable three-wire power cord and plug supplied. EMI-suppressed.

Protection: Leakage to chassis <0.5mA at 115V, <0.7mA at 230V. AC power input is RFI-suppressed.

Fuse: ½-amp 3AG Slow-Blow for 115V operation; ¼-amp (250mA) 5x20mm "T" type for 230V operation.

Options

Security Cover (acrylic): To prevent unauthorized adjustment of controls.
Order SC2 CLEAR for a clear cover, SC2 BLUE for a transparent blue cover, or SC2 WHITE for an opaque white cover.

Audio Processing Circuitry

Dual-Band Limiter

Attack Time: Approximately 2ms; program-dependent.

Release Time: Program-dependent; not user-adjustable.

Compression Ratio: >20:1 (static); program-dependent (dynamic).

Range of Limiting: 15dB.

Interchannel Tracking: ±0.5dB (dual-channel 4000 strapped for coupled operation).

Total Harmonic Distortion (TEST mode): <0.035%, 20-15,000Hz.
Measured at level equivalent to 90% peak modulation.

SMPTE Intermodulation Distortion: <0.075%
Measured at level equivalent to 90% peak modulation.

Limiting Element: Class-A VCA.

High-frequency Limiter

Pre-emphasis: Five pre-emphasis curves: 25µs, 50µs, 75µs, 150µs, and CCITT J.17. Can be strapped for flat or pre-emphasized output.

Response: The high-frequency limiting threshold and attack time have been set so that no audible distortion is produced with dynamic program material that has been processed by the leveler/compressor and peak clipper. Because these settings have taken into account the peak-to-average ratio of the leveler/compressor's output, it is not possible to specify the high-frequency limiter's response to test tones with simple, meaningful numbers.

Total Harmonic Distortion: The high-frequency limiter/clipper will add no more than 0.02% THD to sine wave test tones that have been processed by the leveler/compressor.

Release Time: Approximately 30ms, program-dependent.

Interchannel Coupling: Each channel's high-frequency limiter operates independently at all times (the use of fast release times precludes disturbances of the stereo image's stability).

Limiting Element: Junction FET.

HF Limiting Curve: Shelving, 6dB/octave.

"Smart Clipper"

Distortion: Below its clipping threshold, the "Smart Clipper" will add no more than 0.025% THD to sine wave test tones that have been processed by the previous circuitry. Above threshold the circuitry cancels clipping-induced intermodulation distortion in a complex, frequency-dependent manner to maximize psychoacoustic masking of such distortion, minimizing its perceptibility.

FCS Overshoot Compensator

Distortion: Below its clipping threshold, the FCS Overshoot Compensator will add no more than 0.01% THD to sine wave test tones that have been processed by the previous circuitry. Above threshold the circuitry performs "band-limited clipping" to remove overshoot without introducing out-of-band distortion power above 15kHz.

Warranty

One Year, Parts and Labor: Subject to the limitations set forth in Orban's Standard Warranty Agreement.

Specifications subject to change without notice.

Circuit Description

On the following pages, a detailed description of each circuit's function is accompanied by a component-by-component description of that circuit. **Keywords are highlighted** throughout the circuit descriptions to help you quickly locate the information you need.

The circuitry is described in thirteen major blocks: input buffer, J.17 pre-emphasis, dual-band limiter, dual-band limiter control circuit, gating detector, LIMITING metering, high-frequency limiter, "Smart Clipper," VCA (voltage-controlled amplifier), Frequency-Contoured Sidechain Overshoot Corrector, balanced floating output amplifier, control logic, and power supply.

This description applies to the single-channel 4000A1. The two channels of the 4000 are identical, so this description applies exactly if the "channel B" reference designators are substituted for the "channel A" reference designators.

The **block diagram** on page 6-33 illustrates the following overview of 4000 circuitry.

The signal, which enters the 4000 in a balanced form, receives moderate **RF suppression**, then is applied to a very low-noise differential amplifier made up of three opamps in the classic "instrumentation amplifier" configuration. This circuit functions as an "**active transformer**."

The signal then is applied to the low-frequency section of the J.17 pre-emphasis. This circuit is bypassed when J.17 pre-emphasis is not used.

The **dual-band limiter** divides the audio into two bands (above and below 150Hz) with a phase-linear crossover whose outputs sum to the crossover's original input signal. The "master" band (above 150Hz) usually controls the gain of both the "master" and "bass" bands, which track to preserve frequency balances. However when strong bass appears, the "bass" band compressor increases its limiting to prevent the bass from overdriving the following peak limiting circuitry.

Each of the two band-compressors is a feedback circuit: the output of the compressor is looped back to develop a **gain-control signal** that is applied to its VCA. This arrangement results in superior stability of characteristics with time and temperature, extremely low distortion, and optimized control-loop dynamic response.

The proprietary dual-band limiter **timing module** generates a control signal that enables the 4000 to achieve natural-sounding control and very low modulation distortion. All dynamic parameters are determined by the timing module on the basis of the past history of the input. They were very carefully "tuned" to minimize audible compression-induced artifacts.

The voltage-controlled gain blocks used in the 4000's **dual-band limiter** are class-A **voltage-controlled amplifiers** (VCAs). They have a "decilinear" response: their gain is proportional to the exponential of the voltage applied to their gain-control port. Any "**thumps**" due to control current feedthrough are eliminated by applying DC offset to the VCA's input.

A **gating detector** monitors the level of the 4000's input signal and activates the gate if this level drops below a factory-set threshold.

The **LIMITING meter** consists of ten comparators arranged to produce a meter with a 0 to 15dB linear scale.

High-frequency limiting is effected by applying the output of the dual-band limiter to a bandpass filter. When summed with its input, the output of this filter provides a 6dB/octave **pre-emphasis** up to 15kHz (or to about 5kHz with J.17 pre-emphasis). The +3dB breakpoint frequency for the pre-emphasis is determined by the amount of bandpass output that is summed with the input signal — the greater the contribution from the bandpass output, the lower the breakpoint frequency.

The contribution from the bandpass output is determined by the settings of jumpers that determine the pre-emphasis, and by circuitry that can dynamically reduce the pre-emphasis to effect the high-frequency limiting function.

The output of the high-frequency limiter is applied to the "**Smart Clipper**," which controls peak levels while canceling difference-frequency intermodulation distortion. It operates in two frequency bands (above and below 2kHz). The signal is clipped and then applied to the top band, which eliminates distortion below 2kHz. The un-clipped signal is applied to an 2kHz low-pass filter and then to a VCA. The difference between the clipper's input and its output is rectified, low-pass filtered, and used to control the gain of the VCA. This smoothed control signal limits low-frequency peaks effectively while introducing less distortion than would a control signal that were not smoothed.

The distortion cancelation in the "Smart Clipper" adds some overshoots to its output. Its integral **15kHz low-pass filter**, which is used as a delay line as well as a means for spectrum control, also adds overshoots. These are eliminated in the **FCS Overshoot Corrector**. This circuit operates as a "band-limited clipper" — it clips off peaks exceeding 100% modulation but does not introduce out-of-band power above 15kHz as would a simple clipper. If the subsequent **de-emphasis** has been jumpered out, the absolute peak ceiling at the 4000's output will be independent of frequency; if de-emphasis is applied, the peak ceiling will be frequency-dependent, following the de-emphasis curve selected by jumper JB.

The output of the de-emphasis circuit is applied to the **OUTPUT LEVEL control**, and then to the **balanced output amplifier**. This amplifier uses two opamps in a complex cross-coupled arrangement with positive and negative feedback to simulate an **active transformer**. A **servo amplifier** ensures that the quiescent DC level at the output of the amplifier will be centered at ground.

Unregulated voltage is supplied by two pairs of full wave diode rectifiers. **Regulated voltages** are supplied by a pair of overrated 500mA "three-terminal" IC regulators. Several pairs of opamps provide bias and reference voltages for various parts of the circuitry.

1. Input Buffer

Located On Main Circuit Board

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 limiting, the Input Attenuation pads 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.

Component-level description:

The input is RF-filtered, then applied to 10K bridging pad R100, R103. Strapping R101 and R102 into the pad introduces 20dB attenuation (The 4000 is shipped with R101 and R102 strapped in).

The output of the pad is connected to low-noise true instrumentation amplifier IC2-A, IC1-A, IC1-B, and associated resistors. R104, R105 provide bias current for IC1-A, IC2-A, which are low-noise bipolar-input dual IC opamps. R106-A, R106-B are feedback resistors for IC1-A, IC2-A. The differential gain is controlled by the series resistance of R107 and the INPUT ATTENuator control R1. The common-mode gain of the IC1 pair is 1.

The differential output of IC1-A and IC2-A is converted to a single-ended output; the common mode component of the output is nulled by differential amplifier IC1, IC2-A and associated resistors.

Nearby lightning strikes may induce energy into the 4000's audio input that is sufficient to pass through the RFI protective networks and destroy IC1 and IC2. If the 4000 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.

Ceramic RFI-suppression capacitors shunt RF from the input leads to the chassis. Since these capacitors are not effective at VHF and higher frequencies, ferrite beads have been placed around the input and output leads to suppress such high-frequency RF. Although this RF suppression is modest, it should be adequate for the vast majority of installations.

2. J.17 Pre-Emphasis Network (part 1)

Located On Main Circuit Board

The output of the input buffer amplifier is applied to a circuit that generates the part of the J.17 pre-emphasis extending from approximately 100Hz to 1.3kHz. This is a rising shelf whose low-frequency gain is 0dB, and whose high-frequency gain is +9.4dB.

Component-level description:

The shelf is generated by non-inverting amplifier IC2-B and associated components. C19 shunts the feedback at high frequencies, permitting the gain of the amplifier to rise as frequency increases.

3. Dual-Band Limiter

Located On Main Circuit Board

The **dual-band limiter**[1] divides the audio band into two bands (above and below 150Hz) with a phase-linear crossover whose outputs sum to the crossover's original input signal. The major part of the dual-band limiter is the "master" channel (above 150Hz). This is a feedback limiter. Its gain-control voltage is summed in a dB-linear manner with the control voltage developed by the "bass" limiter to control the gain of the "bass" VCA, which passes frequencies below 150Hz.

When the bass content of the program is moderate, the control voltage summation forces the "bass" limiter to limit as much as the "master" limiter, and the system operates essentially as a wideband limiter, preserving frequency balances. However, when the bass content of the program is heavy, sufficient bass appears at the output of the "bass" limiter to activate the "bass" control loop, causing the "bass" channel to limit more than the "master" channel. This prevents overdriving later peak-limiting stages in the 4000, while also preventing the bass from causing unnatural-sounding gain reduction in the frequencies above 150Hz. Such unnatural-sounding gain reduction would occur if the limiter were *truly* wideband, because the bass would then force excess limiting in the *entire* audio frequency range instead of being momentarily rolled-off by the "bass" limiter.

Because the attack time of the "bass" control loop is relatively slow, transients can still pass through the "bass" limiter without limiting. To prevent these transients from inter-modulating with the material in the "master" band, the output of the "bass" band is limited with a clipper.

The dual-band limiter's crossover is a 12dB/octave phase-linear crossover whose outputs sum to the original input of the crossover without phase or amplitude error. The crossover is "distributed": part of it is placed prior to the VCAs in the dual-band limiter, and part of it is placed after the VCAs and bass clipper. The crossover thus rolls off any harmonic distortion introduced by the bass clipper.

[1] U.S. Patent #4,249,042

Component-level description:

IC3-A and associated components form a 150Hz 6dB/octave high-pass filter, which is the first part of the "master" crossover. The "master" crossover is completed with shelving filter R118, R119, R120, C4.

This shelving filter feeds IC4-C, an integrated VCA with a virtual-ground input and current-mode output. Its voltage gain is proportional to the exponential of the voltage appearing at pin 5, and to the negative exponential of the voltage appearing at pin 7. Thus the VCA's gain in dB is proportional to the control voltage appearing at pin 7 subtracted from the control voltage appearing at pin 5. The current-mode output of IC4-C is converted to a voltage in IC5-A. This is the output of the "master" limiter.

The output of high-pass filter IC3-A is subtracted from its input with R116 and R117. This produces a complementary low-pass filter, whose output is applied to bass VCA IC4-D. The current-mode output of IC4-D is converted to a voltage in IC5-B. This output of the "bass" limiter is applied to clipper CR19, CR20. R136, R137, C15 are a low-pass filter that complete the "distributed crossover."

The outputs of the "master" and "bass" bands are summed in IC3-B and applied to the high-frequency limiter.

R121, C16 are frequency compensation components to prevent VCA IC4-C from oscillating. R172, C17 perform the same function for IC4-D.

4. Dual-band Limiter Control

Located On Main Circuit Board

Both limiters in the **dual-band limiter** are feedback circuits: the gain-controlled output of a given limiter is used to develop a **gain-control signal** that is applied to the gain-control port of its VCA. This arrangement results in superior stability of characteristics with time and temperature, extremely low distortion, and optimized control-loop dynamic response.

The output of a given VCA is applied to two comparators. One detects signals that exceed a positive reference set by the **clipping voltage reference**, and the other detects signals that exceed the negative reference.

The comparators feed the dual-band limiter **timing module**, which contains proprietary circuitry that outputs a control voltage with dynamics that achieve natural-sounding control and low modulation distortion. The output of the module can be wired in a logical "OR" circuit with other such modules to effect stereo tracking of an arbitrary number of channels.

Component-level description:

The output of IC5-A in the "master" VCA is applied to two comparators in IC7. The outputs of these comparators are "OR'ed" together, and go negative whenever the output of IC5-A exceeds the positive or negative CLIP voltage. These negative-going signals are applied to the **timing module**, which develops a gain control voltage that depends on the past history of the program material. This voltage represents the gain of the VCA in dB.

The output of "bass" VCA at IC5-B is processed similarly.

The CLIP voltages are generated by IC6 (and associated components). The CLIPPING trim control R167 sets the clip voltages and thus the threshold of limiting. In turn, this determines the drive level to the following high-frequency limiter and peak-limiting circuitry and thus the amount of limiting and clipping that these circuits will execute.

The timing module has "master" and "bass" outputs. The "master" output is buffered by IC16-B; the "bass" output is buffered by IC16-A.

These buffers contain diodes CR11 and CR12 within their feedback loops. These diodes force the outputs of the buffers to be low-impedance *unidirectional* voltage sources, negative-going with increasing gain reduction, with a scale factor of approximately 0.93V/dB. 0V corresponds to 0dB gain reduction. Approximately –14V corresponds to the maximum available gain reduction (15dB).

These buffer amplifiers can be OR'ed together for stereo tracking, such that the output is the *lowest* voltage produced by any buffer. Thus all channels produce the same amount of limiting as the channel requiring the most limiting.

The "master" control voltage drives the "master" VCA IC4-C through voltage divider R148, R149. The "master" control voltage is also summed with the "bass" control voltage in R146 and R147. This sum drives the gain control port of the "bass" VCA IC4-D.

5. Gating Detector

Located On Main Circuit Board

A **gating detector** monitors the level of the 4000's input signal, and activates the gate if this level drops below a factory-set threshold. When on, the gate slows the release time by a factor of about 50x. For most program material with relatively short pauses or low-level passages, the limiter's gain appears to "freeze." However, the gain is still recovering very slowly toward maximum so the limiter cannot get "stuck" at abnormally low gain if a low-level passage lasts for many minutes.

Component-level description:

The gating detector uses a level detector built into IC4-B. The input signal to the dual-band limiter is applied to high-pass filter R138, C20. The –3dB frequency of this filter is approximately 340Hz.

The output of this filter is applied to the input of IC4-B's internal rectifier. This input (pin 15 of IC4) is an "AC virtual ground" — its DC quiescent voltage is approximately +1.8VDC, but it has a very low AC input impedance and little or no AC signal can be detected at this pin when the rectifier is working correctly.

The peak output of the rectifier appears at pin 13 of IC4 in dB-linear form. It is smoothed by C22. The release time of the detector is determined by R139.

IC7 is used as a comparator to determine when the gate should turn on or off. R140 and R141 bias the (–) input of the comparator to determine its threshold. This threshold can be lowered by applying –15V to CR10 such that the gate is OFF for all input signals.

Under OPERATE conditions and in absence of signal, pins 9 and 11 of IC7 are pulled negative and the gate is ON (i.e., the gain of the dual-band limiter is frozen). If the level at the input to the dual-band limiter exceeds about –23dBu, the output of the comparator goes positive. This turns the gate OFF and permits the normal limiter release process to occur. The release is switched on and off by circuitry inside the timing module, and is triggered by the signal on pin 14 of IC7-C. This is positive when the gate is OFF and negative otherwise. IC8D is used as an inverter to apply positive feedback to the gate circuit. This provides hysteresis to prevent the gain from "chattering."

6. Limiting Meter

Located On Display Circuit Board

The "master" band **LIMITING meter** consists of ten comparators with current regulators at their outputs. The comparators are arranged to produce a meter with a dB-linear scale. The ten LEDs in the bargraph are connected in series.

Component-level description:

The "master" control voltage, which is dB-linear and negative-going, is inverted and attenuated by IC2-A (on the display board) such that +3V = 15dB gain reduction. The attenuated voltage is mixed with a 50 or 60Hz "dither" signal through C2, R6 (connected to the power transformer secondary), and then applied to the input of LM3914 **bargraph driver** IC1.

The LM3914 bargraph consists of ten comparators with current regulators at their outputs. The comparators are arranged to produce a meter with a linear scale. The LM3914 applies current to the appropriate node to light the desired LEDs.

Q6 is used as a zener diode to reduce the supply voltage to the LM3914 so that it is within the chip's 25V maximum rating. R7 sets the current through the LED bargraph.

The LM3914 has an internal string of series resistors that provide reference voltages for its ten comparators. The bottom of this string is grounded at pin 4; the top of the string is provided with +3.00VDC from pin IC23A of on the main board.

C1 bypasses the LM3914 power supply to prevent the LM3914 from oscillating.

7. High-Frequency Limiter

Located On Main Circuit Board

The output of the dual-band limiter is applied to **a bandpass filter** with a peak frequency of 36.4kHz, a "Q" of 0.77, and a peak gain of 0dB. When summed with its input, the output of this filter provides a 6dB/octave **pre-emphasis** up to 20kHz. The +3dB breakpoint frequency for the pre-emphasis is determined by the amount of bandpass output that is summed with the input signal — the greater the contribution from the bandpass output, the lower the breakpoint frequency.

The contribution from the bandpass output is determined by jumper JA and by circuitry that can dynamically reduce the pre-emphasis to effect the high-frequency limiting function.

Note that **swept sine wave tests** of the high-frequency limiter will not yield the exact inverse of the pre-emphasis curves. This is because a high-pass filter causes the comparators to see a signal which is slightly different from the signal at the high-frequency limiter output, and because the **threshold of high-frequency limiting** is set above the steady-state output level of the dual-band limiter. The threshold is set this way to keep the high-frequency limiter from being activated by peak overshoots resulting from the moderate attack time of the dual-band limiter when operating on program material.

The output of the high-frequency limiter is applied to a **peak-limiting system** consisting of the "**Smart Clipper**" and **FCS Overshoot Corrector**, both of which are described below. These circuits provide absolute peak control at the 4000's output.

If the subsequent **de-emphasis** has been jumpered out by jumper JD, the absolute peak ceiling at the 4000's output will be independent of frequency; if de-emphasis is applied, the peak ceiling will be frequency-dependent, falling at 6dB/octave beyond the break frequency determined by the setting of jumper JB (or following the standard J.17 de-emphasis if J.17 is selected). The high-frequency limiter is flat ±0.1dB to 15kHz, and falls at 12dB/octave thereafter when de-emphasis is applied.

Component-level description:

The bandpass filter consists of IC39-A and associated circuitry. Bandpass response can be measured at pin 1 of IC39-A.

The contribution from the bandpass output is determined by the gain of a voltage divider, the gain of which is adjusted with jumper JA. The contribution of the bandpass filter to the output is further determined by the resistance of JFET Q101, which can dynamically reduce the pre-emphasis to effect the high-frequency limiting function.

The loss in the voltage divider is compensated for by IC38, which has a gain of 28.5dB. The output of IC38 (representing the band-passed signal) is summed with the input signal in IC39-B to create the pre-emphasized signal.

The +3dB break-points that correspond to the time constant calibrations for the HF LIMIT PRE-EMPHASIS switch are: 1.06kHz for 150µs, 2.12kHz for 75µs, 3.18kHz for 50µs, and 6.37kHz for 25µs. The J.17 pre-emphasis is more complex, and has break-points at 477Hz and 4134Hz.

The positive and negative peak levels of the pre-emphasized signal are evaluated by two comparators in IC41. If either exceeds the 6.08V threshold voltages established by R229-R231 (and inverter IC40-B), the appropriate comparator fires. Each comparator has an open collector NPN output stage and charges the high-frequency limiter smoothing circuit negative through attack time resistor R225. The smoothing circuit consists of CR40-CR43, C81, C91, and R224.

C86, R228 form the 6dB/octave high-pass filter that prevents the high-frequency limiter from being activated on low-frequency program material.

In the absence of high-frequency gain reduction, the output of the smoothing circuit (at the anode of CR42) is biased at a positive voltage determined by FET BIAS trimmer R223. This pinches-off Q101.

When high-frequency gain reduction occurs, the voltage at the anode of CR42 goes more negative than the quiescent voltage, turning on Q101 and resulting in less and less pre-emphasis. Pre-emphasis is dynamically decreased until comparator IC41 no longer fires, indicating that the high-frequency overload has been removed.

IC32-B drives the HF LIMIT LED. The FET control voltage is applied to IC32-B's pin 6; the quiescent FET bias is applied to pin 5. In addition, IC32-B's pin 5 is offset by current flowing through R221, which forces IC32-B's pin 5 to be more negative than its pin 6, and causes pin 7 of IC32-B to go low (close to ground). When the voltage on pin 6 becomes more negative than pin 5 due to high-frequency gain reduction, pin 7 goes high, lighting HF LIMITER LED CR8. CR8 is OFF when IC32-B's pin 7 is close to ground.

8. "Smart Clipper"

Located On Main Circuit Board

The "Smart Clipper"[2] is a peak-limiting circuit that operates in two frequency bands. Its input signal is clipped, and the output of the clipper is applied to a 2-15kHz band-pass filter created by subtracting the output of a 2kHz low-pass filter from the output of a 15kHz low-pass filter that is phase- and amplitude-matched to the 2kHz low-pass filter. This band-pass filter removes both difference-frequency intermodulation distortion caused by the clipper and program material below 2kHz.

[2] U.S. Patent #4,208,548, U.K. Patent #2,001,495

Program material below 2kHz is handled by a second circuit path. The input signal to the clipper is applied to a second 2kHz low-pass filter identical to the first 2kHz low-pass filter. The output of the second 2kHz low-pass filter is applied to a VCA, and the output of the VCA *is* added to the output of the 2-15kHz band-pass filter. (The VCA circuit is described on page 6-17.)

The gain of the VCA is controlled by a circuit that subtracts the output of the clipper from its input, rectifies this difference signal, adds a DC level to it, and then smooths this signal with a low-pass filter whose delay is equal to that of the 2kHz low-pass filters. The gain of the VCA is inversely proportional to this signal: clipped peaks will cause gain reduction in the VCA.

If the control-signal low-pass filter were not present, this would be equivalent to clipping the program material below 2kHz identically to the program material above 2kHz. Being of opposite polarity, the output signals from the two 2kHz low-pass filters would cancel completely, and the output of the entire "Smart Clipper" circuit would simply be equivalent to a clipper followed by a 15kHz low-pass filter.

However, the control-signal low-pass filter smooths the control signal to the VCA that processes the program material below 2kHz, and the output signals from the two 2kHz low-pass filters no longer cancel completely. The addition of the control-signal low-pass filter thus reduces distortion. Because the audio signal applied to the 2kHz VCA has been low-pass filtered, it is relatively "slow," and smoothing the control voltage to the VCA therefore does not cause consequential overshoot. The overshoot that is added can be considered to be a "distortion-canceling signal" that adds a slight amount of peak uncertainty to the output of the "Smart Clipper" in order to significantly reduce distortion by comparison to a simple clipper.

Component-level description:

The signal enters and is clipped by CR45, CR46. It is then applied to a chain of three allpass phase correctors: IC29, IC30, IC31 and associated components. Each of these circuits has a flat amplitude response but a phase response that changes with frequency. Together, these three circuits add delay as necessary to make the total group delay of the phase correctors plus the following 15kHz low-pass filter as constant as possible.

The 15kHz low-pass filter is an active-RC analog of a passive LC ladder filter. It is realized by resistors, capacitors, and frequency-dependent negative resistors (FDNRs). An FDNR is realized with 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 FDNRs.

Each FDNR resonates with a series resistor to create a notch in the frequency response of the filter. This is analogous to a series LC circuit to ground. The notches are located in the "stopband" (beyond approximately 18.77kHz). The circuit associated with IC13 produces a notch at 35.28kHz ±4%. The circuit associated with IC14 produces a notch at 19.04kHz ±4%. The circuit associated with IC15 produces a notch at 21.90kHz ±4%.

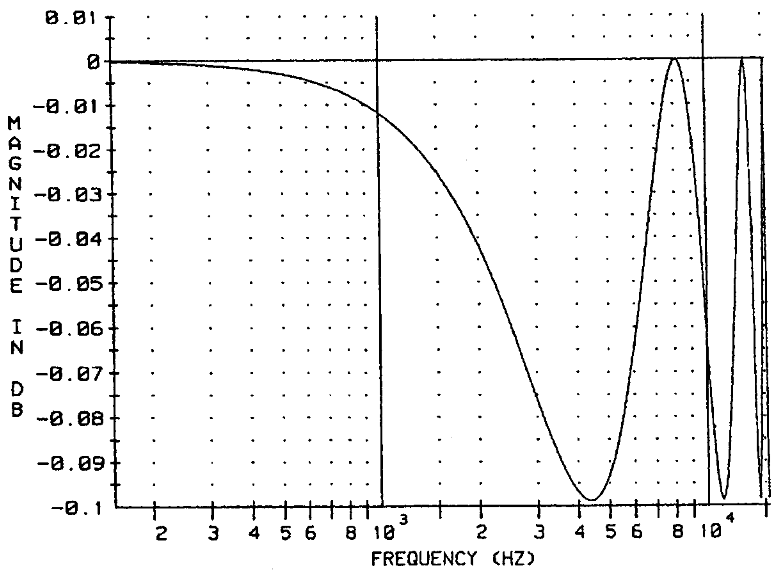


Figure 6-1: 15kHz Low-Pass Filter Response in Passband

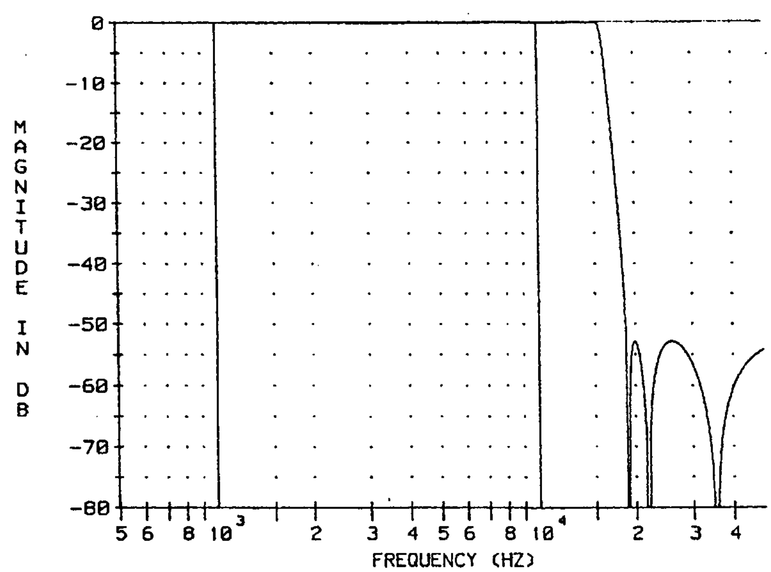


Figure 6-2: 15kHz Low-Pass Filter Response
Passband and Stopband

To avoid possible clipping, the signal is attenuated 2dB with voltage divider R252, R253 before being applied to the filter. This gain is made up by IC11-A to restore unity gain at low frequencies. IC11-A is also a summing amplifier for the two sidechains each containing a 2kHz low-pass filter. IC12-A is a servo amplifier that eliminates any DC offset at IC11-A's output.

The output of clipper CR45, CR46 is also applied to a 2kHz low-pass filter consisting of IC9 and associated components. This filter is phase- and amplitude-matched to the 15kHz low-pass filter from 0 to 2kHz. Its output is subtracted from the output of the 15kHz low-pass filter in IC11-A to yield a 2-15kHz band-pass function. Fig. 6-3 shows its normal frequency response.

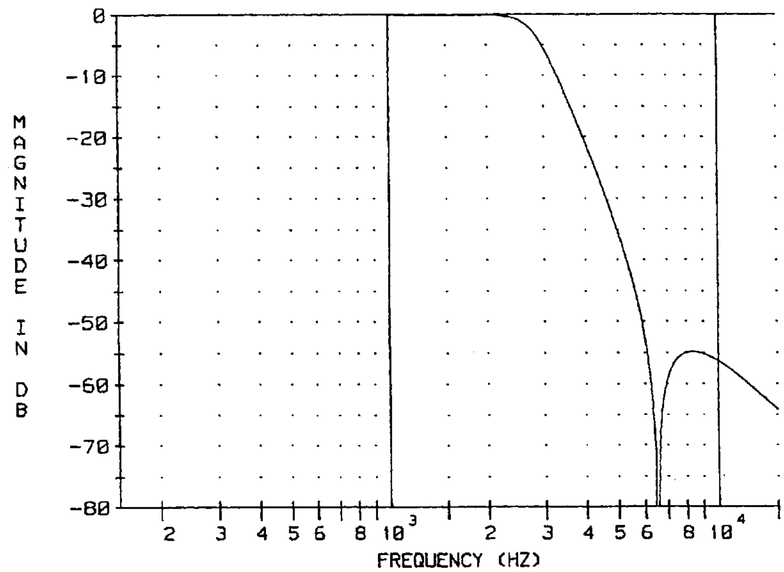


Figure 6-3: 2kHz Low-Pass Filter Response Passband and Stopband

If the frequency response of any filter is abnormal, first replace any opamps associated with the filter. If this does not cure the problem, suspect passive component failure. Capacitors are more likely to fail than resistors. Components interact, so it is almost impossible to identify which passive component has failed by examining the overall response of the filter. Instead, it is usually necessary to test the passive components on an impedance bridge, one at a time.

IC28 and associated components subtract the output of clipper CR45, CR46 from its input and full-wave rectify the difference signal, which appears at pin 3 of IC27-A. This signal appears as a series of positive-going "spikes" representing the signal that was removed by the clipper. IC27-A amplifies this signal by 19.3dB and applies it to control-voltage low-pass filter IC27-B and associated components. This low-pass filter has a relatively gentle roll-off. Its time delay is equal to the delay of the IC9 2kHz filter.

The output of low-pass filter IC27-B is applied to pin 6 of IC25-B. This pin is the divider control port of the "Smart Clipper" VCA (IC25 and associated components — see the detailed description below). The gain of the VCA is inversely proportional to the current flowing into this pin. This pin normally sits at about –13.5VDC, while the output of low-pass filter IC27-B is centered about 0VDC. Therefore a constant bias current flows into pin 6 of IC25-B through R304. This bias current determines the quiescent gain of the VCA when CR45 and CR46 are not clipping.

The audio to the VCA is supplied by 2kHz low-pass filter IC26 and associated components. This filter, which is identical to the IC9 filter, is fed by the unclipped signal occurring prior to CR45 and CR46. When no clipping occurs, the signals through the IC9 and IC26 filters are identical but out-of-polarity and therefore cancel upon summation in IC11-A. The remaining signal at the output of IC11-A is therefore the output of the 15kHz low-pass filter.

When CR45 and CR46 clip, pin 7 of IC27-B goes positive, causing the control current into the VCA to increase and its gain to decrease proportionally, causing a distortion-reduced "clipping" function to be applied to the output signal from the IC26 2kHz low-pass filter. When clipping occurs, the signals through the two 2kHz low-pass filters are thus no longer identical, no longer cancel, and peak control occurs as described earlier in the overview to this section.

9. Voltage-Controlled Amplifier in "Smart Clipper"

Located On Main Circuit Board

The current-controlled gain block used in the "Smart Clipper" is a proprietary class-A **voltage-controlled amplifier** (VCA). It operates as a two-quadrant analog divider with gain *inversely* proportional to a current injected into a first gain-control port, and is cascaded with a two-quadrant analog multiplier with gain *directly* proportional to a current injected into a second gain-control port. For most gains, levels, and frequencies, total harmonic distortion (THD) is well under 0.1%. Overload-to-noise ratio (noise measured in a 20-20,000Hz band) is typically 90dB, and is constant with respect to gain and level.

A specially-graded CA3280 Dual Operational Transconductance Amplifier ("OTA") contains two matched, non-linear gain-control blocks with differential inputs and current outputs. Used alone, one such gain-control block would introduce considerable distortion. Therefore, the first of the two matched blocks is used as the feedback element for a separate opamp, and the second is driven by the pre-distorted output of that opamp. The gain of the VCA is therefore *inversely* proportional to the gain of the non-linear gain-control blocks. This enables the VCA to function as a two-quadrant analog *divider*.

If the VCA is not perfectly balanced, **"thumps"** due to **control current** feedthrough can appear at the output. These are eliminated by applying DC offset to the VCA's input.

The basic current-controlled gain in the dual-band limiter is inversely proportional to the control current generated by the "Smart Clipper" control circuitry.

Component-level description:

The first gain-control port is pin 6 of IC25-B; the second gain-control port is pin 3 of IC25-A.

IC25 is the specially-graded Orban IC containing two matched non-linear gain-control blocks with differential inputs and current outputs. The forward-path opamp in the VCA is IC24.

The output of IC24 is first attenuated by R305, R306, C76, and then applied to the input of the feedback element IC25-B at pin 9. The output of IC24 is pre-distorted as necessary to force the current *output* of IC25-B to precisely and linearly cancel the audio input into the "virtual ground" summing junction of IC24. This same pre-distorted voltage is also connected to the input of IC25-A at pin 15. Thus the output of IC25-A at pin 13 is an undistorted current. This current is converted to a voltage in IC11-A. which is also the summing amplifier for the "Smart Clipper" filters.

The VCA behaves like a two-quadrant analog *divider* when the control current from IC27-B is applied to the control port (pin 6) of IC25-B. The gain-control current injected into this control port is developed by the "Smart Clipper" control circuitry.

The gain of IC25-A is fixed by the current through R310.

Second-harmonic distortion is introduced by differential offsets in either section of IC25. This distortion is canceled by applying a nulling voltage directly to the input of IC25-A by means of resistor network R307, R308, and L DIST NULL trimmer R309.

The control-voltage feedthrough, which can occur if the VCA is not perfectly balanced, are equivalent to multiplying the control current by DC. An adjustable DC offset is applied to the VCA input provided by R300 and L FEEDTHROUGH trimmer R301 for nulling this equivalent DC multiplication to zero.

R87 and R92 further balance cancellation to prevent audio modulation of the control current for IC25-B.

C64, C74, R302, R303 provide frequency-compensation to prevent the VCA from oscillating supersonically.

10. Frequency-Contoured Sidechain Overshoot Corrector

Located On Main Circuit Board

This circuit[3] acts as a "band-limited safety clipper." It subtracts the output of a clipper from its input. If this differential signal were then subtracted from the clipper's input, it would be equivalent to clipping the signal and would eliminate overshoot. However, this would add out-of-band power that would destroy the 4000's excellent spectral control. Therefore, the differential signal is low-pass filtered prior to subtraction. The low-pass filter has a rising response towards 15kHz, and its frequency response falls quickly thereafter. The filter's rising gain for frequencies immediately below 15kHz helps compensate for the removal of the clipper-induced frequencies above 15kHz that would otherwise be required to fully control the peaks.

[3] U.S. Patent #4,460,871

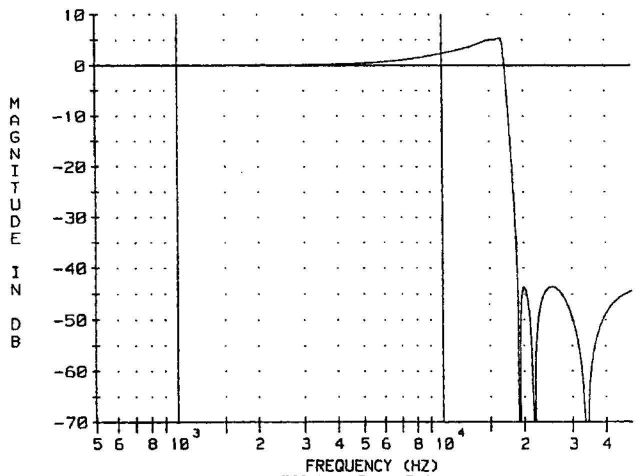


Figure 6-4: Response of FCS Sidechain Low-Pass Filter in the Passband and Stopband

Component-level description:

The output of the "Smart Clipper" (containing some overshoots) is applied to clipper CR30, CR31. IC11-B subtracts the output of this clipper from its input. This differential signal is applied to the 16.6kHz sidechain filter consisting of IC20, IC21, IC22 and associated components. This is an FDNR-based low-pass filter like the 15kHz filter in the "Smart Clipper" (see page 6-13). Fig. 6-4 shows its frequency response. The circuit associated with IC20 produces a notch at 19.22kHz ±4%. The circuit associated with IC21 produces a notch at 21.67kHz ±4%. The circuit associated with IC22 produces a notch at 33.76kHz ±4%.

IC17-A buffers the filter and makes up gain lost in voltage divider R99, R409. IC17-A is also the summing amplifier for servo amplifier IC12-B and associated components. This servo minimizes DC offset at the 4000's output.

The output of the "Smart Clipper" is also applied to IC10 and associated components. This is an allpass delay element. Its amplitude response is flat, but its group delay varies with frequency. Its group delay plus the group delay produced by allpass phase shifter IC17-B and associated components closely matches the group delay of the 16.67kHz FCS sidechain low-pass filter, whose output is subtracted from the delayed signal in IC17-B to cancel overshoots.

The group delay of the FCS sidechain filter (and thus, the group delay of its matching delay network) is not constant with frequency. Allpass phase shifters IC18 and IC19 apply group delay correction to the FCS sidechain filter to make the group delay of the entire FCS circuit constant with frequency to ensure that peak levels are correctly controlled.

The output of the FCS circuit is applied to a de-emphasis circuit consisting of C82 and associated resistors. Various de-emphasis characteristics can be selected by jumper JB. De-emphasis can be defeated by lifting C416's ground with jumper JD. IC33-A buffers the de-emphasis circuit and drives the OUTPUT LEVEL control. This control is buffered by IC33-B, which drives the balanced floating output amplifier circuit.

11. Balanced Floating Output Amplifier

Located On Main Circuit Board

The **balanced output amplifier** converts the unbalanced single-ended signal to a balanced, floating output. Output impedance is 30Ω, ±5%.

Simpler "electronically-balanced to ground" output stages can cause problems because grounding one side of their output to unbalance them will short an output amplifier to ground. In contrast, the 4000 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 4000 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:

IC35 is a low-offset servo amplifier that centers the average DC level at the (+) and (–) outputs of the module around ground. The floating characteristic is achieved by complex cross-coupled positive and negative feedback between the two sections of IC34, 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 5-2).

12. Control Logic

Located On Main Circuit Board and Display Board

The **control logic** interfaces the front-panel buttons and the remote control terminals to the analog circuitry. Three R/S latches remember the BYPASS, TEST and TONE states. If the logic is in none of these states, it is, by definition, in the OPERATE state.

The **remote control** terminals are interfaced to the logic through opto-isolators to break potential ground loops and to provide RFI suppression.

The front-panel **indicator lamps** are arranged in a special "tree" arrangement that reduces current consumption, as current is shared with as many lamps as practical. The same current that drives the TONE, TEST and OPERATE LEDs also drives the bypass relay.

Component-level description:

CMOS NAND gates IC42-A and IC42-B are cross-coupled to form an R/S latch that remembers the BYPASS state. The logic operates from –15V to ground, and uses "negative logic": –15V is TRUE and 0V is FALSE. So in BYPASS mode, pin 4 of IC42-B is at –15V.

The other two modes have identically-structured R/S latches associated with them.

The OPERATE pushbutton and remote control opto-isolator drive the OPERATE line TRUE (to –15V), forcing the BYPASS, TEST, and TONE lines FALSE through diodes CR33, CR34, CR35, and CR36. Power-up circuit CR32, C105, and R452 pulls the OPERATE line TRUE through C418 on power-up.

If the BYPASS line goes TRUE, it transmits a negative-going pulse through C97, R460 that switches the TEST and TONE latches FALSE. If the TEST line goes TRUE, it transmits a negative-going pulse through C98, R458 that switches the BYPASS latch FALSE. If the TONE line goes TRUE, it forces the TEST line TRUE through CR38.

If the BYPASS line is TRUE, it switches the BYPASS lamp CR1 on through Q1. If the $\overline{\text{BYPASS}}$ line is TRUE, it applies current to the bypass relay coil through level-shifter circuit Q4, Q5 and associated components. (The bypass relay bypasses the 4000 circuitry when its coil is *not* carrying current to ensure that a power failure will automatically connect the 4000's input directly to its output.)

When the bypass relay coil is carrying current, this current is applied to a "tree" consisting of CR2-CR5. The current through the relay thus lights at least one of these LEDs, depending on the state of the logic driving them. If the TONE mode is selected, *both* the TONE and TEST LEDs are lit, and both are driven in series from the same current. If both the TONE and TEST LEDs are OFF, current is then diverted to CR4 and CR5 (whose normal voltage drop is higher than CR2 and CR3), and the OPERATE lamp lights. If the BYPASS line is TRUE, no current is supplied to the "tree" and only the BYPASS lamp CR1 lights.

13. Power Supply

Located On Main Circuit Board

Unregulated voltage is supplied by two pairs of full-wave diode rectifiers. The nominal unregulated voltage is ±22 volts DC at rated line voltage. This will vary widely with line voltage variations. **Regulator dropout** will occur if the unregulated voltage falls below about ±17.8 volts.

Regulated voltages are supplied by a pair of overrated 500mA "three-terminal" IC regulators. Because they are operated conservatively, they are expected to be reliable.

Component-level description:

The two pairs of full-wave diode rectifiers that supply **unregulated voltage** are located in package CR2. The rectifier pairs drive energy storage capacitors C103 and C104. The power transformer T1 can be strapped for either 115-volt or 230-volt operation (the two sections of the primary are paralleled for 115-volt operation and connected in series for 230-volt operation).

The pair of ICs which supply regulated voltages are "three-terminal" IC regulators IC48, IC49. IC48 and IC49 are frequency-compensated by C101-102 at their outputs to prevent high-frequency oscillations. Small 0.1F/25V ceramic capacitors bypass the power busses to ground locally throughout the board to prevent signal-carrying ICs from oscillating due to excessive power-lead inductance.

(If replaced, C101-102 *must* be replaced by low-inductance aluminum electrolytic capacitors only — see "Power Supply Problems" on page 5-2.)

Parts List

Parts are listed by ASSEMBLY, then by TYPE, then by REFERENCE DESIGNATOR. Widely used common parts are not listed; such parts are described generally below (examine the part to determine exact value). See the following assembly drawings for locations of components.

SIGNAL DIODES, if not listed by reference designator in the following parts list, are:

Orban part number 22101-000, Fairchild (FSC) part number 1N4148, also available from many other vendors. This is a silicon, small-signal diode with ultra-fast recovery and high conductance. It may be replaced with 1N914 (BAY-61 in Europe).

(BV: 75V min. @ I_r = 5μA; I_r: 25nA max. @ V_r = 20V; V_f: 1.0V max. @ I_f = 100mA; trr: 4ns max.) See Miscellaneous list for ZENER DIODES (reference designator VRxx).

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, consult the schematic or the factory. Performance and stability will be compromised if you do not use exact replacements. Unless listed by reference designator in the following parts list, you can verify resistors by their physical appearance:

Metal film resistors have conformally-coated bodies, and are identified by five color bands or a printed value. They are rated at 1/8 watt @ 70°C, ±1%, 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, and Matsushita.

Carbon film resistors have conformally-coated bodies, and are identified by four color bands. They are rated at 1/4 watt @ 70°C, ±5%. Orban part numbers 20001-xxx, Manufactured by R-Ohm (R-25), Piher, Beyschlag, Dale, Phillips, Spectrol, and Matsushita.

Carbon composition resistors have molded phenolic bodies, and are identified by four color bands. The 0.090 x 0.250 inch (2.3 x 6.4 mm) size is rated at 1/4 watt, and the 0.140 x 0.375 inch (3.6 x 9.5 mm) size is rated at 1/2 watt, both ±5% @ 70°C. Orban part numbers 2001x-xxx, USA Military Specification MIL-R-11 Style RC-07 (1/4 watt) or RC-20 (1/2 watt). Manufactured by Allen-Bradley, TRW/IRC, and Matsushita.

Cermet trimmer resistors have 3/8-inch (9 mm) square bodies, and are identified by printing on their sides. They are rated at 1/2 watt @ 70°C, = ±10%, with a temperature coefficient of 100 PPM/°C. Orban part numbers 20510-xxx and 20511-xxx. Manufactured by Beckman (72P, 68W- series), Spectrol, and Matsushita.

Obtaining spare parts

Special or subtle characteristics of certain components are exploited to produce an elegant design at a reasonable cost. *It is therefore unwise to make substitutions for listed parts.* Consult the factory if the listing of a part includes the note "selected" or "realignment required."

Orban normally maintains an inventory of tested, exact replacement parts that can be supplied quickly at nominal cost. Standardized spare parts kits are also available. When ordering parts from the factory, please have available the following information about the parts you want:

Orban part number
Reference designator (e.g., C3, R78, IC14)
Brief description of part
Model, serial, and "M" (if any) number of unit — see rear-panel label

To facilitate future maintenance, parts for this unit have been chosen from the catalogs of well-known manufacturers whenever possible. Most of these manufacturers have extensive worldwide distribution and may be contacted through their local offices. Addresses for each manufacturer's USA headquarters are given on page 6-31.

REF DES	DESCRIPTION	ORBAN P/N	VEN (1)	VENDOR P/N	ALTERNATE VENDORS (1)	NOTES
CHASSIS ASSEMBLY						
	Integrated Circuits					
IC48	D.C. Regulator, 15V Positive	24304-901	NAT	LM78M15UC	TI,MOT	Attached To Heatsink
IC49	D.C. Regulator, 15V Negative	24303-901	NAT	LM79M15AUC	TI,MOT	Attached To Heatsink
	Miscellaneous					
F1	Fuse, 3AG, Slo-Blo, 1/2A	28004-150	LFE	313.500	BUS	
None	Line Cord, CEE	28102-002	BEL	17500	MANY	
None	Filter, Line, 3 Amp	28015-000	COR	3EF1	MANY	
None	Fuseholder, Panel	28019-001	LFE			
T1	Transformer, Power; 41.7VCT, 17.7VA	55007-000	ORB			Mono Unit Only
T1	Transformer, Power; 39VCT, 23VA	55011-000	ORB			Stereo Unit Only
	Switches					
None	Switch, Slide, Mains voltage selector	26140-000	SW	EPSI-SLI		
PCB DISPLAY ASSEMBLY						
	Capacitors					
C1	Alum., Radial, 63V, -20% +100%; 2.2uF	21209-522	SPR	502D 225G063BB1C	PAN	
C2	Met. Polyester, 100V, 10%; 0.01uF	21441-310	WES	160C 103K630	SIE,WIM	
C3	Alum., Radial, 63V, -20% +100%; 2.2uF	21209-522	SPR	502D 225G063BB1C	PAN	Stereo Unit Only
C3-6	Monolythic Ceramic, 50V, 20%; 0.1uF	21123-410	SPR	1C25 Z5U104M050B	KEM	Mono Unit Only
C4	Met. Polyester, 100V, 10%; 0.01uF	21441-310	WES	160C 103K630	SIE,WIM	Stereo Unit Only
C5-8	Monolythic Ceramic, 50V, 20%; 0.1uF	21123-410	SPR	1C25 Z5U104M050B	KEM	Stereo Unit Only
	Diodes					
CR1-3,7-8	LED, Red	25106-003	HP	HLMP-1300	GI	Mono Unit Only
CR4,5	LED, Green	25106-002	HP	HLMP-1503	GI	Mono Unit Only
CR6	LED Array, 9-Yellow, 1-Red	25153-000	ORB			Mono Unit Only
CR1-3	LED, Red	25107-001	HP	HLMP-1300	GI	Stereo Unit Only
CR4,5,7,18	LED, Green	25107-002	HP	HLMP-1503	GI	Stereo Unit Only
CR6	LED Array, 9-Yellow, 1-Red	25152-000	ORB			Stereo Unit Only
CR8,16	LED, Amber	25107-003	HP	HLMP-1300	GI	Stereo Unit Only
CR9-11	LED, Red	25106-003	HP	HLMP-1300	GI	Stereo Unit Only
CR12,13,15,17	LED, Green	25106-002	HP	HLMP-1503	GI	Stereo Unit Only
CR14	LED Array, 9-Yellow, 1-Red	25152-000	ORB			Stereo Unit Only

FOOTNOTES:
(1) See page 6-31 for Vendor 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

Orban Model 4000

Chassis Assembly - Integrated Circuits, Misc., Switches; PCB Display Assembly - Capacitors, Diodes

REF DES	DESCRIPTION	ORBAN P/N	VEN (1)	VENDOR P/N	ALTERNATE VENDORS (1)	NOTES
PCB DISPLAY ASSEMBLY (continued)						
Integrated Circuits						
IC1	Digital, Display Driver	24712-302	NAT	LM3914		
IC2	Linear, Dual Opamp	24202-202	RAY	RC4558NB	MOT,FSC	
IC3	Digital, Display Driver	24712-302	NAT	LM3914		Stereo Unit Only
Resistors						
R1	Pot, Single, 25K	20761-000	ORB			
R17	Pot, Single, 25K	20761-000	ORB			Stereo Unit Only
Switches						
S1-4	Switch, MOM.; SPST	26301-016	ORB			Stereo Unit Only
S5-8	Switch, MOM.; SPST	26301-016	ORB			Stereo Unit Only
Transistors						
Q1-4	Transistor, Signal, PNP	23002-101	MOT	2N4402	FSC	
Q5,6	Transistor, Signal, NPN	23202-101	MOT	2N4400	FSC	
Q7-10	Transistor, Signal, PNP	23002-101	MOT	2N4402	FSC	Stereo Unit Only
Q11,12	Transistor, Signal, NPN	23202-101	MOT	2N4400	FSC	Stereo Unit Only

FOOTNOTES:
(1) See page 6-31 for Vendor 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

Orban Model 4000

PCB Display Assembly - Integrated Circuits, Resistors, Switches, Transistors

REF DES	DESCRIPTION	ORBAN P/N	VEN (1)	VENDOR P/N	ALTERNATE VENDORS (1)	NOTES

PCB MAIN ASSEMBLY

Capacitors

REF DES	DESCRIPTION	ORBAN P/N	VEN (1)	VENDOR P/N	ALTERNATE VENDORS (1)	NOTES
C1	Mica, 500V, +1/2pF -1/2pF; 10pF	21017-010	CD	CD15-CD100D03	SAN	
C2,3	Met. Polyester, 100V, 10%; 0.047uF	21441-347	WES	160C 473K250	SIE	
C4	Met. Polycarb., 100V, 2%; 0.12uF	21602-412	ECI	652A 1B124G	IMB	
C5	Mica, 500V, +1/2pF -1/2pF; 47pF	21017-047	CD	CD15-CD470D03	SAN	
C6	Monolythic Ceramic, 50V, 20%; 0.1uF	21123-410	SPR	1C25 Z5U104M050B	KEM	
C7	Alum., Radial, 63V, -20% +100%; 1uF	21209-510	SPR	502D 105G063BBIC	PAN	
C8	Monolythic Ceramic, 50V, 20%; 0.1uF	21123-410	SPR	1C25 Z5U104M050B	KEM	
C9	Mica, 500V, +1/2pF -1/2pF; 10pF	21017-010	CD	CD15-CD100D03	SAN	
C10,11	Monolythic Ceramic, 50V, 20%; 0.1uF	21123-410	SPR	1C25 Z5U104M050B	KEM	
C12	Polypropylene, 50V, 1%; 0.022uF	21701-322	NOB	CQ15P1H223FPP		
C13	Mica, 500V, +1/2pF -1/2pF; 10pF	21017-010	CD	CD15-CD100D03	SAN	
C14	Met. Polyester, 100V, 10%; 0.047uF	21441-347	WES	160C 473K250	SIE	
C15	Polypropylene, 50V, 2.5%; 0.068uF	21702-368	NOB	CQ15P1H683GPP		
C16,17	Met. Polyester, 100V, 10%; 0.0022uF	21441-222	WES	160C 222K1000	SIE,WIM	
C18	Mica, 500V, +1/2pF -1/2pF; 47pF	21017-047	CD	CD15-CD470D03	SAN	
C19	Met. Polycarb., 100V, 1%; 0.01uF	21601-310	ECI	652A 1B103F	IMB,SO	
C20	Met. Polyester, 100V, 10%; 0.047uF	21441-347	WES	160C 473K250	SIE	
C21	Mica, 500V, 1%; 1000pF	21022-210	CD	CD19-FD102F03	SAN	
C22	Alum., Radial, 63V, -20% +100%; 4.7uF	21209-547	SPR	502D 475G063BB1C	PAN	
C23	Polypropylene, 50V, 1%; 4700pF	21701-247	NOB	CQ15P1H472FPP	WES	
C24	Mica, 500V, +1/2pF -1/2pF; 5pF	21017-005	CD	CD15-CD050D03	SAN	
C25	Mica, 500V, 1%; 220pF	21018-122	CD	CD15-FD221F03	SAN	
C26	Mica, 500V, 1%; 1000pF	21022-210	CD	CD19-FD102F03	SAN	
C27,28	Polypropylene, 50V, 1%; 4700pF	21701-247	NOB	CQ15P1H472FPP	WES	
C29	Met. Polyester, 100V, 10%; 0.1uF	21441-410	WIM	MKS-4100V5.0.1	WES,SIE	
C30-32	Polypropylene, 50V, 1%; 4700pF	21701-247	NOB	CQ15P1H472FPP	WES	
C33-36	Monolythic Ceramic, 50V, 20%; 0.1uF	21123-410	SPR	1C25 Z5U104M050B	KEM	
C37	Mica, 500V, 1%; 1000pF	21022-210	CD	CD19-FD102F03	SAN	
C38	Met. Polyester, 100V, 5%; 0.047uF	21440-347	WES	160C 473J250	SIE,WIM	
C39-43	Polypropylene, 50V, 1%; 4700pF	21701-247	NOB	CQ15P1H472FPP	WES	
C44	Mica, 500V, 1%; 1000pF	21022-210	CD	CD19-FD102F03	SAN	
C45	Mica,1500V, 5%; 390pF	21018-139	CD	CD15-FD391F03	SAN	
C46-48	Polypropylene, 50V, 1%; 4700pF	21701-247	NOB	CQ15P1H472FPP	WES	

FOOTNOTES:
(1) See page 6-31 for Vendor 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

Orban Model 4000
PCB Main Assembly - Capacitors

Capacitors (continued)

REF DES	DESCRIPTION	ORBAN P/N	VEN (1)	VENDOR P/N	ALTERNATE VENDORS (1)	NOTES
C49-52	Monolythic Ceramic, 50V, 20%; 0.1uF	21123-410	SPR	1C25 Z5U104M050B	KEM	
C53-59	Polypropylene, 50V, 1%; 4700pF	21701-247	NOB	CQ15P1H472FPP	WES	
C60	Mica, 500V, 1%; 1000pF	21022-210	CD	CD19-FD102F03	SAN	
C61-63	Polypropylene, 50V, 1%; 4700pF	21701-247	NOB	CQ15P1H472FPP	WES	
C64	Mica, 500V, 5%; 150pF	21020-115	CD	CD15-FD151J03	SAN	
C65,66	Mica, 500V, 1%; 1000pF	21022-210	CD	CD19-FD102F03	SAN	
C67	Mica, 500V, 1%; 220pF	21018-122	CD	CD15-FD221F03	SAN	
C68,69	Monolythic Ceramic, 50V, 20%; 0.1uF	21123-410	SPR	1C25 Z5U104M050B	KEM	
C70	Mica, 500V, 1%; 1000pF	21022-210	CD	CD19-FD102F03	SAN	
C71,72	Polypropylene, 50V, 1%; 4700pF	21701-247	NOB	CQ15P1H472FPP	WES	
C73,74	Monolythic Ceramic, 50V, 20%; 0.1uF	21123-410	SPR	1C25 Z5U104M050B	KEM	
C75	Polypropylene, 50V, 1%; 4700pF	21701-247	NOB	CQ15P1H472FPP	WES	
C76	Mica, 500V, +1/2pF -1/2pF; 5pF	21017-005	CD	CD15-CD050D03	SAN	
C77	Mica, 500V, 5%; 150pF	21020-115	CD	CD15-FD151J03	SAN	
C78,79	Mica, 500V, 1%; 1000pF	21022-210	CD	CD19-FD102F03	SAN	
C80	Mica, 500V, 1%; 470pF	21022-147	CD	CD19-FD471F03	SAN	
C81	Tantalum, 35V, 10%; 0.22uF	21307-422	SPR	196D 224X9035HA1	MANY	
C82	Polypropylene, 50V, 1%; 0.01uF	21701-310	NOB	CQ15P1H103FPP	WES	
C83,84	Mica, 500V, 1%; 1000pF	21022-210	CD	CD19-FD102F03	SAN	
C85	Met. Polyester, 100V, 5%; 0.047uF	21440-347	WES	160C 473J250	SIE,WIM	
C86	Mica, 500V, 5%; 1000pF	21024-210	CD	CD19-FD102J03	SAN	
C87	Polypropylene, 50V, 2.5%; 0.1uF	21702-410	NOB	CQ15P1H104GPP		
C88,89	Monolythic Ceramic, 50V, 20%; 0.1uF	21123-410	SPR	1C25 Z5U104M050B	KEM	
C90	Met. Polyester, 63V, 5%; 0.1uF	21442-410	MAL	168104J63A	WIM	
C91	Met. Polyester, 100V, 10%; 0.1uF	21441-410	WIM	MKS-4100V5.0.1	WES,SIE	
C92-95	Monolythic Ceramic, 50V, 20%; 0.1uF	21123-410	SPR	1C25 Z5U104M050B	KEM	
C96	Mica, 500V, 5%; 1800pF	21024-218	CD	CD19-FD182J03	SAN	
C97,98	Ceramic Disc, 1KV, 10%; 0.001uF	21112-210	CRL	DD-102	MUR	
C99,100	Monolythic Ceramic, 50V, 20%; 0.1uF	21123-410	SPR	1C25 Z5U104M050B	KEM	
C101,102	Alum., Radial, 25V, -20% +100%; 100uF	21206-710	PAN	ECE-A1EV101S		
C103,104	Alum., Axial, 40V, -10% +100%; 1000uF	21224-810	SIE	B41010-1000-40	PAN	Channel A Only
C105	Ceramic Disc, 25V, 20%; 0.15uF	21106-415	CRL	UK25-154	MUR	

FOOTNOTES:
(1) See page 6-31 for Vendor 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

Orban Model 4000A

PCB Main Assembly - Capacitors

REF DES	DESCRIPTION	ORBAN P/N	VEN (1)	VENDOR P/N	ALTERNATE VENDORS (1)	NOTES
Diodes						
CR1	Diode, Rectifier, 400V, 1A	22201-400	MOT	1N4004	MANY	
CR2	Diode, Bridge, 200V, 1A	22301-000	VARO	VE-27	GI	Channel A Only
CR14	Diode, Signal, Hot Carrier	22102-001	HP	HP5082-2800	MANY	
CR30,31	Diode, Signal, Hot Carrier	22102-001	HP	HP5082-2800	MANY	
CR45,46	Diode, Signal, Hot Carrier	22102-001	HP	HP5082-2800	MANY	
Integrated Circuits						
IC1-3	Linear, Dual Opamp	24207-202	SIG	NE5532N	TI,EXR	
IC4	Digital, Dynamic Range Processor	24719-302	PMI	SSM-2120		
IC5	Linear, Dual Opamp	24209-202	NAT	LF412CN		
IC6	Linear, Dual Opamp	24202-202	RAY	RC4558NB	MOT,FSC	
IC7,8	Quad Comparator	24710-302	NAT	LM339		
IC9-11	Linear, Dual Opamp	24207-202	SIG	NE5532N	TI,EXR	
IC12	Linear, Dual Opamp	24209-202	NAT	LF412CN		
IC13-15	Linear, Dual Opamp	24207-202	SIG	NE5532N	TI,EXR	
IC16	Linear, Dual Opamp	24206-202	TI	TL072CP	MOT	
IC17-22	Linear, Dual Opamp	24207-202	SIG	NE5532N	TI,EXR	
IC23	Linear, Dual Opamp	24209-202	NAT	LF412CN		
IC24	Linear, Single Opamp	24014-202	SIG	NE5534N	TI	
IC25	Linear, Dual Opamp	24208-302	RCA	CA3280A		
IC26	Linear, Dual Opamp	24207-202	SIG	NE5532N	TI,EXR	
IC27	Linear, Dual Opamp	24209-202	NAT	LF412CN		
IC28-31	Linear, Dual Opamp	24207-202	SIG	NE5532N	TI,EXR	
IC32	Linear, Dual Opamp	24203-202	MOT	MC1458CP1	TI,RCA	
IC33,34	Linear, Dual Opamp	24207-202	SIG	NE5532N	TI,EXR	
IC35	Linear, Single Opamp	24017-202	NAT	LF411CN		
IC36,37	Linear, Dual Opamp	24202-202	RAY	RC4558NB	MOT,FSC	
IC38	Linear, Single Opamp	24014-202	SIG	NE5534N	TI	
IC39	Linear, Dual Opamp	24207-202	SIG	NE5532N	TI,EXR	
IC40	Linear, Dual Opamp	24209-202	NAT	LF412CN		
IC41	Quad Comparator	24710-302	NAT	LM339		
IC42,43	Digital, NAND Gate	24501-302	RCA	CD4011BE	MOT	
IC44-47	Optoisolator, NPN	25003-000	SIE	SFH-601-1		

FOOTNOTES:
(1) See page 6-31 for Vendor 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

Orban Model 4000

PCB Main Assembly - Diodes, Integrated Circuits

REF DES	DESCRIPTION	ORBAN P/N	VEN (1)	VENDOR P/N	ALTERNATE VENDORS (1)	NOTES
Miscellaneous						
K1,2	Relay, DPDT	28024-000	PB	T85N11D114-12		
Modules						
A100	Module, Timing	31345-000-xx		ORB		Add suffix printed on part
Resistors						
R1	Resistor Set, MF; 13.3K/10.2K	28522-003	ORB			3
R3	Resistor Set, MF; 4.53K/3.01K	28522-004	ORB			3
R4	Resistor Set, MF; 13.3K/10.2K	28522-003	ORB			3
R5	Resistor Set, MF; 4.64K/4.53K	28522-005	ORB			3
R106	Resistor Network, 8 POS; 10.0K	20202-503	AB	F16B-103-B	BEK	
R240	Resistor Set, MF; 2.00K	28521-024	ORB			3
R244	Resistor Set, MF; 2.00K	28521-024	ORB			3
R248	Resistor Set, MF; 2.00K	28521-024	ORB			3
R256	Resistor Set, MF; 2.00K	28520-002	ORB			3
R260	Resistor Set, MF; 2.00K	28520-002	ORB			3
R264	Resistor Set, MF; 2.00K	28520-002	ORB			3
R401	Resistor Set, MF; 2.00K	28521-024	ORB			3
R412	Resistor Set, MF; 2.00K	28520-002	ORB			3
R416	Resistor Set, MF; 2.00K	28520-002	ORB			3
R420	Resistor Set, MF; 2.00K	28520-002	ORB			3
R432	Resistor Set, MF; 2.00K	28521-024	ORB			3
R437	Resistor Set, MF; 2.00K	28521-024	ORB			3
Transistors						
Q100	Transistor, JFET/N	23406-101	NAT	J113	SIL	
Q101	Transistor, JFET/P	23407-101	NAT	J174	SIL	
Q102-105	Transistor, JFET/N	23406-101	NAT	J113	SIL	
Q200	Transistor, Signal, NPN	23202-101	MOT	2N4400	FSC	

FOOTNOTES:
(1) See page 6-31 for Vendor 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

Orban Model 4000

PCB Main Assembly - Misc., Modules, Resistors Transistors

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

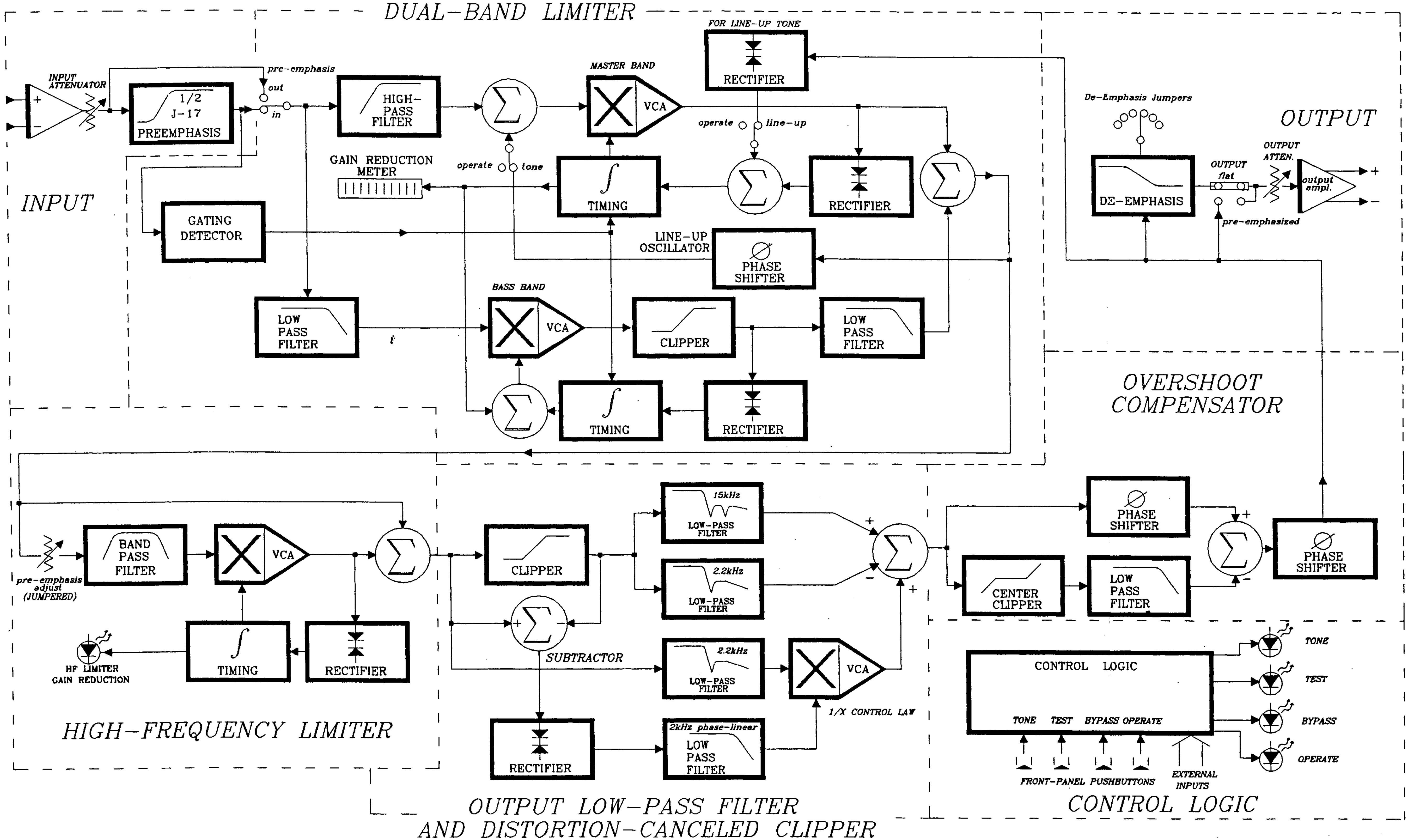
ZI ZILOG Inc.
210 Hacienda Ave.
Campbell, CA 95008

Schematics, Assembly Drawings

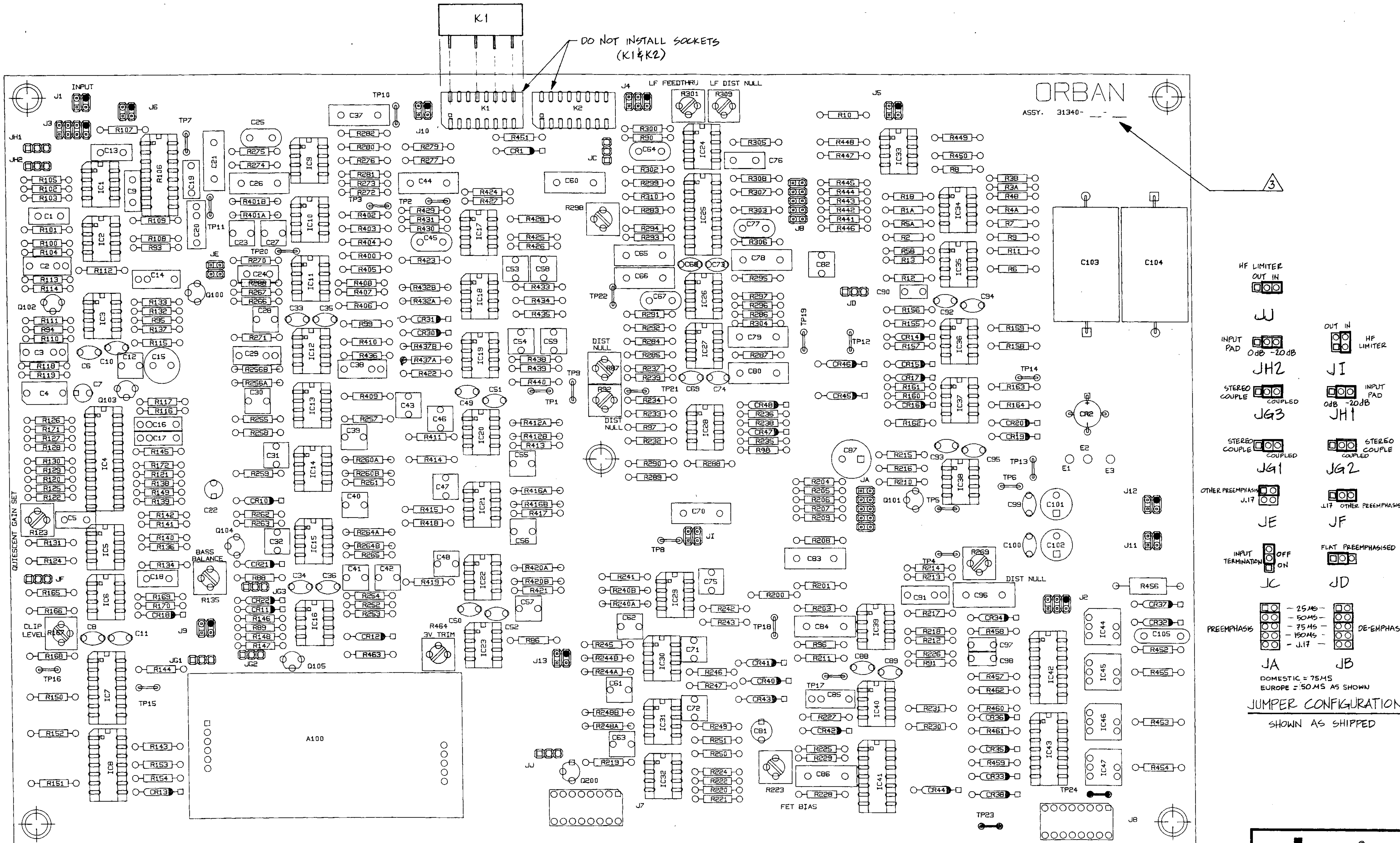
The following drawings are included in this manual:

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 (when they occur) are described in addenda located at the front of this manual.

If you intend to replace parts, please read page 23



orban®
TITLE:
4000A TRANSMISSION LIMITER BLOCK DIAGRAM



5. CLIP PIN#4 OF J1,J5,J6,J9,J10,J11,J12,J13 PIN#6 OF J4,J2 PIN#8 OF J3 (SHADED PAD)

COMPONENT SIDE

4. VER-002 DO NOT INSTALL C103,C104,CR2,R463 & R464 TP23, TP24 (SHADED COMPONENTS)

3. MARK ASSEMBLY REVISION LEVEL IN SPACE PROVIDED.

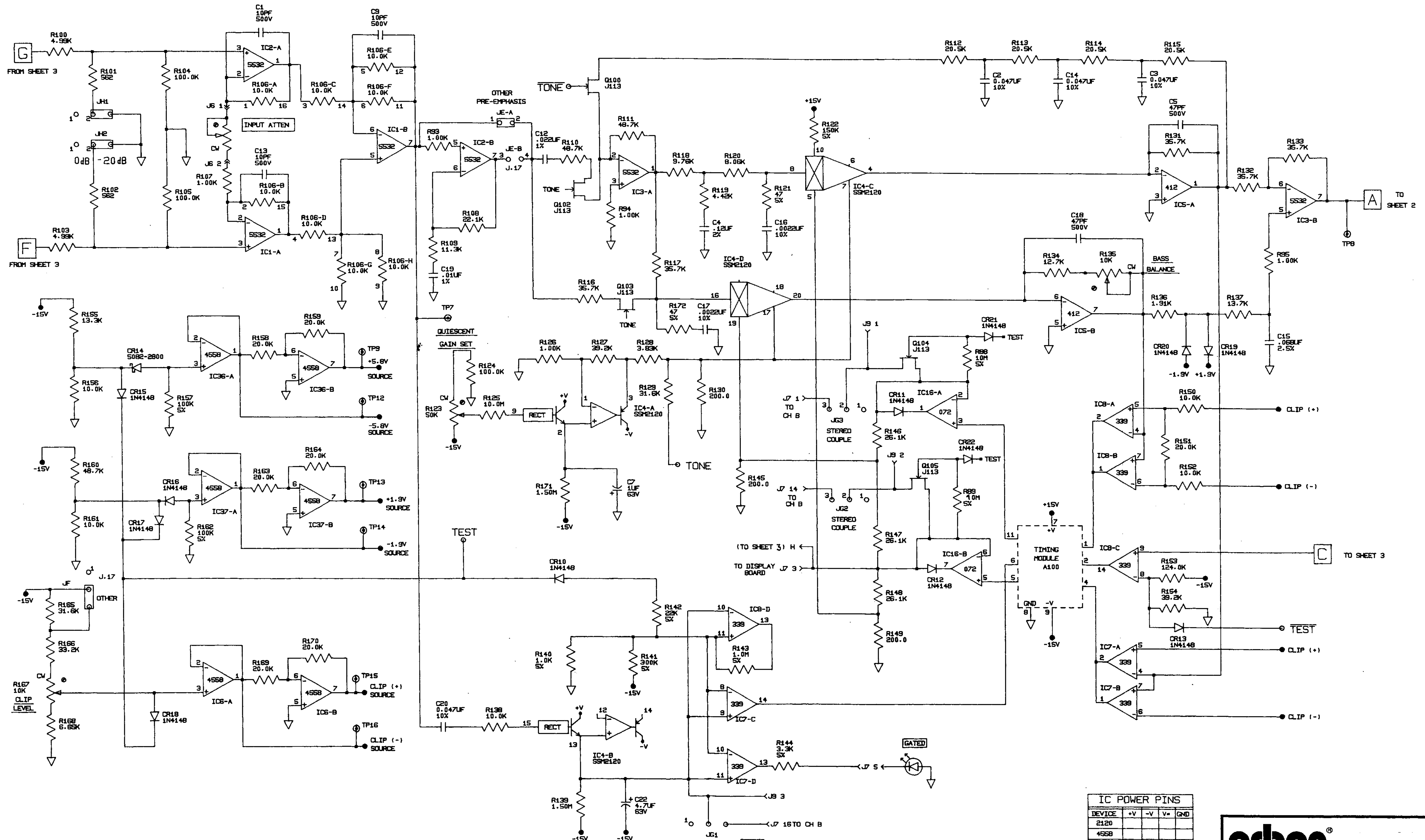
2. REFERENCE SCHEMATIC DRAWING NO. 61076-000.

1. SQUARE PADS INDICATE PIN 1 OF CONNECTORS, CATHODE OF DIODES, POS. SIDE OF CAPS., PIN 1 OF ICS.

NOTES: (UNLESS OTHERWISE SPECIFIED)

orban®

TITLE: PCB ASSEMBLY MAIN BOARD 31340-VER-01



1. ALL RESISTORS ARE 1/8W, 1%, CF

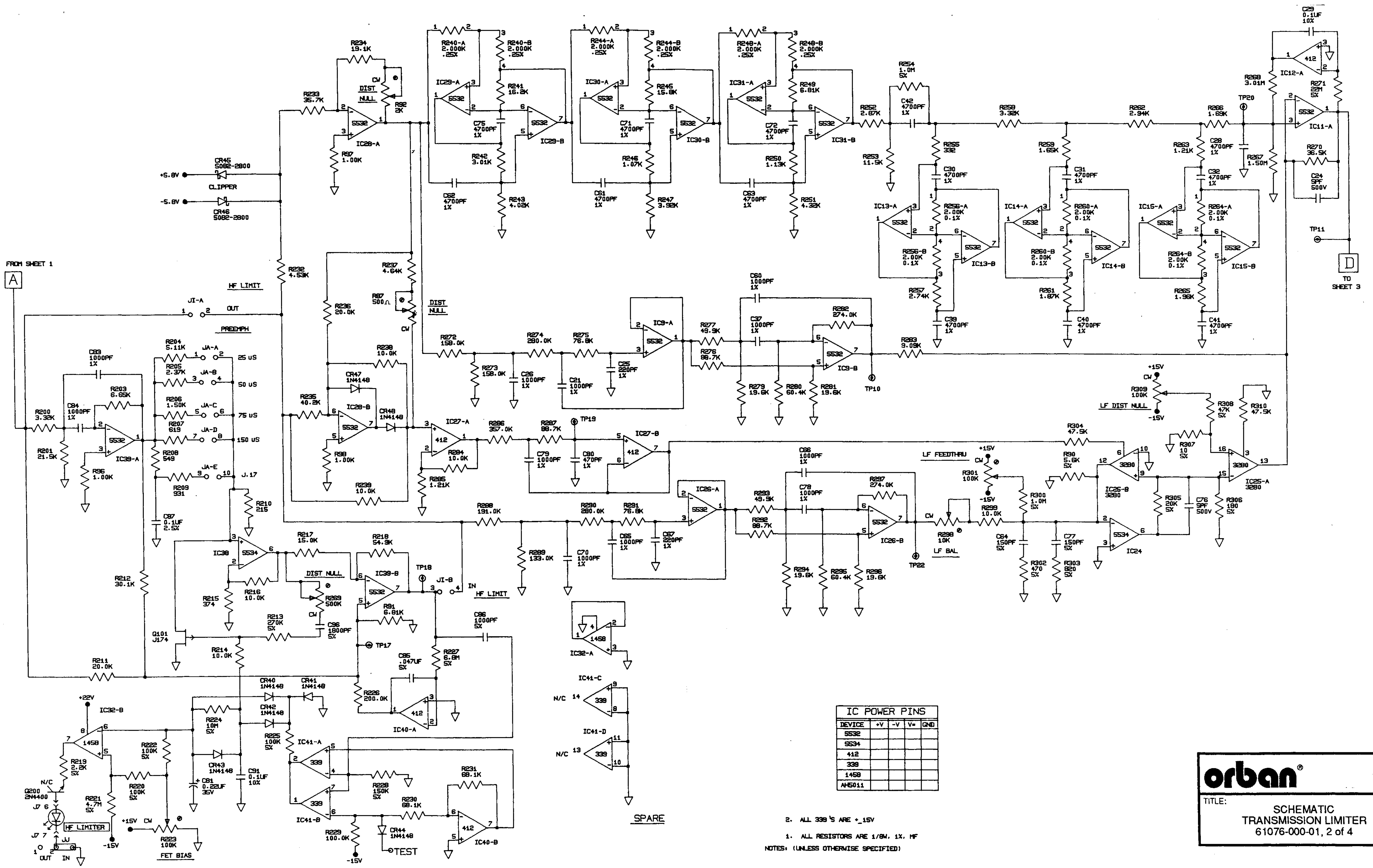
NOTES: (UNLESS OTHERWISE SPECIFIED)

IC POWER PINS				
DEVICE	+V	-V	V=	GND
2120				
4558				
339				
072				
5532				
412				

orban®

TITLE:

SCHEMATIC
TRANSMISSION LIMITER
61076-000-01, 1 of 4



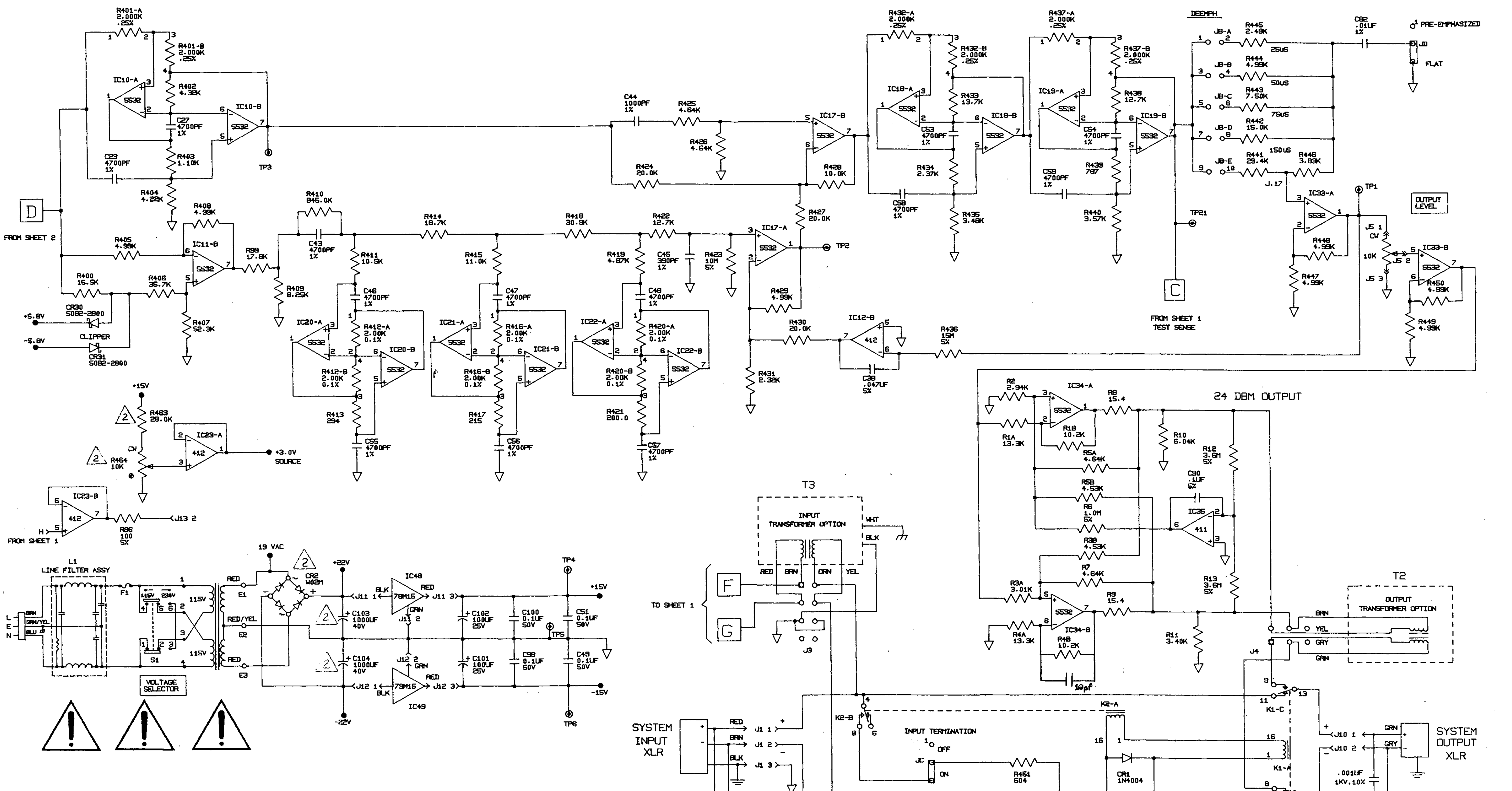
IC POWER PINS				
DEVICE	+V	-V	V=	GND
5532				
5534				
412				
339				
1458				
AH5011				

NOTES: (UNLESS OTHERWISE SPECIFIED)

1. ALL RESISTORS ARE 1/8W, 1%, MF
2. ALL 339'S ARE ±15V

orban®

TITLE:
SCHEMATIC
TRANSMISSION LIMITER
61076-000-01, 2 of 4



⚠ Components marked with this symbol have critical specifications important for protection from fire and electrical shock hazards. When servicing, it is essential that only manufacturer's specified parts be used for replacement.

Prior to the return of this appliance to the customer, and upon completion of servicing, service personnel are required to test this unit for adequate insulation resistance between the power supply and exposed parts.

REFERENCE DESIGNATORS

ITEM	1ST USED	LAST USED	NOT USED
C	400		
CR	30		
DS			
R	400		
S			
Q	-		
TP			
IC	31		

IC POWER PINS

DEVICE	+V	-V	V+	GND
5532				
411				
412				

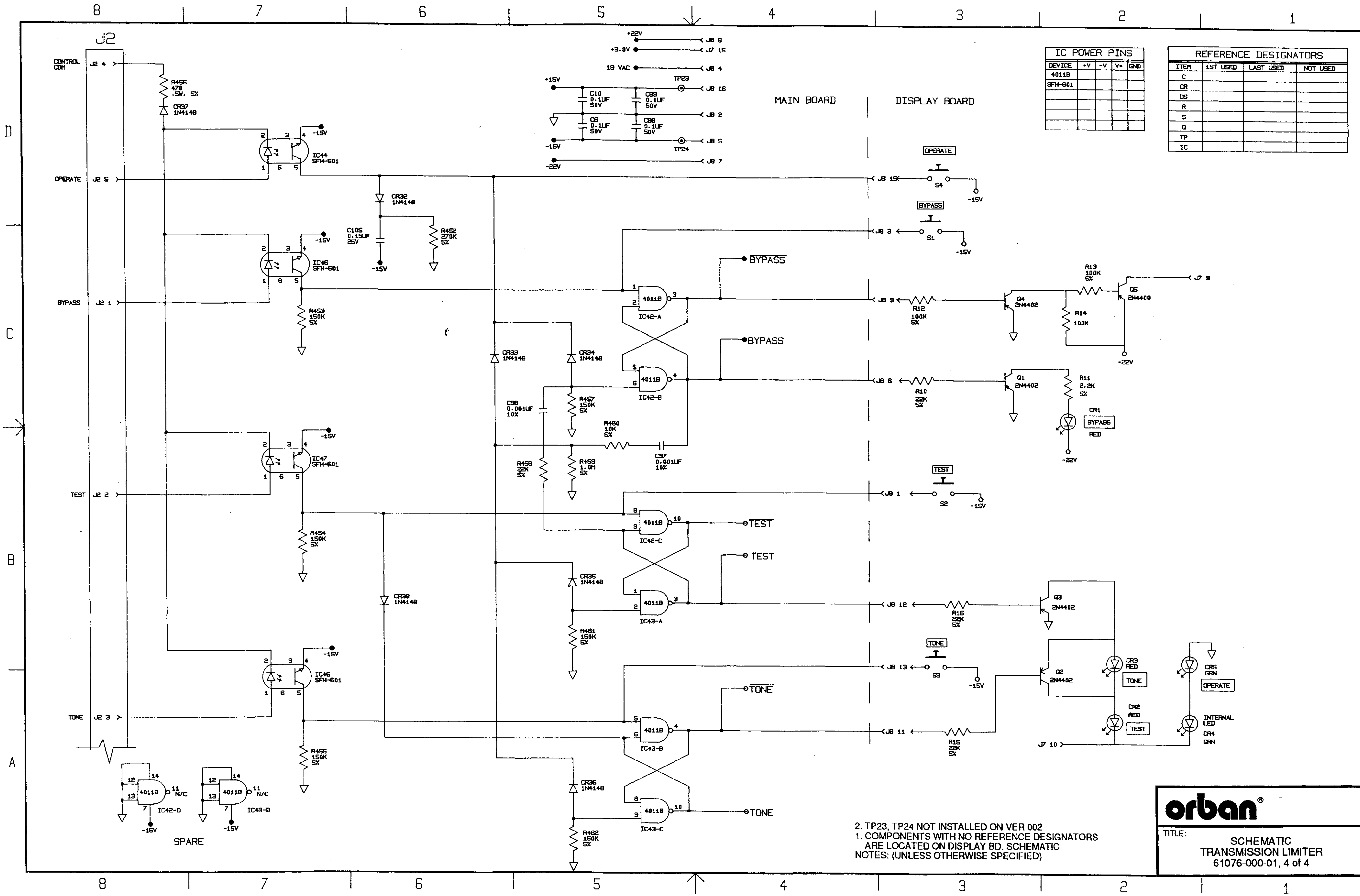
⚠2 NOT USED ON VER-002

1. IF INPUT AND OUTPUT TRANSFORMERS ARE NOT USED, INSTALL JUMPERS TO CONNECT PIN 1 TO PIN 2 AND PIN 3 TO PIN 4

NOTES: (UNLESS OTHERWISE SPECIFIED)

orban®

TITLE: SCHEMATIC TRANSMISSION LIMITER 61076-000-01, 3 of 4



IC POWER PINS

DEVICE	+V	-V	V+	GND
4011B				
SFH-601				

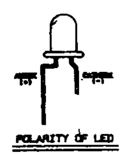
REFERENCE DESIGNATORS

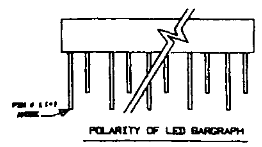
ITEM	1ST USED	LAST USED	NOT USED
C			
CR			
DS			
R			
S			
Q			
TP			
IC			

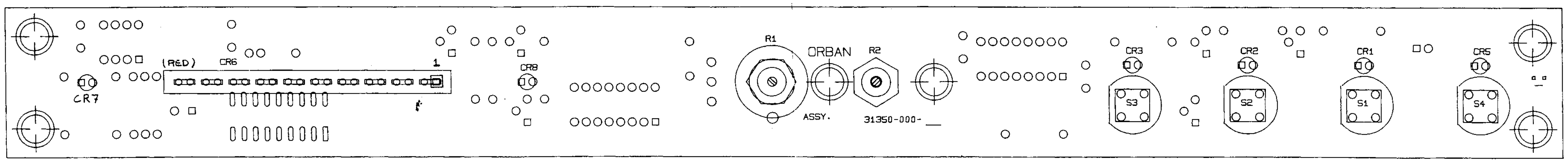
2. TP23, TP24 NOT INSTALLED ON VER 002
1. COMPONENTS WITH NO REFERENCE DESIGNATORS ARE LOCATED ON DISPLAY BD. SCHEMATIC
NOTES: (UNLESS OTHERWISE SPECIFIED)

orban®

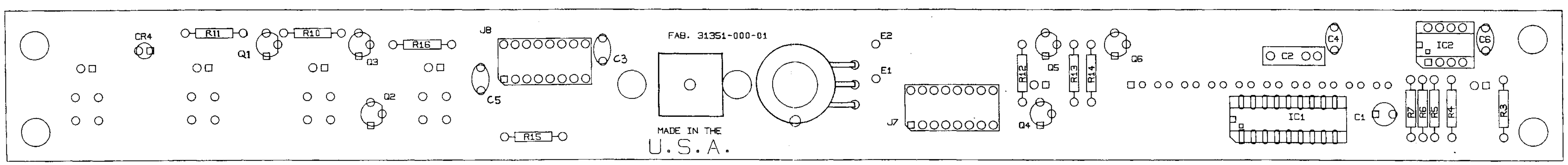
TITLE: SCHEMATIC TRANSMISSION LIMITER 61076-000-01, 4 of 4







COMPONENT SIDE



SOLDER SIDE

4. POTS SHOWN ON COMP SIDE INSTALLED FROM SOLDER SIDE.

2. REFERENCE SCHEMATIC DRAWING NO. 61079-000

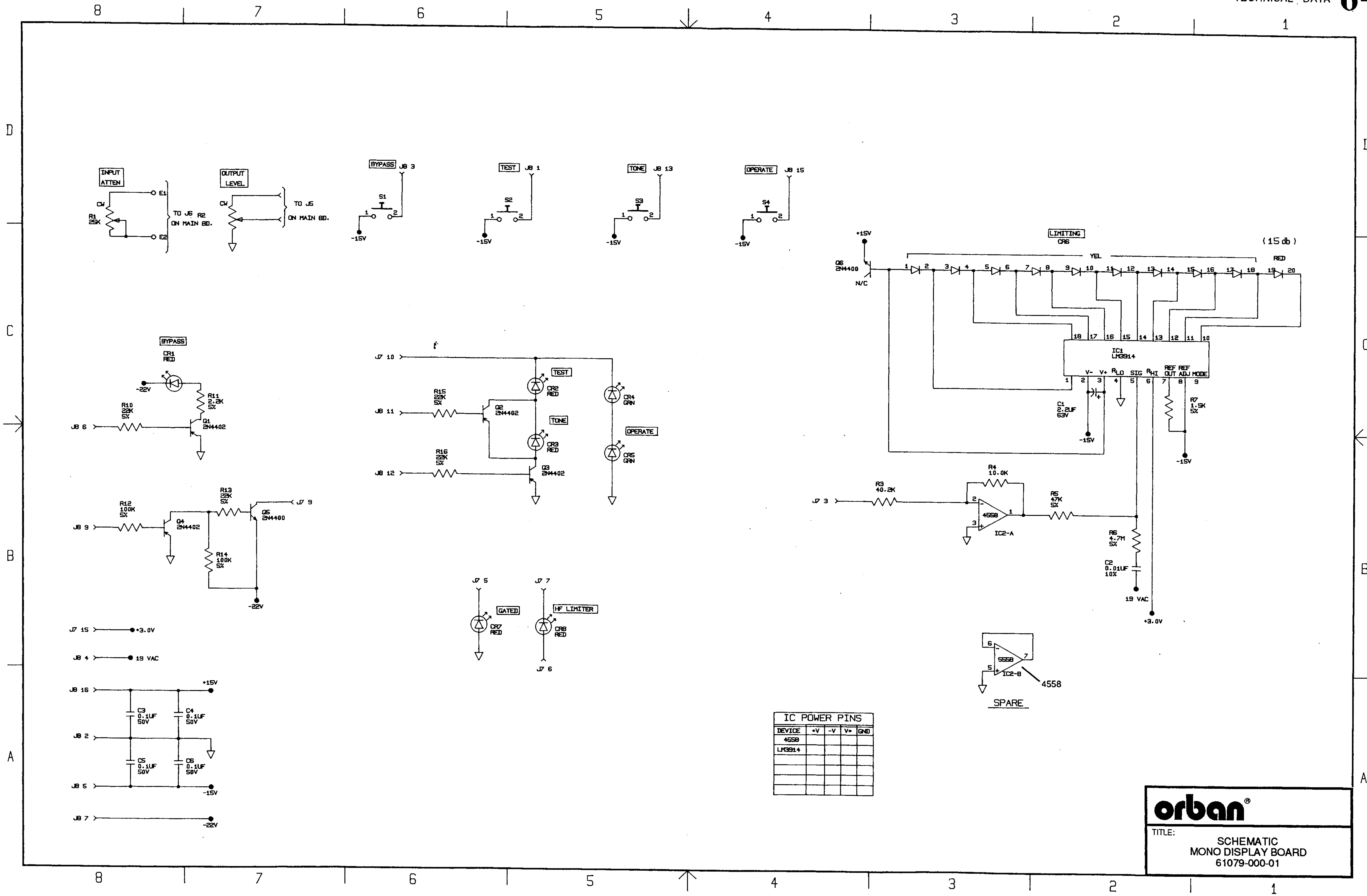
1. SQUARE PADS INDICATE PIN #1 OF CONNECTORS, ICS, BARGRAPHS, POS. SIDE OF CAPS, CATHODE OF DIODES.

NOTES: (UNLESS OTHERWISE SPECIFIED)

orban®

TITLE:

PCB ASSEMBLY
MONO DISPLAY BOARD
31350-000-01

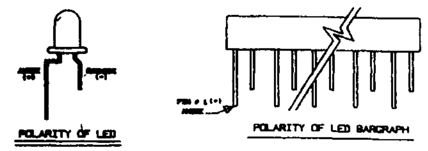


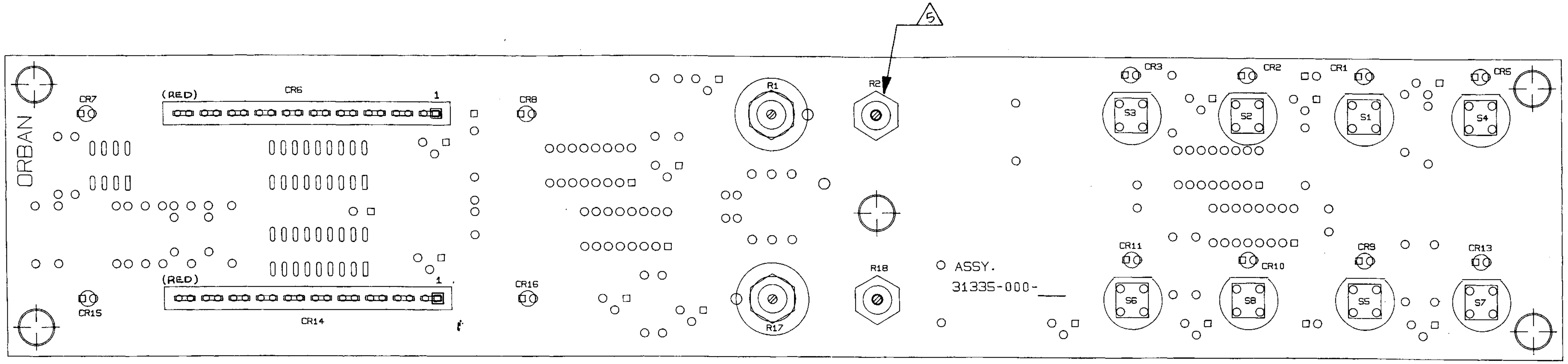
IC POWER PINS

DEVICE	+V	-V	V+	GND
4558				
LM3914				

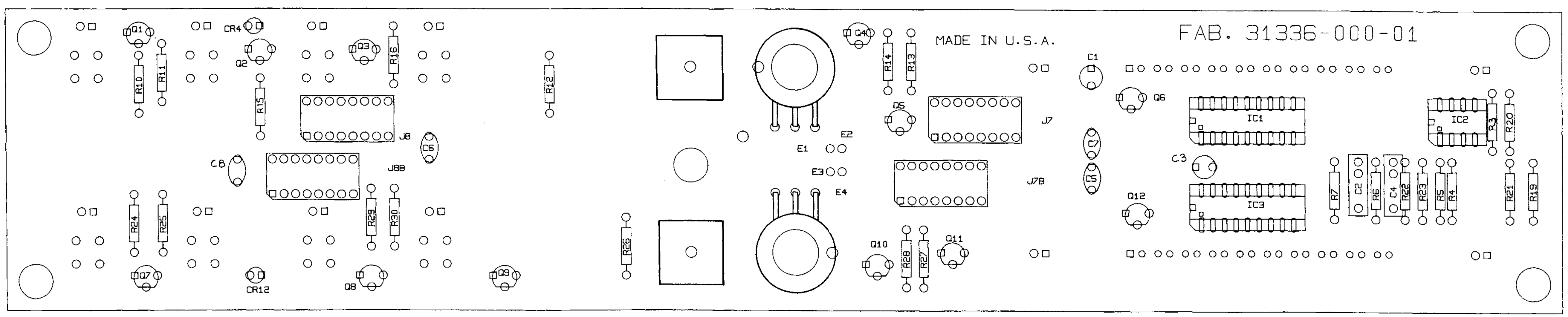
orban®

TITLE:
SCHEMATIC
MONO DISPLAY BOARD
61079-000-01





COMPONENT SIDE



SOLDER SIDE

4 POTS SHOWN ON COMP. SIDE INSTALLED FROM SOLDER SIDE.
2 REFERENCE SCHEMATIC DRAWING NO. 61077-000.
1 SQUARE PADS INDICATE PIN #1 OF CONNECTORS, IC'S, BARGRAPHS, POS. SIDE OF CAPS, CATHODE OF DIODES.
NOTES: (UNLESS OTHERWISE SPECIFIED)

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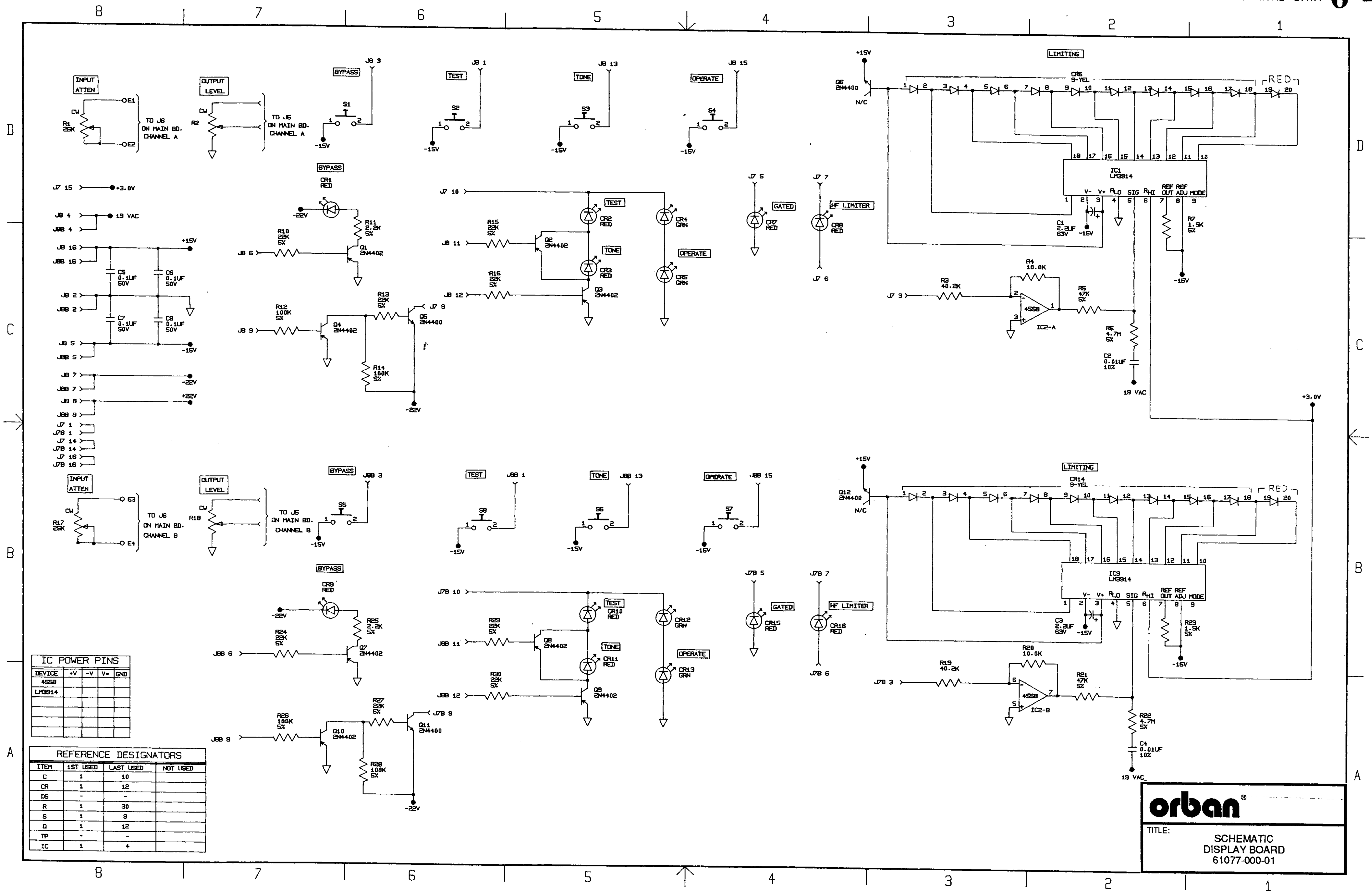
TITLE: PCB ASSEMBLY
STEREO DISPLAY BOARD
31335-000-01



IC POWER PINS				
DEVICE	+V	-V	V=	GND
4558				
LM3914				

REFERENCE DESIGNATORS			
ITEM	1ST USED	LAST USED	NOT USED
C	1	10	
CR	1	12	
DS	-	-	
R	1	30	
S	1	8	
Q	1	12	
TP	-	-	
IC	1	4	

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TITLE: SCHEMATIC DISPLAY BOARD 61077-000-01

Abbreviations

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

AGC	automatic gain control
dBm	decibel power measurement. 0dBm = 1mW applied to a specified load. In audio, the load is usually 600Ω.
dBu	decibel voltage measurement. 0dBu = 0.775V RMS. 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
EMI	electromagnetic interference
FCC	Federal Communications Commission (USA regulatory agency)
FET	field effect transistor
FFT	fast Fourier transform
G/R	gain reduction
HF	high-frequency
HP	high-pass
IC	integrated circuit
IM	intermodulation (or "intermodulation distortion")
JFET	junction field effect transistor
LED	light-emitting diode
LF	low-frequency
LP	low-pass
MHF	midrange/high-frequency
MLF	midrange/low-frequency
N&D	noise and distortion
RF	radio frequency
RFI	radio-frequency interference
RMS	root-mean-square
TRS	tip-ring-sleeve (2-circuit phone jack)
THD	total harmonic distortion
VCA	voltage-controlled amplifier
XLR	a common style of 3-conductor audio connector