

Operating Manual

Adaptive Enhancement Processor

MODEL 290RX

orban

IMPORTANT NOTE: Refer to the unit's rear panel for your Model #.

Model #:	Manual References	Description:
290RX/U	290R _x	Adaptive Enhancement Processor, 115V
290RX/E	290R _x + OPT-024	Adaptive Enhancement Processor, 230V

OPTIONS AVAILABLE

Model #	Purpose
SC2	Security Cover (CLEAR, BLUE or WHITE)



CAUTION: TO REDUCE THE RISK OF ELECTRICAL SHOCK, DO NOT REMOVE COVER (OR BACK). NO USER SERVICEABLE PARTS INSIDE. REFER SERVICING TO QUALIFIED SERVICE PERSONNEL.

WARNING: TO REDUCE THE RISK OF FIRE OR ELECTRICAL SHOCK, DO NOT EXPOSE THIS APPLIANCE TO RAIN OR MOISTURE.



This symbol, wherever it appears, alerts you to the presence of uninsulated dangerous voltage inside the enclosure — voltage that may be sufficient to constitute a risk of shock.



This symbol, wherever it appears, alerts you to important operating and maintenance instructions in the accompanying literature. Read the manual.

Operating Manual

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R_x is a trademark of AKG Acoustics, Inc.

The 290R_x is protected by USA patent #4,731,852; Swedish patent #444,750; other patents pending.

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Orban 290RX

Adaptive Enhancement Processor

Operating Manual

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Section 1

Introduction

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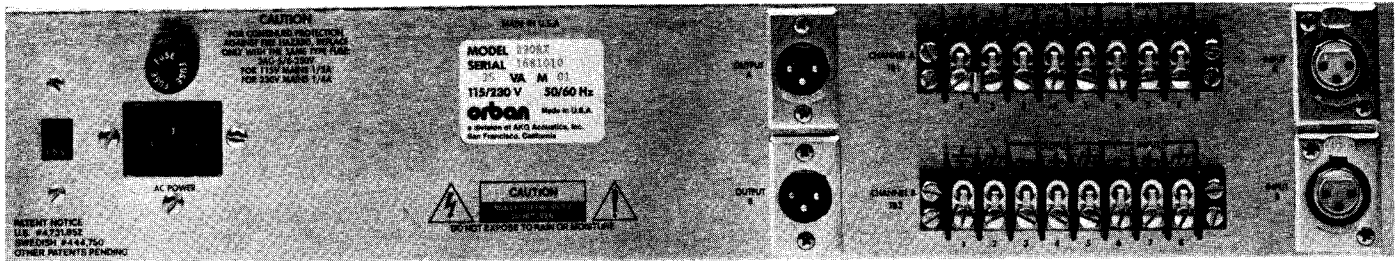
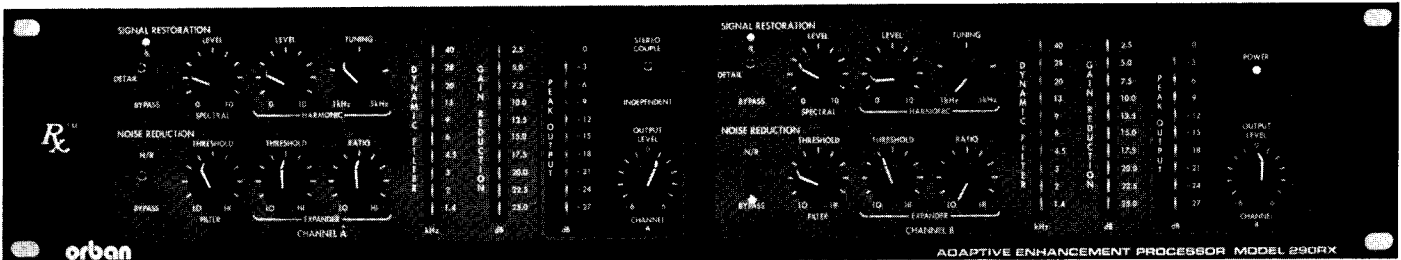


Fig. 1-1: Front and Rear Panels

Orban's R_x Adaptive Enhancement Processor

The Orban R_x Adaptive Enhancement Processor is an efficient and powerful production tool that “brings sound to life” by increasing the definition, detail, and intelligibility of both single tracks and mixed program material. It is applicable to almost all areas of professional audio, including recording, motion picture and video sound, post-production, electronic music, sound reinforcement, and radio and television broadcasting.

Restoration Circuitry:

- Distortion-canceling Harmonic Restoration adds detail-enhancing second harmonic energy without introducing difference-frequency intermodulation (IM) distortion.
- Dynamically-controlled Spectral Restoration analyzes the spectral balance of input material and dynamically re-equalizes as necessary to improve definition and increase realism. It operates simply with a single SPECTRAL LEVEL control.
- TUNING and LEVEL controls, familiar to users of other enhancement processors, are provided in the Harmonic Restoration circuitry.

Dynamic Single-Ended Noise Reduction (DSNR):

- DSNR circuitry combines a subtle downward expander with a program-controlled low-pass filter to achieve significant noise reduction without pumping, breathing, or loss of intelligibility.
- In addition to reducing noise that could be added by enhancement, the DSNR circuit can reduce noise to below the noise level of the *original* signal.
- Separate THRESHOLD controls are provided for the Downward Expander and Dynamic Filter.
- Downward Expander Gain Reduction and Dynamic Filter Bandwidth are each metered by ten-segment LED meters, facilitating easy adjustment of the THRESHOLD controls.

System Features:

- The true peak-reading PEAK OUTPUT meters are used with each channel's OUTPUT LEVEL control to detect and correct clipping.
- The three-position SIGNAL RESTORATION switch enables un-enhanced (BYPASS mode), R_x -enhanced (R_x mode), or enhancement sidechain (DETAIL mode) signals to be heard and compared.
- The STEREO COUPLE switch can force left and right expander gain reductions to track, maintaining correct stereo imaging.
- Inputs and outputs are transformerless, balanced, and floating.
- Inputs accept -10dBV and +4dBu signal levels.
- The R_x features extensive RF suppression on its input, output, and power leads.

Section 2

Installation

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CAUTION

The installation and servicing instructions in this manual are for use by qualified personnel only. To avoid electric shock do not perform any servicing other than that contained in the Operating Instructions unless you are qualified to do so. Refer all servicing to qualified service personnel.



Installation

Allow about 15 minutes for installation.

Installation consists of unpacking and inspecting the R_x, mounting it in a rack (if desired), and connecting audio and power.

1) Unpack and inspect.

If obvious physical damage is noted, contact the carrier immediately to make a damage claim.

If you should ever have to ship the R_x (e.g. for servicing), it is best to ship it in the original packing materials since these have been carefully designed to protect the unit. Therefore, make a mental note of how the unit is packed and *save all packing materials*.

Packed with the R _x are:	1	Warranty Certificate
	1	Registration Card
	1	Operating Manual
	1	Power Cable for AC Mains

2) Mount the R_x in a rack. (optional)

The R_x requires two standard rack units (3½ inches, 8.9 cm).

If the R_x will be grounded through the rack, there should be a good ground connection between the rack and the R_x chassis. Check this with an ohmmeter.

Mounting the unit directly over large heat-producing devices (such as a vacuum-tube power amplifier) may shorten component life and is not recommended. Ambient temperature should not exceed 113°F (45°C) when equipment is powered.



3) Connect audio input and output.

See the audio connections and grounding information on the following pages.

4) Connect power.

A DO NOT connect power to the unit yet.

B Check the line voltage.

The R_x is shipped ready for 115 or 230V, 50/60Hz operation. Refer to the unit's rear panel for your Model # and the inside front cover of this manual for your Model #'s line voltage setting. To change the operating voltage, set the VOLTAGE SELECTOR to 115V or 230V as appropriate (voltages 15% of the nominal voltage are acceptable).



- c Check the value of the fuse and change the fuse if the value is incorrect.

For safety the fuse must be 1/2-amp 250V Slo-Blo fuse, 3AG or 250mA "T" type as appropriate (for 115-volt (or) 230-volt operation).

- d Connect the R_x's power cord to an appropriate AC power source.

The power cord is ordinarily terminated in a "U-ground" plug (USA standard), or CEE7/7 plug (Continental Europe), as appropriate to your R_x's Model #. The green (or green/yellow) wire is connected directly to the R_x chassis.

If it becomes necessary to lift this ground to suppress ground loops, do so with a three-prong to two-prong adapter plug, rather than by damaging the power plug. But you should *not* defeat the ground unless absolutely necessary, because it eliminates the intrinsic safety feature of the three-wire system.



WARNING

If the ground is defeated, certain fault conditions in the unit or in the system to which it is connected can result in full line voltage between chassis and earth ground. Severe injury or death can then result if the chassis and earth ground are touched simultaneously.

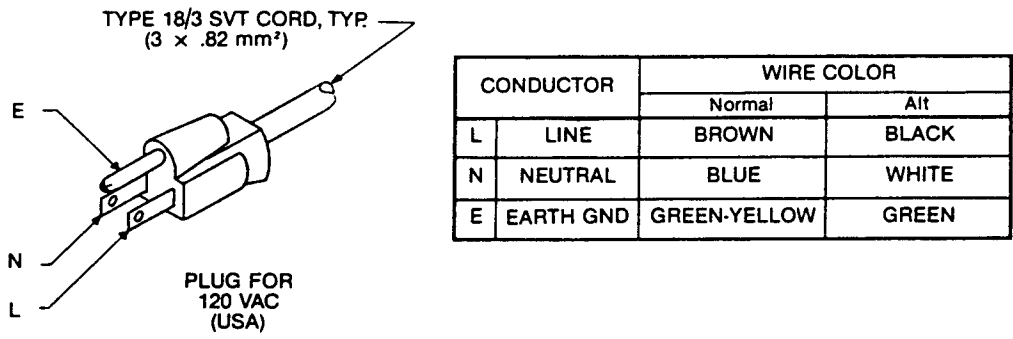


Fig. 2-1: AC Power Cord Color Coding

5) Complete the Registration Card and return it to Orban (please).

The Registration Card enables us to inform you of new applications, performance improvements, and service aids which may be developed, and it helps us respond promptly to claims under warranty without having to request a copy of your bill of sale or other proof of purchase. Please fill in the Registration Card and send it to us today.

Audio Connections

Cable:

We recommend using **two-conductor shielded cable** (such as Belden 8451 or equivalent), because signal current flows through the two conductors only. The shield does not carry signal, is used *only* for shielding, and is ordinarily connected to ground at one end only.

Because use of single-conductor cables virtually eliminates any possibility of carefully controlling the system grounding scheme, it is **NOT RECOMMENDED!** Even so, it often does work adequately.

Sometimes, particularly if you are using the R_X with musical instruments or home-type equipment, single-conductor shielded cable may be the only practical alternative. In this case, connect the inner conductors of the shielded cables to the (+) sides of the R_X inputs and outputs. Connect the shield of the R_X *input* cable to the (-) input, and connect the shield of the R_X *output* cable to the R_X 's (-) output terminal on the rear-panel barrier strip. Connect the OUT (-) terminal to the corresponding ($\frac{1}{2}$) terminal.

Connectors:

- **Input and output connectors** are both barrier strip terminals (with #5 screws) and XLR-type connectors. In the XLR connectors, pin 1 is chassis ground; pin 2 is high, and pin 3 is low (per IEC standard).

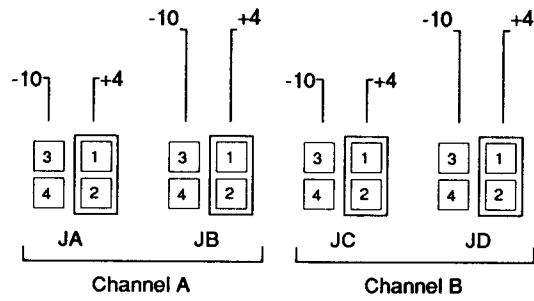
Levels:

- **Nominal input level** is between -10 and +8dBu. The absolute overload point is +21dBu. (0dBu = 0.775V RMS; for this application, the dBm @ 600 Ω scale on voltmeters can be read as if it were calibrated in dBu.)
- Some "semi-professional" and almost all **consumer equipment** uses a nominal operating level of -10dBV (-7.8dBu). The R_X 's input can be strapped for this level. To do so, open the top cover, and move jumpers JA, JB, JC and JD according to Fig. 2-2. If the R_X is used in a -10dBV system, it might be wise to place a 12dB-loss pad at the R_X 's output to avoid overloading subsequent circuitry, since the R_X will otherwise put out peak levels as high as +21dBu.

Input Configuration:

See Fig. 2-3 for some examples.

- The **electronically-balanced input** of each channel is compatible with most professional and semi-professional sound equipment, balanced or unbalanced, having a source impedance of 600 ohms or less. If the source impedance is greater (as in some vacuum-tube audiophile preamps), remove capacitors C1 (channel A) and C3 (channel B), and connect the hot side of the driving equipment's outputs to the R_X 's (+) inputs. Connect the ground side of the driving equipment's outputs to the R_X 's (-) inputs, and to the R_X 's ($\frac{1}{2}$) terminals.



JUMPERS

Shown as shipped
(+4)

Fig. 2-2: Input Level Strapping

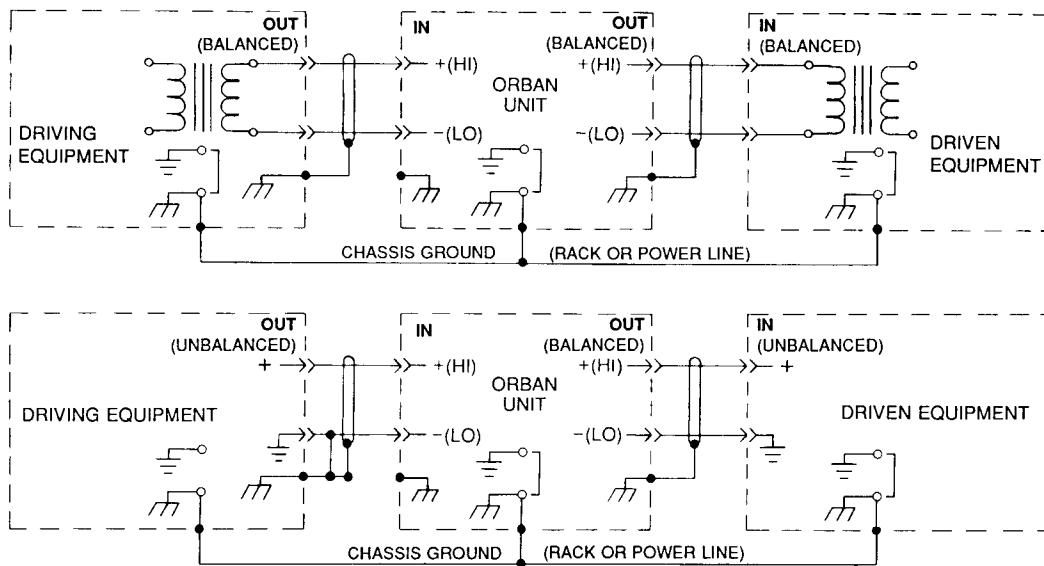


Fig. 2-3: Some Possible Connection Schemes

Audio Connections (continued)

Audio Input:

- Input connections are the same whether the driving source is balanced or unbalanced.
- Do not connect the cable shield — it should be connected at the source end only. Connect the red (or white) wire to the appropriate (+) input terminal, and the black wire to the corresponding (-) input terminal.
- If the output of the other unit is unbalanced and does not have separate (\perp) and (-) (or LO) output terminals, connect both the shield and the black wire to the common (-) or ground terminal. It is rarely necessary to balance an unbalanced output with a transformer. As long as it is feeding a balanced input, the system will work correctly.

(The only situation where the addition of an input transformer is warranted is one in which the source equipment is powered from a separate mains transformer and power ground. In such a situation, terminate the transformer's secondary with a 20K resistor.)

Output Configuration:

See Fig. 2-3 for some examples.

- The **electronically-balanced and floating output** of each channel simulates a true transformer output. The *source* impedance is 30 ohms. In addition, there is a 1000pF capacitor from each output (+) and (-) to the chassis for RFI suppression. The output is capable of driving loads of 600 ohms or higher; maximum output level is >+20dBu.
- If an **unbalanced output** is required (to drive unbalanced inputs of other equipment), it should be taken between the (+) and (-) outputs. No special precautions are required even though one side of the output is grounded: Connect the (-) output terminal to (\perp).

Audio Output:

- Use two-conductor shielded cable (Belden 8451, or equivalent).
- At the R_x 's output (and at the output of other equipment in the system), connect the cable's shield to the (\perp) terminal for that channel. Connect the red (or white) wire to the channel's (+) terminal, and the black wire to the channel's (-) terminal.
- In difficult environments, it may be necessary to isolate the R_x with output transformers (available as Retrofit Kit RET-051).

Grounding

Audio and power grounding can be a “hit or miss” endeavor. But it is possible to wire the equipment so it is free from ground loops which can cause hum, buzzing and even oscillation. Correct wiring provides maximum protection from power faults as well. In an ideal system:

- All units in the system should have *balanced inputs*. In a modern system with low output impedances and high input impedances, a balanced input will provide common-mode rejection and prevent ground loops — regardless of whether it is driven from a balanced or unbalanced source. (The R_x has balanced inputs.)
- All equipment *circuit grounds* must be connected to each other; all equipment *chassis grounds* must be connected together.
- *Cable shields* should be connected at one end only — preferably the source (output) end.

Power Ground:

- Ground the R_x chassis through the third wire in the power cord. Proper grounding techniques *never* leave equipment chassis unconnected to power/earth ground. *A proper power ground is essential to safe operation.* Lifting a chassis from power ground creates a potential safety hazard.



Circuit Ground:

To maintain the same potential in all equipment, the circuit (audio) grounds must be connected together:

- *In a simple one-studio system*, the connection through power ground (via the power cord's third wire) will suffice. Connect the R_x 's channel A IN (\perp) terminal to its channel A OUT (\llcorner) terminal (only one channel should be jumpered in this way — leave the channel B grounds unconnected). Also connect the circuit and chassis grounds of other equipment.
- *In larger systems*, it is common to establish an isolated circuit ground system that is insulated from the power ground except at one point (usually the studio power distribution panel). If this grounding system is used, disconnect the R_x 's channel A IN (\perp) terminal from its channel A IN (\llcorner) terminal, then connect the R_x 's channel A OUT (\perp) terminal to the isolated circuit ground system.

Grounding (continued)

Difficult Situations:

Because it is not always possible to determine if the equipment driving or being driven by the R_x has its circuit ground internally connected to its chassis ground (which is always connected to the ground prong of the AC power cord, if present), and because the use of the AC power ground often introduces noise or other imperfections such as RFI, hum, clicks, and buzzes, the wiring techniques in Fig. 2-3 are not universally applicable.

If you follow the wiring techniques in Fig. 2-3 and hum or noise appears, don't be afraid to experiment. If the noise sounds like a low-level crackling buzz, then probably there isn't *enough* grounding. Try connecting the (-) input of the R_x to a chassis ground terminal on the barrier strip and see if the buzz goes away. You can also try strapping the R_x 's chassis and circuit grounds together, and see if this helps.

A ground loop usually causes a smooth, steady hum rather than a crackly buzz. If you have a ground loop, you can often break it by *disconnecting* the jumper between circuit and chassis grounds on the R_x 's rear-panel barrier strip. In either case, think carefully about what is going on, and keep in mind the general principle: one and *only one* circuit ground path should exist between each piece of equipment!

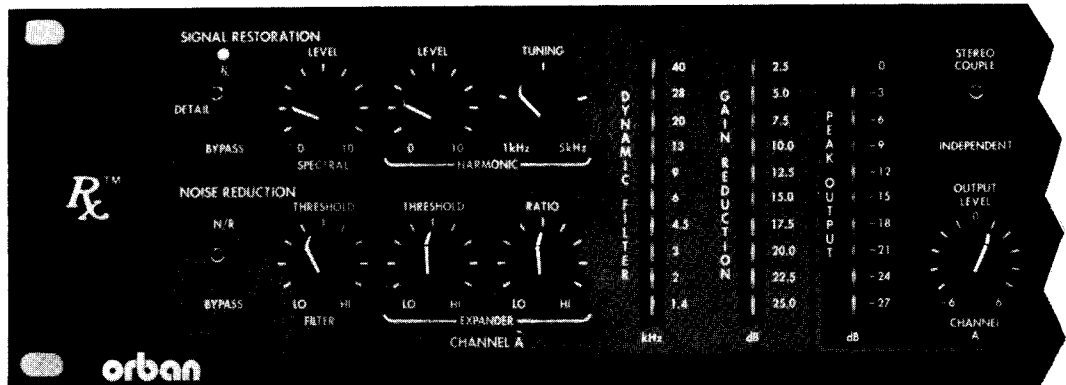
When a single-conductor shielded cable is used for audio connections, the shield will ordinarily receive chassis ground from the external equipment that it is connecting to the input of the R_x . The chassis ground/circuit ground jumper on the rear barrier strip of the R_x should be left in whichever configuration gives minimum hum or buzz. To minimize hum or buzz, it may be necessary to jumper one or more shields to chassis ground, and/or to jumper the R_x 's (-) output to chassis ground.

Section 3

Operation

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Controls and Displays



Channel A

POWER lamp lights when the R_x is powered. (The lamp operates from the R_x 's -15V rail.)

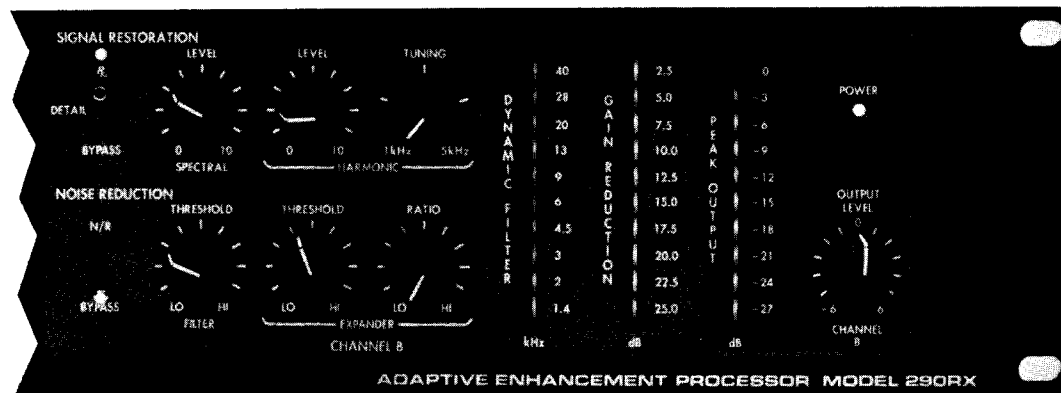
PEAK OUTPUT display shows the instantaneous peak level (attack time = 10 μ s) at the R_x 's output. The red lamp (0dB) indicates clipping. To adjust this level, use the OUTPUT LEVEL control.

SIGNAL RESTORATION switch determines which signal appears at the output.

BYPASS position defeats restoration processing only. This switch is not a complete *system* bypass because noise reduction will still occur if the NOISE REDUCTION switch is set to N/R.

DETAIL position blocks the main signal, and passes only the restoration signal (the signal added to the input to produce the R_x effect). The DETAIL setting can help you hear the effect of fine-tuning the various SIGNAL RESTORATION controls. (**Note:** When the SIGNAL RESTORATION switch is in DETAIL, the noise reduction expander sees only the detail signal. This may cause the noise reduction to produce odd-sounding pumping effects unrelated to the restoration processing. It is therefore wise to set the NOISE REDUCTION switch to BYPASS when you are using the DETAIL setting to help you fine-tune the processing.

R_x position mixes the restoration signal with the input signal to produce the R_x effect.



Channel B

HARMONIC LEVEL control determines the amount of Harmonic Restoration signal added to the input signal. The Harmonic Restoration signal consists of second harmonics and sum-frequency intermodulation. Difference-frequency intermodulation is canceled by Orban's patented circuitry. (Competitive products claiming to add "harmonics" add both sum-frequency *and* undesirable difference-frequency intermodulation.)

HARMONIC TUNING control selects the frequencies that are applied to the Harmonic Restoration generator: all frequencies *above* the setting of this control are passed to the Harmonic Restoration generator. (Since the first even harmonic generated by the Harmonic Restoration circuit is one octave above the source frequency, setting the control to 1kHz means that the lowest full amplitude harmonic to be added to the signal will be 2kHz.)

SPECTRAL LEVEL control determines the amount of Spectral Restoration signal added to the input signal. Spectral Restoration is a form of dynamic phase and amplitude equalization. Continuous analysis of the input signal intelligently and automatically determines the amount of equalization necessary at each moment to achieve detailed, defined audio that is never shrill or over-sibilant.

NOISE REDUCTION switch enables or defeats the single-ended noise reduction circuitry. This circuitry consists of a dynamic low-pass filter before the restoration circuitry and a downward expander after the restoration circuitry. Note that the BYPASS position of the SIGNAL RESTORATION switch *does not bypass* the noise reduction. To defeat *all* processing, both the NOISE REDUCTION switch *and* the SIGNAL RESTORATION switch must be set to BYPASS.

FILTER THRESHOLD control determines the level of high frequency energy (with reference to the input) that first causes the dynamic low-pass filter to increase its bandwidth. The control is normally adjusted clockwise until audible *noise modulation* (a “puffing” sound accompanying the program material) is eliminated. The DYNAMIC FILTER display is a useful guide to setting the control because it shows the bandwidth of the low-pass filter at every moment, and you can therefore determine if audible noise modulation is caused by the dynamic filter, or by something else (like the downward expander).

DYNAMIC FILTER display indicates the bandwidth of the program-controlled low-pass filter. The range of the filter is from 1.4kHz to beyond 40kHz at -3dB.

EXPANDER THRESHOLD control determines the level of broadband energy (with respect to the restoration processing section’s output) that first causes the downward expander to produce gain reduction. As with the FILTER THRESHOLD control, the EXPANDER THRESHOLD control is usually adjusted clockwise until audible noise modulation is eliminated.

EXPANDER RATIO control scales the expander expansion ratio either “harder” or “softer.” The expander has an extremely “soft” knee: the expansion ratio starts very low at threshold, and gradually increases as gain reduction increases. The EXPANDER RATIO control does not change the essential soft-knee *shape* of this curve; instead, it *scales* it so that the ratio associated with any given amount of gain reduction becomes higher or lower as the control is adjusted.

EXPANDER GAIN REDUCTION display indicates the amount of gain reduction (“G/R”) produced by the downward expander circuit. Its range is 0 to 25dB of gain reduction. During silence, it is normal for this display to “flicker” a bit — particularly at lower expansion ratios. This indicates that the very sensitive and fast expander is being slightly “opened up” by normal random variations in the noise floor. (See page 3-7.)

STEREO COUPLE/INDEPENDENT switch, when set to STEREO COUPLE, forces the gains of the downward expanders in the two channels to be identical. This ensures that the stereo image will not be distorted by the action of either expander. The gain will be the average (in dB) of the gains that the two channels would otherwise have if they were not coupled. To provide maximum versatility, the STEREO COUPLE switch setting does not couple any operating controls. While corresponding controls are ordinarily set identically when the R_x processes stereo material, there may be exceptions — see page 3-8.

Using the R_x — General Considerations

The operating controls of the R_x have been configured to permit easy, intuitive adjustment — particularly if you have used other “exciter”-type devices or single-ended noise reduction systems. If you are familiar with such devices, you will probably notice the R_x 's improved cleanliness, consistency, and freedom from side-effects and processing artifacts.

The best way to become familiar with the R_x is to pass audio through it and listen to the effects produced by turning the various controls.

Using the Restoration Section

To avoid confusion when you are first learning to use the R_x 's restoration section, defeat the noise reduction by setting the NOISE REDUCTION switch to BYPASS. Then activate the restoration section by setting the SIGNAL RESTORATION switch to R_x .

Set both the SPECTRAL LEVEL and HARMONIC LEVEL controls fully counterclockwise to defeat all restoration. Apply program material to the input of the R_x .

The SPECTRAL LEVEL and HARMONIC LEVEL controls are “level” controls that “mix” the desired effect into the original program material.

Spectral Restoration: Advance the SPECTRAL LEVEL control clockwise and listen to the audible effect. On mixed program material, the SPECTRAL LEVEL control usually produces the best sound if adjusted in the 11:00 to 1:00 range: the detail and definition of the program material is improved, yet the material does not sound excessively shrill.

If Spectral Restoration processing is applied to single tracks, the SPECTRAL LEVEL control must be set to individual taste, and might be set almost anywhere. Use your ears, and judge how R_x processing affects the sound of the track in the context of the entire mix.

If the program material is very bright to begin with, you will hear little effect. If the program material is dull, you will hear very significant brightening.

Harmonic Restoration: Now set the HARMONIC TUNING to 2kHz (about 10:00), and advance the HARMONIC LEVEL control clockwise. The effect of this control is more subtle than the effect of the SPECTRAL LEVEL control. However, you should hear a noticeable increase in “air,” “sparkle” and “definition” as you advance the control. With mixed program material, this control is typically set between 9:00 and 11:00.

When R_x processing is applied to single tracks, the HARMONIC RESTORATION control must be set to individual taste, and might be set almost anywhere. Very high settings are particularly useful to make percussion instruments “cut” through a mix while minimally increasing their peak levels, and to enhance the realism and apparent bandwidth of sampled instruments playing single lines (like individual brass, woodwind, or stringed instruments).

Although described as a “harmonic generator,” the most popular enhancement processor on the market prior to the introduction of the R_X actually functions primarily by adding high-frequency boost to the original signal. Only about 10% of the “enhancement” signal generated by that processor contains a mixture of harmonics, sum-frequency IM, and difference-frequency IM content. The remaining 90% consists of the output from the high-pass filter preceding the effects generator.

In contrast, the HARMONIC LEVEL control of the R_X adds *pure* second-harmonic and sum-frequency IM. The SPECTRAL LEVEL control of the R_X adds a program-adaptive dynamic equalization component independently, giving you much more control over the overall effect of the processing.

If you advance the HARMONIC LEVEL control *too* far, you will hear distortion because the output of the Harmonic Restoration generator in the R_X contains *only* harmonics and sum-frequency IM. Therefore, a little Harmonic Restoration goes a long way in the R_X : most of the work is done by the Spectral Restoration section, and the Harmonic Restoration section simply adds a bit more “air,” “sparkle” and “bite” that helps the processed audio “cut” through the mix.

The HARMONIC TUNING control has a *very subtle* effect by comparison to older processors, because other non-adjustable tuning in the processor has been optimized for most improvement of detail, “air,” and “definition” consistent with minimum perceived distortion — particularly on spoken word. The easiest way to hear the effect of the HARMONIC TUNING control is to set the SIGNAL RESTORATION switch to DETAIL position and then to turn the SPECTRAL LEVEL control off (fully counterclockwise). Now you are hearing *only* the harmonic and sum-frequency IM components of the restoration signal. (You will notice that virtually no low-frequency “grunge” is audible because of Orban’s patented difference-frequency IM distortion-canceling circuitry.) Now adjust the HARMONIC TUNING control, and you will clearly hear its effect as a change in the amount of upper mid-range energy produced by the processing.

If you set the SIGNAL RESTORATION switch to DETAIL, you hear the signal that the R_X adds to its input to create the R_X effect. The main purpose of the DETAIL position is ear training: it lets you clearly hear the *difference* between the input and output of the R_X .

The DETAIL position is also useful if you drive the R_X from the effects bus on a console. If you set the SIGNAL RESTORATION switch to DETAIL, you can return the output of the R_X to a console input and operate it as a sidechain effects device.

We recommend that you set the NOISE REDUCTION switch to DEFEAT whenever the SIGNAL RESTORATION switch is set to DETAIL. Otherwise, the noise reduction circuitry will tend to introduce odd pumping effects which will interfere with the detail signal.

Using the Noise Reduction Section

The Spectral and Harmonic Restoration processors introduce surprisingly little noise because they intelligently differentiate noise from program material and do not enhance noise. You can use the single-ended noise reduction not only to reduce this small amount of added noise, but also to reduce noise present on the original input material. To activate noise reduction at any time, set the NOISE REDUCTION switch to N/R.

The noise reduction will work regardless of the setting of the SIGNAL RESTORATION switch because the SIGNAL RESTORATION switch affects *only* the restoration section, not the noise reduction section.

Setting the THRESHOLD controls: Your goal is to achieve a noise floor that does not appear to change, but which is lower than the noise floor of the original program material. Set the FILTER THRESHOLD and EXPANDER THRESHOLD controls slightly further clockwise than the point at which you no longer hear “noise breathing.”

“Noise breathing” occurs when the noise level audibly changes in sync with the program material.

Watch the DYNAMIC FILTER and EXPANDER GAIN REDUCTION displays as you adjust the noise reduction controls — the displays will help you understand how the bandwidth of the dynamic filter and the gain reduction of the downward expander affect the sound. Each has a different audible effect, and you will soon train yourself to hear the difference.

Setting the EXPANDER RATIO control: The EXPANDER RATIO control tunes the downward expander for different program material. Low ratios are most suited for mixed program material, where a few dB of expansion around the extremely “soft-knee” expansion threshold is almost imperceptible, yet achieves significant noise reduction. Higher ratios are best for single tracks, when you want a more traditional “noise gate” action.

The expansion ratio will seldom exceed 2:1 even when the EXPANDER RATIO control is set fully HI. Therefore, the downward expander will never sound the same as a hard 20:1 gate — and consequently, it will not require the constant readjustment that a traditional “switching gate” would require.

Particularly when the EXPANDER RATIO control is set toward LO and the EXPANDER THRESHOLD control is set very LO, the EXPANDER GAIN REDUCTION display may never reach a full 25dB gain reduction even during pauses in the program, but instead will stay at some higher level and flicker slightly. This is because the expander is being activated by the noise floor of the input program, or even by the very low noise floor of the R_x itself. This is a natural consequence of using very low expansion ratios, and does not have any offensive audible effect.

If you hear distortion: Because the release time of the expander is very fast, it can add audible distortion to certain pure bass sounds by modulating each cycle of the instrument’s waveform. To minimize this effect if it occurs, set the EXPANDER THRESHOLD control fully counterclockwise, and use the DYNAMIC FILTER to achieve noise reduction.

Headroom

The overload-to-noise ratio available from the R_x is typically 95dB when the noise reduction is defeated, and may be as high as 115dB when the noise reduction is activated.

Regardless of whether the noise reduction is activated or defeated, the noise performance of the R_x is compatible with 16-bit digital and other applications requiring the highest possible technical quality (such as CD mastering).

To achieve best signal-to-noise ratio, you must drive the R_x with the correct level.

Depending on the strapping of the input jumpers (see Fig. 2-2 on page 2-5), this is either +4dBu or -10dBV.

When the SIGNAL RESTORATION and NOISE REDUCTION switches are set to BYPASS and the OUTPUT LEVEL control is at 0, overall gain from input to output is unity when the input is strapped for +4dBu. The gain is +14dB when the input is strapped for -10dBV. Very large amounts of enhancement can increase the peak level at the output to the point where the output clips. To correct clipping, turn the OUTPUT LEVEL control down until the PEAK OUTPUT display no longer reads in the red.

If the PEAK OUTPUT display reads low, the best way to optimize signal-to-noise ratio is to increase the *input drive* to the R_x by increasing the *output level* of the device driving it until the PEAK OUTPUT display on the R_x reads normally. If you cannot do this, turn up the R_x 's OUTPUT LEVEL control instead.

Turning up the R_x 's OUTPUT LEVEL control will slightly increase its noise floor (by 1dB for every 2dB of gain added by the OUTPUT LEVEL control), but noise should still be adequately low for any application.

The range of the OUTPUT LEVEL control is ± 6 dB.

Stereophonic Operation

To process stereo material, set the STEREO COUPLE/INDEPENDENT switch on the R_x to STEREO COUPLE. This forces the left and right downward expanders to have equal gain. The gain will be the average (in dB) of the gains that the two expanders would otherwise have if they were not coupled.

No other controls or circuitry are coupled by the STEREO COUPLE switch setting. All listening tests have shown that independent operation of the other circuits in corresponding stereo channels causes fewer audible side-effects than stereo-coupling these circuits.)

It is usually wise to set corresponding left and right controls identically on the basis of front-panel scales. However, like any rule, this one could be broken — for example, if one channel was noisier than the other, it might need a higher setting of its FILTER THRESHOLD control.

Specific Applications

This section provides specific instructions and suggestions for using the R_x in recording studios, sound reinforcement, dance clubs, film and video post-production, and broadcasting. We recommend that anyone involved in pro audio (and especially those involved in its more multi-faceted disciplines, such as theater) read all of the following.

Recording Studios

R_x processing can be applied to both single tracks and mixed program material to increase apparent loudness, improve intelligibility, improve the ability of program material to cut through noise or other sounds, and make the sound seem more natural and alive.

Mixed Program Material: With mixed program material, the SPECTRAL LEVEL control should generally be set between 11:00 and 1:00, the HARMONIC LEVEL control should be set from 9:00 to 11:00, and the HARMONIC TUNING control should be set about 2kHz (10:00).

Single Tracks: With single tracks, you must use your ears as a guide. Almost any track will be improved by a certain amount of Spectral Restoration. However, not all material is well-suited for Harmonic Restoration. The HARMONIC LEVEL control has a wide enough range so that it can make almost any program material sound audibly distorted if Harmonic Restoration is used to excess. Harmonic Restoration should add subtle “sheen” or “air” to most material while letting Spectral Restoration do most of the work. Use Harmonic Restoration with taste and restraint.

Monophonic instruments (instruments that play only one note at a time) can often benefit from large amounts of Harmonic Restoration — particularly if they are being reproduced by a digital sampler. Drums and percussion can be dramatically enhanced by very large amounts of Harmonic Restoration as well.

If application of Harmonic Restoration to a track makes it sound distorted before any positive benefits are noted, try adjusting the HARMONIC TUNING control to a higher frequency. If this does not work, use only Spectral Restoration — the R_x 's separate SPECTRAL LEVEL and HARMONIC LEVEL controls give you the versatility to use the type of restoration that exactly complements the program material with which you are working.

Synthesizers: Digital synthesizers usually have sharp cut-off reconstruction filters that limit the high-frequency spectral content of the output audio. In addition, many use less than 16-bit converters and are audibly noisy. R_x processing can be invaluable in improving the audio quality of a synthesizer or less-than-16-bit sampler. Use the Harmonic Restoration section to add the energy missing at the top of the audio spectrum. Use the noise reduction section to clean up both the idle noise and the modulation noise. Because each synthesizer and sample is different, you must use your ears to guide your adjustment of the R_x .

Sound Reinforcement

The information on **Recording Studios** on page 3-9 directly applies to sound reinforcement, provided that acoustic feedback is considered. The Spectral Restoration circuitry can increase the gain at high frequencies as much as 15dB if program material is very dull and the SPECTRAL LEVEL control is adjusted aggressively. This could conceivably cause a reinforcement system to feed back.

Unlike a compressor, the Spectral Restoration circuit creates very little excess gain during pauses. In general, if the Spectral Restoration causes feedback, it will do so at the *peaks* of the program instead of during pauses. In addition, if feedback starts, it will tend to be self-limiting (as if there were a compressor in the signal path) because the Spectral Restoration circuit will interpret it as added high frequency spectral energy at the input and will reduce the amount of Spectral Restoration accordingly. Because the Spectral Restoration circuitry behaves differently from any signal processing that you may be familiar with, it is wise to experiment with it *before* the audience arrives to familiarize yourself with its characteristics!

The output of the Harmonic Restoration circuitry contains no frequencies that are present at its input, so it cannot cause the system to feed back. The HARMONIC LEVEL control can therefore be adjusted solely to achieve the desired artistic effect.

System gain should be adjusted with the noise reduction defeated (set to BYPASS). If noise reduction is then activated, it can only reduce gain and can never cause the system to feed back.

Dance Clubs

Dance clubs usually want a sound that will make people get up and dance until they have to sit down and drink!

The most successful systems usually have very high acoustic power output capability, with extended high-frequency and low-frequency power handling capability. Substantial bass and treble boost is common.

The R_x can add that extra degree of sparkle and presence to a dance club sound system *without* the danger of over-equalization. We recommend that a dance club signal processing chain should contain the R_x followed by our 642B Parametric Equalizer. The R_x can add some extra clarity, and the 642B can be used to equalize the sound system for the desired acoustic response. Use settings appropriate for "mixed tracks," as described in the section on **Recording Studios** on page 3-9.

We *do not recommend* that the DJ be permitted to operate the R_x once the system has been equalized. High frequency hearing acuity decreases with sound exposure, and an ear-fatigued DJ might turn up the R_x to the point where it fries customers' ears or shatters the glass in the video monitors! The R_x should be adjusted once by the installing contractor to the manager's specifications, and then locked up or protected with an Orban Security Cover (see page 6-3).

Video and Film Post-production

The general suggestions in **Recording Studios** on page 3-9 apply to video and film post-production. The R_x can be particularly useful in improving the intelligibility of dialog without adding shrillness or excessive sibilance. Use it on music and effects as well — anywhere that increased presence and realism are needed.

When using the R_x on dialog, be sensitive to possible audible distortion when excessive Harmonic Restoration is used. With raw voice, Harmonic Restoration usually sounds best with the HARMONIC TUNING control set above 2.5kHz (10:00). See page 3-5 for a further discussion.

The noise reduction section of the R_x can be employed very profitably in motion picture and video sound to clean-up somewhat noisy tracks. Refer to **Using the Noise Reduction Section** on page 3-7 for further discussion of its use.

When the noise reduction section is used to *reduce*, rather than *eliminate* audible noise, you can usually get the most audibly subtle results by setting the EXPANDER RATIO control closer to LO.

Broadcasting

In the main studio: The R_x can be used to process the announcer's microphone for maximum presence and punch. Spectral Restoration is most useful here; use Harmonic Restoration with restraint to avoid introducing audible distortion. See the comments on dialog in **Video and film post-production** immediately above.

Most control rooms have a certain amount of acoustic noise due to cart and tape machine motors, air conditioning, and the like. Use the R_x 's noise reduction section to prevent these noises from being heard on the air. Because most of the noise energy is at low frequencies, the expander (not the filter) does most of the work in removing it. For most effective gating action, set the EXPANDER RATIO control fully HI, and set the EXPANDER THRESHOLD just high enough to completely open the expander when the announcer or presenter is speaking. Set the FILTER THRESHOLD control low enough to ensure that such speech fully opens the filter.

In the production studio: The R_x can "sweeten" records, equalize the microphone, and enhance in-house promos, spots, and IDs. It is particularly powerful in increasing the apparent loudness of voice without proportionally increasing its peak or average level. Use it on "oldies" to give them a much more contemporary quality, and to improve consistency from cut to cut. It is difficult to be very specific because of the wide range of program material that must be dealt with. Read the section on **Recording Studios** on page 3-9 for some hints.

Satellite feeds, telephone lines: The R_x can enhance the sound of telephone calls, remotes, satellite feeds, shortwave broadcasts, and network feeds. Many of these sources have limited bandwidth as well as insufficient presence. Use the R_x 's Harmonic Restoration section to extend the apparent bandwidth of the source, while using the Spectral Restoration section to automatically correct presence deficiencies.

Use the noise reduction section to reduce the noise that often accompanies these sources. If the noise level is very high, it is often possible to subtly reduce it without introducing audible noise breathing by setting the EXPANDER RATIO control fully LO and operating the expander with a few dB of gain reduction at all times.

RFI suppression: Substantial RFI suppression has been applied to input, output, and power leads. In AM, FM, and TV broadcasting applications, this integral RF suppression will greatly facilitate installation of the R_x . The optional output transformers (Retrofit Kit RET-051) may be required for stations with the studio and transmitter located at the same site or systems such as mobile production vehicles in which the R_x is the final processor feeding lines to the outside world. Normal precautions regarding grounding and shielding should be taken when the R_x is installed.

Section 4

Maintenance

page	contents
4-2	Routine Maintenance
4-2	Getting Inside the Chassis
4-2	Servicing Components on the Display Board
4-4	Performance Evaluation, Alignment

CAUTION

The installation and servicing instructions in this manual are for use by qualified personnel only. To avoid electric shock do not perform any servicing other than that contained in the Operating Instructions unless you are qualified to do so. Refer all servicing to qualified service personnel.



Routine Maintenance

No routine maintenance of this product is required.

If the front panel becomes soiled, clean it with a mild household detergent and a damp cloth. Stronger solvents should not be used because they may damage plastic parts, paint, or the silk-screened lettering (99% isopropyl alcohol can be safely used).

Getting Inside the Chassis

To access the circuit boards, remove all eight screws holding the top cover in place, then lift the top cover off. When replacing the cover, replace all screws snugly (be careful not to strip the threads by fastening the screws too tightly).

Be sure that power is disconnected before removing covers.



Servicing Components on the Display Board

1) Accessing the Display Board

- A To remove the front panel, remove the four large black screws on its four corners with a $\frac{3}{32}$ hex wrench. Remove the small black screw in the center of the panel with a $\frac{1}{16}$ hex wrench. Then pull the front panel toward you.

Take care not to cosmetically damage the knobs or LED meter assemblies by scraping them with the panel.

The display board is now revealed. Its components are mounted on the back of the board.

- B To access the components, remove the eight screws holding the display board on its supporting stand-off posts.
- C *Very slowly and carefully* tilt the board down toward you, imagining a hinge on its bottom edge.

The ribbon cables connecting the display board to the main board are easily damaged by excessive tension or flexing. **Treat them gently!**

2) Reassembling the Display Board and Front Panel

- A *Very slowly and carefully* tilt the board up and align the mounting holes with the stand-off posts.
- B Start, but do not tighten, all eight screws holding the display board on its supporting stand-off posts.
- C Carefully center the board.
If you neglect this step, the knobs may bind against the front panel after it is replaced.
- D Set both SIGNAL RESTORATION switches to DETAIL.
- E Set all other switches to their upward position.
This makes it easier to replace the front panel.
- F "Thread" the switches, knobs, and LED displays through their associated holes in the front panel.
- G Center the panel on its stand-offs, and replace the five hex screws removed in step 1-A above.
If any knobs bind against the panel, you may have to re-center the circuit board per step 2-B and 2-C above.

Performance Evaluation, Alignment

Use these instructions to thoroughly check the performance of the R_x . The evaluation includes checks of the power supplies, main audio paths and enhancement circuitry.



IMPORTANT

Because the R_x circuitry is highly stable, routine performance evaluation and alignment are *not* required and *not* recommended. The following evaluation procedures are extremely thorough, and they are included primarily for reference. If you are familiar with the operation of your R_x , problems with its circuitry will be readily apparent to you in the audio or in abnormal behavior of the displays. **If you must perform these tests**, be sure you have the necessary equipment. If you do not have the proper instruments, please use Orban's excellent factory service facility (see page 5-5).

See assembly drawings in Section 6 for locations of components and test points.

NOTE: If you are only interested in verifying performance, skip the adjustment steps (Steps 13 through 15).

Equipment required:

Digital voltmeter

With an accuracy of $\pm 0.1\%$

Ultra-low distortion sine-wave oscillator with distortion below 0.0015% .

Harmonic analyzer, capable of reading second, third and THD

AC meter, calibrated in dBm.

DC-coupled oscilloscope

With a 5MHz vertical bandwidth.

Audio spectrum analyzer

Tektronix 5L4N plug-in with 5111 bistable storage mainframe, or equivalent. *Alternatively*, an FFT analyzer (HP 3561A or equivalent) can be used, although most FFT-based analyzers update slowly and thus make the interactive adjustments described below more difficult.

1) Test power transformer and associated wiring.

(optional)

CAUTION! This is only a check for the DC resistance of the power transformer. Therefore, the power cord should not be plugged into the AC receptacle for this test.



- A Verify that the resistance between the AC cord ground pin and the chassis is nearly 0Ω .
- B Verify that the resistance between both AC cord blades and the chassis is infinite.
- C Set the VOLTAGE SELECT switch to 115 VOLTS. Verify that the resistance between the AC cord blades is $40\Omega \pm 10\%$.
- D Set the VOLTAGE SELECT switch to 230 VOLTS.
- E Verify that the resistance between the AC cord blades is $150\Omega \pm 10\%$.
- F Return the switch to 115 VOLTS.

2) Test the unregulated power supply.

- A Connect the unit to a power source.
- B Measure the voltage of the positive unregulated power supply.
The voltage must be between +18 and +26 volts.
This voltage is found across large electrolytic capacitor C1.
- C Measure the voltage of the negative unregulated power supply.
The voltage must be between -18 and -26 volts.
This voltage is found across large electrolytic capacitor C2.

3) Test the regulated power supply.

- a Verify that the POWER LED is lit.
- b Measure the outputs of the +15 volt regulator (at the (+) terminal of C3).
The voltage must be +15 volts, $\pm 0.75V$. If it is not, see the power supply troubleshooting information on page 5-4.
- c Measure the outputs of the -15 volt regulator (at the (-) terminal of C4).
The voltage must be -15 volts, $\pm 0.75V$. If it is not, see the power supply troubleshooting information on page 5-4.
- d Observe the regulated power supply rails with an oscilloscope.
Verify that the noise and ripple is below 4mV peak.

4) Set the controls as follows:

SIGNAL RESTORATION	BYPASS
SPECTRAL LEVEL	0
HARMONIC LEVEL	0
HARMONIC TUNING	1kHz
NOISE REDUCTION	BYPASS
FILTER THRESHOLD	CENTERED
EXPANDER THRESHOLD	CENTERED
EXPANDER RATIO	CENTERED
OUTPUT LEVEL	0
STEREO COUPLE	INDEPENDENT

5) Measure frequency response.

- a Connect a 600 Ω resistor between the channel A (+) and (-) output terminals.
- b Connect the channel A (-) output terminal to any ($\frac{1}{2}$) terminal.
- c Connect the high side of the oscillator to the channel A (+) input.
- d Connect the low side of the oscillator to the R_x chassis.
- e Monitor the channel A output with an audio voltmeter.
- f Sweep the oscillator and verify that the response is flat ($\pm 0.5dB$) from 20-20,000Hz.

The slight high-frequency roll-off (less than 1dB at 20kHz) is caused by the dynamic filter, which is not switched out of the circuit when the NOISE REDUCTION switch is set at BYPASS. Instead, it is forced to its maximum bandwidth (40kHz) and still has a very slight effect at the very highest frequencies.

6) Measure harmonic distortion.

- A Set the oscillator for 1kHz.
- B Set the oscillator's OUTPUT LEVEL control to make the voltmeter read +18dBu.
The voltmeter should still be monitoring the R_x's channel A output.
0dBu = 0.775V rms. Read dBu on the "dBm/600Ω" scale of the audio voltmeter.
- C Measure the total harmonic distortion at 20Hz, 50Hz, 100Hz, 400Hz, 1kHz, 2.5kHz, 5kHz, 10kHz, 15kHz, and 20kHz.

The THD should not exceed 0.1% at any frequency.

If the THD seems unusually high, verify that the SIGNAL RESTORATION switch is set to BYPASS and that the HARMONIC LEVEL control is set to 0. Any leakage of signal from the HARMONIC LEVEL control can greatly increase the measured THD.

Of course, you may use more frequencies and/or an automatically sweeping distortion analyzer if you wish to make a more thorough measurement.

7) Test the balanced floating line amplifier.

- A Advance the oscillator's OUTPUT ATTENUATOR until clipping is first observed at the R_x's channel A output.
If the oscillator cannot provide enough output level, you may temporarily advance the R_x's OUTPUT LEVEL control to achieve clipping.
- B Observe the output between the channel A (+) and (-) output terminals with the test set.
Verify that the output level exceeds +21dBu.
Verify that the red "0dB" LED on the R_x's CHANNEL A LEVEL METER is lit.
The test set must have a balanced input.
- C Reduce the R_x's output level to +18dBu.
Verify that the red "0dB" LED on the R_x's CHANNEL A LEVEL METER goes out, but that the other LEDs remain lit.
- D Momentarily short the channel A (+) output terminal to ground.
Verify that the output level does not vary by more than 0.5dB.
- E Momentarily short the channel A (-) output terminal to ground.
Verify that the output level does not vary by more than 0.5dB.

- F Remove the load and the connections to the output.
- G Ground the (-) input of the test set.
- H Monitor the R_X's channel A (+) and then its channel A (-) output terminals.
Verify that the levels observed are within 3dB of each other.
- I If you temporarily adjusted the R_X's output level at the beginning of step 7, return the OUTPUT LEVEL control to the setting it had prior to step 7.

8) Repeat steps 5 through 7 for channel B.

9) Test the common mode rejection.

- A Set the oscillator for 100Hz.
The oscillator should be connected to channel B.
- B Measure the level at the R_X's channel B output.
- C Remove the ground from the (-) input.
- D Connect the signal to both the (+) and (-) inputs in parallel.
- E Verify that the output level is reduced by at least 50dB.
- F Remove the signal from the (-) input and replace the ground.

10) Repeat step 9 for channel A.

11) Measure Noise.

- A Remove the oscillator from the R_X.
- B Connect a wire between the (+) and (-) terminals of the channel A input to short it.
- C Switch a 20-20kHz band-pass filter into the metering circuit of the audio voltmeter.
- D Measure the level at the R_X's channel A output with the voltmeter.
It should not exceed -70dBu.
- E Switch the R_X's channel A NOISE REDUCTION switch to N/R.
- F Measure the level at the R_X's channel A output with the voltmeter.
It should not exceed -85dBu.

12) Repeat step 11 for channel B.**13) Adjust the expander's THUMP NULL trimmer.**

- A Remove the top cover.

See **Getting Inside the Chassis** on page 4-2 for instructions.

- B Connect the low side of the oscillator output to (\perp).

- C Connect the high side of the oscillator output to terminal E51 on the main circuit board.

See the assembly drawing on page 6-24 to find this terminal.

CAUTION! This terminal is connected to the center tap of the channel B OUTPUT LEVEL control. So be sure that this control is set to 0 (12:00). If the control is set to either end-stop, you may damage the oscillator by grounding its output, or, worse, connecting it to the -15V power supply!

- D Set the oscillator frequency to 100Hz, and its output level to 0dBu.

- E Observe the channel B output of the R_x with the audio voltmeter.

- F Adjust R487 (THUMP NULL) for a minimum reading on the voltmeter.

You may find it useful to monitor the channel B output of the R_x with an oscilloscope as well as the voltmeter. Verify that the output consists mainly of 100Hz feed-through, and that the R487 adjustment nulls this feedthrough satisfactorily.

14) Repeat step 13 for channel A.

Use terminal E35 and adjust R287. Carefully note the **CAUTION**.

15) Adjust the FEEDTHROUGH NULL trims on the Harmonic Restoration processor.

- A Connect the high side of the oscillator to the R_x 's channel A (+) input.

- B Connect the low side of the oscillator to the R_x chassis.

Be sure that the (-) input is still strapped to (\perp).

- C Connect the input of the spectrum analyzer to the channel A output of the R_x

- D Set the oscillator's frequency to 2kHz, and its output level to 0dBu.

- ε Set the R_x controls as follows:

SIGNAL RESTORATION	DETAIL
SPECTRAL LEVEL	0
HARMONIC LEVEL	5
HARMONIC TUNING	1kHz
NOISE REDUCTION	BYPASS
FILTER THRESHOLD	CENTERED
EXPANDER THRESHOLD	CENTERED
EXPANDER RATIO	CENTERED
OUTPUT LEVEL	0
STEREO COUPLE	INDEPENDENT

- ƒ Adjust the spectrum analyzer for a 0 to 10kHz linear sweep, and adjust its sensitivity so that all spectral components are easily seen.

You should see two spectral components: the 2kHz fundamental from the oscillator, and the 4kHz second harmonic.

- g Adjust R224 (Y FEEDTHROUGH NULL) to minimize the level of the 2kHz component. Then adjust R228 (X FEEDTHROUGH NULL) to further minimize the 2kHz component. Repeat the adjustments until no further improvements are available.

R224 and R228 do not interact. However, *both* must be correctly set to their individual nulls to maximize the overall null.

16) Repeat step 15 for channel B.

Use R424 and R428.

17) Test difference-frequency IM rejection. (optional)

- A Apply an equal mixture of 3kHz and 4kHz to the R_x's channel A input.

A CCIF Intermodulation Distortion test set will usually generate this twin-tone signal directly. You can also use two oscillators and mix their outputs. A convenient way to do this is to connect the output of one oscillator between the R_x's (+) input and ($\frac{1}{2}$), and to connect the output of the other oscillator between the R_x's (-) input and ($\frac{1}{2}$).

- B Set the individual oscillator levels so that the peak level at the input is approximately 2V peak-to-peak, and each oscillator contributes equally.

The 2V level is not particularly critical.

- c Continue to observe the R_x 's output on the spectrum analyzer.

You should observe major spectral components at 1kHz (difference-frequency intermodulation), 3kHz (fundamental), 4kHz (fundamental), 6kHz (second-harmonic of 3kHz), 7kHz (sum-frequency intermodulation), and 8kHz (second-harmonic of 4kHz). If the R_x is working properly and the adjustment of both the X FEEDTHROUGH NULL and Y FEEDTHROUGH NULL trimmers (see step 15 above) has been done, the 6kHz, 7kHz, and 8kHz components should be at least 30dB higher than any other components in the spectrum.

If the 1kHz component is suppressed less than 30dB, suspect a failure in the Hilbert transformer circuitry. See **Harmonic Restoration Processor** on page 6-8 for troubleshooting hints.

18) Repeat step 17 for channel B. (optional)

19) Test D.C. offset.

- A Remove the 600 Ω resistor from the channel B output terminals.
- B Disconnect any oscillators or generators from the R_x channel B input.
- C Monitor the channel B (+) OUTPUT terminal with the DVM.
Verify that the DC offset is less than $\pm 15\text{mV}$ (typically less than $\pm 5\text{mV}$).
- D Monitor the channel B (-) OUTPUT terminal with the DVM.
Verify that the DC offset is less than $\pm 15\text{mV}$ (typically less than $\pm 5\text{mV}$).

20) Repeat step 19 for channel A.

Notes:

Section 5

Troubleshooting

page contents

5-2 Problems and Possible Causes

5-5 Technical Support

5-5 Factory Service

5-6 Shipping instructions

CAUTION

The installation and servicing instructions in this manual are for use by qualified personnel only. To avoid electric shock, do not perform any servicing other than that contained in the Operating Instructions unless you are qualified to do so. Refer all servicing to qualified service personnel.



Problems and Possible Causes

To avoid using your time unprofitably, it is always a good idea to double-check that the problem is not in the source material being fed to the R_X , or in other parts of the system.

RFI, hum, clicks, or buzzes:

A grounding problem is likely. Review the information on grounding in Section 2.

The R_X 's moderate RF suppression should be adequate for the vast majority of installations. However, installation next to a high-power transmitter may still cause problems. Additional RF suppression, careful examination of the grounding scheme, and other techniques familiar to the engineer may have to be employed.

The Harmonic Restoration circuitry seems to introduce too much distortion:

Bear in mind that the output of the Harmonic Restoration circuit is *pure* distortion, and normally contains both second-harmonic and sum-frequency intermodulation components. For most program material, a little bit of Harmonic Restoration goes a long way — most of the work is done by the Spectral Restoration circuitry, and the Harmonic Restoration circuitry just adds a bit of “sheen” to the sound.

Exceptions are raw voice and some solo instrument tracks. Raw voice is very sensitive to degradation by harmonic distortion. Usually, Harmonic Restoration on raw voice sounds best with the HARMONIC TUNING control set very high. Some voices will not tolerate any Harmonic Restoration whatsoever, and you should use *only* Spectral Restoration on these.

When voice is mixed with instruments, the adverse effects of harmonic distortion usually vanish. Substantial amounts of Harmonic Restoration can then improve intelligibility and loudness, and can help the voice cut through the mix.

Solo instrument tracks can often benefit from substantially *more* Harmonic Restoration than can mixed program material. Harmonic Restoration is particularly valuable in putting the life back into sampled sounds whose upper partials have been completely removed by the sharp anti-aliasing and reconstruction filters used in the sampling process.

See **Using the Restoration Section** on page 3-5 for more information on how to adjust the Harmonic Restoration controls.

Note: Due to the patented distortion-cancelling circuitry used in the R_X , you should not have a problem with low-frequency “grunge.” While a noticeable amount of such grunge is typical in other processors, its presence in an R_X processed signal probably signals a component failure. If you suspect a circuit malfunction, audibly compare the suspect channel with the remaining channel to verify that a problem exists. See **Harmonic Restoration Processor** on page 6-8 for troubleshooting hints.

The noise reduction sounds unnatural:

To achieve natural-sounding noise reduction you must carefully adjust the FILTER THRESHOLD, EXPANDER THRESHOLD, and EXPANDER RATIO controls *for each new piece of program material*. This is *crucial*.

If you hear noise modulation (a “puffing” sound in sync with the program material), advance the FILTER THRESHOLD and EXPANDER THRESHOLD controls interactively clockwise until the noise modulation is no longer audible.

If you hear the loudness varying unnaturally, set the EXPANDER RATIO control more counterclockwise and/or set the EXPANDER THRESHOLD more counterclockwise to reduce the amount of gain reduction, and to reduce the amount of gain change triggered by a given variation in input level.

If you hear harmonic distortion on bass instruments, set the EXPANDER THRESHOLD more counterclockwise to minimize any waveform modulation caused by the action of the expander.

If you have set the SIGNAL RESTORATION switch to DETAIL, *always* set the NOISE REDUCTION switch to BYPASS.

See Using the Noise Reduction Section on page 3-7 for more information.

The EXPANDER GAIN REDUCTION meters will not return to zero even with loud signals:

If one channel is undriven by signal and its NOISE REDUCTION switch is set to N/R, its expander will attempt to achieve full gain reduction. When stereo-coupled, the gain of both expanders is the *average* of the gains they would have had if they were uncoupled. Thus stereo coupling can limit the ability of the driven channel's expander to achieve full gain. Always set the STEREO COUPLE switch to INDEPENDENT when driving only one channel.

The SIGNAL RESTORATION or NOISE REDUCTION BYPASS switch causes very small “ticks” at the output when it is activated:

These ticks are caused by the normal operation of the switching circuit, and should be at least 40dB below nominal operating level. They will not interfere with normal operation of the R_x , which adaptively self-adjusts its processing and does not require being “punched in.”

Power supply problems:

The voltage regulators are operated conservatively, and can be expected to be extremely reliable. Before replacing the regulators, check to see whether other abnormalities in the circuitry (such as a shorted IC) have caused excessive current demand which is, in turn, causing the regulator ICs to either current limit or go into thermal shutdown (the two built-in protective modes). If it becomes necessary to replace a regulator, be sure to remount it exactly as before (use the other regulator as a model).

To prevent high-frequency oscillations, regulators IC40 and IC41 are frequency compensated at their outputs by C3 and C4. If C3 or C4 is ever replaced, be sure to use a low-inductance aluminum electrolytic. A tantalum can fail because the current-delivering capacity of the power supply can cause a runaway condition if the dielectric is punctured momentarily; a high-inductance aluminum can fail to prevent a regulator from oscillating. Check for oscillation on the power bus with an oscilloscope if C3 or C4 is replaced.

Output circuit failure:

The 5532 and 411 opamps used in the balanced output circuit may be freely replaced as necessary. However, the circuit is extremely sensitive to the characteristics of the resistors, so field repair of resistor failure (which is very unlikely) requires replacement of the entire output circuit in question if adequate headroom and common-mode rejection are to be maintained (see page 5-5 for information about factory service).

Troubleshooting IC opamps:

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

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

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

Technical Support

If the above troubleshooting procedures don't help you solve your problem, contact Orban Customer Service. Be prepared to accurately describe the problem, including the results of diagnostic tests you have performed. Know the serial number (and "M" number, if any) of your R_x — these are printed on a label attached to the rear panel of the R_x.

Telephone: (415) 351-3500
or Telex: 17-1480
or FAX: (415) 351-0500
or write: Customer Service
Orban
a division of AKG Acoustics, Inc.
1525 Alvarado Street
San Leandro, CA 94577
USA

Factory Service

Before you contact Customer Service to return a product to the factory for service, we recommend you refer to the manual. If you are still unable to solve the problem, contact Customer Service for consultation. Often, a problem is relatively simple and can be quickly fixed after telephone consultation.

In any case, products will be accepted for factory service *only* after Customer Service has issued a Return Authorization number. This number flags the returned unit for priority treatment when it arrives on our dock, and ties it to the appropriate information file.

Please refer to the terms of your Limited One-Year Standard Warranty, which extends to the first end-user. After expiration of the warranty, a reasonable charge will be made for parts, labor, and packing if you choose to use the factory service facility. Repaired units will be returned C.O.D if the unit is not under warranty. If the unit is under warranty, Orban will pay the return shipping costs. In all cases, transportation charges to the factory (which are usually quite nominal) are paid by the customer.

Shipping Instructions

Use the original packing material if it is available. If it is not, use a sturdy, double-wall carton no smaller than 22 × 12 × 6 inches (56 × 30 × 15 cm) with a minimum bursting test rating of 200 pounds (91 kg). Place the chassis in a plastic bag (or wrap it in plastic) to protect the finish, then pack it in the carton with at least 1.5 inches (4 cm) of cushioning on all sides of the unit. "Bubble" packing sheets, thick fiber blankets, and the like are acceptable cushioning materials; foam "popcorn" and crumpled newspaper are not. Wrap cushioning materials tightly around the unit and tape them in place to prevent the unit from shifting out of its packing. Close the carton without sealing it and shake it vigorously. If you can hear or feel the unit move, use more packing. Seal the carton with 3-inch (8 cm) reinforced fiberglass or polyester sealing tape, top and bottom in an "H" pattern. Narrower or parcel-post type tapes will not withstand the stresses applied to commercial shipments.

Mark the package with the name of the shipper, and with these words in red:

DELICATE INSTRUMENT, FRAGILE!

Insure the package appropriately. Ship prepaid, *not collect*. Do not ship parcel post.

Your **Return Authorization number** must be shown on the label, or the package will *not* be accepted.

Section 6

Technical Data

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6-2	Specifications
6-4	Circuit Description
6-14	Parts List
6-21	Schematics, Assembly Drawings
6-30	Abbreviations

Specifications

Note: 0dBu = 0.775Vrms.

Performance

Frequency response: ± 0.5 dB, 20–20,000Hz (with SPECTRAL LEVEL and HARMONIC LEVEL controls set to 0).

Total harmonic distortion: $< 0.1\%$, 20–20,000Hz at an output level of +18dBu (with SPECTRAL LEVEL and HARMONIC LEVEL controls set to 0). Distortion decreases smoothly as level is reduced.

Noise at output: < -110 dB below clipping (with SPECTRAL LEVEL and HARMONIC LEVEL controls set < 5 , noise reduction set to N/R); < -90 dB below clipping (with SPECTRAL LEVEL and HARMONIC LEVEL controls set < 5 , noise reduction set to BYPASS).

Interchannel crosstalk: < -90 db, 20–20,000Hz.

Gain: -6 dB to $+6$ dB.

Installation

Input

Load impedance: ~ 20 k Ω in parallel with 500pF, electronically balanced.

Driving impedance: Ideally 600 Ω or less, balanced or unbalanced.

Nominal input level: -10 dBu to $+8$ dBu.

Absolute overload point: $+21$ dBu.

Common mode rejection: > 50 dB, 50–60Hz.

RFI suppressed: Yes.

Connectors: Barrier strip (#5 screw) and XLR-type connectors.

Output

Load impedance: $\geq 600\Omega$.

Source impedance: 30 Ω $\pm 5\%$, balanced, floating.

Maximum output level: $\geq +20$ dBm into 600 Ω load.

RFI suppressed: Yes.

Connectors: Barrier strip (#5 screw) and XLR-type connectors.

Power

Power requirements: 115/230 volts AC $\pm 10\%$, 50–60Hz, 20VA.

Connector: IEC standard mains connector.

RFI suppressed: Yes.

Fuse: Slow-Blow ($\frac{1}{2}$ -amp for 115V, $\frac{1}{4}$ -amp for 230V operation).

Physical

Dimensions: 19 inches (48.3 cm) wide, 3¹/₂ inches (8.9 cm) high, 11¹/₄ inches (28.5 cm) deep.

Operating temperature range: 32–113°F (0–45°C)

Humidity: 0–95% relative humidity, non-condensing.

Weight: 12.5 lb. (5.63 kg) net; shipping weight is 16 lb. (7.27 kg).

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.

Balanced output transformers: To isolate the R_x's output stages from the equipment being driven by the R_x, and to improve RFI rejection in difficult environments. Order RET-051.

Warranty

One year, parts and labor: Subject to the limitations set forth in Orban's Standard Warranty Agreement.

Circuit Description

The R_x incorporates the following proprietary circuitry and features to provide you with a professional level of control over your enhancement processing.

Circuit description:	Page:
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Spectral Restoration Processor	6-7
Harmonic Restoration Processor	6-8
Expander	6-10
Balanced Floating Line Amplifier	6-11
Metering Circuitry	6-12
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Whenever circuitry is duplicated for the two channels, only channel A will be described.

1. Overview

The input signal is applied to an **input buffer**, which is capable of operating at either +4dBu or -10dBV nominal line level.

The **Dynamic Filter** section of the **Noise Reduction** circuit follows the input attenuator. The **Dynamic Filter** uses a spectral analysis of the input signal to control its bandwidth. When there is little high-frequency energy present at the filter's input, the bandwidth of the filter becomes small, and it filters out high-frequency hiss. When there is considerable high-frequency energy, the desired program energy tends to psychoacoustically "mask" any hiss. So the bandwidth of the filter is permitted to increase to pass this high-frequency program energy to the output.

The **FILTER THRESHOLD** control determines how much high-frequency energy at the input is necessary to cause the filter's bandwidth to start to increase.

The output of the dynamic filter is applied simultaneously to the **Spectral Restoration Processor** and **Harmonic Restoration Processor**. These circuits operate in parallel. Their outputs are mixed with the unprocessed signal to create the R_x 's spectral restoration and harmonic restoration functions.

The **Spectral Restoration** circuit (patent pending) is essentially a dynamic equalizer. It analyzes the spectral content of its input signal, and introduces high-frequency boost if it "thinks" that the high-frequency spectral content of the program is insufficient.

The **Harmonic Restoration** processor creates pure second-harmonic and sum frequency intermodulation products. Difference-frequency intermodulation products are canceled by a patented circuit using Hilbert transformers. The result is cleaner, purer enhancement.

The **Expander** section of the **Noise Reduction** circuit is the final processing in the system. The expander applies downward expansion to the processed signal. The characteristics of the expansion are determined with the EXPANDER THRESHOLD and EXPANDER RATIO controls. The EXPANDER THRESHOLD determines the amount of broadband signal energy necessary to prevent the expander's gain from decreasing. The EXPANDER RATIO control determines how much a given change in the expander's input level causes its output level to change.

The **balanced floating line amplifier** circuit is a single-ended-to-differential output converter. A precise combination of negative feedback, positive feedback and cross-coupling yields a fully symmetrical differential output with high common-mode rejection, a well-defined 30Ω output impedance, and excellent stability into any reactive load. The worst-case output drive capability is approximately +20dBm.

The **Metering** circuits drive three LED meters: DYNAMIC FILTER, EXPANDER GAIN REDUCTION, and PEAK OUTPUT. The PEAK OUTPUT meter is conditioned with a "peak stretching" circuit so that the smallest peaks are held and can be seen readily.

2. Input Buffer

The signal enters the R_x in balanced form. RF suppression is provided by 1000pF RF bypass capacitors and ferrite beads on the terminal strips. Note that this degree of RF-proofing is moderate, but adequate for a vast majority of installations. However, installation adjacent to a high-powered transmitter may still cause problems. Additional RF suppression, careful examination of the grounding scheme, and other measures familiar to the broadcast engineer may have to be used in conjunction with the R_x 's built-in RF suppression.

The filtered signal is sent to the input buffer circuit on the main circuit board. The buffer is a differential amplifier serving as an "active transformer." Its gain is set with jumpers JA and JB to be either unity (for operation at +4dBu), or +14dB (for operation at -10dBV).

Component-level description:

The differential inputs are connected to IC1a and associated components. This circuit is a differential amplifier whose gain is 5.0 when R201 and R204 are connected to the circuit with JA and JB, and 1.0 otherwise.

3. Dynamic Filter

Patent Pending

The buffered input signal is applied to a program-controlled low-pass filter, which is tuned by a VCA (Voltage-Controlled Amplifier).

The control signal that determines the bandwidth of the filter is derived from a level detector, which consists of a rectifier, a log converter, and a smoothing circuit. This circuit is driven by a high-pass filtered version of the input signal to the program-controlled low-pass filter.

Component-level description:

The VCA and level detector are integrated onto a single SSM2120 integrated circuit.

The “heart” of the voltage-controlled low-pass filter is a voltage-controlled integrator formed by the VCA in IC2b, whose current-mode output drives integrator IC3a and associated components. Summing amplifier IC1b closes a feedback loop around the voltage-controlled integrator (through R207) and also provides correct summation of the input signal (through R209) to produce a low-pass characteristic at IC1b’s output.

R212 and C201 are frequency-compensation components that prevent IC2b from oscillating.

The input signal is applied to control-chain high-pass filter IC10a and associated components. The cut-off frequency of this filter is approximately 5kHz.

C219 is part of the filter and also blocks DC from the input of the rectifier (pin 15 of IC2d). Pin 15 of IC2d is an “AC virtual ground,” and normally sits at +1.8VDC. There is normally little or no AC signal visible at this pin.

The rectified, log-converted, smoothed signal appears on C220. This signal is buffered by IC42a. The sensitivity of the circuit is 3mV/dB, so the DC voltage at pin 13 will change only a few hundred millivolts with large changes in the level of the input signal.

When the high-frequency content of the signal is low, the voltage on C220 is normally a few hundred millivolts below ground. This forces the output of IC42a to the negative power supply rail, which corresponds to the dynamic filter’s having its 1kHz minimum bandwidth.

When the high-frequency content of the signal exceeds the threshold established by FILTER THRESHOLD control R5 through R251, the output of IC42a comes out of saturation and starts to rise towards ground. (Ground corresponds to the dynamic filter’s having its maximum 40kHz bandwidth; CR30 constrains the control voltage produced by IC42a from rising above ground.)

The output of IC42a is conditioned by the circuitry inside module “A” and is then applied to gain-control pin 19 of IC2b. This pin has a “decilinear” characteristic and has a sensitivity of 18mV/octave. This high sensitivity means that the control voltage at pin 19 will only vary approximately 190mV DC as the filter’s bandwidth changes from its maximum to its minimum value.

Troubleshooting Hints: Like most filters, the details of the operation of the dynamic low-pass filter must be explained by mathematical analysis. Fortunately, it is unnecessary to understand the filter at this level to troubleshoot it, and we will not provide this analysis here.

The most likely cause of a problem with the filter is IC2, since this contains a majority of the circuitry including the VCA and level detector. IC2 can be replaced without need for re-alignment. The next most likely suspects are IC1 and IC10.

If it appears that all of these ICs are good, check the capacitors C202, C217, C218, C219, C220. Since C220 is a polar capacitor, it is likely to be less reliable than the other capacitors. If C220 fails, the level detector will not work properly and you are likely to see large amounts of “garbage” on pin 13 of IC2. Failure of C220 can also cause strange problems in other circuits associated with IC2, including the expander (which uses the second VCA and level detector in IC2’s dual package).

4. Spectral Restoration Processor

Patent Pending

The Spectral Restoration Processor is a program-controlled equalizer. It achieves spectral restoration by adding the output of a first-order high-pass filter to the main signal. The amount of filtered signal that is added is controlled by a VCA whose gain is determined by an analysis of the input signal.

Component-level description:

The output of the dynamic filter is applied to high-pass filter C221, R257. This filter is buffered by IC14a. IC14a's output is applied to VCA IC12a, and to module "B." Module "B" determines the gain-control voltage for IC12a, which, along with the setting of SPECTRAL LEVEL control R7, determines the amount of spectral restoration.

R261 and C222 are frequency-compensation components that prevent IC12a from oscillating.

The gain-controlled current-mode output of VCA IC12a is converted to a voltage by IC8b and associated components, and is then applied to the SPECTRAL LEVEL control R7, which determines the amount of spectral restoration signal that is mixed with the original unprocessed signal.

The input to the spectral restoration circuitry is further applied to passive band-pass filter C224, C225, R265, R266. The output of this band-pass filter is applied to a fast peak detector IC11 and associated components.

The positive peak value of the signal applied to pin 3 of IC11a is developed on C226, which is buffered by IC11b. The output of IC11b is fed back through R269 to IC11a's inverting input. This closes a feedback loop to ensure that the voltage on C226 accurately represents the positive peak voltage at IC11a's non-inverting input. CR26 prevents IC11a from saturating.

IC9c and associated components are a dual time-constant circuit for the peak detector. After C226 has been charged by a brief peak, IC9c turns ON and charges C227 negative. This turns Q22 OFF, and the recovery time of the peak detector becomes quite slow, as determined by R273 (10M Ω) which is bootstrapped by R274, R275.

If no other peaks occur within approximately 8ms of C227's being charged to -15 volts, C227 will discharge through R271 to the point where Q22 begins to turn ON. This switches the recovery time of the peak detector to FAST through R272. Thus the dual time-constant circuit minimizes ripple in the peak detector output (because of the 8ms hold time), while simultaneously letting it follow falling levels very quickly.

The output of the peak detector is used by module "B" to help determine the gain of the spectral restoration VCA.

The bandwidth-control voltage from the dynamic filter is summed into the spectral restoration VCA's gain-control port through R262. This prevents the spectral restoration from causing audible noise modulation by attempting to increase the high-frequency content of program material whose high-frequency energy is mostly hiss or noise.

5. Harmonic Restoration Processor

U.S. Patent # 4,731,852; Swedish Patent # 444,750; other patents pending

The harmonic restoration circuit uses a multiplier to generate a pure second-harmonic and sum-frequency intermodulation signal.

The output from the dynamic filter is applied to a high-pass filter. The output of the high-pass filter is applied to one port of the multiplier, and a compressed, Hilbert-transformed version of the output of the high-pass filter is applied to the other port of the multiplier.

If the compressor were not present, the multiplication process would cause the output level of the harmonic restoration circuit to vary as the square of its input level (i.e., the output would change 2dB for every 1dB that the input changed). The compressor ensures, instead, that the output level of the harmonic restoration circuit is directly proportional to its input (because the input signal is multiplied by a signal with essentially constant level).

The Hilbert-transform operation ensures that the multiplication process will not produce difference-frequency intermodulation distortion or DC thumps. This can only be justified with a mathematical explanation which is beyond the scope of this manual.

Component-level description:

The output of the dynamic filter is applied to third-order high-pass filter IC16a and associated components. The cutoff frequency of this filter is approximately 1.5kHz.

The output of this filter is connected to variable second-order high-pass filter IC4. This filter can be tuned from approximately 1kHz to 5kHz (at -3dB) by the HARMONIC TUNING control R4.

The output of IC4 is connected to Hilbert transformer IC40, consisting of a pair of second-order all-pass filters. Each of these filters has a flat magnitude response and a phase response which varies with frequency. To achieve good cancelation of difference-frequency intermodulation, the phase difference between the outputs of IC40a and IC40b must be controlled to precise tolerances. If the circuit begins to produce difference-frequency intermodulation, check the passive components associated with IC40 (particularly the capacitors) with an impedance bridge to ensure that they meet their specification. (Refer to the schematic diagram on page 6-25, and to the parts list following page 6-14.)

The output of IC40b is applied to a simple compressor. Its VCA is IC12b, whose current-mode output is converted to a voltage by IC8a.

Comparators IC9a, IC9b monitor the output of IC8a to detect positive and negative excursions (respectively) that exceed the $\pm 1.66\text{V}$ threshold established by voltage divider R244, R245, R246. Such excursions cause IC9 to pull its pins 1 and 2 to the negative supply, charging capacitors C215, C216 negative through R243.

R242 determines the release time of the circuit. CR23 and R241 provide a delay before release commences after an attack, which helps smooth the control voltage developed across C215. This control voltage is buffered by IC14b and applied to the gain control port of IC12b through voltage divider R239, R240. R238 provides a fixed bias for the control port, which causes

IC12b to have approximately 23dB gain in the absence of signals that would cause gain reduction.

The multiplier, IC6, is a CA3280 dual Operational Transconductance Amplifier (OTA) operated as a two-quadrant analog multiplier. Its output is mathematically expressed as the product of two inputs, called "X" and "Y." The "X" input of the multiplier is the left side of R222, while the "Y" input is the bottom of R232.

IC6 contains two matched non-linear gain-control blocks with differential inputs and current outputs. The gain of the multiplier circuit is directly proportional to the current injected into pin 6 of IC6, and inversely proportional to a current injected into pin 3 of IC6.

If used alone, one of the paired gain-control blocks would introduce considerable distortion. Therefore, the first of the two matched blocks (IC6a) is used as the feedback element in a high-quality operational amplifier (IC5), forcing the output of IC5 to be pre-distorted as necessary to force the current output of IC6a to precisely and linearly cancel the audio input into the virtual ground summing junction of IC5.

The output of IC5 is first attenuated by R229, R233, C210, and then applied to the input of IC6a. This same pre-distorted voltage is also connected to the input of IC6b. The output of IC6b is therefore an undistorted current, which is converted to a voltage in current-to-voltage converter IC7a and associated components. The output of IC7a is the output of the multiplier.

Pin 6 of IC6 receives the output of IC8a, which is the output of the compressor. Because the output of IC8a is centered at ground, and because pin 6 of IC6b nominally sits at -13.5VDC, a fixed bias current also flows through R232 and into IC6b's gain control port.

Frequency-compensation components R223, R226, R229, C208, C209, C210 prevent the VCA from oscillating supersonically.

Fixed bias current through R227 and X FEEDTHROUGH NULL trimmer R228, and through R232 (into the multiplier gain control port) both determine the quiescent gain of the multiplier. Because this gain is not zero, some of the multiplier's "X" input signal (left side of R222) is passed to its output. This feedthrough component is canceled by summing the input signal through R231 with the multiplier/divider's output out-of-polarity. R228 (X FEEDTHROUGH NULL) permits the gain of the multiplier/divider to be trimmed to exactly cancel the feedthrough component.

Similarly, any intrinsic DC unbalance in the multiplier/divider can cause a fixed feedthrough of the signal applied to the "Y" input of the multiplier (pin 6 of IC6). This DC unbalance can be canceled by injecting a slight DC bias current into the input of the multiplier/divider through R225 and trimmer R224 (Y FEEDTHROUGH NULL). The two feedthrough null trims (R224 and R228) are not interactive, but *both* must be accurately nulled if no leakage from the harmonic restoration circuit's input signal is to appear at the circuit's output.

6. Expander

The final processing circuit in the R_x is the Expander section of the Noise Reduction circuit.

The first part of the expander is a mixer that creates the processed signal by combining the spectral restoration and harmonic restoration signals with the main signal (which has already been processed by the dynamic filter). The expander uses "feedforward control" — the processed signal at the expander's input is applied to a VCA, and also to a level-sensing circuit that creates the control voltage that determines the amount of expansion as a function of the level of the processed signal.

This function is controlled by the user with the EXPANDER THRESHOLD and EXPANDER RATIO controls. The EXPANDER THRESHOLD determines the amount of broadband signal energy necessary to prevent the expander's gain from decreasing. The EXPANDER RATIO control determines how much a given change in the expander's input level causes its output level to change.

The OUTPUT LEVEL control applies a DC control voltage to the VCA to vary the overall gain of the R_x by ± 6 dB.

Component-level description:

IC16b and associated components is a mixer circuit. The circuit is straightforward and easy to understand by examining the schematic diagram.

IC17a is a servo integrator that eliminates any DC offset that might have built up in the earlier processing circuitry. Its effect is to make IC16b into a high-pass filter with a -3 dB frequency of approximately 0.1Hz. This is sufficiently low to prevent any audible effect in the audio frequency range.

The output of IC16b is applied through R285 to the input of VCA IC2a. R286 and C231 are frequency-compensation components that prevent IC12a from oscillating. The current-mode output is translated into a voltage by IC3b and associated components.

IC15b is a servo integrator that eliminates any DC offset at the output of IC3b. It has no audible effect.

The control signal that determines the gain of the expander is derived from a level detector, which consists of a rectifier, a log converter, and a smoothing circuit. This circuit is driven by 6dB/octave high-pass filtered version of the input signal to the expander. The filter is realized by C229, R293. Its -3 dB frequency is approximately 450Hz, so that the expander ignores low-frequency noise.

C229 also blocks DC from the input of the rectifier (pin 9 of IC2c). Pin 9 of IC2c is an "AC virtual ground," and normally sits at +1.8VDC. There is normally little or no AC signal visible at pin 9 of IC2c.

The rectified, log-converted, smoothed signal appears on C230, at pin 2 of IC2c. This signal is buffered by IC42b. The sensitivity of the circuit is 3mV/dB, so the DC voltage at pin 2 will change only a few hundred millivolts with large changes in the level of the input signal.

When the level of the input signal to the expander is low, the voltage on C230 is normally a few hundred millivolts below ground. This forces the output of

IC42b to the negative power supply rail, which corresponds to the expander's having its -25dB minimum gain.

When the level of the signal exceeds the threshold established by EXPANDER THRESHOLD control R10 through R291, the output of IC42b comes out of saturation and starts to rise towards ground. (Ground corresponds to the expander's having its 0dB maximum gain; its gain is reduced as the output of IC42b goes more negative.)

The EXPANDER RATIO control R8 varies the gain of IC42b, determining how much of the gain-control voltage developed at pin 2 of IC2c will be applied to the VCA control port, pin 5.

The output of IC42b is conditioned by the circuitry inside module "A" to create a "soft-knee" expansion characteristic, and is then applied to gain-control pin 5 of IC2b. This pin has a "decilinear" characteristic, and has a sensitivity of 3mV/dB . This high sensitivity means that the control voltage at pin 5 will only vary approximately 230mV DC as the expander's gain changes from its maximum to its minimum value.

The DC output of the OUTPUT LEVEL control R9 is applied through voltage divider R289, R290 to the negative gain-control port of IC2a, pin 7. (The gain of IC2a increases as the voltage on pin 7 becomes more *negative* and as the voltage on pin 5 becomes more *positive*.)

7. Balanced Floating Line Amplifier

The output module converts the unbalanced single-ended signal from IC3b to a balanced, floating output. Output impedance is $30\Omega, \pm 5\%$.

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 R_x 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 R_x 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 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 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 5-4).

8. Metering

The peak-detecting PEAK OUTPUT meter is an LED bargraph that monitors the output level of IC3b. The meter is driven by a **peak detector** capable of indicating the peak level of a 10-microsecond pulse with an accuracy of 0.5dB (typical) when compared with its reading on a steady-state tone. It thus provides a **true peak-reading capability**, rather than a quasi-peak capability like an EBU-standard PPM.

The EXPANDER GAIN REDUCTION and DYNAMIC FILTER meters are LED bargraphs that directly indicate the gain reduction control voltage (in dB) of the expander, and the bandwidth (in kHz) of the dynamic filter. In contrast to the PEAK OUTPUT meter, no further signal conditioning is applied to the signals indicated by the EXPANDER GAIN REDUCTION and DYNAMIC FILTER meters.

Component-level description:

The output of IC3b is applied to full-wave rectifier IC35a and associated components. When the signal at the input to the rectifier is negative, IC35a actively inverts this signal, which appears at the cathode of CR28 with a gain of -0.274 . The impedance at the cathode of CR28 is low, and any contribution from R302 is swamped out.

When the signal to the rectifier is positive, CR28 turns off (becomes high impedance) and the signal appears at the cathode of CR28 with a gain of $+0.274$ through voltage divider R302, R303. (The (-) input of IC35a is always a virtual ground.) Thus the signal appearing at the cathode of CR28 is a full-wave rectified version of the original signal with a gain of 0.274.

IC35b, IC36, and associated components operate as a **dual time-constant peak detector**. A DC voltage equal to the peak value of the rectified signal at pin 5 of IC35b is developed at the top of C235, which is charged by IC35b's pin 7 through diode-connected transistor Q23. IC36 buffers this voltage and provides feedback to IC35b's pin 6, "telling" IC35b how to charge C235, C236 so that the peak value at pin 5 of IC35b is followed accurately.

To achieve the very fast response time desired, the **peak-holding capacitors** C235 and C236 are relatively small. To achieve a sufficiently slow recovery time with a practical value resistor ($R305 = 22M\Omega$), R305 is bootstrapped to the output of IC36 through R309. R308 introduces enough DC offset to produce approximately 0.5V across R305 at all times. This multiplies the effective value of R305 by about 30, and slows down the recovery time as desired.

The attenuation in the rectifier (IC35a) has scaled the output of the peak detector (pin 6 of IC36) such that +3V corresponds to +21dBu (the clipping point of the expander). This scaled, peak-detected voltage is mixed with a 50 or 60Hz "dither" signal through R310, R311, C237 (connected to the power transformer secondary), and then applied to the input (pin 5) of an LM3915 bargraph driver IC1 (located on the display board behind the front panel).

The LM3915 bargraph consists of ten comparators with current regulators at their outputs. The comparators are arranged to produce a meter whose elements are dB-linear. Each element indicates a level 3dB above the one below it. The LM3915 applies current (through any one of pins 1 through 10) to the appropriate node to light the desired LEDs.

Q1 is used as a zener diode to reduce the supply voltage to the LM3915 so that it is within the chip's 25V maximum rating. R1 sets the current through the LED bargraph.

The LM3915 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 a +3.00VDC reference from pin 1 of IC39a (on the main circuit board).

C1 bypasses the LM3915's power supply to prevent the LM3915 from oscillating.

Except for the fact that the EXPANDER GAIN REDUCTION and DYNAMIC FILTER meters use LM3914s (which have a linear scale so they can produce the desired dB-linear or octave-linear scale from the log-converted control voltages that they are monitoring), these LED drivers operate exactly the same as the LED drivers for the PEAK OUTPUT meter, and the description above applies by analogy.

9. Power Supply

The power supply is very conventional. It uses industry-standard "three-terminal" regulators.

Component-level description:

Unregulated voltage is supplied by two pairs of full-wave diode rectifiers within CR1. The power transformer T1 can be operated at 115V by connecting its primary windings in parallel, and at 230V by connecting them in series.

The nominal unregulated voltage is $\pm 22\text{VDC}$ at rated line voltage. This will tend to vary widely with line voltage variations. Regulator dropout occurs at $\pm 17.8\text{V}$.

IC40 and IC41 supply $\pm 15\text{V}$ respectively. They are internally protected from overload. Therefore, before replacing the regulators, check to see if other abnormalities in the circuitry (such as a shorted IC) have caused excessive current demand which is shutting down the regulators.

The regulators are frequency-compensated by C3 and C4 at their outputs to prevent oscillation. C3 and C4 must be replaced *only* by low-inductance aluminum electrolytics: tantalums are unreliable in this position because of potential runaway if the dielectric is momentarily punctured, while high-inductance aluminum electrolytics can fail to prevent the regulators from oscillating.

Be sure to check the power supply for oscillation with an oscilloscope if IC40, IC41, C3, or C4 is replaced.

Small ceramic capacitors C5 . . . , C8 . . . are distributed throughout the circuitry to locally bypass the circuitry to ground, thus preventing signal-carrying ICs from oscillating.

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. @ $I_T = 5\mu\text{A}$ I_T : 25nA max. @ $V_T = 20\text{V}$ V_f : 1.0V max. @ $I_f = 100\text{mA}$ t_{rr} : 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, resistors are:

Metal film resistors have conformally-coated bodies, and are identified by five color bands or a printed value. They are rated at $\frac{1}{8}$ watt @ 70°C , $\pm 1\%$, with a temperature coefficient of 100 PPM/ $^\circ\text{C}$. 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 $\frac{1}{4}$ watt @ 70°C , $\pm 5\%$. 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 0.090×0.250 inch (2.3×6.4 mm) size is rated at $\frac{1}{4}$ watt, and the 0.140×0.375 inch (3.6×9.5 mm) size is rated at $\frac{1}{2}$ watt, both $\pm 5\%$ @ 70°C . Orban part numbers 2001x-xxx, USA Military Specification MIL-R-11 Style RC-07 ($\frac{1}{4}$ watt) or RC-20 ($\frac{1}{2}$ watt). Manufactured by Allen-Bradley, TRW/IRC, and Matsushita.

Cermet trimmer resistors have $\frac{3}{8}$ -inch (9 mm) square bodies, and are identified by printing on their sides. They are rated at $\frac{1}{2}$ watt @ 70°C , $\pm 10\%$, with a temperature coefficient of 100 PPM/ $^\circ\text{C}$. 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. Their USA headquarters addresses are given on page 6-20.

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

Miscellaneous

F1	Fuse, 3AG, Slo-Blo, 1/2A	28004-150	LFE	313.500	BUS	
None	Filter, Line, 3 Amp	28015-000	COR	3EF1	MANY	
T1	Transformer, Power; 42.3VCT	55014-000	ORB			

Switches

S1	Switch, Slide, Mains voltage selector	26140-000	SW	EPSI-SLI		
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OTHER

Capacitors

None	Ceramic Disc, 1KV, 10%; 0.001uF	21112-210	CRL	DD-102	MUR	Located on TB1 & TB2
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Miscellaneous

None	Line Cord, CEE	28102-002	BEL	17500	MANY	
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OUTPUT MODULE ASSEMBLY

Capacitors

C1	Met. Polyester, 63V, 5%; 0.1uF	21442-410	MAL	168104J63A	WIM	
C2,3	Monolythic Ceramic, 50V, 20%; 0.1uF	21123-410	SPR	1C25 Z5U104M050B	KEM	

Integrated Circuits

IC1	Linear, Single Opamp	24017-202	NAT	LF411CN		
IC2	Linear, Dual Opamp	24207-202	SIG	NE5532N	TI, EXR	

PCB DISPLAY ASSEMBLY

Capacitors

C1-6	Alum., Radial, 63V, -20% +100%; 2.2uF	21209-522	SPR	502D 225G063BB1C	PAN	
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FOOTNOTES:

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| <p>(1) See last page for abbreviations</p> <p>(2) No Alternate Vendors known at publication</p> <p>(3) Actual part is specially selected from part listed, consult Factory</p> | <p>(4) Realignment may be required if replaced, see Circuit Description and/or Alignment Instructions</p> |
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**SPECIFICATIONS AND SOURCES FOR
REPLACEMENT PARTS**

Model 290RX

il Assy - Misc, Switches
 Other - Capacitors, Misc.
 Output Module Assy - Capacitors, Integrated Circuits
 PCB Display Assy - Capacitors

REF DES	DESCRIPTION	ORBAN P/N	VEN (1)	VENDOR P/N	ALTERNATE VENDORS (1)	NOTES
<u>Integrated Circuits</u>						
IC1	Digital, Display Driver	24720-302	NAT	LM3915		
IC2,3	Digital, Display Driver	24712-302	NAT	LM3914		
IC4	Digital, Display Driver	24720-302	NAT	LM3915		
IC5,6	Digital, Display Driver	24712-302	NAT	LM3914		
IC7,8	Linear, Dual Opamp	24202-202	RAY	RC4558NB		MOT, FSC
<u>LED's</u>						
CR1	LED Array, 9-Yellow, 1-Red	25152-000	ORB			
CR2,3	LED Array, 10-Yellow	25153-000	ORB			
CR4	LED Array, 9-Yellow, 1-Red	25152-000	ORB			
CR5,6	LED Array, 10-Yellow	25153-000	ORB			
CR7-9	LED, Green	25106-002	HP	HLMP-1503		GI
<u>Resistors</u>						
R4	Pot, Dual; 50K/50K (5020R)	20759-000	ORB			20% CCW Log
R5	Pot, Single; 50K (5050)	20753-000	ORB			Linear
R6	Pot, Single; 5K (5010)	20760-000	ORB			10% CW Log
R7	Pot, Single; 5K (5020)	20752-000	ORB			20% CW Log
R8	Pot, Single; 2K (5050)	20757-000	ORB			Linear
R9	Pot, Single; 10K (5050)	20758-000	ORB			Linear
R10	Pot, Single; 50K (5050)	20753-000	ORB			Linear
R14	Pot, Dual; 50K/50K (5020R)	20759-000	ORB			20% CCW Log
R15	Pot, Single; 50K (5050)	20753-000	ORB			Linear
R16	Pot, Single; 5K (5010)	20760-000	ORB			10% CW Log
R17	Pot, Single; 5K (5020)	20752-000	ORB			20% CW Log
R18	Pot, Single; 2K (5050)	20757-000	ORB			Linear
R19	Pot, Single; 10K (5050)	20758-000	ORB			Linear
R20	Pot, Single; 50K (5050)	20753-000	ORB			Linear
<u>Switches</u>						
S1	Switch, Toggle, Min.; DPDT	26042-201	CK	7203L1YZQE		CH
S2,3	Switch, Toggle, Min.; SPDT	26041-101	CK	7101L1YZBE		
S4	Switch, Toggle, Min.; DPDT	26042-201	CK	7203L1YZQE		CH
S5	Switch, Toggle, Min.; SPDT	26041-101	CK	7101L1YZBE		
<u>Transistors</u>						
Q1-6	Transistor, Signal, NPN	23202-101	MOT	2N4400		FSC

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

Orban Model 290RX

PCB Display Assy - Integrated Circuits, LED's,
Resistors, Switches, Transistors

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

Capacitors

C1,2	Alum., Axial, 40V, -10% +100%; 1000uF	21224-810	SIE	B41010-1000-40	PAN	
C3,4	Alum., Radial, 25V, -20% +100%; 100uF	21206-710	PAN	ECE-A1EV101S		
C5-22	Monolithic Ceramic, 50V, 20%; 0.1uF	21123-410	SPR	1C25 Z5U104M050B	KEM	
C100-103	Polypropylene, 50V, 2.5%; 0.01uF	21702-310	NOB	CQ15P1H103GPP	WES	
C104	Met. Polyester, 100V, 5%; 0.1uF	21440-410	WES	160C 104J100	SIE, WIM	
C105,108	Polypropylene, 50V, 2.5%; 0.01uF	21702-310	NOB	CQ15P1H103GPP	WES	
C109	Met. Polyester, 100V, 5%; 0.1uF	21440-410	WES	160C 104J100	SIE, WIM	
C201	Mica, 500V, 2%; 2000pF	21023-220	CD	CD19-FD202G03	SAN	
C202	Mica, 500V, 5%; 430pF	21024-168	CD	CD19-FD681J03	SAN	
C203-205	Polypropylene, 50V, 2.5%; 2200pF	21702-222	NOB	CQ15P1H222GPP	WIM	
C206	Mica, 500V, 5%; 2200pF	21024-222	CD	CD19-FD222J03	SAN	
C207	Polypropylene, 50V, 2.5%; 2200pF	21702-222	NOB	CQ15P1H222GPP	WIM	
C208,209	Mica, 500V, 5%; 150pF	21020-115	CD	CD15-FD151J03	SAN	
C210	Mica, 500V, +1/2pF -1/2pF; 5pF	21017-005	CD	CD15-CD050D03	SAN	
C211	Mica, 500V, 1%; 1500pF	21022-215	CD	CD19-FD152F03	SAN	
C212	Mica, 500V, +1/2pF -1/2pF; 10pF	21017-010	CD	CD15-CD100D03	SAN	
C213	Mica, 500V, 2%; 2000pF	21023-220	CD	CD19-FD202G03	SAN	
C214	Mica, 500V, +1/2pF -1/2pF; 10pF	21017-010	CD	CD15-CD100D03	SAN	
C215	Met. Polyester, 100V, 10%; 0.047uF	21441-347	WES	160C 473K250	SIE	
C216	Tantalum, 35V, 10%; 1uF	21307-510	SPR	196D 105X90335HA1	MANY	
C217,218	Mica, 500V, 5%; 1000pF	21024-210	CD	CD19-FD102J03	SAN	
C219	Polypropylene, 50V, 2.5%; 3300pF	21702-233	NOB	CQ15P1H332GPP	WIM	
C220	Tantalum, 20V, 10%; 10uF	21305-610	SPR	196D 106X9020JA1	MANY	
C221	Mica, 500V, 5%; 1000pF	21024-210	CD	CD19-FD102J03	SAN	
C222	Mica, 500V, 2%; 2000pF	21023-220	CD	CD19-FD202G03	SAN	
C223	Mica, 500V, +1/2pF -1/2pF; 10pF	21017-010	CD	CD15-CD100D03	SAN	
C224-227	Met. Polyester, 100V, 10%; 0.01uF	21441-310	WES	160C 103K630	SIE, WIM	
C228	Tantalum, 35V, 10%; 1uF	21307-510	SPR	196D 105X90335HA1	MANY	
C229	Polypropylene, 50V, 2.5%; 0.1uF	21702-410	NOB	CQ15P1H104GPP		
C230	Tantalum, 35V, 10%; 4.7uF	21307-547	SPR	196D 475X90335JA1	MANY	
C231	Mica, 500V, 2%; 2000pF	21023-220	CD	CD19-FD202G03	SAN	
C232	Mica, 500V, +1/2pF -1/2pF; 47pF	21017-047	CD	CD15-CD470D03	SAN	
C233-239	Met. Polyester, 100V, 10%; 0.01uF	21441-310	WES	160C 103K630	SIE, WIM	
C240	Tantalum, 20V, 10%; 10uF	21305-610	SPR	196D 106X9020JA1	MANY	
C4xx	Subtract 200 and refer to C2xx series					

Diodes

CR1	Diode, Bridge, 200V, 1A	22301-000	VARO	VE-27	GI	
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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

Orban Model 290RX
 PCB Main Assy - Capacitors, Diodes

REF DES	DESCRIPTION	ORBAN P/N	VEN (1)	VENDOR P/N	ALTERNATE VENDORS (1)	NOTES
<u>Integrated Circuits</u>						
IC1	Linear, Dual Opamp	24207-202	SIG	NE5532N	TI, EXR	
IC2	Digital, Dynamic Range Processor	24719-302	PMI	SSM-2120		
IC3	Linear, Dual Opamp	24207-202	SIG	NE5532N	TI, EXR	
IC4	Linear, Single Opamp	24017-202	NAT	LF411CN		
IC5	Linear, Single Opamp	24014-202	SIG	NE5534N	TI	
IC6	Linear, Dual Opamp	24208-302	RCA	CA3280A		
IC7,8	Linear, Dual Opamp	24206-202	TI	TL072CP	MOT	
IC9	Quad Comparator	24710-302	NAT	LM339		
IC10,11	Linear, Dual Opamp	24209-202	NAT	LF412CN		
IC12	Digital, Dynamic Range Processor	24719-302	PMI	SSM-2120		
IC13	Linear, Dual Opamp	24206-202	TI	TL072CP	MOT	
IC14,15	Linear, Dual Opamp	24209-202	NAT	LF412CN		
IC16	Linear, Dual Opamp	24207-202	SIG	NE5532N	TI, EXR	
IC17	Linear, Dual Opamp	24209-202	NAT	LF412CN		
IC18	Linear, Dual Opamp	24207-202	SIG	NE5532N	TI, EXR	
IC19	Digital, Dynamic Range Processor	24719-302	PMI	SSM-2120		
IC20	Linear, Dual Opamp	24207-202	SIG	NE5532N	TI, EXR	
IC21	Linear, Single Opamp	24017-202	NAT	LF411CN		
IC22	Linear, Single Opamp	24014-202	SIG	NE5534N	TI	
IC23	Linear, Dual Opamp	24208-302	RCA	CA3280A		
IC24,25	Linear, Dual Opamp	24206-202	TI	TL072CP	MOT	
IC26	Quad Comparator	24710-302	NAT	LM339		
IC27,28	Linear, Dual Opamp	24209-202	NAT	LF412CN		
IC29	Digital, Dynamic Range Processor	24719-302	PMI	SSM-2120		
IC30	Linear, Dual Opamp	24206-202	TI	TL072CP	MOT	
IC31,32	Linear, Dual Opamp	24209-202	NAT	LF412CN		
IC33	Linear, Dual Opamp	24207-202	SIG	NE5532N	TI, EXR	
IC34,35	Linear, Dual Opamp	24209-202	NAT	LF412CN		
IC36	Linear, Single Opamp	24017-202	NAT	LF411CN		
IC37	Linear, Dual Opamp	24209-202	NAT	LF412CN		
IC38	Linear, Single Opamp	24017-202	NAT	LF411CN		
IC39	Linear, Dual Opamp	24202-202	RAY	RC4558NB	MOT, FSC	
IC40-43	Linear, Dual Opamp	24209-202	NAT	LF412CN		

Modules

A1	Module Assy, Output	31160-001-xx*	ORB		*Add suffix printed on part
A3	Module Assy, B	31325-000-xx*	ORB		*Add suffix printed on part
A4	Module Assy, A	31320-000-xx*	ORB		*add suffix printed on part
A5	Module Assy, Output	31160-001-xx*	ORB		*Add suffix printed on part
A7	Module Assy, B	31325-000-xx*	ORB		*Add suffix printed on part
A8	Module Assy, A	31320-000-xx*	ORB		*Add suffix printed on part

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

Orban Model 290RX

PCB Main Assy - Integrated Circuits, Modules

REF DES	DESCRIPTION	ORBAN P/N	VEN (1)	VENDOR P/N	ALTERNATE VENDORS (1)	NOTES
<u>Resistors</u>						
R100	Resistor Set, MF; 10.0K	28520-004	ORB			3
R104	Resistor Set, MF; 10.0K	28520-004	ORB			3
R108	Resistor Set, MF; 10.0K	28520-004	ORB			3
R112	Resistor Set, MF; 10.0K	28520-004	ORB			3

Transistors

Q21	Transistor, Signal, NPN	23202-101	MOT	2N4400	FSC
Q22	Transistor, JFET/N	23405-101	NAT	J114	
Q23	Transistor, Signal, NPN	23202-101	MOT	2N4400	FSC
Q4x	Subtract 20 and refer to Q2x series				

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

Orban Model 290RX

PCB Main Assy - Resistors, Transistors

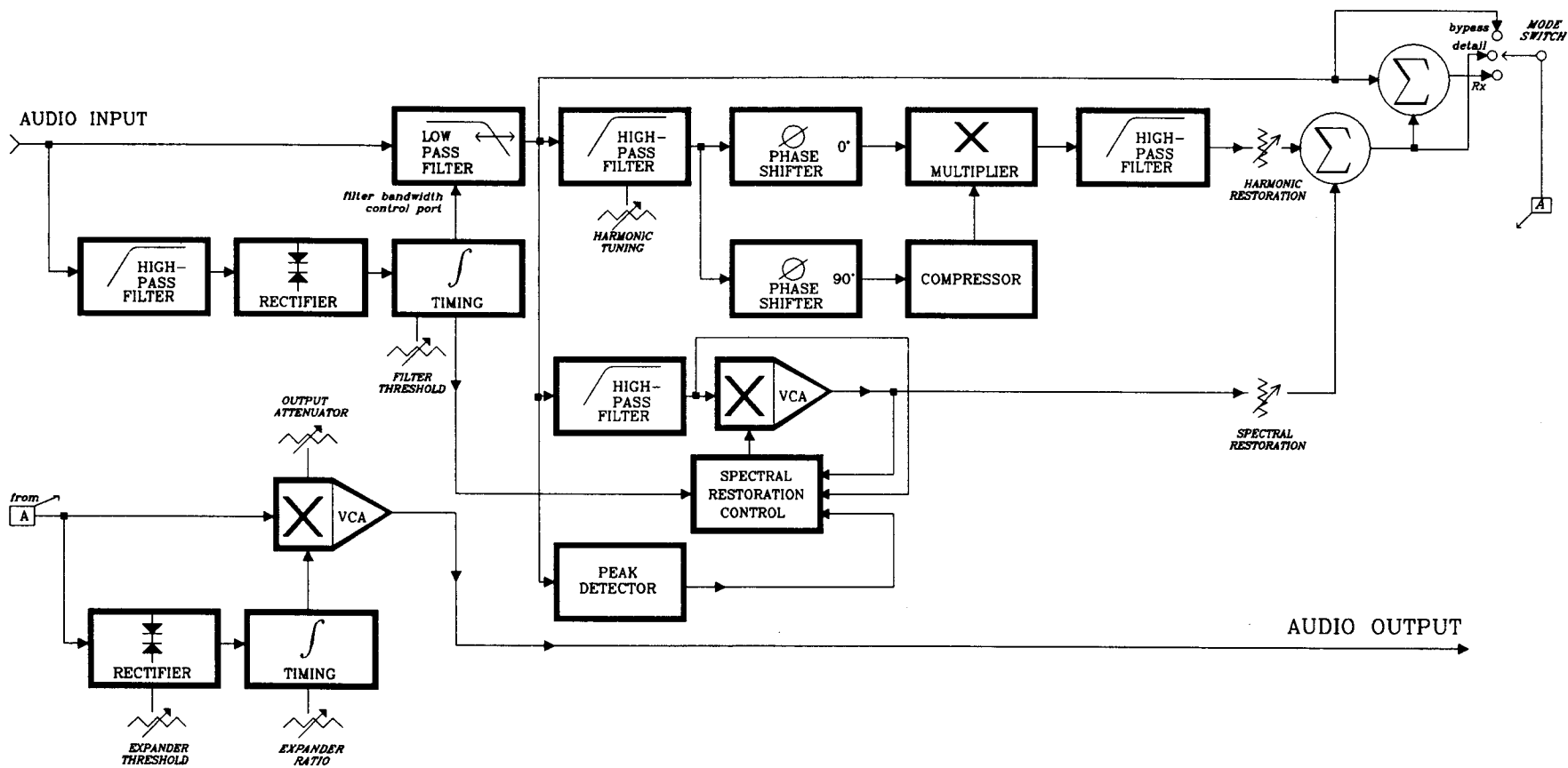
Schematics, Assembly Drawings

The following drawings are included in this manual:

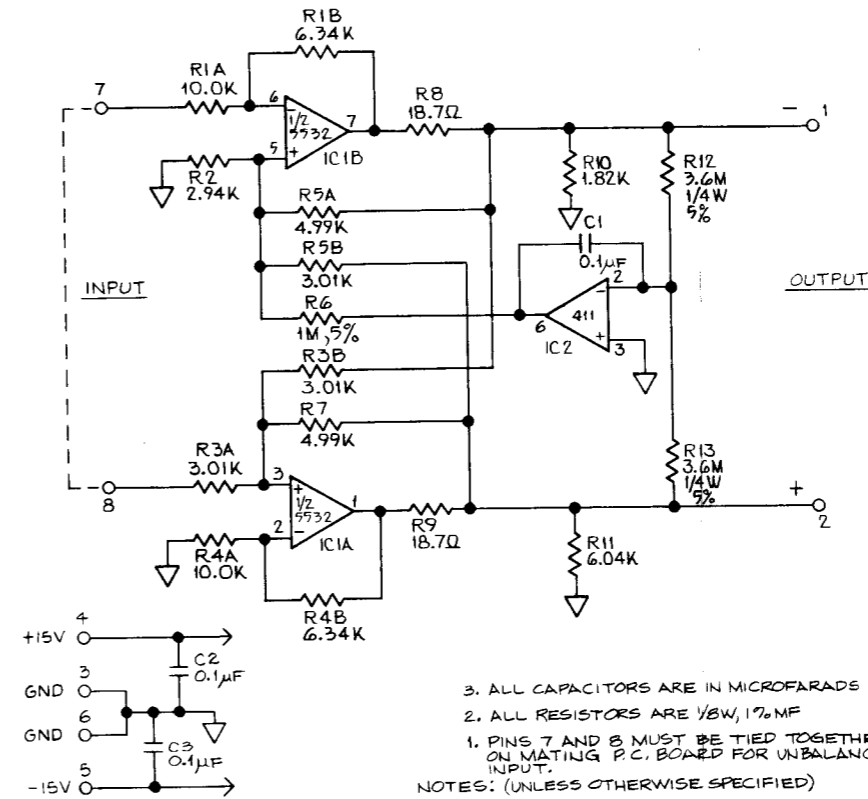
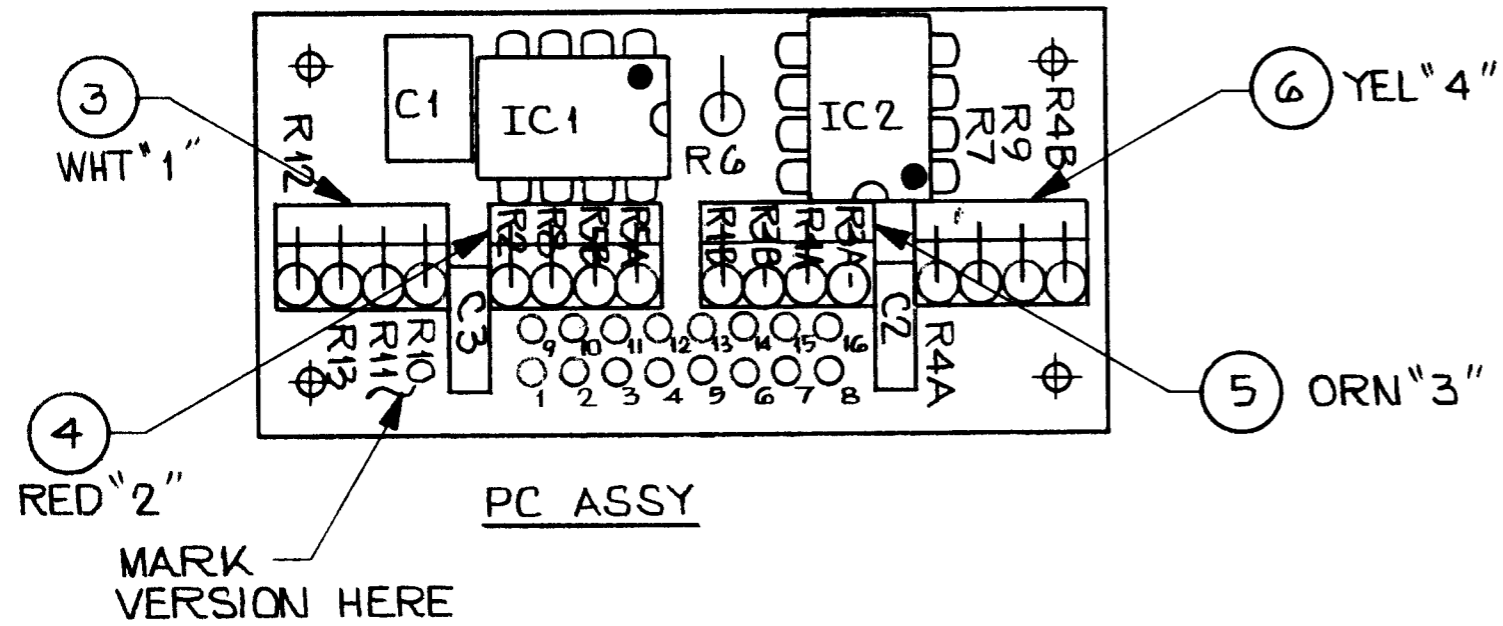
Page	Function	Circuit Board	Drawing
6-22	BLOCK DIAGRAM		
6-23	Output	Output Module	Assembly Drawing
6-23	Output	Output Module	Schematic
6-24	Audio; Meters; Power Supply	Main	Assembly
6-25	Channel A Audio Processing	Main	Schematic
6-26	Channel B Audio Processing	Main	Schematic
6-27	Meters; Power Supply	Main	Schematic
6-28	Displays & Controls	Display	Assembly
6-29	Displays & Controls	Display	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 6-14.



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		AKG Acoustics, Inc.
TITLE:		
290RX BLOCK DIAGRAM		



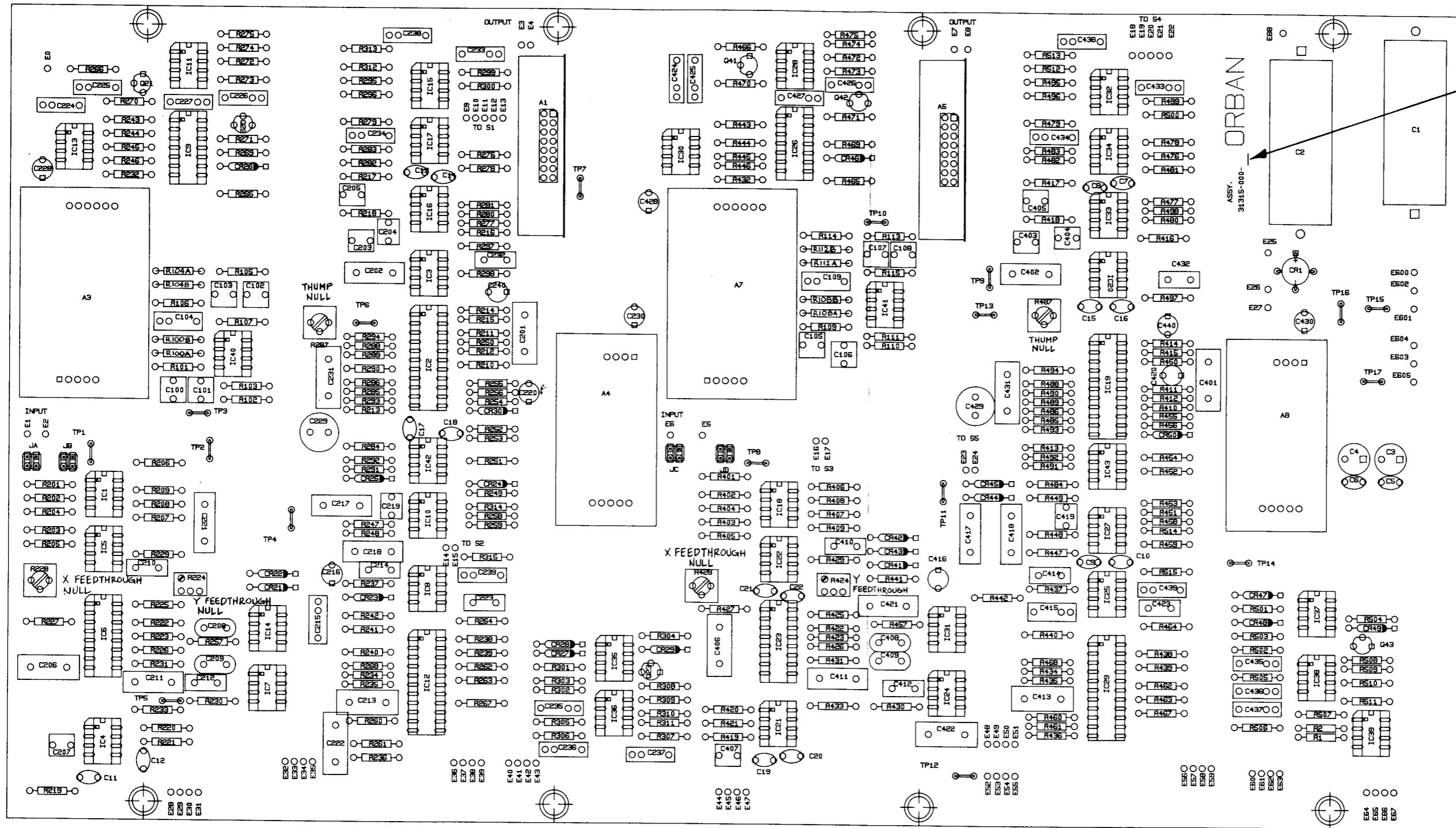
IC POWER PINS			
DEVICE	+V	-V	GND
411	7	4	-
5532	8	4	-

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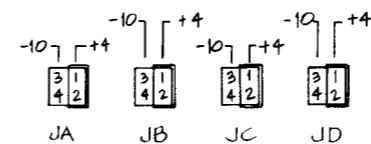
TITLE:
ASSEMBLY DRAWING
OUTPUT MODULE
31160-VER-01

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TITLE:
SCHEMATIC
OUTPUT MODULE
61031-000-01



COMPONENT SIDE

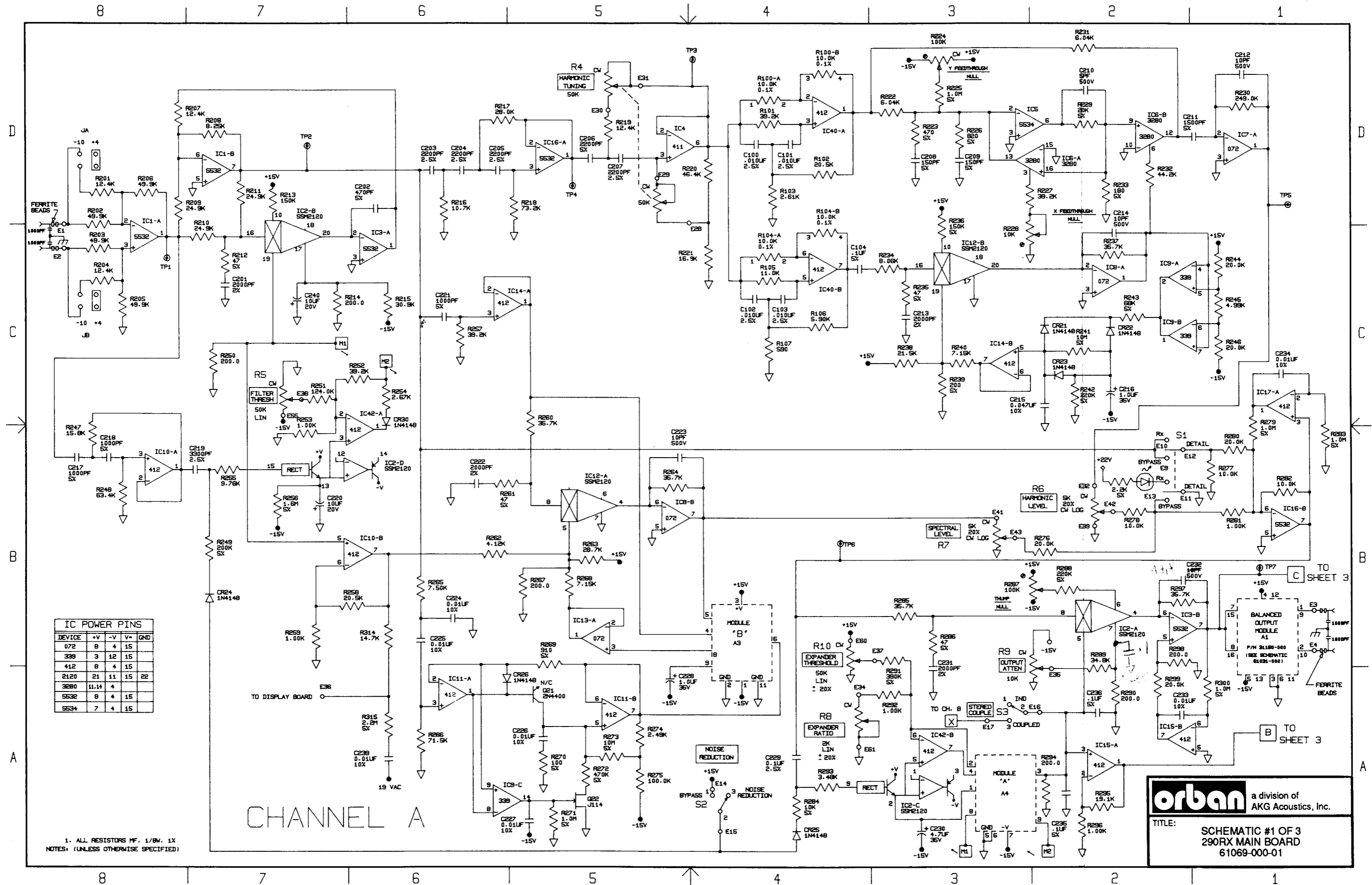


JUMPERS
SHOWN AS SHIPPED
(+4)

- 1. MARK ASSEMBLY REVISION LEVEL IN SPACE PROVIDED
- 2. REFERENCE SCHEMATIC DRAWING NO. 31315-000
- 3. SQUARE PADS INDICATE PIN 1 OF CONNECTORS, CATHODE OF DIODES.
- POS. SIDE OF CAPS., PIN 1 OF IC'S
- NOTES: (UNLESS OTHERWISE SPECIFIED)

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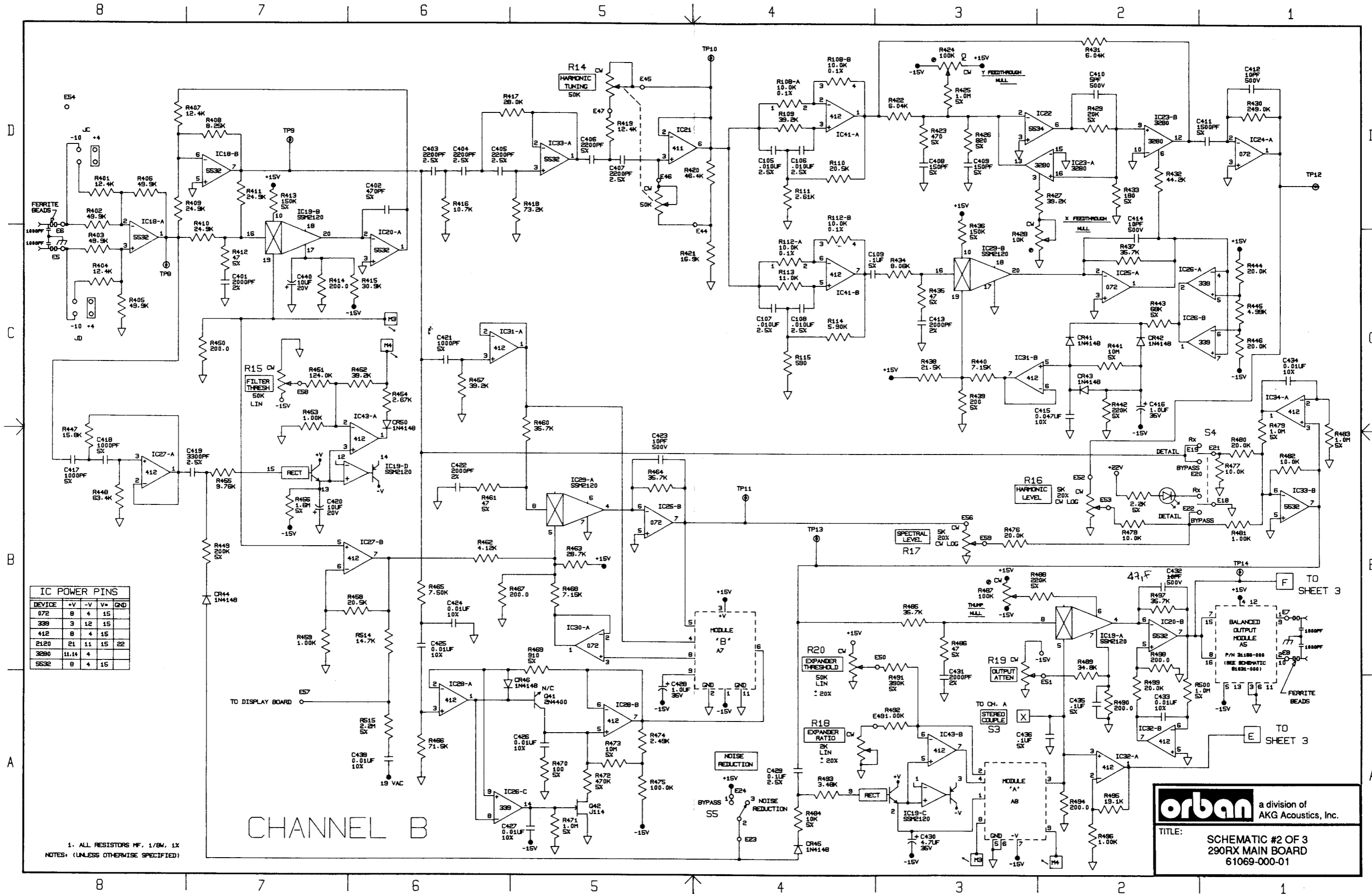
TITLE:
PCB ASSEMBLY DRAWING
MAIN BOARD
31315-000-01



IC POWER PINS				
DEVICE	+V	-V	V	GND
072	8	4	15	
339	3	12	15	
412	8	4	15	
2120	21	11	15	22
3280	11,14	4	15	
5532	8	4	15	
5534	7	4	15	

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

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 TITLE: SCHEMATIC #1 OF 3
 290RX MAIN BOARD
 61069-000-01

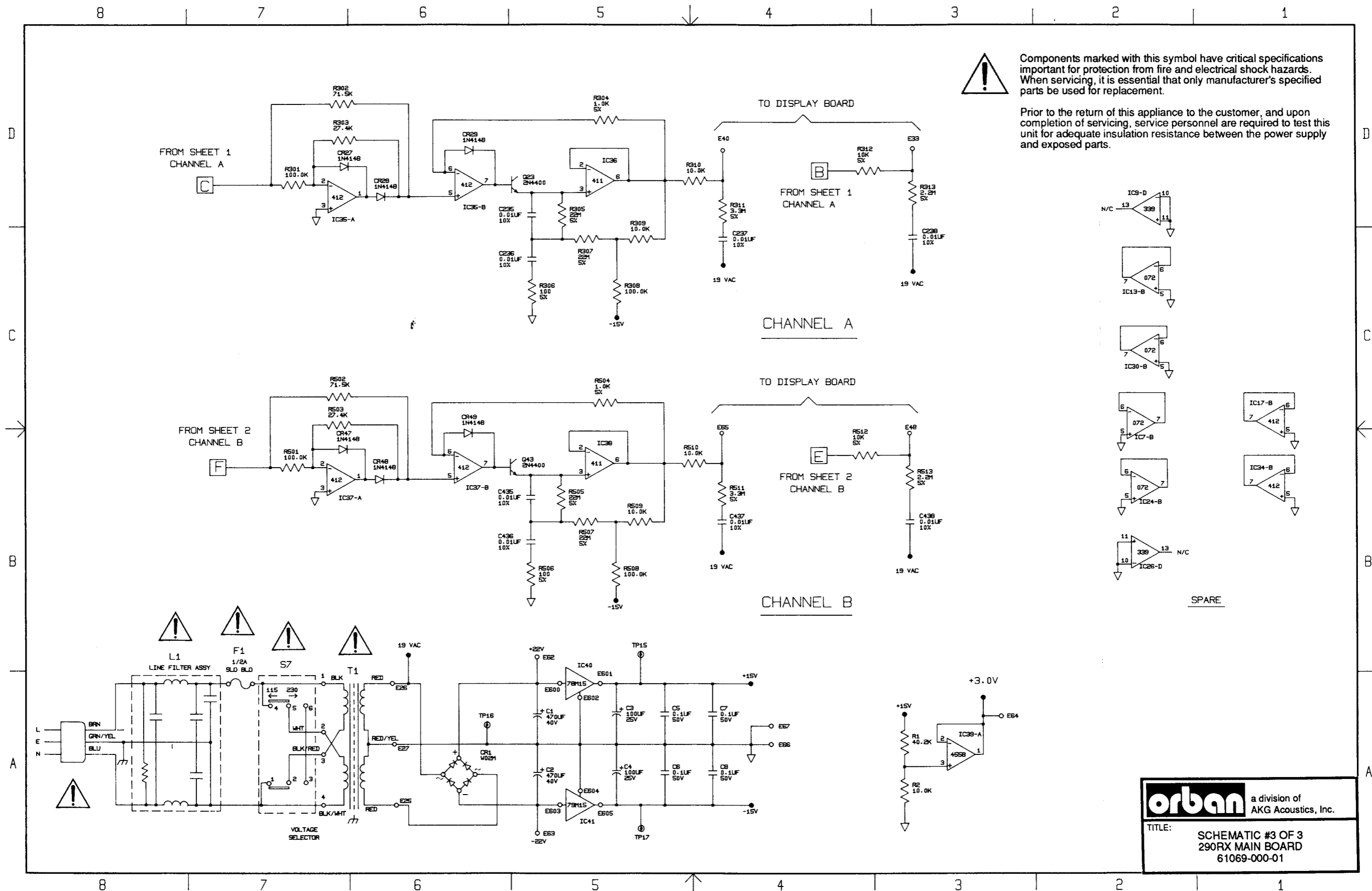


IC POWER PINS

DEVICE	+V	-V	V ₊	GND
072	8	4	15	
339	3	12	15	
412	8	4	15	
2120	21	11	15	22
3290	11,14	4		
5532	8	4	15	

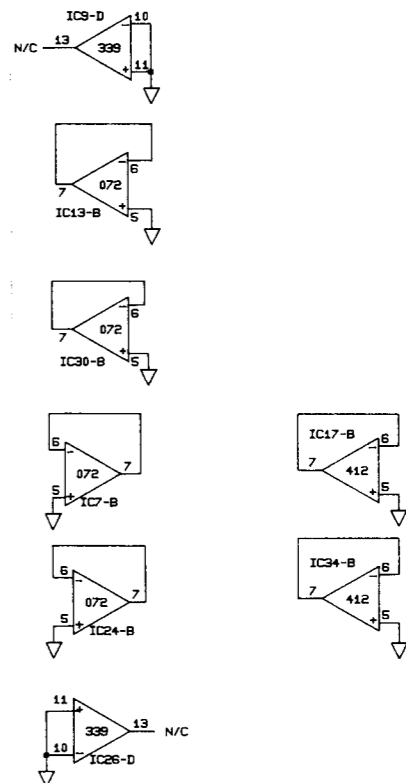
1. ALL RESISTORS MF. 1/8W. 1%
 NOTES: (UNLESS OTHERWISE SPECIFIED)

orban a division of
 AKG Acoustics, Inc.
 TITLE: SCHEMATIC #2 OF 3
 290RX MAIN BOARD
 61069-000-01



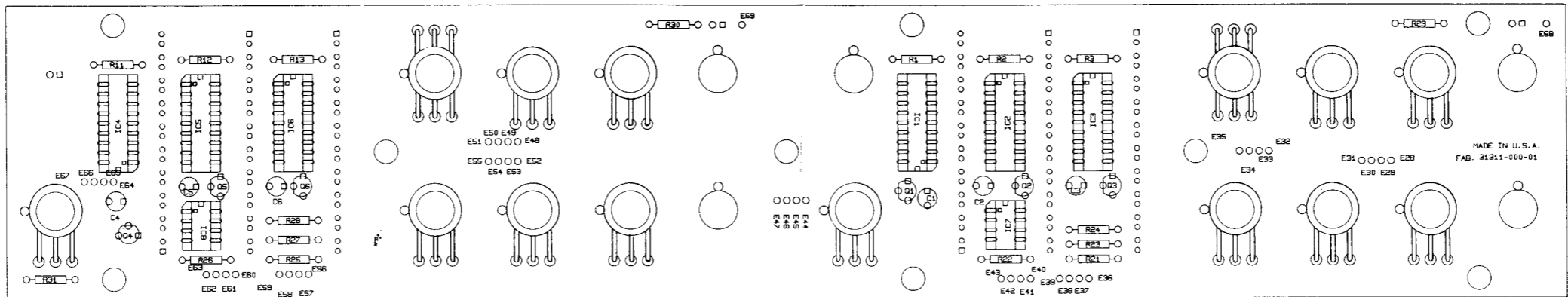
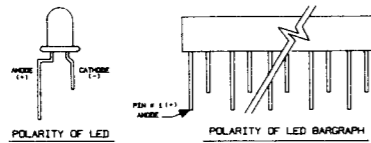
Components marked with this symbol have critical specifications important for protection from fire and electrical shock hazards. When servicing, it is essential that only manufacturer's specified parts be used for replacement.

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.

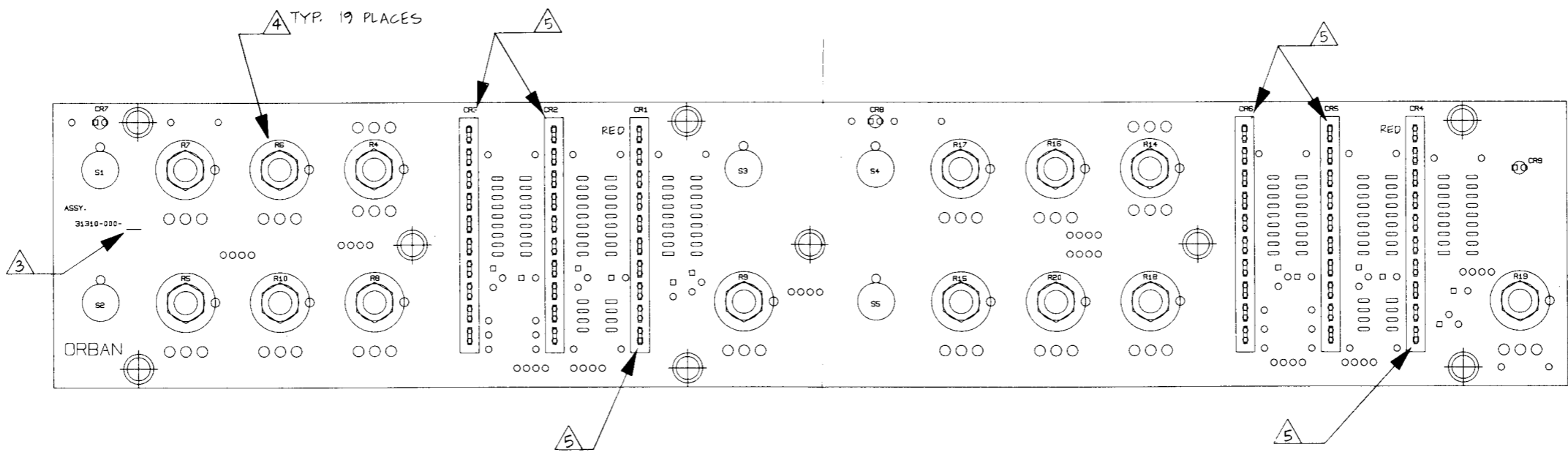


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TITLE:
SCHEMATIC #3 OF 3
290RX MAIN BOARD
61069-000-01



SOLDER SIDE

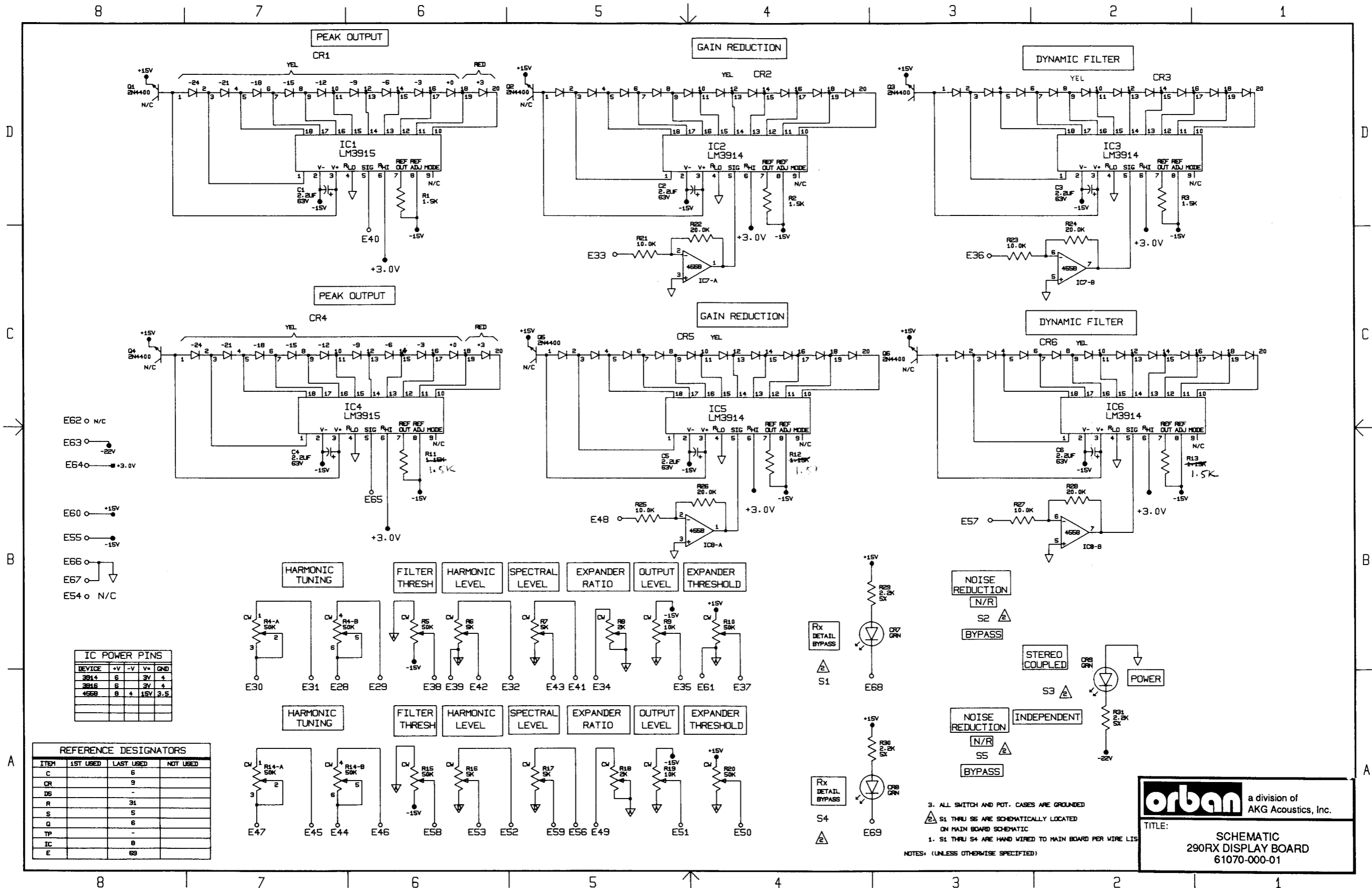


COMPONENT SIDE

- ▲ LED ARRAY CR1 THRU CR6 PIN 1 IS ANODE (LONG LEAD)
 - ▲ SWITCHES AND POTS, SHOWN ON COMPONENT SIDE, INSTALLED FROM SOLDER SIDE
 - ▲ MARK ASSEMBLY REVISION LEVEL IN SPACE PROVIDED
 - 2. REFERENCE SCHEMATIC DRAWING NO. 61070-000
 - 1. SQUARE PADS INDICATE PIN 1 OF CONNECTORS. CATHODE OF DIODES.
 - POS. SIDE OF CAPS., PIN 1 OF ICs
- NOTES: (UNLESS OTHERWISE SPECIFIED)

orban a division of
AKG Acoustics, Inc.

TITLE: PCB ASSEMBLY DRAWING
DISPLAY BOARD
31310-000-01



IC POWER PINS				
DEVICE	+V	-V	V+	GND
3914	6	3V	4	
3915	6	3V	4	
4558	8	15V	3,5	

REFERENCE DESIGNATORS			
ITEM	1ST USED	LAST USED	NOT USED
C		6	
CR		9	
DS		-	
R		31	
S		5	
Q		6	
TP		-	
IC		8	
E		69	

3. ALL SWITCH AND POT. CASES ARE GROUNDED
 S1 THRU S5 ARE SCHEMATICALLY LOCATED ON MAIN BOARD SCHEMATIC
 1. S1 THRU S4 ARE HAND WIRED TO MAIN BOARD PER WIRE LIS
 NOTES: (UNLESS OTHERWISE SPECIFIED)

orban a division of AKG Acoustics, Inc.

TITLE:
 SCHEMATIC
 290RX DISPLAY BOARD
 61070-000-01

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 = 0.775V RMS 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
FET	field effect transistor
FFT	fast Fourier transformation
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
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