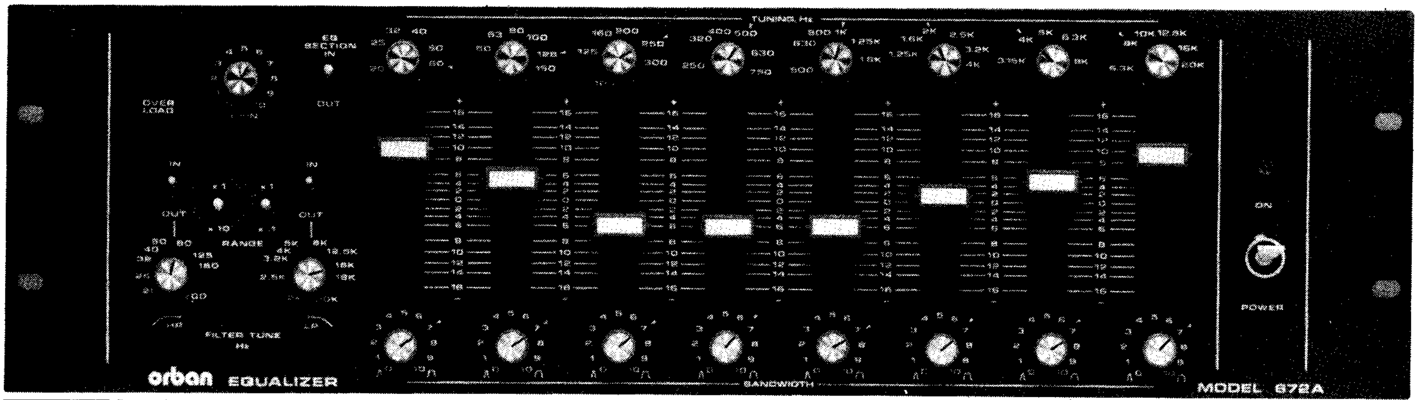
672A Equalizer

OPERATING MANUAL

orban



Specifications: 672A Equalizer

All specifications apply when driving 600 ohms or higher impedances. Noise measured on an average-reading meter through a 20-20,000Hz bandpass filter with 18dB/octave Butterworth skirts.

Electrical

Input:
Impedance, Load (each leg): 100K in parallel with 1000pF, electronically balanced
Impedance, Driving: Ideally 600 ohms or less, balanced or unbalanced
Nominal Input Level: Between -10 and +4dBm
Absolute Overload Point: +26dBm

Output:
Impedance, Source: 47 ohms in parallel with 1000pF, unbalanced (Optional transformer balanced 600 ohm outputs)
Impedance, Load: Should be 600 ohms or greater-will not ring into any capacitive load
Nominal Output Level: +4dBm
Max. Output Level Before Clipping: +19dBm, 20-20,000Hz

Frequency Response:
±0.25dB, 20-20,000Hz: EQ controls set at "O" detents

Available Gain:
+12dB; adjustable to — infinity by means of front-panel GAIN control

Slew Rate:
Varies between 6 and 13V/uS depending upon setting of GAIN control; slewing is symmetrical. Internal bandlimiting assures that slew rate limiting will not occur even with the most severe equalization and program material.

Square Wave Response:
Square wave exhibits no spurious ringing at any output level. The only ringing observable is that theoretically associated with any given equalization curve.

Total Harmonic Distortion:
Less than 0.05%, 20-20,000Hz (+18dBm)

SMPTE Intermodulation Distortion:
Less than 0.05% (+18dBm: 60/7000Hz,4:1)

Noise at Output:
Less than -75dBm (EQ in, Filters out, Controls centered)

Overload/Noise Ratio:
Better than 113dB for any single bandpass filter, for any settings of TUNING or BANDWIDTH controls.

Equalization Ranges:
±16dB peaking EQ, Reciprocal

Tuning Ranges:
20-60Hz;40-150Hz; 110-310Hz; 230-750Hz; 480-1900Hz; 1.1-4.5Hz; 2.8-9.0kHz; 5.9-21kHz. Dials calibrated at ISO preferred frequencies.

"Q" Range:
Greater than 0.5 to 10 for any setting of the TUNING control

Low Pass Filter Section:
Tunable in 2 ranges: 200-2000Hz or 2.0-20kHz, 12dB/octave, (2nd-order Butterworth)

High Pass Filter Section:
Tunable in 2 ranges: 20-200Hz or 200-2000Hz, 12dB/octave, (2nd-order Butterworth)

Overload Circuit:
Lamp lights for 200mS if the instantaneous peak output of any amplifier rises to within 1dB of its clipping point.

Circuit Design:
Active RC realized with FET-input opamps. Line driver employs discrete transistor current booster.

Operating Temperature:
0-50°C

Power Requirements:
115/230VAC ±10%; 50/60Hz; 6 watts

Physical

Operating Controls:
EQUALIZATION, TUNING, and BANDWIDTH for each of eight bands. TUNING, RANGE (x1; x10), and FILTER IN/OUT for each filter. EQUALIZATION IN/OUT, POWER ON/OFF, and GAIN for entire equalizer.

Panel:
19" x 5¼" (48.3 x 13.3cm): 3 units

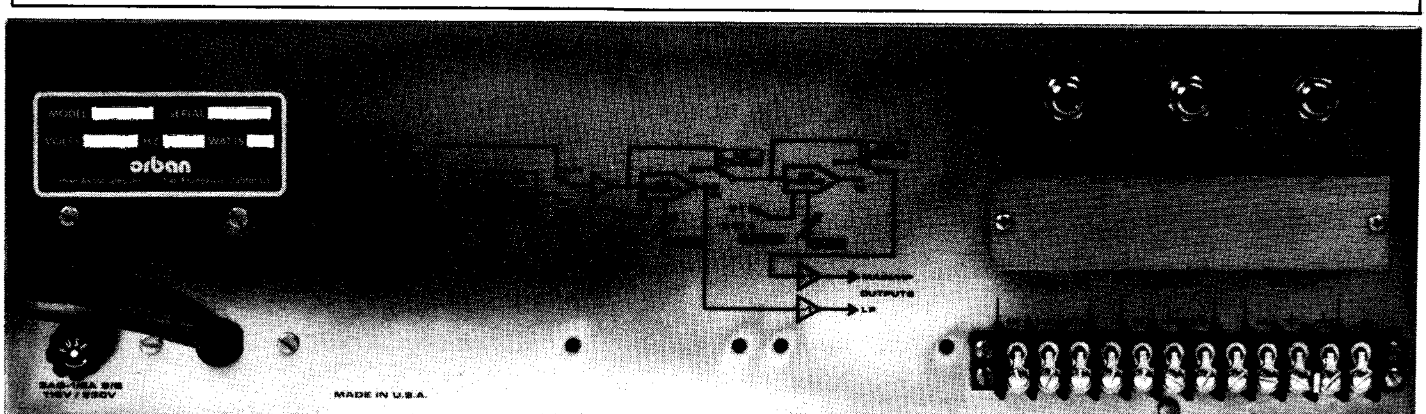
Chassis Depth Behind Panel:
5¼" (13.3cm)

Weight:
Net: 8 lbs. (3.6kg); Shipping: 12 lbs. (5.4kg)

AC Cord:
3-wire U-ground to USA Standard

Connectors:
140 type barrier strip (#5 screw) plus parallel-wired ¼" 3 ckt. phone jacks (Switchcraft 12B or equal). Holes punched for XLR-type connectors (Switchcraft D3F and D3M or equal)

Circuit Ground:
Available on barrier strip; normally jumpered to chassis.



Specifications subject to change without notice.

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Part A: Installation and Operation

INTRODUCTION

The Orban 672A is a single-channel eight-band quasi-parametric equalizer of high professional quality. It is equipped with graphic-type EQ controls providing up to 16dB of reciprocal boost or cut. The center frequency and bandwidth of each band are continuously variable to enable precise control of the audio spectrum. Wide-range high- and low-pass filters (12dB/octave) follow the EQ section for added versatility. When these filters are overlapped (200-2000Hz), the 672A can be used as a combined graphic/parametric equalizer <u>and</u> tunable electronic crossover. Separate lowpass and highpass outputs are provided for this purpose.

The 672A has an electronically-balanced bridging input, and unbalanced outputs (which can be balanced by the addition of optional output transformers). Input, outputs, and power line connections all contain effective RF filtering. 12dB of gain is available. <u>All</u> potential overload points in the equalizer are monitored by an extremely fast "peak-stretching" overload detector, so that peak clipping can be detected and corrected before it becomes audible.

The flexibility offered by the 672A makes it a particularly powerful tool in nearly all areas of audio: sound reinforcement, public address, recording studio, broadcasting, motion picture sound, disco, theater.

The 672A easily meets the quality, performance, and reliability requirements of the demanding professional, and is also well-suited for use in semi-pro or audiophile applications.

The controls and features of the 672A are fully described in this manual. It will familiarize you with the unit's potential and enable you to imaginatively use the 672A for your specific installation and application.

PERFORMANCE HIGHLIGHTS

<u>EQ Section</u>

-- Eight bands, each with TUNING and BANDWIDTH control

-- ±16dB equalization range

-- Reciprocal curves

-- Each band tunes over 3:1 frequency range

-- "Q" is variable between 0.5 and 10

-- "Tic" marks on TUNING and BANDWIDTH controls guide you to octave-band graphic equalization settings

-- Bands are totally non-interacting

<u>LP/HP Filter Sections</u>

-- Each section is continuously tunable over 100:1 range in 2 decades

- Each section is independently switchable
- 12dB/octave slopes
- Separate highpass and lowpass outputs permit use as full electronic crossover in the range of 200-2000Hz

General

- 12dB available gain
- Very low noise and distortion
- High slew rate for minimum TIM (SID)
- "Peak-stretching" overload lamp warns of clipping anywhere in equalizer before distortion is audible
- EQ controls are long-throw dust-shielded sliders for good resolution
- Industrial-grade parts and construction, including socketed IC's
- RFI suppression on input, output, and power leads
- Balanced output optional (order retrofit kit as required)
- Holes for XLR-type connectors are provided

FRONT PANEL DESCRIPTION

The GAIN control adjusts the drive level to the filters and equalizers.

The OVERLOAD indicator monitors all critical points to warn of excessive signal amplitude due to excessive input amplitude or to large amounts of peak boost equalization. Overloads are eliminated by turning down the GAIN control.

The EQ IN/OUT switch defeats the graphic EQ section.

The EQ controls adjust the maximum peak or dip in each band over a range of ±16dB. Center detent corresponds to flat output from the band.

The TUNING controls adjust the center frequency of each of the eight bands in the EQ section.

The BANDWIDTH controls adjust the "Q" (sharpness) of each band in the EQ section. The "Q" becomes broader when turned clockwise, sharper when turned counterclockwise.

The HIGHPASS FILTER IN/OUT switch defeats the highpass filter action.

The HIGHPASS FILTER TUNING control adjusts the corner frequency of the highpass filter over two ranges. The RANGE switch determines whether the range is 20-200Hz or 200-2000Hz.

The LOWPASS FILTER IN/OUT switch adjusts the corner frequency of the lowpass filter in two ranges. The RANGE switch determines whether the range is 2-20kHz or 200-2000Hz.

The POWER switch and green LED pilot lamp complete the front panel.

REAR PANEL DESCRIPTION

The FUSE used in the 672A is a 3AG 1/8 amp slo-blo type, used for both 115V and 230V operation. Replace with the same type only.

The INPUT and OUTPUT connectors provided allow connection via barrier strip (#5 screw) or standard 1/4" phone plugs. Each input or output of both connector types are connected in parallel. In addition, a cover plate masks holes for user-installed XLR-type connectors.

Please refer to the **Electrical Installation** section for connection instructions.

AC POWER

The power transformer can be strapped for 115 volt or 230 volt 50 or 60Hz AC operation. If the unit was ordered for 230 volts, a tag on the power cord warns of the modification.

To strap the power transformer for a different voltage, remove the bottom cover of the 672A. Strapping instructions are found on the insulating fishpaper around the power transformer. It is not necessary to rearrange the heavy insulated wiring; all strapping can be performed with bare jumper wire. Take care not to burn the insulation.

The power cord is terminated in a "U-Ground" plug to USA standards. The green (or green/yellow) wire (which is connected to the long prong) is connected directly to the 672A chassis. If it becomes necessary to lift this ground to suppress ground loops, this should be done with a three-prong to two-prong adapter plug, rather than by damaging the power plug. It is not recommended that this ground be defeated 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 THE SYSTEM TO WHICH IT IS CONNECTED CAN RESULT IN APPEARANCE OF FULL LINE VOLTAGE BETWEEN CHASSIS AND EARTH GROUND. SUCH VOLTAGE IS CAPABLE OF CAUSING SEVERE INJURY OR DEATH!

MECHANICAL INSTALLATION

Vertical space of three standard rack units (5 1/4"/13.3cm) is required.

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

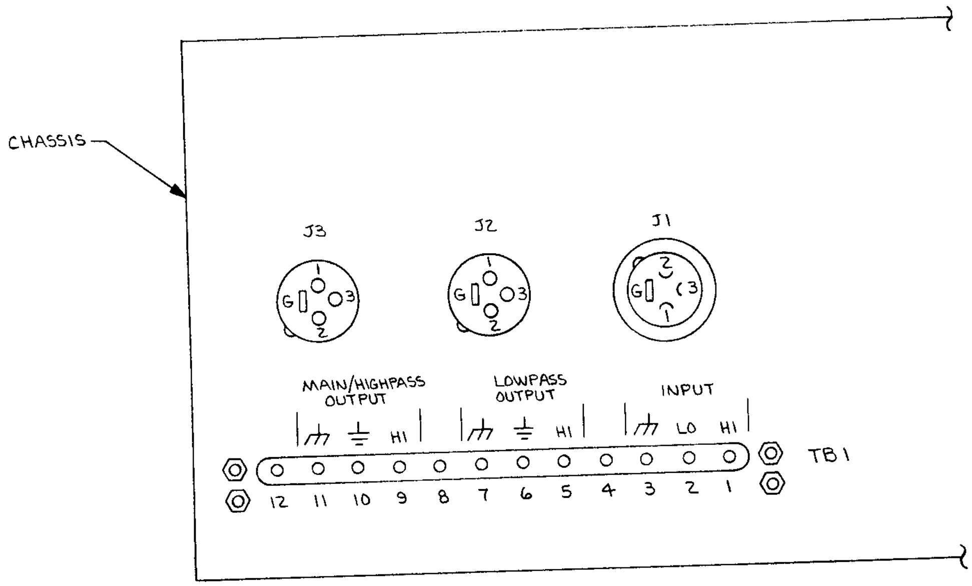
INSTALLATION OF OPTIONS

XLR Connector Installation: To install the optional XLR connectors, obtain (2 ea.) Switchcraft D3M and (2 ea.) Switchcraft D3F (or equivalent) connectors from a local supplier. These connectors are also available directly from Orban as retrofit kit RET-28.

Remove the cover plate from the rear chassis apron and install each connector with a pair of #4-40-1/4" flat-head screws, nuts, and lockwashers. On each channel in turn, connect jumper wires from the barrier strip to the XLR's as shown in Fig. 1.

Phone Jack Installation: To install the optional phone jacks, obtain (4 ea.) Switchcraft #12B (tip-ring-sleeve) phone jacks from a local supplier. These jacks are also available directly from Orban as RET-29.

Remove the hole plugs from the rear panel and install the jacks using the hardware supplied with the jacks. Then connect jumper wires from the barrier strip to the jacks as shown in Fig. 1.



VIEW FROM INSIDE OF 672A CHASSIS

WIRE LIST

XLR CONNECTOR INPUT			XLR CONNECTOR LP OUT			XLR CONNECTOR MAIN/HP OU		
FROM	TO	COLOR	FROM	TO	COLOR	FROM	TO	COLO
J1-1 (⏊)	J1-G (GND)	BLK	J2-1 (⏊)	J2-G (GND)	BLK	J3-1 (⏊)	J3-G (GND)	BLK
J1-2 (LO)	TB1-2 IN (LO)	BRN } TWIST	J2-2 (LO)	TB1-6 (⏚)	BLK } TWIST	J3-2 (LO)	TB1-10 (⏚)	BLK } TV
J1-3 (HI)	TB1-1 IN (HI)	RED	J2-3 (HI)	TB1-5 (HI)	YEL	J3-3 (HI)	TB1-9 (HI)	GRN

Fig. 1: WIRING OF OPTIONAL CONNECTORS

Balanced Output Transformer Installation: If transformers were not installed at the factory, refer to the installation instructions furnished with the transformer kit, known as "RET 6". The transformer supplied with this kit has been designed to have a negligible effect on published specifications. Should you wish to use some other transformer, it would be wise to make careful performance measurements with special attention to LF distortion and HF response at high output levels, thus determining the output level achievable with performance acceptable for your application. A transformer meeting Orban standards should produce approximately +20dBm (limited by clipping in the output amplifier) without significantly compromising performance.

The **Electrical Installation** section describes grounding procedures in the event transformers are used.

BLOCK DIAGRAM

The BLOCK DIAGRAM outlines the signal flow through the various sections of the 672A. It is reproduced here:

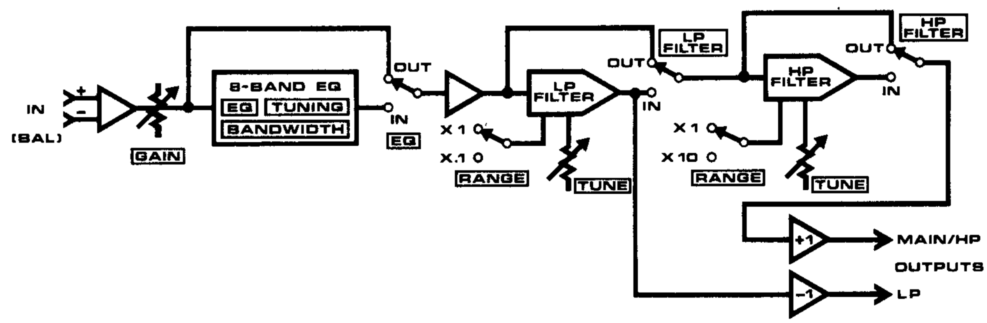


FIG.2: BLOCK DIAGRAM

ELECTRICAL INSTALLATION

Connecting the 672A Equalizer to other equipment is quite straightforward. Relatively uncomplicated systems (such as home playback systems, "semi-pro" recording studios, electronic music studios, discos, etc.) tend to come together without serious grounding problems even if the wiring practices are somewhat casual, provided that high RF fields are not present. Unusual situations can be analyzed if you are familiar with the standard rules governing grounding and interfacing between balanced and unbalanced systems.

The instructions below will apply to the majority of cases. A comprehensive discussion of interconnections and grounding can be found in the **Appendix.**

Input

The electronically-balanced input of the 672A equalizer is compatible with most professional and semi-professional sound equipment, balanced or unbalanced, whose source impedance is 600 ohms or less. If it is greater (as in some vacuum-tube audiophile preamps), a minor modification may be made to the input to accomodate the situation. Please refer to the **Appendix** for further details.

Nominal input level is between -10 and +4dBm. The absolute overload point is +26dBm.

Output

The two outputs of the 672A are unbalanced (unless fitted with the optional transformers), and the source impedance is 47 ohms in parallel with 1000pF to the chassis (for RFI suppression).

Use the MAIN/HIGHPASS output for normal operation when the crossover feature is not used.

If the 672A is being used as a full electronic crossover, use the LOWPASS output to drive the low-frequency amplifier, and the MAIN/HIGHPASS output to drive the high-frequency amplifier. These outputs are out-of-phase, as is correct with 12dB/octave crossovers.

Wiring the 672A With Two-Conductor Shielded Cable

We recommend wiring with 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. The following table and diagram are applicable to a great majority of installations.

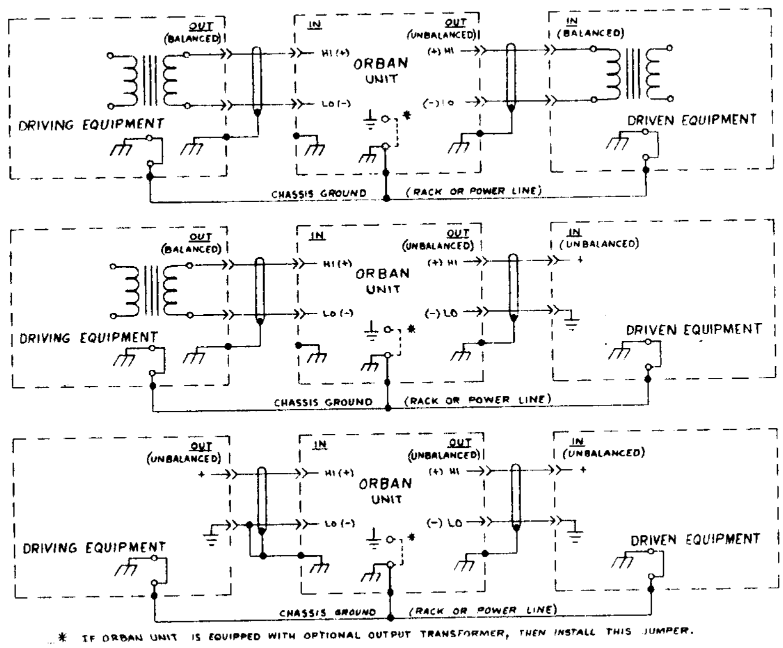


Fig. 3: GROUNDING

TABLE I:
TYPICAL INPUT/OUTPUT CONNECTION RULES

INPUT

1) Always use HI and LO as the two input terminals to the 672A.

2) When the 672A is driven from an unbalanced source, connect shield both to circuit ground of source, and to chassis ground of 672A.

3) When the 672A is driven from a balanced source, connect shield at source end to chassis ground. Do not connect shield at 672A end.

4) If the source is balanced by means of a transformer, a 620 ohm 1/2w 5% load resistor is probably required. Consult the manufacturer's manual.

OUTPUT

1) On the 672A output, connect shield at 672A end to chassis ground (whether driving balanced or unbalanced). Do not connect shield at other end.

2) When driving a balanced load, jumper circuit ground to chassis ground on 672A (on rear panel). When driving an unbalanced load, do not attach jumper.

3) 672A chassis should always be earth-grounded (i.e. through third wire in power cord or through rack.) For maximum protection from shock, float this ground only as last resort.

4) If optional output transformer(s) are installed on 672A, jumper the circuit ground to chassis ground on the 672A.

Because it is not always possible to determine if the pieces of equipment driving or being driven by the 672A have their circuit grounds internally connected to their chassis grounds (which are always connected to the ground prong of the AC line cord), and because the use of the AC power line ground often introduces problems because it can be noisy or otherwise imperfect, the wiring techniques in the diagram are not universally applicable.

If you follow the diagram 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 LO input of the 672A to a chassis ground terminal on the 672A's barrier strip and see if the buzz goes away. You can also try strapping the 672A's chassis and circuit grounds together, and see if this helps.

A ground loop usually sounds like 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 672A'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!

Wiring The 672A With Single-Conductor Shielded Cable: Sometimes, particularly if you are using the 672A with musical instruments or home-type equipment, you will find yourself with no time to correctly connect the 672A, and will find instead that you must use single-conductor shielded cables (usually terminated by 1/4" phone plugs which can be plugged into the 672A's auxiliary phone-plug input and outputs). If this happens, connect the inner conductors of the shielded cables to the HI sides of the 672A input and output(s). Connect the shields to the LO sides. (The HI side appears on the tip of the phone jacks; the LO side on the ring. The sleeve is chassis ground).

The shield will ordinarily receive chassis ground from the external equipment which it is connecting to the 672A. The chassis ground/circuit ground jumper on the rear barrier strip of the 672A 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. IF A TWO-CONDUCTOR PHONE PLUG IS USED AS THE EXTERNAL CONNECTOR, THIS WILL HAPPEN AUTOMATICALLY, AND MAY INTRODUCE A GROUND LOOP. Because use of single-conductor cables virtually eliminates any possibility of carefully controlling the system grounding scheme, it is NOT RECOMMENDED!

OPERATING INSTRUCTIONS

Using the EQ Section: To use the EQ section alone, switch the HP and LP filter switches OUT. Switch the EQ section switch IN.

For those who have never used a Parametric Equalizer before, the easiest way to become familiar with the 672A is to set the TUNING and BANDWIDTH controls at the "tic" marks. The 672A will now behave like an eight-band octave graphic equalizer (on ISO standard octave frequencies of 63, 125, 250, 500, 1000, 2000, 4000, and 8000Hz). Once you have gotten the "feel" of the 672A in this mode, try experimenting with the TUNING and BANDWIDTH controls to see how they affect the sound.

When you boost the EQ, discover the subtle shelving effects available from broadband peaking (BANDWIDTH control close to full clockwise; EQ control above the center detent). Contrast this with the "ringy", colored quality of setting the BANDWIDTH control toward narrow (ccw).

When you cut the EQ observe the effects you now achieve. Narrowband dips are essentially inaudible, but permit suppressing sounds of fixed frequency (like hum), up to 16dB in each band. (If the sound to be suppressed is rich in harmonics, use one band per dominant harmonic.)

The EQ curves are reciprocal: boost and cut are mirror images of each other. A given amount of EQ (in recording a track, for example) can be precisely cancelled later by passing the track through the equalizer with all TUNING and BANDWIDTH controls set as they were during the original recording, but with all EQ controls set equal but opposite to their original settings. Boost becomes cut, and vice-versa.

More boost or cut can be achieved by tuning adjacent bands to the same frequency. ±32dB of EQ is then available. But beware of overload and noise buildup when boosting!

While in the narrowband boost mode, a band's TUNING control can be continuously swept to give a sound similar to "phasing".

The "Q" increases (i.e., the bandwidth in terms of fractions of an octave decreases) as the TUNING control is moved higher in frequency. But the absolute bandwidth (in Hertz) does not vary.

Specified "Q" range for any setting of the TUNING control exceeds 0.5 to 10. This means that with TUNING centered, the available "Q" range is typically 0.3 to 20.

When varying the BANDWIDTH control, the peak gain remains constant while the skirts of the curve vary.

To provide best value, the 672A uses controls of high reliability but modest calibration accuracy. Calibrations are approximate, and are intended primarily as reference guides. However, placing an EQ control on its center detent accurately defeats the equalization in that band. When operating with narrow bandwidths, accurate stereophonic matching of several channels of 672A equalization on the basis on panel calibrations alone is impractical. However, if the BANDWIDTH controls are operated on, or more clockwise than, their "tic" marks, then no problems will occur. (See the subsection on **Stereo** in **Part B** for matching instructions.)

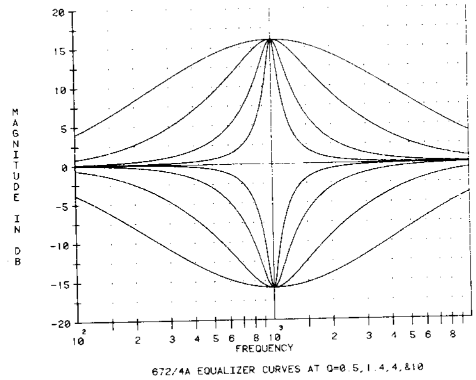


Fig. 4: BOOST/CUT CURVE FAMILIES

Using the Highpass And Lowpass Filters

Be sure that the HP and LP filter switches are IN as appropriate. This creates a passband: the low frequency cutoff is determined by the HP TUNING knob, and the high frequency cutoff by the LP TUNING knob, both in conjunction with their associated RANGE switches.

Because these filters are in series after the EQ section, EQ is possible within the passband. The EQ controls can also modify the 12dB/octave cutoff characteristics of the HP and LP filters when tuned near or at the corner frequency of the filter(s).

The ability of these filters to roll off the frequency extremes obviates the need to use the first and last EQ bands for this function. (The filters are more effective, as well.)

Deliberately narrowing the passband radically (by tuning the filters close to each other) is useful for special effects like telephone, transistor radio, and "old-time" recordings. The authenticity of such effects can often be augmented by deliberately driving the equalizer into clipping distortion (by advancing the GAIN control beyond the point where the OVERLOAD lamp lights).

Using The 672A As An Electronic Crossover

If you do not otherwise need the lowpass and highpass filters, they may be used as a full 12dB/octave Butterworth electronic crossover in bi-amped systems.

Connect the MAIN/HIGHPASS output to the high frequency amplifier, and the LOWPASS output to the low frequency amplifier. Turn the LOWPASS FILTER IN/OUT switch to OUT, and the HIGHPASS FILTER IN/OUT switch to IN. Select the x0.1 range on the LOWPASS FILTER RANGE SWITCH, and the x10 range on the HIGHPASS FILTER RANGE SWITCH. Now adjust both HIGHPASS TUNING and LOWPASS TUNING to the desired crossover frequency. Any frequency between 200Hz and 2kHz can be accomodated.

Refer to the speaker manufacturer's literature to determine the recommended crossover frequency. Typical crossover frequencies used with two-way horn-loaded systems range from 500 to 700Hz.

Ideally, the crossover frequencies can be slightly trimmed for maximally flat response around the crossover frequency by observing a real-time analyzer as the TUNING controls are adjusted. If a real-time analyzer is unavailable and you wish to adjust the crossover frequency to accuracies superior to those offered by the panel calibrations, use an oscillator and AC voltmeter (with dB scale) as follows:

First, disconnect 672A outputs from the amplifiers. Then, switch both filters OUT temporarily.

CAUTION!

DO NOT SWITCH THE HIGHPASS FILTER SWITCH OUT WHILE DRIVING A TWEETER. YOU ARE LIKELY TO DESTROY IT!

Connect the oscillator to the 672A input, and the AC VTVM to the 672A's MAIN/HIGHPASS output. Adjust the oscillator's output frequency to 1kHz, and its output level for a 0dB reading on the AC VTVM's dB scale. Adjust the oscillator frequency to the desired crossover frequency. Now switch the HIGHPASS filter IN, and adjust its TUNING control until the AC VTVM reads -3dB. Then switch the HIGHPASS filter OUT and switch the LOWPASS filter IN. Adjust the LOWPASS FILTER TUNING until the AC VTVM reads -3dB. Both filters are now matched, and the crossover frequency is correct within the frequency calibration of the oscillator and the accuracy of the AC VTVM.

When the trimming procedure is complete, switch the LOWPASS FILTER IN. Reconnect the amplifiers to the 672A outputs. The two outputs are already out-of-phase as required by the 12dB/octave configuration. DO NOT REVERSE THE PHASE OF THE DRIVERS.

Notes On Headroom

The overload-to-noise ratio available from the 672A varies from about 100 to 105dB depending on the settings of the controls. To minimize audible noise while driving power amplifiers, for example, the overload point of the 672A should be matched to the overload point of the power amplifier. This is done by adjusting the INPUT ATTENUATOR settings on the power amp(s) to make the amp(s) barely clip when a sinewave input to the 672A is adjusted in level such that it just barely lights the 672A OVERLOAD lamp. Clipping in the amplifier may be detected by means of an oscilloscope, power output meters, or other overload indicator, depending on the amplifier used. This procedure assures minimum noise and distortion from the 672A/power amp combination.

WARNING!

PRIOR TO TESTING, BE SURE THAT THE POWER AMP LOAD (SUCH AS A LOUDSPEAKER) IS NOT DAMAGED BY FULL-POWER SINEWAVE. IF YOU THINK THAT IT MIGHT BE, USE A DUMMY LOAD OR A TEST SIGNAL WITH A HIGHER PEAK-TO-AVERAGE RATIO (LIKE PINK NOISE LOWPASS FILTERED AT 1KHZ) SO AS NOT TO BURN OUT TWEETERS.

Part B: Specific Applications

This part of the manual provides very specific instructions and suggestions on how to use the 672A in the fields of Sound Reinforcement, Recording Studios, Motion Picture Sound, Broadcasting, Dance Bars, and provides comments on Electronic Music. We recommend that anyone involved in pro audio (and certainly those involved in its more eclectic aspects, such as Theater) read all the sections. The applications information in each will undoubtedly provide much food for thought.

1: STEREO

For broadband equalization (BANDWIDTH controls at or clockwise of the "tic" marks), no difficulty should result when the equalizers are matched on the basis of panel calibrations alone. However, if any bandwidth control is adjusted "narrowband" (i.e., 0 through 5), test instruments should be used to assure matching between 672A's when two or more are employed in multi-channel sound systems.

The following procedure assumes that one equalizer has been adjusted by ear or instrument to achieve the desired effect. The other equalizer(s) must then be instrument-matched to this reference. This is most readily done by the "differential method": the reference unit and the equalizer under adjustment are swept out-of-phase, and their outputs are summed. The equalizer under adjustment is tweaked to minimize the amplitude of the sum. This method is very sensitive because it automatically indicates both phase and amplitude mismatches. It is performed as follows:

1) Connect a sinewave sweep generator with logarithmic sweep to the inputs of the reference equalizer such that the hot output is connected to the reference equalizer's HI input, and its LO input is grounded.
2) Connect another output from the sweep generator to the equalizer under adjustment. Connect the hot output to this equalizer's LO input; ground its HI input.
3) Sum the outputs of the two equalizers by connecting each hot output to one side of a 22K 5% 1/4 watt carbon resistor (the value is not particularly critical). Connect the other side of both resistors to the vertical input of an oscilloscope.
4) Sweep the equalizers from 20-20,000Hz, and adjust the scope sensitivity to easily see the swept component.
5) Switch all IN/OUT switches on both equalizers OUT. Adjust the GAIN control on the equalizer under adjustment to null the output observed on the scope.
6) Switch all IN/OUT switches IN (unless some of these switches are normally out on the reference equalizer). Adjust the controls of the equalizer under adjustment until they are visually as close as possible to the control settings on the reference equalizer.
7) Slightly adjust the various controls on the equalizer under adjustment to minimize the amplitude of the differential component as observed on the scope.

2: SOUND REINFORCEMENT

The 672A is an extremely versatile sound reinforcement equalizer. It can function as a notch filter, broadband equalizer, filter, and electronic crossover. Many of these functions are simultaneously available.

House Tuning: In an economy installation, the 672A can do a surprisingly effective job of tuning a reinforcement system to a room without the use of a third-octave filter set. Use three or four of the bands in their narrowband notching mode (BANDWIDTH full counterclockwise) to notch out the major ring modes. This is most effectively and safely done if there is a limiter or compressor in the circuit before the power amplifier to prevent speaker damage. Advance system gain until it feeds back at a single frequency. Make sure that the limiter is in gain reduction to protect the speakers. Estimate the frequency of the feedback, and choose a band on the 672A which covers it. Turn the BANDWIDTH control to broad, and pull the EQ control down to -16dB. Adjust the TUNING control until the feedback changes frequency. Continue to adjust the TUNING control until the feedback returns at its original frequency. Set the TUNING control half-way between the two settings where the feedback was observed to change frequency. Now reduce the BANDWIDTH to full CCW (narrowband), and readjust the TUNING as necessary to keep the notch centered on the ring frequency. Finally, move the EQ control up toward center until the ring frequency reappears. Back off about 4dB. This will leave headroom so that the ring frequency will not reappear when the system gain is increased when more ring modes are tuned out later. This procedure may be repeated with the new ring frequencies as they appear. Usually after the first four ring frequencies have been eliminated, the "point of diminishing returns" is reached.

NOTE:

> If you are doing a permanent installation, be aware of the fact that air temperature changes may significantly shift the frequency of the room ring modes. To obtain added stability over time, you may wish to use slightly broader bandwidths than the very narrow (typical "Q"=20) bandwidths created by the full CCW rotation of the BANDWIDTH controls.

The remaining bands on the 672A are now available to perform broadband equalization of the system. Use a pink-noise generator and third-octave real-time analyzer for most precise results. However, if your budget doesn't permit a third-octave analyzer, use your ears. Fortunately, you only have four or five bands to deal with -- not a whole third-octave set!

The filters on the 672A may be used to roll-off the very low and high frequencies. Low frequencies tend to rob amplifier power and can damage speakers (particularly bass horns) if substantial power is applied to the loudspeaker below its cutoff frequency. Removing unnecessary high frequencies can protect tweeters and can help control feedback problems in certain specialized applications like stage monitors.

Notch Filtering: If a third-octave filter set is available for broadband equalization, the 672A may be used solely as a narrowband notch filter set to eliminate up to eight ring modes. The notches obtainable are considerably sharper than those created by a third-octave equalizer. The 672A's highpass and lowpass filters may also be employed to roll-off the system in a controlled way at low and high frequencies.

Full Electronic Crossover: If the highpass and lowpass filters are not otherwise required, the house tuning, notch filtering, and electronic crossover functions can all be performed simultaneously by the 672A. Set up the crossover function as described in the **Operating Instructions** (in **PART A),** and follow the guidelines above for **House Tuning** and **Notch Filtering.**

Partial Electronic Crossover and Individual Driver Equalizer: Substantial advantages are sometimes obtained if each individual driver in a sound reinforcement system is assigned its own equalizer. Some practitioners feel that this is the most powerful way of equalizing a system. The 672A is ideal for this application, because its lowpass and highpass filters can also be used as a 12dB/octave electronic crossover, and because it is cost-effective.

For this application, use the MAIN/HIGHPASS output on each 672A.

Ordinarily, using 12dB/octave crossovers requires adjacent frequency range drivers to be connected out-of-phase. This phase reversal is readily obtained either at the power amplifier output terminals or at the input terminals of the 672A, exploiting the balanced input feature.

To use a 672A as a high frequency equalizer/crossover, adjust the HIGHPASS FILTER RANGE switch to x10, and switch the HIGHPASS FILTER IN/OUT switch IN. Adjust the HIGHPASS FILTER TUNING control to the desired crossover frequency (200-2000Hz). The bands in the EQ section which are tunable above the cutoff frequency can be used for EQ. The lowpass filter is still available to shape the upper cutoff frequency in the system.

To use a 672A as a low frequency equalizer/crossover, adjust the LOWPASS FILTER RANGE switch to x0.1, and switch the LOWPASS FILTER IN/OUT switch IN. Adjust the LOWPASS FILTER TUNING control to the desired crossover frequency (200-2000Hz). The bands in the EQ section which are tunable below the cutoff frequency can be used for EQ. The highpass filter is still available to shape the lower cutoff frequency of the system.

To use a 672A as a midrange equalizer and crossover, use both the highpass and lowpass filters to create the desired bandpass for the midrange driver. The bands in the EQ section which can be tuned within the passband can be used for EQ.

Stage Monitors: The 672A is the ideal stage monitor equalizer because of its low cost and notching capabilities. Follow the instructions in **House Tuning** above. Use the highpass and lowpass filters to limit the frequency response of the stage monitors in the extreme high and low frequencies. This will result in maximum intelligibility, and will minimize feedback problems.

3: DANCE BARS

The sound generally desired in a dance bar is one that will make the customers get out and boogie (or sit down and drink....). This usually implies a large bass boost in the region of 40-80Hz, and a smaller amount of treble boost. Bands 1 and 8 of the 672A can be employed for this purpose, leaving the remaining bands available for "house tuning". In this case, we mean smoothing out midbass and midrange acoustic response of the loudspeakers in the room.

We do not recommend that the D.J. be permitted to operate the 672A in the course of his normal activities. The 672A should be adjusted once by the installing contractor to the manager's specifications, and then locked up. If the D.J. is to be provided with equalization, sufficient power to correct the sound of inadequate records can be supplied by a simple 5-band graphic equalizer with more limited range.

If the sound contractor has access to a third-octave real-time analyzer and pink-noise source, these can be of substantial aid in adjusting bands 2-7 for flat acoustic response in the midbass and midrange. Coloration here is undesirable, and can cause customer edginess. It can also interfere with conversation. For the same reason, excessive treble boost should be avoided because of its potential for subliminal irritation.

The amount of bass boost is primarily limited not by subjective considerations but by available amplifier power and loudspeaker bass power-handling capacity. For maximum capability, bi-amping is recommended because the bass amplifier can be clipped occasionally without causing obvious harshness. In this case, the 672A can also be used as an electronic crossover.

In all cases, the setting of the 672A low frequency TUNING and BANDWIDTH controls is quite critical in obtaining bass that is punchy, "tight", and sensual, without being "boomy" (like "jukebox bass"). Correct settings will vary considerably with loudspeaker type and room acoustics. In particular, satisfactory results cannot be obtained with a horn-loaded bass system with a cutoff frequency above 40Hz. Trying to boost bass below the cutoff frequency of the horn will cause severe distortion and also has the potential of damaging the drivers.

4: RECORDING STUDIOS

The 672A can be used in the recording studio just about anywhere that a conventional equalizer is used. Most studios find at least two channels of patchable Parametric Equalization to be invaluable in cleaning up "difficult" tracks that the internal console equalizers can't handle.

If a track is plagued by hum or other interference of fixed pitch, the 672A can be used in its narrowband notching mode (BANDWIDTH full CCW; EQ at -16dB) to reduce the level of the sound and its most important harmonics by 16dB, which is often sufficient to render it inaudible. The notching of each harmonic requires use of a separate band.

The 672A is capable of producing a wide variety of special effects. Sweeping wideband notches gives a true "phasing" sound. Sweeping narrowband peaks gives a different sound with a similar flavor.

Telephone, transistor radio, and "old-time" recording effects are most easily generated by adjusting bands 5 and 6 close together in frequency (around 1.3kHz, for example). The BANDWIDTH controls are adjusted to give moderately narrow bandwidths and both EQ controls are set for 16dB boost. This produces the sound of a ringy bandpass filter with approximately 12dB/octave slopes and gives the distinctive sound desired. If you want further selectivity, use the highpass and lowpass filters. Authentic-sounding distortion can be generated by overdriving the input of the 672A beyond the point where the OVERLOAD lamp flashes.

The 672A can also be effectively employed as a monitor system equalizer/electronic crossover, particularly when a third-octave equalizer is too costly. See the **Sound Reinforcement** section above.

5: MOTION PICTURE SOUND

The 672A can be used to particular advantage as a dialog equalizer because of its many versatile features, such as:

1) Fine-tuning capability, allowing the mixer to obtain the best possible sound for difficult or poorly-recorded location recordings;

2) Instant notch filtering which can reduce hum and camera whine;

3) Instant lowpass and highpass filters which effectively remove both low and high frequency acoustical noise from the track without affecting dialog;

4) Ability to use the equalizer as a standard octave-band graphic by setting TUNING and BANDWIDTH controls to their standard settings.

The scoring mixer can similarly benefit from the fine adjustability of the 672A.

The 672A can be used to equalize the motion picture monitoring environment by adjusting the "B" chain in the re-recording theater to the studio's accepted acoustic response standard. The music scoring stage monitoring system can be similarly adjusted. In many cases, the lowpass filter can be used to simulate the Academy Rolloff used in mixing tracks intended for optical release prints. A curve corresponding to typical studio practice is generated by setting the lowpass filter to 4.5kHz.

Those interested in motion picture applications should also review the section on **Recording Studios** immediately above.

6: BROADCASTING

In AM, FM, and TV broadcasting applications, the integral RF suppression will greatly facilitate installation of the 672A. The optional output transformer is particularly recommended for stations with studio and transmitter at the same site. Normal precautions regarding grounding and shielding should be followed when the 672A is installed.

The 672A is invaluable in the production studio. It can be used to "sweeten" records (if two channels are available for stereo), and to equalize the announce microphone for maximum punch.

If sibilance is a problem, the best solution is the use of an Orban Dynamic Sibilance Controller. If one is unavailable, tuning a 672A band to 6kHz, adjusting the BANDWIDTH close to the "tic" mark, and lowering the EQ control as necessary will help control sibilance -- although at the expense of vocal presence.

Use of narrowband peaking, and sweeping can create some wild gimmicks. However, be aware that excessive high frequency boost can saturate the 7.5ips tape cartridges usually used. This can be avoided by following the 672A with the Orban Stereo Compressor/Limiter, which assures clean carts under all EQ conditions.

The 672A can also be used to enhance the sound of telephone calls, remotes, satellite feeds, shortwave broadcasts, and network feeds. Use the LP and HP filters to remove out-of-band noise. Presence and intelligibility can often be enhanced by boosts in the 4-5kHz region.

The 672A is a most effective phone line equalizer. Unlike simpler phone company equalizers, the 672A's flexibility can effectively deal with minor response "glitches".

In the main studio, the 672A can be used to notch out cart or tape machine motor hum and ventilation system noise with minimal effect on voice quality. Use one band for each major 60Hz harmonic, with BANDWIDTH control adjusted close to "narrowband".

The 672A may also be used in the AM program line to equalize the air sound, thus partially compensating for the inadequacies of typical consumer AM radios. A certain amount of high frequency boost is essential to counteract the extremely rolled-off performance of such radios. However, extreme boosts can cause problems with conventional compressors and limiters (such as severe pumping, "gulping" on material with large amounts of high frequency energy, and audibly obvious de-essing). Therefore, for ultimate performance, we recommend using the Orban OPTIMOD-AM, which is a complete signal processor <u>including</u> adjustable equalization.

7: ELECTRONIC MUSIC

The 672A is a highly valuable adjunct to any electronic music synthesizer. It is particularly useful as a formant filter, and can be used as a resonator to simulate certain instrument body sounds. The synthesist will find the more extreme equalization settings to be particularly useful in approaching live instrument sound and getting away from the raw sound of typical synthesizer systems.

As this whole area is highly specialized, we will not explore it further. We suggest that the beginner familiarize himself with the literature on musical instrument physics.

Part C: Maintenance

Introduction: This part of the manual provides instructions on how to maintain the 672A, how to make sure that it is working according to specifications, and how to repair it if something goes wrong.

Factory service is available throughout the life of the 672A. Please refer to **Factory Service** subsection of **MAINTENANCE AND SERVICE** below for further information.

1: PERFORMANCE EVALUATION

General:

This section provides a series of thorough, definitive bench tests which will verify whether or not the 672A is operating normally. The 672A has no trimmers, and requires no alignment during its life.

Power Supply:

Equipment Required:
1) VTVM or DVM
2) Oscilloscope

The following tests will verify correct operation of the Power Supply:

1) Using the DC voltmeter, measure the voltage from circuit ground to both positive and negative unregulated supplies. This can be readily measured across the two large filter capacitors. This voltage may be expected to vary widely depending on line voltage; it should measure between ±18 and ±26 volts DC.

2) Measure the voltage between circuit ground and the outputs of the positive and negative voltage regulators, VR1 and VR2. The supplies should put out between ±14.25 and ±15.75 VDC. If either supply exceeds 15.75 VDC, it implies that its associated IC regulator is defective. If either supply is lower than 14.25 VDC, refer to the **Power Supply** portion of **Part 3** in this section for troubleshooting hints.

3) Using the oscilloscope, measure the ripple and noise on the regulated positive and negative power busses. Ripple and noise should be less than 2mV peak on each bus.

Signal Processing Circuitry:

Equipment Required:

1) Oscilloscope with DC-coupled display
2) Audio sweep generator with sinewave output and logarithmic sweep (A Tektronix 5L4N Low-Frequency Spectrum Analyzer in a Tektronix 5111 Bistable Storage mainframe may be substituted for items (1) and (2).)
3) 20-20,000Hz bandpass filter, 18dB/octave slopes
4) VTVM or DVM

5) Harmonic distortion analyzer with built-in 400Hz and 80kHz filters and residual THD below 0.0015%
6) Low-distortion oscillator with residual THD below 0.0015%

(A Sound Technology 1700A or H-P 339 will satisfy (5) and (6))

For the following tests, a 600 ohm load must be provided across each 672A output. 620 ohm 1/2 watt 5% carbon resistors are suitable.

1) Signal Passage Test

a) Connect the HI side of the 672A main output to the input of the harmonic distortion analyzer, and also to the vertical input of the oscilloscope. Connect the ground side of the 672A to instrument ground.
b) Ground the LO input of the 672A and connect the output of the low-distortion oscillator to the HI input of the 672A.
c) Move all IN/OUT switches to OUT, and center all EQ controls.
d) Adjust the GAIN control clockwise, and verify that an undistorted sinewave appears at the output.
e) Continue to advance the GAIN control until clipping is barely visible. Verify that this clipping level exceeds +19dBm for 20Hz, 1kHz, and 20kHz input signals.
f) Verify that the OVERLOAD lamp flashes at, or slightly below, the clipping level.

2) DC offset

a) Disconnect the oscillator from the 672A input.
b) Move all IN/OUT switches to IN. Measure the DC voltage appearing at each output of the 672A. Either voltage should not exceed 30mV DC.

3) Distortion and Inverting Operation

a) Ground the HI input of the 672A and connect the low-distortion oscillator to the LO input of the 672A. Adjust the oscillator to 1kHz.
b) Move the LOWPASS and HIGHPASS FILTER IN/OUT switches to OUT, but leave the EQ IN/OUT switch IN.
c) Using the same procedure as in the **Signal Passage Test** above, verify that the gain is the same as previously measured $\pm$0.3dB.
d) Apply a 20kHz signal and adjust the output level of the oscillator and the 672A's GAIN control until +18dBm is observed at the 672A main output.
e) Measure the Total Harmonic Distortion, using the 400Hz and 80kHz filter on the distortion meter. The THD should not exceed 0.08%.
f) Repeat at 20Hz; +18dBm output; 400Hz filter OUT. The THD should not exceed 0.05%.
g) Repeat step (f) using the lowpass output of the 672A.

4) Noise

a) Adjust the 672A GAIN control to produce unity input/output gain.
b) Switch OUT the 400Hz and 80kHz filters in the analyzer. Connect the 20-20,000Hz bandpass filter between the 672A main output and the analyzer input.
c) Disconnect the oscillator from the 672A, and connect both HI and LO 672A inputs to circuit ground.

d) Center all controls except for GAIN (adjusted in step (a)), LOWPASS FILTER TUNING (2-20kHz; full clockwise), and HIGHPASS FILTER TUNING (20-200Hz; full counterclockwise). Place all IN/OUT switches IN.

e) Measure the noise at the main output of the 672A. With the test setup as described, it should not exceed -78dBm and will typically measure -80dBm. If only the 80kHz filter internal to the analyzer is available, the noise will measure somewhat higher.

5) Filter Sweep Tests

a) Set the oscilloscope for an X/Y display.
b) Connect the sweep generator output to the HI input of the 672A. Leave the LO input connected to circuit ground. Connect the sweep generator ramp output to the "X" input of the oscilloscope. Verify that the 672A main output is still connected to the "Y" input of the oscilloscope; if not, connect it.
c) Move the EQ IN/OUT switch to OUT.
d) Move the LOWPASS FILTER IN/OUT switch to IN.
e) Adjust the oscilloscope and sweep generator to exhibit a 20-20,000Hz logarithmically-swept response.
f) Adjust the LOWPASS FILTER tuning control from 2kHz to 20kHz while observing the swept response. Verify that the -3dB points correspond to the panel calibrations $\pm$ 1/3 octave. Verify that the response exhibits a smooth rolloff with a 12dB/octave ultimate slope.
g) Switch the RANGE to 200-2000Hz and repeat (f).
h) Switch the LOWPASS FILTER OUT. Switch the HIGHPASS FILTER IN.
i) Repeat step (f) while sweeping the highpass filter from 20-200Hz.
j) Repeat step (f) while sweeping the highpass filter from 200-2000Hz.
k) Switch the highpass and lowpass filters OUT.

6) Equalizer Swept Response

The following procedure should be performed on each of the eight equalizer bands in turn. As you perform the tests, be sure that the seven EQ controls of the bands not under test are set at their center detents. If the OVERLOAD lamp flashes at any time, reduce the GAIN.

a) Center the TUNING and BANDWIDTH controls. Adjust the EQ control throughout its range, and verify that a bell-shaped curve is produced. The peak gain should be adjustable between +16dB (6.31 times the "flat" level) and -16dB (0.158 times the "flat" level). The response should be flat $\pm$0.25dB when the EQ control is set at its center detent.
b) Set the EQ control at +16dB. Adjust the BANDWIDTH control throughout its range. The peak gain should change less than 2dB as this is done.
c) Adjust the BANDWIDTH control full counterclockwise (full narrow). Adjust the TUNING control throughout its range, and verify that the dial calibrations are correct $\pm$ 1/3 octave. The curve should get sharper as the TUNING control is moved clockwise.

This concludes the performance test and verification.

2: MAINTENANCE AND SERVICE

Preventive Maintenance: The front panel may be cleaned with a mild household detergent. Stronger solvents should be avoided, as they may damage the paint, the silk-screened lettering, or the plastic control knobs.

WARNING!

DO NOT LET DETERGENT LEAK INTO THE SLOTS OF THE SLIDER CONTROLS. WHILE THESE CONTROLS ARE EQUIPPED WITH "BOOTS" TO MINIMIZE DUST PENETRATION, THEY ARE NOT MOISTURE-PROOF AND CAN BE DAMAGED BY CARELESSNESS.

The interior of the 672A should be kept free of dust and dirt, since dirt buildup inside the chassis can cause loss of cooling and can also cause high-resistance short-circuits if the dirt absorbs moisture from the air. It is particularly important in a dusty or humid environment that the covers be periodically removed and the interior of the chassis cleaned.

Access: The 672A employs a number of front-panel controls which are directly soldered to the PC board. In order to access the solder side of the PC board, these controls must be freed from the front panel. Because this procedure is tedious, all IC's are mounted in sockets. Replacement of an IC therefore does not require that the PC board be dismounted.

To dismount the board, remove all knobs. The knobs on the EQ sliders push on; the rotary knobs are affixed to the control shafts by means of two 0.050" hex (Allen) screws. When replacing these knobs, mechanical reliability will be enhanced if both screws are first fastened only moderately tightly. Then, each screw should in turn be "set" by tightening it down hard until the hex wrench stops turning. Then "stress" the screw for about one second by keeping up the pressure. This gives the crystal structure in the metal of the shaft sufficient time to accomodate itself to the stress, and assures that the screws will not come loose with time and wear.

After all knobs have been removed, remove the twelve screws holding the PC board to its mounting standoffs on the rear of the panel. The controls may now be cleared from their front-panel holes, and the PC board may be lifted out. Be sure not to overstress the connections to the power transformer or the barrier strip on the rear panel.

To reassemble the 672A, follow the above procedure in reverse. Center the controls in their openings before tightening down the PC board.

Replacement of Components on Printed Circuit Boards: It is important to use the correct technique for replacing components mounted on PC boards. Failure to do so will result in possible circuit damage and/or intermittent problems.

The circuit board used in the 672A Equalizer is of the double-sided plated-through variety. This means that there are traces on both sides of the board, and that the through-holes contain a metallic plating in order to conduct current through the board. Because of the plated-through holes, solder often creeps 1/16" up into the hole, requiring a sophisticated technique of component removal to prevent serious damage to the board.

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

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

Use the following technique to replace a component:

1) Use a 30 watt soldering iron to melt the solder on the solder (underneath) side of the PC board. Do not use a soldering gun or a high-wattage iron! As soon as the solder is molten, vacuum it away with a spring-actuated desoldering tool like the Edsyn "Soldapullt". AVOID OVERHEATING THE BOARD; overheating will almost surely damage the board by causing the conductive foil to separate from the board. Use a pair of fine needle-nose pliers to wiggle the lead horizontally until it can be observed to move freely in the hole.

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

3) Now lift the component out.

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

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

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

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

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

Exceptions are IC's used without feedback (as comparators) and IC's whose outputs have been saturated due to excessive input voltage because of a defect in an earlier stage. Also, be sure that the voltmeter is not interacting with these sensitive points and affecting the measured voltage. However, if an IC's (+) input is more positive than its (-) input, yet the output of the IC is sitting at -14 volts, this almost certainly indicates that it is bad. The same holds if the al polarities are reversed.

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

Factory Service

Please refer to the terms of your Orban Associates Limited One-Year Standard Warranty, which extends to the first end-user. This warranty was packed separately from the 672A and is not bound with this manual. 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. In all cases, transportation charges (which are usually quite nominal) shall be borne by the customer.

After a formal Return Authorization number is obtained from the factory, units should be shipped to CUSTOMER SERVICE at the address shown on the front page of this manual.

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

Shipping Instructions: If the original packing material is available, it should be used. Otherwise, a carton of at least 200 pounds bursting test and no smaller than 22" x 10" x 10" should be employed.

The 672A Equalizer should be packed so that there is at least 1-1/2" of packing material protecting every point. A plastic wrap around the chassis will protect the finish. Cushioning material such as Air-Cap, Bubble-Pak, foam "popcorn", or fibre blankets are acceptable. Folded newspaper is not suitable. Blanket-type materials should be tightly wrapped around the 672A Equalizer and taped in place to prevent the unit from shifting out of its packing and contacting the walls of the carton.

The carton should be packed evenly and fully with the packing material filling all voids such that the unit cannot shift in the carton. Test for this by closing but not sealing the carton and shaking vigorously. If the unit can be felt or heard to move, use more packing.

The carton should be well-sealed with 3" reinforced sealing tape applied across the top and bottom of the carton in an "H" pattern. Narrower or parcel-post type tapes will not stand the stresses applied to commercial shipments.

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

3: CIRCUIT DESCRIPTION

General: The circuitry is divisible into six major blocks. These are:

1) input buffer
2) equalizer
3) lowpass filter and output buffer
4) highpass filter and output buffer
5) overload indicator
6) power supply

These will be described in order.

Input Buffer: The signal enters the 672A in balanced form. C1, C2 shunt RF from the input leads to the chassis. These capacitors are not effective at VHF and higher frequencies; therefore, ferrite beads have been placed around the input and output leads to suppress such high frequency RF. It should be noted that this degree of RF-proofing is moderate but adequate for a 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 considerations familiar to the broadcast engineer may have to be used in conjunction with the 672A's built-in RF suppression.

The filtered signal is applied to IC1, a very low-noise opamp configured as a differential amplifier with a gain of 0.5. When both non-inverting and inverting inputs are driven by a source impedance which is small with respect to 100K (such as 600 ohms or less), the amplifier is essentially insensitive to signal components that appear equally on the non-inverting and inverting inputs (such as hum), and responds with full gain to the <u>difference</u> between the non-inverting and inverting inputs. Thus it serves as an "active transformer". Ordinarily, best results are obtained for unbalanced signals if the inverting input is grounded and the non-inverting input is driven. Note that high frequency common mode rejection is compromised by C3, which limits the amplifier bandwidth. This is not important, because full rejection is maintained for hum and buzz components.

The GAIN control is located <u>after</u> IC1. Therefore, IC1 will overload if its differential input exceeds approximately +26dBm. The OVERLOAD lamp will indicate this.

Equalizer Sections: The eight equalizer bands are all connected in a non-interacting "series-leapfrog" configuration. Each band requires two main-channel amplifiers. However, to save amplifiers, it is possible to use the <u>second</u> amplifier in an earlier band as the <u>first</u> amplifier in a later band, thus sharing one amplifier between two bands. This creates the "leapfrog" topology.

There are therefore nine main-channel amplifiers in the eight equalizer bands. These equalizer bands are essentially identical topologically, except that the first amplifier IC2 is a special low-noise type which is permitted to take 18dB of gain (thus making up for the 6dB loss in IC1 and yielding 12dB potential gain), and that the last amplifier IC15b is a summing amplifier which incorporates the EQ IN/OUT switch. All of the other amplifiers are unity gain when no equalization is taking place.

Because band 3 (IC4a, IC7b, IC6) is typical, we will discuss it below. The discussion is readily extended to the other bands by analogy.

Band 3 creates peak boost by passing the output of IC4a through a "quasi-parametric" bandpass resonator (IC6 and associated circuitry). The output of this resonator appears at the output of IC6a, and is added to the main signal in the next amplifier down the chain (IC7b) through half of the EQ control R33. Peak boost from band 3 thus appears at the output of IC7b.

Reciprocal cut is achieved by placing the bandpass resonator in the feedback loop of IC4a. The feedback signal is introduced to IC4a's inverting input through the other half of the EQ control R33. The two halves of R33 are isolated by means of a grounded center tap, so that no interaction between boost and cut functions occurs. Thus the peak cut function appears at the output of IC4a, and is passed to the equalizer output through the remaining amplifiers in the main audio path. Note that the full peak boost and cut functions for band 3 do not appear until the output of IC7b. Similarly, the full effect of band 2 appears at the output of IC4a, which drives the band 3 resonator. Thus band 3 is effectively in series with band 2, and no interaction between bands occurs despite the interleaved "leapfrog" topology.

At frequencies far from the equalization frequency, the gain of IC4a is -1, as determined by input resistor R32 and feedback resistor R34. C15 rolls off the supersonic response of IC4a in a controlled way to eliminate overshoot, supersonic ringing, and potential TIM.

We will now discuss the third resonator, which consists of IC6 and associated circuitry. The resonator is an active bandpass filter. Negative feedback is taken around IC6a through R41, R42; positive feedback is taken around IC6a through R39. The amount of positive feedback is determined by R40 (connected to AC ground: the output of IC6b), and by R36, R37 and R38 (the BANDWIDTH control). R36, R37 attenuate the signal entering the resonator such that the overall peak gain from the input of R36 to the output of IC6a is 0dB regardless of the settings of R38 (BANDWIDTH) and R43 (TUNING).

The output of IC6a is integrated by inverting integrator IC6b, R43, R44, C14, and is fed back to IC6a's non-inverting input through R40. This point is also connected to ground through C13. The frequency-selective properties of the integrator plus C13 force the output of IC6a to have a bandpass characteristic. Adjustment of R38 does not affect the center frequency of the bandpass characteristic. These various characteristics are not intuitively obvious, but can be demonstrated by a mathematical analysis of the resonator.

Because of the multiple feedback loops, troubleshooting the resonator is usually a cut-and-try affair. Replace IC6 first; if this does not solve the problem, the individual components must be removed and tested on an impedance bridge. Of course, the adjustable controls R38, R43 are the least reliable passive components, and should be investigated first. The fixed passive components are highly understressed, and failures are most improbable.

EQ IN/OUT Switch: The final summing amplifier associated with the band 8 equalizer (IC15b) can be switched from inverting (EQ IN) to non-inverting (EQ OUT) operation in order to maintain consistent input/output polarity as the EQ IN/OUT switch is operated. In EQ OUT mode, S1B disconnects the output of the equalizer section from IC15b. S1A disconnects the input of the band 1 bandpass resonator, thus defeating band 1 equalization but retaining IC2, with its 18dB gain. S1A simultaneously connects the output of IC2 to the non-inverting input of IC15b through voltage divider R113, R114. The overall gain of IC15b in either inverting or non-inverting modes is -4dB. This compensates for the 4dB gain in IC17b.

C30 eliminates any DC offsets which may have accumulated through the main equalizers. R111 assures that C30 does not build up a charge in OUT mode, which could cause a pop when the EQ IN/OUT switch was operated.

If the EQ IN/OUT switch is operated while program material is passing through the equalizer, a click may be heard because the program is interrupted for a few milliseconds while the switch is changing state.

Lowpass Filter: This filter consists of IC15a and associated components arranged in a "Sallen and Key" unity-gain positive feedback configuration. The filter characteristic is 12dB/octave Butterworth. The gain of IC15a is +1 in the flat part of its frequency range. The lowpass filter is also coupled to an inverting amplifier with 4dB of gain, and a discrete output stage which enables it to drive 600 ohm loads. This is the external LOWPASS FILTER OUTPUT.

For troubleshooting hints and a reference, see "Highpass Filter; Output Buffer" immediately below.

Highpass Filter; Output Buffer: The highpass filter consists of a "Sallen and Key" positive feedback active filter IC17b and associated circuitry. A discrete complementary-symmetry output stage is appended to IC17b to enable this IC to drive 600 ohm loads. IC17b exhibits 4dB non-inverting gain in its flat response region. This compensates for the gain loss in IC15b.

The filter is designed to provide a "second-order Butterworth" response with an ultimate slope of 12dB/octave. R122, R139 set the gain, and thus the "Q" of the filter. R117, R120, R121, C35, C36, C37, C38 determine the tuning and further affect the "Q". This group of components all interact. Therefore, the best way to troubleshoot the filter is:

a) Replace IC15 and/or IC17. If this does not cure the problem, then
b) Check the gain in the "flat" part of the filter's response curve. If this is not 4.03dB ±2%, R122, R139 are suspect. If this does not cure, then
c) Check the other passive components on an impedance bridge. In particular, the tracking of dual pot R117 is important to assure consistent "Q" as the filter is tuned. R117 is by far the most suspect component because it can wear and deteriorate in hostile environments.

For further details, see: (Tobey,G.E., Graeme,J.G., & Huelsman,L.P.: Operational Amplifiers: Design and Applications, pp.295-298 (New York, McGraw-Hill, 1971)).

The output transistors Q1, Q4 are operated as emitter followers in a class AB configuration. R123, R125 provide local DC feedback to stabilize the quiescent bias current through the output stage. The output stage is biased by diode-connected transistors Q2, Q3, which are thermally connected to their associated output transistors to provide thermal feedback which stabilizes the output stage against thermal runaway. Current limiting to short-circuit-protect the output stage is provided by CR27, CR28 in conjunction with R123, R125. When the voltage drop across R123, R125 exceeds the turn on voltage of its associated diode (about 0.55 volts), then the diode conducts, shunting the drive current away from Q1, Q4 and into the load, thus protecting Q1, Q4 from burnout.

IC17b, the driver, is loaded by R126, R127. The junction of R126 and R127 is bootstrapped to the current-booster stage output by C40, and thus looks to IC17b like a constant-current (infinite impedance) load. This reduces distortion in IC17b.

The output is connected to the outside world through the load-isolating, RF-suppression network R124, C41, C42. The output impedance of the equalizer is thus 47 ohms in parallel with 1000pF. When the optional output transformer is installed, R124 is omitted.

Overload Indicator: The output of each main-signal-path amplifier in the 672A is connected to its own pair of diodes CR7 - CR34. One diode is connected to a +10 volt bus (created by voltage divider R128, R119); the other diode is connected to a -10 volt bus (created by R131, R132). If the instantaneous output of any amplifier exceeds $\pm$10.6 volts, then the appropriate diode will conduct and couple a pulse onto one of the busses, which are relatively high impedance.

Positive-going overload pulses are fed into transistor inverter Q5 and appear at Q5's collector amplified and inverted so that they are negative-going. Negative going overload pulses are connected directly to Q5's collector. Thus any overload appears at Q5's collector as a negative-going pulse, and is coupled through C44 to IC16 and associated circuitry, connected as a one-shot multivibrator.

Ordinarily, IC16 is held OFF (pin 6 LOW) because R134 holds IC16's inverting input at a higher voltage than voltage divider R133, R136 holds its non-inverting input. A negative-going pulse transmitted through C44 pulls IC16's inverting input down, thus briefly switching IC16's output HIGH. This in turn pulls IC16's non-inverting input HIGH through R135, C45, and latches IC16's output HIGH until C45 can discharge through R133, R135, R136, which normally takes about 200 milliseconds. While IC16's output is HIGH, the OVERLOAD lamp is illuminated through R137 and Q6, connected as a Zener diode. Thus very fast overloads are "time stretched" and can be easily seen.
Under continuous overload conditions, it is normal for the OVERLOAD lamp to flash on and off.

Power Supply: Unregulated voltage is supplied by two pairs of full wave diode rectifiers CR1, CR3, and CR2, CR4 operating into a pair of energy storage capacitors C46, C47. The power transformer T1 is strappable for either 115 volt or 230 volt operation; the two sections of the primary are paralleled for 115 vol operation and connected in series for 230 volt operation.

The nominal unregulated voltage is $\pm$22 volts DC at rated line voltage. This will vary widely with line voltage variations. Regulator dropout will occur if the unregulated voltage falls below about $\pm$17.8 volts.

Regulated voltages are supplied by a pair of overrated 500mA "three terminal" IC regulators VR1, VR2. Because they are operated so conservatively, they can be expected to be extremely reliable. Therefore, 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 causing the regulator IC's to go either into current limiting or into thermal shutdown, their two built-in protective modes. If it becomes necessary to replace a regulator, be sure to replace its heat sink, and to securely insulate the regulators from each other by means of the fish paper included in the original assembly.

The regulators VR1 and VR2 are frequency-compensated by C48, C49 at their outputs to prevent high frequency oscillations. If C48 or C49 are ever replaced, be sure to use low-inductance aluminum electrolytics. Tantalums can fail because the current-delivering capacity of the power supply can cause a runaway condition if the dielectric is punctured momentarily; high-inductance aluminums can fail to prevent the regulators from oscillating. It is therefore necessary to check for oscillation on the power bus with an oscilloscope if C48 or C49 is replaced.

CR5, CR6 are connected from ground to each power bus in reverse polarity, and protect the rest of the circuitry from a fault condition that might otherwise cause a reverse polarity voltage on either power bus. In addition, small 0.05uF/25V ceramic capacitors bypass the power busses to ground locally throughout the board to prevent signal-carrying IC's from oscillating due to excessive power-lead inductance.

Appendix: Interconnections and Grounding

DRIVING THE 672A FROM HIGH-IMPEDANCE/ HIGH-LEVEL SOURCES

Small systems usually come together easily because cable runs are usually short and the interconnections between various pieces of equipment are not terribly complex. Therefore, do not be intimidated by the seeming complexity of the discussion on interconnections and grounding below. This is more information than most people will ever need to successfully install a small system; we have included it in case things don't work right and you need to find out why.

Both HI and LO sides of the 672A input are bypassed to chassis ground for RF through 1000pF capacitors. To assure common mode rejection, and to assure that these capacitors do not affect the frequency response of the system, the output impedance of the equipment driving the 672A should be 600 ohms or less. Most professional and semi-professional sound equipment will satisfy this requirement.

The 672A can be driven by unbalanced sources up to 10,000 ohms (such as the outputs of some vacuum tube preamps) by removing the 1000pF capacitor from the HI input, and driving this input from the hot side of the driving equipment's output. (See the section below on **Grounding** for an explanation of balanced and unbalanced connections.)

If the 1000pF capacitor is left in place, it will cause a high frequency rolloff which is 3dB down at 16kHz, and which rolls off at 6dB/octave thereafter.

The absolute clipping level of the 672A input is +26dBm. If such clipping occurs, it will cause the OVERLOAD lamp to flash on and off regardless of the setting of the GAIN control.

If levels greater than +26dBm are expected, an external loss pad must be used before the 672A input. The Audio Cyclopedia, Section 5, contains instructions for making such pads. (Tremaine, H.M.: The Audio Cyclopedia, Second Edition, Indianapolis, Howard W. Sams & Co., Inc., 1969).

GROUNDING

Grounding serves two purposes: it joins the ground references of various pieces of electronic equipment, and it shields the electronics from various electric fields (RFI and hum).

(Interference caused by magnetic fields is not decreased by conventional shielding, and special magnetic shielding materials must be used where hum is a problem. In audio, such shielding is ordinarily used with low-level magnetic transducers like tape heads, magnetic phono cartridges, and dynamic microphones, and with low-level transformers. Line-level equalizers such as the 672A are not normally sensitive to this sort of interference.)

There are two types of ground: circuit and chassis. Circuit ground serves as a ground reference for the electronics. Chassis ground permits use of the chassis as a shield in the same way that the shield on shielded cable protects the inner conductors. Whether the circuit and chassis grounds are identical, are separate, or are intentionally joined depends on the type of equipment and the interconnecting scheme.

In professional systems correct grounding is important. The general principles are these:

1) In an audio system, the chassis of each piece of equipment must be connected to a good common ground point (ideally a cold water pipe or a rod driven into the earth) by one and only one wire.

2) Meanwhile, there must be one and only one circuit ground path between each piece of equipment.

It is when these two requirements become confused, omitted, or redundant that problems develop. If there is a connection missing, hum and noise will result. If more than one ground path exists, then a "ground loop" may develop.

A ground loop can be viewed as a single turn of a giant transformer. Because 60Hz AC magnetic fields exist at every point served by mains power, the ground loop will have a hum current induced in it by stray AC magnetic fields. Because the ground wire has appreciable impedance, this current will cause a hum voltage to appear between different parts of the ground system. If great care is not taken, this hum voltage can intrude on the audio signal.
How grounding is accomplished depends on whether the equipment to be interconnected is balanced or unbalanced.

An unbalanced connection uses two terminals: "hot" and ground. Wires used in such connections are typically single-conductor shielded. (RCA plugs and two-conductor phone plugs are often used to terminate such cables.) If because of stray fields or ground loops, a hum voltage appears between "hot" and ground, then this hum will be mixed into the desired signal since the unbalanced connection cannot distinguish between the desired signal and hum.

In the case of balanced connections, audio is applied to the HI and LO terminals; the input responds to the difference between the voltages at the two terminals. A third terminal is connected to chassis ground and is available for the connection of the shield of the two-conductor shielded wire that would be used (Belden 8451, for example). If a hum voltage is developed between the shield and both audio wires, then the balanced input would reject this "common mode" voltage, since the input responds only to the difference in voltage between the audio wires. This ability to reject hum and noise is the primary advantage of a balanced configuration.

Referring back to the **ELECTRICAL INSTALLATION** section, notice how these rules are applied in the table and diagram.

For involved systems such as arena-type sound reinforcement, professional recording studios, or large broadcasting facilities, a formal and systematic "transmission ground system" should be worked out for the entire system. See Section 24 of The Audio Cyclopedia for details (op. cit.).

(Interesting digression: The "balanced" technique was first perfected by the telephone company, which has to run miles of unshielded cables close to each other and also to high voltage AC lines without pickup of excessive hum or crosstalk from other circuits. Originally, telephone circuits were unbalanced on single wires, with the earth providing the ground return. As soon as electric lighting became popular and power lines were placed on telephone poles, the power lines interfered with the telephone service so badly as to render conversation impossible. The telephone company embarked on a research program which led to both the balanced line technique, and to the choice of the familiar 600 ohm impedance as the optimum compromise between rejection of electrical and magnetic interference. Today, the telephone company's specification for maintenance of line balance is extremely tight, as proper common mode rejection is vital to the success of the entire system.)

REF DES	DESCRIPTION	ORBAN P/N	VEN (1)	VENDOR P/N	ALTERNATE VENDORS(1)	QUAN/ SYS.	NOTES
CAPACITORS							
C1,2	Ceramic Disc, 10%, 1000V, .001uF	21112-210	CRL	DD-102	MANY	6	
C3	Mica, 5%, 500V, 22pF	21020-022	CD	CD15-ED220J03	MANY	2	
C4	Same as C3						
C5	Tantalum, 10%, 15V, 22uF	21304-622	SPR	196D		4	
C6	Mica, ± .5pF, 500V, 10pF	21017-010	CD	CD15-CD100D03		3	
C7	Polyester, Radial, 100V, 10%, .82uF	21441-482	PLE	160		1	
C8	Polyester, Radial, 100V, 10%, .47uF	21441-447				1	
C10	Polyester, Radial, 100V, 10%, .39uF	21441-439				1	
C11	Polyester, Radial, 100V, 10%, .27uF	21441-427				1	
C13	Polyester, Radial, 100V, 10%, .15uF	21441-415				1	
C14	Polyester, Radial, 100V, 10%, .082uF	21441-382				1	
C16	Polyester, Radial, 100V, 10%, .068uF	21441-368				1	
C17	Polyester, Radial, 100V, 10%, .039uF	21441-339				1	
C19	Polyester, Radial, 100V, 10%, .033uF	21441-333				1	
C20	Polyester, Radial, 100V, 10%, .027uF	21441-327				1	
C22	Polyester, Radial, 100V, 10%, .015uF	21441-315				1	
C23	Polyester, Radial, 100V, 10%, .01uF	21441-310				1	
C25	Polyester, Radial, 100V, 10%, .0056uF	21441-256				1	
C26	Polyester, Radial, 100V, 10%, .0033uF	21441-233				1	
C28	Polyester, Radial, 100V, 10%, .0027uF	21441-227				1	
C29	Polyester, Radial, 100V, 10%, .0022uF	21441-222				1	
C30	Same as C5						
C31	Mica, 2%, 500V, 2000pF	21203-220	CD	CD19-FD202G03		1	
C32	Polystyrene Film, 2%, 50V, .02uF	21702-320	SPR	287P		1	
C33	Mica, 1%, 500V, 1000pF	21022-210	CD	CD19-FD102F03		1	
C34	Polystyrene Film, 2%, 50V, .01uF	21504-310	WI	FKP2		1	
C35	Polycarbonate, 2%, 50V, .15uF	21602-415	ECI	652A1A54G		2	
C36	Polystyrene Film, 2%, 50V, .015uF	21504-315	WE	104		2	
C37	Same as C35						
C38	Same as C36						
C39	Same as C6						
C40	Same as C5						
C41,42	Same as C1						
C43	Ceramic Disc, +80%, -20%, 50V, .005uF	21108-250	CRL	CK-502		2	
C44	Same as C43						
C45	Ceramic Disc, 20%, 25V, .15uF	21106-415	CRL	UK25-154		1	
C46	Aluminum, Axial, 40V, 470uF	21224-747	SIE	B41313-470/40/81000		2	
C47	Same as C46						
C48	Aluminum, Radial, 25V, 22uF	21206-622	SPR	502D		2	
C49	Same as C48						
C50-53	Ceramic Disc, 20%, 25V, .05uF	21106-350	CRL	UK25-503		20	
C54	Same as C6						
C55	Same as C5						
C56,57	Same as C1						
C58-73	Same as C50						

FOOTNOTES:

(1) See last page for abbreviations
(2) No Alternate Vendors known at publication
(3) Actual part is specially selected from
(4) Realignment may be required if replaced, see Circuit Description and/or Alignment Instructions

SPECIFICATIONS AND SOURCES FOR REPLACEMENT PARTS
EQUALIZER MODEL 672A
Rev. 07 11/85

REF DES	DESCRIPTION	ORBAN P/N	VEN (1)	VENDOR P/N	ALTERNATE VENDORS(1)	QUAN/ SYS.	NOTES
DIODES							
CR1-6	Rectifier, 1N4004	22201-400	MOT	1N4004		6	
CR7	Signal, 1N4148	22101-000	FSC	1N4148		26	
CR8-28	Same as CR7						
CR31-34	Same as CR7						
INTEGRATED CIRCUITS							
IC1	Lin, Single Opamp, 5534	24014-202	SIG	NE5534N		2	
IC2	Same as IC1						
IC3	Lin, Dual Opamp, 4558	24202-202	RAY	RC4558NB		7	
IC4	Lin, Dual Opamp, TL072	24206-202	TI	TL072CP		6	
IC5	Same as IC3						
IC6	Same as IC3						
IC7	Same as IC4						
IC8	Same as IC3						
IC9	Same as IC3						
IC10	Same as IC4						
IC11	Same as IC3						
IC12	Same as IC3						
IC13	Same as IC4						
IC14	Lin, Dual Opamp, 5532	24207-202	SIG	NE5532N		1	
IC15	Same as IC4						
IC16	Lin, Single Opamp, 741C	24002-402	NAT	LM741CH		1	
IC17	Same as IC4						

RESISTORS

ALL COMMON RESISTORS NOT LISTED ARE GENERALLY SPECIFIED THUS:

Replace resistors only with the same style and with the exact value as marked on the resistor body, lest performance or stability be compromised. If the resistor is damaged, consult the factory or refer to the Schematic to obtain the value.

Metal Film Resistors

Body: conformally-coated
I.D.: five color bands or printed value
Orban P/N: 20040-XXX
Power Rating: 1/8 Watt @ 70°C
Tolerance: 1%
Temperature Coefficient: 100 PPM/°C
U.S. Military Spec.: MIL-R-10509, Style RN55D
Manufacturers: R-Ohm(CRB-¼FX), TRW/IRC, Beyschlag, Dale, Corning, Matsushita

Carbon Composition Resistors

Body: molded phenolic
I.D.: four color bands
Orban P/N: 20011-XXX
Power Rating: (70°C) ¼ Watt (Body 0.090" x 0.250")
½ Watt (Body 0.140" x 0.375")
Tolerance: 5%
U.S. Military Spec.: MIL-R-11, Style RC-07 (¼W) or RC-20 (½W)
Manufacturers: Allen-Bradley, TRW/IRC, Stackpole, Matsushita

FOOTNOTES:
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SPECIFICATIONS AND SOURCES FOR REPLACEMENT PARTS
EQUALIZER MODEL 672A
Rev. 07 11/85
DIODES, INTEGRATED CIRCUITS, RESISTORS

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

RESISTORS, Cont'd

Carbon Film Resistors

Body: conformally-coated
I.D.: four color bands
Orban P/N: 20001-XXX
Power Rating: ¼ Watt @ 70°C
Tolerance: 5%
Manufacturers: R-Ohm (R-25), Piher, Beyschlag,
Dale, Phillips, Matsushita

REF DES	DESCRIPTION	ORBAN P/N	VEN (1)	VENDOR P/N	ALTERNATE VENDORS (1)	QUAN/ SYS.	NOTES
R5	Pot, Single, CW Log, 5K	20731-000	CTS	270-SERIES		1	
R7	Pot, Slide, Lin, 25K	20749-000	NOB	VJ6012-2PVN20D1-BM25KΩ		8	
R13	Pot, Single, CCW Log, ±10%, 100K	20730-000	CTS	270-SERIES		16	
R16	Same as R13						
R20	Same as R7						
R25	Same as R13						
R29	Same as R13						
R33	Same as R7						
R38	Same as R13						
R43	Same as R13						
R46	Same as R7						
R51	Same as R13						
R56	Same as R13						
R59	Same as R7						
R64	Same as R13						
R69	Same as R13						
R72	Same as R7						
R77	Same as R13						
R82	Same as R13						
R85	Same as R7						
R90	Same as R13						
R95	Same as R13						
R98	Same as R7						
R103	Same as R13						
R108	Same as R13						
R116	Pot, Dual, CCW Log, 50K/50K	20729-000	CTS	270-SERIES		2	
R117	Same as R116						

SWITCHES

REF DES	DESCRIPTION	ORBAN P/N	VEN (1)	VENDOR P/N	ALTERNATE VENDORS (1)	QUAN/ SYS.	NOTES
S1	Toggle, DPDT, PCB MOUNTING	26050-002	CK	7201-SERIES		1	
S2	Toggle, DPDT, PCB MOUNTING	26050-003	CK	7201-SERIES		2	
S3	Toggle, SPDT, PCB MOUNTING	26050-001	CK	7201-SERIES		2	
S4	Same as S2						
S5	Same as S3						

FOOTNOTES:

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(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

REF DES	DESCRIPTION	ORBAN P/N	VEN (1)	VENDOR P/N	ALTERNATE VENDORS(1)	QUAN/ SYS.	NOTES
TRANSISTORS							
Q1	Signal, NPN	23202-101	FSC	2N4400		6	
Q2	Same as Q1						
Q3	Signal, PNP	23002-101	FSC	2N4402		4	
Q4	Same as Q3						
Q5-8	Same as Q1						
Q9,10	Same as Q3						
VOLTAGE REGULATOR							
VR1	IC, P.S. Regulator, +15V	24304-901	FSC	uA78M15UC		1	
VR2	IC, P.S. Regulator, -15V	24303-901	FSC	uA79M15AUC		1	
MISCELLANEOUS							
Chassis							
J1,2,3	Connector, Jack, Stereophone	27078-000	SWC	12B		3	
F1	MSE, Fuse, 3AG, Sloblo, 1/8A	28004-113	LFE	313.125		1	
T1	Power Transformer, 38 VCT, 3.1 VA	29005-000	ORB	38VCT, 3.1VA		1	
L1,2	MSE, Inductor, 1mH, 160mA	29502-000	MIL	4662		2	
	Line Cord, 3 wire, UL	28101-000	ELECTRICORD	C-2103-076-GY			
Front Panel							
CR30	LED, Red	25103-000	FSC	FLV-150		1	
CR29	LED, Green	25104-000	FSC	FLV-350		1	
S6	Toggle Switch, AC Power, SPST	26002-001	CH	8280K21C		1	
Optional Parts on Motherboard							
C9	Cap, Mica, 500V, 10pF, $\pm$.5pF	21017-010	CD	CD15-CD100D03			
C12	Same as C9						
C15	Same as C9						
C18	Same as C9						
C21	Same as C9						
C24	Same as C9						
C27	Same as C9						
Other							
	Stiffener, Slide Pot	50084-000	ORB			2	
	Socket, IC, 8 Pin DIP	27149-000	TI	C93-08-02		17	
	Heatsink, Voltage Regulator	16005-001	WAKEFIELD	291-H-8-AB		2	
	Heatsink, Output Transistors	16002-000	WAKEFIELD	256-DM		4	

P/L REVISIONS

06015-000-04 FINAL ASSEMBLY
30125-000-06 PCB ASSEMBLY

FOOTNOTES:

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SPECIFICATIONS AND SOURCES FOR REPLACEMENT PARTS
EQUALIZER MODEL 672A
Rev. 07 11/85
MISCELLANEOUS

Vendor Codes

AB Allen-Bradley Co.
1201 South Second Street
Milwaukee, WI 53204

AD Analog Devices, Inc.
Route 1, Industrial Park
P.O. Box 280
Norwood, MA 02062

AM Amphenol North America
An Allied Company
2122 York Road
Oak Brook, IL 60521

BEK Beckman Instruments, Inc.
Helipot Division
2500 Harbor Blvd.
Fullerton, CA 92634

BEL Belden Corporation
Electronic Division
Richmond, IN 47374

BRN Bourns, Inc.
Trimpot Products Division
1200 Columbia Avenue
Riverside, CA 92507

BUS Bussmann Manufacturing Div.
McGraw-Edison Company
P.O. Box 14460
St. Louis, MO 63178

CD Cornell-Dubilier Electronics
150 Avenue "L"
Newark, NJ 07101

CK C & K Components, Inc.
15 Riverdale Avenue
Newton, MA 02158

CRL Centralab, Inc.
A North American Company
5757 North Green Bay Ave.
Milwaukee, WI 53201

COR Corcom, Inc.
1600 Winchester Road
Libertyville, IL 60048

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

ECI Electrocube
1710 South Del Mar Avenue
San Gabriel, CA 91776

ERE Erie Tech. Products, Inc.
644 West Twelfth Street
Erie, PA 16512

EXR Exar Integrated Systems, Inc.
P.O. Box 62229
Sunnyvale, CA 94088

FDY F-Dyne Electronics Company
449 Howard Avenue
Bridgeport, CT 06605

FSC Fairchild Camera & Instr. Corp.
464 Ellis Street
Mountain View, CA 94042

GI General Instruments
Optoelectronics Div.
3400 Hillview Avenue
Palo Alto, CA 94304

HP Hewlett-Packard Corporation
1501 Page Mill Road
Palo Alto, CA 94304

INS Intersil, Inc.
10710 North Tantau Avenue
Cupertino, CA 95014

IRC TRW/IRC Resistors
401 North Broad Street
Philadelphia, PA 19108

LFE Littelfuse
A Subsidiary of Tracor
800 East Northwest Highway
Des Plaines, IL 60016

MAL Mallory Timers Company
Emhart Electrical/Electronic Gr.
3029 East Washington Street
Indianapolis, IN 46206

ME Mepco/Electra, Inc.
Columbia Road
Morristown, NJ 07960

MIL J.W. Miller Division
Bell Industries
19070 Reyes Avenue
P.O. Box 5825
Compton, CA 90221

MOT Motorola, Inc.
P.O. Box 20912
Phoenix, AZ 85036

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

NOB Noble
Teikoku Tsushin Kogyo Co. Ltd.
335, Kariyado, Nakahara-ku
Kawasaki 211, JAPAN

OHM Ohmite Manufacturing Company
A North American Philips Co.
3601 Howard Street
Skokie, IL 60076

ORB Orban Associates, Inc.
645 Bryant Street
San Francisco, CA 94107

PAK Paktron
Div. of Illinois Tool Works Inc.
900 Follin Lane, S.E.
Vienna, VA 22180

PAN Panasonic
Electronic Components Div.
P.O. Box 1503
Seacaucus, NJ 07094

RAY Raytheon Semiconductor Division
350 Ellis Street
Mountain View, CA 94042

RCA RCA Solid State Division
Route 202
Somerville, NJ 08876

SAE Stanford Applied Eng.
3520 De La Cruz Blvd.
Santa Clara, CA 95050

SCH ITT Schadow, Inc.
8081 Wallace Road
Eden Prairie, MN 55343

SIE Siemens
Components Division
186 Wood Avenue, South
Iselin, NJ 08830

SIG Signetics Corporation
A Sub. of US Philips Corp.
P.O. Box 9052
Sunnyvale, CA 94086

SPR Sprague Electric Co
125 Marshall Street
North Adams, MA 01247

STK Stackpole Components Co
P.O. Box 14466
Raleigh, NC 27620

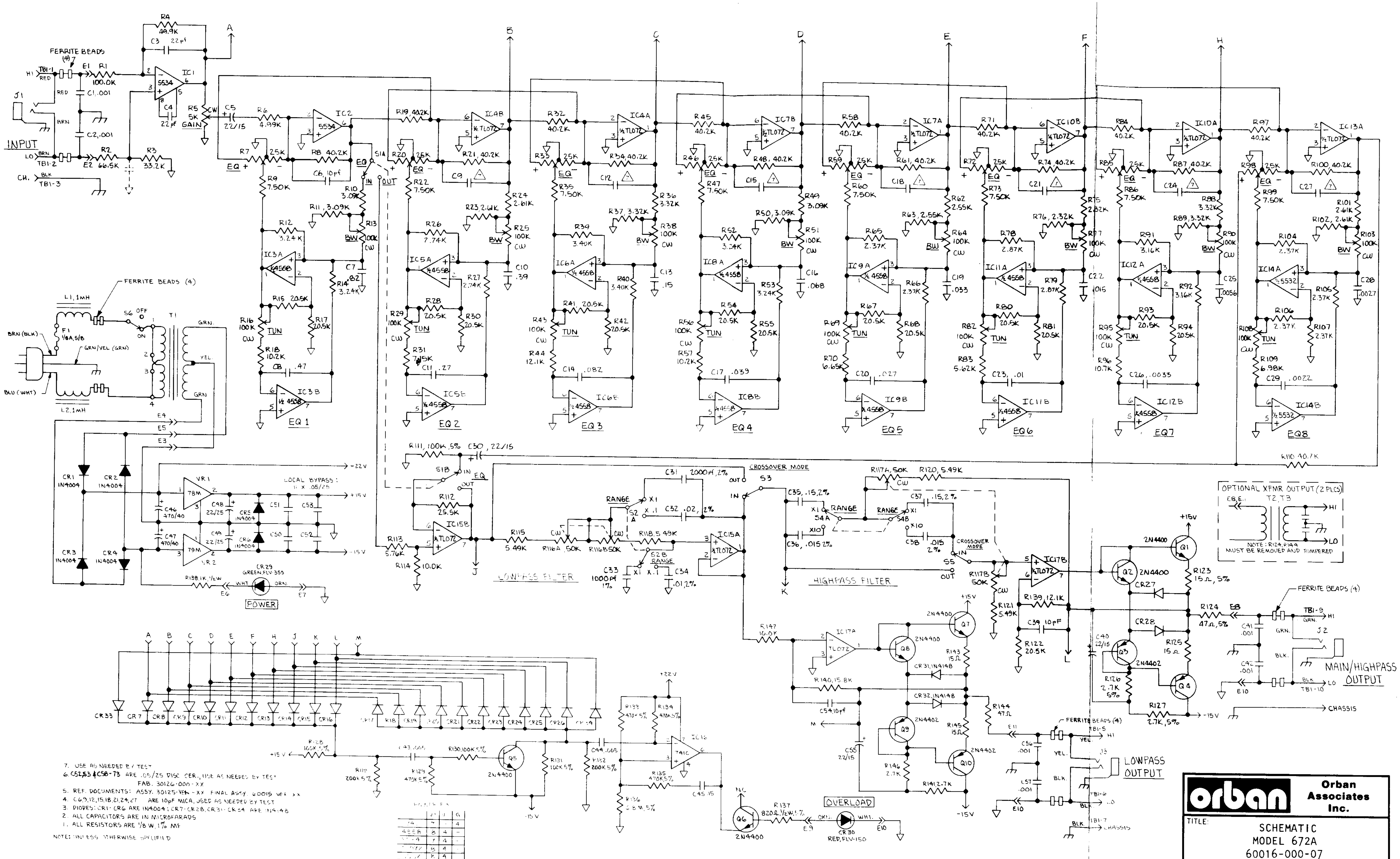
SUL Sullins Elec. Corp.
P.O. Box 757
San Marcos, CA 92069

SYL Sylvania Conn. Prod. Op.
GTE Products Corp.
Box 29
Titusville, PA 16354

TI Texas Instruments
P.O. Box 225012
Dallas, TX 75265

WES Westlake
5334 Sterling Ctr Drive
Westlake Village, CA 91361

WIM WIMA
P.O. Box 2345
Augusta-Anlage 56
D-6800 Mannheim 1
GERMANY



7. USE AS NEEDED BY TEST
6. C52,53 & C58-73 ARE .05/25 DISC CER., USE AS NEEDED BY TEST
FAB. 30126-000-XX
5. REF. DOCUMENTS: ASSY. 30125-VER-XX FINAL ASSY. 60015 VER XX
4. C6,9,12,15,18,21,24,27 ARE 10pF MICA, USED AS NEEDED BY TEST
3. DIODES: CR1-CR6 ARE IN4004; CR7-CR28, CR31-CR34 ARE IN4148
2. ALL CAPACITORS ARE IN MICROFARADS
1. ALL RESISTORS ARE 1/8 W, 1% MF

NOTE: UNLESS OTHERWISE SPECIFIED

orban

Orban Associates Inc.

TITLE: SCHEMATIC MODEL 672A 60016-000-07