Operating Manual

The Co-Operator

Gated Leveler/Compressor/High-Frequency Limiter/Peak Clipper

Model 464A

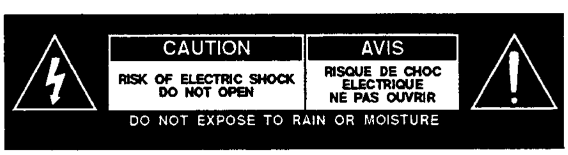
orban®

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

Model Number:	**Description:**
464A/U	CO-OPERATOR Level Control System, 2 ch 115V
464A/E	CO-OPERATOR Level Control System, 2 ch 230V

OPTIONS:

Model Number:	**Description:**
SC1	Security Cover (CLEAR, BLUE, or WHITE)



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

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

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

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

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The Co-Operator

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Model 464A

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This Orban product has been manufactured by AKG Acoustics, Inc.

This manual is part number 95059-000-03
300 - FB - 1/93

orban
a division of AKG Acoustics, Inc.

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Orban 464A

The Co-Operator

Operating Manual

page contents

1-1 Section 1: Introduction
- Orban's Co-Operator
- Applications
- Registration, Warranty, Feedback

2-1 Section 2: Installation
- Installation and Set-up
- Level-matching

3-1 Section 3: Operation
- Controls and Meters
- Recommended Control Settings
- More About Co-Operator Audio Processing

4-1 Section 4: Maintenance
- Routine Maintenance
- Getting Inside the Chassis
- Performance Evaluation

5-1 Section 5: Troubleshooting
- Problems and Possible Causes
- Technical Support, Factory Service

6-1 Section 6: Technical Data
- Specifications
- Circuit Description
- Parts List, Schematics, Assembly Drawings
- Abbreviations

INDEX on next page

Index

abbreviations 6-26
accessories 2-13, 6-2
applications 1-4
assembly drawings 6-20
audible distortion 3-8, 5-3
audio
  connections 2-5
  input 2-5
  output 2-5
  tape recorder 3-4, 3-10
audio/video production 1-4
automatic gain control (AGC) 3-8
average modulation, increasing 2-10

balanced inputs 2-7
balanced output transformer 2-7,8
bargraph driver 6-9, 6-12
bi-amped systems 1-4, 3-7
block diagram 6-21
buzzes 5-2

cable shielding 2-5, 2-7
cassette duplication 1-4, 3-6
chassis, getting inside 4-2
chassis ground 2-7
circuit boards
  access to 4-2
  front panel 4-2
circuit description 6-4
circuit ground 2-7
clicks 5-2
clipper-defeat jumper 2-2, 2-9
clipping 2-10, 3-10
  bias 2-10, 3-4, 5-3, 6-10
  increasing 2-10, 5-3
  level calibration 2-11
  transient 3-8
common-mode rejection 2-7
component
  numbering system 6-4
  vendors 6-19
compression 3-8, 6-8
connectors, audio 2-5
constant-directivity horns 1-4
controls 3-2
control settings 3-4
  BetaCam/MII VCR 3-5
  broadcast cart machine 3-5
  broadcast transmission 2-12, 3-4
  cassette duplication 3-6
  FM subcarriers 2-12, 3-6
  Quad VTR 3-5
  satellite uplink 3-5
  sound system protection 3-7
  STL protection 2-12, 3-4
  type B VTR 3-5
  type C VTR 3-5
  U-Matic VCR 3-6
covers, removing/replacing 4-2
customer service 5-3

dBu (definition) 4-5, 6-26
de-essing 3-9
distortion 3-8, 5-3, 6-6
dual mode 3-10

factory service 5-4
FM subcarrier generators 1-5
  protection 2-9
front panel 1-2, 3-2
fuse 2-4, 6-2

gain reduction 3-8
  meter 3-8, 6-8
gating 3-8, 5-2, 6-8
  control circuits 4-3
grounding 2-6,7, 5-2
  difficult situations 2-8
  ground loop 2-7,8

harshness 5-2
high-frequency
  limiter 3-9, 4-3, 6-10
  pre-emphasis 3-9
  saturation 1-4
high-SPL environments 1-4
hum 5-2

impedance 2-5
input
  attenuator 3-8, 6-5
  balanced 2-7
  buffer 6-5
  impedance 2-5
  level 2-5, 6-8
  stages 4-3
  overload point 2-5
  unbalanced 2-8
installation 2-1
  FM broadcast 2-9

jumpers
  access to 4-2
  positions 2-3

leveling 3-8, 6-8
loudness 3-4, 3-8

maintenance, routine 4-2
meters 3-2, 4-3, 6-8, 6-11
  calibration 2-10, 2-14, 6-11
  red zone 3-8

nastinesses, various 3-8
noise rush-up, pumping 3-8, 5-2

options 2-13, 6-2
ordering parts 6-13
output
  impedance 2-5
  level 2-5
    matching to load 2-14
  stages 4-3
  unbalanced load 2-5
overheating, thermal failure 1-4
overshoot 5-2

packing for shipment 5-4
parts list 6-13
peak
  clippers 5-2
  control 5-2, 6-10
  level 3-8
  overload point of load 2-15
    analog tape recorders 2-15
    audio power amplifiers 2-15
    USA-standard phone lines 2-15
  output level meter 6-11
    calibration 2-10, 2-14
performance evaluation 4-3
phone jacks 2-5
physical dimensions 6-2
power
  cord 2-4
  requirements 6-2
  supplies 4-3, 5-2, 6-12

pre-emphasis 3-9,10, 5-2, 6-10
  jumper 2-2, 2-9
  LF/HF drivers 3-10
problems 5-2
product features 1-3

rack-mounting unit 2-4
rear panel 1-2
recording studios 1-4
registration card 1-6
regulated voltage 6-12
regulator dropout 6-12
release shape 3-8,9, 6-8
release time 3-8, 6-8
retrofit kit 6-2
return authorization 5-4
RF suppression 5-2, 6-5
ringing 5-2

SCA channels 1-5
schematics 6-20
security cover 2-13, 6-2
service 5-4
shipping
  damage 2-2
  instructions 5-4
shrillness 5-2
sound systems 1-4, 3-7
specifications 6-2
stereo mode 3-10
STL protection 1-5, 2-9
swept sine wave tests 3-10, 6-10

tape 3-10
technical support 5-3
thumps 6-6
tilt 5-2
timing module 6-8
transmitter
  pre-emphasis 2-9
  protection 2-9
troubleshooting 5-1

unbalanced input 2-8
unbalanced load 2-5
unregulated voltage 6-12
user feedback 1-6

VCAs 4-3, 6-6
voltage regulators 5-2, 6-12

warranty 1-6

XLR connectors 2-5

Section 1
Introduction

page	contents

1-3 The Orban Co-Operator
1-2 Fig. 1-1: Front and Rear Panels

1-4 Applications

1-6 Registration, Warranty, Feedback

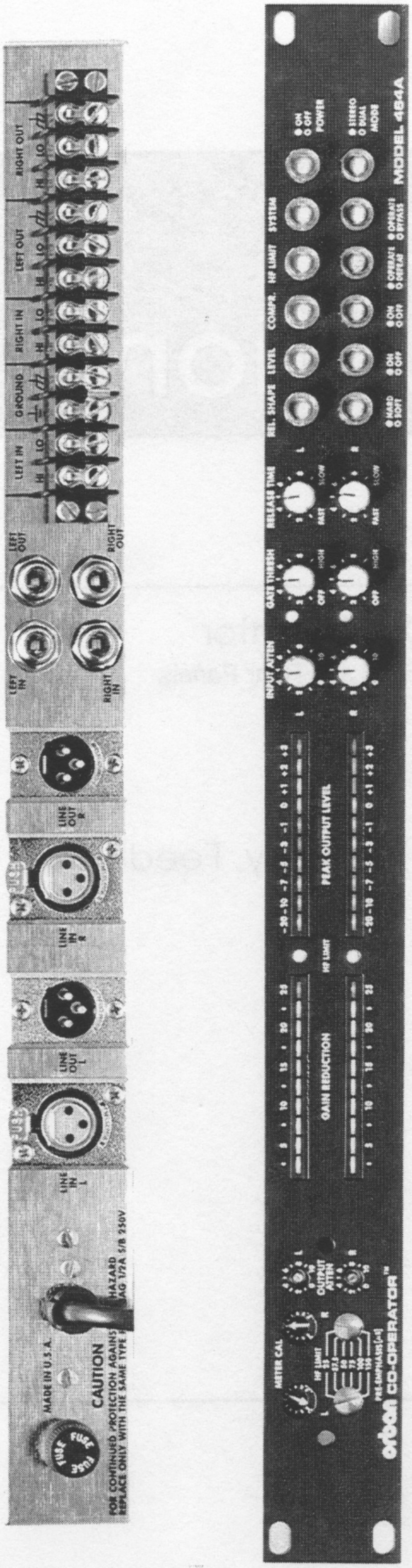


Fig. 1-1: Front and Rear Panels

The Orban Co-Operator

The Orban Model 464A Co-Operator™ Leveler/Compressor/HF Limiter is an integrated automatic gain control (AGC) device of the highest professional quality. The Co-Operator is a friendly, automatic "assistant operator" that smoothly and unobtrusively rides gain, controls high-frequency levels, and limits peaks.

The Co-Operator achieves its outstandingly transparent audio performance through the use of finely-tuned control loops which eliminate the dynamic distortions that are the downfall of most conventional compressors and limiters, and through the use of a clean, class-A proprietary VCA to ensure negligible static distortion and noise.

- A smooth leveler function provides transparent gain riding — without long-term distortion-producing overshoots.
- A faster "compression" function can be switched in to provide additional transient overshoot protection for material with abrupt level changes or unusually high peak-to-average ratios. The compression function is available without leveling for applications that require safety limiting only.
- Release time and release shape are adjustable to optimize processing for music or voice.
- A defeatable "silence gate" prevents noise rush-up, holes, pumping, and breathing by inhibiting sudden gain increases once the signal level falls below a preset threshold (during pauses or low-level program material).
- Six switchable HF limiter pre-emphasis/de-emphasis curves (25 to 150μs) allow the HF limiting to react optimally for the medium or device being protected and guard against excessive sibilance.
- A defeatable clipper follows the HF limiter for absolute peak protection.
- Either stereo-tracking or independent two-channel operation can be selected.
- The least-used controls are concealed behind a security panel to avoid confusing non-technical operators, and to permit tamper-proof calibration.
- Two LED bargraphs per channel simultaneously display gain reduction and peak output levels.
- Output level meter can be calibrated to match the overload point of the device being driven.
- Balanced, floating inputs and outputs are EMI-suppressed; the Co-Operator is compatible with the levels and impedances found in both professional and semi-professional applications.
- 25dB gain reduction range is achieved with a low-distortion, class-A VCA.
- Two channels packaged in a space-saving, rugged, all-metal, 1¾-inch chassis.
- Hard-wired bypass switch is included.

Applications

The flexibility and natural sound of the Co-Operator are ideally suited to recording studio, sound reinforcement, broadcast, motion picture, and video sound applications. The defeatable high-frequency limiter can be used to prevent pre-emphasized material from overloading tape recorders, disk cutters, high-frequency drivers in sound systems, broadcast STLs (studio-transmitter links), FM SCAs ("subsidiary communications authorization"), and for controlling cassette masters which have excessive high-frequency energy. Controlling high-frequency energy permits average recording or transmission levels to be increased, yielding improved signal-to-noise ratios.

Recording Studios

With the RELEASE SHAPE control set to SOFT, the Co-Operator will subtly reduce the dynamic range of an entire mix. The HARD setting provides effective gain riding on single tracks, increasing "punch" and intelligibility while retaining the basic feel of the performance and the apparent dynamic range of the voice or instrument. The RELEASE TIME control is useful in governing the uniformity of loudness in the final result.

Audio and Video Production

The Co-Operator can be used to protect VTRs, ATRs, or cart machines from overload during transfer. On mic channels the Co-Operator's smoothness and silence-gating guarantee uniform, punchy voice quality without noise rush-up during pauses.

Cassette Duplication

Even with the latest advancements, such as "hot" tape and Dolby® HX Pro, there are still some masters which can cause high-frequency saturation in cassette dupes. The Co-Operator's high-frequency limiter can be set to eliminate problems caused by synthesizers, cymbals, and sibilance, while still permitting high average modulation on the cassette. The broadband AGC/leveler can be defeated to permit use of the HF limiter alone when automatic gain riding or broadband peak protection is not desired.

Sound Systems

The Co-Operator provides colorless protection for your system — whether it be a fixed installation or traveling PA. For example, in an unattended bi-amped system, the slow AGC leveler can efficiently ride gain while the faster compressor protects the system from abrupt increases in level.

Placed after the mixer and equalizer and before an active two-way crossover, the Co-Operator will protect power amps from excessive clipping and high-frequency drivers from thermal overload.

Especially with constant-directivity horns, the selectable pre-emphasis of the HF Limiter can protect the horn from the boost that is required to compensate for the constant-power high-end roll-off. When horns and drivers are located 75 feet in the air, this becomes critically important. The Co-Operator guards against overheating and subsequent thermal failure.

In an attended bi-amped system, the Co-Operator can be placed *after* an electronic crossover. The two channels of the unit are arranged to separately feed the power amps for LF and HF drivers. In this application the leveler is defeated (so it does not fight with the mixing engineer), leaving the compressor, high-frequency limiter, and peak clipper to guard the system from overload. In particularly high-SPL environments, the compressor may be uncoupled so that each channel of the Co-Operator can operate independently to deliver the maximum level to each driver without distortion.

Similarly, the Co-Operator's controlled clipping avoids clipping of the power amplifier, which can cause "sticking", instability, and other audible problems.

Broadcast Studio/Transmitter Link Protection

The STL is often the weak link in the broadcast chain due to barely adequate signal-to-noise ratio. Clean protective limiting ahead of the pre-emphasized STL transmitter helps maximize the signal-to-noise ratio at the receiver and prevents overload. The selectable pre-emphasis ensures matching of the high-frequency limiting function to the STL's overload characteristic.

FM Subcarriers

Voice or music SCA channels are typically pre-emphasized at 150μs. In addition to providing transparent gain riding and level control for the subcarrier, the Co-Operator can also provide the rarely found 150μs HF limiting function, which permits more efficient use of the SCA channel by eliminating overmodulation on HF peaks.

See Section 3 for specific information on setting the controls for your application.

Registration, Warranty, Feedback

Registration Card

There are two good reasons for returning the Registration Card shipped with this product:

1) It enables us to inform you of new applications, performance improvements, and service aids which may be developed, and

2) It helps us respond promptly to claims under warranty without having to request a copy of your bill of sale or other proof of purchase.

Please fill in the Registration Card and send it to us today. If it is lost (or you have purchased this unit used), please photocopy the duplicate below, fill it in, and send it to Orban at the address on the inside of the front cover.

Registration Card

Model # ____________ Serial # ____________________________ Purchase Date ______________

Your name ____ Title ______________________

Company ____ Telephone __________________

Street ____

City, State, Mail Code (Zip), Country ____

Nature of your product application ____

How did you hear about this product? ______________________ Purchased from ____________

Comments ____

____

Which magazines do you find the most useful to your job?

___ Audio	___ Broadcast Engineering	___ Broadcast	___ dB Magazine
___ Electronic Musician	___ EQ	___ Millimeter	___ Mix
___ Post	___ Pro Sound News	___ Radio & Records	___ Radio World
___ RE/P	___ Sound & Communications	___ S & VC	___ TV Broadcast
___ TVTech	___ ________________	___ ________________	
95101-000-07 1/91	___ ________________	___ ________________	

Warranty

The warranty, which can be enjoyed only by the first end-user of record, is stated on the separate Warranty Certificate packed with this manual. Save it for future reference. Details on obtaining factory service are provided on page 5-4.

User Feedback Form

We are very interested in your comments about this product. Your suggestions for improvements to either the product or the manual will be carefully reviewed. A postpaid User Feedback Form is provided in the back of this manual for your convenience. If it is missing, please write us at the address on the inside of the front cover. Thank you.

Section 2
Installation

page contents

2-2 Installation — Most Applications

2-3 Fig. 2-1: Pre-Emphasis and Clipper Defeat Jumpers

2-5 Fig. 2-2: AC Power Cord Color Code

2-5 Audio Wiring, Connectors, Levels

2-7 Grounding: Power, Audio, Difficult Situations

2-6 Fig. 2-3: Some Possible Grounding Schemes

2-9 Installation — FM Transmitter, STL, Subcarrier Generator Protection

2-14 Matching Output Level to Device Being Driven

CAUTION

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

Installation — Most Applications

Allow about 20 minutes for installation.

If you will be using the Co-Operator to **protect an FM transmitter, STL, or subcarrier generator** use the "Installation — FM Transmitter, STL, Subcarrier Generator Protection" instructions on page 2-9.

Installation consists of unpacking and inspecting the Co-Operator, optional resetting of clipper-defeat and pre-emphasis jumpers, mounting the Co-Operator in a rack, then connecting audio and power.

1) Unpack and inspect.

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

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

Packed with the Co-Operator are:

1	Warranty Certificate
1	Registration Card
1	Operating Manual

2) Reposition clipper-defeat and pre-emphasis jumpers. (optional)

A list of recommended jumper positions for various applications begins on page 3-4.

If you want to reposition these jumpers, you will need to remove the top cover of the Co-Operator to access the main circuit board. Remove all screws holding the cover in place, then lift it off. When replacing the cover, replace all screws snugly. (Be careful not to strip the threads by fastening the screws too tightly.)

a) If you want to enable the peak clippers, reposition jumper A on the main circuit board to the "OPERATE" position (see Fig. 2-1).

The Co-Operator is shipped with this jumper in the "DEFEAT" position. In general, the clippers should only be activated if the device being driven has an absolute peak overload point (a broadcast transmitter, for example). The HF LIMIT buttons must be set to OPERATE for the peak clippers to be active.

b) If you want a pre-emphasized output, reposition jumpers B and C on the main circuit board to the "PRE-EMPHASIZED" position (see Fig. 2-1).

The HF LIMIT PRE-EMPHASIS switches determine the pre-emphasis curve that will be used.

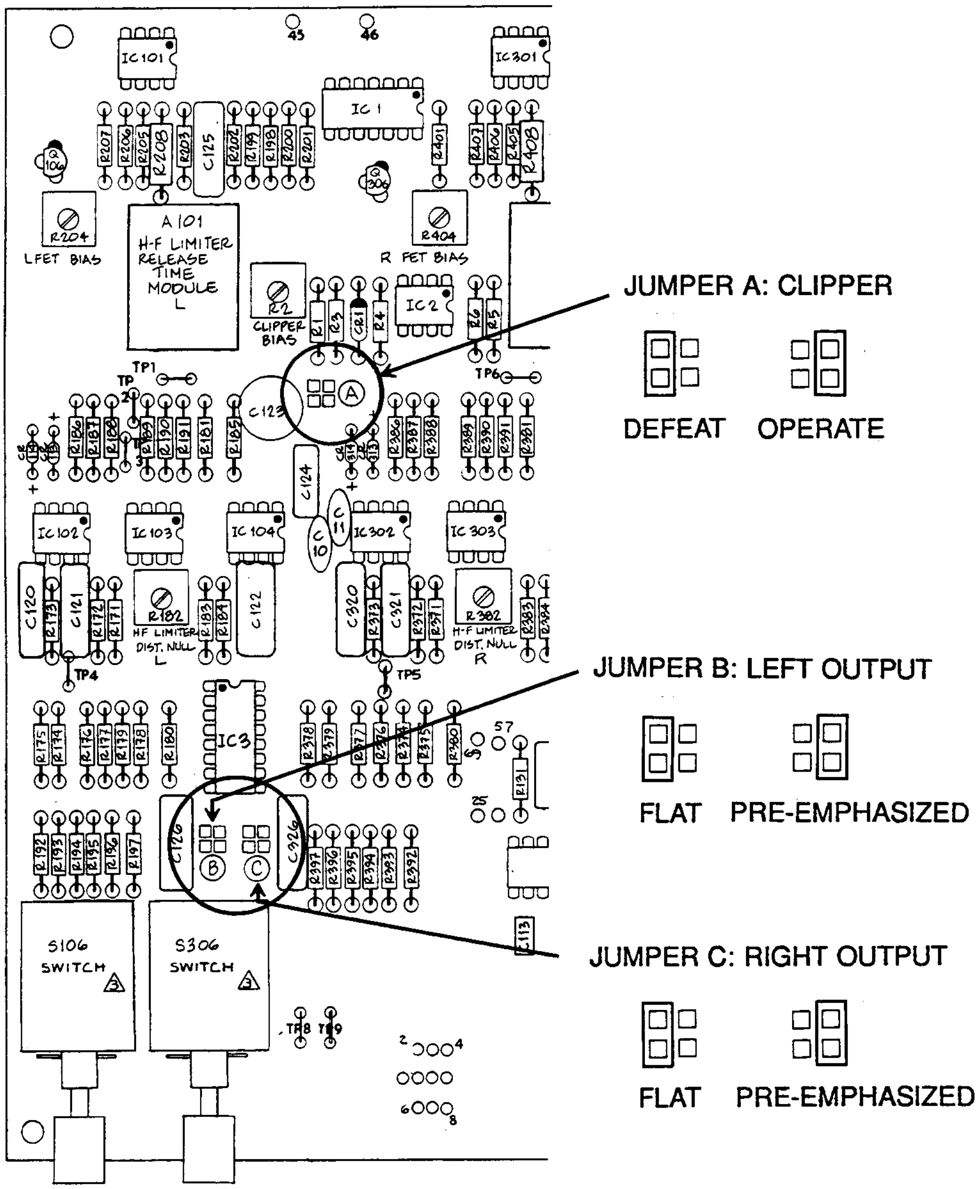


Fig. 2-1: Pre-Emphasis and Clipper Defeat Jumpers

3) Mount the Co-Operator in a rack.

The Co-Operator requires one standard rack unit (1¾ inches, 4.4 cm).

There should be a good ground connection between the rack and the Co-Operator chassis — check this with an ohmmeter.

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

4) Connect audio input and output.

See the hook-up and grounding information on the following pages.

5) Check the line voltage, fuse and power cord.

The Co-Operator is shipped ready for 115-volt, 50/60Hz operation — unless a label on the power cord indicates otherwise.

A❑ *DO NOT connect power to the unit yet!*

B❑ Check the value of the fuse and change the fuse if the value is incorrect.

For safety, the fuse must be 3AG 250V Slow-Blow, ½-amp for 115V, or 250mA "T"-type for 230V.

C❑ Connect power cord.

AC power passes through an IEC-standard mains connector and an RF filter designed to meet the standards of all international safety authorities.

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

If you need to change the plug to meet your country's standard and you are qualified to do so, see Fig 2-2 on page 2-6. Otherwise, purchase a new mains cord with the correct plug attached.

WARNING

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

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

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

Audio Input and Output Connections

Wire:

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

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

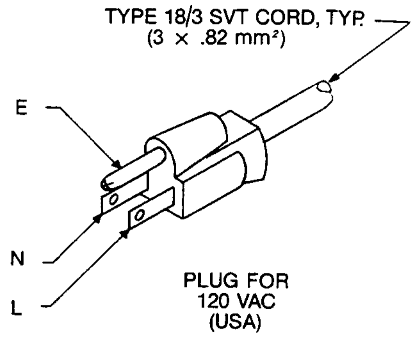
Sometimes, particularly if you are using the Co-Operator with musical instruments or home-type equipment, single-conductor shielded cable may be the only practical alternative. In this case, connect the inner conductors of the shielded cables to the HI sides of the Co-Operator inputs and outputs. Connect the shield of the Co-Operator *input* cable to the LO input, and connect the shield of the Co-Operator *output* cable to the Co-Operator's LO output terminal on the rear-panel barrier strip. Connect both IN LO and OUT LO terminals to ⏚.

Connectors:

- **Input and output connectors** are either barrier strip terminals (with #5 screw), ¼-inch tip/ring/sleeve phone jacks, or XLR-type jacks.

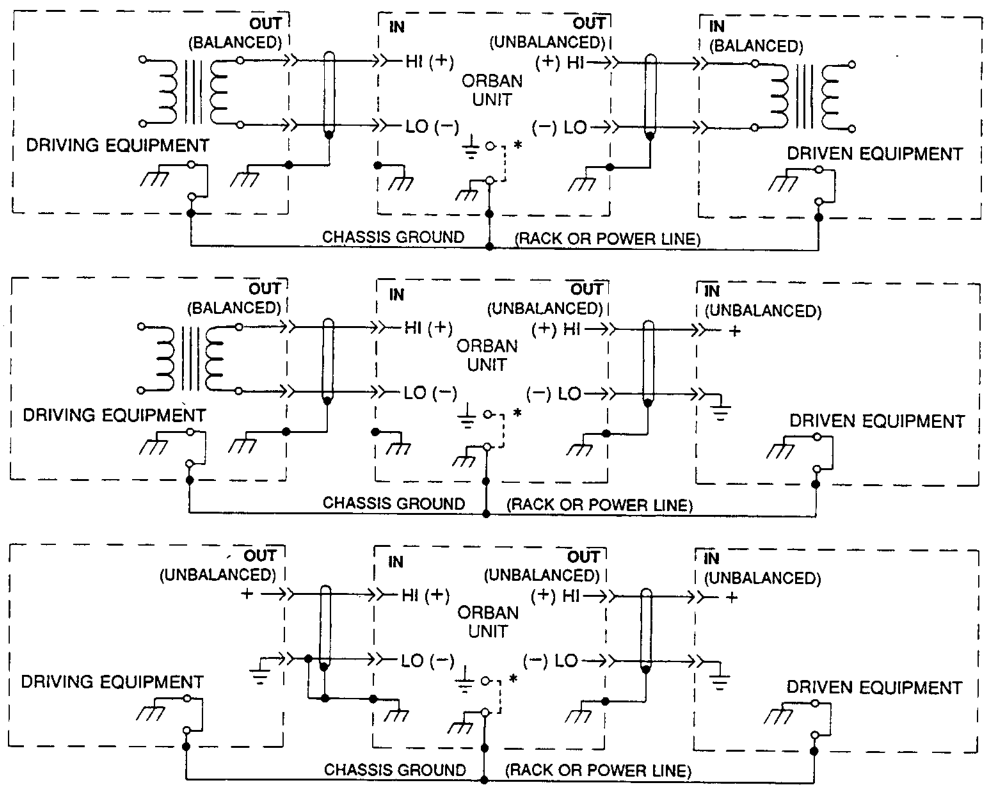
Levels:

- **Nominal input level** is between −10 and +8dBu. The absolute overload point is +20dBu. (0dBu = 0.775V RMS; for this application, the dBm @ 600Ω scale on voltmeters can be read as if were calibrated in dBu.)
- The **electronically-balanced input** of each channel is compatible with most professional and semi-professional sound equipment, balanced or unbalanced, with a source impedance of 600 ohms or less. If the source impedance is greater (as in some vacuum-tube audiophile preamps), remove capacitors C102 (left channel) and C302 (right channel), and connect the hot side of the driving equipment's outputs to the Co-Operator's HI inputs.
- The two **electronically-balanced and floating outputs** of each channel simulate a true transformer output. The *source* impedance is 30 ohms (93 ohms for units with serial numbers below 1306000 — see note on page 2-14). In addition, there is a 1000pF capacitor between each output (HI and LO) to the chassis for RFI suppression. The output is capable of driving loads of 600 ohms or higher.
- If an **unbalanced output** is required (to drive unbalanced inputs of other equipment), it should be taken between the HI and LO outputs. No special precautions are required even though one side of the output is grounded. Connect the LO output terminal to ⏚.



CONDUCTOR		WIRE COLOR	
		Normal	Alt
L	LINE	BROWN	BLACK
N	NEUTRAL	BLUE	WHITE
E	EARTH GND	GREEN-YELLOW	GREEN

Fig. 2-2: AC Power Cord Color Coding



*If Orban unit is equipped with optional output transformer, then install this jumper.

Fig. 2-3: Some Possible Grounding Schemes

Grounding

Very often, grounding is approached in a "hit or miss" manner. But with care it is possible to wire an audio studio so that it is free from ground loops (which induce hum and can cause oscillation) and provides maximum protection from power faults.

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

Power:

- Ground the Co-Operator chassis through the third wire in the power cord. Proper grounding techniques *never* leave equipment chassis unconnected to power/earth ground. *A proper power ground is essential to safe operation.* Lifting a chassis from power ground is a safety hazard. If there is a power fault to the chassis, death could result!

Circuit:

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

- *In a simple one-studio system,* the connection through power ground (via the power cord's third wire) will suffice, Connect the Co-Operator's circuit ground (⏚) terminal to its chassis ground (⏚) terminal. Also connect the circuit and chassis grounds of other equipment.
- *In larger systems,* it is common to establish an isolated circuit ground system that is insulated from the power ground except at one point (usually the studio power distribution panel). In this case, disconnect the Co-Operator's circuit ground (⏚) terminal from its chassis ground (⏚) terminal, then connect the Co-Operator's circuit ground (⏚) terminal to the isolated circuit ground system.

Audio Output:

- Use two-conductor shielded cable (Belden 8451, or equivalent).
- At the Co-Operator's output (and at the output of other equipment in the system), connect the cable's shield to the ⏚ terminal for that channel. Connect the red (or white) wire to the channel's HI terminal, and the black wire to the channel's LO terminal.
- To interface units with unbalanced inputs in a professional system, install a balancing transformer (Jensen JE-11P-1, or equivalent) to prevent ground loops.

Grounding (continued)

Audio Input:

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

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

Difficult Situations:

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

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

A ground loop usually causes a smooth, steady hum rather than a crackly buzz. If you have a ground loop, you can often break it by *disconnecting* the jumper between circuit and chassis grounds on the Co-Operator'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! (Bear in mind that the circuit grounds of the two channels of the Co-Operator are connected together internally, and could conceivably introduce a ground loop if you do not take this connection into account in planning your wiring.)

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

Installation — FM Transmitter, STL, Subcarrier Generator Protection

If you are not using the Co-Operator to protect an FM transmitter, studio-transmitter link (STL), or subcarrier generator, follow the installation instructions which begin on page 2-2 — the following does not apply to you.

Allow about 45 minutes for installation and set-up.

You will need an audio sine wave generator. If you do not have a modulation monitor, you will also need an audio voltmeter.

Installation includes unpacking and inspecting the Co-Operator, setting of clipper-defeat and pre-emphasis jumpers, mounting the Co-Operator in a rack, then connecting it to audio input and output, power, and ground. Transmitter protection set-up consists of defeating your transmitter's pre-emphasis, adjusting the Co-Operator's clipping bias, calibrating its PEAK OUTPUT LEVEL meters and clipping level, then setting controls for normal operation. An optional security cover can be installed to protect control settings.

1) Defeat your transmitter's pre-emphasis.

The transmitter's pre-emphasis network will probably introduce overshoots that will increase peak modulation without any increase in average modulation. We therefore strongly recommend that the transmitter's pre-emphasis be defeated (freeing the transmitter from such potential overshoot), and that the Co-Operator be used to provide the necessary pre-emphasis.

If the transmitter's pre-emphasis cannot be defeated, then configure the Co-Operator for flat output. In this case average modulation levels may have to be reduced to accommodate the overshoots.

2) Unpack and inspect the Co-Operator.

See page 2-2.

3) Remove the top cover.

Remove all screws holding the cover in place, then lift it off.

4) Reposition clipper-defeat and pre-emphasis jumpers.

a) Place jumper A in the "OPERATE" position (see Fig. 2-1).

b) Place jumpers B and C in the "PRE-EMPHASIZED" position (see Fig. 2-1).

If the transmitter's pre-emphasis cannot be defeated, place these jumpers in the "FLAT" position.

5) Increase clipping. (optional)

The Co-Operator is shipped with the clipper adjusted to produce no audible distortion even on the most unusual program material.

It is possible to increase average modulation about 2dB by reducing clipper bias. Such an adjustment will, however, introduce very slight audible distortion on some uncommon program material.

To reduce clipper bias, turn CLIPPER BIAS trimmer R2 fully counterclockwise.

NOTE: If you readjust this trimmer in the future, you must also recalibrate the Co-Operator's clipping level (see step 11).

6) Replace the top cover.

Replace all screws snugly (be careful not to strip the threads by fastening the screws too tightly).

7) Mount the Co-Operator in a rack.

See page 2-4. Be sure to verify a good ground connection between the Co-Operator and the rack.

8) Connect audio input and output.

See page 2-4.

9) Connect power.

See page 2-4.

10) Calibrate the L PEAK OUTPUT LEVEL meter.

a) Connect an audio sine wave generator to the LEFT IN terminals. Set frequency to 400Hz and amplitude to approximately +10dBu (2.45V RMS).

b) Set the controls as follows:

L METER CAL	0
L HF LIMIT PRE-EMPHASIS	75us*
L OUTPUT ATTEN	0
L INPUT ATTEN	0
L GATE THRESH	0
L RELEASE TIME	5
L REL SHAPE	SOFT
L LEVEL	OFF
L COMPR	ON
L HF LIMIT	OPERATE
L SYSTEM	OPERATE
POWER	ON
MODE	DUAL

* Or to match the pre-emphasis of the transmission system.

c) Advance the L INPUT ATTEN control until the L GAIN REDUCTION meter indicates 5dB gain reduction.

d) Set the L COMPR button to OFF.

e) Turn on the transmitter.

f) Advance the L OUTPUT ATTEN control until your modulation monitor indicates 100% modulation.

If a modulation monitor is not available, observe the transmitter's input with an audio voltmeter, and adjust the L OUTPUT ATTEN control to a level equivalent to 100% modulation.

g) Advance the L METER CAL control until the red +3 segment of the L PEAK OUTPUT LEVEL meter just lights.

The L PEAK OUTPUT LEVEL meter is now calibrated so that +3 corresponds to 100% modulation of the transmitter.

h) Turn the transmitter off.

11) Calibrate clipping level.

a) Advance the L INPUT ATTEN until the L HF LIMIT indicator just lights, then back off slightly so that the L HF LIMIT indicator is no longer lit.

The Co-Operator is now producing a clipped 400Hz sine wave. The peak level of this wave corresponds to 100% modulation.

b) Adjust the L OUTPUT ATTEN control so that the red +3 segment of the L PEAK OUTPUT LEVEL meter just barely lights.

The L OUTPUT ATTEN is now correctly calibrated to the transmitter. Provided that no significant overshoot occurs in the transmitter, the L PEAK OUTPUT LEVEL meter will give an accurate indication of peak modulation.

With the L LEVEL switch set to OFF, and the L COMPR switch set to ON, an undistorted sine wave peaking at between 23% and 29% modulation should be produced. With the L LEVEL switch set to ON, the level should be between 13.5% and 16.5% modulation. It is normal for these levels to vary ±1dB from unit to unit.

c) *For stereo transmission,* reduce the OUTPUT ATTEN control settings to avoid peak over-modulation caused by overshoots in the transmitter's 15kHz audio low-pass filter on certain signals with substantial high-frequency content.

12) Set controls for normal operation with program material.

The Co-Operator can be used for transmitter protection *only*, or it can be used for transmitter protection *and* level control.

For FM broadcast, we recommend both level control and transmitter protection for talk, popular music, light classics, rock, and similar formats. Level control may not be desirable in some situations, such as with classical music intended for serious listening.

The following assumes that a VU meter is used to determine line drive levels with program material.

a) Set controls as follows:

For transmitter protection AND level control:

L METER CAL	Do not change
L HF LIMIT PRE-EMPHASIS	75us*
L OUTPUT ATTEN	Do not change
L GATE THRESH	5
L RELEASE TIME	5
L REL SHAPE	SOFT
L LEVEL	ON
L COMPR	OFF
L HF LIMIT	OPERATE
L SYSTEM	OPERATE
MODE	DUAL**

For transmitter protection ONLY:

L METER CAL	Do not change
L HF LIMIT PRE-EMPHASIS	75us*
L OUTPUT ATTEN	Do not change
L GATE THRESH	0
L RELEASE TIME	0
L REL SHAPE	HARD
L LEVEL	OFF
L COMPR	ON
L HF LIMIT	OPERATE
L SYSTEM	OPERATE
MODE	DUAL**

* Or to match the pre-emphasis of the transmission system.

** For stereo, set MODE to STEREO *after* set-up is complete.

b) Feed the Co-Operator either with tone at your system reference level (0VU), or with typical program material at normal levels.

If you want transmitter protection ONLY (with no level control), feed the Co-Operator either with tone at 3dB above your system reference level (+3VU), or with typical program material at normal levels.

c) **For both transmitter protection AND level control,** adjust the L INPUT ATTEN control for the desired amount of gain reduction.

We recommend 5–10dB gain reduction.

d) **For transmitter protection ONLY,** adjust the L INPUT ATTEN control for 2.5dB gain reduction.

If you are using tone, this level of gain reduction is indicated by the first segment of the L GAIN REDUCTION meter just lighting. If you are using program material, the first segment should light on passages that are at your normal peak operating level.

13) Repeat steps 10, 11, and 12 for the *right* channel.

Use the right channel controls and meters instead of the left.

If the Co-Operator will be used **for mono,** this will prepare a second channel for back-up.

If the Co-Operator will be used **for stereo,** set the MODE button to STEREO after steps 10 through 12 have been performed on both channels.

14) Install a security cover to protect settings from inadvertent adjustment or tampering. (optional)

Orban supplies an optional security cover as Accessory Kit ACC-011. Order Kit ACC-11CL for a clear cover, ACC-11BL for a transparent blue cover, or ACC-11WH for an opaque white cover.

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

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

Matching Output Level to Device Being Driven

When the Co-Operator is used to provide peak overload protection for a recording or transmission device, it is best to adjust the Co-Operator's output so that it drives the device up to, but no further than, its optimum operating level.

The following procedure explains how to match these levels *and* calibrate the Co-Operator's PEAK OUTPUT LEVEL meters to the overload point of the driven device. It is only necessary to match levels once for each protected device. **Level-matching for FM transmitter, STL, and subcarrier generator protection** is covered in the preceding section, "Installation — FM Transmitter, STL, Subcarrier Generator Protection".

NOTE: The Co-Operator's output impedance is 30 ohms. Its output level will therefore be 0.4dB lower with a 600Ω load than it will with a a 10KΩ (bridging) load. Although this drop is small, you may wish to recalibrate the PEAK OUTPUT LEVEL meters for critical applications (the meters do not directly sense the voltage across the output terminals).

(Co-Operators with serial numbers below 1306000 had a 93Ω output impedance. If the load impedance of one of these is changed from 10KΩ to 600Ω, the output level will change by about 1.2dB. If you have a 93Ω unit and would like to convert it to 30Ω output impedance, contact Orban Customer Service for instructions.)

Allow about 15 minutes for level-matching.

You will need a sine wave oscillator and a calibrated oscilloscope (or true peak-reading voltmeter).

1) Set the LEVEL and COMPR buttons to OFF.

2) If you are going to use the high-frequency limiter, set the HF LIMIT buttons to OPERATE. Otherwise, set them to DEFEAT.

   If you want absolute peak control at the output of the high-frequency limiter, be sure that the internal clippers are operational (see step 2 of the Installation Instructions in Section 2).

3) Connect a calibrated oscilloscope or true peak-reading voltmeter to the LEFT OUT terminals of the Co-Operator.

4) Connect a sine wave oscillator to the Co-Operator's LEFT IN terminals. Set the oscillator's frequency to 100Hz.

5) Advance the Co-Operator's L INPUT ATTEN control until you observe a noticeably clipped output waveform on the oscilloscope (or until the reading on the peak-reading meter no longer increases).

6) The clip point of this waveform is the absolute maximum peak output which will be produced by the Co-Operator in normal operation.

7) Adjust the Co-Operator's L OUTPUT ATTEN control (*or* the left input attenuator control of the driven device) until the peak level at the Co-Operator's output matches the peak overload point of the device being driven.

   For **analog tape recorders**, this will typically be 6dB above "Operating Level" (i.e., 6dB above the nominal 1% total harmonic distortion level).

   For **audio power amplifiers**, this will typically be at the point clipping begins.

   For **USA-standard telephone lines**, this will typically be at +17dBu into the line (through a repeat coil supplied by the telephone company). NOTE: Place a 270-ohm ±5%, 1/4-watt carbon film resistor (240-ohm for units serial numbered below 1306000, which have 93-ohm output impedance) in series with each leg of the Co-Operator's balanced output to ensure that the phone line is driven by a true 600-ohm source impedance. The +17dBu must be measured on the *phone line* side of the resistors.

   You may have to determine the peak overload level by experimentation, or by referring to the specifications provided by the manufacturer of the driven equipment (especially with broadcast transmitters and digital audio encoders). This is particularly important if the driven equipment employs a sharp cut-off low-pass filter after its input, since such a filter will overshoot and ring, and may increase the peak level applied to the device by several dB.

8) Adjust the Co-Operator's L METER CAL control until the L PEAK OUTPUT LEVEL meter's red +3 segment just lights.

   The L PEAK OUTPUT LEVEL meter is now calibrated to the driven equipment. When the red +3 segment lights, the overload point of the driven equipment has been reached.

9) Repeat steps 3 through 8 for the right channel.

   Use the Co-Operator's *right* channel terminals, controls, and meters in place of the left.

Notes:

Section 3
Operation

page contents

3-2 Co-Operator Controls and Meters

3-4 Example Control Settings

3-8 More About Co-Operator Audio Processing

Co-Operator Controls and Meters

A pop-off cover protects the following three pairs of set-up controls:

METER CALibration controls calibrate the PEAK OUTPUT LEVEL meters so that full-scale indicates a peak anywhere between −2 and +20dBu (0dBu = 0.775V RMS). With these controls, the meters can be precisely matched to the overload or 100% modulation point of equipment being driven by the Co-Operator.

HF LIMITing PRE-EMPHASIS switches determine the pre-emphasis curves for the high-frequency limiter. The 25µs setting produces the least high-frequency limiting; the 150µs setting produces the most. If the internal pre-emphasis jumper is in the PRE-EMPHASIZED output position, the switch also determines the pre-emphasis at the Co-Operator's output.

OUTPUT ATTENuator controls adjust the gain of the balanced line amplifiers for matching output levels to equipment that does not have convenient input sensitivity controls.

GAIN REDUCTION meters show the true peak gain reduction in dB. If the red LED at the far right of the bargraph lights, no further gain reduction is available.

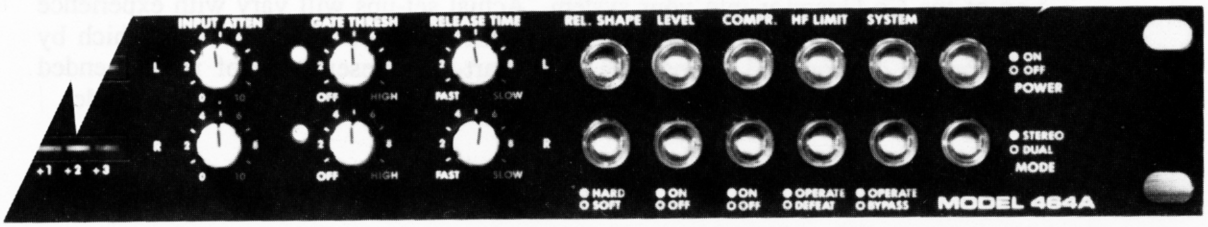
HF LIMITing indicators light when HF limiting occurs.

PEAK OUTPUT LEVEL meters indicate the peak output level of the Co-Operator just before its final "active transformer" line amplifier. The meter reads within 0.5dB of the true peak value of a 10-microsecond pulse. The meter is particularly useful as a peak modulation indicator for a microwave STL or FM subcarrier generator that does not have accurately calibrated peak-reading meters.

INPUT ATTENuator controls determine the amount of gain reduction by adjusting the drive level into the leveler and compressor.

GATE THRESHold indicators light when the input levels fall below those set by the GATE THRESHold controls.

GATE THRESHold controls determine the input level below which the leveling gain control is "frozen" to prevent noise rush-up during pauses and low-level program material. Once frozen, the leveling starts drifting slowly toward a point equal to the average gain reduction over the past 30 seconds. The fast compression release process is unaffected.



RELEASE TIME controls speed or slow the program-controlled release time to match the processing to the type of audio being processed. The scale is arbitrary because the release time is automatically varied according to the nature of the program material (to minimize audible compression-induced side effects).

RELease SHAPE buttons select a constant dB/second release rate when set to HARD. When set to SOFT, the release rate slows as gain reduction decreases. The HARD setting, which results in uniformity and loudness, is intended for use with single tracks and live voice; the SOFT setting rides gain more subtly, and works well with mixed program material.

LEVELing buttons enable or disable the Co-Operator's slow attack time (about 200ms) average-leveling function. Relatively well-controlled material (most commercial recordings, for example) will sound most natural if processed by the leveling function only, with the compressor defeated.

COMPRessor buttons enable or defeat the compression function, which provides better fast transient overshoot protection than the leveling function can. Because the threshold of compression is substantially higher than the threshold of leveling, compression is only activated by those transients that are too fast for the slower attack time of the leveling circuitry. Program material that has an unusually high peak-to-average ratio or is characterized by many abrupt level increases may require both compression and leveling.

HF LIMITing buttons enable or defeat the high-frequency limiting and optional clipping functions. (The clipping function can be enabled by repositioning an internal jumper. If a pre-emphasized output is desired, these buttons must be set to OPERATE and jumpers B and C on the main circuit board must be correctly positioned. See step 2 on page 2-2 for information about the jumpers.)

SYSTEM buttons hardwire-connect the input of the system directly to the output terminals when set to BYPASS.

POWER button turns the unit on and off.

MODE button causes the two audio channels to function independently when set to DUAL. When set to STEREO, both channels receive identical gain reduction to better preserve stereo imaging. In STEREO mode, the amount of gain reduction is determined by the channel that requires the *most* gain reduction at any given instant. (The high-frequency limiters *always* operate independently, since their short release times preclude stereo imaging problems. Their operation is unaffected by the MODE button.)

Example Control Settings

NOTE: These specific application set-ups are intended as a starting point for integration of the Co-Operator into your system. Actual set-ups will vary with experience and experimentation. There are also many other production applications which by their nature do not lend themselves to a chart-like presentation of recommended settings. In these applications, experience and experimentation are the best guides.

Audio Tape Recorder

Because applications are so diversified, each with special needs, no generalized settings can be recommended. Read "More About Co-Operator Audio Processing" on page 3-8. The table on page 3-10 suggests appropriate pre-emphasis for various recording speeds.

STL Protection

Assumes that *only* safety and high-frequency limiting are wanted. If leveling is also desired, use "Broadcast Transmission" settings.

METER CAL	+3 (= 100% peak modulation)
HF LIMIT PRE-EMPHASIS	75 or 50µs, depending on your country's standard
INPUT ATTEN	set to apply G/R only when the normal maximum level at the Co-Operator's input is exceeded
GATE THRESH	0
RELEASE TIME	0
REL SHAPE	HARD
LEVEL	OFF
COMPR	ON
HF LIMIT	OPERATE
Clipper jumper	OPERATE

Broadcast Transmission

METER CAL	+3 (= 100% peak modulation)
HF LIMIT PRE-EMPHASIS	75 or 50µs, depending on your country's standard
INPUT ATTEN	for 5–10dB G/R (or for amount of leveling wanted)
GATE THRESH	5
RELEASE TIME	5
REL SHAPE	SOFT
LEVEL	ON
COMPR	OFF
HF LIMIT	OPERATE
Clipper jumper	OPERATE

More loudness can be obtained by reducing bias voltage on the clipper with internal trimmer R2 to produce more clipping (see step 5 on page 2-10). After adjusting the trimmer, advance the OUTPUT ATTEN control to achieve to 100% modulation.

Satellite Uplink

For protection *only*, use "STL Protection" settings. For protection *plus* leveling, use "Broadcast Transmission" settings.

Broadcast Cart Machine (Protection Only)

METER CAL	+3 (= 3% THD)
HF LIMIT PRE-EMPHASIS	50μs
INPUT ATTEN	set to apply G/R only when the normal maximum level at the Co-Operator's input is exceeded
GATE THRESH	OFF
RELEASE TIME	0
REL SHAPE	HARD
LEVEL	OFF
COMPR	ON
HF LIMIT	OPERATE
Clipper jumper	DEFEAT

Broadcast Cart Machine (Compression)

METER CAL	+3 (= 3% THD)
HF LIMIT PRE-EMPHASIS	50μs
INPUT ATTEN	for G/R equal to the amount of leveling wanted
GATE THRESH	5
RELEASE TIME	6
REL SHAPE	SOFT
LEVEL	ON
COMPR	OFF
HF LIMIT	OPERATE
Clipper jumper	DEFEAT

Type B or C VTR, BetaCam/MII VCR, Quad VTR

METER CAL	+3 (= 3% THD level from tape)
HF LIMIT PRE-EMPHASIS	50μs
INPUT ATTEN	for the amount of G/R wanted
GATE THRESH	as needed to prevent noise rush-up during pauses
RELEASE TIME	5
REL SHAPE	HARD for speech, SOFT for mixed program material
LEVEL	ON
COMPR	ON
HF LIMIT	OPERATE
Clipper jumper	DEFEAT

If you wish, adjust the RELEASE TIME, REL SHAPE, INPUT ATTEN, GATE THRESH controls by ear to get the best sound for the particular program material being recorded.

U-Matic VCR

To avoid objectionable distortion and/or noise, the U-Matic format requires more careful high-frequency limiting and less dynamic range than do 1-inch or ½-inch tape formats.

METER CAL	+3 (= 3% THD level from tape)
HF LIMIT PRE-EMPHASIS	100µs
INPUT ATTEN	for the amount of G/R wanted
GATE THRESH	as needed to prevent noise rush-up during pauses
RELEASE TIME	5
REL SHAPE	HARD for speech, SOFT for mixed program material
LEVEL	ON
COMPR	ON
HF LIMIT	OPERATE
Clipper jumper	DEFEAT

Cassette Duplication

METER CAL	+3 (= 3% THD level from tape)
HF LIMIT PRE-EMPHASIS	75µs for FeO_2 or CrO_2 with Dolby® HX Pro 100µs for CrO_2 without HX Pro processing
INPUT ATTEN	for G/R only on overload from master
GATE THRESH	OFF
RELEASE TIME	0
REL SHAPE	HARD
LEVEL	OFF
COMPR	ON
HF LIMIT	OPERATE
Clipper jumper	DEFEAT

Set LEVEL to ON to reduce the dynamic range of the master. The compressor and high-frequency limiter will provide safety limiting only.

FM Subcarrier Generators

HF LIMIT PRE-EMPHASIS	150µs

For protection *only*, use the "STL Protection" settings for the other controls. For protection *plus* leveling, use the "Broadcast Transmission" settings for the other controls.

Sound System Protection (Unattended Bi-amped System)

Place the Co-Operator before the crossover, amps, and drivers.

METER CAL	+3 (= amplifier clip point)
HF LIMIT PRE-EMPHASIS	match to thermal overload characteristic of driver (see the table on page 3-10)
INPUT ATTEN	so system is below feedback when AGC is at 0dB
GATE THRESH	5
RELEASE TIME	6
REL SHAPE	SOFT
LEVEL	ON
COMPR	ON
HF LIMIT	OPERATE
Clipper jumper	OPERATE

Sound System Protection (Attended Bi-amped System)

Place the Co-Operator after the crossover. Use one channel for low frequency, the other for high frequency.

METER CAL	+3 (= amplifier clip point)
HF LIMIT PRE-EMPHASIS	match to thermal overload characteristic of driver (see the table on page 3-10)
INPUT ATTEN	for G/R equal to the amount of leveling & compression wanted
GATE THRESH	OFF
RELEASE TIME	0
REL SHAPE	HARD
LEVEL	OFF
COMPR	ON
HF LIMIT	OPERATE *
Clipper jumper	OPERATE

The MODE button can be set to DUAL in high-SPL environments.

* Set both HF LIMIT buttons to OFF when using one channel for low frequency and one channel for high frequency.

More About Co-Operator Audio Processing

Leveling and compression.

The Co-Operator's automatic gain control (AGC) is divided into a leveling function and a compression function. Leveling provides slow, averaging gain control that yields the most natural sound on well-controlled material like commercial recordings. Compression adds fast transient protection for program material that has an unusually high peak-to-average ratio or frequent abrupt level changes.

The INPUT ATTENuator controls determine the overall amount of gain reduction by setting the signal level going into the gain control circuitry. The GATE THRESHold controls set the level below which the AGC will gate to prevent noise rush-up during pauses and low-level passages. The RELEASE TIME controls determine how fast the gain recovers when the audio level drops: FAST rates produce audio that is more consistent and dense, while SLOW rates give a more natural sound. The RELease SHAPE controls select a constant, HARD release rate (for a uniform, loud sound from voices or single tracks) or a progressively slowing, SOFT rate (for a natural, more subtle sound from mixed material).

(The Co-Operator's gating function is *not* the same as a conventional "noise gate" in that it is not intended to reduce noise or other undesired sounds to a level below that at which they occur in the original program. Its purpose is to prevent unnatural exaggeration of such material. If needed, a conventional noise gate can be used *before* the Co-Operator.)

Be careful not to adjust the controls to produce so much gain reduction that the red LED at the far right of each GAIN REDUCTION meter lights.

Unlike the metering in some processors, the red segments of the Co-Operator's GAIN REDUCTION meters give a warning that must be heeded. When the meter in the red, the compressor has run out of gain reduction range, the circuitry is being overloaded, and various nastinesses are likely to commence.

In general, the peak level at the Co-Operator's output is relatively constant regardless of the settings of the INPUT ATTEN and RELEASE TIME controls. However, if the program material contains abrupt transients, you may wish to set the COMPR buttons to ON to protect the equipment driven by the Co-Operator from audible distortion due to transient clipping.

Because peak output levels are held relatively constant, you can readily *hear* the effect of any control upon loudness. FAST RELEASE TIMEs and a HARD REL SHAPE will result in low peak-to-average ratios and, therefore, maximum loudness. Such processing will, however, introduce the greatest risk of audible side effects, despite the special Co-Operator circuitry designed to minimize these effects.

(With both HARD and SOFT settings, the release rate in dB/second is constant above 10dB gain reduction (see Fig. 3-1). Below 10dB, the SOFT setting causes the release time to progressively slow, while the HARD setting maintains a constant release rate.)

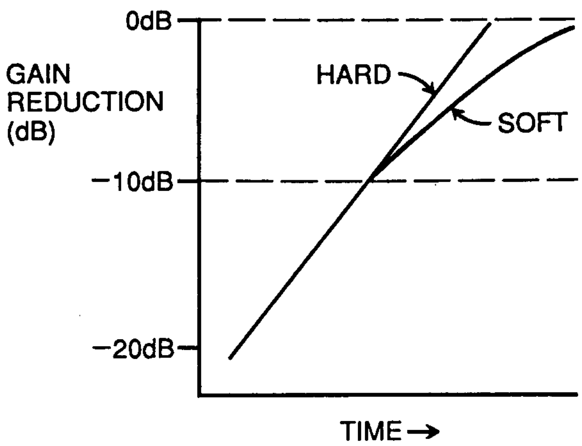


Fig. 3-1: Release Shape Curves

High-frequency limiting.

The high-frequency limiter is essentially a variable 6dB/octave low-pass filter that adapts to the spectrum of the program material to prevent overloading pre-emphasized media following the Co-Operator. In addition to general-purpose high-frequency limiting, the high-frequency limiter may be useful in de-essing vocals which have already been mixed with other program material (it performs this task significantly more smoothly than the Orban dedicated de-essers because its threshold does not follow the average input level, and because it cannot punch "holes" in the program).

The HF LIMIT buttons enable or defeat the high-frequency limiter. The HF LIMIT buttons do not introduce gaps in the program material, although waveform discontinuities between the input and output of high-frequency limiter may result in slight "clicks" being heard if the buttons are pressed during heavily-processed program material. Since their short release times preclude stereo imaging problems, the high-frequency limiters remain in DUAL mode (each channel operating independently) regardless of the position of the MODE button.

The high-frequency limiter is located *after* the leveler/compressor, and is essentially independent of it. Ordinarily, the leveler/compressor controls the input levels to the limiter. **To use the high-frequency limiter independently,** set the LEVEL and COMPR buttons and the GATE THRESH controls to OFF. When the Co-Operator is used this way, adjust the INPUT ATTEN controls with particular care to avoid over-driving the high-frequency limiter or clipping the VCAs.

The HF LIMIT PRE-EMPHASIS switches select the pre-emphasis for the high-frequency limiter. These are all 6dB/octave curves which are up 3dB at $1/(2\pi T)$Hz, where T is the time constant in seconds. 25µs produces the least high-frequency limiting; 150µs produces the most. Generally, the **pre-emphasis curve** should match that of medium being protected (see the preceding "Example Control Settings" and the following table).

Pre-emphasis	Up 3dB at	Application
none	—	Recording tape at 30ips (Set HF LIMIT to DEFEAT)
25µs	6.37kHz	Recording tape at 15ips
37.5µs	4.24kHz	Recording tape at 7.5ips
50µs	3.18kHz	FM broadcast (Europe)*
75µs	2.12kHz	FM broadcast*, cassette duplication**, microwave STLs
100µs	1.59kHz	Cassette duplication**
150µs	1.06kHz	FM SCA subcarriers

* FM broadcast pre-emphasis standards vary by country.
** Depends on tape quality and whether Dolby® HX Pro processing is used.

(To ensure accuracy in broadcast STL or SCA applications, the pre-emphasis network in the STL or SCA generator should be defeated, and the Co-Operator's jumpers should be set for pre-emphasized output — see "Installation — FM Transmitter, STL, and Subcarrier Generator Protection" in Section 2.)

If high-frequency distortion is observed, try switching the HF LIMIT PRE-EMPHASIS switches to a higher setting. If excessive high-frequency loss is heard, try a lower setting.

It is difficult to suggest an appropriate pre-emphasis curve for LF and HF drivers, since the choice depends on the power-handling capabilities of the individual drivers. Experience is the best guide here. Higher pre-emphasis curves provide more overload protection, but will produce a duller sound from HF drivers. Feed to LF drivers should typically be clipped very slightly below the clipping threshold of the power amp (unless you are using a power amp that is too powerful for the driver, in which case you might want to clip the input to the power amp substantially below the amp's own clipping point and/or use the Co-Operator's leveling function to limit the *average* power applied to the driver). Activate the compressor function in any case, to avoid excessive clipping or high-frequency limiting.

The thresholds, time constants, and compression ratios of the high-frequency limiter have been optimized for unobtrusive processing of dynamic program material. Consequently, if swept sine wave measurements (which do not resemble real program material) are made on the high-frequency limiter, the curves that are produced will not be the exact inverses of the curves selected with the HF LIMIT PRE-EMPHASIS switch. (The primary reason for this is that the threshold of the high-frequency limiter has been set several dB above the steady-state threshold of the leveling circuit to avoid having transient overshoots from the leveling circuit cause unnecessary high-frequency gain reduction.)

Stereo and dual modes.

Setting the MODE button to STEREO ensures stable stereo imaging. In STEREO mode, all leveler and compressor VCAs will track the channel requiring the *greater* amount of gain reduction. If the GATE THRESH controls for both channels are set identically, both channels will remain ungated as long as at least one channels receives sufficient input level to ungate. In STEREO mode, all controls are usually set identically. The HF limiters remain independent.

When the MODE button is set to DUAL, the left and right channels function independently.

Section 4
Maintenance

page contents

4-2 Routine Maintenance

4-2 Getting Inside the Chassis

4-3 Performance Evaluation

CAUTION

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

Routine Maintenance

No routine maintenance of this product is required.

See Section 3 for information about calibrating the PEAK OUTPUT LEVEL meters to the overload point of the device being driven.

Getting Inside the Chassis

To access the circuit boards, remove all screws holding the appropriate cover in place, then lift that cover off.

Remove the *top cover* for access to the rear of the front-panel circuit board or the jumpers on the component side of the main circuit board.

Remove the *bottom cover* for access to the solder side of the main circuit board.

When replacing the covers, replace all screws snugly (be careful not to strip the threads by fastening the screws too tightly).

To get at the front of the front-panel circuit board, remove the top cover, remove the four screws that attach the board to the front panel, then carefully tilt the board back and down. DO NOT attempt to remove the front-panel board from the chassis — it is hard-wired to the main circuit board.

When replacing the front-panel circuit board, be sure that the insulating paper beneath the right channel pots is in place.

Performance Evaluation

These are instructions for thoroughly checking the performance of the Co-Operator. The evaluation includes checks of the power supplies, input stages, VCAs, gate control circuits, VCA control circuits, meters, high-frequency limiters, output stages, and overall performance.

This procedure is useful in detecting and diagnosing problems, as well as for checking routine performance.

See assembly drawings in Section 6 for locations of components, jumpers, and test points. *All jumpers and test points are located on the main circuit board.*

Perform procedures in order without skipping steps.

Equipment required:

- Oscilloscope
  DC-coupled, with at least 5MHz vertical bandwidth.
- Digital voltmeter
  Accurate to 0.1%.
- Audio voltmeter
  Accurate to 2%. Sound Technology 1710B or equivalent preferred.
- Low-distortion audio oscillator
  With verified residual distortion below 0.003%. Sound Technology 1710B or equivalent preferred.
- THD analyzer
  With verified residual distortion below 0.003%. Sound Technology 1710B or equivalent preferred.
- Spectrum analyzer with tracking generator
  Tektronix 5L4N plug-in with 5111 bistable storage mainframe, or equivalent. *Alternatively*, a sweep generator with 50–20,000Hz logarithmic sweep can be used with an oscilloscope in X/Y mode.

1) Remove the top cover.

Remove the six screws that hold the top cover in place, then lift off the top cover.

2) Record all control and internal jumper settings.

3) Check power supplies.

a) Set the POWER button to OFF.

b) Verify the following resistances:

Between:	And:	Resistance:
Power cord ground pin	Chassis	0Ω
Each of the power cord blades	Chassis	∞Ω
One power cord blade	The other blade	∞Ω

c) Set the POWER button to ON.

d) Verify that the resistance between the two power cord blades is about 100Ω (for a 110V unit).

For a 220V unit, the resistance should be about 350Ω.

e) Remove the jumper connecting the GROUND ⏚ and ⏚ terminals on the rear panel.

f) Verify the following resistances:

Between:	And:	Resistance:
GROUND ⏚	GROUND ⏚	∞Ω
GROUND ⏚	Chassis	0Ω
GROUND ⏚	Test point TP19 (power supply common)	0Ω

g) Replace the jumper connecting the GROUND ⏚ and ⏚ terminals.

h) Power the unit.

i) Verify that the negative unregulated power rail is between −18V and −26V, and that the positive unregulated power rail is between +18V and +26V.

j) Verify that the outputs of the ±15V regulators at test points TP18 (+) and TP20 (−) are 15.00V ±0.75V.

k) Verify with an oscilloscope that the noise and ripple on the regulated power supply rails is below 4mV peak.

l) Place jumper A in the "DEFEAT" position.

m) With a digital voltmeter, verify that the voltage at test point TP2 is −14.00V ±0.75V.

n) Verify that the voltage at test point TP3 is +14.00V ±0.75V.

o) Place jumper A in the "OPERATE" position.

p) Adjust CLIPPER BIAS trimmer R2 to produce −5.5V ±0.1V at TP2.

q) Verify that the voltage at TP3 is +5.5V ±0.1V.

r) Place jumper A in the "DEFEAT" position.

s) Adjust +3 VOLT trimmer R8 to produce +3V ±0.1V at test point TP14.

t) Verify that the voltage at pin 8 of IC5 is −0.70V ±0.15V.

4) Check the input stages.

a) Connect an audio oscillator to the LEFT IN HI terminal. Set the oscillator's frequency to 1kHz and its output level to −10dBu.

> 0dBu = 0.775V RMS. The dBm/600Ω scale commonly found on test instruments can be read as dBu for this application.

b) Ground the LEFT IN LO terminal.

c) Connect an audio voltmeter and an oscilloscope to E28.

d) Turn the L INPUT ATTEN control fully clockwise.

e) Verify a level of −16.5dBu ±0.5dB at E28.

f) Verify that the signal at E28 is a sine wave of normal appearance.

g) Mute the oscillator, verify that there is no "popcorn" noise or oscillation, then restore the signal.

h) Rotate the L INPUT ATTEN control through its range. Verify smooth and quiet operation of the control.

i) Turn the L INPUT ATTEN control fully clockwise.

j) Remove the ground from the LEFT IN LO terminal.

k) Connect the audio oscillator to both the LEFT IN HI and LEFT IN LO terminals.

l) Verify a common mode cancellation of at least 40dB.

m) Check the right channel input stage by repeating the above for the right channel.

> Substitute the right channel controls and terminals, and E32 for E28.

n) Disconnect the oscillator, voltmeter, and oscilloscope from the Co-Operator.

5) Check VCA stages.

a) Connect the audio oscillator to the LEFT IN HI terminal, and ground the LEFT IN LO terminal. Set the oscillator's frequency to 1kHz and its output level to −10dBu.

b) Connect a THD analyzer, audio voltmeter, and oscilloscope to test point TP7.

c) Set the L LEVEL and L COMPR buttons to OFF. Verify that the L INPUT ATTEN control is turned fully clockwise.

d) Center L GAIN trimmer R129 and L THUMP NULL trimmer R119.

e) Verify a level of +14.0dBu ±2.0dB at TP7.

f) Verify that the signal at TP7 is a sine wave of normal appearance.

g) Adjust L DIST NULL trimmer R124 for minimum THD at TP7. Verify that THD is below 0.05% in a 20–20,000Hz bandwidth.

h) Adjust L GAIN trimmer R129 to produce a +14.0dBu ±0.2dB level at TP7.

i) Disconnect the audio oscillator from the LEFT IN HI terminal and connect to pin 9 of IC5. Set the oscillator's frequency to 1kHz and its output level to −30dBu.

j) Adjust L THUMP NULL trimmer R119 to minimize 1kHz feedthrough (observe the distortion residual on the oscilloscope).

k) Disconnect the audio oscillator from IC5 and connect it to the LEFT IN HI terminal. Set the oscillator's frequency to 1kHz and its output level to 0dBu.

l) Increase the audio oscillator's output level until clipping is observed at TP7. Verify that the oscillator's output level is at least +18dBu when clipping is first seen.

m) Mute the audio oscillator and verify that there is no "popcorn" noise or oscillation.

n) Check the right channel VCA stage by repeating the above for the right channel.

Use the right channel controls, terminals, and trimmers instead of the left, and substitute TP10 for TP7, and pin 12 of IC5 for pin 9 of IC5.

o) Disconnect the THD analyzer, the audio voltmeter, and the oscilloscope from the Co-Operator.

6) Check gate control circuits.

a) Connect the audio oscillator to the LEFT IN HI terminal, and ground the LEFT IN LO terminal. Set the oscillator's frequency to 1kHz and its output level to −10dBu.

b) Set the MODE button to DUAL and turn the L GATE THRESH control fully clockwise.

The L INPUT ATTEN control should still be turned fully clockwise.

c) Mute the oscillator. Verify that the L GATE THRESH indicator (the LED next to the L GATE THRESH control) lights.

d) Increase the audio oscillator's output level until the L GATE THRESH indicator goes out. Verify that this occurs when the level at test point TP7 is +5.0dBu ±1.0dB.

e) Turn the L GATE THRESH control fully counterclockwise.

f) Mute the oscillator, verify that the L GATE THRESH indicator does not light, then restore the signal.

g) Turn both GATE THRESH controls fully clockwise, and turn both INPUT ATTEN controls fully counterclockwise.

h) Verify that both GATE THRESH indicators light.

i) Set the audio oscillator's output level to 0dBu.

j) Slowly turn the L INPUT ATTEN control clockwise until the L GATE THRESH indicator goes out.

k) Set the MODE button to STEREO, verify that the R GATE THRESH indicator goes out.

l) Set the MODE button to DUAL, and turn both GATE THRESH controls fully counterclockwise.

m) Check the right channel gate control circuit by repeating the above for the right channel.

Use the right channel controls, LED, and terminals instead of the left, and substitute TP10 for TP7.

n) Disconnect the audio oscillator from the Co-Operator.

7) Check VCA control circuits and GAIN REDUCTION meters.

a) Connect the audio oscillator to the LEFT IN HI terminal, and ground the LEFT IN LO terminal. Set the oscillator's frequency to 1kHz and its output level to 0dBu.

b) Set the controls as follows:

L INPUT ATTEN	FULLY CLOCKWISE
L GATE THRESH	FULLY COUNTERCLOCKWISE
L RELEASE TIME	FULLY COUNTERCLOCKWISE
L LEVEL	ON
L COMPR	ON
MODE	DUAL

c) Verify that all LED segments of the L GAIN REDUCTION meter light.

d) Set the L REL SHAPE button to HARD.

e) Mute the oscillator, verify that the L GAIN REDUCTION meter reading decays to "0dB" in 7 seconds ±2 seconds, then restore the signal.

f) Turn the L RELEASE TIME control fully clockwise.

g) Mute the oscillator, verify that the L GAIN REDUCTION meter reading decays to "0" in 28 seconds ±5 seconds, then restore the signal.

h) Turn the L RELEASE TIME control fully counterclockwise, and set the MODE button to STEREO.

i) Mute the oscillator, verify that *both* GAIN REDUCTION meters' readings decay, and that the meters track each other closely. Restore the signal.

j) Set the MODE button to DUAL.

k) Set the audio oscillator's output level to −10dBu.

l) Adjust the L INPUT ATTEN control until the second (5dB) LED segment of the L GAIN REDUCTION meter just lights.

m) Connect the audio voltmeter to test point TP7, and observe the level at TP7.

n) Increase the audio oscillator's output level to 10dBu.

o) Verify that the L GAIN REDUCTION meter indicates 25dB gain reduction, and that the level at TP7 is no more than 1.0dB greater than that observed before increasing the oscillator's output level.

p) Set the L REL SHAPE button to SOFT.

q) Mute the oscillator, verify that the L GAIN REDUCTION meter reading decays to "0dB" in 10 seconds ±2 seconds, with the release slowing as it nears "0dB".

Do not restore the signal.

r) Set the L LEVEL button to ON, and the L COMPR button to OFF.

s) Restore the signal, verify that the L GAIN REDUCTION meter indicates 22 to 25dB gain reduction in 2 seconds ±1 second, then mute the oscillator.

t) Set the L LEVEL button to OFF, and the L COMPR button to ON.

u) Restore the signal, and verify that the L GAIN REDUCTION meter indicates 15 to 22dB gain reduction immediately.

v) Mute the oscillator. When the gain reduction begins to diminish, turn the L GATE THRESH control fully clockwise, and verify that the L GAIN REDUCTION meter "freezes" when the L GATE THRESH indicator lights.

w) Turn the L GATE THRESH control counterclockwise, and verify that the L GAIN REDUCTION meter reading begins to decrease when the L GATE THRESH indicator goes out.

x) Check the right channel VCA control circuit and GAIN REDUCTION meter by repeating the above for the right channel.

Use the right channel controls, terminals, LED, and meter instead of the left, and substitute TP10 for TP7.

8) Check high-frequency limiters. (part 1)

a) Connect the audio oscillator to the LEFT IN HI terminal, and ground the LEFT IN LO terminal. Set the oscillator's frequency to 1kHz and its output level to −10dBu.

b) Set controls, trimmers, and jumpers as follows:

L HF LIMIT	OPERATE
L *and* R PRE-EMPHASIS	150
HF LIMITER DIST NULL TRIMMER R182	CENTER
FET BIAS TRIMMER R204	FULLY CLOCKWISE
JUMPER A	DEFEAT
JUMPER B	FLAT

c) Connect a THD analyzer, audio voltmeter, and oscilloscope to test point TP8.

d) Adjust the L INPUT ATTEN to produce a level of 0.0dBu ±0.5dB at TP8.

e) Verify that the signal at TP8 is a sine wave of normal appearance.

f) Mute the oscillator, verify that there is no "popcorn" noise or oscillation, then restore the signal.

g) Slowly turn L FET BIAS trimmer R204 counterclockwise until the level at TP8 begins to decrease. Then turn R204 clockwise until the level at TP8 stops increasing. Turn R204 clockwise about 1/10-turn further.

h) Set the oscillator's frequency to 5kHz and its output level to 0dBu.

i) Adjust L HF LIMITER DIST NULL trimmer R182 for minimum THD. Verify that THD does not exceed 0.06% in a 20–20,000Hz bandwidth at TP8.

j) Set the oscillator's frequency to 1kHz, and verify that the L HF LIMIT indicator does not light.

k) Set the oscillator's frequency to 10kHz, and verify that the L HF LIMIT indicator lights.

l) Set the L HF LIMIT button to DEFEAT, and verify that the L HF LIMIT indicator goes out.

m) Observe the level at TP8, then set the audio oscillator's frequency to 1kHz, and verify that the level at TP8 increases by about 10dB.

n) Turn the L INPUT ATTEN fully counterclockwise.

9) Check high-frequency limiters. (part 2)

a) Place jumper A in the "OPERATE" position, and jumper B in the "PRE-EMPHASIZED" position.

b) Set the oscillator's frequency to 10kHz and its output level to +10dBu.

c) Slowly turn the L INPUT ATTEN control clockwise, and verify (on the oscilloscope) that symmetrical clipping occurs at 5.5V peak.

5.5V peak is approximately equivalent to 4V RMS or +14dBu.

d) Place jumper A in the "DEFEAT" position, and verify that the clipping disappears.

e) Turn the L INPUT ATTEN control fully clockwise, and set the L HF LIMIT button to OPERATE.

f) Place jumper B in the "FLAT" position.

g) Disconnect the audio oscillator from the Co-Operator.

h) Connect the tracking generator output of the spectrum analyzer to the LEFT IN HI terminal (ground the LEFT IN LO terminal). Set the spectrum analyzer for a 20–20,000Hz log sweep and a 2dB/division display. Adjust the generator's output level until the HF LIMIT indicator does not light.

i) Connect the spectrum analyzer's input to TP8.

j) Verify a flat response (±0.25dB) for each position of the L PRE-EMPHASIS switch.

k) Set the L PRE-EMPHASIS switch to 25µs.

l) Slowly increase the tracking generator's output level until limiting action is clearly visible.

m) Verify that the limiting action is as shown in Fig. 4-1 for each position of the L PRE-EMPHASIS switch.

n) Check the right channel high-frequency limiter by repeating the above (both parts 1 and 2) for the right channel.

> Use the right channel controls, terminals, LED, trimmers, and meter instead of the left, and substitute TP9 for TP8, TP10 for TP7, and jumper C for jumper B.

o) Disconnect the spectrum analyzer from the Co-Operator.

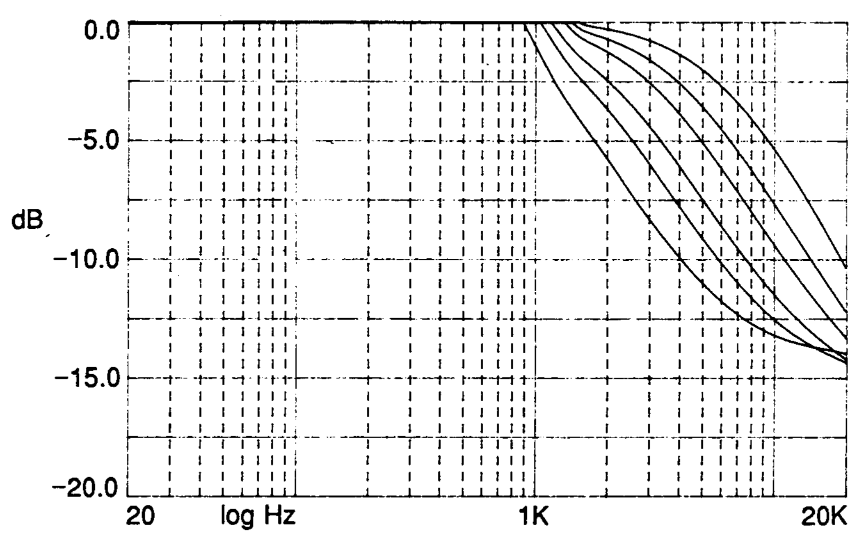


Fig. 4-1: Limiting Curves (see step 9m)

10) Check the output stages and PEAK OUTPUT LEVEL meters.

a) Turn the L OUTPUT ATTEN control fully clockwise, and set the L HF LIMIT and L SYSTEM buttons to OPERATE.

b) Verify that the DC offset between the LEFT OUT HI and LEFT OUT ⏚ terminals is less than 15mV. Verify that the DC offset between the LEFT OUT LO and the LEFT OUT ⏚ terminals is less than 15mV.

There should be no signal applied to the inputs.

c) Verify (with the oscilloscope) that both the LEFT OUT HI and the LEFT OUT LO are free of "popcorn" noise or oscillation when observed against ground.

d) Connect the audio oscillator to the LEFT IN HI terminal, and ground the LEFT IN LO terminal. Set the oscillator's frequency to 1kHz and its output level to -10dBu.

e) Set the L LEVEL and L COMPR to OFF, and the L HF LIMIT button to DEFEAT.

f) Load the LEFT OUT terminals with a 600Ω resistor.

A 620Ω ½-watt resistor will do.

g) Connect the audio voltmeter across the LEFT OUT HI and LEFT OUT LO terminals.

h) Connect the oscilloscope to the LEFT OUT terminals.

i) Advance the L INPUT ATTEN until slight clipping is observed, then disconnect the oscilloscope. Verify that the output level is at least +19.0dBu.

j) Turn the L METER CAL control fully clockwise.

k) Rotate the L OUTPUT ATTEN control though its range. Verify that the output level varies correspondingly, and that all segments of the L PEAK OUTPUT LEVEL meter light when the control is turned fully clockwise.

l) Rotate the L METER CAL control through its range. Verify that the L PEAK OUTPUT LEVEL meter reading varies correspondingly.

m) Remove the 600Ω resistor from the LEFT OUT terminals.

n) Check the right channel output stage and PEAK OUTPUT LEVEL meter by repeating the above for the right channel.

Use the right channel controls, terminals, and meter instead of the left.

o) Disconnect the audio oscillator, audio voltmeter, and oscilloscope from the Co-Operator.

11) Check overall performance.

a) Turn the L INPUT ATTEN and L OUTPUT ATTEN controls fully clockwise, turn the L GATE THRESH control fully counterclockwise, and set the HF LIMIT button to OPERATE.

b) Short both the LEFT IN HI and LEFT IN LO terminals to ground.

c) Connect the audio voltmeter to the LEFT OUT HI terminal.

d) Verify that the residual noise at the LEFT OUT HI terminal is below −67dBu in a 20–20,000Hz bandwidth.

e) Remove the jumper(s) between the LEFT IN HI and LEFT IN LO terminals and ground.

f) Set the L LEVEL and L COMPR switches to OFF.

g) Connect the audio oscillator to the LEFT IN HI terminal. Set the oscillator's frequency to 1kHz and its output level to −10dBu.

h) Adjust the L INPUT ATTEN to produce a +18.0dBu ±0.5dB level at the LEFT OUT HI terminal.

i) Connect the THD analyzer to the LEFT OUT HI terminal.

j) Verify that the THD is below 0.06% in a 20–20,000Hz bandwidth.

k) Set the L LEVEL and L COMPR buttons to ON, the HF LIMIT button to OPERATE, and the L RELEASE TIME control to 5.

l) Adjust the L INPUT ATTEN to produce 10dB gain reduction.

m) Verify that THD is below 0.05% in a 20–20,000Hz bandwidth with the audio oscillator set to 35Hz, 2kHz, and 15kHz.

n) Check the overall performance of the right channel by repeating the above for the right channel.

Use the right channel controls and terminals instead of the left.

o) Disconnect all test instruments from the Co-Operator.

12) Restore controls and internal jumpers.

Return all controls and jumpers to the positions recorded in step 2.

13) Replace the top cover.

Replace all six screws that hold it in place.

Section 5
Troubleshooting

page contents

5-2 Problems and Possible Causes

5-3 Technical Support
5-4 Factory Service
5-4 Shipping instructions

CAUTION

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

Problems and Possible Causes

Always verify that the problem is not in the source material being fed to the Co-Operator, or in other parts of the system.

RFI, hum, clicks, or buzzes:

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

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

Power supply problems:

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

Regulators IC8 and IC7 are frequency-compensated by C4, C5 at their outputs to prevent high-frequency oscillations. If C4 or C5 is ever replaced, be sure to use a low-inductance aluminum electrolytic. (A tantalum can fail because the current-delivering capacity of the power supply can cause a runaway condition if the dielectric is punctured momentarily; a high-inductance aluminum can fail to prevent a regulator from oscillating.) Check for oscillation on the power bus with an oscilloscope if C4 or C5 is replaced.

Poor peak control:

Check that the peak clippers are enabled: jumper A on the main circuit board should be in the "OPERATE" position (see Fig. 2-1).

Apparent peak control problems may actually result from problems with the device the Co-Operator is driving. A digital tape recorder or FM transmitter, for example, could introduce overshoot and ringing. A device with poor frequency response might cause "tilt" with low-frequency material. Be sure that the instrument used to measure the peak output of the Co-Operator (or the device it is driving) has accurate transient response and dynamic accuracy.

Shrill, harsh sound:

This could be caused when the Co-Operator is supplying pre-emphasis to a device that doesn't need it. If the device driven by the Co-Operator does not require pre-emphasis, place jumpers B and C on the main circuit board in the "FLAT" position (see Fig. 2-1).

Noise pumped up during pauses:

The GATE THRESH controls are probably set too low. See "Example Control Settings" beginning on page 3-4.

Audible distortion:

First make sure that the program material presented to the Co-Operator's inputs is clean and distortion-free.

If the GAIN REDUCTION meters' red segments are lighting, reduce the amount of gain reduction. See Section 3, especially the discussion of "Leveling and compression" on page 3-8.

If distortion can still be heard, check if the clipping bias has been adjusted below ±5.5VDC (see step 5 on page 2-10). Such a clipping bias will introduce slight audible distortion on some program material. Measure the clipping bias at test points TP2 (−) and TP3 (+) with jumper A in the "OPERATE" position. CLIPPER BIAS trimmer R2 adjusts the bias. (See assembly drawing in Section 6 for locations of components).

Technical Support

If the above troubleshooting procedures don't help you solve your problem, contact Orban Customer Service. Be prepared to accurately describe the problem, including the results of diagnostic tests you have performed. Know the serial number of your 464A.

Telephone: (1) 510/351-3500

or Fax: (1) 510/351-0500

or Write:

Customer Service
Orban
a division of AKG Acoustics, Inc.
1525 Alvarado Street
San Leandro, CA 94577 USA

Factory Service

Always contact Customer Service before returning a product to the factory for service. Often, a problem is due to misunderstanding, or is relatively simple and can be quickly fixed after telephone consultation.

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

Please refer to the terms of your Orban One-Year Standard Warranty, which extends to the first end-user. After expiration of the warranty, a reasonable charge will be made for parts, labor, and packing if you choose to use the factory service facility. Repaired units will be returned C.O.D. In all cases, transportation charges (which are usually quite nominal) are paid by the customer.

Shipping Instructions

Use the original packing material if it is available. If it is not, use a sturdy, double-wall carton no smaller than 22" x 12" x 5" (56cm x 30cm x 13cm) with a minimum bursting test rating of 200 pounds. Place the chassis in a plastic bag (or wrap it in plastic) to protect the finish, then pack it in the carton with at least 1.5" (4cm) of cushioning on all sides of the unit. "Bubble" packing sheets, foam "popcorn", thick fiber blankets, and the like are acceptable cushioning materials; folded newspaper is not. Wrap cushioning materials tightly around the unit and tape them in place to prevent the unit from shifting out of its packing. Close the carton without sealing it and shake it vigorously. If you can hear or feel the unit move, use more packing. Seal the carton with 3" (8cm) reinforced fiberglass or polyester sealing tape, top and bottom in an "H" pattern. Narrower or parcel-post type tapes will not withstand the stresses applied to commercial shipments.

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

DELICATE INSTRUMENT, FRAGILE!

Insure the package appropriately. Ship prepaid, *not collect.* Do not ship parcel post. Your **Return Authorization number** must be shown on the label, or the package will *not* be accepted.

Section 6
Technical Data

page contents

6-2 Specifications

6-4 Circuit Description
6-4 1. Overview
6-5 2. Input Buffer
6-6 3. Voltage-controlled Amplifiers
6-8 4. Leveler/Compressor Control
6-10 5. High-frequency Limiter
6-11 6. Peak Output Level Meter
6-12 7. Power Supply

6-13 Parts List

6-20 Schematics, Assembly Drawings

6-26 Abbreviations

Specifications

Performance

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

RMS noise (20–20,000Hz): >85dB (90dB typical) below output clipping threshold with high-frequency limiter strapped for flat output.

Interchannel crosstalk: Better than −60dB at 15kHz (−67dB typical), falling at 6dB/octave below 15kHz.

Installation

Audio Input

Impedance: >10K ohms, active balanced, EMI-suppressed.

Operating level: Usable with −10dBu to +8dBu lines.

(0dBu = 0.775V RMS; for this application, the dBm @ 600Ω scale on voltmeters can be read as if were calibrated in dBu.)

Connectors: Barrier strip (#5 screws) in parallel with 1/4" tip-ring-sleeve (TRS) phone jacks and XLR-type jacks.

Audio Output

Impedance: 30 ohms (93 ohms for units with serial numbers below 1306000), electronically balanced and floating to simulate true transformer output. Minimum load impedance is 600 ohms. Output can be unbalanced by grounding one output terminal.

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

Connectors: Barrier strip (#5 screws) in parallel with 1/4" TRS phone jacks and XLR-type jacks.

Physical

Buttons: "Wink-eye" type — end of buttons turn white when pressed in.

Meters: Four 10-segment LED bargraph displays show gain reduction and peak output level for each channel.

Indicators: Four LEDs light to show operation of gating or high-frequency limiting.

Dimensions: 19" (48.3 cm) wide, 9⅝" (24.5 cm) deep, 1¾" (4.5 cm) high.

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

Power requirements: 115/230 volts AC ±10%, 50–60Hz, 16VA. Three-wire "U-Ground" plug (USA standards) or CEE7/7 plug (Continental Europe) attached. EMI-suppressed.

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

Options

Security cover (acrylic): To prevent unauthorized adjustment of controls. Order SC1 CLEAR for a clear cover, SC1 BLUE for a transparent blue cover, or SC1 WHITE for an opaque white cover.

Audio Processing Circuitry

Leveler/Compressor

Attack time: Approximately 200ms for leveler, 5ms for compressor; program-dependent.

Release time: Adjustable between approximately 1dB/sec and 5dB/sec; program-dependent. Below 10dB gain reduction, either a constant dB/sec release rate (HARD RELEASE SHAPE) or an exponentially declining rate (SOFT RELEASE SHAPE) may be selected.

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

Range of gain reduction: 25dB.

Interchannel tracking: ±0.5dB (with MODE button set to STEREO).

Total harmonic distortion: <0.05% at 1kHz (with RELEASE TIME controls centered and 15dB gain reduction). Typically <0.1% at 20Hz, <0.03% at 100–2,000Hz, <0.05% at 2,000–10,000Hz, and <0.1% at 10,000–20,000Hz.

SMPTE intermodulation distortion: <0.05% (60/7,000Hz 4:1 with 15dB gain reduction).

Gain reduction element: Class-A proprietary VCA.

High-frequency Limiter

Pre-emphasis: Six switch-selectable 6dB/octave pre-emphasis curves: 25, 37.5, 50, 75, 100, and 150µs. Can be strapped for flat or pre-emphasized output. An defeatable peak clipper can enforce an absolute peak ceiling on the (pre-emphasized) output of the HF limiter.

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

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

Release time: Approximately 30ms, program-dependent.

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

Gain reduction element: Junction FET.

HF limiting curve: Shelving, 6dB/octave.

Warranty

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

Specifications subject to change without notice.

Circuit Description

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

The circuitry is described in six major blocks: input buffer, VCA (voltage-controlled amplifier), leveler/compressor control, high-frequency limiter, PEAK OUTPUT LEVEL metering, and power supply.

Whenever circuitry is duplicated for the left and right channels, *only the left channel* will be described. The schematic at the end of this section also shows only the left channel (left channel components are numbered 100 through 299; right channel components have corresponding numbers in the 300–499 range; power supply and shared components are numbered 0–99).

1. Overview

The **block diagram** on page 6-21 illustrates the following overview of Co-Operator circuitry.

The signal, which enters the Co-Operator in a balanced form, receives moderate **RF suppression,** then is applied to a very low-noise opamp configured as an "**active transformer**".

The current-controlled gain block used in the Co-Operator is a proprietary class-A **voltage-controlled amplifier** (VCA). It operates as a two-quadrant analog divider with gain *inversely* proportional to a current injected into a first gain-control port, and is cascaded with a two-quadrant analog multiplier with gain *directly* proportional to a current injected into a second gain-control port. Any "**thumps**" due to control current feedthrough are eliminated by applying DC offset the VCA's input.

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

The proprietary leveler/compressor **timing module** generates a control signal that enables the Co-Operator to achieve natural-sounding control and very low modulation distortion. The RELEASE TIME **control** allows a 5:1 variation in the basic release dynamics, which are determined by the timing module on the basis of the past history of the input.

The RELEASE SHAPE **button,** when set to HARD, causes recovery to proceed at a constant rate (in dB/second) regardless of the absolute gain reduction. When the button is set to SOFT, recovery proceeds at a constant rate from 25 to 10dB gain reduction, and then progressively slows as the gain reduction approaches 0dB.

A **gating detector** monitors the level of the Co-Operator's input signal, and activates the gate if this level drops below a threshold set with the GATE THRESHold control.

The GAIN REDUCTION **meter** consists of ten comparators arranged to produce a meter with a linear scale (calibrated in dB).

High-frequency limiting is effected by applying the output of the leveler/compressor to a bandpass filter. When summed with its input, the output of this filter provides a 6dB/octave **pre-emphasis** up to 20kHz. The +3dB breakpoint frequency for the pre-emphasis is determined by the amount of bandpass output that is summed with the input signal — the greater the contribution from the bandpass output, the lower the breakpoint frequency.

The contribution from the bandpass output is determined by the HF LIMIT PRE-EMPHASIS **switch** and by circuitry which can dynamically reduce the pre-emphasis to effect the high-frequency limiting function.

The output of the high-frequency limiter is applied to a **clipper which provides absolute peak control** at the Co-Operator's output when the HF LIMIT **button** is set to OPERATE. (When it is set to DEFEAT, absolute peak control is effected by controlled clipping in the leveler/compressor's VCA.)

If the subsequent **de-emphasis** has been jumpered out, the absolute peak ceiling at the Co-Operator's output will be independent of frequency; if de-emphasis is applied, the peak ceiling will be frequency-dependent, falling at 6dB/octave beyond the break frequency determined by the setting of the HF LIMIT PRE-EMPHASIS switch.

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

Unregulated voltage is supplied by two pairs of full wave diode rectifiers. **Regulated** voltages are supplied by a pair of overrated 500mA "three-terminal" IC regulators.

2. Input Buffer

The signal enters the Co-Operator in balanced form, receives modest **RF suppression**, then is applied to a very low-noise opamp configured as a differential amplifier with a 0.5 gain. When both non-inverting and inverting inputs are driven by a source impedance which is small with respect to 100K (as 600 ohms or less would be), 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 *difference* between the non-inverting and inverting inputs. It therefore serves as an "**active transformer**".

Since the INPUT ATTENuator control is located *after* the opamp, the opamp will overload if its differential input exceeds approximately +26dBu (0dBu = 0.775V RMS; for this application, the dBm @ 600Ω scale on voltmeters can be read as if were calibrated in dBu).

Component-level description:

C101, C102 shunt RF from the input leads to the chassis. Since these capacitors are not effective at VHF and higher frequencies, ferrite beads have been placed around the input and output leads to suppress such high-frequency RF. Although this **RF suppression** is modest, it should be adequate for the vast majority of installations.

The filtered signal is applied to **opamp** IC108a.

3. Voltage-Controlled Amplifiers

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

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

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

The basic current-controlled gain in the leveler/compressor is inversely proportional to the **control current** generated by the leveler/compressor control circuitry. The gain is made proportional to a control voltage in dB by an **exponential current converter**.

Component-level description:

The first gain-control port is pin 6 of IC105b; the second gain-control port is pin 3 of IC105a.

IC105 is the specially-graded Orban IC containing two matched **non-linear gain-control blocks** with differential inputs and current outputs. The separate **opamp** in the feedback loop is IC106.

The output of IC106 is first attenuated by R120, R121, C109, and then applied to the input of the feedback element IC105b at pin 9. The output of IC106 is **pre-distorted** as necessary to force the current *output* of IC105b to precisely and linearly cancel the audio input into the "virtual ground" summing junction of IC106. This same pre-distorted voltage is also connected to the input of IC105a at pin 16. Thus the output of IC105a at pin 13 is an undistorted current. This current is converted to a voltage in current-to-voltage converter IC107, R128, L GAIN TRIM R129, and C111. The output of IC107 at pin 1 is the output of the VCA.

The VCA behaves like a **two-quadrant analog *divider*** when the control current from Q101 is applied to the control port (pin 6) of IC105b. The **gain-control current** injected into this control port is developed by the leveler/compressor control circuitry.

The gain of IC105a is fixed by the current through R125.

Second-harmonic distortion is introduced by differential offsets in either section of IC105. This distortion is canceled by applying a nulling voltage directly to the input of IC105a by means of resistor network R122, R123, and **L DIST NULL trimmer** R124.

The "**thumps**" which can occur if the VCA is not perfectly balanced, are equivalent to multiplying the control current by DC. An adjustable DC offset is applied to the VCA input provided by R118 and **L THUMP NULL trimmer** R119 for nulling this equivalent DC multiplication to zero.

C107, C108, R116, R117 provide **frequency-compensation** to prevent the VCA from oscillating supersonically.

The basic leveler/compressor control current is transformed into a gain which is proportional to a control voltage in dB by **exponential current converter** IC5 and associated components.

IC6b, IC5, and associated components (on the second page of the schematic) form a **log/antilog multiplier** which multiplies the current flowing in R9 by the exponential of the voltage on the base of IC5 (pin 9). The current gain of the multiplier (and thus the output current of the exponential converter) increases as the voltage on the base of IC5 (pin 9) becomes more positive. Note that the **reference −0.7VDC source** developed at the output of IC6b is used for both the left and right channels.

The current output of the log/antilog multiplier appears on the collector of IC5 (pin 11). Since it is the wrong polarity and level to correctly drive the control-current port of IC105b, it is applied to **current inverter** IC4a, Q101, R149, R150, C116. This circuit has a gain of 6.66×, and operates as follows:

A voltage proportional to the current output of IC5 (pin 11) is developed across R150 because of the feedback action of IC4. C116 **stabilizes IC4a** against oscillations. Feedback forces IC4's − and + inputs to be at the same voltage. Thus, the same voltage that appears across R150 also appears across R149, and current flows in R149 in proportion to the ratio between the values of R150 and R149.

This current flows out of the + input line of IC4a into the emitter of Q101. Because Q101's base current is small compared to its emitter current, essentially the same current flows out of Q101's collector into the gain-control port of IC105b.

Since the base of Q101 is grounded, its emitter therefore sits at +0.6V. This forces both + and − inputs of IC4 to also sit at +0.6V, and ensures correct **bias voltage** for IC5's collector (pin 11).

CR106 protects Q101 from **reverse base-emitter voltage** which otherwise could cause junction breakdown and latch-up of the entire current-inverter circuit.

4. Leveler/Compressor Control

The **leveler/compressor** is a feedback circuit: the gain-controlled output of the leveler/compressor is used to develop a **gain-control signal** that is applied to the leveler/compressor gain-control port of the VCA. This arrangement results in superior stability of characteristics with time and temperature, extremely low distortion, and optimized control-loop dynamic response.

The output of opamp in the VCA is applied to two rectifiers with threshold. One serves as the **leveling rectifier**, and the other is the **compression rectifier**. The two rectifiers have different thresholds and attack times.

The rectifiers feed the leveler/compressor **timing module**, which contains proprietary circuitry that outputs a control voltage with dynamics appropriate to achieving natural-sounding control and very low modulation distortion. The output of the module can be wired in a logical "OR" circuit with other such modules to effect stereo tracking of an arbitrary number of channels.

The **RELEASE TIME control** allows a 5:1 variation in the basic release dynamics, which are determined by the timing module on the basis of the past history of the input.

The **RELEASE SHAPE button,** when set to HARD, causes recovery proceeds at a constant rate (in dB/second) regardless of the absolute gain reduction. When the button is set to SOFT, recovery proceeds at a constant rate from 25 to 10dB gain reduction, and then progressively slows as the gain reduction approaches 0dB.

A **gating detector** monitors the level of the Co-Operator's input signal, and activates the gate if this level drops below a threshold set with the GATE THRESHold control.

The **GAIN REDUCTION meter** consists of ten comparators with current regulators at their outputs. The comparators are arranged to produce a meter with a linear scale. The ten LEDs in the bargraph are connected in series.

Component-level description:

The output of IC106 in the VCA is applied to two rectifiers with threshold in IC109. The two halves of IC109 are both conventional full-wave rectifiers. IC109b is the **leveling rectifier**; IC109a is the **compression rectifier. Threshold currents** are applied through R159, R166. **Attack times** are determined by R167, R169 (compression) and R160, R162 (leveling). Any DC offsets at IC106's output are blocked by C118, C119.

The output of the **timing module** is a low-impedance unidirectional voltage source, positive-going with increasing gain reduction (scale factor of approximately 0.4V/dB). 0V corresponds to 0dB gain reduction. Approximately +10V corresponds to the maximum available gain reduction (25dB).

The **gain control voltage** is averaged over the long term (30 seconds or so) by R153, C117. This average is buffered by IC110b, and appears at pin 7 in low-impedance form. Under gated conditions (when the gating FET Q103 is turned off by pulling its gate towards −15 volts), the gain control voltage is forced to move slowly towards this average by being routed to the timing module through R154.

IC110a and diode-connected transistor Q104 form a **precision clamp** that prevents the gain control voltage from going below ground.

The **gate is activated** when the output of IC115b at pin 7 is negative, and **defeated** when it is positive.

The **input level detector** is a half-wave negative peak detector, consisting of IC115a and associated components. The input line is connected to the + input of IC115a at pin 3. IC115a's pin 1 output charges C106 through CR101 and R108. The voltage across C106 is fed back to IC115a's – input (pin 2) through voltage divider R107, R106, which also serves to discharge C106 in the absence of signal, thus determining the recovery time of the detector.

The voltage at C106 (representing 46× the negative peak value of the Co-Operator's input signal after input attenuation) is applied to the – input of IC115b at pin 6. IC115b is operated as a comparator with hysteresis. The **comparator threshold** is a voltage developed at IC115b's + input (pin 5) through resistor network R109, R110, R111, R112, and L GATE THRESH control R113. When the voltage at IC115b's – input (pin 6) is more positive than the voltage at its + input, IC115b's pin 7 output goes negative and the gate turns on. Feedback for hysteresis is provided through R110. The negative threshold voltage at IC115b's +input (pin 5) is adjusted by R113. R109 is connected to the +15V supply to ensure that turning R113 fully counter-clockwise will force the voltage at IC115b's + input (pin 5) slightly *positive* and turn the gating function off, since the voltage across C106 (applied to IC115b's – input at pin 6) can never go positive. In **gated** conditions, Q103 is pinched off by pulling its gate to a high negative voltage through CR102. This opens the release time path and permits IC110b (pin 7) to inject a voltage into R154 that forces the output voltage of the timing module to drift towards the average of the last thirty seconds of gain control voltage.

In **ungated** conditions, CR102 is off, Q103's gate is clamped to the same voltage as its source through R155, and Q103 becomes equivalent to a low resistance. Since Q103's source is driven from a low impedance, the effect of R154 is entirely swamped out, and RELEASE TIME control R157 is permitted to conduct normally.

The dB-linear gain reduction voltage is attenuated by R210, R209 such that +3V = 25dB gain reduction. The attenuated voltage is mixed with a 50 or 60Hz "dither" signal through C128, R211 (connected to the power transformer secondary), and then applied to the input of LM3914 **bargraph driver** IC116.

The LM3914 bargraph consists of ten comparators with current regulators at their outputs. The comparators are arranged to produce a meter with a linear scale. The LM3914 applies current (through any one of pins 1 through 10) to the appropriate node to light the desired LEDs.

Q107 is used as a zener diode to reduce the supply voltage to the LM3914 so that it is within the chip's 25V maximum rating. R212 sets the current through the LED bargraph.

The LM3914 has an internal string of series resistors that provide reference voltages for its ten comparators. The bottom of this string is grounded at pin 4; the top of the string is provided with +3.00VDC from pin 1 of IC6a.

C127 bypasses the LM3914 power supply to prevent the LM3914 from oscillating.

5. High-Frequency Limiter

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

The contribution from the bandpass output is determined by the **HF LIMIT PRE-EMPHASIS switch** and by circuitry which can dynamically reduce the pre-emphasis to effect the high-frequency limiting function.

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

The output of the high-frequency limiter is applied to a **clipper which provides absolute peak control** at the Co-Operator's output provided that the HF LIMIT button is set to OPERATE. (If it is set to DEFEAT, absolute peak control is effected by controlled clipping in the leveler/compressor's VCA.)

If the subsequent **de-emphasis** has been jumpered out, the absolute peak ceiling at the Co-Operator's output will be independent of frequency; if de-emphasis is applied, the peak ceiling will be frequency-dependent, falling at 6dB/octave beyond the break frequency determined by the setting of the HF LIMIT PRE-EMPHASIS switch. The high-frequency limiter is flat ±0.1dB to 20kHz, and falls at 12dB/octave thereafter when de-emphasis is applied.

Component-level description:

The **bandpass filter** consists of IC102b and associated circuitry. Bandpass response can be measured at pin 7 (or at test point TP4).

The contribution from the bandpass output is determined by the gain of a **voltage divider**, the gain of which is adjusted with **HF LIMIT PRE-EMPHASIS switch** S106. The contribution of the bandpass filter to the output is further determined by the resistance of JFET IC3, which can dynamically reduce the pre-emphasis to effect the high-frequency limiting function.

The loss in the voltage divider is compensated for by IC104, which has a gain of 29dB. The output of IC104 (representing the bandpassed signal) is summed with the input signal in IC103a to create the **pre-emphasized signal.**

The **+3dB breakpoints** that correspond to the time constant calibrations for the HF LIMIT PRE-EMPHASIS switch are: 1.06kHz for 150µs, 1.59kHz for 100µs, 2.12kHz for 75µs, 3.18kHz for 50µs, 4.24kHz for 37.5µs, and 6.37kHz for 25µs.

The positive and negative peak levels of the pre-emphasized signal are evaluated by two comparators in IC1. If either exceeds the ±3.0V **threshold** voltages established by R198–R201, the appropriate comparator fires. Each comparator has an open collector NPN output stage and charges the high-frequency limiter **timing module** negative through attack time resistor R203.

C125, R202 form the 6dB/octave **high-pass filter** which prevents the high-frequency limiter from being activated on low-frequency program material.

In the absence of high-frequency gain reduction, the output of the high-frequency limiter **release time module** (at pin 2) is biased at a positive voltage determined by **L FET BIAS trimmer** R204. This pinches off IC3.

When high-frequency gain reduction occurs, the voltage at pins 2 and 7 of the high-frequency limiter release time module goes more negative than the quiescent voltage, turning on IC3 and resulting in less and less **pre-emphasis**. Pre-emphasis is dynamically decreased until comparator IC1 no longer fires, indicating that the high-frequency overload has been removed.

IC101 drives the **HF LIMIT LED**. The FET control voltage is applied to IC101's pin 6; the quiescent FET bias is applied to pin 5. In addition, IC101's pin 5 is offset by current flowing through R207, which forces IC101's pin 5 to be more negative than its pin 6, and causes pin 7 of IC101 to go low (close to ground). When the voltage on pin 6 becomes more negative than pin 5 due to high-frequency gain reduction, pin 7 goes high, lighting HF LIMIT LED DS102. Q106 serves as a zener diode to ensure that DS102 is off when IC101's pin 7 is close to ground.

The output of the high-frequency limiter is applied to clipper R191, CR113, CR114. The subsequent **de-emphasis** is provided by C126 and associated switched resistors.

The **clippers are biased** with temperature-compensated ±5.5VDC source IC2 and associated components. The clippers can be defeated by forcing the ±5.5VDC supply to the power supply rails by placing jumper A in the "DEFEAT" position.

6. PEAK OUTPUT LEVEL Meter

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

Component-level description:

The output of IC111a (pin 1) is applied through the **METER CAL control** R218 to amplifier IC113a. The output of IC113a is rectified by an inverting half-wave precision rectifier IC113b and associated components. Double the output of the rectifier is summed (through R217) with its input to create a **full-wave rectified signal** at the + input of IC114b (pin 5). The rectifier has a voltage gain of 0.89.

IC114b operates as a **dual-time constant peak detector**. A DC voltage equal to the peak value of the rectified signal at pin 5 of IC114b is developed at the top of C129, which is charged by IC114b's pin 7 through diode-connected transistor Q109. IC114a buffers this voltage and provides feedback to IC114b's pin 6, "telling" IC114b how to charge C129, C130 so that the peak value of the waveform on IC114b's pin 5 is accurately followed.

To achieve the very fast response desired, the **peak-holding capacitors** C129 and C130 are relatively small. To achieve a sufficiently slow recovery time with a practical value resistor (R222 = 22meg), R222 is bootstrapped to the output of IC114a through R223. R224 introduces enough DC offset to produce approximately 0.5V across R222 at all times. This multiplies the effective value of R222 by about 30, and slows down the recovery time as desired.

The output of peak detector IC114a (pin 1) is applied to LM3916 **bargraph driver** IC117. Other than the fact that this IC provides a VU (rather than a linear) scale, its operation is identical to the operation of the LM3914 used in the IC116 socket (see above).

7. Power Supply

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

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

Component-level description:

The two pairs of full-wave diode rectifiers that supply **unregulated voltage** located in package CR3. The rectifier pairs drive energy storage capacitors C2 and C3. The power transformer T1 can be strapped for either 115-volt or 230-volt operation (the two sections of the primary are paralleled for 115-volt operation and connected in series for 230-volt operation).

The pair of ICs which supply regulated voltages are "three-terminal" IC regulators IC8, IC7. IC8 and IC7 are frequency-compensated by C4, C5 at their outputs to prevent high-frequency oscillations. Small 0.1µF/25V ceramic capacitors bypass the power busses to ground locally throughout the board to prevent signal-carrying ICs from oscillating due to excessive power-lead inductance.

(If replaced, C4 and C5 *must* be replaced by low-inductance aluminum electrolytic capacitors *only* — see "Power supply problems" on page 5-2.)

Parts List

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

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

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

(BV: 75V min. @ $I_r = 5V$ I_r: 25nA max. @ $V_r = 20V$ V_f: 1.0V max. @ $I_f = 100mA$ t_{rr}: 4ns max.) See Miscellaneous list for **ZENER DIODES** (reference designator VRxx).

RESISTORS should only be replaced with the same style and with the *exact* value marked on the resistor body. If the value marking is not legible, consult the schematic or the factory. Performance and stability will be compromised if you do not use exact replacements. Unless listed by reference designator in the following parts list, resistors are:

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

Carbon film resistors have conformally-coated bodies, and are identified by four color bands. They are rated at ¼ watt @ 70°C, ±5%. Orban part numbers 20001-xxx, Manufactured by R-Ohm (R-25), Piher, Beyschlag, Dale, Phillips, Spectrol, Matsushita.

Carbon composition resistors have molded phenolic bodies, and are identified by four color bands. The 0.090" × 0.250" (2.3mm × 6.4mm) size is rated at ¼ watt, and the 0.140" × 0.375" (3.6mm × 9.5mm) size is rated at ½ watt, both ±5% @ 70° C. Orban part numbers 2001x-xxx, USA Military Specification MIL-R-11 Style RC-07 (¼ watt) or RC-20 (½ watt). Manufactured by Allen-Bradley, TRW/IRC, Matsushita.

Cermet trimmer resistors have ⅜" (9mm) square bodies, and are identified by printing on their sides. They are rated at ½ watt @ 70°C, ±10%, with a temperature coefficient of 100 PPM/°C. Orban part numbers 20510-xxx and 20511-xxx. Manufactured by Beckman (72P, 68W- series), Spectrol, Matsushita.

Obtaining spare parts:

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

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

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

To facilitate future maintenance, parts for this unit have been chosen from the catalogs of well-known manufacturers whenever possible. Most of these manufacturers have extensive worldwide distribution and may be contacted through their local offices. Their USA headquarters addresses are given on page 6-19.

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

PCB MAIN ASSEMBLY

Capacitors

REF DES	DESCRIPTION	ORBAN P/N	VEN (1)	VENDOR P/N	ALTERNATE VENDORS (1)	NOTES
C1	Monolythic Ceramic, 50V, 20%; 1.0uF	21123-510	SPR	2C25 Z5U105M050B		
C2,3	Alum., Axial, 40V; 470uF	21224-747	SIE	B41283 470 40	PAN	
C4,5	Alum., Radial, 25V; 100uF	21206-710	PAN	ECE-A1EV101S		
C6-23	Monolythic Ceramic, 50V, 20%; 0.1uF	21123-410	SPR	1C25 Z5U104M050B	KEM	
C103,104	Alum., Radial, 50V; 47uF	21208-647	SPR	502D 476G050CD1C	PAN	
C105	Met. Polyester, 100V, 10%; 1.0uF	21441-510	WIM	MKS-4100V5.1.0	WES,SIE	
C106	Met. Polyester, 100V, 10%; 0.1uF	21441-410	WIM	MKS-4100V5.0.1	WES,SIE	
C107,108	Mica, 500V, 5%; 150pF	21020-115	CD	CD15-FD151J03	SAN	
C109	Mica, 500V, +1/2pF -1/2pF; 5pF	21017-005	CD	CD15-CD050D03	SAN	
C110	Met. Polyester, 100V, 10%; 0.22uF	21441-422	WES	60F224K100	SIE	
C111	Mica, 500V, +1/2pF -1/2pF; 10pF	21017-010	CD	CD15-CD100D03	SAN	
C112	Mica, 500V, +1/2pF -1/2pF; 5pF	21017-005	CD	CD15-CD050D03	SAN	
C113	Monolythic Ceramic, 50V, 20%; 0.1uF	21123-410	SPR	1C25 Z5U104M050B	KEM	
C116	Mica, 500V, +1/2pF -1/2pF; 10pF	21017-010	CD	CD15-CD100D03	SAN	
C117	Tantalum, 35V, 10%; 1uF	21307-510	SPR	196D 105X9035HA1	MANY	
C118	Met. Polyester, 100V, 10%; 0.047uF	21441-347	WES	60C 473K250	SIE	
C119	Tantalum, 35V, 10%; 2.2uF	21307-522	SPR	196D 225X9035JA1	MANY	
C120,121	Mica, 500V, 1%; 1000pF	21022-210	CD	CD19-FD102F03	SAN	
C122	Mica, 500V, 5%; 1800pF	21024-218	CD	CD19-FD182J03	SAN	
C123	Alum., Radial, 63V; 33uF	21209-633	SPR	502D 336G063CC1C	PAN	
C124	Met. Polyester, 100V, 10%; 0.1uF	21441-410	WIM	MKS-4100V5.0.1	WES,SIE	
C125,126	Mica, 500V, 1%; 1000pF	21022-210	CD	CD19-FD102F03	SAN	
C128-131	Met. Polyester, 100V, 10%; 0.01uF	21441-310	WES	60C 103K630	SIE, WIM	
C3xx	Subtract 200 and refer to C1xx series					

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

SPECIFICATIONS AND SOURCES FOR REPLACEMENT PARTS

CO-OPERATOR MODEL 464A

PCB MAIN ASSEMBLY: Capacitors

REF DES	DESCRIPTION	ORBAN P/N	VEN (1)	VENDOR P/N	ALTERNATE VENDORS (1)	NOTES
	Diodes					
CR1	Diode, Signal, Hot Carrier	22102-001	HP	HP5082-2800		
CR3	Diode, Bridge, 200V, 1A	22301-000	VARO	VE-27	GI	
CR106	Diode, Signal, Hot Carrier	22102-001	HP	HP5082-2800		
CR113,114	Diode, Signal, Hot Carrier	22102-001	HP	HP5082-2800		
CR3xx	Subtract 200 and refer to CR1xx series					
	Integrated Circuits					
IC1	Quad Comparator	24710-302	NAT	LM339		
IC2	Linear, Dual Opamp	24202-202	RAY	RC4558NB	MOT,FSC	
IC3	Multiple FET, Hi Frequency	24405-303	NAT	AH5011CN		See Footnote #3
IC4	Linear, Dual Opamp	24209-202	NAT	LF412CN		
IC5	Multiple FET	24402-302	NAT	LM3046N	RCA	
IC6	Linear, Dual Opamp	24209-202	NAT	LF412CN		
IC7	D.C. Regulator, 15V Negative	24303-901	FSC	F79M15AUC	TI	
IC8	D.C. Regulator, 15V Positive	24304-901	FSC	F78M15UC	TI	
IC101	Linear, Dual Opamp	24203-202	MOT	MC1458CP1	TI,RCA	
IC102,103	Linear, Dual Opamp	24211-202	MOT	MC34082P		
IC104	Linear, Single Opamp	24014-202	SIG	NE5534N	TI	
IC105	Linear, Dual Opamp	24208-302	RCA	CA3280A		
IC106	Linear, Single Opamp	24014-202	SIG	NE5534N	TI	
IC107	Linear, Dual Opamp	24211-202	MOT	MC34082P		
IC108	Linear, Dual Opamp	24207-202	SIG	NE5532N	TI,EXR	
IC109	Linear, Dual Opamp	24211-202	MOT	MC34082P		
IC110	Linear, Dual Opamp	24209-202	NAT	LF412CN		
IC111	Linear, Dual Opamp	24211-202	MOT	MC34082P		
IC112	Linear, Dual Opamp	24207-202	SIG	NE5532N	TI,EXR	
IC113-115	Linear, Dual Opamp	24209-202	NAT	LF412CN		
IC3xx	Subtract 200 and refer to IC1xx series					

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

SPECIFICATIONS AND SOURCES FOR REPLACEMENT PARTS

CO-OPERATOR MODEL 464A

PCB MAIN ASSY: Diodes, IC's

REF DES	DESCRIPTION	ORBAN P/N	VEN (1)	VENDOR P/N	ALTERNATE VENDORS (1)	NOTES
Miscellaneous						
A101	Module Assy, H-F Limiter Release Time	30465-000-xx*	ORB			*Add suffix printed on part
A102	Module Assy, Timing	30995-000-xx*	ORB			*Add suffix printed on part
A3xx	Subtract 200 and refer to Alxx series					
Resistors						
R133	Res., Ratio Matched Set; 10.0K & 6.34K	28522-001	ORB			3
R137	Res., Ratio Matched Set; 4.99K & 3.01K	28522-002	ORB			3
R142	Resistor Set, MF; 3.01K	28520-005	ORB			3
R144	Res., Ratio Matched Set; 10.0K & 6.34K	28522-001	ORB			3
R3XX	Subtract 200 and refer to Rlxx series					
Switches						
S2	Switch, 6 Sta., Push-Push, DPDT	26121-000	SCH	F-Series		
S106	Switch, Rotary, Min., 2P6T	26204-000	ELSW	73-9123		
S201-205	Part of S2					
S3xx	Subtract 200 and refer to Slxx series					
Transistors						
Q101	Transistor, Signal, PNP	23002-101	MOT	2N4402	FSC	
Q103	Transistor, JFET/N	23405-101	NAT	J114		
Q104	Transistor, Signal, NPN	23202-101	MOT	2N4400	FSC	
Q106	Transistor, Signal, NPN	23202-101	MOT	2N4400	FSC	
Q109	Transistor, Signal, NPN	23202-101	MOT	2N4400	FSC	
Q3xx	Subtract 200 and refer to Qlxx series					

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

SPECIFICATIONS AND SOURCES FOR REPLACEMENT PARTS

CO-OPERATOR MODEL 464A

PCB MAIN ASSY: Misc, Resistors, Switches, Transistors

REF DES	DESCRIPTION	ORBAN P/N	VEN (1)	VENDOR P/N	ALTERNATE VENDORS (1)	NOTES
PCB FRONT PANEL ASSEMBLY						
Capacitors						
C127	Alum., Radial, 63V; 2.2uF	21209-522	SPR	502D 225G063BB1C	PAN	
C132	Alum., Radial, 63V; 2.2uF	21209-522	SPR	502D 225G063BB1C	PAN	
C3xx	Subtract 200 and refer to C1xx series					
Integrated Circuits						
IC116	Digital, Display Driver	24712-302	NAT	LM3914		
IC117	Digital, Display Driver	24713-302	NAT	LM3916		
IC3xx	Subtract 200 and refer to IC1xx series					
LEDs						
DS101	LED, Green	25106-002	HP	HLMP-1503		
DS102	LED, Yellow	25106-001	HP	HLMP-1400		
DS103	LED Array, 9-Yel, 1-Red	25152-000	ORB			
DS104	LED Array, 6-Grn, 3-Yel, 1-Red	25151-000	ORB			
DS3xx	Subtract 200 and refer to DS1xx series					
Resistors						
R105	Pot, Single, 5K, (5020)	20752-000	ORB			20% CW Log
R113	Pot, Single, 50K, (5050)	20753-000	ORB			Linear
R132	Pot, Single, 100K, (5020)	20751-000	ORB			20% CW Log
R157	Pot, Single, 1 Meg, (5020)	20750-000	ORB			20% CW Log
R218	Trimpot, Cermet, 1 Turn; 100K	20523-410	BEK	93PR100K		
R4xx	Subtract 200 and refer to R2xx series					
Transistors						
Q107,108	Transistor, Signal, NPN	23202-101	MOT	2N4400	FSC	
Q3xx	Subtract 200 and refer to Q1xx series					

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

SPECIFICATIONS AND SOURCES FOR REPLACEMENT PARTS

CO-OPERATOR MODEL 464A

PCB FRONT PANEL ASSY

REF DES	DESCRIPTION	ORBAN P/N	VEN (1)	VENDOR P/N	ALTERNATE VENDORS (1)	NOTES
FINAL ASSEMBLY						
Capacitors						
C101,102	Ceramic Disc, 1KV, 10%; 0.001uF	21112-210	CRL	DD-102	MUR	
C114,115	Ceramic Disc, 1KV, 10%; 0.001uF	21112-210	CRL	DD-102	MUR	
C2xx	Subtract 100 and refer to C1xx series					
Inductors						
L1,2	Inductor, RF Choke, 1mH, 160 mA	29502-000	MIL	4662		
Miscellaneous						
F1	Fuse, 3AG, Slo-Blo, 1/4A	28004-125	LFE	313.250	BUS	
NONE	Line Cord, AC, 3 Wire	28101-000	BEL	17534		
T1	Transformer, Power; 41.7VCT, 17.7VA	55007-000	ORB			
Switches						
S1	Switch, 6 Sta., Push-Push, DPDT	40061-000	ORB			
S101-105	Part of S1					

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

SPECIFICATIONS AND SOURCES FOR REPLACEMENT PARTS

CO-OPERATOR MODEL 464A

FINAL ASSY

AB	Allen-Bradley Co., Inc. 1201-T South Second Street Milwaukee, WI 53204
AD	Analog Devices, Inc. One Technology Way PO Box 9106 Norwood, MA 02062-9106
AKG	AKG Acoustics, Inc. 1525 Alvarado Street San Leandro, CA 94577
AM	Amphenol Corporation 358 Hall Avenue Wallingford, CT 06492
BEK	Beckman Industrial Corporation 4141 Palm Street Fullerton, CA 92635-1025
BEL	Belden Electronic Wire & Cable PO Box 1980 Richmond, IN 47374
BRN	Bourns, Inc Resistive Components Group 1200 Columbia Avenue Riverside, CA 92507
BUS	Bussmann Division Cooper Industries PO Box 14460 St. Louis, MO 63178
CD	Cornell-Dubilier Elec. 1700 Rte. 23 North Wayne, NJ 07470
CRL	Mepcopal/Centralab See Mepcopal
CSC	Crystal Semiconductor Corporation 4210-T. South Industrial Dr. Austin, TX 78744
CTS	CTS Corporation 907 North West Blvd. Elkhart, IN 46514
CW	CW Industries 130 James Way Southampton, PA 18966
DBX	dbx A division of AKG Acoustics, Inc. 1525 Alvarado Street San Leandro, CA 94577
DEL	Delta Products Corp 361 Fairview Way Milpitas, CA 95035
DUR	Duracell, Inc. Berkshire Industrial Park Bethel, CT 06801
ELSW	Electro Switch 77 King Avenue Weymouth, MA 02188
EMI	Emico Inc. 123 Main Street Dublin, PA 18917
EXR	Exar Corporation 2222 Qume Dr. PO Box 49007 San Jose, CA 95161-9007
FR	Fair-Rite Products Corp. PO Box J Wallkill, NY 12589
FSC	Fairchild Camera & Instr. Corp. See National Semiconductor
GI	General Instruments Optoelectronics Division See Quality Technologies
HA	Harris Semiconductor 2460 N 1st Street Suite 200 San Jose, CA 95131-0124
HO	Hoyt Elect. Inst. Works 19 Linden St. Penacook, NH 03303
HP	Hewlett-Packard Co. Components Group 640 Page Mill Road Palo Alto, CA 94304
INS	Intersil, Inc. See Harris Semiconductor
ITW	ITW Switches An Illinois Tool Works Co. 6615 W. Irving Park Rd. Dept. T Chicago, IL 60634
KEM	KEMET Electronics Corporation Post Office Box 5928 Greenville, South Carolina 29606
KEY	Keystone Electronics Corp. 31-07 20th Rd. Astoria, NY 11105
LFE	Littlefuse A Subsidiary of Tracor, Inc. 800 E. Northwest Hwy Des Plaines, IL 60016
LT	Linear Technology Corp. 1630 McCarthy Blvd. Milpitas, CA 95035
LUMX	Lumex Opto/Components Inc. 292 E. Hellen Road Palatine, IL 60067
MAL	Mallory Capacitor Co. Emhart Electrical/Electronic Gr. 4760 Kentucky Ave Indianapolis, IN 46241
MAR	Marquardt Switches, Inc. 2711-TR Route 20 East Cazenovia, NY 13035
MAT	Matsushita Electric Corp of America One Panasonic Way Secaucus, NJ 07094
ME	Mepcopal/Centralab A North American Phillips Corp. 11468 Sorrento Valley Road San Diego, CA 92121
MID	Hollingsworth/Wearnes Hollingsworth Solderless Terminal Div. 357 Beloit Street Burlington, WI 53105
MIL	J.W. Miller Division Bell Industries 306 E. Alondra Gardenia, CA 90247
MOT	Motorola Semiconductor PO Box 20912 Phoenix, AZ 85036
MUR	Murata Erie North America 2200 Lake Park Drive Smyrna, GA 30080
NAT	National Semiconductor Corp. 2900 Semiconductor Drive PO Box 58090 Santa Clara, CA 95051
NEL	NEL Frequency Controls, Inc. 357 Beloit Street Burlington, WI 53105
NOB	Noble U.S.A., Incorporated 5450 Meadowbrook Industrial Ct. Rolling Meadows, IL 60008
OKI	OKI Semiconductor 785 N. Mary Ave. Sunnyvale, CA 94086-2909
OHM	Ohmite Manufacturing Company 3601 Howard Street Skokie, IL 60076
ORB	Orban A division of AKG Acoustics, Inc. 1525 Alvarado Street San Leandro, CA 94577
PAN	Panasonic Industrial Company Two Panasonic Way 7E-2T Secaucus, NJ 07094
QT	Quality Technologies, Inc. 610 North Mary Ave. Sunnyvale, CA 94086
RAL	Raltron Electronics Corp. 9550 Warner Ave. Fountain Valley, CA 92708
RAY	Raytheon Company Semiconductor Division 350 Ellis Street Mountain View, CA 94039
RCA	RCA Solid State See Harris Semiconductor
ROHM	Rohm Corporation 8 Whatney Irvine, CA 92718
SAE	Stanford Applied Engineering, Inc 340 Martin Avenue Santa Clara, CA 95050
SAN	Sangamo Weston Inc. Capacitor Division See Cornell-Dubilier
SCH	ITT Schadow, Inc. 8081 Wallace Road Eden Prairie, MN 55344
SIE	Siemens Components Inc. Heimann Systems Div. 186 Wood Avenue South Iselin, NJ 08830
SIG	Philips Components - Signetics North American Phillips Corp. 811 E. Arques Sunnyvale, CA 94088
SPR	Sprague Electric Co. 41 Hampden Road PO Box 9102 Mansfield, MA 02048-9102
SW	Switchcraft A Raytheon Company 5555 N. Elston Avenue Chicago, IL 60630
TAI	Taiyo America, Inc. 700 Frontier Way Bensenville, IL 60106
TDK	TDK Electronics Corporation 12 Harbor Park Port Washington, NY 11050
TI	Texas Instruments, Inc. PO Box 225012 Dallas, TX 75265
TOS	Toshiba America, Inc. 9740 Irvine Blvd. Irvine, CA 92718
TRW	TRW Electronics Components Connector Division 1501 Morse Avenue Elk Grove Village, IL 60007
VARO	Varo Semiconductor, Inc. PO Box 469013 Garland, TX 75046-9013
WES	Westlake See Mallory Capacitor Co.
WIM	The Inter-Technical Group Inc. Wima Division PO Box 23 Irvington, NY 10533
ZI	ZILOG Inc. 210 Hacienda Ave. Campbell, CA 95008

Schematics, Assembly Drawings

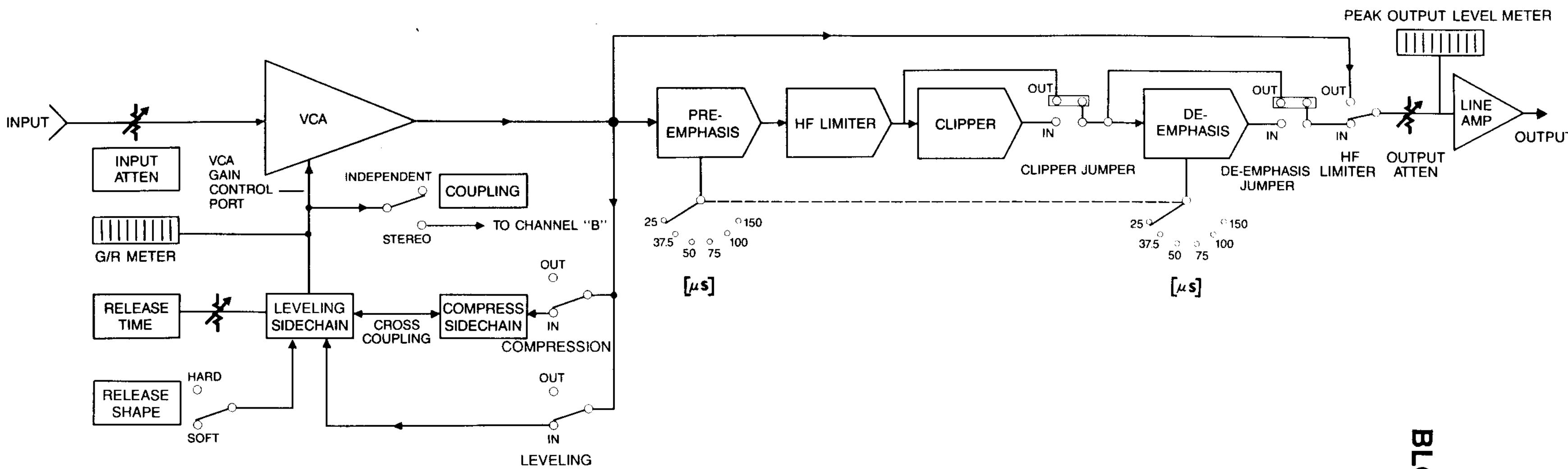
The following drawings are included in this manual:

Page	Function	Circuit Board	Drawing
6-21	BLOCK DIAGRAM		
6-22	Audio Processing	Main	Assembly Drawing
6-23			Schematic
6-24			Schematic
6-25	Displays, Controls	Front Panel	Assembly Drawing

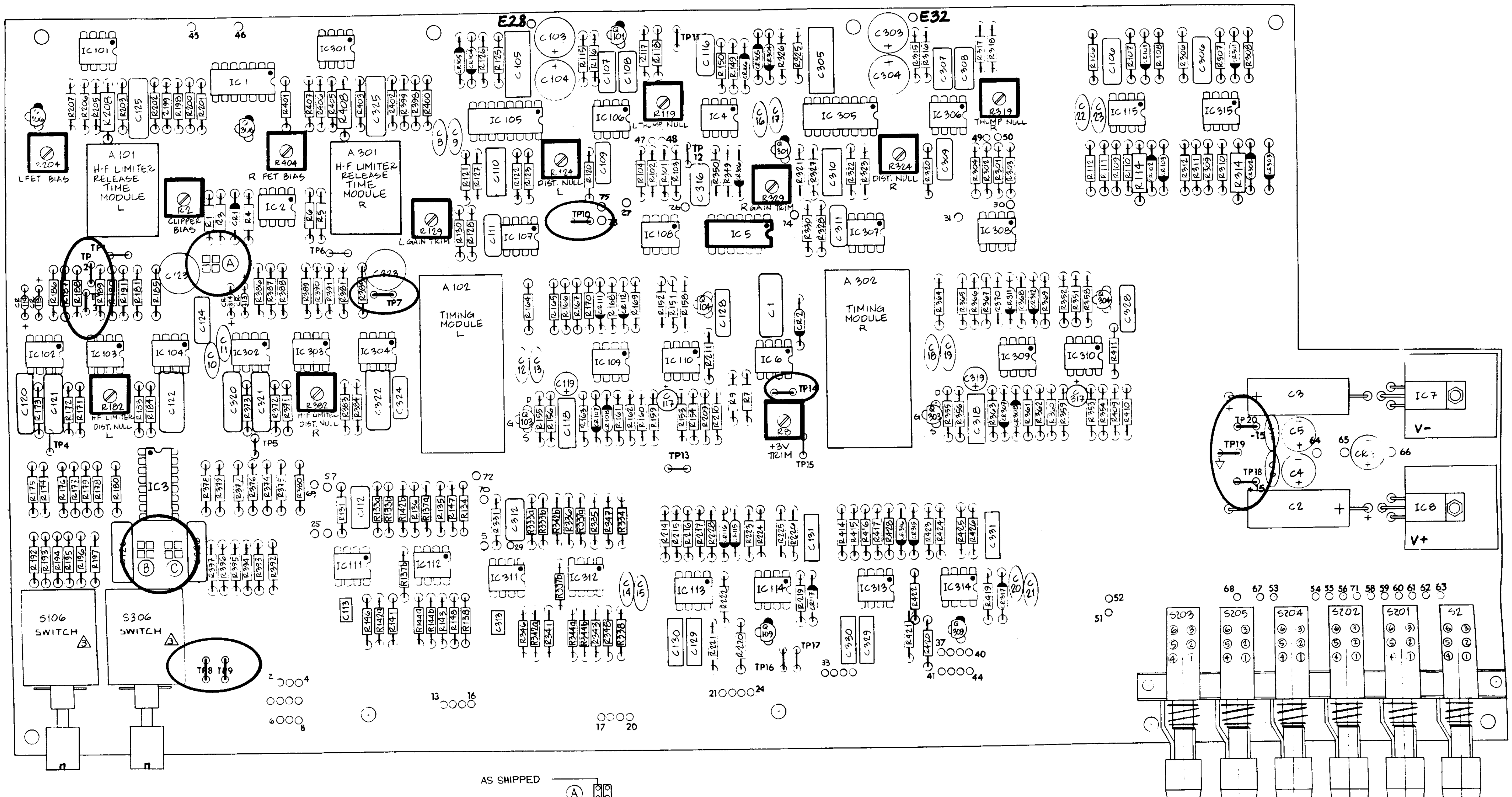
These drawings reflect the actual construction of your unit as accurately as possible. Differences between the drawings and your unit are almost undoubtedly due to product improvements or production changes which have not yet found their way into this manual. Such changes are included during periodic updates of this manual; major changes are described in addenda mailed to the registered owner of the unit.

If you intend to replace parts, please see page 6-13.

BLOCK DIAGRAM



LEFT CHANNEL ONLY
(RIGHT CHANNEL IDENTICAL)



AS SHIPPED — (A) — OPERATE / DEFEAT } CLIPPER JUMPER

AS SHIPPED — (B) — PRE-EMPHASIZED / FLAT } LEFT OUTPUT JUMPER

AS SHIPPED — (C) — PRE-EMPHASIZED / FLAT } RIGHT OUTPUT JUMPER

JUMPERS

2. TICK MARKS INDICATE PIN #1 OF IC'S, CATHODE OF DIODES, POS. SIDE OF CAPACITORS & EMITTERS OF TRANSISTORS.

1. RIGHT CHANNEL REF. DESIGNATORS 300 THRU 400 SERIES, LEFT CHANNEL REF. DESIGNATORS 100 THRU 200 SERIES, POWER SUPPLY AND SHARED COMPONENTS 0 THRU 99 SERIES.

NOTES: (UNLESS OTHERWISE SPECIFIED)

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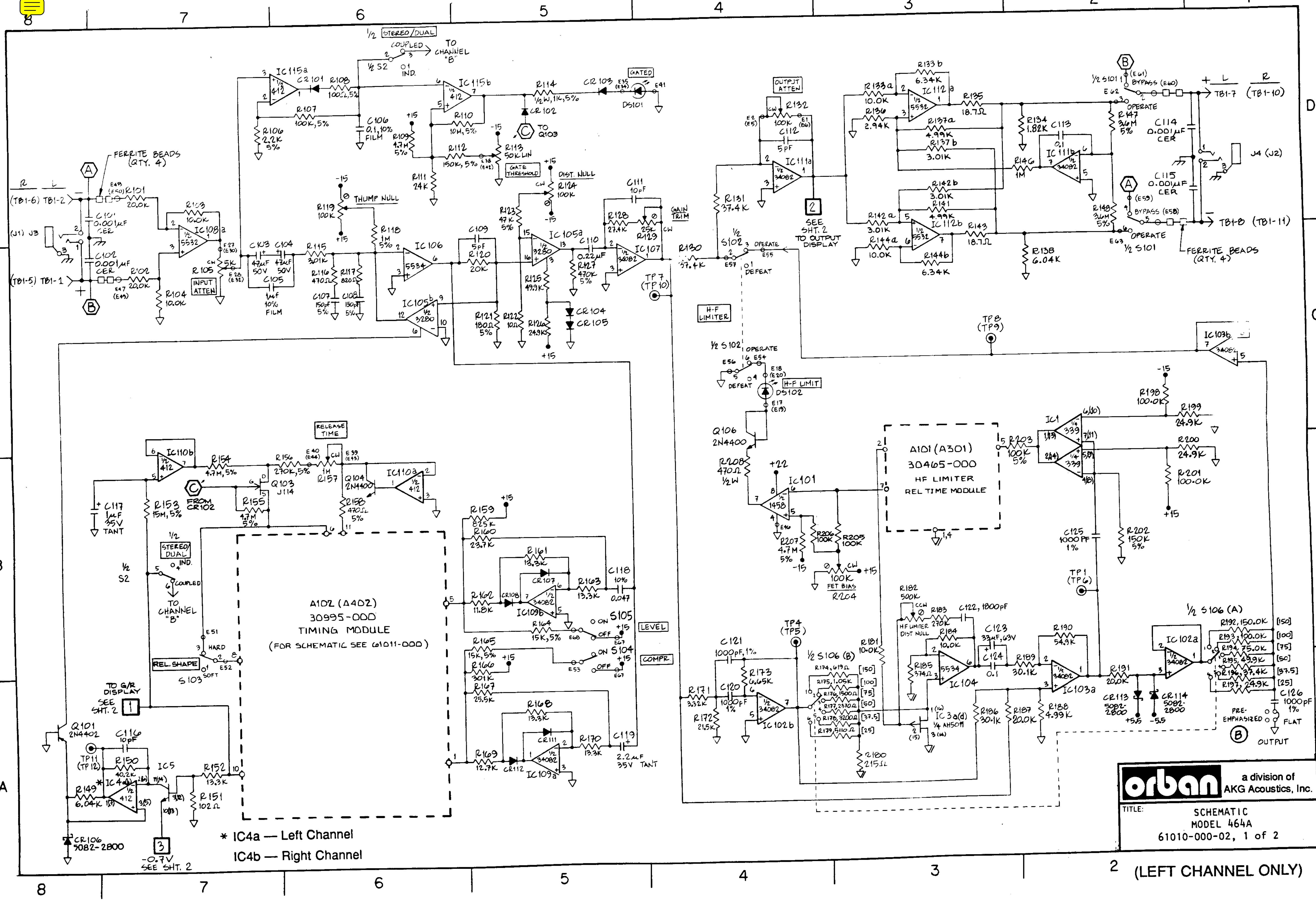
TITLE: ASSEMBLY DRAWING, MAIN BOARD MODEL 464A 31000-000-01



* IC4a — Left Channel
IC4b — Right Channel

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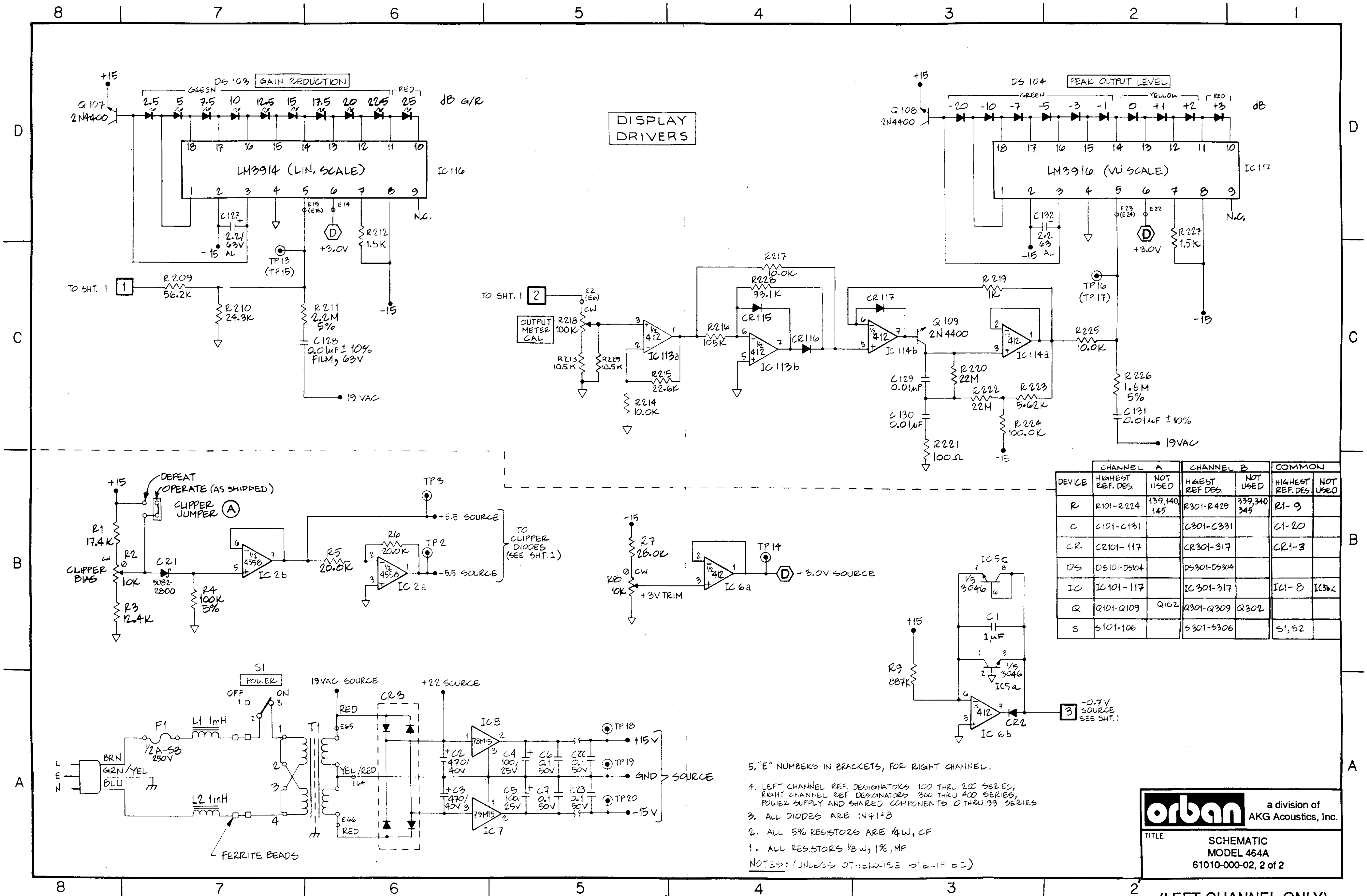
TITLE: SCHEMATIC MODEL 464A 61010-000-02, 1 of 2

(LEFT CHANNEL ONLY)



DEVICE	CHANNEL A HIGHEST REF. DES.	CHANNEL A NOT USED	CHANNEL B HIGEST REF DES.	CHANNEL B NOT USED	COMMON HIGHEST REF. DES.	COMMON NOT USED
R	R101-R224	139, 140, 145	R301-R429	339, 340 345	R1-9	
C	C101-C131		C301-C331		C1-20	
CR	CR101-117		CR301-317		CR1-3	
DS	DS101-DS104		DS301-DS304			
IC	IC101-117		IC 301-317		IC1-8	IC3b,c
Q	Q101-Q109	Q102	Q301-Q309	Q302		
S	S101-106		S301-S306		S1, S2	

5. "E" NUMBERS IN BRACKETS, FOR RIGHT CHANNEL.

4. LEFT CHANNEL REF. DESIGNATORS 100 THRU 200 SERIES, RIGHT CHANNEL REF. DESIGNATORS 300 THRU 400 SERIES, POWER SUPPLY AND SHARED COMPONENTS 0 THRU 99 SERIES

3. ALL DIODES ARE 1N4148

2. ALL 5% RESISTORS ARE 1/4 W, CF

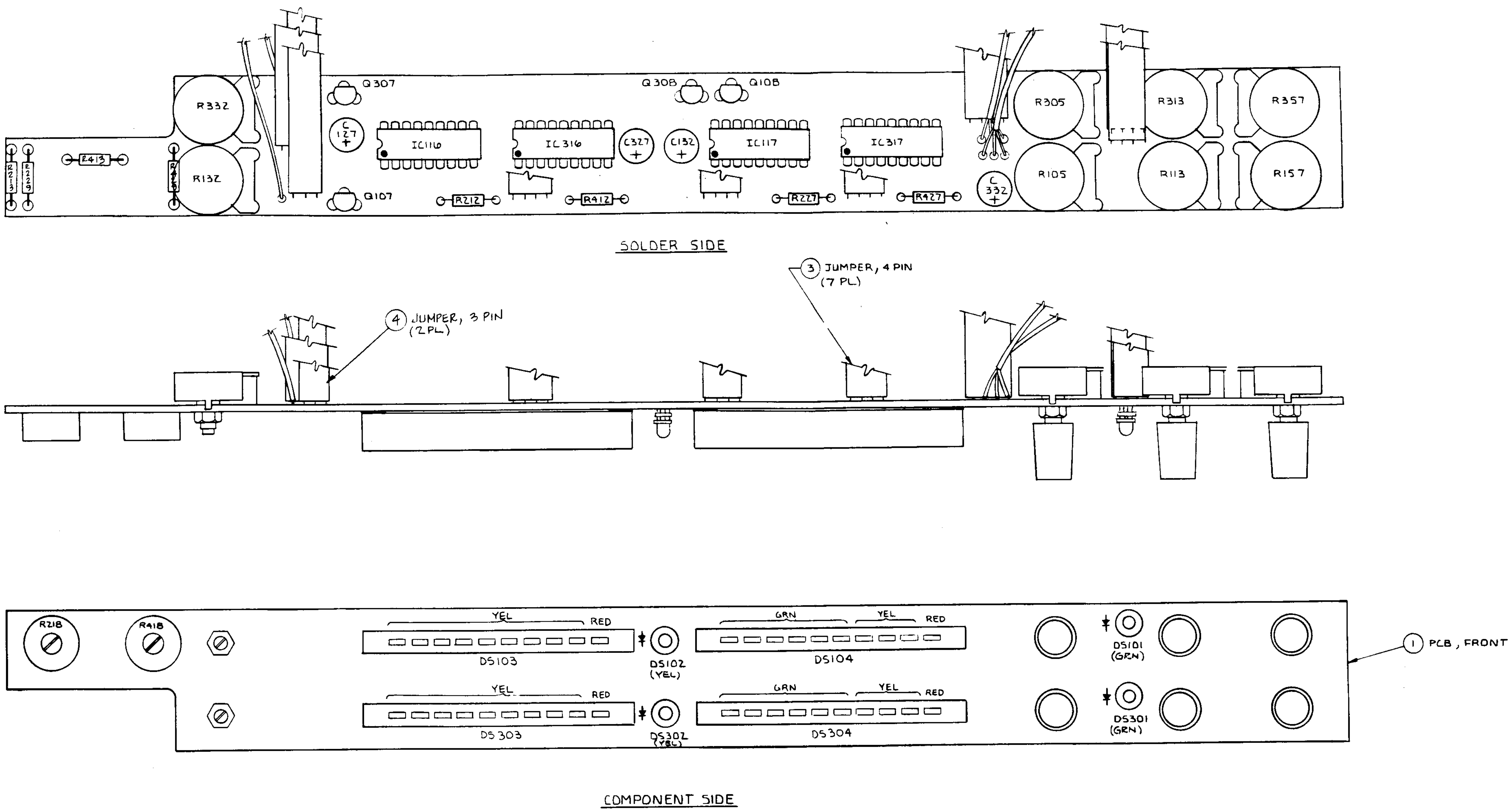
1. ALL RESISTORS 1/8 W, 1%, MF

NOTES: (UNLESS OTHERWISE STATED)

orban a division of AKG Acoustics, Inc.

TITLE: SCHEMATIC MODEL 464A 61010-000-02, 2 of 2

(LEFT CHANNEL ONLY)



2. TICK MARKS INDICATE PIN#1 OF IC'S, CATHODE OF DIODES, POS. SIDE OF CAPACITORS, AND EMITTERS OF TRANSISTORS.

1. LEFT CHANNEL REF. DESIGNATORS 100 THRU 200 SERIES
RIGHT CHANNEL REF. DESIGNATORS 300 THRU 400 SERIES

NOTES: (UNLESS OTHERWISE SPECIFIED)

orban a division of AKG Acoustics, Inc.

TITLE: ASSEMBLY DWG., FRONT PANEL
MODEL 464A
31005-000-01

Abbreviations

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

AGC	automatic gain control
ATR	audio tape recorder
dBu	0dBu = 0.775V RMS. For this application, the dBm @ 600Ω scale on voltmeters can be read as if were calibrated in dBu.
EBU	European Broadcasting Union
EMI	electromagnetic interference
FET	field effect transistor
G/R	gain reduction
HF	high-frequency
IC	integrated circuit
IM	intermodulation (or "intermodulation distortion")
JFET	junction field effect transistor
LED	light-emitting diode
LF	low-frequency
N&D	noise and distortion
PA	public address system
PPM	peak program meter
RF	radio frequency
RFI	radio-frequency interference
RMS	root-mean-square
SCA	subsidiary communications authorization (USA)
SPL	sound pressure level
STL	studio-transmitter link
TRS	tip-ring-sleeve (stereo phone jack)
THD	total harmonic distortion
VCA	voltage-controlled amplifier
VHF	very high frequency
VTR	video tape recorder
XLR	a common style of 3-conductor audio connector

User Feedback

Please use this form to send us your comments and suggestions regarding this product or manual. Cut out and fold this page — or make a copy.

← First Fold

Cut Along This Line →

Second Fold →

Thank You.

Model #: ____________________

Serial #: ____________________

Date of comments: ____________

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orban

Installation Instructions
RETROFIT KIT RET–040

For The Co-Operator Model 464A

Purpose: Adds XLR Connectors

This kit modifies the Model 464A Co-Operator (gated stereo leveler/compressor/HF limiter/peak clipper) to accommodate XLR connectors.

Retrofit Kit RET-040 contains:

2	Pre-wired input connectors, 3P, female (Switchcraft D3F)
2	Pre-wired output connectors, 3P, male (Switchcraft D3M)
8	Screws, 4-40 × 5/16-inch
8	Nuts, 4-40 Kep
2	Cable ties
1	Installation Instructions

Allow about an hour for this retrofit.

1) Remove the six screws attaching the 464A's top cover, then lift off the cover.

2) Remove the two plates covering the pre-punched holes in the rear panel.

You may discard the plates and the hardware that attached them.

3) Install the four supplied connectors in the pre-punched holes, attaching them with the supplied screws and nuts.

See Fig. 1. One of the male connectors has longer leads — install it in the L OUT position.

4) Tack solder the wires from the connectors to the solder lugs on the back of the terminals indicated in Fig. 1.

Be careful not to confuse right with left or input with output. Check all connections against the chart in Fig. 1 when you're done.

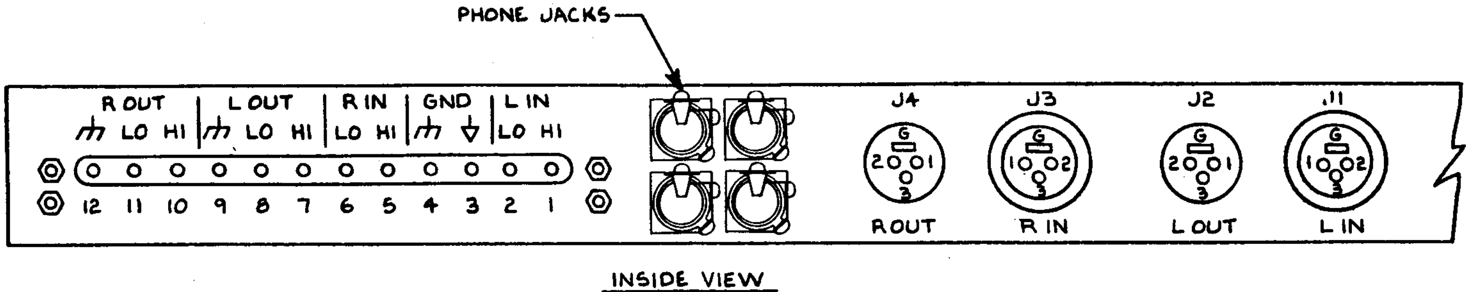
5) Bundle the connector leads together with the supplied cable ties.

6) Test the wiring by passing signals through the connectors.

7) Replace the top cover and the six screws that hold it in place.

95299-000-01 6/87

Orban Associates Inc. 645 Bryant Street San Francisco, CA 94107
Main: (415) 957-1063 Sales: (415) 957-1067 Telex: 17-1480



RIGHT

XLR CONNECTOR LINE IN		
FROM	TO	COLOR
J3-1 (⏚)	J3-G (GND)	BLK
J3-2 (LO)	TB1-6 IN (LO)	BRN } TWIST
J3-3 (HI)	TB1-5 IN (HI)	RED } TWIST

XLR CONNECTOR LINE OUT		
FROM	TO	COLOR
J4-1 (⏚)	J4-G (GND)	BLK
J4-2 (LO)	TB1-11 OUT (LO)	GRY } TWIST
J4-3 (HI)	TB1-10 OUT (HI)	GRN } TWIST

LEFT

XLR CONNECTOR LINE IN		
FROM	TO	COLOR
J1-1 (⏚)	J1-G (GND)	BLK
J1-2 (LO)	TB1-2 IN (LO)	BRN } TWIST
J1-3 (HI)	TB1-1 IN (HI)	RED } TWIST

XLR CONNECTOR LINE OUT		
FROM	TO	COLOR
J2-1 (⏚)	J2-G (GND)	BLK
J2-2 (LO)	TB1-8 OUT (LO)	GRY } TWIST
J2-3 (HI)	TB1-7 OUT (HI)	GRN } TWIST

Fig. 1: Wiring Diagram, Retrofit Kit RET-040