412A/414A Compressor/Limiter

OPERATING MANUAL

orban

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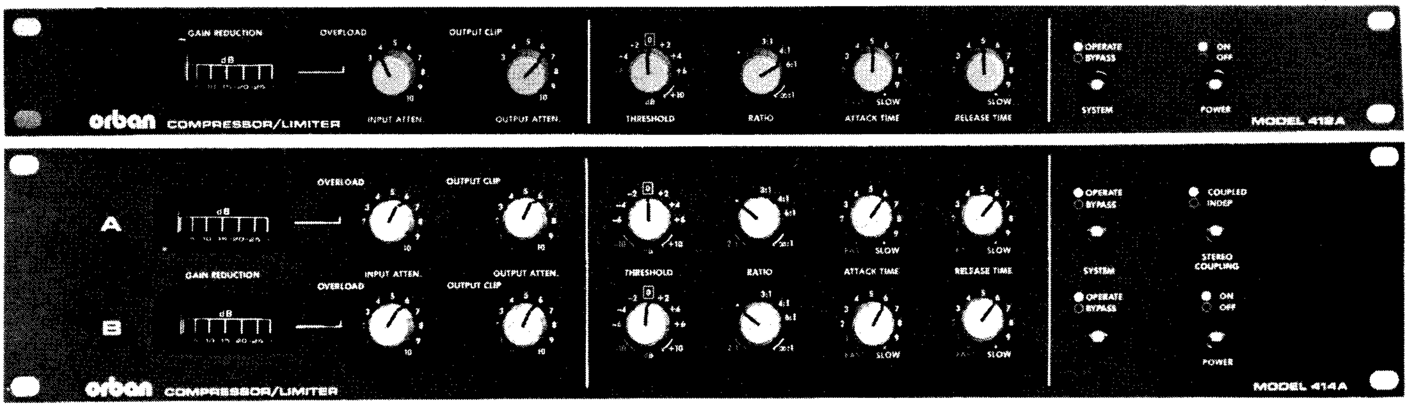


PART A:
Introduction

The Orban Model 412A/414A Compressor/Limiter is a general-purpose AGC device of highest professional quality. It can perform compression and peak limiting simultaneously with unusual freedom from side-effects.

The flexibility and natural sound of the 412A/414A make it applicable in virtually all areas of professional audio: recording studios, broadcasting, sound reinforcement, public address, motion picture sound, etc. However, it is not optimized for overmodulation protection of broadcast transmitters; the Orban OPTIMOD-AM, -FM, or -TV should be used in such applications.

The product is available in both single- (412A) and dual- (414A) channel versions. (For clarity, only the 414A will be referenced in this manual.) The dual-channel version is equipped with a coupling switch which forces the gain of both channels to be equal, tracking the channel demanding the greatest amount of gain reduction. This preserves correct imaging in stereo applications. However, the stereo coupling switch does not couple the operating controls, and these are ordinarily set identically in stereo operation. (If they are set non-identically, the gain of both channels will still be equal, tracking the channel demanding the highest amount of G/R. However, the control circuitry will respond differently to material in the two channels even if a mono feed is used. This might be useful for special effects.)

Attack and release times are both program-controlled, but can be scaled faster or slower by means of front-panel controls. This results in maximum flexibility, plus extremely natural sound over a wide range of control settings.

The 414A Compressor/Limiter is equipped with electronically-balanced input and output, and is compatible with the levels and impedances found in both professional and semi-professional applications. RF suppression applied to the input, output, and power leads enables use in relatively high RFI fields such as those common in broadcasting.

Because the front-panel controls are marked in a familiar way, you may be tempted to jump right in without reading the manual. However, if you take the time to review the **Description And Function Of Front-Panel Controls** and **Operating Instructions** in **Part C,** you will find that there is "more than meets the eye" inside the 414A, and that the time you take reading the manual will be well-rewarded by a greater understanding of the unit's potential.

PERFORMANCE HIGHLIGHTS

-- Streamlined, straightforward front panel offers the most-demanded user controls, including ATTACK TIME, RELEASE TIME, RATIO, and THRESHOLD. The wide range of these controls permits extremely natural sound or special effects.

-- Uses exclusive Orban feedback control circuitry adapted from our popular 424A Gated Compressor/Limiter/De-Esser to achieve remarkably natural sound.

-- User controls interact intelligently to simplify and speed setup, and to prevent errors.

-- Peak limiting and compressor functions are crosscoupled to eliminate potential pumping and modulation effects.

-- THRESHOLD control with 20dB range allows user to determine the level at which gain reduction first occurs, without changing below-threshold gain. Ideal for sound reinforcement applications.

-- Proprietary circuitry achieves optimum headroom and signal-to-noise regardless of THRESHOLD control setting.

-- Front-panel OUTPUT ATTENUATOR control with OUTPUT CLIP LED to indicate line amplifier clipping.

-- Illuminated, true peak-reading GAIN REDUCTION meter is more accurate and readable than LED displays.

-- GAIN REDUCTION OVERLOAD lamp warns of control circuit overload due to a demand for G/R which exceeds the range of the VCA.

-- Hard-wired system bypass switch for fail-safe protection.

-- Side-chain externally accessible for special effects such as frequency-selective limiting.

-- Active-balanced, floating input interfaces easily to any system.

-- Active-balanced, floating output stage can be operated unbalanced simply by grounding one side.

-- Proprietary Class-A Orban VCA features very low distortion and noise.

-- Stereo 414A has STEREO COUPLING switch to permit either stereo or dual-mono operation; an unlimited number of units can be wire-coupled to track $\pm$0.5dB.

-- All-metal chassis with RFI suppression on input, output, and AC leads.

FRONT PANEL DESCRIPTION

The Front-Panel Photograph at the beginning of this Manual shows the various operating controls. These controls and their operation are fully described in **Description and Function of Front Panel Features** in **Part C (OPERATING INSTRUCTIONS)** below.

REAR PANEL DESCRIPTION

The FUSE used in both the 412A and the 414A is a 1/4A (115 volt operation) or 1/8A (230 volt operation) 3AG 250V SLO-BLO type. Replace with the same type only. (An adapter is available from the factory to accommodate a European-style 5x20mm fuse.)

The INPUT and OUTPUT connections are located on a barrier strip (#5 screw). Holes are provided for installation of "XLR"-type connectors; a retrofit kit is available from your dealer.

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

The SIDECHAIN IN and SIDECHAIN OUT connectors are 1/4" 2-conductor (tip/sleeve) normalling phone jacks. These jacks let you insert additional signal processing (such as an equalizer) into the compressor control sidechain to achieve frequency-dependent compression, de-essing, or other such functions. This is further described below in **Sidechain Processing** in **Part C (OPERATING INSTRUCTIONS.)**

PART B:
Installation

MECHANICAL INSTALLATION

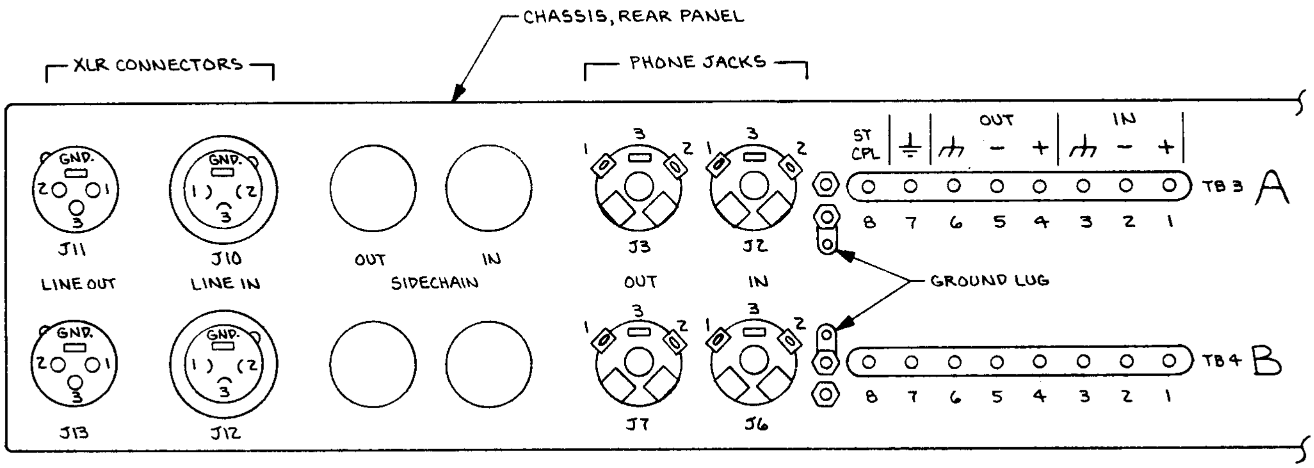
Vertical space of one standard rack unit (1 3/4"/4.5cm) is required for the 412A; two rack units (3 1/2"/8.9cm) are required for the 414A.

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

INSTALLATION OF OPTIONS

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

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



VIEW FROM INSIDE OF 414A CHASSIS

RET 28, WIRE LIST
(XLR CONNECTORS)

XLR CONNECTOR LINE IN			XLR CONNECTOR LINE OUT		
FROM	TO	COLOR	FROM	TO	COLOR
J10-1 (⏚)	GND LUG	BLK	J11-1 (⏚)	GND LUG	BLK
J10-2 (LO)	TB3-2 IN(-)	BLU } TWIST	J11-2 (LO)	TB3-5 OUT(-)	BLK } TWIST
J10-3 (HI)	TB3-1 IN(+)	WHT }	J11-3 (HI)	TB3-4 OUT(+)	GRY }

– TABLE SHOWN FOR CHANNEL A, REPLICATE FOR CHANNEL B

Fig. B-1: WIRING OF OPTIONAL CONNECTORS

ELECTRICAL INSTALLATION

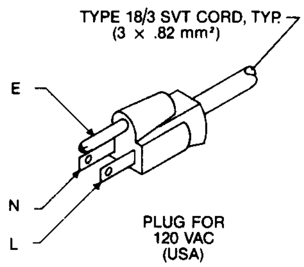
AC Power

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

The two primary windings of the power transformer are connected in parallel for 115 volt operation and in series for 230 volt operation. (See the **Schematic Diagram** in the back of this manual.)

To strap the power transformer for a different voltage, remove the top cover (412A) or bottom cover (414A). Strapping instructions are found on the insulating fishpaper around the power transformer. It is not necessary to rearrange the heavy insulated wiring; all strapping can be performed with bare jumper wire. Take care not to burn the insulation.

The power cord is terminated in a "U-Ground" plug to USA standards. The green/yellow wire (which is connected to the long prong) is connected directly to the 414A chassis. If it becomes necessary to lift this ground to suppress ground loops, this should be done with a three-prong to two-prong adapter plug, rather than by damaging the power plug. It is not recommended that this ground be defeated unless absolutely necessary because it eliminates the intrinsic safety feature of the three-wire system.



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

Fig. B-2: AC MAINS LINE CORD DETAIL

WARNING!

If the ground is defeated, certain fault conditions in the unit or the system to which it is connected can result in appearance of full line voltage between chassis and earth ground. Such voltage is capable of causing electrical shock, possibly resulting in severe injury or death!

Control Loop Bass Rolloff Jumper

The compressor/limiter control loop is ordinarily operated with a bass rolloff which simulates the response of the ear and results in a more natural sound. However, certain applications demand that the 414A perform an accurate peak limiting function. This requires a "flat" response from the control loop.

The bass rolloff network can be jumpered out on the circuit board(s) inside the 414A. Each unit is shipped with the jumpers in the "rolloff" position. To restrap to the "flat" position, move the jumpers according to Fig. B-3, following the **User Access** instructions in **Part D.** (The jumper is on the bottom side of the board on Channel B of the 414A.)

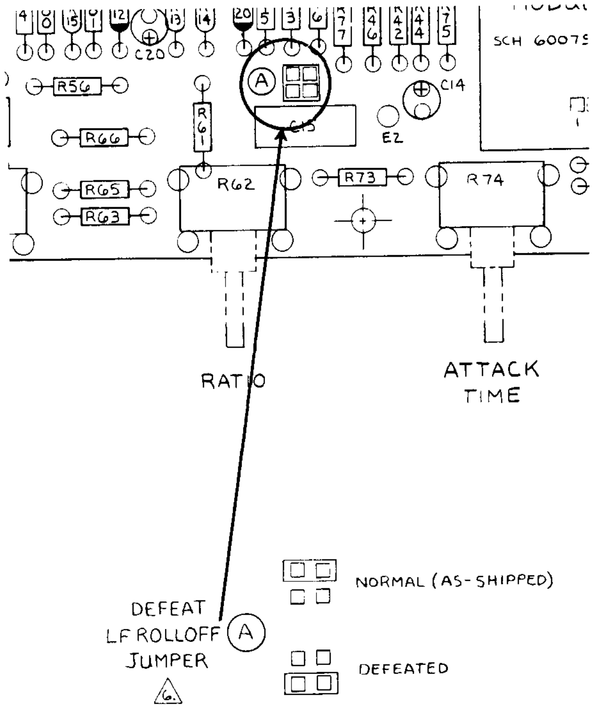


Fig. B-3: Control Loop Bass Rolloff Strapping

Audio Connections

Connecting the 414A Compressor/Limiter to other equipment is quite straightforward. Relatively uncomplicated systems (such as home playback systems, "semi-pro" recording studios, electronic music studios, dance bars, etc.) tend to come together without serious grounding problems even if the wiring practices are somewhat casual, provided that high RF fields are not present. Unusual situations can be analyzed if you are familiar with the standard rules governing grounding and interfacing between balanced and unbalanced systems.

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

Input: The cable should be connected to the 414A input according to **Table 1** below.

The electronically-balanced input of each channel of the 414A Compressor is compatible with most professional and semi-professional sound equipment, balanced or unbalanced, whose source impedance is 600 ohms or less. If it is greater (as in some vacuum-tube audiophile preamps), a minor modification may be made to the input to accomodate the situation. Please refer to **Appendix A** for further details.

Nominal input level is between -10 and +4dBm. The absolute overload point is +20dBm.

Output: The two outputs of each channel of the 414A are electronically-balanced and floating. The source impedance of each leg is less than 100 ohms in parallel with 1000pF to the chassis (for RFI suppression). The output is capable of driving loads of 600 ohms or higher.

Both balanced and unbalanced outputs can be taken between the (+) and (-) output terminals. In the unbalanced case, the output amplifier is designed to operate correctly if its (-) output is grounded, and no special precautions need be taken.

Preferred Wiring: We recommend wiring with two-conductor shielded cable (such as Belden 8451 or equivalent) because signal current flows through the two conductors only. The shield does not carry signal, is used only for shielding, and is ordinarily connected to ground at one end only. The following table and diagram are applicable to a great majority of installations.

If you wish to use single-conductor shielded cable, see the section immediately below.

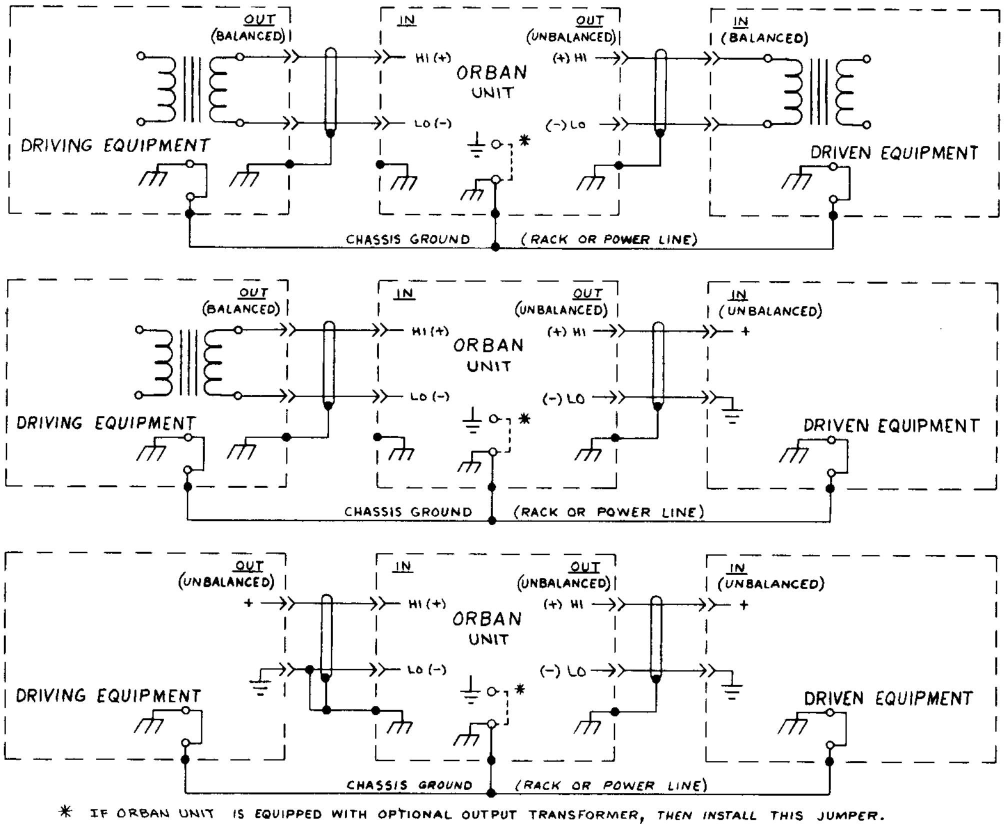


Fig. B-4: GROUNDING

TABLE 1:
GENERAL INPUT/OUTPUT CONNECTION RULES

INPUT

1) Always use (+) and (-) as the two input terminals to the 414A.

2) When the 414A is driven from an unbalanced source, connect the shield to circuit ground at the source and to chassis ground at the 414A. Connect the (-) input to chassis ground as well.

3) When the 414A is driven from a balanced source, connect shield at the source end to chassis ground. Do not connect shield at 414A end.

OUTPUT

1) At the 414A output, connect the shield at the 414A end to chassis ground (whether driving balanced or unbalanced loads). Do not connect the shield at the other end.

2) When driving an unbalanced load, connect the circuit ground of the driven equipment to the 414A's (-) output. Connect the hot side of the driven equipment's input to the 414A's (+) output.

3) When driving a balanced load, jumper the circuit ground to the chassis ground on the 414A (on rear panel). When driving an unbalanced load, do not use this jumper.

GENERAL

1) The 414A chassis should always be earth-grounded (through the third wire in the power cord or through the rack) for maximum protection from shock. Float this ground (to reduce hum) only as a last resort.

Because it is not always possible to determine if the equipment driving or being driven by the 414A has its circuit ground internally connected to its chassis ground (which is always connected to the ground prong of the AC line cord, if present), and because the use of the AC power line ground often introduces noise or other imperfections such as RFI, hum, clicks, and buzzes, the wiring techniques in the diagram are not universally applicable.

If you follow the diagram and hum or noise appears, don't be afraid to experiment. If the noise sounds like a low-level crackling buzz, then there probably isn't enough grounding. Try connecting the (-) input of the 414A to a chassis ground terminal on the barrier strip and see if the buzz goes away. You can also try strapping the 414A's chassis and circuit grounds together (on the barrier strip) to 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 414A'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 414A dual-channel unit are connected together internally, and could conceivably introduce a ground loop if you do not take this connection into account in planning your wiring.)

Wiring The 414A With Single-Conductor Shielded Cable: Sometimes, particularly if you are using the 414A with musical instruments or home-type equipment, single-conductor shielded cable may be the only type immediately available (as opposed to the preferred two-conductor cable). In this case, connect the inner conductors of the shielded cables to the (+) sides of the 414A inputs and outputs. Connect the shield of the 414A input cable to the (-) input, and connect the shield of the 414A output cable to the (-) output on the rear-panel barrier strip.

The shield will ordinarily receive chassis ground from the external equipment which it is connecting to the output of the 414A. The chassis ground/circuit ground jumper on the rear barrier strip of the 414A 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. 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.

PART C:

Operating Instructions

QUICK OPERATING GUIDE

This section is designed to help you get started using your 412A/414A. While the unit is easy and "friendly" to use, it does contain many sophisticated and powerful features. Later parts of this **OPERATING MANUAL** describe these features in more detail, and can help you get the most from your 414A after you have become familiar with the basics.

Since the 412A is a single-channel version of the 414A, we will refer only to the 414A in the text unless the context demands otherwise.

The 414A is a compressor, a limiter, or both, depending primarily upon the setting of the ATTACK time and RELEASE time controls. This is explained below under ATTACK TIME.

Referring to the instructions in **Part B,** install the unit.

To activate the circuitry, the SYSTEM OPERATE/BYPASS button must be IN (white dot showing).

The INPUT ATTENuator, THRESHOLD, RATIO, ATTACK TIME, and RELEASE TIME controls are adjusted by ear to obtain the desired sound. If you have used any common professional compressor or limiter before, these controls should be familiar.

1) INPUT ATTENuator AND THRESHOLD: Both of these controls affect the amount of gain reduction (G/R) produced by the unit, but in different ways. (The amount of G/R is indicated by the illuminated G/R METER.)

   The INPUT ATTENuator is located before the main part of the compressor/limiter circuitry, and consequently adjusts the audio level presented to this circuitry.

   The THRESHOLD control affects the compressor/limiter control circuitry, determining the audio level (as seen after the INPUT ATTENuator) that first begins to cause G/R.

   For most applications, the amount of G/R is determined by adjusting the INPUT ATTENuator (thus changing the drive to the main compressor/limiter circuitry), while leaving the THRESHOLD control at its center detent ("0"). Unless the RATIO control (explained below) is adjusted for low ratios, determining the amount of G/R in this way produces a relatively constant level at the output of the compressor/limiter regardless of the amount of G/R. Therefore, using the INPUT ATTENuator to adjust the amount of G/R is most appropriate when the device driven by the compressor/limiter (such as a tape recorder) has a fixed overload level, beyond which distortion or other problems occur.

   Determining the amount of G/R by means of the THRESHOLD control is most useful in sound reinforcement. Here, the system gain must be constrained to a maximum value or feedback can occur. Adjusting the G/R with the INPUT ATTENuator would also change the overall gain (even with no G/R occurring), and might therefore cause the system to feed back. By using the THRESHOLD control to adjust the amount of G/R, there is no danger of introducing feedback.

Provided that the compressor/limiter is into G/R, its average output level will change in proportion to the setting of the THRESHOLD control. (Lowering the threshold, for example, causes more G/R, thus reducing the output level.) Determining G/R by adjusting this control is therefore inconvenient if your primary goal is to protect a following piece of equipment from overload, since every change in the THRESHOLD control will require a compensating adjustment of the OUTPUT ATTENuator control to readjust the output level of the compressor/limiter to the desired value.

The available range of the THRESHOLD control is only ±10dB, so even if you wish to determine G/R with the THRESHOLD control, you may have to first adjust the INPUT ATTENuator to bring the THRESHOLD control within range.

Ordinarily, you will determine the desired amount of G/R by ear: simply adjust the INPUT ATTENuator and/or THRESHOLD controls until the desired subjective effect is obtained.

If the G/R OVERLOAD LED comes on, you must reduce the setting of the INPUT ATTENUATOR. (G/R overloads cannot be cleared with the THRESHOLD control.)

2) RATIO: This control determines if compression will be "tight" or "loose". "Tight" means that a large change in input level will produce a small change in output level. As the ratio becomes "looser", the output level will change more for a given change in input level. 2:1 is the "loosest" ratio; ∞:1 is the "tightest".

"Looser" ratios tend to give more natural, dynamic sound at the expense of lower average loudness and less consistent levels. "Tighter" ratios produce maximum loudness and density, but may tend to sound less natural than looser ratios. By comparison to conventional compressors and limiters, the 414A's program-controlled attack and release time constants minimize these less natural effects.

(Adjusting the RATIO control to "looser" settings automatically lowers the compression threshold to prevent peak overload of the 414A circuitry or that of the device being driven by the 414A when high amounts of gain reduction are used.)

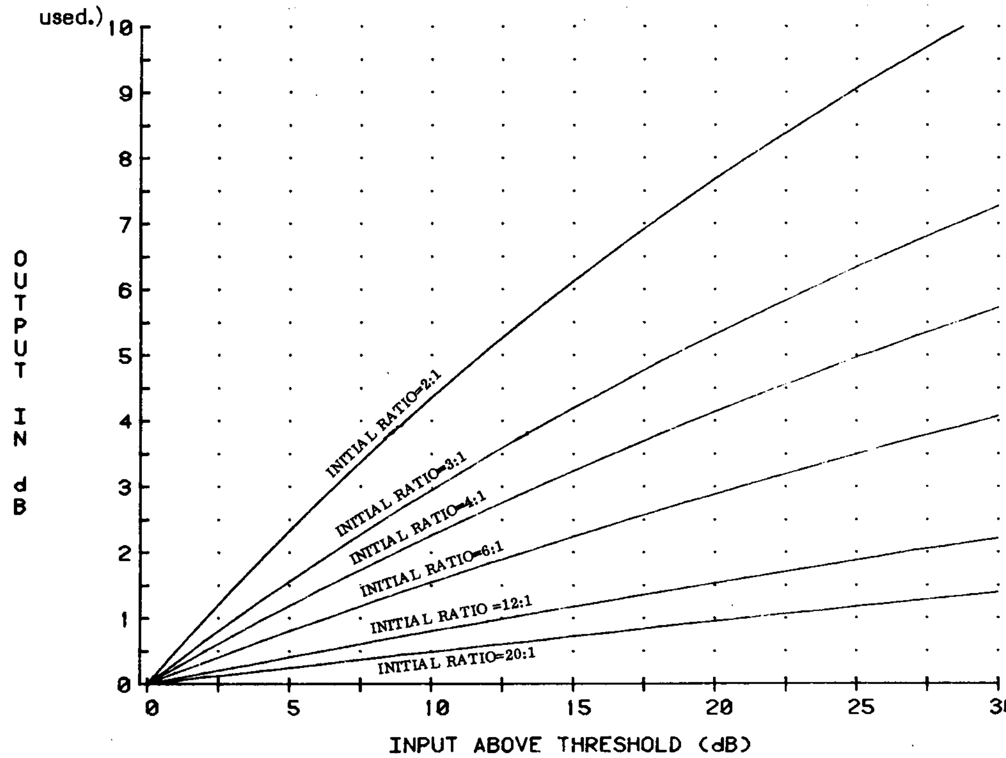


Fig. C-1: OUTPUT LEVEL AS A FUNCTION OF INPUT LEVEL FOR VARIOUS SETTINGS OF THE RATIO CONTROL

3) ATTACK TIME: Traditionally, a compressor is considered to be an automatic gain control device which controls the average (or RMS) level of an audio signal, and which operates with relatively slow attack and release times. Conversely, a limiter controls peak levels, and operates much more quickly.

The 414A can operate as a compressor, as a limiter, or as a combination of both depending on the setting of its ATTACK TIME control. The ATTACK TIME control determines how quickly the 414A responds to an input level increase.

When the ATTACK TIME is operated towards the fast part of the scale, the 414A behaves like a limiter if only a small amount of G/R is used. As the amount of G/R is increased, the unit begins to behave more and more like a compressor cascaded with a limiter.

When the ATTACK TIME control is set towards the slow part of the scale, the amount of limiting is progressively reduced, while the amount of compression stays essentially the same: The unit behaves more and more like a pure compressor.

Fast attack times produce the most consistent control of peak levels (and therefore produce highest average loudness). However, fast attack times tend to produce more audible side effects than slow attack times. Slow attack times permit transient material to pass through the 414A unaffected, so that transient definition is retained at the cost of peak control.

(To prevent any transient overshoots permitted by slow attack times from overloading either the 414A circuitry or subsequent devices, the threshold of compression is automatically reduced as the attack time is made slower. This way, the peak level at the output remains approximately constant as the ATTACK TIME control is adjusted.)

The ATTACK TIME control is calibrated with an arbitrary scale (0 to 10) because the actual attack time varies automatically according to the nature of the program material. This minimizes audible side-effects.

Because the range of the ATTACK TIME control has purposely been made very wide, certain sounds can cause the 414A to produce distortion when operated with fast attack times. Such sounds include certain male voices, Hammond organ, and some types of bass (particularly synthesizer-produced). Such distortion can be eliminated by operating with slower attack times -- usually between "5" and "SLOW" on the dial

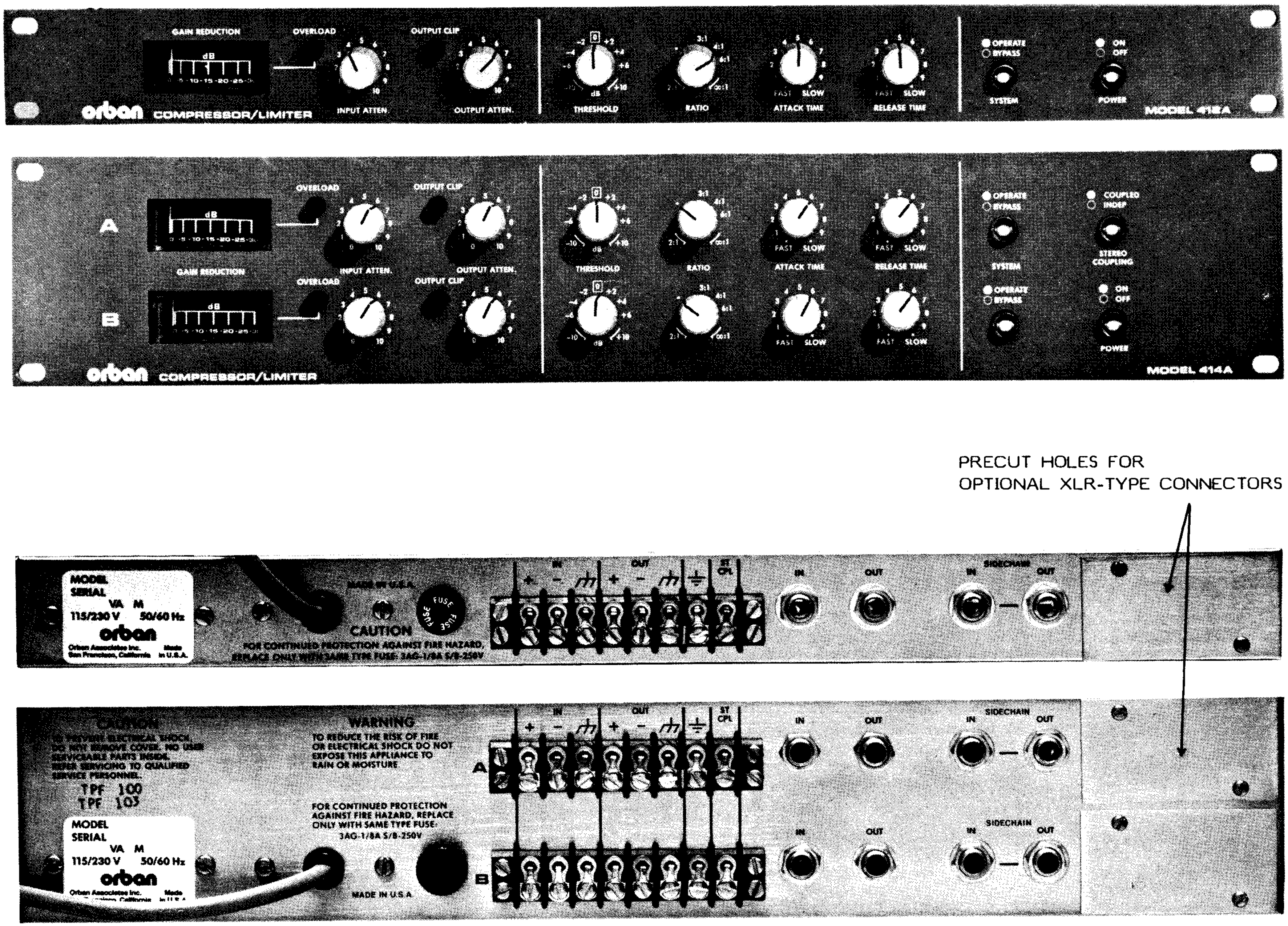
RELEASE TIME: This control determines how fast the 414A gain recovers toward maximum (0dB G/R) during those times when its output level is below the threshold of compression.

Fast release times produce the greatest "density" and most consistent output levels. However, they also create the greatest risk of audible side-effects. They are most useful in recording studios or production situations where the program material being processed is a single track and is to be mixed with other material which can hide any side-effects.

Slower release times generally produce a more natural sound on mixed program material. Accordingly, they are more useful in such applications as broadcast production or cassette duplication.

The RELEASE TIME control is calibrated with an arbitrary scale because the actual release time varies automatically according to the nature of the program material. This minimizes audible side-effects.

5) OUTPUT ATTEN: This control can be adjusted to achieve the desired level at the 412A's output. If the CLIP lamp lights, reduce the setting of the control until it goes out.



FRONT AND REAR PANEL FEATURES

DESCRIPTION AND FUNCTION OF FRONT PANEL FEATURES

While the following control descriptions might seem unnecessarily complex on first reading, they have been crafted to answer any reasonable question either the novice or the experienced user might ask. The effects of, and interactions between, the controls have been designed to promote ease of use, facilitating good results with minimum effort. Some of these interactions and effects are subtle, and are much more easily appreciated by actual practice than by reading.

Refer to the **Quick Operating Guide** above for an overview, and to the Front Panel Photograph at the front of this Manual.

-- The INPUT ATTENuator adjusts the drive level to the compressor/limiter, thus determining the amount of gain reduction for a given setting of the THRESHOLD control.

In most cases (such as recording studios) where a relatively constant level at the 414A output is desired, this control is used (instead of the THRESHOLD control) to determine the amount of G/R, since there is no need to readjust the OUTPUT ATTENuator to compensate for INPUT ATTENuator adjustments (except when very low ratios are used). In addition, adjusting either the ATTACK TIME or RATIO controls also adjusts the threshold to keep the peak output level approximately constant. However, this automatic threshold adjustment does not affect the amount of G/R available.

-- The GAIN REDUCTION meter is electronically conditioned to show the true peak gain reduction of the VCA (Voltage-Controlled Amplifier) in dB.

-- The G/R OVERLOAD lamp lights when no further G/R is available. When this lamp is lit, the gain of the VCA is "stuck" at its lowest available value. Further increases in input level will cause proportional increases in output level, rapidly driving the VCA into clipping.

The amount of available gain reduction changes with the setting of the THRESHOLD control: When the control is set to "+10", 15dB of G/R is available. This increases to 35dB when the control is set to "-10". Therefore, G/R overloads cannot be cleared with the THRESHOLD control, because the available gain reduction is reduced in exact proportion to the increase in threshold. G/R overloads must be cleared by turning down the INPUT ATTENuator.

-- The THRESHOLD control determines the threshold of compression (and thus the amount of gain reduction) without changing the below-threshold gain. It is mostly useful in sound reinforcement applications where the system gain must be constrained to a maximum value (to avoid feedback), while control over the amount of gain reduction is retained. Adjusting the control will proportionally change the nominal compressor output level.

This control has been carefully implemented to avoid compromising the signal-to-noise ratio of the compressor regardless of the setting of the control. Accordingly, the amount of available gain reduction available from the compressor varies in direct proportion to the setting of the THRESHOLD control: there is less G/R available at high thresholds (where less G/R will be produced) than at low thresholds (where more G/R will be produced).

Best VCA distortion and signal-to-noise performance are achieved with the control at its detented "0" setting. However, performance compromises are extremely small over the range of the control, and it can be used freely to achieve your goals.

-- The RATIO control adjusts the compression ratio (i.e., the dB change in input level divided by the resultant dB change in output level). The calibrations are only valid at the threshold of gain reduction. As more gain reduction is used, the compression ratio increases, yielding a "soft knee" curve when the RATIO control is adjusted for lower ratios.

-- The ATTACK TIME control scales the program-controlled attack characteristic faster or slower, and simultaneously adjusts the compression threshold. (The attack time is not constant: it varies according to the recent history of the program dynamics.)

At faster ATTACK TIME settings, substantial peak limiting action is produced with typical program material. As the ATTACK TIME is slowed, the 414A acts more and more like a pure compressor, and fast peaks are permitted to overshoot more and more.

Because of these overshoots, the compression threshold is automatically lowered as the attack time is slowed to avoid clipping the VCA used as the gain-control element. At the very slowest attack times, the release time is also lengthened by a factor of approximately 4:1 to assure that the 414A is working in a truly "averaging" mode at these very slow attack times, and that the attack time does not get slower than the release time.

-- The RELEASE TIME control scales the program-controlled release characteristic faster and slower. (The release time is not constant; it varies according to the recent history of the program dynamics.)

To avoid having fast transients punch "holes" in the program material, the release rate is automatically speeded up after a large change in gain reduction. This creates a fast "peak limiting" function which rides on top of a much slower "compression" function. It is the recovery rate of the "compression" function which is affected by the RELEASE TIME control.

-- The OUTPUT ATTENuator control adjusts the gain of the balanced line amplifier in the 414A. Under certain conditions, enough gain is available to clip the line amplifier. Such clipping is indicated by illumination of the CLIP lamp. To clear this clipping, turn the OUTPUT ATTENuator down.

-- The SYSTEM OPERATE/BYPASS switch is a hard-wired bypass switch; its principal use is to keep a sound system functioning in an emergency mode despite a failure in the 414A. Because it bypasses all 414A circuitry, it is ordinarily not used as an in/out switch since it tends to produce clicks and level changes when operated.

-- The COUPLED/INDEPENDENT switch (414A only) permits the use of the two-channel unit either as two independent compressor/limiters, or as a coupled stereo unit. In the COUPLED mode, the gain reduction in both channels tracks that channel calling for the most gain reduction at any given instant. Therefore, stereo imaging is always preserved even if operating controls are adjusted differently on the two channels. (Ordinarily, they would be adjusted identically.)

-- The POWER ON/OFF switch is self-explanatory.

Using The Compressor/Limiter

To use the Compressor/Limiter, apply signal to the unit and adjust the operating controls by ear to achieve the sound desired. (An explanation of the operating controls is found above.)

Adjust the INPUT ATTENuator control until the desired amount of gain reduction is indicated on the G/R meter. You may now further adjust the amount of gain reduction over a ±10dB range by means of the THRESHOLD control. Be careful not to over-compress such that the G/R OVERLOAD lamp comes on. You may wish to readjust the ATTACK, RELEASE, and RATIO controls to "fine-tune" the sound to your taste. This will often result in a change in the amount of gain reduction, and you may wish to readjust the INPUT ATTENuator or THRESHOLD controls to compensate.

If you hear a "hashy" distortion on voice, or on instruments like electric bass, synthesizer, or Hammond organ, this can be completely eliminated by slowing down the attack time. (The "hash" is caused by the very fast release-time peak limiting function modulating the instrument waveforms. By slowing the attack time, you produce less peak limiting, forcing the 414A to behave more like a pure compressor.)

If you hear unnatural "pumping" or "breathing", this can usually be eliminated by slowing the release time and/or by using less gain reduction.

In general, the peak level at the 414A output will remain relatively constant regardless of the adjustment of the ATTACK and RELEASE TIME controls. If you choose a relatively low RATIO, the peak level will decrease at gain reductions less than 25dB. This prevents VCA clipping if the input level rises sufficiently to cause a full 25dB of gain reduction, since the output level will, in this case, increase significantly due to the low compression ratio.

Because peak output levels are held relatively constant, you can readily hear the effect of adjusting any control upon the relative loudness achieved by the processing. Fast attack and release times and high ratios result in maximum loudness (low peak-to-average ratios), but introduce the greatest risk of audible side-effects. In the 414A, special circuitry minimizes these effects when compared to conventional limiters and compressors.

SPECIFIC APPLICATIONS

Sidechain Processing

External signal processors can be inserted in the control sidechain of the 414A by use of the normalling SIDECHAIN jacks on the rear panel. These outputs and inputs are line-level, unbalanced, and require tip/sleeve (2-conductor) phone jacks. The output impedance is 100 ohms, and the input impedance is greater than 10K. Any signal processor inserted in the sidechain should be capable of +20dBm peak headroom.

De-Essing: If a highpass filter or bandpass filter tuned to approximately 6kHz is inserted in the sidechain, the 414A can be used as a de-esser. Adjust the ATTACK TIME control to "2" and the RELEASE TIME control to "0" for smoothest sound. If you insert an external compressor (you can use the other channel of the 414A) in front of the filter, then constant de-essing over a range of input levels equal to the amount of gain reduction used in the external compressor can be achieved. In this mode of operation, gain reduction is desired only on the "esses", and the 414A cannot be used simultaneously as a vocal compressor.

If you want to use the 414A to compress and de-ess simultaneously, use an equalizer instead of a filter in the sidechain, and boost the 6kHz region. This is a compromise mode, because the optimum time constants for vocal compression and de-essing are very different. It is necessary to set attack and release times very carefully to avoid punching "holes" in the audio when de-essing occurs.

The Orban 536A Dynamic Sibilance Controller is an economical two-channel de-esser which has been specifically optimized for no-compromise de-essing. Because the 536A is extremely easy-to-use and performs better than the 414A with sidechain processing in this application, we recommend use of the 536A if you require high-precision de-essing.

Frequency-Selective Limiting: The de-essing application is one example of frequency-selective limiting. If you insert an equalizer or filter into the sidechain, then compression and limiting action will be increased when program material containing large amounts of energy in the boosted frequency range is applied to the compressor. Conversely, if a certain frequency range is suppressed by the equalizer, then program material rich in energy in the suppressed frequency range will not produce as much gain reduction as it otherwise would.

This principle can be used for a wide variety of special effects, or to increase naturalness when processing some types of program material. For example, the 414A already contains a frequency-selective element in the side-chain: the LF rolloff network reduces the sensitivity of the compressor to low frequency material, reducing the normal tendency of bass to audibly modulate midrange loudness in wideband compressors such as the 414A.

The gain of the external sidechain processor must be adjusted to optimize the signal-to-noise ratio in the 414A's VCA. Too much gain will cause excessive gain reduction, resulting in poor noise performance (due to under-utilization of VCA headroom), while too little gain will cause insufficient gain reduction, leading to VCA clipping. Because there is no VCA clipping indicator (the 414A control circuitry without external sidechain processing has been carefully designed to automatically optimize VCA signal-to-noise while avoiding clipping), you must use your ears to determine if the VCA is producing audible distortion. Certainly, if temporarily pulling out the plugs from the 414A's SIDECHAIN jacks (thus bypassing your sidechain processing) causes substantial increases in gain reduction, there is danger of VCA clipping, and you should increase the gain of your sidechain processing until at least as much G/R occurs with the processing as without.

Stereo And Multichannel Operation

The two channels of the 414A may be strapped by means of the INDEPendent/COUPLED switch to assure stereo tracking and stable imaging. In addition, any reasonable number of 412A's or 414A's can be tracked by paralleling their rear-panel STEREO CPL terminals. All compressor/limiter VCA's will then track the channel requiring the highest amount of gain reduction. All operating controls are usually set identically.

Speech-Activated Ducking of Music

Speech-activated ducking of music is one unusual capability which requires the use of two (or more) channels with the controls set in a unique way. In this broadcast-oriented application, the level of the music in the on-air mix is automatically reduced whenever speech is present.

A 414A or two 412A's, in COUPLED or strapped mode, must be used. Channel "A" is used for the speech, and Channel "B" for the music.

Apply the speech to Channel "A", and adjust the "A" operating controls to produce fast attack and release times.

Apply the music to Channel "B". Adjust the "B" INPUT ATTENuator so that the music never causes gain reduction to occur in channel "B" even on the highest peaks.

Speech appearing at the Ch. "A" input at a level high enough to cause gain reduction in Ch. "A" will cause equivalent gain reduction in Ch. "B", thus ducking the music automatically during speech. The RATIO control determines if the music level is reduced in direct proportion to the speech level (high RATIO), or less than proportionately (low RATIO). The setting of the INPUT ATTENuator and/or THRESHOLD primarily determines the depth to which the music is ducked (the more gain reduction, the more ducking).

The outputs of the "A" and "B" channels (speech and music) may be mixed in an external mixer in any proportion desired. The original speech source may even be processed by another 414A with different settings, processed by other equipment, or left unprocessed.

By analogy, a similar setup can be used to modulate any signal by the envelope of any other signal. The range of the ATTACK and RELEASE TIME controls define the ability of this setup to track rapidly-varying envelopes.

PART D:
Maintenance

Introduction: This part of the manual provides instructions on how to maintain the 414A, how to make sure that it is working according to specifications, and how to repair it if something goes wrong.

Factory service is available throughout the life of the 414A. Please refer to **Factory Service** subsection of **MAINTENANCE AND SERVICE** below for further information.

CAUTION

Service instructions are included for use by qualified personnel only. To avoid electrical shock, do not perform servicing other than that described within Operating Instructions unless you are qualified to do so. Refer all such servicing to qualified service personnel.

1: ALIGNMENT AND PERFORMANCE EVALUATION

General:

This procedure refers to the 414A (dual-channel version), but is equally applicable to the 412A (single-channel version). This section provides a series of thorough bench tests which will usually verify whether or not the 414A is operating normally. Certain subtle failures in the dynamic control circuitry cannot be detected by these tests, since special factory test procedures and equipment are necessary to fully characterize the dynamic operation of the 414A. Such subtle failures are usually detected by ear in the field, and factory service is recommended.

In the case of the dual-channel 414A, the completely redundant channels make "by ear" trouble diagnosis easier, as the bad channel can be directly compared with the good one.

The 414A is aligned as these tests are performed. The 414A has five trimmers per channel (which standardize VCA gain, calibrate the meter, and which null DC offset, thump and distortion). Alignment is ordinarily required only when IC3, IC13, or IC14 is replaced.

Power Supply:

Equipment Required:
1) VTVM or DVM
2) Oscilloscope

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

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

2) Measure the voltage between circuit ground and the outputs of the positive and negative voltage regulators, IC13 and IC12. The supplies should deliver between ±14.25 and ±15.75 VDC. If either supply exceeds 15.75 VDC, it implies that its associated IC regulator is defective. If either supply is lower than 14.25 VDC, refer to the **Power Supply** portion of **Part 3** in this section for troubleshooting hints.

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

Signal Processing Circuitry:

Equipment Required:

1) Oscilloscope with DC-coupled display
2) 20-20,000Hz bandpass filter, 18dB/octave slopes
3) VTVM or DVM
4) Harmonic distortion analyzer with built-in 400Hz and 80kHz filters and residual THD below 0.0015%
5) Low-distortion oscillator with residual THD below 0.0015%
6) A 0.1uF film capacitor; ±20% or better; 50VDC or better
7) A 620 ohm ±5% resistor

[A Sound Technology 1700A or H-P 339 will satisfy (4) and (5)]

IN THE CASE OF THE 414A, THE TEST PROCEDURE BELOW SHOULD BE FOLLOWED FROM BEGINNING TO END FOR CHANNEL "A", THEN REPEATED FOR CHANNEL "B".

1) Gain and Distortion Tests and VCA Alignment

a) Connect the oscillator to the 414A input. Connect a 620 ohm ±5% resistor between the 414A (+) and (-) OUTPUTs. Connect the THD meter/AC VTVM between the 414A (+) and (-) OUTPUTs. Set the controls as follows:

INPUT ATTEN	10
OUTPUT ATTEN	5
THRESHOLD	0 (at the detent)
RATIO	infinity
ATTACK TIME	5
RELEASE TIME	5
COUPLED/INDEP SWITCH	independent
SYSTEM BYPASS	OPERATE
LF ROLLOFF JUMPER	DEFEAT (i.e., flat response in control loop: see **Part B: Installation**)

b) Suppress the oscillator output. Measure the voltage across R51 with the DVM, and adjust R53 (GAIN TRIM) until the DVM reads 617mV DC ±3mV.

c) Set the oscillator frequency to 1kHz and adjust its output level to obtain a reading of "-10" on the 414A's G/R meter.

d) **(414A only):** Temporarily switch the COUPLED/INDEP switch to COUPLED, and verify that the Channel "B" G/R METER also reads 10dB G/R, ±2dB. Restore the switch to INDEP.

e) Without changing any settings on the oscillator or 414A, measure the THD at the 414A output and adjust R14 (DISTORTION NULL) to minimize it. THD should not exceed 0.03% if measured using a 20-20kHz bandpass filter to minimize the effect of supersonic noise upon the distortion reading.

f) Disconnect the oscillator from the 414A input, and connect it to the wiper of R53 (GAIN TRIM) through a 0.1uF film capacitor (see <u>Equipment Required</u> above). Set the oscillator frequency to 100Hz, and adjust the oscillator output level until a distorted 100Hz feedthrough component can be seen on the scope monitoring the AC VTVM. (Approximately +10 to +15dBm will be required from the oscillator, and you should observe the distortion analyzer's amplified "DISTORTION OUTPUT" on the scope to best see the feedthrough.) Adjust R7 (THUMP NULL) to minimize the amount of feedthrough.

2) Noise Test

a) Reconnect the oscillator to the 414A input. Observe the 414A output with the scope. (The distortion analyzer's MONITOR OUTPUT is probably the most convenient place to connect the scope). Set the THRESHOLD control to "+10". Advance the oscillator output level until the scope indicates that the 414A's output has just reached clipping. (The 414A's G/R OVERLOAD lamp will be on when this happens.) Use this level as a "0dB" reference for the AC VTVM section of the distortion analyzer.
b) Suppress the oscillator and turn the 414A INPUT ATTEN to "0". Measure the noise at the 414A output through a 20-20kHz bandpass filter with 18dB/oct or greater slopes. The noise should not exceed -85dB (RMS) below the "0dB" reference just established.

NOTE: If this specification is not met, be sure that hum or RF pickup due to poor test equipment configuration or grounding is not causing falsely high readings.

3) Compressor/Limiter Operate Mode Tests

a) Restore the THRESHOLD control to "0". Set the oscillator frequency to 100Hz, and adjust the oscillator output level until the 414A G/R meter reads 20dB G/R. Measure the THD at the 414A output, and verify that it is less than 0.05%. Observe the distortion output from the THD analyzer on a scope, and verify that the distortion residual looks like Fig. D-1.

(**NOTE:** The distortion at 100Hz will rise rapidly with faster settings of the RELEASE TIME control.)

b) Without changing the oscillator output level, measure the THD at 1kHz and 10kHz, and verify that it is less than 0.03% at 1kHz and 0.05% at 10kHz.
c) Set the RELEASE TIME control to "10". Suppress the oscillator output, and verify that the time required for the G/R meter to move from 20dB to 0dB G/R is 5.7seconds, $\pm$1.0seconds.

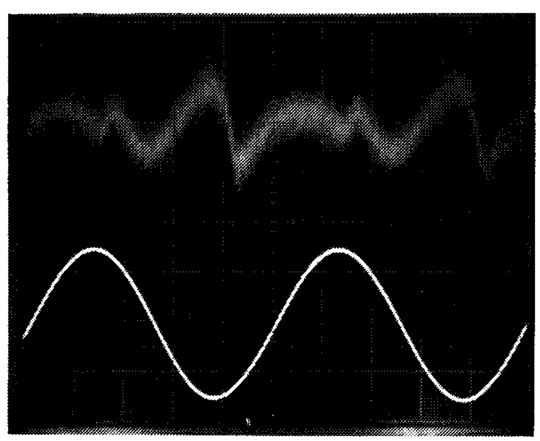


Fig. D-1: 100HZ DISTORTION RESIDUAL

NOTE

The shape of the distortion residual provides a good indication of whether the timing module and other circuitry within the control loop are operating properly. If the distortion residual which you observe is significantly different than the Fig. D-1 (particularly if accompanied by audible problems with sound quality), we recommend returning the 414A for factory service, as it is usually impractical to diagnose and repair subtle control circuitry problems in the field.

4) COMPRESSION RATIO control test

a) Set the 414A ATTACK TIME control to "0" (FAST), and the RATIO control to "infinity". Set the oscillator frequency to 1kHz, and its output to produce 10dB G/R. Adjust the OUTPUT ATTEN control as necessary to produce 0dBm at the 414A output.
b) Set the RATIO control at each of the panel markings in **TABLE D-1,** and verify that the 414A output level is close to the values indicated, ±1dB.

Ratio	Output Level
oo	0dBm
6:1	-1.8dBm
4:1	-3.0dBm
3:1	-3.8dBm
2:1	-3.2dBm

TABLE D-1
RATIO CONTROL TEST

5) ATTACK TIME control and threshold circuitry test

a) Without changing other control settings, restore the RATIO control to "infinity". The G/R meter should read "10dB".
b) Adjust the attack time control to the settings shown in **TABLE D-2,** and verify that the 414A output level approximately corresponds to the values shown in the Table, ±1dB.

Attack Time	Output Level
"fast"	0dBm
"4"	-1.4dBm
"6"	-3.8dBm
"8"	-6.8dBm
"slow"	-11.0dBm

TABLE D-2
OUTPUT LEVEL VS ATTACK TIME TEST

This concludes alignment and performance verification.

2: MAINTENANCE AND SERVICE

Preventive Maintenance

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

Corrective Maintenance

All Orban products are designed to be completely free of failures throughout eternity. However, Orban research has recently discovered that there is no justice in the world and, in fact, there is not supposed to be any.

For this reason, the following **Corrective Maintenance** section is included.

CAUTION

> Repairs made to this product should be performed in accordance with applicable safety standards for your country, and should be performed only by a well-qualified, professionally-trained service technician.

Service Access

Access to the 412A/414A for service and adjustment is relatively straightforward.

The 412A contains only one card, and full access is obtained by removing the top and bottom covers.

In the 414A, each channel has its own horizontally-mounted circuit card. These are stacked, so direct access to the bottom of the CHANNEL "A" board or the top of the CHANNEL "B" board requires a certain amount of disassembly beyond removing the top and bottom covers. However, all alignment trimmers can be accessed by cover removal alone, since the CHANNEL "B" alignment trimmers are mounted on the bottom of the CHANNEL "B" board, whereas the CHANNEL "A" trimmers are mounted on the top of the CHANNEL "A" board.

Full access to one board in the 414A requires removal of the other board. (It is generally best to remove the top board.) This is done as follows:

1) **Knob Removal:** Pry the plastic cap off the front of each top-row knob. Using the wrench supplied with the packing materials, loosen the now-exposed collet nut counterclockwise until the knob pulls off the pot shaft easily. (If you have lost the wrench, a screwdriver or can-opener will probably work.)

2) **LED Removal:** Grasping the leads, gently pull each LED out of its plastic lens.

3) **Board Access:** Remove several machine screws from the front edge of the circuit board. The rear of the board is supported by a rail which is affixed to the sides of the chassis by means of two self-tapping screws. Remove these two screws. Slide the board about 3/4" (19mm) backward to assure that the pot shafts clear the front panel. Then tilt the board outward, imagining a hinge at the rear edge. To secure the board temporarily, replace the two self-tapping screws.

4) **Complete Board Removal:** If you want to remove a board entirely, the various interconnections must be unsoldered.

In the 414A, power is supplied from the CHANNEL "A" board to the CHANNEL "B" board through a harness containing five wires. These must be unsoldered from the CHANNEL "B" board. (If, upon reassembly, you lose track of which wire goes into which hole, refer to the Assembly Drawing at the rear of this manual.) In addition, the two boards are interconnected by means of a wire lead connected to the COUPLED/INDEP switch. The wire may be unsoldered at the COUPLED/INDEP switch. (This switch is soldered to floating pads on the board to secure it mechanically. However, it does not connect to any printed wiring.)

Reassembly is performed in the reverse of disassembly. (If notations as to which wire goes to which terminal are misplaced, consult the schematic at the back of this manual to deduce the correct wiring.)

Circuit boards should be fastened using the screws removed above, taking care to center the switch buttons in their holes to avoid binding.

When the knobs are reattached, they should first be partially tightened, leaving a small clearance between the knob and the panel. Once partially tightened, each knob should be turned so that it aligns with the markings on the panel at the counterclockwise stop of the pot.

Once properly aligned, each knob should be firmly tightened. Then replace the snap-on caps, accurately aligning the marking on the cap to the marking on the knob.

Reinsert the LED's in their respective lenses.

Operation of the unit should be checked before the covers are installed.

Lamp Replacement: The lamp supplied with the 414A is a long-life type which is operated below its rated voltage. It is not expected to fail in the field under normal circumstances. If it does, it can be replaced in the 412A by removing the bottom cover to gain access to the lamp socket. (The lamp is a press-fit type.) In the case of the 414A, the single lamp (used for both channels) is mounted below the Channel "A" meter, and must be accessed by removing the top PC board according to the instructions provided in **Service Access** above. The correct replacement is shown in the Parts List at the rear of this manual.

Component Replacement: All IC's in the unit are socketed and can be readily replaced from the top surface of each board. Complete realignment (except for R83) is required if IC4 or IC14 is replaced. If IC13 is replaced, R83 (OFFSET TRIM) must be aligned according to paragraph (1.a) in **Signal Processing Circuitry** at the beginning of this **Part.**

Other components are soldered in place, and may be replaced following the instructions in **Replacement of Components On Printed Circuit Boards** immediately below.

The potted module on each board is not field-repairable, and must be replaced in its entirety. While the module can be replaced without realignment of the unit, diagnosing failures in the module can be tricky and is best left to the factory.

If filter capacitors are to be replaced, fasten them securely to the board, using the original factory installation as a model. This will prevent their breaking loose in the future from vibration.

Replacement Parts: If you have difficulty finding parts for this or any other Orban product, Orban Customer Service stands ready to supply you with the required parts at a fair price. Please contact us at the address shown at the front of this Manual.

Replacement of Components on Printed Circuit Boards

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

The circuit boards used in the 414A are of the double-sided plated-through variety. This means that there are traces on both sides of the board, and that the through-holes contain a metallic plating in order to conduct current through the board. Because of the plated-through holes, solder often creeps 1/16" up into the hole, requiring a sophisticated technique of component removal to prevent serious damage to the board.

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

Another technique is:

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

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

3) Now lift the component out.

Installation:

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

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

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

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

Troubleshooting IC Opamps

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

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

Because the characteristics of the 414A are essentially independent of opamp AC characteristics, an opamp can usually be replaced without need for recalibration. However, most of the circuitry in the compressor/limiter control loop is sensitive to opamp DC characteristics, like bias current and offset voltage. Because of this, high-performance dual opamps are used in many sockets. These devices must be replaced by exact replacements.

NOTE

The dual current-controlled gain block IC4 used in the VCA is not an opamp. If it is replaced, recalibration according to the instructions in **Section 1** of this **MAINTENANCE** section is absolutely necessary.

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

Factory Service

Please refer to the terms of your Orban Associates Limited One-Year Standard Warranty, which extends to the first end-user. This warranty was packed with the 414A but is not bound with this manual. After expiration of the warranty, a reasonable charge will be made for parts, labor, and packing if you choose to use the factory service facility. Repaired units will be returned C.O.D. In all cases, transportation charges (which are usually quite nominal) shall be borne by the customer.

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

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

Shipping Instructions

If the original packing material is available, it should be used. Otherwise, a carton of at least 200 pounds bursting test and no smaller than 22" x 8" x 7" should be employed.

The 414A should be packed so that there is at least 1-1/2" of packing material protecting every point. A plastic wrap around the chassis will protect the finish. Cushioning material such as Air-Cap, Bubble-Pak, foam "popcorn", or fibre blankets are acceptable. Folded newspaper is not suitable. Blanket-type materials should be tightly wrapped around the 414A and taped in place to prevent the unit from shifting out of its packing and contacting the walls of the carton.

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

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

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

3: CIRCUIT DESCRIPTION

General: Except for the power supply, the "A" and "B" channels of the dual-channel 414A are independent and identical.

The circuitry is divisible into five major blocks. These are:

1) input buffer
2) voltage-controlled amplifier
3) compressor/limiter control circuitry
4) line amplifier
5) power supply

These will be described in order.

1) Input Buffer

The signal enters the 414A in balanced form. C1, C2 shunt RF from the input leads to the chassis. These capacitors are not effective at VHF and higher frequencies; therefore, ferrite beads have been placed around the input and output leads to suppress such high frequency RF. It should be noted that this degree of RF-proofing is moderate but adequate for a vast majority of installations. However, installation next to a high-power transmitter may still cause problems. Additional RF suppression, careful examination of the grounding scheme, and other considerations familiar to the broadcast engineer may have to be used in conjunction with the 414A's built-in RF suppression.

The filtered signal is applied to IC8b, a very low-noise opamp configured as a differential amplifier with a gain of 1. When both non-inverting and inverting inputs are driven by a source impedance which is small with respect to 100K (such as 600 ohms or less), the amplifier is essentially insensitive to signal components that appear equally on the non-inverting and inverting inputs (such as hum), and responds with full gain to the difference between the non-inverting and inverting inputs. Thus it serves as an "active transformer". Ordinarily, best results are obtained for unbalanced signals if the non-inverting (+) input is grounded and the inverting (-) input is driven.

The INPUT ATTEN. control is located after IC8b. Therefore, IC8b will overload if its differential input exceeds approximately +20dBm.

2) Voltage-Controlled Amplifier (VCA) Operation

Current-Controlled Gain: The current-controlled gain block used in the 414A is a proprietary Class-A VCA which operates as a two-quadrant analog divider with gain inversely proportional to a current injected into a first gain-control port, 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, 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. If used alone, one such gain-control block would introduce considerable distortion. Therefore, the first of the two matched blocks IC4b is used as the feedback element in a high-quality operational amplifier, IC3. The second of the matched blocks IC4a is then driven by the predistorted output of IC3. To provide more detail: The output of IC3 is first attenuated by R10, R11, C6, and then applied to the input of the feedback element IC4b. The output of IC3 is predistorted as necessary to force the current output of IC4b to precisely and linearly cancel the audio input into the "virtual ground" summing junction of IC3. This same predistorted voltage is also connected to the input of IC4a. Thus the output of IC4a is an undistorted current. This current is converted to a voltage in current-to-voltage converter IC5b, R16, C7, C8. The output of IC5b is the output of the VCA.

Because IC4b is in the feedback loop of IC3, the gain of the VCA is inversely proportional to the gain of IC4b. Thus if the control current is applied to the control port of IC4b (from IC14d), the VCA behaves like a two-quadrant analog divider. The gain-control current injected into this control port is developed by the compressor/limiter control circuitry.

A current developed from the THRESHOLD control R59 is injected into the control current port of IC4a through IC5a, varying the gain of IC4a in direct proportion to this control current. A proportional current developed from R59 is also injected into the gain control port of IC4b (through exponential converter circuitry IC6 and associated components), varying the gain of IC4b in inverse proportion to the control current. Thus when the THRESHOLD control R59 is operated, the gains of IC4b and IC4a vary inversely, and there is no overall gain change.

However, since the compressor/limiter control loop is driven from the output of IC3 (which is affected only by IC4b), the THRESHOLD control has the effect of varying the gain before the control loop (like an input attenuator control). Thus, by feedback, the loop constrains the output of IC3 to be at a level dependent upon the compressor threshold voltage as developed by IC8a and associated circuitry. This level is then amplified or attenuated by IC4a according to the setting of the THRESHOLD control, resulting in the output level's rising or falling with changes in the THRESHOLD control. This arrangement thus always uses the maximum available dynamic range from the VCA: the VCA's clipping level and noise are reduced proportionally when the THRESHOLD control is turned down and less output level is produced. The converse occurs when the THRESHOLD control is turned up.

Second-harmonic distortion is introduced by differential offsets in either IC4b or IC4a. This distortion is cancelled by applying a nulling voltage directly to the input of IC4a by means of resistor network R13, R14, R82.

If the VCA is not perfectly balanced, "thumps" due to control current feedthrough can appear at the output. These are equivalent to multiplying the control current by DC. If a correct DC offset is applied to the VCA input, then this equivalent DC multiplication can be nulled to zero and the "thumps" eliminated. Such an adjustable DC offset is provided by R6, R7.

C5, R9 are frequency-compensation components to prevent the VCA from oscillating supersonically.

Exponential Converter: The basic current-controlled gain in the compressor/limiter is inversely proportional to the control current. We wish to transform this into a gain which is proportional to a control voltage in dB. This is done in the exponential current converter consisting of IC6a and associated components.

IC6a, IC14a, IC14b, IC14c and associated components form a log/antilog multiplier. This multiplier multiplies the current flowing in R57 by the exponential of the voltage on the base of IC14a. The current gain of the multiplier increases as the voltage on the base of IC14a becomes more negative.

Because the voltage on the base of IC14a is in log (i.e., dB-linear) form, various control voltages can be summed into this base, and they will add in a dB-linear manner. These control voltages include the main gain-control output of the timing module (through R56) and a gain trim (through R54).

The current output of the log/antilog multiplier appears on the collector of IC14c. It is the wrong polarity and level to correctly drive the control-current port of IC4b. It is therefore applied to a current inverter IC6b, IC14d, R51, R52, C16. This circuit has a gain of 6.66x, and operates as follows:

A voltage proportional to the current output of IC14c is developed across R52 because of the feedback action of IC6b. (C16 stabilizes IC6b against oscillations.) Feedback forces IC6b's (-) and (+) inputs to be at the same voltage. Thus, the same voltage which appears across R52 also appears across R51, and current flows in R51 in proportion to the ratio between the values of R52 and R51.

This current flows out of the (+) input line of IC6b into the emitter of IC14d. Because IC14d's base current is small compared to its emitter current, essentially the same current flows out of IC14d's collector into the gain-control port of IC4b.

The base of IC14d is grounded; its emitter therefore sits at +0.6V. This forces both (+) and (-) inputs of IC6b to also sit at +0.6V, and assures correct bias voltage for IC14a's collector.

CR5 protects IC14d from reverse base-emitter voltage which could otherwise cause junction breakdown and latchup of the entire current-inverter circuit.

3) Compressor/Limiter Control Circuitry

General: The compressor/limiter is a feedback circuit. That is, the gain-controlled output of the compressor/limiter is sensed, and is used to develop a gain-control signal which is applied to the compressor/limiter 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.

Rectifier With Threshold: The output of IC3 in the VCA is applied to a rectifier with threshold. This circuit has a current input and current output. Its current gain is adjustable with R74, the ATTACK TIME control.

IC3's output is gain-controlled but predistorted, and its peak level rises faster than the peak level of the VCA output as VCA clipping is approached. Using this signal as the control source to the rectifier makes the compressor/limiter circuit automatically resist VCA clipping, as the error signal used in the feedback control loop becomes rapidly larger as clipping is approached, thus effectively speeding the attack time and reducing overshoots at the VCA output.

Any DC offsets at IC3's output are blocked by C14. Network R42, C15 provides a highpass shelving rolloff in the bass, making the control circuit less sensitive to bass. This matches the equal-loudness curves of the ear (the ear is less sensitive to bass than to midrange frequencies), and prevents obvious modulation of midrange material by bass. A jumper is available to defeat this rolloff if the 414A is to be used as a true peak limiter which must be equally sensitive to all frequencies.

The output of the shelving network is applied to a conventional precision halfwave rectifier IC10b, R43, R45, CR6, CR7. The output of this rectifier (which inverts its input) is applied to the summing junction (a virtual ground) of IC10a through R46 with a relative gain of 2x. The input of the half-wave rectifier is also applied to IC10a's summing junction through R44, with a relative gain of 1x. The current input to IC10a's summing junction is thus a full-wave rectified signal with a relative gain of 1x.

When there is no output from rectifier IC10b, threshold current is removed from the IC10a summing junction through R75. This current flows through CR20, and IC10a's external PNP output transistor (IC11d) is turned off. When the current output from the rectifier exceeds the threshold current, CR20 turns off and the output transistor is turned on through CR11, thus permitting output current to flow from the circuit into the following timing module.

R75 (through which the threshold current is removed) is fed from the output of IC8a, which supplies a threshold voltage which is varied in ways which will be described below. For the moment, observe that adjusting R74 will vary the amount of current removed from IC10a's summing junction, thus lowering the compression threshold when the attack time is lengthened.

IC10a and associated components are essentially a current-in, current-out circuit with adjustable current gain. The current input is IC10a's (-) input; the current output of the circuit is the collector of IC11d. This output current is further applied to a three-transistor Wilson current mirror IC11a, IC11b, IC11c which inverts and level-shifts the current so that the final output current flows from the collector of IC11a into the timing module.

The output current of the circuit is essentially equal but opposite to the current flowing into the emitter of IC11d. This current is the sum of the current flowing through R73 and the current flowing through the R73 side of R74.

When the wiper of R74 is far from R73, IC10a (through its output transistor) behaves like a high-gain inverting amplifier, forcing a considerable voltage drop across R73, and therefore resulting in a high current through R73 and high current gain in the circuit. This corresponds to a fast attack time.

As the wiper of R74 is moved closer and closer to R73, the inverting gain decreases and the attack time lengthens. Simultaneously, the threshold decreases. When the wiper of R74 is almost at, or at, its R73 endstop, a minimum current gain of approximately 1x is achieved.

At this point, the offset introduced into the (+) input of IC10a by voltage divider R76, R77 (as fed by the threshold voltage) comes into play to swiftly and radically lower the rectifier threshold by causing a current flow through R73 which almost balances the current flow out of R75. This keeps the peak output level of the compressor/limiter approximately constant, as extremely slow attack times are rather abruptly produced as R74's wiper comes close to the R73 endstop, and these attack times must be complemented by large decreases in threshold.

It should be noted that IC10a must have offset of less than 1mV for this scheme to work reliably, and it is therefore important to replace IC10a by an identical IC in case of failure.

Timing Module: The collector of IC11a feeds the compressor/limiter timing module. This module contains proprietary circuitry which receives the input current from the rectifier with threshold, and outputs a control voltage with appropriate dynamics to achieve natural-sounding control and very low modulation distortion. The output of the module is a low-impedance unidirectional voltage source which can be wire-"OR"ed with other such modules to effect stereo tracking of an arbitrary number of channels.

The RELEASE TIME control R69 allows a 20:1 variation in the basic release dynamics, which are determined by the timing module on the basis of the past history of the input. When attack current flows into the timing module from the collector of IC11a, Q3 is turned ON. This turns IC11e ON, pulling its collector and the gate of Q2 to +15V, thus turning Q2 OFF and suppressing the release process while attack is occurring.

Threshold-Setting Circuitry and RATIO Control: As was explained above, the compression threshold is modified by the setting of R74 in order to lower the threshold as the attack time is lengthened.

The threshold is modified by two other factors.

The first factor is the gain of the COMPRESSION RATIO control R62. The basic compressor circuit has a high compression ratio (approaching infinity-to-one). To achieve lower compression ratios, the VCA gain-control voltage is fed back into the threshold circuit through R61 and R62 in such a way as to increase the threshold as more gain reduction occurs. The amount of feedback is adjusted by R62 from none (infinity-to-one) to enough to produce a 2:1 ratio at compression threshold. It can thus be seen that the compressor output level increases as gain reduction increases, lowering the compression ratio as desired. (Because of details of the circuit configuration, all ratios increase as gain reduction increases beyond threshold, yielding a "soft knee" curve.)

The second factor is the position of the COMPRESSION RATIO control R62. The network R63, R64, R65, R61, R62 provides a reference voltage for IC8b which in turn determines the basic compression threshold. This reference voltage is decreased as R62 is turned counterclockwise towards lower ratios, thus lowering the threshold and increasing the gain reduction to avoid potential VCA overload as its output level increases.

The circuit has been designed so that at 25dB (maximum achievable) gain reduction, the VCA output is approximately constant regardless of the position of R62. The change in VCA gain-control voltage fed into the circuit through R61 approximately compensates for the change in current flowing through R63 and R66 as the loading on these resistors is changed by adjustment of R62.

Gain Reduction Meter: The gain-control voltage at the output of the timing module is fed to a peak-detector circuit (consisting of IC9 and associated components) which in turn drives the gain reduction meter.

The gain-control voltage is applied to the (+) input of IC9b. The output of IC9b drives a peak detector network C20, C19, CR15, CR14, CR13, CR12. When IC9b's (+) input goes more negative than its (-) input (indicating that the output of the meter driver circuit needs to be updated), IC9b's output goes negative and charges both C20 and C19 to approximately equal voltages through CR15 and CR12. IC9b's output stays negative and continues charging until C20 is charged to the negative peak value of the gain control voltage. IC9a, configured as a voltage-follower, buffers C19 and provides a negative feedback voltage for IC9b.

As long as C20 is charged to a more negative voltage than is present on the (+) input of IC9b, the output of IC9b will be positive, turning off both CR15 and CR12 and permitting C20 to discharge towards ground through R80 and R81. As C20 discharges, the voltage differential between C20 and C19 ultimately becomes sufficient to turn CR14 and CR13 ON, discharging C19 as well. Until these diodes are turned on, the peak voltage on C19 is held constant. This permits the meter to mechanically rise to the full peak value and to display the peaks accurately.

4) Line Amplifier

The line amplifier consists of IC13 and associated resistors R18 through R29. By use of crosscoupled negative and positive feedback, this circuit creates a balanced, floating output. This means that the voltage developed across the (+) and (-) outputs will be the same regardless of the resistance between the (-) output and ground -- the (-) output may even be grounded to achieve an unbalanced output.

The nominal output impedance of this circuit is 91 ohms with a worst-case output drive capability of approximately +20dBm into 600ohms. When operating properly, its gain is approximately -0.1dB from input to output when loaded by 100K.

A servo circuit consisting of IC15b and associated circuitry zeros common-mode DC offset voltage. The signals on the (+) and (-) output lines are summed into integrator IC15b through R85 and R28 respectively. The AC signals on the (+) and (-) lines cancel because they are equal and opposite. Feedback holds the (-) input of IC15b at 0VDC. If the average DC level on the (+) and (-) lines is not 0VDC, current flows through R28, R85 and C30 charges, producing a DC voltage at the output of IC15b which is applied to the line amplifier through R84. This closes the DC servo feedback loop, which reaches equilibrium when the average DC voltage at the (+) and (-) outputs of the line amplifier is 0VDC.

5) Power Supply

Unregulated voltage is supplied by two pairs of full wave diode rectifiers CR16, CR17 and CR18, CR19 operating into a pair of energy storage capacitors C21, C22. The power transformer T1 is strappable 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 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 IC2, IC1. Because they are operated so conservatively, they can be expected to be extremely reliable. Therefore, before replacing the regulators, check to see whether other abnormalities in the circuitry (such as a shorted IC) have caused excessive current demand which is causing the regulator IC's to go either into current limiting or into thermal shutdown, their two built-in protective modes. If it becomes necessary to replace a regulator, be sure to replace its heat dissipator securely.

The regulators IC2 and IC1 are frequency-compensated by C23, C24 at their outputs to prevent high frequency oscillations. If C23 or C24 are ever replaced, be sure to use low-inductance aluminum electrolytics. Tantalums can fail because the current-delivering capacity of the power supply can cause a runaway condition if the dielectric is punctured momentarily; high-inductance aluminums can fail to prevent the regulators from oscillating. It is therefore necessary to check for oscillation on the power bus with an oscilloscope if C23 or C24 is replaced. In addition, small 0.05uF/25V ceramic capacitors bypass the power busses to ground locally throughout the board to prevent signal-carrying IC's from oscillating due to excessive power-lead inductance.

APPENDIX A:
Interconnection and Grounding

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

DRIVING THE INPUT FROM HIGH-IMPEDANCE/ HIGH-LEVEL SOURCES

Both "+" and "-" sides of the inputs are bypassed to chassis ground for RF through 1000pF capacitors. To assure common mode rejection, and to assure that these capacitors do not affect the frequency response of the system, the output impedance of the equipment driving the 414A should be 600 ohms or less. Most professional and semi-professional sound equipment will satisfy this requirement.

The 414A can be driven by unbalanced sources of up to 10,000 ohms (such as the outputs of some vacuum tube preamps) by removing the 1000pF capacitors from the "+" inputs, and driving these inputs from the hot side of the driving equipment's outputs. (See the section below on **Grounding** for an explanation of balanced and unbalanced connections.)

If the 1000pF capacitors are left in place and the source impedance is 10K, the capacitors will cause a high frequency rolloff which is 3dB down at 16kHz, and which rolls off at 6dB/octave thereafter.

The absolute clipping level of the 414A input is +20dBm. If levels greater than +20dBm are expected, an external loss pad must be used before the input. The Audio Cyclopedia, Section 5, contains instructions for making such pads. (Tremaine, H.M.: The Audio Cyclopedia, Second Edition, Indianapolis, Howard W. Sams & Co., Inc., 1969).

GROUNDING

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

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

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

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

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

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

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

How grounding is accomplished depends on whether the equipment to be interconnected is balanced or unbalanced.

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

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

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

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

APPENDIX B:
Specifications

Input

Impedance: greater than 10 k ohms active balanced.

Level: -15dBm produces 10dB gain reduction with ATTACK TIME control centered, INPUT ATTEN control fully CW, and RATIO control at infinity-to-one.

Absolute Overload Level: +21dBm

Output

Impedance: approximately 100 ohms, electronically balanced and floating.

Level: +4dBm nominal; absolute peak overload better than +20dBm.

Frequency Response

$\pm$0.25dB 20-20,000 Hz below limiting and de-esser thresholds.

Compressor/Limiter Characteristics

Attack Time: manually adjustable in approximate range of 500us to 200ms; automatically scaled by program content.

Release Time: adjustable in approximate range of 3dB/sec to 80dB/sec; automatically scaled by program content.

Compression Ratio: adjustable from 2:1 to infinity-to-one at threshold. Lower ratios automatically increase beyond threshold.

Range Of Gain Reduction: from 15dB to 35dB depending on setting of THRESHOLD control; 25dB with THRESHOLD control at center detent.

Tracking Of Multiple Channels: $\pm$0.5dB.

Total Harmonic Distortion (ATTACK and RELEASE TIME controls centered; infinite RATIO; 15dB gain reduction): less than 0.05% @1kHz. Typically 0.04% @100Hz; 0.025% @1kHz; 0.035% @10kHz.

SMPTE IM Distortion (controls set as above; 60/7000Hz 4:1; 15dB gain reduction): typically 0.2%.

System Noise

RMS noise in 20-20kHz bandwidth better than 85dB below output clipping threshold for any degree of gain reduction; 90dB typical.

Crosstalk (414A Only)

Better than -70dB @20kHz. Unmeasureable below 10kHz.

Operating Controls

INPUT ATTENUATOR
OUTPUT ATTENUATOR
THRESHOLD
COMPRESSION RATIO
ATTACK TIME
RELEASE TIME
SYSTEM OPERATE/BYPASS (Hardwire Bypass)
STEREO COUPLING (414A only)
POWER ON/OFF

Indicators

GAIN REDUCTION METER
GAIN REDUCTION OVERLOAD LAMP
OUTPUT CLIP LAMP

Power Requirement

115/230 VAC ±10%; 50-60Hz; approximately 6 VA (412A), 10 VA (414A). U-ground power cord attached.

Input/Output Connectors

Barrier strip (#5 screw). Chassis is punched to accept customer-installed 1/4" phone jacks and/or XLR-type connectors.

Dimensions

412A

19" (48.3cm) wide x 1.75" (4.5cm/1 unit) high x 5.3" (13.5cm) deep

414A

19" (48.3cm) wide x 3.5" (8.9cm/2 units) high x 5.3" (13.5cm) deep

Operating Temperature

0-45°C

Warranty

One year, parts and labor. Subject to limitations set forth in our Standard Warranty Agreement.

SPECIFICATIONS SUBJECT TO CHANGE WITHOUT NOTICE.

Parts List

Parts are listed by part class (such as "Resistors"), by assembly (such as "Card #5"), in Reference Designator order. Exceptions are certain widely-used common parts such as

Fixed Resistors
3/8" Square Trimmer Resistors
Signal Diodes

which are described generally. Such parts must be checked against the appropriate Schematic Diagram or physically examined to determine their exact value.

Obtaining Spare Parts

Because special or subtle characteristics of some components are exploited to produce an elegant design at reasonable cost, it is unwise to make substitutions for listed parts. It is also unwise to ignore notations in the Parts List indicating "Selected" or "Realignment Required" when replacing components. In such cases, the factory should be consulted to help you maintain optimum performance.

Orban ordinarily maintains an inventory of tested, exact-replacement spare parts to supply any present or normally-expected future demand quickly at a fair price.

If you order parts from the factory, please supply all of the following information:

-- The Orban Part Number, if you can determine it
-- The Reference Designator (like R6) for the part
-- A brief description of the part
-- And, from the Serial Label on the rear panel:
  - The exact Model Number
  - The Serial Number
  - The "M" number, if any

Orban can supply standardized Spare Parts Kits for this product during its production life. Consult your dealer or the factory to obtain a list of the prices and contents of such kits.

To ease future maintenance, parts for this unit have been chosen from the catalogs of well-known manufacturers. Their U.S. headquarter addresses are listed at the end of the Parts List. Most manufacturers have extensive distribution facilities throughout the world and can often be contacted through local offices.

REF DES	DESCRIPTION	ORBAN P/N	VEN (1)	VENDOR P/N	ALTERNATE VENDORS(1)	QUAN/SYS.	NOTES
CHASSIS ASSEMBLY							
	Capacitors						
C1,2	Ceramic Disc, 1KV, 10%; 0.001uF	21112-210	CRL	DD-102	MUR		
C9,10	Ceramic Disc, 1KV, 10%; 0.001uF	21112-210	CRL	DD-102	MUR		
	Diodes						
CR4,8	LED, Red	25103-000	GI	MV-5053			
	Inductors						
L1,2	Inductor, RF Choke, 160mA; 1mH	29502-000	MIL	4662			
	Meters						
M1	Meter, Edge, 1mA, Black/White, 1 to 30	28010-003	EMI	13-F			950 Ohms
	Miscellaneous						
DS1	Lamp, 28V, Sub. Min. Wedge Base	25302-000	GE	85			
F1	Fuse, 3AG, Slo-Blo, 1/8A	28004-113	LFE	313.125	BUS		
NONE	Line Cord, AC, 3 Wire	28101-000	BEL	17534			
T1	Transformer, Power; 48.3VCT, 5.3VA	55006-000	ORB				

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
COMP/LIM MODEL 412A/414A
Rev. 03 1/86
MODULES/CAPACITORS

PCB MAIN ASSEMBLY

Capacitors

REF DES	DESCRIPTION	ORBAN P/N	VEN (1)	VENDOR P/N	ALTERNATE VENDORS (1)	QUAN/ SYS.	NOTES
C3,4	Alum., Radial, 50V, -20% +100%; 47uF	21208-647	SPR	502D 476G050CD1C	PAN		
C5	Mica, 500V, 5%; 150pF	21020-115	CD	CD15-FD151J03	SAN		
C6	Mica, 500V, +1/2pF -1/2pF; 5pF	21017-005	CD	CD15-CD050D03	SAN		
C7	Met. Polyester, 100V, 10%; 0.1uF	21441-410	WIM	MKS-4100V5.0.1	WES,SIE		
C8	Mica, 500V, +1/2pF -1/2pF; 10pF	21017-010	CD	CD15-CD100D03	SAN		
C11,12	Ceramic Disc, 50V, +80% -20%; 0.005uF	21108-250	CRL	CK-502			
C13	Ceramic Disc, 25V, 20%; 0.15uF	21106-415	CRL	UK25-154	MUR		
C14	Tantalum, 35V, 10%; 1uF	21307-510	SPR	196D 105X9035HA1	MANY		
C15	Met. Polyester, 100V, 10%; 0.047uF	21441-347	WES	160C 473K250	SIE		
C16	Mica, 500V, +1/2pF -1/2pF; 10pF	21017-010	CD	CD15-CD100D03	SAN		
C17	Mica, 500V, 5%; 100pF	21020-110	CD	CD15-FD101J03	SAN		
C18	Tantalum, 35V, 10%; 1uF	21307-510	SPR	196D 105X9035HA1	MANY		
C19	Tantalum, 35V, 10%; 0.22uF	21307-422	SPR	196D 224X9035HA1	MANY		
C20	Tantalum, 35V, 10%; 4.7uF	21307-547	SPR	196D 475X9035JA1	MANY		
C21,22	Alum., Axial, 40V, -10% +100%; 470uF	21224-747	SIE	B41283-470-40	PAN		
C23,24	Alum., Radial, 25V, -20% +100%; 100uF	21206-710	PAN	ECE-A1EV101S			
C25,26	Monolythic Ceramic, 50V, 20%; 0.1uF	21123-410	SPR	1C25 Z5U104M050B	KEM		
C27	Not Used	-----					
C28,29	Monolythic Ceramic, 50V, 20%; 0.1uF	21123-410	SPR	1C25 Z5U104M050B	KEM		
C30	Met. Polyester, 100V, 10%; 0.1uF	21441-410	WIM	MKS-4100V5.0.1	WES,SIE		

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
COMP/LIM MODEL 412A/414A
Rev. 03 1/86
DIODES/IC's/INDUCTORS/TRANSISTORS

REF DES	DESCRIPTION	ORBAN P/N	VEN (1)	VENDOR P/N	ALTERNATE VENDORS (1)	QUAN/ SYS.	NOTES
	Diodes						
CR16	Diode, Bridge, 200V, 1A	22301-000	VARO	VE-27	GI		
CR17-19	Not Used	-----					
	Integrated Circuits						
IC1	D.C. Regulator, 15V Negative	24303-901	NAT	LM79M15AUC	TI,MOT		
IC2	D.C. Regulator, 15V Positive	24304-901	NAT	LM78M15UC	TI,MOT		
IC3	Linear, Single Opamp	24014-202	SIG	NE5534N	TI		
IC4	Linear, Dual Opamp	24208-303	ORB	CA3280AG Selected			3
IC5	Linear, Dual Opamp	24206-202	TI	TL072CP	MOT		
IC6	Linear, Dual Opamp	24209-202	NAT	LF412CN			
IC7	Linear, Single Opamp	24006-102	RCA	CA3140S			
IC8	Linear, Dual Opamp	24207-202	SIG	NE5532N	TI,EXR		
IC9	Linear, Dual Opamp	24202-202	RAY	RC4558NB	MOT,FSC		
IC10	Linear, Dual Opamp	24209-202	NAT	LF412CN			
IC11	Multiple Discrete, TR. Array	24406-302	RCA	CA3096AE			
IC12	Linear, Single Opamp	24002-202	TI	UA741CN	RAY		
IC13	Linear, Dual Opamp	24207-202	SIG	NE5532N	TI,EXR		
IC14	Multiple Discrete, TR. Array	24406-302	RCA	CA3096AE			
IC15	Linear, Dual Opamp	24209-202	NAT	LF412CN			
	Modules						
A1	Module Assy, Timing	30780-000-xx*	ORB				*Add suffix printed on part

FOOTNOTES:

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

SPECIFICATIONS AND SOURCES FOR REPLACEMENT PARTS
COMP/LIM MODEL 412A/414A
Rev. 03 1/86
RESISTORS/SWITCHES

REF DES	DESCRIPTION	ORBAN P/N	VEN (1)	VENDOR P/N	ALTERNATE VENDORS(1)	QUAN/SYS.	NOTES
	Resistors						
R5	Pot, Single; 5K (5020)	20728-000	ORB				20% CW Log
R16	Pot, Single; 100K (5020)	20726-000	ORB				20% CW Log
R18	Res., Ratio Matched Set; 10.0K & 6.34K	28522-001	ORB				3
R19	Resistor Set, MF; 3.01K	28520-005	ORB				3
R23	Res., Ratio Matched Set; 4.99K & 3.01K	28522-002	ORB				3
R25	Res., Ratio Matched Set; 10.0K & 6.34K	28522-001	ORB				3
R59	Pot, Single; 10K (5020)	20748-000	ORB				20% CW Log
R62	Pot, Single; 10K (5050)	20720-000	ORB				Linear
R69	Pot, Single; 100K (5020)	20726-000	ORB				20% CW Log
R74	Pot, Single; 50K (5020)	20721-000	ORB				20% CW Log
	Switches						
S1	Switch, Single, Push-Push; DPDT	26112-000	SCH	F-Series			"SYSTEM"
S2	Switch, Power, Push-Push; DPDT	26113-000	SCH	F-Series			"POWER"
S3	Switch, Single, Push-Push; DPDT	26112-000	SCH	F-Series			"STEREO COUPLING"
	Transistors						
Q1	Transistor, Signal, PNP	23002-101	MOT	2N4402	FSC		
Q2	Transistor, JFET/P	23407-101	NAT	J174	SIL		
Q3-5	Transistor, Signal, NPN	23202-101	MOT	2N4400	FSC		

FOOTNOTES:

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

SPECIFICATIONS AND SOURCES FOR REPLACEMENT PARTS
COMP/LIM MODEL 412A/414A
Rev. 03 1/86
MISCELLANEOUS

Vendor Codes

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

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

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

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

BEL Belden Corporation
Electronic Division
Richmond, IN 47374

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

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

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

CH Cutler-Hammer
Landmark Office Center
2081 Landings Drive
Mountain View, CA 94043

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

RCA RCA Solid State Division
Route 202
Somerville, NJ 08876

SAE Stanford Applied Eng.
340 Martin Avenue
Santa Clara, CA 95050

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

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

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

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

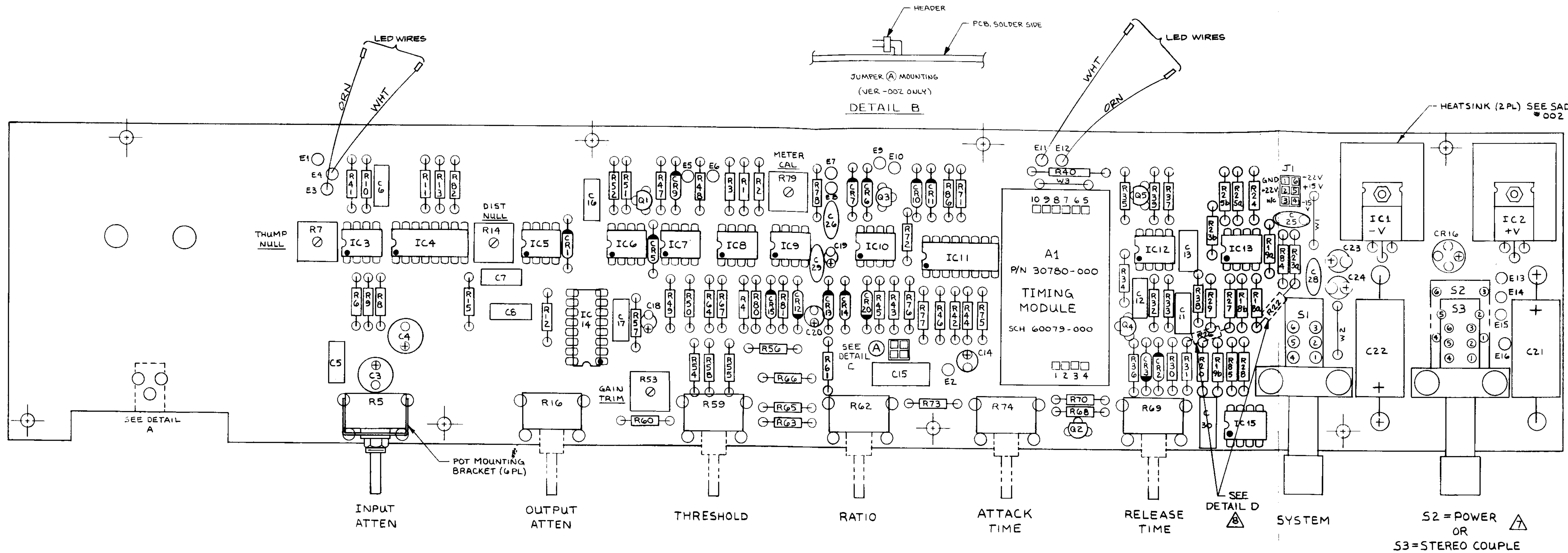
STK Stackpole Components Co
P.O. Box 14466
Raleigh, NC 27620

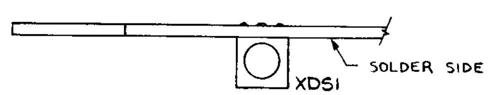
SYL Sylvania Conn. Prod. Op.
GTE Products Corp.
Box 29
Titusville, PA 16354

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

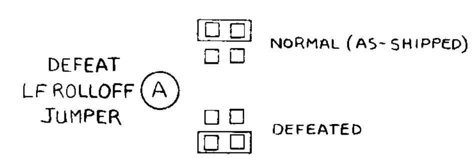
WES Westlake
5334 Sterling Ctr Drive
Westlake Village, CA 91361

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



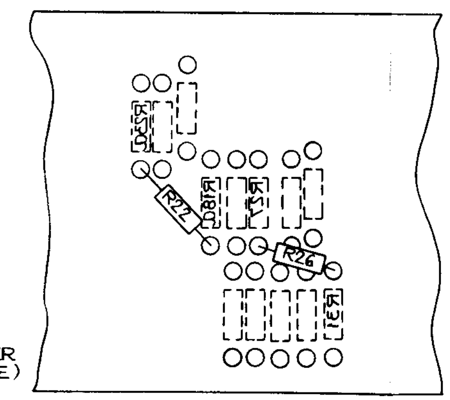


DETAIL A



DETAIL C

DETAIL D
TACK SOLDER
(SOLDER SIDE)



8. ON SOLDER SIDE TACK SOLDER R22 AND R26 AS SHOWN ON DETAIL D
7. WHEN POWER SWITCH (ITEM 6) IS USED MOUNT INSULATOR ON SOLDER SIDE UNDER SCREWS.
6. W1, W2, W3 ARE FOR THE CONVENIENCE OF TEST DEPT.
5. MTG. HOLES TO BE MASKED FOR WAVE SOLDERING.
4. USE COMPONENT MTG. PADS P/N 15051-000 FOR C3, C4 ONLY.
3. SCHEMATIC 60080-000.
2. TICK MARKS INDICATE PIN ONE OF ICs, MODULES; CATHODE OF DIODES; POSITIVE LEAD OF CAPACITORS AND RECTIFIER; EMITTER OF TRANSISTORS.
1. DOTS ON IC'S INDICATE PIN #1.

NOTES:

MAIN PCB WIRING

	FUNCTION	FROM	TO
	SIDECHAIN	E1	SIDECHAIN OUT J5
	SIDECHAIN	E2	SIDECHAIN IN J4
	OVERLOAD LED	E3	CR8 ANODE
	OVERLOAD LED	E4	CR8 CATHODE
	ST. CPL SWITCH	E5	TB-8
	⏚	E6	TB-7
	GAIN RED. METER	E7	METER POS
	GAIN RED. METER	E8	METER ⏚
	(−) IN	E9	TB-2
	(+) IN	E10	TB-1
	OUT. CLIP LED	E11	CR4 CATHODE
	OUT. CLIP LED	E12	CR4 ANODE
	AC	E13	XFMR GRN
	AC	E14	XFMR GRN
	⏚	E15	XFMR YEL
VER -001 414A	ST. CPL SWITCH	E16	S3-2
VER-002 414A	ST. CPL SWITCH	E16	S3-3

SYSTEM OPERATE BYPASS WIRING

FUNCTION	FROM	TO
(−) IN	S1-1	TB-2
(−) OUT	S1-2	TB-5
(+) IN	S1-4	TB-1
(+) OUT	S1-5	TB-4

VERSION SCHEDULE

VERSION	WHERE USED	COMPONENTS NOT LOADED	COMMENTS
-001	414A TOP PCB	J1, S2	NONE
-002	414A BOTTOM PCB	CR16, IC1,2 C21, C22, S3, XDS1	LOAD TRIMPOTS R7,14 R53,79, *JUMPER A ON SOLDER SIDE
-003	412A MAIN PCB	J1, S3	NONE

* SEE DETAIL B

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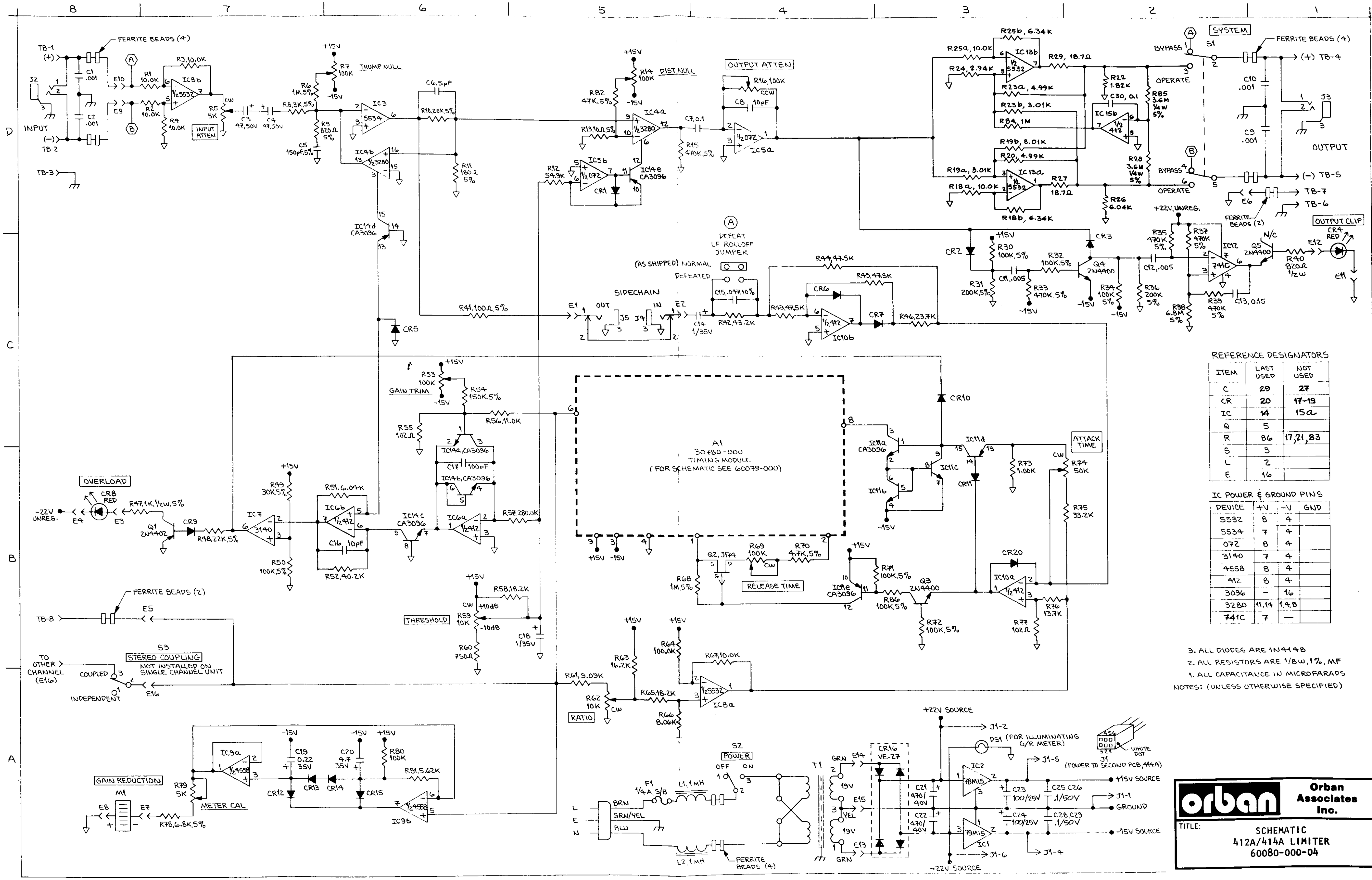
TITLE: ASSEMBLY DRAWING
412A/414A MAIN BOARD
30775-000-03



REFERENCE DESIGNATORS

ITEM	LAST USED	NOT USED
C	29	27
CR	20	17-19
IC	14	15a
Q	5	
R	86	17,21,83
S	3	
L	2	
E	16	

IC POWER & GROUND PINS

DEVICE	+V	-V	GND
5532	8	4	
5534	7	4	
072	8	4	
3140	7	4	
4558	8	4	
412	8	4	
3096	—	16	
3280	11,14	1,4,8	
741C	7	—	

3. ALL DIODES ARE 1N4148
2. ALL RESISTORS ARE 1/8W, 1%, MF
1. ALL CAPACITANCE IN MICROFARADS
NOTES: (UNLESS OTHERWISE SPECIFIED)

orban | Orban Associates Inc.

TITLE: SCHEMATIC 412A/414A LIMITER 60080-000-04