OPERATION AND MAINTENANCE MANUAL

STEREO LIMITER

MODEL 418A

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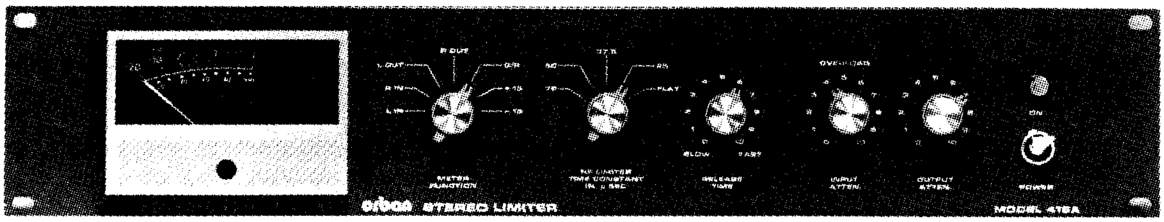

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REGISTRATION CARD

The original purchaser should have received a postpaid Registration Card packed with this manual.

Registration is of benefit to you because it enables us to tell you of new applications, possible performance improvements, service aids, etc., which may be developed over the life of the product. It also provides us with the date of sale so that we may more promptly respond to possible claims under Warranty in the future (without having to request a copy of your Bill of Sale or other proof of purchase).

Please fill in the Registration Card and return it to us.

If the Registration Card has become lost or you have purchased the unit used, please photocopy the image of the card reproduced below and send it to us in an envelope. Use the address shown on the title page.

Model # ______________________ Serial # ______________

Name or Title ______________________

Organization ______________________

Street ______________________

City/State/Country ______________________

Zip or Mail Code ______________________

Purchased from ______________ City __________ Date of Purchase ________

Nature of your application ______________________

How did you hear about it? ______________________

Comments: ______________________

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Fig. 1: REGISTRATION CARD

WARRANTY

The Warranty, which applies only to the first end-user of record, is stated on the Warranty Certificate on a separate sheet packed with this manual. Save it for future reference.

INTRODUCTION

The principal use of your new 418 Limiter is to condition arbitrary complex audio signals (not just single tracks, although the 418 may be used with these, too) in such a way that they can be recorded on tape or optical film without overload, excessive noise, or distortion due to excessive high frequencies, In order to do this while introducing minimal artifacts into the signal, the 418 incorporates a highly refined program-controlled release time circuit, as well as a separate high-frequency limiter which can control the high frequencies present in the program on an instantaneous basis without distortion and without disturbing the basic program loudness.

The release time and high-frequency limiter are both adjustable by the user in order to obtain the desired amount of high-frequency control, level control, compression, and density augmentation. The controls have been arranged to minimize the probability of audible side-effects of an undesirable nature regardless of their settings.

Some uses of the 418 include: (1) mixing through while doing multitrack reductions in order to save time while doing radio commercials, demo sessions, and the like; (2) conditioning recorded program material so that it can be copied onto cassette or low-speed tape without excessive hiss and/or high-frequency distortion; (3) transfering from magnetic to optical film; (4) transferring from disc to 7.5 ips tape cartridge in broadcast stations; (5) recording production work through in broadcast production studios; and (6) transferring from tape to disc (with certain limitations -- see OPERATING INSTRUCTIONS). Other applications will doubtless suggest themselves to the creative engineer.

The 418 is not rigorously RFI/EMI shielded, and its output contains substantial amounts of fast overshoots. It is therefore specifically not recommended for driving broadcast transmitters. Orban Associates Division manufactures a line of devices, the OPTIMOD-FM and the OPTIMOD-AM, specifically designed for this purpose.

INSTALLATION: MECHANICAL

The 418 Limiter is designed to mount in a standard 19" (48.26 cm) rack, and requires 3.5" (8.89 cm) of vertical space. All operating controls are accessible from the front. The fuse, AC line cord, and audio connections are made from the rear. The audio connects to a Jones 140-type barrier strip (#5 screw), and connections can be made by means of spade lugs or a fanning strip, in those cases where quick connects/disconnects are required.

In a rack mount installation, the 418 will pick up its chassis ground from the rack. Be sure to measure the resistance from chassis to rack after installation and correct any high-resistance situations before proceeding. It may be necessary to scrape the paint from the rack and/or the rear of the panel in order to effect an adequate ground. It is advisable to make sure that the rack is grounded to some earth ground simultaneously. Grounding of racks and other equipment to power line conduit grounds as a sole means of grounding often creates troublesome problems.

In rack-mounting the 418, very strong AC magnetic fields should be avoided because these can introduce hum into the input transformers. In addition, the 418 should not be mounted directly over equipment producing large amounts of heat, like vacuum tube power amplifiers. Ambient temperature should not exceed 45°C (113°F) when the 418 is powered.

If the 418 is rack-mounted, the jumper on the rear barrier strip connecting terminal 7 (signal ground) to terminal 8 (chassis ground) should be removed to avoid ground loops. If the 418 is used in a portable situation, this jumper should be retained in order to assure that the chassis is grounded. When the jumper is retained, it is advisable to terminate the line cord with a three-prong to two-prong AC adapter in order to avoid introducing ground loops through the AC power line grounding system. The center (ground) prong on the 418 line cord (green wire) is connected directly to the chassis.

INSTALLATION: ELECTRICAL

Input:

The input of the 418A is a 100K ohm balanced bridging input. It is synthesized by means of an electronic differential amplifier; no transformer is used. Absolute input clipping occurs at +21 dBm; higher levels require use of an external balanced pad. With the INPUT ATTEN full clockwise, -10 dBm will produce 10 dB gain reduction.

It is important that both (+) and (-) inputs be driven by a source impedance of 600 ohms or less in order to assure best "common mode rejection" (i.e., ground loop hum rejection). If the device driving the 418A has a balanced output, the two output leads should be driven directly into the (+) and (-) inputs of the 418A. If the device driving the 418A has an unbalanced output, it should also be connected to the 418A with a two conductor shielded cable. The black wire should be connected between the driving device's signal ground and the 418A's (-) input. The second wire should be connected between the driving device's output and the 418A's (+) input. This arrangement takes maximum advantage of the hum-reducing ability of the 418 A's balanced input. In either case, the shield of the interconnecting cable should be connected to chassis ground at one end only.

No special RF suppression techniques have been used in the 418A. If RF interference is experienced in high RF fields, we suggest bypassing audio inputs, outputs, and the power line to chassis ground through 0.001 mfd ceramic capacitors with short as possible leads. Be sure that the voltage rating of the power line bypass capacitor is at least 1.6 kV, and that bypassing occurs after the fuse to avoid a potential fire should the capacitor short. Because the chassis metalwork has not been designed to be rigorously RF-tight, it is unlikely that the 418A could be operated immediately adjacent to a transmitter. In a broadcast production studio, sufficient RF suppression usually exists so that successful operation can be easily obtained.

Output:

The output of the 418 is unbalanced, and follows the OUTPUT ATTEN control, which is configured as a standard potentiometer. Maximum output resistance occurs with this control at 12 o'clock; in this case, the output resistance is approximately 400 ohms. Maximum available level is +13.4 dBm.

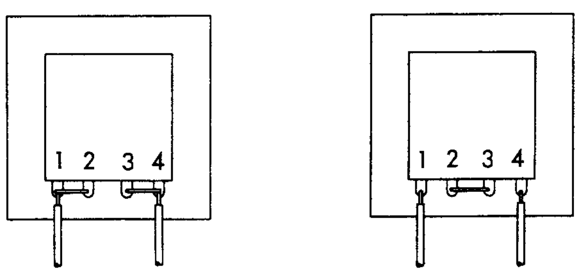
The output may be used to drive either balanced or unbalanced-and-floating inputs of external equipment. A three conductor shielded cable should be used, with the inner conductors connected to the 418 output and signal ground, and the shield terminated to the 418 chassis ground, and unterminated at the other end. The comments concerning ground loops in INSTALLATION: MECHANICAL (above), should be noted. In most cases, the balanced input will provide ground-loop protection if grounding is effected as described above.

The 418's VU meter, in OUTPUT positions, is connected to the output of the 418's line amplifier before the OUTPUT ATTEN control in order to avoid reflecting meter rectifier distortion into the output. Therefore, this metering position will not show any adjustments of the OUTPUT ATTEN control.

Power:

The power transformer can be wired for 105-125 VAC or 210-250 VAC operation, 50 or 60 Hz. The nominal voltage for which the unit is wired is marked on the carton. If the unit is wired for 230 volts, a warning tag is also affixed to the line cord.

To change line voltage, remove the top cover to reveal the power transformer. For 115 volt operation, connect terminal 1 to terminal 2, and terminal 3 to terminal 4 (See figure 1). For 230 volt operation, connect terminal 2 to terminal 3. When altering the position of the jumpers, take great care not to overheat or bend terminals or the power transformer may be damaged. Do not rearrange the insulated wiring.



a. Power transformer wired for 115 volts

b. Power transformer wired for 230 volts

Figure 1: Power transformer wiring

If the 418 is to be used in a situation where ground loops may be introduced through the power line, an alternative to fitting a three-prong to two-prong adapter on the AC line plug is to disconnect the green wire emerging from the line cord inside the chassis. However, be sure that the chassis is grounded through one (and only one) path when the 418 is installed.

OPERATING CONSIDERATIONS

In order to use the 418 most successfully, some understanding of its particular operating characteristics is required.

First, the attack time of the 418 is moderate (in the order of 2 or 3 milliseconds). Therefore, fast-rising waveforms will overshoot at the 418 output. The overshoots are sufficiently short so that they can be clipped by the recording or transmission medium following the 418 without audible ill effects, provided that said media can themselves clip. Examples of suitable media are magnetic tape (whose saturation characteristic provides an ideal "soft" clipping characteristic), and optical film, which has a much more sudden clip point, but which can be clipped without damage to the medium.

On the other hand, disc recording requires absolute protection in order to avoid overcutting and/or cutter lift. Therefore, in the case of disc transfer, the 418 should be followed by some sort of absolute protection, such as a clipper or a very fast limiter.

The second important consideration is the fact that the gain reduction capability of the broadband AGC section of the 418 has been purposely limited to 15 dB. This was done to obtain a maximally smooth characteristic from the FET attenuator, and also to assure that excessive compression (with accompanying unpleasant side-effects) cannot be used. It is therefore essential to choose the input operating level with a certain degree of care, compared with operation of compressors capable of, say, 30 dB compression. This care can only result in better-sounding product, and we therefore consider it a distinct advantage.

If attempts are made to exceed the permissible AGC gain reduction range, the front-panel overload lamp will light. Simultaneously, a brief dropout of high-frequency content will be noted, because the AGC output will overshoot dramatically and force the high-frequency limiter into maximum de-emphasis. These conditions are easily avoided by use of the GAIN REDUCTION metering position, which will clearly indicate when a potential overload situation exists.

Third, both INPUT and OUTPUT attenuators are stereo-ganged controls. They were configured this way in order to maximize the speed with which adjustments could be made without concern over unbalancing the stereo channels. However, this means that initial channel balance must be done on the equipment driving the 418.

Lastly, the 418 is not two limiters, but rather a stereo device utilizing a single control loop for both channels. The gains of the two channels are forced to track each other, and the amount of gain reduction is determined by the louder channel at any given moment. This means that the two channels of the 418 cannot be used for two independent program sources; if the 418 is to process mono material, either channel may be used, with the other channel carrying no signal.

There is at least one specialized use for this facility: if a disc jockey wishes to have voice-actuated "ducking" of music while doing production, one channel of the 418 can carry his voice, while the other channel can carry music at a lower level. Automatic ducking of the music by voice can occur to whatever degree desired by adjusting how hard the voice drives the 418 (and thus, the resulting degree of gain reduction obtained).

OPERATING INSTRUCTIONS

Connect the 418 to a source of AC power corresponding to the voltage for which the power transformer is strapped (see INSTALLATION: ELECTRICAL above). Turn the AC POWER switch ON. The neon pilot lamp should glow. All metering positions should read zero, except for GAIN REDUCTION (100% with no signal), and +15 and -15 monitor the positive and negative regulated power supplies respectively, and verify that these are working properly.

The L IN and R IN positions monitor the input levels after the input "active transformer" differential amplifier, but before the input attenuator. This position is principally useful in verifying whether signal exists on the input line, and if so the approximate signal level. "O" VU on the meter corresponds to approximately +4 dBm (into 600 ohms) equivalent input level.

The L OUT and R OUT positions monitor the output before the output attenuator.

The G/R (GAIN REDUCTION) position indicates the approximate amount of broadband gain reduction in dB.

The amount of gain reduction is determined by the input level being presented to the limiter; this can be affected by the drive level to the 418, and also by the 418's INPUT ATTEN control. As this control is turned clockwise, the amount of gain reduction will increase. If the operator attempts to exceed approximately 15 dB gain reduction, the red OVERLOAD lamp will light, and distortion and severe high-frequency loss may be perceived.

The RELEASE TIME control is not a release time control in the classic sense, because automatic circuits inside the 418 are constantly analyzing the program material and continuously varying the release time to minimize audible limiting "action". The function of the RELEASE TIME control is to adjust the speed of this entire process. As the release time is speeded up (control towards "fast"), the 418 will increase the average level ("density") of the program to a greater and greater extent. As the RELEASE TIME control is moved into the last quarter of its range towards "fast", there is greater and greater danger that the limiting process will produce objectionable results. In general, it is desirable to use less than 6 dB gain reduction when operating with such fast release times. As the release time is slowed down, more and more gain reduction can be used without significant audible side-effects. Slower release times are particularly useful for "gain riding" functions, such as mixing through the limiter, where no change in the <u>quality</u> of the sound is desired, but rather protection from excessive level which would tend to overload the following recording medium is wanted. The automatic release time adjustments assure that heavy transients (like kick drum) do not knock "holes" in the audio, while simultaneously instruments like French horn or strings do not "pump". Slower release times are also useful for preparing masters for cassette duplication, where acceptable signal-to-noise ratios must be obtained by a certain amount of compression of the master.

Most recording media (with the exception of 15 and 30 ips tape) are significantly more subject to overload at high frequencies than at low frequencies, due to the application of record pre-emphasis. Cassettes are particularly problematical. The high-frequency limiter in the 418 can be switched in to automatically control the high-frequency content of the audio so as to avoid audible high-frequency overload and accompanying distortion. The four "time constants" do not refer to attack or release times (which are not adjustable), but rather to the frequencies at which the control threshold is 3 dB below the broadband (low frequency) threshold. The following table gives these frequencies, as well as suggested uses for each time constant:

25 uS	6.37 kHz	15 ips tape
37.5 uS	4.24 kHz	7-1/2 ips tape (modern oxide); RIAA disc (allowing 6 dB headroom)
50 uS	3.18 kHz	3-3/4 ips tape; 7-1/2 ips broadcast tape cartridge
75 uS	2.12 kHz	1-7/8 ips tape; cassette; optical film; RIAA disc (allowing no high-frequency headroom)

It should be noted that more high frequency content may always be recorded on a given medium by reducing the low frequency level, thus allowing more headroom for high-frequency pre-emphasis. In some cases, this may be a desirable expedient to achieve a brighter sound. In other cases, the loss of signal-to-noise ratio may be intolerable. If the former expedient is adopted, the high-frequency limiter may be set on a higher frequency time constant than normal, thus reducing the amount of high-frequency limiting. Because of the complex nature of high-frequency overload distortion, the ear should always be the final arbiter of the proper setting of the TIME CONSTANT control.

Further details of 418 operation are largely dependent upon the sound and effect desired from the device. Experimentation in actual use situations is the best way to develop a knowledge of the 418's usefulness as well as its limitations.

MAINTENANCE

Preventive Maintenance:

The 418 is an entirely solid-state device. The only preventive maintenance required is keeping the unit clean. Dust on the circuit board can absorb moisture, causing high-resistance short-circuits and erratic operation. The front panel should be periodically cleaned; use of a strong household detergent will usually do an adequate job without danger of damaging paint, screening, or plastic parts.

In time, operation of the pots and/or rotary switch may become erratic because of wear, corrosion, or dirt build-up. These units are not hermetically sealed, and may be cleaned with commercial spray-type contact cleaner. Avoid letting excess cleaner drip onto parts other than those being serviced.

The electronics are stable indefinitely, and require no periodic alignment. Alignment instructions have been included as Appendix A primarily for reference. Alignment should not be attempted unless the service facility has the necessary specified test equipment, and the technician is highly skilled and experienced in the maintenance of equipment employing IC's.

Corrective Maintenance -- A General Note:

The 418 employs advanced and sophisticated circuit techniques based largely upon linear integrated circuit technology. In case of failure, it is highly advised that repairs be performed at the factory, in order to take advantage of the factory technicians' experience and stock of correct spare parts. Field repairs should only be attempted if the technician is highly experienced and competent in the field of linear integrated circuits, and is skilled in the fine art of working on double-sided PC boards with plated-through holes (see following section). In most cases, failed IC opamps or comparators may be replaced without realignment. However, other parts will often affect alignment. This is particularly true of the quad-FET arrays and associated components.

In addition, a number of tight-tolerance parts are used. These must be replaced by exact equivalents, or circuit performance will suffer.

SERVICE NOTE: It is usually more economic to return the 418 to the factory for repair, unless your house technicians are extremely familiar with the unit, and an adequate stock of spare parts is on hand.

Replacement of Components in Printed Circuit Boards:

Most circuit boards used in the 418 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 more sophisticated technique for component removal in order to prevent serious damage to the traces on the board. In particular, excessive heating of a point on the board will almost always cause damage.

If the user is not thoroughly familiar with elegant techniques of removing components from double-sided boards, it is wiser to cut each of the leads of an offending component from the body while the leads are still soldered into the board. The body is then discarded and each of the leads is heated independently and pulled out of the hole with a pair of long nose pliers. Each hole may then be cleared of solder by carefully heating with a low wattage iron and sucking the residual solder with a spring activated solder vacuum tool.

The new component should be installed in the usual way and soldered from the bottom side of the board. 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 carefully at the topside as well in order to avoid potential intermittent problems.

After soldering, the residual flux should be removed with a cotton swab moistened with a solvent such as 1, 1, 1 trichloroethane, naphtha, or 99% isopropyl alcohol. These first two solvents are often available in supermarkets marketed 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. Note: Rubbing alcohol is highly diluted with water and is not effective. There are also other solvents marketed under various trade names which contain Freon^{tm}. These are often available in electronic supply houses and are also useful.

It is good policy to make sure that this defluxing operation has actually removed the flux and not just smeared it about so that it is less visible. While rosin flux is not corrosive normally, it can absorb moisture and become conductive enough to cause severe deterioration in specifications over time.

Comments on IC Opamps:

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

Exceptions are IC's used open-loop as comparators, and IC's whose outputs have been saturated in one direction or the other due to abnormal inputs. However, if the technician measures that the (+) input is more positive than the (-) input, yet the output of the IC is sitting at -14 volts, this almost surely indicates IC failure. If all the above polarities are reversed, the same thing holds.

Because the characteristics of the 418 are essentially independent of IC opamp characteristics, an IC opamp can usually be replaced with no change in performance. A defective opamp may appear to work, yet have extreme temperature sensitivity of DC characteristics. If parameters appear to drift excessively with temperature, use a can of freeze-spray to locate the offending component. Freeze-spray is also very useful in tracking down intermittents.

CIRCUIT DESCRIPTION (WITH TROUBLESHOOTING HINTS):

General:

The 418 is divided into four major blocks. In order of signal passage these are:

1) The input buffer and broadband AGC;
2) The program-controlled pre-emphasis, which serves as a high-frequency limiter;
3) The de-emphasis and output stage; and
4) The power supply.

Left and right audio paths are identical, and share a common control circuit. Only the left channel, plus the control circuit will be described.

Input Buffer and Broadband AGC:

The signal enters the 418A in balanced form, and is applied to IC201, an LF356 low-noise FET-input opamp configured as a gain-of-one differential amplifier. When both (+) and (-) inputs are driven from source impedances very small compared to 50K (such as 600 ohms), the amplifier is essentially insensitive to signal components that appear equally on both (+) and (-) inputs (such as hum), and responds with full unity gain to the difference between the (+) and (-) input. Thus it serves as an "active transformer."

If signals in excess of +21 dBm are applied to the input, this amplifier will clip regardless of the setting of the input attenuator, and an external balanced loss pad must be employed before the 418A input.

The gain control element is a P-channel junction field effect transistor, IC216A, operated as a voltage variable resistor. This FET shunts the lower leg of the voltage divider R213, 223 to reduce the gain. Note that the values of R213 and R223 are selected at the factory to complement the particular FET employed. If IC216 is ever replaced (a highly unlikely occurrence), the factory should be consulted.

The audio level across the FET is 16 mv at the threshold of limiting. This level is amplified back up by IC205, a 709 opamp configured for 34.5 dB non-inverting gain. IC205 is frequency-compensated by C213, 217, 219 and R215, 217. The output of IC205 is clamped to ±2.4 volts by the diode strings CR201, 203, 205, 207, 209, 211, 213, 215 to prevent damage to IC 207 in the event that excessive input signal is applied. The gain of IC205 is determined by R219, 221, and C225. R229 forces a constant current to flow from the output of IC205 to the -15 supply, thus forcing the output stage of IC205 to operate class A to eliminate crossover distortion.

The output of IC205 is applied to the two halves of IC207, a 711 dual comparator. The inputs of IC207 also receive reference voltages of + and -1.2 volts derived from voltage dividers R294-297. If the peak level of the output of IC205 attempts to exceed ±1.2 volts, IC207 turns on, producing a pulse which is coupled through C266 and CR228 to Q211. Q211 is turned on by the pulse, and discharges C267 and C268 through CR230 and CR229 respectively. This voltage change across C267 is coupled to the gate of the FET through R231, thereby decreasing the resistance of the FET and decreasing the gain of the circuit until the overload at the output of IC205 is removed. Attack time of the circuit is determined by R288 and is about 2 ms. The release time is a very complex function of the nature of the program, and is determined by the proprietary circuit inside the module. Basically, the module derives a voltage based on the previous history of the program and applies the voltage to one end of the RELEASE TIME control, P211. The other end of P211 is connected to C268, and permits C268 to charge at a rate controlled by the module in conjunction with the setting of P211. In addition, the network CR231 and R289 provides delayed release to assure low distortion at low frequencies. This is accomplished as follows:

When gain reduction occurs, both C267 and C268 are discharged to the same voltage because CR230 and CR229 have substantially identical voltage drops. However, C267 must charge (release) through CR231 and R289. R289 provides virtually no short-term release because of its high value. Therefore, C267 cannot charge until C268 has charged sufficiently to overcome the turn-on voltage of CR231. This time delay eliminates the usual sawtooth ripple on the control voltage, thus drastically reducing distortion.

The collector of Q211 is clamped to ground through the base-emitter junction of Q210. This way, the gate of the control FET cannot be forward-biased. In addition, when Q210 conducts, it turns on the front-panel OVERLOAD LED, thus indicating that the permissable 15 dB gain reduction range has been exceeded.

P210 determines the quiescent gate voltage of the control FET, and is adjusted to pinch this FET off when no gain reduction occurs. Thus maximum gain is extremely stable, and no distortion is introduced by the FET.

The control FET is contained in a package with four matched, monolithic FET's. The second FET is used to control the gain of the right channel; the third FET is operated with DC across it to control the GAIN REDUCTION meter. The fourth FET is not used. The DC gain reduction signal is amplified by IC219, a non-inverting opamp.

IC 207 (as well as all the other 711 IC's) requires a power supply of approximately +12 and -6 volts. +12.6 volts is supplied by dropping the +15 volts through 3 silicon diodes, CR232-234. C231, 269 bypass the fast risetime pulses produced by IC207 to ground.

A bypassed source of -14 volts for the pulse-handling transistor Q211 is provided by dropping the -15 volt supply through CR227, bypassed by C264, 265. -5.5 volts is derived by dropping the -15 volts through a 9 volt zener diode, CR235.

Program-Controlled Pre-emphasis:

In order to obtain control of excess high-frequency energy, a 6 dB/octave high-frequency pre-emphasis is applied to the output of the broadband AGC. This pre-emphasis continues to 25 kHz, and is then rolled off. A comparator at the output of the pre-emphasis filter creates an error signal if the pre-emphasized signal attempts to exceed a fixed threshold. This error signal, by feedback, reduces the pre-emphasis until the overload is eliminated.

The pre-emphasis is created by summing the output of a bandpass filter centered at 35 kHz (R233, 235, 237 C233, 235, IC209A) with the flat signal. The sum of the two yields a 6 dB/octave pre-emphasis to beyond 20 kHz. The amount of bandpassed signal summed in determines the constant of the pre-emphasis. This gain is determined by two factors: (1) A voltage divider consisting of resistors R107, 109, 111, 113, 115 across terminals 11 and 13, and switched by the front-panel TIME CONSTANT switch; along with R245, and (2) a voltage-controlled attenuator, realized with IC217A, which shunts R245 to reduce the bandpass gain as necessary to eliminate overloads due to excessive high-frequency energy.

IC211 is a 30.1 dB non-inverting amplifier which makes up for losses in the previously mentioned voltage divider.

The summing of the flat and bandpassed signals is done in IC209B. The bandpass filter is inverting; therefore, the overall bandpass path is inverting. In order to sum the flat signal with correct phase, the flat signal must also be inverted. This is accomplished by introducing the flat signal through R239 to IC209B's inverting input; the bandpassed signal is introduced to IC209B's non-inverting input.

In addition, a small amount of bandpassed signal is introduced to IC209B's inverting input through R241. This is because IC217A can never reduce the main bandpass gain to zero. This may be required if the pre-emphasis is to be totally defeated because the program material consists of a high-frequency sine wave, for example. Therefore, the extra out-of-phase bandpassed component means that there is some low, but achievable gain through the main bandpass path that will result in total cancellation of the bandpass component at the output of IC209B, leaving only the flat signal.

Details of the bandpass amplifier and voltage-controlled attenuator (IC211 and associated components) is substantially identical to the broadband VCA, IC205 and associated components. The reader should refer to the previous section for a detailed description.

The high-frequency limiter section has approximately 12 dB gain at low frequencies. Therefore, in order to use the same comparator reference voltage as the broadband limiter, the output of the high-frequency limiter is attenuated approximately 12 dB by voltage divider R263, 265 before being applied to dual comparator IC213.

IC213 and associated circuitry is functionally identical to the control circuitry in the broadband AGC with one exception. Instead of a complex release time circuit, the high-frequency limiter utilizes a simple resistor, R283, to determine the release time. For other details, the reader is referred to the previous section.

De-emphasis and Output Stage:

In order to restore flat response at low levels, a complementary de-emphasis must be applied to the pre-emphasized signal. This is done by IC215A and associated circuitry. IC215A is augmented by a discrete complementary-symmetry output stage, which is inside IC215A's feedback loop. This output stage makes it possible for IC215A to drive 600 ohm loads with low distortion.

In order to permit the de-emphasis to be determined by means of a single resistor, a differential de-emphasis scheme is used. C253 forms a 6 dB/octave highpass filter when loaded by R267, 269 plus a parallel resistor (R117, 119, 121, 123). One of these resistors is selected by the front-panel TIME CONSTANT switch from terminal 7 to ground. R267, 269 form a voltage divider which divides the output of said highpass filter by 2. The pre-emphasized signal is applied to the inverting input of IC215A through R271. The same signal is applied to the non-inverting input of IC215A through the highpass filter. IC215A thus subtracts the highpassed signal from the flat signal, yielding a lowpassed (de-emphasized) signal as desired. The time constant of this de-emphasis is accurately determined by a single precision resistor between terminal 7 and ground.

The output stage is largely conventional. Q201, 205 are diode-connected and thermally connected to their associated output transistors, Q203, 207, to stabilize bias through the output stage and operate the output stage class AB. R275, 277 provide local feedback to improve DC stability. They also work with CR217, 219 to short-circuit-protect the output stage. If the current through Q203 or Q207 forces the voltage across R275 or R277 to exceed the turn-on of CR217, 219 (approximately 0.6 volt), then CR217, 219 will turn on, shunting drive current away from the output transistors Q203, 207, and protecting them from burnout.

R279 loads IC215A and provides current drive for Q207 on negative half-cycles.

R273 is the feedback resistor for the operational amplifier circuitry including IC215A and its discrete output stage. The signal is then applied across P213 providing variable output attenuation. R125 is a current limiting resistor for the meter.

Power Supply:

The AC enters the chassis and is applied through the fuse to the power transformer. This transformer may be strapped for 115 volt or 230 volt operation; instructions for doing so are found in the INSTALLATION: ELECTRICAL section.

The center-tapped secondary of the power transformer is applied to two pairs of diodes, CR601-604, operating as a pair of full-wave rectifiers to derive unregulated voltages of approximately $\pm$22.5 volts DC. The outputs of the rectifiers are smoothed by energy-storage capacitors C601, 602.

Most of the positive regulator is contained in IC601, a 723C voltage regulator. IC601 contains a stable source of reference voltage (nominally 7.15 volts), an operational amplifier to compare the output with the reference, a series pass transistor to drive the external power transistor Q604, and a current-limit transistor. The reference voltage output at pin 6 is filtered by C603 to reduce noise and is introduced to the (+) input of the opamp, pin 5. The unregulated positive voltage is applied to pins 11 and 12, and to the collector of series pass transistor Q604, operated as an emitter-follower. The output current of Q604 passes through R601, which develops a voltage drop proportional to the current through it. This voltage drop is sensed across pins 2 and 3 of IC601. If it exceeds approximately 0.55 volts, the internal current limit transistor turns on and prevents further increase in output current, thus providing short-circuit protection for Q604.

The output is sensed by the voltage divider R602, 603, P601, and is applied to the (-) input of the internal opamp (pin 4). The voltage divider reduces the output voltage until it is equal to the reference voltage. The output voltage is therefore held at a multiple of the reference voltage by means of feedback. This multiple (and therefore the output voltage) is adjusted by means of P601. C604 frequency-compensates the internal opamp to prevent high-frequency oscillations. Further stabilization is provided by C605 across the output of the regulator.

The -15 supply is generated by means of a 741C opamp, IC602, in conjunction with external transistors. IC602 is connected as an inverting, unity gain amplifier with input resistor R607 and feedback resistor R606. Thus, the negative output tracks changes in the positive output.

The positive power supply for IC602 is provided by IC601. IC601 contains an internal 6.8 volt zener diode, which drops the +15.7 volt output of the internal series pass transistor to approximately +9 volts. This voltage is available at pin 9. Negative supply voltage for IC602 is provided by the unregulated negative supply. This scheme assures that the total supply voltage for IC602 can never exceed IC602's maximum 36 volt rating.

IC602 drives a conjugate emitter follower, Q602, 603, R604. As in the case of the positive supply, the output current is dropped across R605, and if the voltage across R605 exceeds approximately 0.55 volts, Q601 turns on and shunts drive current away from Q602, simultaneously activating the protective current limiting circuitry inside IC602 which limits IC602's own output current to a safe level.

FACTORY SERVICE

Factory service is available through the life of the 418 from the address above. During the warranty period, no charge will be made for parts or labor, subject to warranty conditions. After expiration of the warranty, a reasonable charge will be made for parts, labor, and packing. In any event, transportation charges (which are usually quite nominal) shall fall on the customer.

Before returning any unit for repair, please write or telephone for instructions, stating the trouble experienced. Often a problem can be solved by consultation, saving everyone the delay, inconvenience, and expense of actually returning the unit.

SHIPPING INSTRUCTIONS

If the original packing material is available, it should be employed. Otherwise, a carton of at least 200 lbs bursting test should be obtained which is no smaller than 22 x 15 x 9 inches.

The assembly should be packed so that there is at least 1-1/2" of packing material protecting every point. Cushioning material such as Air-Cap, Bubble-Pak, foam "popcorn", or fibre blankets are acceptable. Folded newspaper is not suitable. Blanket-type material should be tightly wrapped around the assemblies 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 so that the units cannot shift in the carton. Test for this by closing but not sealing the carton and shaking vigorously. If the unit can be heard or felt moving, use more packing.

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

The package should be marked with the name of the shipper and the words, in red, DELICATE INSTRUMENTS, 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!

APPENDIX A: ALIGNMENT INSTRUCTIONS

This section of the manual is included primarily for purposes of reference, as PERIODIC COMPLETE ALIGNMENT IS NOT RECOMMENDED OR NECESSARY. Complete alignment is a step-by-step procedure which assumes that none of the trimmer controls are correctly adjusted. IF THE REQUIRED TEST EQUIPMENT IS NOT AVAILABLE, DO NOT ATTEMPT TO PERFORM COMPLETE ALIGNMENT.

Required Instrumentation:

The following instrumentation is required for complete alignment:

(1) Audio Sinewave Generator, with less than 0.05% residual harmonic distortion

(2) Digital Voltmeter, basic DC accuracy 0.1% or better

(3) Audio Voltmeter/Harmonic Distortion Meter with 1 megohm or higher input impedance (e.g. H-P 334A)

(4) Triggered Sweep Oscilloscope with X-Y capability and minimum 5 MHz vertical bandwidth

Setup for Complete Alignment:

Complete alignment must be performed on a test bench away from strong RF fields. Before commencing alignment, apply power and allow 30 minute warmup with covers in place. Remove the top and bottom covers immediately before starting alignment procedure. ALIGNMENT MUST BE PERFORMED SEQUENTIALLY. DO NOT SKIP STEPS. Alignment points can be found on page 11.

Alignment Procedure:

(1) Connect digital voltmeter across C605, and read voltage.

(2) Adjust P601 for a reading of +15.00 volts on DVM.

(3) Jumper chassis and circuit grounds together.

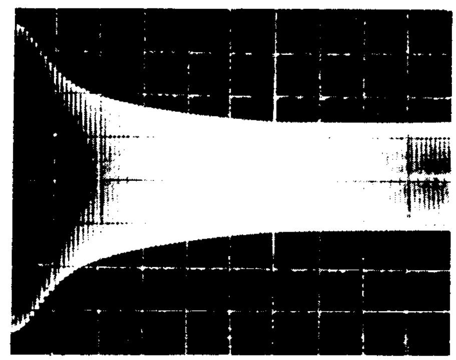
(4) Turn P210 (broadband FET bias) CW until the GAIN REDUCTION meter indicates that gain reduction is beginning. Back off P210 until no further change is noted in GAIN REDUCTION.

(5) Adjust P212 (G/R Meter Cal) until the GAIN REDUCTION meter indicates 100%.

(6) Connect oscillator to LEFT AUDIO INPUT. Adjust oscillator for 5 kHz. Adjust INPUT ATTEN to 12 o'clock. Increase oscillator output until GAIN REDUCTION meter indicates -8.5 dB.

(7) Connect oscilloscope to SCOPE OUTPUT of distortion analyzer. Connect input of distortion analyzer to the left channel broadband limiter output (terminal 29), which is a fork terminal close to the right rear of the limiter board when viewed from the front. Operate distortion analyzer so that the oscilloscope displays the input to the distortion analyzer (normally the "SET LEVEL" mode). Operate the scope in NORMAL TRIGGER mode, and adjust trigger level so scope barely stops triggering.

(8) Remove the hot lead of the oscillator from LEFT AUDIO INPUT. Turn the RELEASE TIME control full CCW. Now reconnect the hot lead of the oscillator, trying to make a clean reconnect. Observe the scope, which should trigger on the overshoot produced by the finite attack time of the broadband limiter. With the scope time base set at 2 ms/cm, adjust P210 (Broadband FET bias) trimmer for a scope pattern similar to Fig. 2 This pattern will be transient, but should be easily visible. Fig. 2 was photographed using a storage scope. To repeat the pattern, it is necessary to alternately disconnect and reconnect the hot lead of the oscillator.



BROADBAND LIMITER ATTACK
(no signal to 10 dB gain reduction)
(2 mS/cm; 1V/cm)
FIGURE 2

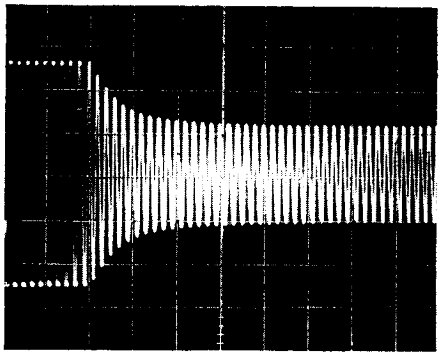
(9) Reconnect the oscillator. Switch frequency to 1 kHz, and reduce the output level until 4dB gain reduction is observed. Without moving the distortion analyzer input, measure the harmonic distortion, and adjust P203 (left distortion null) for minimum THD. Typical reading will be 0.025% if an 80 kHz lowpass filter is employed to reduce the effects of out-of-band noise on the reading.

(10) Connect the oscillator to the RIGHT AUDIO INPUT, and follow the instructions of step 9, substituting P204 (right distortion null), and observing the right channel broadband limiter output (terminal 31).

(11) Connect the distortion analyzer to pin #7 of IC210b. Increase oscillator frequency to 5 kHz; decrease oscillator output until GAIN REDUCTION meter just barely reads 0 dB. Set the front-panel TIME CONSTANT switch to 75 uS.

(12) Operate the distortion analyzer so that the scope displays the input to the distortion analyzer. Reduce analyzer sensitivity until no overload occurs. With scope in NORMAL TRIGGER mode, adjust TRIGGER LEVEL until sweep barely shuts off.

(13) As you did with the broadband limiter test in step 8, alternately connect and remove the hot lead from the oscillator, while observing the scope as it triggers on the overshoot from the high-frequency limiter. Adjust P209 (high-frequency FET bias) until the scope displays a single-shot pattern like FIG. 3 with the scope time base adjusted for 1 ms/cm.



HIGH FREQUENCY LIMITER ATTACK
(5 kHz -- no signal to 10 dB gain reduction)
(5V/cm; 1 mS/cm)
FIGURE 3

(14) Connect the distortion analyzer to fork terminal #5 (and readjust the oscilloscope triggering so that the distortion signal can be viewed). Measure the harmonic distortion. Reduce the level of the oscillator until the distortion is maximum. Adjust P208 (right h. f. distortion null) to minimize THD.

(15) Connect the oscillator to the LEFT AUDIO INPUT and repeat step 14, connecting the distortion analyzer to the left channel h. f. limiter output (terminal 2), and adjusting P207 (left h. f. distortion null) for minimum distortion.

This concludes the alignment procedure.

APPENDIX B: SPECIFICATIONS

INPUT:
Impedance: 150 k ohms balanced; active differential input.
Level: -10 dBm produces 10 dB gain reduction with input attenuator fully clockwise. Absolute input overload occurs at +21 dBm.

OUTPUT:
Impedance: less than 400 ohms, unbalanced.
Level: +4 dBm nominal with output attenuator full clockwise. Peak level approximately +12 dBm.

FREQUENCY RESPONSE:
± 0.5 dB, 20-20,000 Hz below high-frequency limiter threshold.

HIGH-FREQUENCY LIMITER:
Controls high-frequency peaks attempting to exceed a threshold defined by a single-time-constant rolloff of 75, 50, 37.5, or 25 microseconds, ±3%. Rolloffs are switch selectable from front panel, and high-frequency limiter is defeated in "flat" position.
Attack Time: approximately 3 milliseconds.
Release Time: varies around 15 milliseconds according to program history.
Control Element: junction field-effect transistor

BROADBAND LIMITER:
Attack Time: 1 to 2 milliseconds.
Release Time: Program-controlled by means of quadruple time-constant release time analog processor. Release time may be scaled fast or slow by means of continuously variable Release Time control available to user.
Range of Gain Reduction: greater than 15 dB.
Compression Ratio: in excess of 200:1
Interchannel Tracking: ±1.5 dB max.; ±1 dB typ.
Control Element: junction field-effect transistor

SEPARATION:
50 dB or better, 20-20,000 Hz.

NOISE (dB below limiting threshold at 100 Hz; 20-20,000 Hz bandwidth):
-80 dB typ.; -75 dB max.

TOTAL HARMONIC DISTORTION: (See graph)

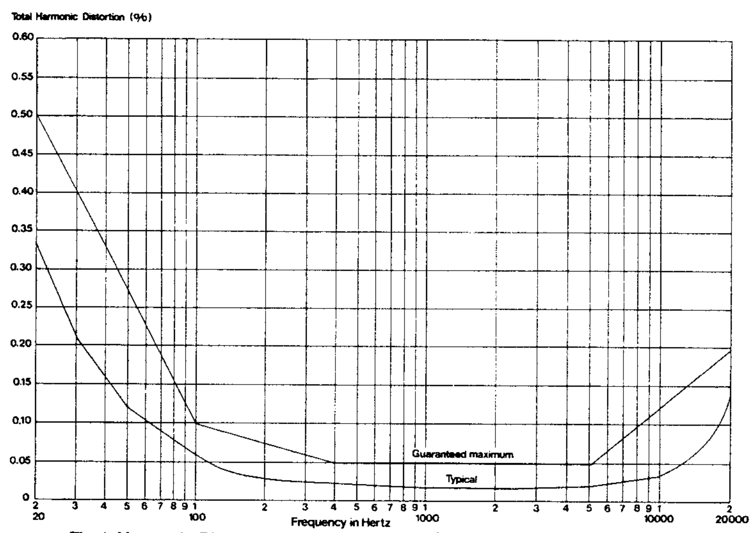


Fig. 1 Harmonic Distortion Versus Frequency (Release Time Control at 12:00) with 5 dB Broadband Limiting and Flat H-F Limiter

OPERATING CONTROLS:
OUTPUT ATTENUATOR (left and right ganged)
INPUT ATTENUATOR (left and right ganged)
RELEASE TIME
H-F LIMITER TIME CONSTANT
75 uS; 50 uS; 37.5 uS; 25 uS; flat
METER SELECTOR
left input; right input; left output; right output; gain reduction; +15 volt power supply; -15 volt power supply
AC LINE OFF/ON

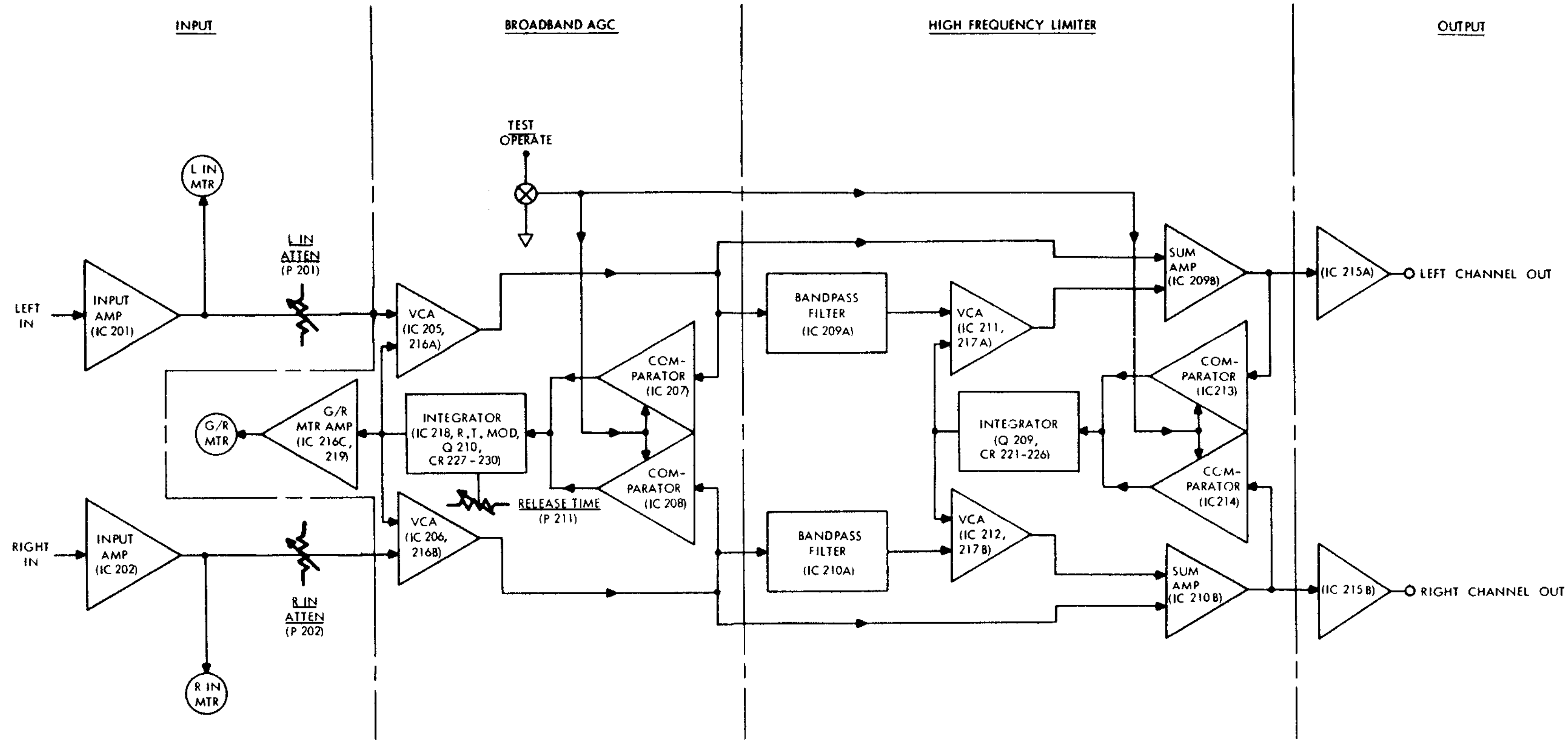
INDICATORS:
AC POWER PILOT LAMP
OVERLOAD (lights if attempt is made to exceed possible broadband AGC range)
METER [3.5" (8.9 cm) with VU "A" scale and characteristics]

POWER REQUIREMENT:
115/230 VAC ±10%; 50-60 Hz, approximately 6 watts. U-ground power cord attached.

DIMENSIONS:
19" (48.3 cm) wide x 3.5" (8.9 cm) high x 10" (25.4 cm) deep.

OPERATING TEMPERATURE RANGE:
0-50° C.

WARRANTY:
1 year, parts and labor. Subject to limitations set forth in our standard warranty agreement.

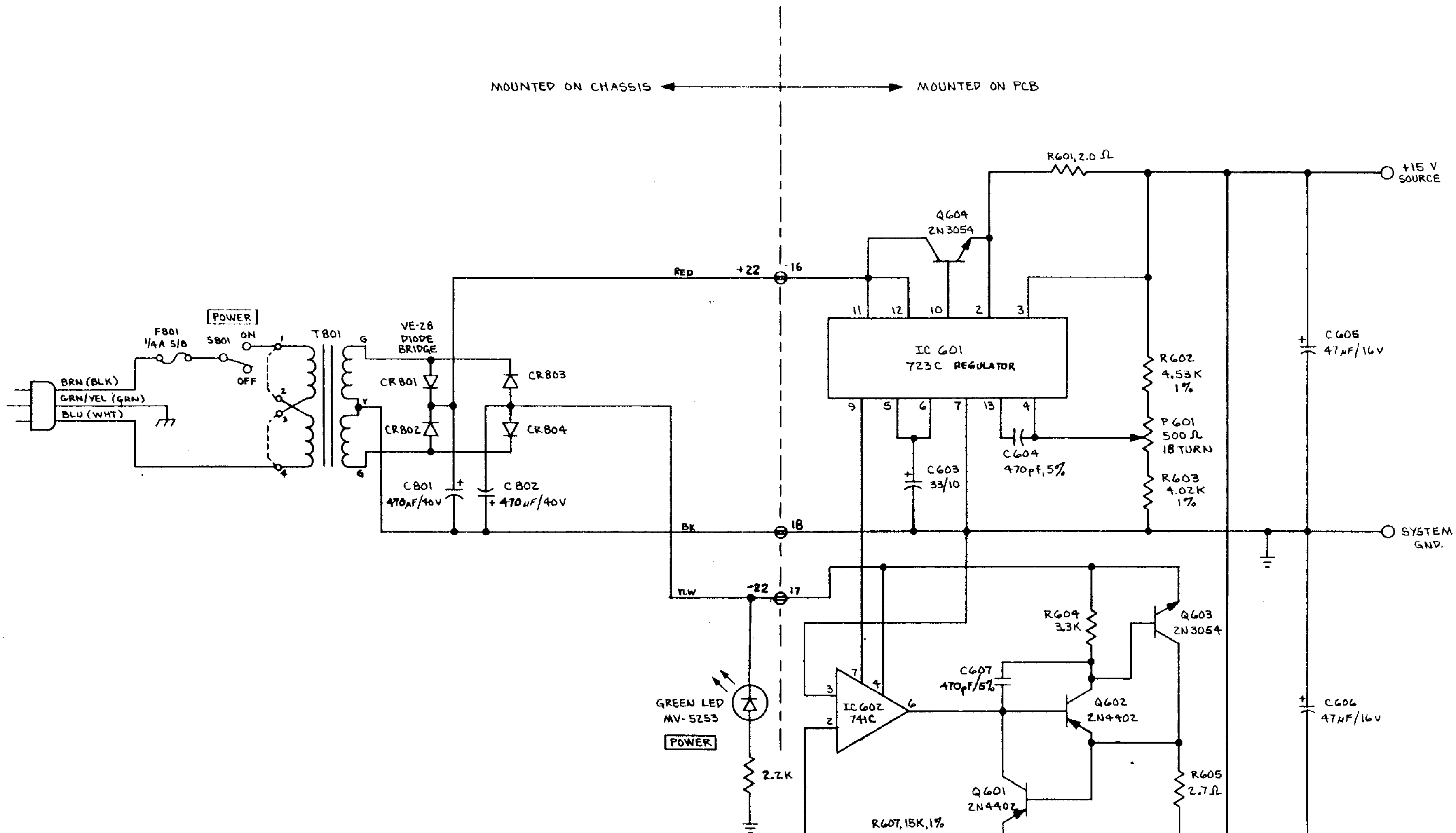


orban

Orban
Associates
Inc.

TITLE:

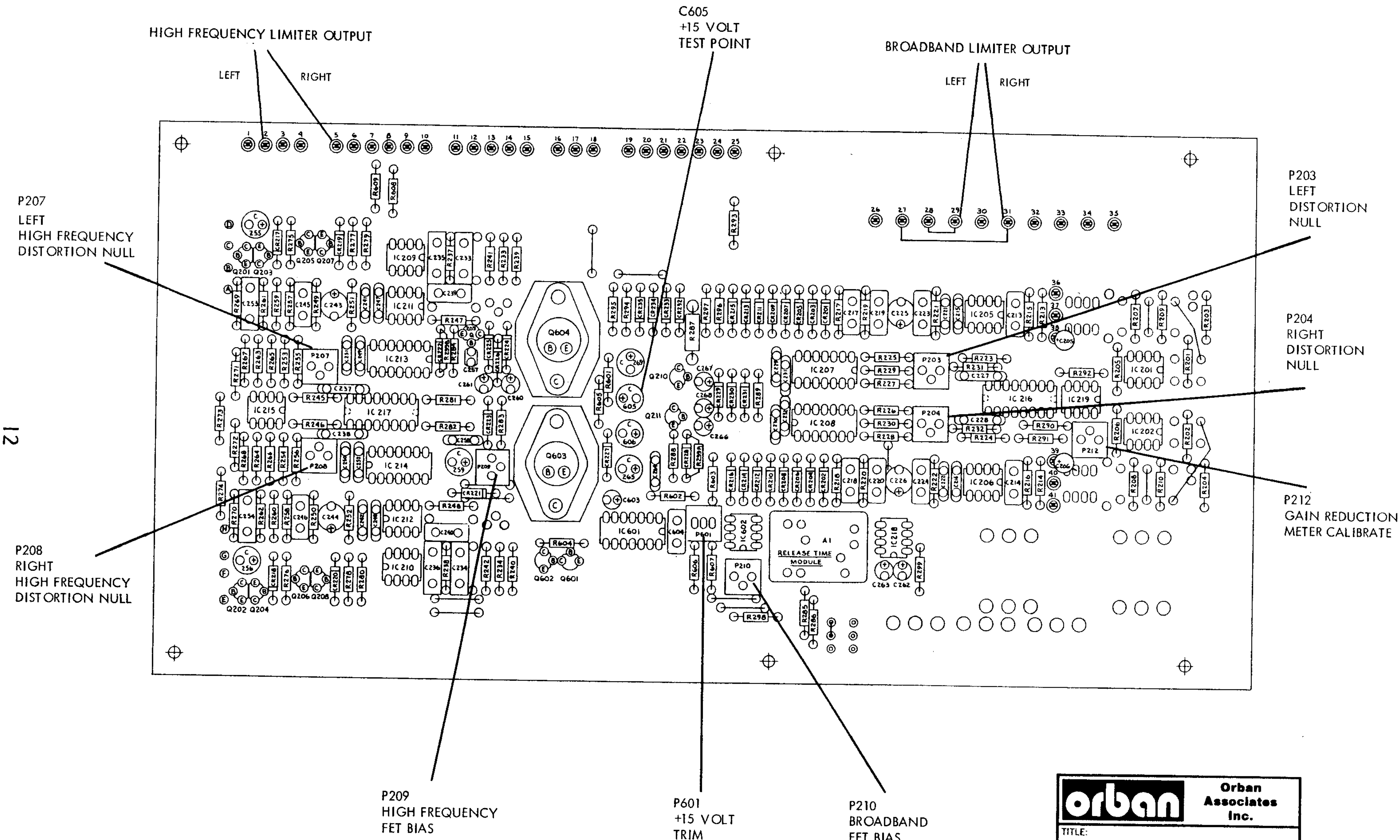
LIMITER BLOCK DIAGRAM
MODEL 418A



Orban Associates Inc.

TITLE:

15V BIPOLAR POWER SUPPLY
MODEL 418A

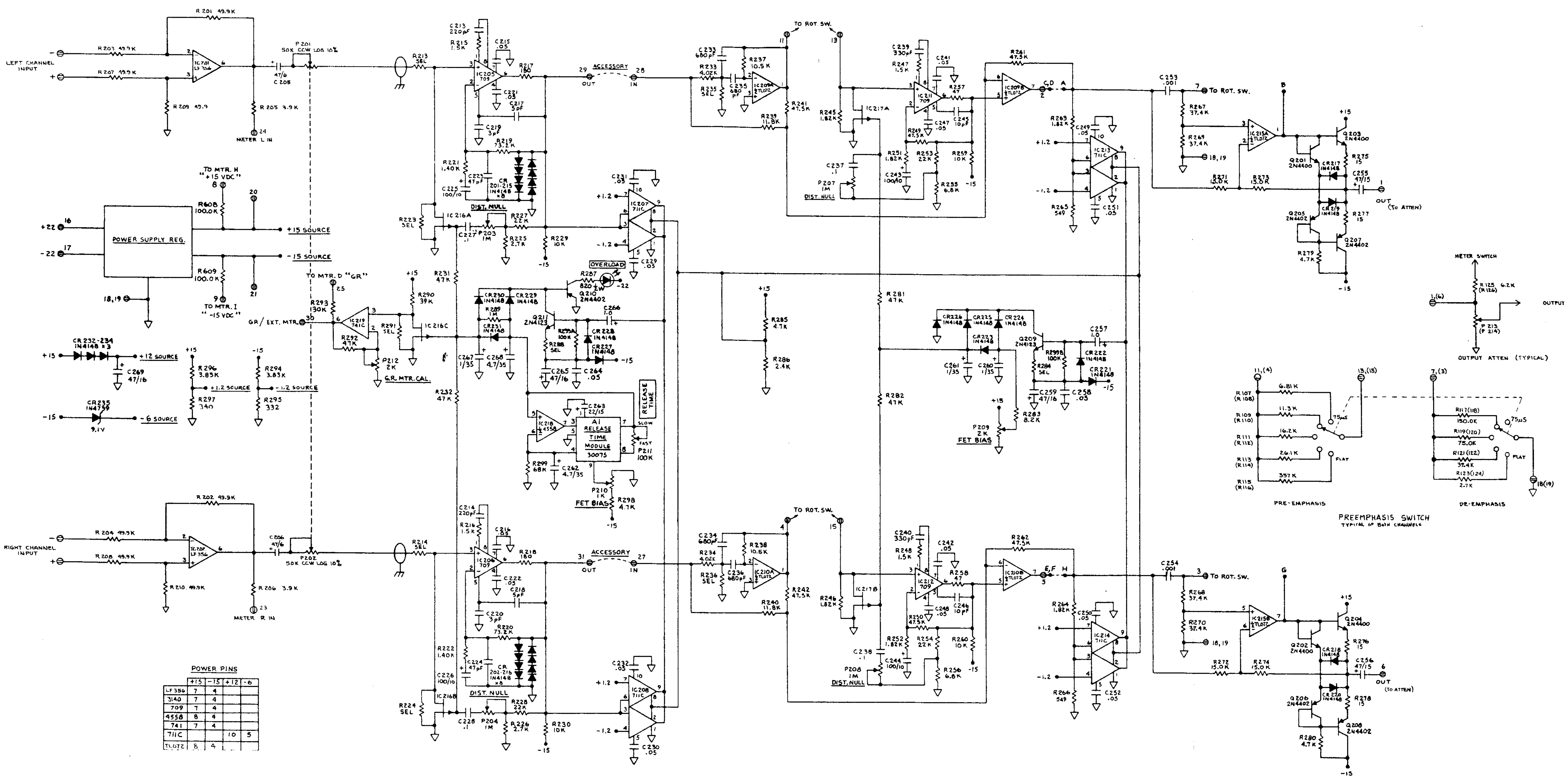


orban Orban Associates Inc.

TITLE:

LIMITER ASSY DWG
MODEL 418A

30080-003-10 © 1980



POWER PINS

	+15	-15	+12	-6
LF356	7	4		
3140	7	4		
709	7	4		
4558	8	4		
741	7	4		
711C			10	5
TL072	8	4		

orban Orban Associates Inc.

TITLE: LIMITER SCHEMATIC MODEL 418A

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