OPERATING AND MAINTENANCE INSTRUCTION MANUAL

MODELS 397 / 997

MAGNETIC FILM PLAYBACK AMPLIFIER

INOVONICS
INCORPORATED

- USER'S RECORD -

Model 397 - Serial Nos. _____

_____

Model 997 - Serial No. _____

Date Purchased _____

Warranty Card Mailed _____

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MAGNETIC FILM PLAYBACK AMPLIFIER

June, 1991

INOVONICS
INCORPORATED

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Section I
INTRODUCTION

MODEL 397 PRODUCT DESCRIPTION

General

Inovonics' 397 is an audio reproduce-only preamplifier specifically intended for motion picture "mag-film" playback applications. Though the 397 was designed for production-related playback in studio situations, it may also be used in exhibition (theater) systems which demand no-compromise performance.

During the design phase of the 397, special consideration was given to motion picture production practices and to the critical noise, headroom and other technical parameters particular to the film industry.

System Components

The 397 Film Playback System is made up from a combination of three system parts:

- The individual plug-in AMPLIFIER MODULES which contain the preamplifier and line-drive circuitry.
- A MODEL 997 POWER SUPPLY MODULE which provides regulated DC voltages to the amplifier plug-ins.
- An unpowered RACK FRAME which can accommodate from one to six of the Amplifier Modules, plus one Power Supply Module.

These system parts may be configured by the user to make up any required playback system; for instance, a 2-, 3-, 4- or 6-track 35mm "dummy" player, or a multi-format playback system with plug-in heads to accommodate both 16mm and 35mm film sizes.

MODEL 397 FEATURES

The Inovonics 397 is distinguished by these operating features and special functions:

- 4 separate Level and EQ setups accommodate any combination of 35mm and 16mm formats. Presets are selected by pushbutton switches on the Power Supply Module.
- A unique ultra-low-noise input configuration yields optimum noise performance with preferred low impedance playback heads without the need for an input matching transformer.
- 3-point equalization adjustments provide independent control over LOW, HIGH and GAP LOSS frequency ranges.
- The transformerless balanced output uses a discrete-transistor "push-pull" driver stage to permit long cable runs without performance sacrifice.
- Each subsection of the amplifier circuitry maintains signal headroom well in excess of oxide saturation; 24dB above Normal Operating Level is typical.

PRODUCT BACKGROUND

The Company

Inovonics was incorporated in 1972 with the idea for a single product to manufacture and market. Though solid state circuitry was nothing new to the professional audio field in the '70s, there were tens of thousands of studio tape recorders still in use with vacuum tube electronics. The tape transports, themselves, were extremely rugged and reliable; but the overall performance of these machines fell short of what was then considered "state of the art." Inovonics' first product was a transistorized replacement electronics assembly for studio tape machines, notably the Ampex 350/351 series - by far the most popular of the older recorders still in widespread use at the time.

Tape Electronics

Over the years that followed, and through several updates and generations, Inovonics manufactured several thousand channels of recorder electronics, while developing many other products for the sound recording, broadcasting and audio instrumentation fields. Today, with the ready availability of remarkably good and relatively inexpensive tape machines, the market for replacement tape recorder electronics has dwindled to make this but a small part of Inovonics' total product family.

Film Use

We had noted for some time that an increasing proportion of our replacement channels were being modified for use in magnetic film recorders of one type or another. Communication between the factory and the field prompted Inovonics' exploration of film recording practices, procedures and techniques, in hopes that a better acquaintance with this industry might help us develop new products to better serve it.

Credits

Inovonics is indebted to numerous film sound and other audio recording professionals who aided us in our endeavor to develop and offer improved mag-film recording and reproducing electronics. We particularly extend our thanks to: Frank Pontius and his crew at Westrex Corp, Bob Morrison of Standard Tape Lab., Jack Dimmers at Teccon Corp., and "Jay" McKnight of Magnetic Reference Lab.

HEAD SELECTION GUIDELINES

"Low-Z" Design

Heads in early magnetic recording systems were matched to vacuum tube electronics which had characteristically higher input and output impedances than later solid state designs. Most retrofit recording electronics, including those made by Inovonics, were developed specifically to match the high-Z heads common to older tape machines. Model 397 circuitry has been optimized for playback heads with windings in the *lower* range of inductance for best noise rejection and to better match solid-state circuit impedances.

Record and Reproduce Heads

In film recording, the Record head is used extensively for playback as well, because the signal reproduced by the Record head is in "sync" with what is being recorded on another track. This is essential when "looping," and when recording additional dialog, music or sound effects tracks.

Unfortunately, any Record/Play "combination" head is at best a compromise because of the gap length dilemma. (Gap spacer thickness largely determines gap *length*, often incorrectly referred to as gap *width*.)

The length of a recording gap is not nearly so critical as that of a reproducing gap. A "long" gap of 500-microinches in a Record head will generate a deeper bias

field to better penetrate the oxide coating. This greatly reduces the effects of surface irregularities, and "dropouts" will be less of a problem.

The same 500 μ-inch gap in a Reproduce head, on the other hand, would introduce significant short-wavelength (high frequency) signal loss. Uncorrected, this loss translates to about 2.8dB at 15kHz for 35mm systems, or over 10dB loss at 10kHz for 16mm recorders. A gap loss equalizer, such as provided in the 397 playback circuitry, can compensate for gap losses to some extent, but optimum high frequency performance dictates a dedicated playback head with a short gap.

MODEL 397 SPECIFICATIONS

Overall system specifications will, of course, depend largely on the heads and recorded media. The following data were derived using industry-standard test films and Sendust alloy heads supplied by Teccon Corp. Track width was 200-mils, and nominal Operating Level approximately 185nW/m.

Reference to *absolute* signal levels in these Specifications uses the term "dBu." As of this writing, dBu is *not* a term which is officially recognized by standards organizations, yet it has come into widespread use through convention. A 0dBu signal has the same 0.775-volt r.m.s. *voltage* reference as 0dBm, but no impedance or power level is implied.

Playback Response From Test Film:
35mm: ±1.5dB, 25Hz - 20kHz
16mm: ±2dB, 20Hz - 12kHz

Signal-to-Noise (in dB, referred to a "peak" flux level of 370nW/m, or 6dB above Operating Level):

	STANDBY		BIASED BLANK FILM STOCK	
	u'wtd.	A-wtd.	u'wtd.	A-wtd.
35mm:	-74	-82	-67	-75
16mm:	-70	-77	-63	-70

Distortion:
Film oxide-induced distortion will typically reach 1% THD at a flux level of 290nW/m; this is approximately 4dB above Operating Level - depending on oxide formulation. Distortion in the Playback Amplifier is >0.1% at any level up to signal clipping. The electronics internal clipping points are at least 20dB above typical average operating levels.

Equalization: "3-point" equalizers have multiturn resolution and ample range to fit the 35 μ-sec 35mm and 70 μ-sec 16mm curves with "flat" low frequency characteristics per the SMPTE Specification. The four equalization presets are selected with pushbutton switches on the Power Supply Module.

Metering: Front-panel VU meter indicates Line Output signal level.

Line Output: Transformerless, electronically-balanced output appears at back-panel "XLR" male connector. Output impedance: 200-ohms, resistive. Output line level: +4dBu, corresponding to 0-VU. Output clipping level: > +24dBu into 600-ohm or higher impedance load.

Head Specification:

Circuitry optimized for heads with inductance of 5mH, ±20%; recommended gap spacer, 200μ-inches. *Model 397 cannot be used with Hi-Z heads!*

Power Requirements: The Model 397 Playback Amplifier Modules each require a preregulated bipolar supply of ±18vdc at 80ma. The Model 997 Power Supply Module, which satisfies these requirements for a system of 6 or fewer channels, operates from 115/230-volt AC mains, 50/60Hz, and draws about 20 Watts fully-loaded.

Size and Shipping Weight:

397 Playback Amplifier Modules: 7"H x 2.2"W x 8"D; 2 lbs.
997 Power Supply: 7"H x 2.2"W x 8"D; 4 lbs.
999 Rack Frame: 7"H x 19"W x 8"D (4U); 3 lbs.

Section II

INSTALLATION

UNPACKING AND INSPECTION

Immediately upon receipt of the equipment, inspect carefully for shipping damage. If any damage is observed, notify the carrier at once; if not, proceed as outlined below. It is recommended that the original shipping carton and packing materials be saved should future reshipment become necessary. In the event of return for Warrant repair, shipping damage sustained as a result of improper packing for return may *invalidate the Warranty!*

IT IS VERY IMPORTANT that the Warranty Registration Card found at the front of this manual be completed and returned. Not only does this assure coverage of the equipment under terms of the Warranty, and provide some means of trace in the case of lost or stolen gear, but the user will automatically receive specific SERVICE OR MODIFICATION INSTRUCTIONS should they be issued by the factory.

MOUNTING

Rack Frame

The Inovonics 397 System includes a Rack Frame which occupies seven vertical inches of standard 19-inch-wide rack space. This frame houses up to six of the individual Model 397 Playback Amplifier Modules, one Model 997 Power Supply Module, and as many Blanking Panels as may be required to cover unused spaces.

Magnetic Interference

The 397 Amplifier Modules employ an extremely high-gain preamp stage which is somewhat susceptible to induced hum from stray magnetic fields. It is therefore quite important that the Rack Frame housing the Amplifier Modules be located *away* from motors, fans and transformers which could aggravate hum problems.

The Rack Frame must be located in an area convenient to adjustment, but out of the direct film path so that adjustments may be made with the film in motion.

It is important that the Rack Frame be secured by rack-screws through *all* mounting holes. This not only provides rigidity, but a good chassis-to-rack ground connection. And *please* use nylon rack washers under the screw heads!

Loading the Rack Frame

Once the Rack Frame is located and mounted, the Amplifier and Power Supply Modules may be installed by sliding them into the Frame's Nylon guides.

Each Module and Blanking Panel is supplied with two, one-half-inch, 6-32 threaded spacers. These *may* already be attached to the Rack Frame, or *may* be shipped with the individual Modules and Blanking Panels - secured by their captive thumbscrews. In the latter case, *remove* these spacers and install them instead in the #6 clearance holes of the Rack Frame top and bottom rails which align with the

Module centerlines. The threaded spacers come with short #6 screws and split washers, and should be tightened securely to the Rack Frame.

If everything is in alignment, Modules should slide effortlessly into the Rack Frame, and the captive thumbscrews thread easily into the spacers. If this is *not* the case, it may be necessary to loosen and retighten the twelve #6 screws which hold the Rack Frame together. This will relieve stresses incurred in shipping or mounting.

390 AMPLIFIER MODULE HOOKUP

Channel Configurations

397 Amplifier Modules are loaded into the Rack Frame from left-to-right, Track 1 of the system leftmost and the 997 Power Supply in the far-right slot.

Power to Modules

Each 397 System is provided with a "daisy-chain" Power Interconnect ribbon cable assembly. The cable will interconnect as many as six of the Playback Amplifiers with the 997 Power Supply; unused connectors may simply be "left hanging."

The connectors are polarized so as to plug in only one way. Additionally, the color-striped edge of the cable faces up.

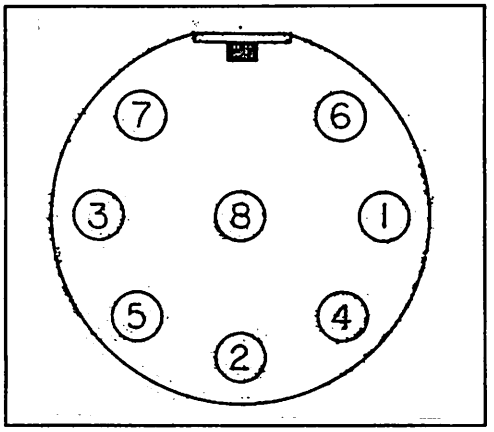
Line Output

The rear-panel XLR male connector labeled LINE OUTPUT is the primary Reproduce Amplifier output. The line level corresponding to a Module meter reading of "0-VU" is +4dBu. Pin assignments are:

PIN 1 - GROUND, PIN 2 - OUTPUT "HIGH," PIN 3 - OUTPUT "LOW."

Head Connectors

The popular 7- or 8-pin "DIN" connector was chosen for head cable connection to the 397 Module. These connectors are used extensively in computer, audio and video equipment, and are readily available in rugged, shielded versions which are very reliable. One mating connector is provided with each 397 Module. Head connector pin assignments are tabulated below.

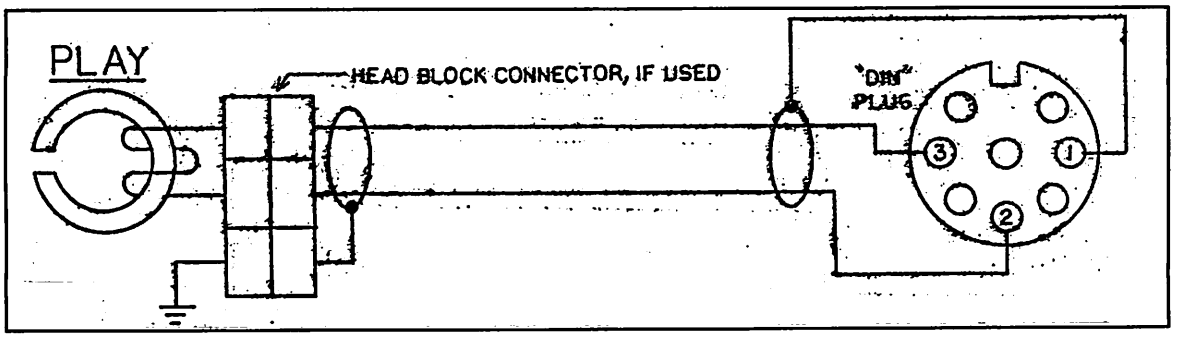


"DIN" CONNECTOR PINOUT
(Shown looking into the rear-panel FEMALE socket, or the back-end view of a MALE connector plug)

PIN 1	GROUND
PIN 2	HEAD "LOW"
PIN 3	HEAD "HIGH"
PIN 4	GROUND
PIN 5	(NO CONN.)
PIN 6	GROUND
PIN 7	GROUND
PIN 8	GROUND

Head Cable Wiring

The diagram below shows the recommended method of wiring the Reproduce Head to the DIN connector for plugging into the Reproduce Head socket on the back of the 397 Amplifier Module. Wiring practice probably has more influence on extraneous noise pickup (inductive and capacitive) than any other single factor.



HEAD CONNECTION (typical of one channel)

The choice of head cable is important. The newer foil-shielded cables are superior to those with braided shields in a number of respects. The integrity of the foil shield itself is certainly a major consideration, and the ease with which the bare "drain" wire can be connected surely beats anyone's pet method of terminating a braided shield.

The shield can serve as a grounding bond between the head block and the Module chassis, and best practice is to keep both sides of the head wiring independent of the shield. High gain, low impedance input circuits have least tendency toward inductive noise pickup when both sides of the input (high and low sides of the head) share identical physical paths.

In the low impedance head circuits of the Model 397, cable capacitance is not a significant factor for the typical 2- to 5-foot runs. Good shielding and lowest microphonic pickup of machine vibration are paramount. The wires listed below are ideally suited for head cabling:

BELDEN 8641; ALPHA 2400; OLYMPIC 2822.

MODEL 997 POWER SUPPLY HOOKUP

AC Mains

The Power Supply chassis is fitted with an "IEC" male power connector and supplied with a mating 6-foot power cord. The AC mains plug is a North-American-standard male connector, but the internal cord conductors are *supposedly* color-coded in accordance with CEE standards:

BROWN = AC "HOT," BLUE = AC NEUTRAL, GRN/YEL = GROUND.

If this turns out *not* to be the case, we offer our apologies (cord vendors vary) and advise that U.S. color coding applies:

BLACK = AC "HOT," WHITE = AC NEUTRAL, GREEN = GROUND.

Mains Voltage Selection

Unless specifically ordered for export shipment, the Model 997 Power Supply is delivered for operation from 115V, 50/60Hz AC mains power. The back-panel designation next to the fuseholder will be marked to confirm both the mains voltage selected and the value of the fuse supplied.

There is a mains voltage selector switch on the printed circuit board inside the Power Supply. It is clearly marked for setting to either 115-volt or 230-volt operation. A proper fuse must always be installed and the appropriate voltage designation marked. It is factory practice to cross out the *inappropriate* fuse value markings with black felt marking pen. This strikethrough can be removed with solvent if the markings need to be changed.

BE SURE that the mains voltage selector setting and primary fuse value are appropriate for the mains supply before plugging the Power Supply into the wall socket.

Section III

PANEL CONTROLS AND FUNCTIONAL DESCRIPTION

397 AMPLIFIER MODULE ADJUSTMENTS

A listing of the front-panel adjustments is given here, along with brief descriptions of their specific functions. In-depth setup and calibration procedures are detailed in Section IV.

LEVEL These are the Reproduce Gain controls. They are normally adjusted for a panel meter reading of "0-VU" during playback of a Standard Reproducer Test Film.

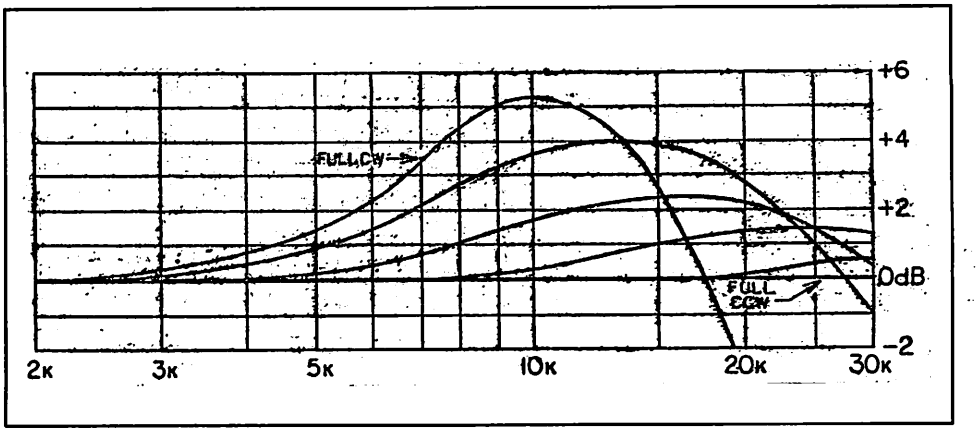
LO EQ Low Frequency Reproduce Equalization affects frequencies below 200Hz, with maximum "leverage" in the 20Hz to 50Hz range. The SMPTE Curve specifies a "flat" low-end, and the Playback Amplifier maintain a true "integrating" characteristic down to 20Hz. A steep high-pass function is introduced at 20Hz to reduce 1/f noise, and filter "Q" is such that a slight emphasis is imparted at the 20Hz cutoff frequency. This helps preserve bottom-end response when the LO EQ control is adjusted to even-out the "head bump" effects.

HI EQ High Frequency Reproduce Equalization adjusts the turnover frequency for top-end control. This means, for instance, that if 10kHz is brought up by 2dB, all frequencies above 10kHz will be increased by 2dB as well. HI EQ is normally set for flat playback in the 4kHz to 6kHz region from a Standard Reproducer Test Film.

GAP EQ A Gap Loss Equalizer has been included in the Playback Amplifier to compensate for the high frequency loss associated with the relationship between reproduce head gap length and the wavelength of the recorded signal. An effective gap length equal to one-half the recorded wavelength yields a loss on the order of 4dB. Above this 0.5 factor loss is quite precipitous and is generally past the point of diminishing return for equalization.

The 397 Gap Loss Equalizer makes use of a second-order low-pass filter with a variable parameter affecting both cutoff frequency and "Q." As the GAP EQ control is turned clockwise, three things happen: 1) the *amount* of boost at the highest frequencies increases, 2) the *steepness* of the tip-up slope increases, and 3) the frequency of the resonant equalizer "peak" *decreases*. This enables correction of moderate gap loss without increasing system noise at frequencies above the useful response of a particular head. A family of GAP EQ response curves for a range of control settings is plotted at the top of the next page.

GAP EQ is adjusted *after* the HI EQ control has been optimized in the 5kHz region. It is set for flattest overall response to the useful system limit. It is often tempting to make certain tradeoffs when touching up the HI EQ and GAP EQ trimmers, slightly compromising overall flatness at the high end for a better system response specification. Keep in mind, however, that "bumps" in the response are *cumulative*. A 2dB peak at 12kHz will become 6dB in a third-generation copy. Thus it may be more prudent to accept a bit less in top-end "specsmanship" to favor a smooth response to a slightly less impressive cutoff frequency.



Gap Loss Equalizer Adjustment Range

MODEL 997 POWER SUPPLY

POWER This alternate-action (push-on / push-off) switch does, indeed, turn ON and OFF the primary (mains) power to the Model 997 Power Supply and, hence, power to the 397 Amplifier Modules thereto connected.

FORMAT / EQ SELECT These interlocked buttons switch between the four LEVEL and EQ presets of the 397 Playback Amplifier Modules. A green LED beside each button indicates which format is currently selected.

Section IV

SYSTEM SETUP

EQUIPMENT REQUIRED

SMPTE-Standard Reproducer Test Film(s) - in the format(s) to which the system will be configured and used.

AC Voltmeter, or alternative "Program Level Test Set," *only if* the Test Film tones are recorded below full Operating Level, as is the case with some 16mm Test Films.

PLAYBACK ALIGNMENT

The various steps of this procedure describe complete calibration of only *one channel* of a system. The steps will, of course, have to be repeated for *each channel*, and for each channel once again for every format (A, B, C, D) utilized.

1. While playing the Operating Level tone on the Reproducer Test Film, adjust the LEVEL trimmers for a meter indication of "0-VU."
2. The LO EQ trimmers are adjusted for a meter reading of "0-VU" during playback of a tone in the 50Hz to 100Hz range, BUT **ONLY** IF THE FORMAT OF THE REPRODUCER TEST FILM IS THE **SAME** AS THAT OF THE PLAYBACK HEAD. This is important as "fringing" effects can seriously effect low-end response readings and calibration. If, for instance, the Reproducer Test Film is recorded across its entire width, and the playback track width is the typical 200-mil track of 35mm formats, the head's sensitivity to long-wavelength recorded signals *outside* the physical track confines can make the 50Hz test tone appear to be as much as 3dB *higher* than if the tone were recorded in the proper 200-mil format. This can lead to miscalibration of the LO EQ trimmer by -3dB. If the Reproducer Test Film does **not** have the proper recorded track format, low-end calibration by the "induction loop" method may give more accurate results.
3. Set the GAP EQ trim controls fully counterclockwise. The HI EQ trimmers may then be adjusted for a meter indication of "0-VU" while reproducing a test tone in the range of 4kHz to 6kHz.
4. While playing the highest frequency test tones on the Reproducer Test Film, check playback head azimuth for maximum output; the GAP EQ trimmers may then be adjusted for optimum top-end response within the capability of the playback head. The hazard implied by availability of this adjustment was discussed on Page 10. Essentially, the GAP EQ trimmer can permit extension of the top-end response *specification* at the expense of response *flatness*. Remember: "bumps" in the response are cumulative over several recording generations. Use the GAP EQ trimmer judiciously; a smooth response is preferable to a lumpy one extended to a slightly higher cutoff frequency.

Section V

CIRCUIT DESCRIPTIONS

PARTS LOCATION NOTE

In glancing over the Schematic Diagrams for the 397 Amplifier Module and the 997 Power Supply Module, it will be noted that the schematic reference designations do not appear to follow any particular order. This is really not the case, only that parts are *physically* designated in logical left-to-right, top-to-bottom order on the *board*, since troubleshooting a function usually begins with analyzing the schematic, *then* locating that area on the board to test for bad components.

397 PLAYBACK AMPLIFIER MODULE (Schematic on Page 21)

Input Preamp Background

Configuration of the input stages closely follows circuitry developed by Doug Self of the U.K. firm, *Soundcraft*. Mr. Self's requirement was for a very low-noise gain stage to aid in determining whether passive components impart a characteristic "sound" to the circuits in which they are used. This work, published in the November, 1987 issue of the *Journal* of the Audio Engineering Society, supports the conclusion shared by all sane audio scientists; that not even a subtle difference can be measured (or heard), for example, between capacitor types used in the audio signal path.

Mr. Self's gain circuit exhibited such good performance that he reconfigured it for a practical application, that of a preamplifier for moving-coil phonograph cartridges. Thankfully, the qualities that render this circuit ideal for its intended service are the same ones necessary for transformerless mag-film playback with low-Z heads.

Input Stage

Q2 and IC2A comprise a very high gain input preamplifier optimized for low source impedances. Emitter-follower Q1 decouples and filters input power to the first stage, and IC2B performs a DC "servo" function to establish the quiescent operating point for the entire preamp. Gain of this circuit is on the order of 53dB, and, since the preamp has a flat frequency characteristic, the output signal has a 6dB/octave rising characteristic for a constant flux in the core of the (inductive) playback head.

The preamplifed audio is fed to the four LEVEL trimmers, R12 through R15. IC3B is a binary-addressed "single-pole, 4-position" CMOS Analog Switch controlled by EQ SELECT logic. This logic is bussed from the Model 997 Power Supply Module FORMAT / EQ selector switches on the ribbon interconnect cable plugged onto J4. A "Truth Table" common to all such "one-of-four" CMOS Switches used in the 397 is given on the next page.

CMOS ANALOG SWITCH TRUTH TABLE

CONNECTOR J4 PIN 08	CONNECTOR J4 PIN 10	CMOS LOGIC INPUT "A"	CMOS LOGIC INPUT "B"	SIGNAL SELECTED
OPEN	OPEN	-9V	-9V	A
+15V	OPEN	+9V	-9V	B
OPEN	+15V	-9V	+9V	C
+15V	+15V	+9V	+9V	D

LF/HF Equalization Amplifier

The playback signal from IC3B is fed to an "integrating" amplifier, IC4B. Most of the negative feedback which establishes gain of this stage is through C17, causing amplification to have a 6dB/octave *falling* characteristic complementing that of the signal from the playback head.

As frequency decreases, the capacitive reactance of C17 becomes smaller, causing gain to increase. A resistance placed in *parallel* with C17 "shelves" the gain increase by establishing a finite minimum feedback regardless of C17. Thus the LF-EQ trimmers, R35 through R38, selected by the CMOS Switch IC3A, adjust IC4B gain at the lower frequency limit.

The LF-EQ trimmers can only *decrease* low-end gain. This means that the SMPTE playback curve with its "flat" low end could be accommodated only by turning the trimmers to maximum resistance. Therefore a second R/C time constant (R17/R19/C4) is series-connected in the feedback path to increase the integration slope below 200Hz. The LF-EQ trimmers can then "spoil" this additional low-end boost to yield "flat" playback in the center of their adjustment range.

DC feedback for IC4B is established with R21, R22 and R23. C2 and C3 bypass audio frequencies to ground, but the insertion of R20 into this shunt leg forms a "bridged-T" network and imparts a second-order high-pass function with a corner frequency at 20Hz. This helps reduce the 1/f noise component of the input preamp. "Q" of the high-pass network is calculated to give a small rise in response at the 20Hz corner frequency as a first-order "head bump" correction.

Resistance placed in *series* with C17 "shelves" the falling response of the equalization stage by limiting feedback which otherwise would continue to climb as capacitive reactance drops with increasing frequency. The HF-EQ trimmers, R48 through R51, selected by CMOS switch IC7B, yield variable control over top-end response.

Gap Loss Equalizer

An additional equalization stage has been included in the Playback Amplifier to compensate for response loss associated with Reproduce Head gap length. The rationale for this equalization and a description of its use and its effect was given on Page 10.

IC4A is a unity-gain stage with a capacitor network in the feedback path. Resistance to ground at the junction of C19 and C20 forms a "T," bridged by C19 to create a second-order low-pass filter. The resistance in this instance is variable, being the four GAP-EQ trimmers, R60 through R63, selected by CMOS switch IC7A. The value of resistance determines both the filter "Q" and cutoff frequency, with the interdependent relationship graphed at the top of Page 11.

Jumpering Options

The 397 Playback Amplifier circuit board is also used in Inovonics' Model 390 Mag-Film Recording Electronics as both a (normal) Reproduce and a Recordist Monitor Amplifier. In the 390 these boards are *jumpered* to perform the two separate playback functions. The jumper pin strip is located near the center of the board, and accepts a pair of plug-on "shunts" in either of two locations: at the two *ends* of the pin strip in the case of the 390 Reproduce board, or together at the *center* of the strip for both the 390 Recordist Monitor board *and* the Model 397 Playback Amplifier board. The locations are also silkscreened in the board legend, as well as shown on the Schematic.

IC8, yet another CMOS Analog Switch, in this instance is used for monitor signal routing rather than for EQ selection.

The 397 Playback Amplifier and Model 390 Recordist Monitor Amplifiers are jumpered such that the A and B logic inputs of IC8 are "jammed" high through diodes CR3 and CR4. This routes the equalized playback signal from IC4A directly into the output amplifier, IC9.

On the Model 390 Reproduce Amplifier board, IC1C and IC1B control monitor selection. These two sections of IC1 are level comparators, converting "tristate" logic from the Recording Console into monitor selection commands for IC8. When the MON SELECT TRISTATE bus from the Recording Console is *open*, the "+" inputs of both IC1C and IC1B are pulled to +9 volts through R8. This drives both comparator outputs (and IC8 logic inputs) high, routing the Reproduce signal from IC4A to the output stage.

When the MON SELECT TRISTATE bus is taken to *ground*, the outputs of IC1C and IC1B both go low, as do both logic inputs of IC8. This switches IC8 to pass the Input Monitor signal, which is bussed in from the Record Board on J1, Pin 02.

If, however, the MON SELECT TRISTATE bus is taken to ground *through a 4.7K resistor*, comparator biasing is such that the output of IC1C goes low, but the output of IC1B remains high. This switches IC8 to pass the Recordist Monitor signal, which is bussed in from the Recordist Monitor Amplifier board on J1, Pin 01.

The MON SELECT TRISTATE bus has no connection in the 397 Playback Amplifier. Though this line left open would result in proper signal routing anyway, the jumpering option is made to ensure the signal path.

Power-On Delay

When power is first applied to the Module, C21 drags the "inhibit" logic input of IC8 high. This turns IC8 completely off and prevents any signal from reaching the output stage. C21 then begins to slowly charge through R55, and after a few seconds the inhibit line reaches a logic low level and the signal is passed.

Line Output Amplifier

IC9 and the associated discrete transistor output stages comprise the Line Output Amplifier. IC9B provides a small amount of voltage gain and, with the R/C network in the input path, it also performs an active, third-order low-pass filter function. The filter begins an 18dB/octave rolloff at about 30kHz.

IC9B drives one side of the Line Output, with Q3 and Q4 as current driver stages. Diodes CR15 and CR14 compensate for the V_{be} of the output transistors, and CR13 and CR12 furnish short circuit protection in conjunction with R67 and R68.

IC9A is simply a unity-gain inverting stage with an identical transistor current driver array. It drives the other side of the Line Output in opposite phase.

Two "buildout" resistors, R75 and R74, are in series with the Line Output for protection and isolation, and impart a purely resistive output impedance characteristic of 200 ohms. Most studio equipment nowadays has electronically-balanced, "bridging" (high impedance) inputs. **However,** should the source impedance of the 390 Line Output Amplifier pose a problem, the buildout resistors may be removed and replaced with bare wire.

The "VU" meter is driven directly from the Line Output from the very low impedance side of the buildout resistors. Thus the meter with its internal rectifier is incapable of introducing distortion in the output signal.

Power Supply Regulators

The Playback Amplifier Module includes a pair of on-board voltage regulators of the "three terminal" variety. These re-regulate the ±18-volt supply from the 997 Power Supply Module to ±15 volts. Two 6.2-volt zener diodes, CR5 and CR6, drop the ±15 volts to ±9 volts for some of the amplifier stages and for the CMOS signal switching ICs.

997 POWER SUPPLY MODULE (Schematic on Page 22)

Voltage selector switch S2 connects the primaries of power transformer T1 either in parallel, for 115-volt operation, or in series for 230-volt mains. The transformer secondary feeds a full-wave, center-tapped bridge rectifier yielding a bipolar "raw" supply of about ±25 volts.

IC1 and IC2 are "three terminal" regulators set to deliver ±18 volts DC. While this is a well-regulated supply, additional regulation in the 390 Playback Amplifier Modules eliminate any chances for crosstalk between channels via the power supply rails.

The FORMAT / EQ SELECT switch, S1A - S1D, translates the interlocking pushbutton commands into binary-coded switching logic. CR1, a 3-volt zener diode, drops the +18 supply to +15 volts to match the re-regulated power rail in the Amplifier Module.

When the A button is actuated, both EQ bus lines (J1-08 and J1-10) are floating; these are held low by pulldown resistors in the Amplifier Modules. The B button routes +15 volts to J1-08, the C button to J1-10. Actuating the D button forces both EQ bus lines high through CR2 and CR3. The CMOS Analog Switch Truth Table at the top of Page 14 explains the translation back from binary to 1-of-4 selection within the 397 Amplifier Modules.

Section VI

APPENDIX

The following section of this Manual contains Parts Lists and Schematic Diagrams for the 397 Playback Amplifier and 997 Power Supply Modules, and an explanation of Inovonics' Warranty Policy.

PARTS LISTS

EXPLANATION OF PARTS LISTINGS

The following pages contain listings of component parts used in the Model 397 Amplifier Module and the Model 997 Power Supply Module.

The first parts listings are those components which are "peculiar" to individual circuit assemblies, or which require more than a "generic" description. These are listed by schematic component reference designation under each assembly heading. This is the *first* place to look for a parts description and ordering callout.

If the component in question is *not* listed under its subassembly heading, it may be considered a "generic" part, common enough to most of the 397 / 997 circuitry to be lumped into a single category. These components are referred-to by physical description and value, rather than by reference designation. The "GENERIC PARTS" section follows the individual subassembly listings.

Components which are *not listed at all* are probably not considered typical replacement parts. Should it become necessary to specify an unlisted part, a call to the factory with a brief description should straighten the matter out.

397 PLAYBACK AMPLIFIER MODULE

C5	Capacitor, Electrolytic, radial leads, 47μF, 25 VDC; Elna RE-series or equiv.
C6	Capacitor, Electrolytic, radial leads, 4.7μF, 25 VDC; Elna RE-series or equiv.
C10	Capacitor, Electrolytic, radial leads, 220μF, 6.3 VDC; Elna RE-series or equiv.
CR5,8	Diode, Zener, 6.2-volt; 1N4735 or equiv.
CR6,7,9,10	Diode, Rectifier, 1A; 1N4005 or equiv.
FB1,2	Ferrite Bead; Amidon FB 75B 101
IC1	Integrated Cct.; (open mfgr.) LM324N
IC2,4	Integrated Cct.; (Raytheon, T.I.) RC4458NB
IC3,7,8	Integrated Cct.; (open mfgr.) CMOS 4052BE
IC5	Integrated Cct.; (National) LM317LZ
IC6	Integrated Cct.; (National) LM337LZ
J3	DIN Connector, 8-pin PC Female; Switchcraft 62 PC 8F
J5	"XLR" Connector, PC Male; Switchcraft RAPC 3M HG
Q1,4,6	Transistor, PNP; (open mfgr.) 2N3906
Q2	Transistor, Ultra-Low-Noise NPN; Rohm 2SB 737S *(LIMITED DISTRIBUTION - may be ordered from Inovonics)*
Q3,5	Transistor, NPN; (open mfgr.) 2N3904
- - -	Meter, "VU"; Selco AL 19W (Front Adjust)

CHECK "GENERIC" SECTION FOR PARTS NOT LISTED ABOVE

997 POWER SUPPLY MODULE

C1,2	Capacitor, Electrolytic, axial leads, 1000μF, 35 VDC; Elna TE-series or equiv.
CR1	Diode, Zener, 3.6-volt; 1N5227 or equiv.
CR4-9	Diode, Rectifier, 1A; 1N4005 or equiv.
F1	Fuseholder; Littlefuse 345-611-010, with 345-601-000 cap (U.S.) or 345-621-020 cap (metric); fuse per rear-panel callout.
I1-4	LED Indicator, Diffused Pastel Green, T-1 package; Stanley MPG 3878S
IC1	Integrated Cct.; (open mfgr.) LM317T
IC2	Integrated Cct.; (open mfgr.) LM337T
- - -	AC Mains Connector; Switchcraft EAC 309
S1	Switch, 5-station pushbutton assembly; *CUSTOM PART, Inovonics Part No. 1848*
S2	Switch, DPDT Voltage Selector; C&K V202-12-MS-02-QA
T1	Power Transformer, Toroidal; Avel-Lindberg 40/3034

CHECK "GENERIC" SECTION FOR PARTS NOT LISTED ABOVE

LISTING OF "GENERIC" COMPONENT PARTS FOR ALL ASSEMBLIES

This classification identifies all components which were *not* listed under individual subassembly headings. Grouped here are those components which are used "universally" and in large quantities. In searching for a particular component description (to order a replacement, etc.), look *first* under the proper subassembly heading. If the part is *not* found there, check the following listings.

UNLESS OTHERWISE SPECIFIED:

Capacitors:

a: **Under 1.0μF** are of the metalized mylar or polyester variety; value in microfarads, ±5%, working voltage of 50 volts or more. The style used in 390/990 circuitry is the "minibox" package with a lead spacing of 0.2 inches. **Preferred mfgr.:** WIMA, MKS-2 or FKS-2 series. **Alternates:** CSF-Thompson IRD series; Panasonic ECQ-V series (values above 0.1μF require lead forming).

b: **2.2μF caps** used throughout for power supply rail bypassing, etc. are 50-volt, high reliability radial-lead electrolytic. **Preferred mfgr:** Illinois Capacitor 225 RMR 050M.

Diodes, other than rectifier and Zener diodes, are general-purpose, small-signal silicon diodes of low leakage, and with a breakdown voltage of at least 50 volts. **Preferred part:** 1N4151. **Alternates:** 1N4148, 1N914, etc. in DO-7 or DO-35 package.

Resistors:

a: **Fixed resistors** with no tolerance specified are ¼-Watt, 5%, carbon-film type; with 1% tolerance specified are ¼-Watt, 1% metal-film type. Values are in ohms; manufacturer open.

b: **Multi-Turn Trimming Potentiometers** are Beckman 89PR series or equivalent "cermet" type.

Male "Shrouded Header" connectors are 16-pin, right-angle, PC board-mounted and accept mating female ribbon-cable-ends. **Preferred parts:** 3M 929340-01-16, Circuit Assembly CA-16HLR-1C.

Female Ribbon-Cable end connectors are polarized; there is only one way they can be mated with the rear-panel male headers. When crimping onto the ribbon cable, take care to observe the same polarity convention as those supplied with the System. *Pin 01 of the female connectors is indicated with a small arrow. This should match the colored edge of the ribbon cable.* **Preferred part:** DuPont/Berg 66902-216.

Ribbon Cable to interconnect 397 Amplifier Modules with the 997 Power Supply Module has 16 *stranded* conductors and is available from a number of sources. **Suppliers:** Mouser ME172-1601; Digi-Key R022-ND; Active 58102.

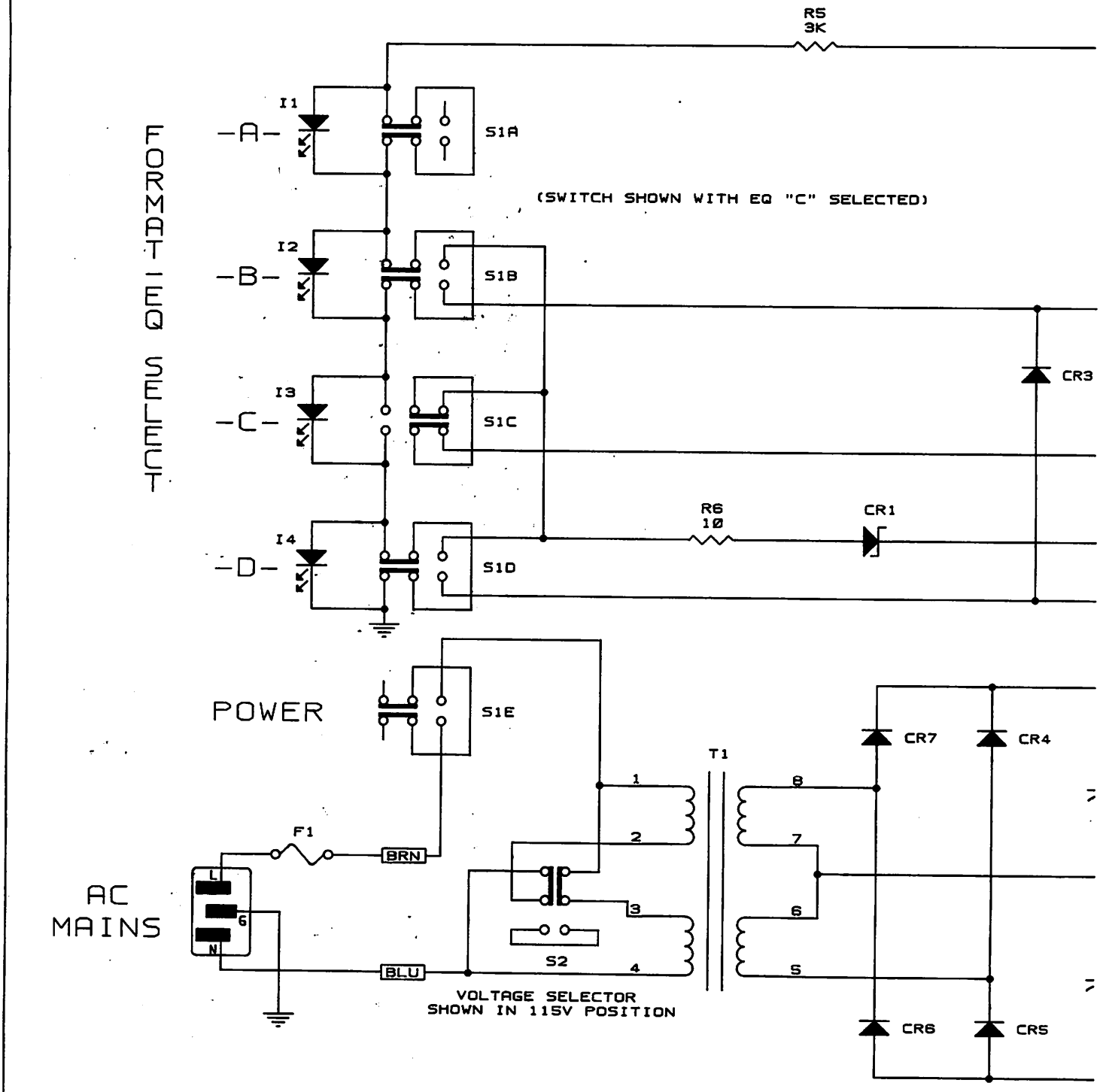
MAIL-ORDER COMPONENT SUPPLIERS

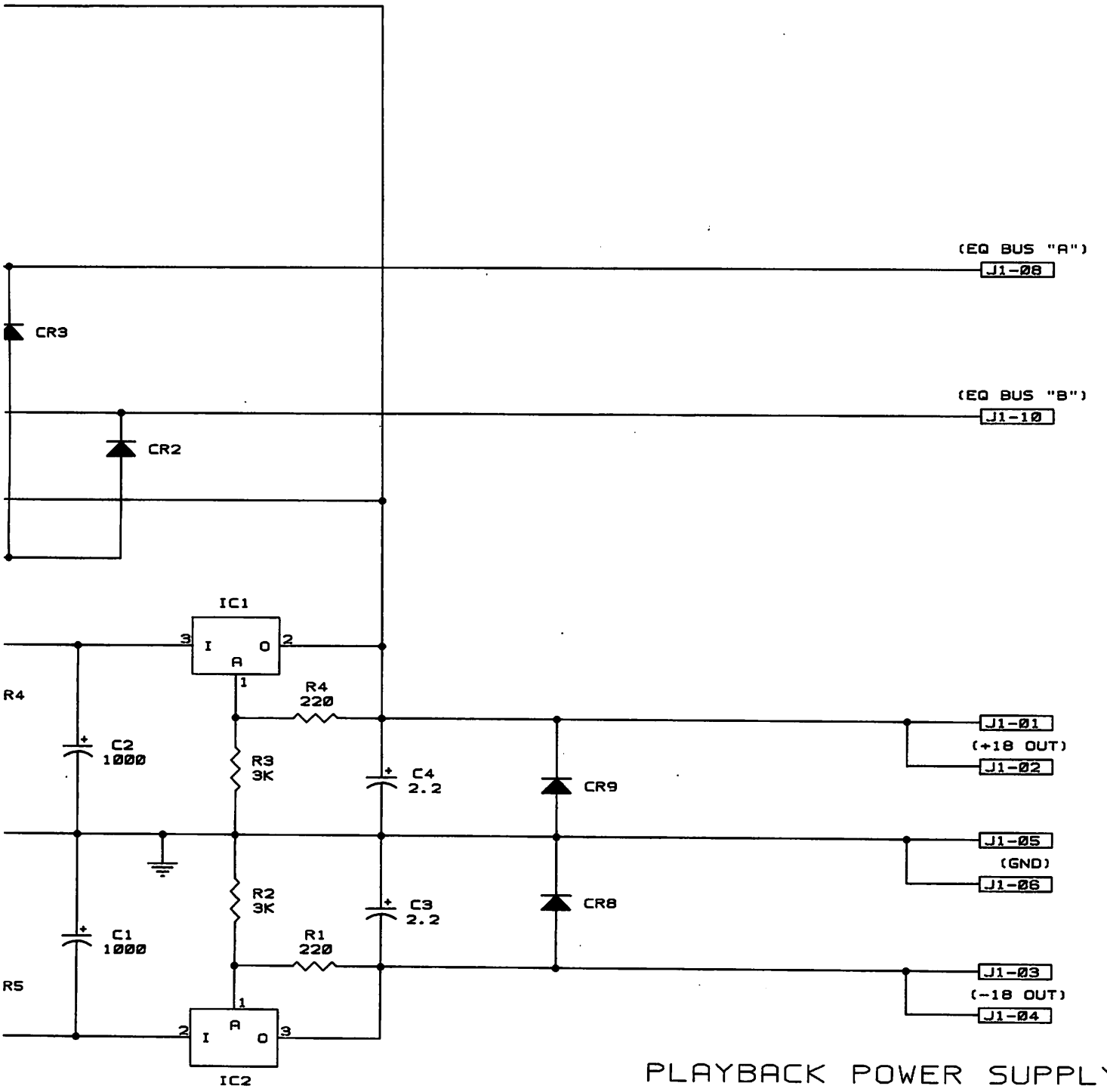
The following electronic component distributors are reputable suppliers of both large and small quantities of parts. Any semiconductor, IC, capacitor, resistor, or connector used in the 397 / 997 are available from one or more of these firms.

Mouser Electronics - Call: 1-800-34-MOUSER

Digi-Key Corporation - Call: 1-800-DIGI-KEY

ACTIVE (div. of Future Electronics) - Call: 1-800-ACTIVE-6


R5
3K
I1
-A-
S1A
(SWITCH SHOWN WITH EQ "C" SELECTED)
FORMAT EQ SELECT
I2
-B-
S1B
CR3
I3
-C-
S1C
R6
10
CR1
I4
-D-
S1D
POWER
S1E
T1
CR7
CR4
1
2
3
4
8
7
6
5
F1
BRN
AC
MAINS
L
G
N
S2
BLU
VOLTAGE SELECTOR
SHOWN IN 115V POSITION
CR6
CR5



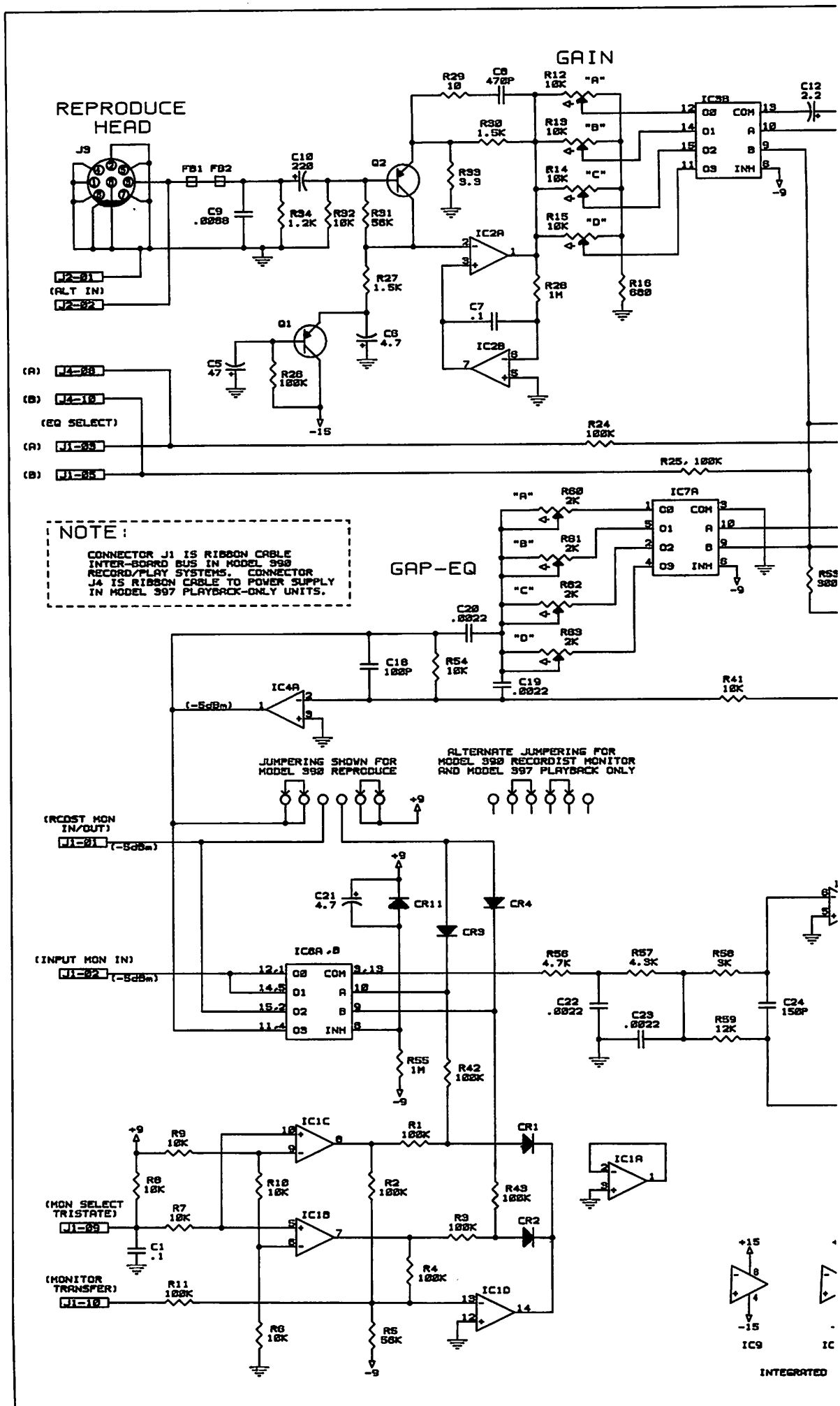
PLAYBACK POWER SUPPLY

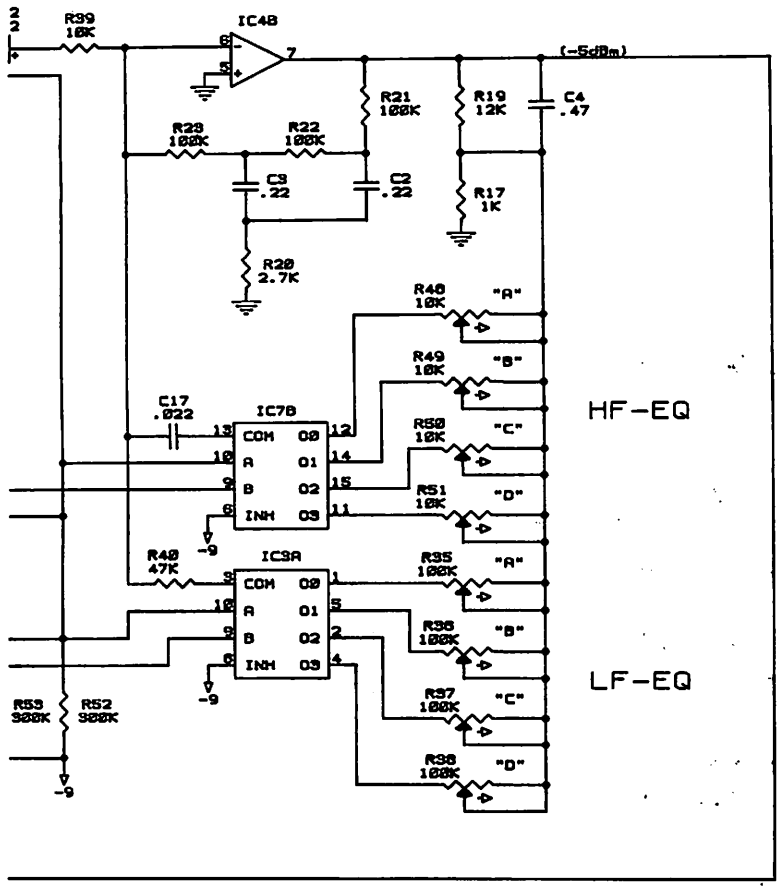
INOVONICS, INC.

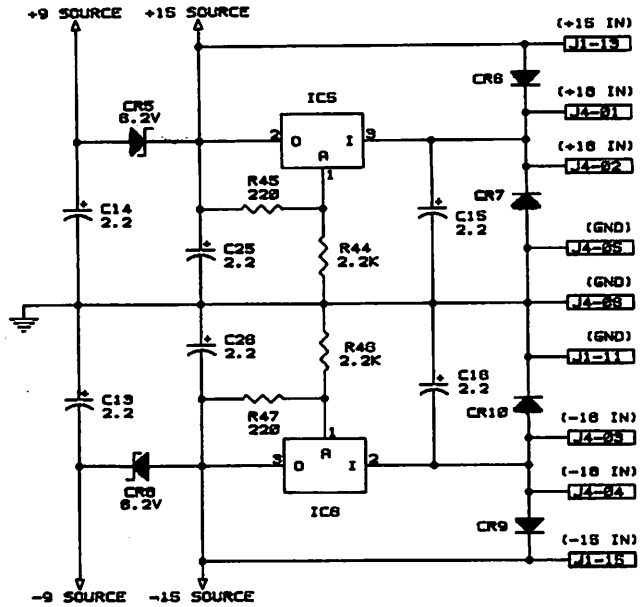
1305 Fair Avenue - Santa Cruz, CA 95060

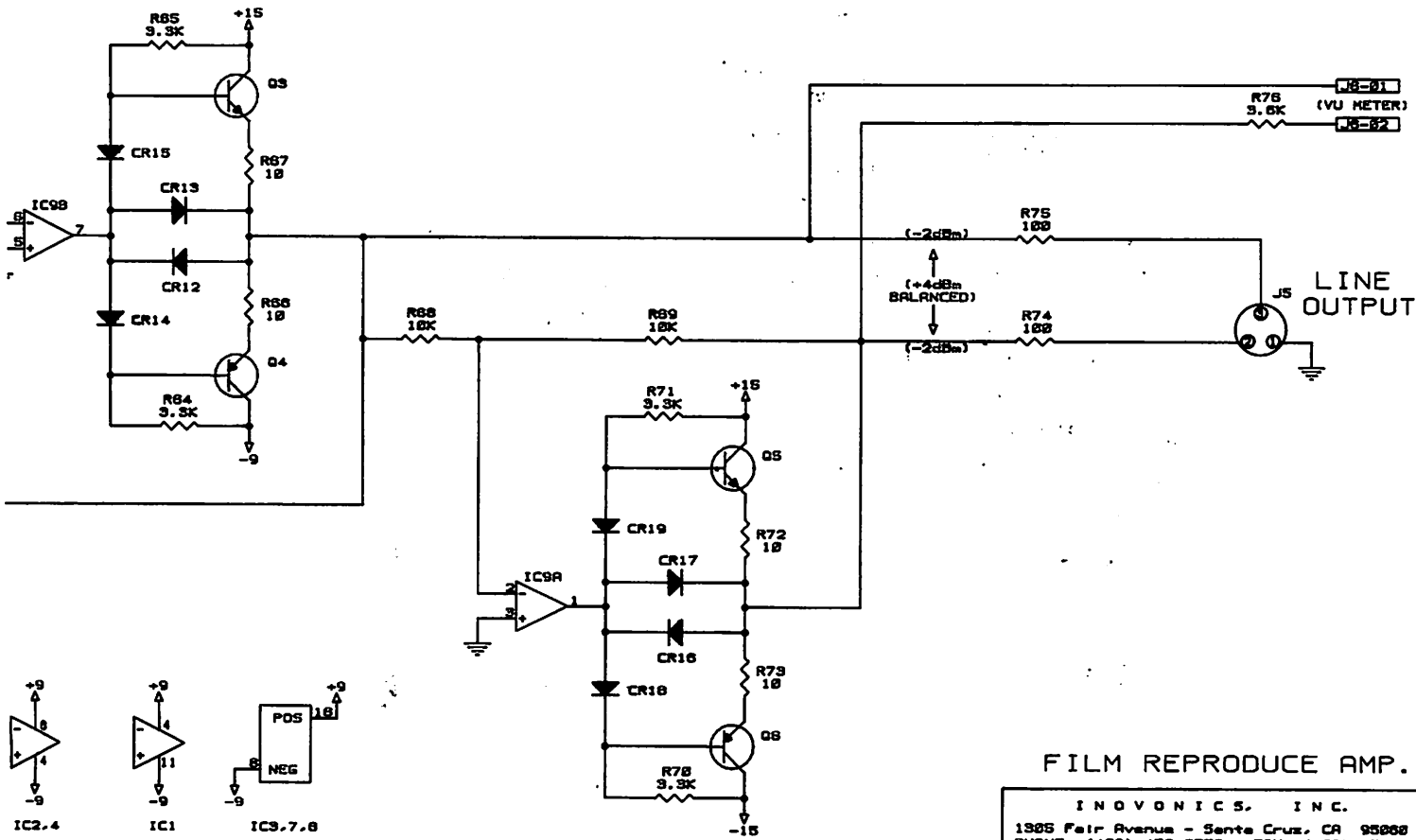
PHONE: (408)458-0552 FAX: (408)458-0554

Title: SCHEMATIC, 997 POWER SUPPLY (PLAYBACK-ONLY)		
Size: B	Document Number: 186400	REV: A
Date: June 12, 1991	Sheet 1 of 1	


GAIN
REPRODUCE HEAD
J3
FB1 FB2
C10 220
Q2
R29 10
C8 470P
R12 10K "A"
R30 1.5K
R13 10K "B"
R14 10K "C"
R15 10K "D"
IC3B
C12 2.2
R39 3.9
C9 .0068
R34 1.2K
R32 10K
R31 56K
IC2A
R27 1.5K
R28 1M
R16 680
J2-01 (ALT IN)
J2-02
C7 .1
Q1
C6 4.7
IC2B
C5 47
R26 100K
-15
(A) J4-08
(B) J4-10
(EQ SELECT)
(A) J1-09
(B) J1-05
R24 100K
R25. 100K
NOTE:
CONNECTOR J1 IS RIBBON CABLE INTER-BOARD BUS IN MODEL 990 RECORD/PLAY SYSTEMS. CONNECTOR J4 IS RIBBON CABLE TO POWER SUPPLY IN MODEL 397 PLAYBACK-ONLY UNITS.
GAP-EQ
"A" R60 2K
"B" R61 2K
"C" R62 2K
"D" R63 2K
IC7A
C20 .0022
C18 100P
R54 10K
C19 .0022
R41 10K
IC4A
(-5dBm)
JUMPERING SHOWN FOR MODEL 990 REPRODUCE
ALTERNATE JUMPERING FOR MODEL 990 RECORDIST MONITOR AND MODEL 397 PLAYBACK ONLY
(RCDST MON IN/OUT) J1-01 (-5dBm)
C21 4.7
CR11
CR4
CR3
(INPUT MON IN) J1-02 (-5dBm)
IC8A,B
R56 4.7K
R57 4.3K
R58 3K
C22 .0022
C23 .0022
C24 150P
R59 12K
R55 1M
R42 100K
IC1C
R1 100K
CR1
R9 10K
R8 10K
R10 10K
R2 100K
R49 100K
IC1A
(MON SELECT TRISTATE) J1-03
R7 10K
IC1B
R3 100K
CR2
C1 .1
R4 100K
(MONITOR TRANSFER) J1-10
R11 100K
IC1D
R6 10K
R5 56K
+15
-15
IC9
INTEGRATED







ED CIRCUIT POWER CONNECTIONS

FILM REPRODUCE AMP.

INOVONICS, INC.
1305 Fair Avenue - Santa Cruz, CA 95060
PHONE: (408) 458-0552 FAX: (408) 458-0554

Title: SCHEMATIC, 398 / 397 REPRODUCE BOARD		
Size: C	Document Number: 164200	REV: A
Date: June 12, 1991	Sheet 1 of 1	

INOVONICS WARRANTY

I **TERMS OF SALE:** Inovonics products are sold with an understanding of "full satisfaction"; that is, full credit or refund will be issued for products sold as new if returned to the point of purchase within 30 days following shipment, provided that they are returned in "as-shipped" condition.

II **CONDITIONS OF WARRANTY:** The following terms apply unless amended *in writing* by Inovonics, Inc.

A. Warranty Registration Card supplied with product *must* be completed and returned to the factory within 10 days of delivery.

B. Warranty applies only to products sold "as new." It is extended only to the original end-user and may not be transferred or assigned.

C. Warranty does not apply to damage caused by misuse, abuse or accident. Warranty is voided by unauthorized attempts at repair or modification, or if the serial identification has been removed or altered.

III **TERMS OF WARRANTY:** Inovonics, Inc. products are warranted to be free from defects in materials and workmanship.

A. Any discrepancies noted within 90 days of the date of delivery will be repaired free of charge, or the equipment will be replaced at the option of Inovonics.

B. Additionally, parts for repairs required between 90 days and one year from the date of delivery will be supplied free of charge. Labor for *factory* installation of such parts will be billed at the prevailing "shop rate."

IV **RETURN OF GOODS FOR FACTORY REPAIR:**

A. Equipment *will not be accepted* for Warranty or other repair without a Return Authorization (RA) number issued by Inovonics prior to its return. An RA number may be obtained by calling the factory, and should be prominently displayed on the outside of the shipping carton.

B. Equipment must be shipped *prepaid* to Inovonics. Shipping charges will be reimbursed for valid Warranty claims. Damage sustained as a result of improper packing for return to the factory is *not* covered under terms of the Warranty, and may occasion additional charges.