OPERATING AND MAINTENANCE INSTRUCTION MANUAL

MODEL 630

FM RELAY RECEIVER

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INOVONICS INCORPORATED

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OPERATING AND MAINTENANCE INSTRUCTION MANUAL

MODEL 630

FM RELAY RECEIVER

February, 1997

INOVONICS INCORPORATED

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Section I

INTRODUCTION

MODEL 630 PRODUCT DESCRIPTION

General Inovonics' Model 630 is a frequency-agile FM "Relay" Receiver intended for single-channel translator (re-broadcast) service and for other professional applications requiring high quality off-air program pickup. The receive frequency is user-programmable over the FM broadcast band in 100kHz increments.

The 630 has two outputs: a conditioned composite "baseband" output which may be fed directly to the broadband input of an FM exciter, and balanced program line outputs which provide demodulated left- and right-channel stereo audio.

Features Features of the Inovonics 630 include:

- Wide/narrow IF bandwidth which may be locally or remotely selected.
- A noise-reducing "blend" function for the demodulated program audio output which may be locally or remotely enabled.
- Automatic output muting and over-deviation limiting circuits to protect the re-broadcast signal.
- Alarms with remote outputs for low incoming RF and for loss of program audio.
- Local and remote measurements of incoming signal level and multipath distortion for accurate antenna orientation.
- Accurate front-panel metering of relevant signal levels.

MODEL 630 TECHNICAL SPECIFICATIONS

Receiver Sensitivity:
10µV for 50dB stereo SNR with WIDE IF.

Receiver Selectivity:
WIDE IF: –6dB at ±150kHz;
NARROW IF: –6dB at ±75kHz.
(See Figure 1, below.)

Stereo Separation:
WIDE IF: >45dB (typically 50dB), 20Hz–15kHz;
NARROW IF: Typically 20dB, 20Hz–15kHz.

Distortion (in baseband signal or demodulated audio):
WIDE IF: <0.3% THD;
NARROW IF: <3% THD.

Composite Baseband Output:
Adjustable between 2V p-p and 5V p-p; 75-ohm source impedance, unbalanced.

Program Line Outputs:
Left and right channel active-balanced outputs deliver 0dBm into 600 ohms at ±75kHz deviation.

Frequency Response (of demodulated program audio):
±0.5dB, 20Hz–15kHz

Noise (in demodulated stereo program audio):
Better than 60dB below ±75kHz deviation with 250µV or greater RF input.

Remote Control Logic:
Individual contact closures to ground initiate forced-mono reception, select narrow IF bandwidth, defeat output muting and defeat the "blend" feature.

Remote Alarm Provision:
Open-collector NPN transistors saturate to ground for loss of carrier and for loss of program audio.

Power Requirements:
105–130VAC or 210–255VAC, 50/60Hz; 15 watts.

Size and Weight:
1¾"H x 19"W x 7"D (1U);
7 lbs (shipping).

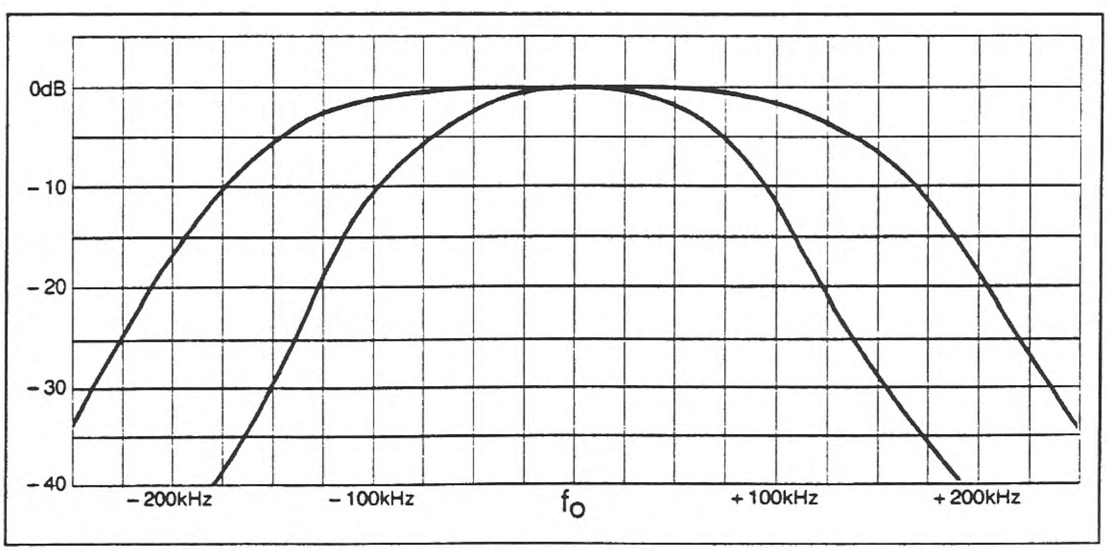
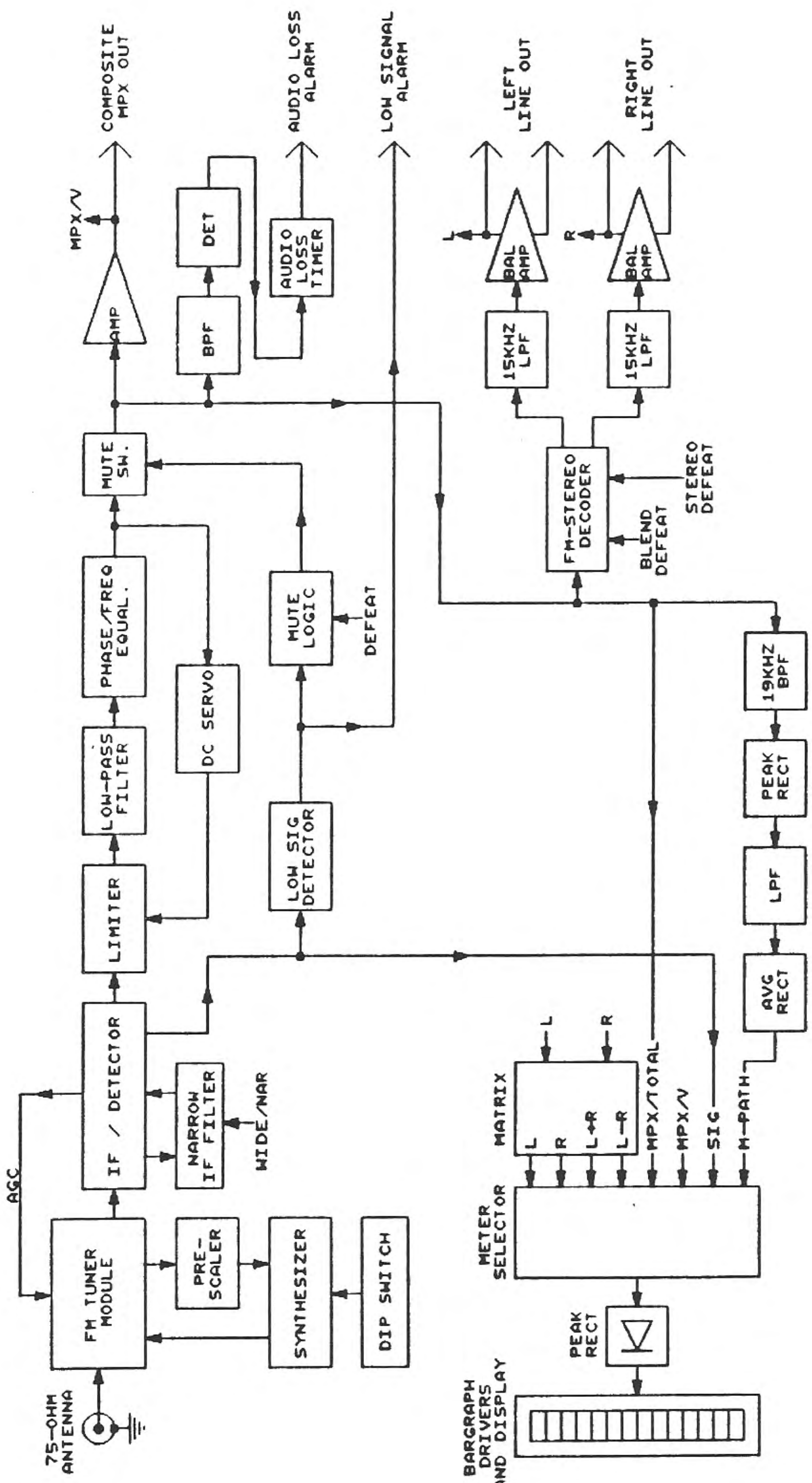


Figure 1 - Receiver RF/IF Bandwidth, WIDE and NARROW Modes.

BLOCK DIAGRAM

A simplified Block Diagram of the Model 630 is shown below. Receiver circuitry is explained in detail in the Circuit Descriptions starting on Page 22, which reference Schematic Diagrams found in the Appendix.



Section II

INSTALLATION AND CONNECTION

UNPACKING AND INSPECTION

Immediately upon receipt of the equipment, inspect carefully for any shipping damage. If damage is suspected, notify the carrier at once, then contact Inovonics.

It is recommended that the original shipping carton and packing materials be saved for future reshipment. In the event of return for Warranty 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 Inovonics.

MOUNTING

Rack Requirement

Inovonics' Model 630 is packaged to mount in a standard 19-inch equipment rack and requires only 1¾ inches (1U) of vertical rack space. The use of plastic "finishing" washers is recommended to help protect the painted finish around the mounting holes.

Heat Dissipation

Consuming far less power than an electric coffee grinder, heat generated by the 630 is insignificant. The unit is specified for operation within an ambient temperature range extending from freezing to 120°F/50°C. Because adjacent, less efficient equipment may radiate substantial heat, be sure that the equipment rack has sufficient ventilation to keep the temperature below the stated maximum.

AC (MAINS) POWER

As Delivered

Unless specifically ordered for export shipment, the Model 630 is set at the factory for operation from 115V, 50/60Hz AC mains. The rear-panel designation next to the fuseholder will confirm both the mains voltage selected and the value of the fuse supplied.

Voltage Selector

A mains voltage selector switch is located beneath the top cover of the unit and adjacent to the AC mains connector on the circuit board.

With primary AC power disconnected, you may slide the red actuator with a small screwdriver so that the proper mains voltage (115 or 230) is visible. You must always install an appropriate fuse, and check that the rear-panel voltage/fuse designation is properly marked. It is factory practice to cross-out the *inappropriate* designation with an indelible black marking pen. You can remove this strikethrough with solvent to redesignate.

BE SURE that the mains voltage selector setting and primary fuse value are appropriate for the mains supply before plugging the 630 into the wall outlet.

Power Cord

The detachable IEC-type power cord supplied with the 630 is fitted with a North-American-standard male plug. The individual cord conductors are *supposed* to be color-coded in accordance with CEE standards; that is:

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

RADIO FREQUENCY INTERFERENCE (R F I)

Location

Although we anticipate installation of the 630 in the immediate proximity of broadcast transmitters, you should practice care in locating the unit away from *abnormally* high RF fields. This includes the exercise of common sense when locating the receive antenna as well. (See additional installation comments in the following Antenna Considerations subsection.)

Ground Loops

With some installations a mains frequency or RF ground loop may be formed between the antenna or output cable shield grounds and the AC power cord ground. Use of a "ground-lifting" AC adapter may remedy the situation, though the chassis ultimately must be returned to earth ground for safety. Generally, being screwed-down in the equipment rack will satisfy the safety requirement.

ANTENNA CONSIDERATIONS

The 630 has a rear-panel "F" connector for the receiving antenna. This is a 75-ohm unbalanced input which should be fed with 75-ohm foil-shielded coax cable. Appropriate cable and the "F" connector are standard items with consumer cable-TV equipment in the U.S. and should be readily available. If the "F" connector is foreign to your area, feel at liberty to replace it with a more common type.

The Receiving Antenna

Almost by definition, FM relay (translator) installations are in the fringe of the primary broadcast reception area. This means that a high-gain, directional receiving antenna must be used if the re-transmitted signal is to maintain full broadcast quality. This is particularly important when composite-baseband is re-broadcast directly. SCA and RDS subcarriers can be degraded, even when the stereo program *sounds* fine.

A number of professional FM receiving antennas are available to broadcasters, and no doubt your preferred equipment distributor can be coerced into making a recommendation. Be sure to check antenna impedance, however. A 50-ohm antenna will require a "balun" matching transformer to properly match a 75-ohm feedline and the antenna input of the Model 630.

Residential FM antennas should not be ignored for translator receivers. Something equivalent to the *Radio Shack®* (Tandy) 15-2163 is a quite acceptable "low-end" choice, and some of the so-called "deep fringe" consumer FM antennas are really quite good. Many in this category will exhibit a 300-ohm impedance and will require an appropriate balun, such as the popular 300/75 matching balun used for cable connections to older TV sets.

Input Filters

Installations which co-locate the re-broadcast receiving and transmitting antennas may require installation of a notch filter "trap" in the Model 630 antenna feed. This keeps the transmitter from desensitizing (or completely "blocking"!) the receiver. The closer the receive and transmit frequencies, the more likely this is to be a problem. The "tuned-cavity" trap will probably prove best for this job.

PROGRAMMING THE RECEIVE FREQUENCY

The 630 is tuned by programming the SET FREQ. "DIP" switch beneath the top cover. This is located on the circuit board directly behind the front-panel headphone jack. A programming chart is affixed to the inside of the top cover and shows the DIP-switch settings for each 100kHz frequency increment between 87.9Mhz and 108.1MHz. A copy of this chart also appears in the Appendix of this Manual on Pages 28 and 29.

The chart has eleven columns of switch settings. These are labeled A through K and correspond to the first eleven DIP-switch positions which are similarly labeled in the circuit board legend to the right of the switch. Each column of the chart contains a 0 or a 1, signifying OFF or ON, also labeled on the circuit board.

Use a ballpoint pen or small screwdriver to set the switches. To program a 0, push the switch actuator down-to-the-left, or *away* from the large synthesizer chip, IC39. To program a 1, push the switch actuator down-to-the-right, or *toward* IC39. Figure 2, below, illustrates Model 630 programming for a receive frequency of 103.1MHz.

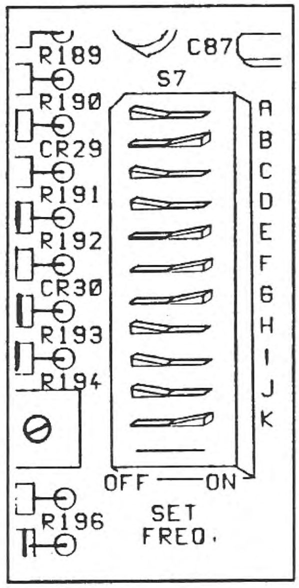


Figure 2 - DIP-Switch Programming for 103.1MHz Station Reception

DE-EMPHASIS SELECTION

The rear-panel left- and right-channel PROGRAM LINE OUTPUT follows the transmission de-emphasis characteristic. Either the 50- or the 75-microsecond curve may be selected. The factory setting is proper for the shipment destination, if this destination is known at the time of shipping.

De-emphasis selection is made with jumper programming beneath the top cover. Two jumper strips, labeled JMP2 and JMP3 in the circuit-board legend, are located about three inches behind the front-panel MUTE switch. Legend markings designate the proper jumper position for either 75 or 50 (microsecond) operation. Figure 3, below, illustrates the two jumpering options.

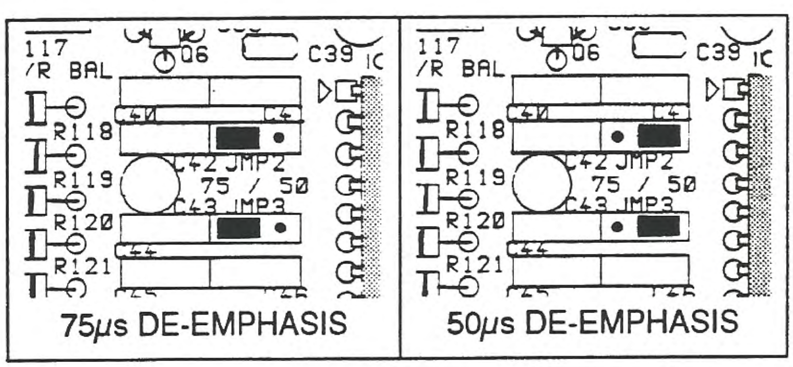


Figure 3 - Program De-emphasis Jumpering

AUDIO LOSS DELAY JUMPERING

The 630 signals a remote alarm for loss of program audio. The delay between the loss of audio and the alarm output may be set for one, two or four minutes of "dead air." This selection is made with a jumper selection beneath the top cover. The factory setting is for a 1-minute delay.

The jumper strip, labeled JMP1, is located about an inch behind, and midway between, the FAULT indicators and the STEREO switch. The circuit board legend shows the jumper positions for the three timing delays. Figure 4, below, illustrates the three jumpering options.

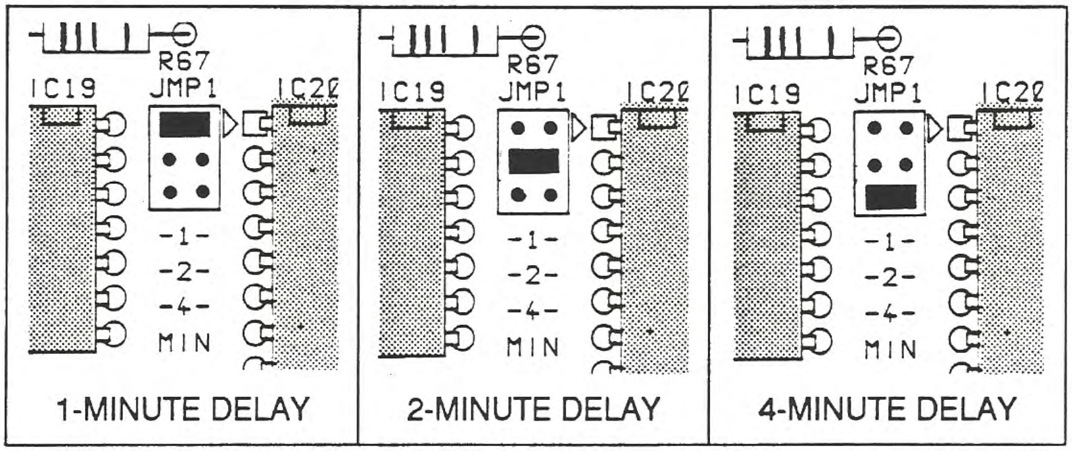


Figure 4 - Program Audio Loss Alarm Delay Jumpering

THE COMPOSITE MPX OUTPUT

The composite or "baseband" output is a conditioned, amplified, wideband output taken directly from the FM detector. It contains the multiplex stereo program signal along with any SCA, RDS, and/or high-speed data subcarriers. The rear-panel "BNC" connector labeled COMPOSITE MPX OUTPUT is an unbalanced output with a source impedance of 75 ohms. Cable runs from this output should be kept as short as possible, consistent with providing isolation between the Model 630 receiver and the re-broadcast transmitter. The 630 is capable of driving 75-ohm cables up to about 100 feet in length. Excessive cable length can degrade performance, not the worst of which is a loss in stereo separation.

The COMPOSITE MPX OUTPUT is variable between 2 volts p-p and 5 volts p-p, and is adjusted by the front-panel MPX OUTPUT LEVEL control. The instantaneous peak value of the received signal at the rear-panel connector may be observed by setting the front-panel multimeter to MPX / OUTPUT VOLTS P-P and referencing the lower (volts) scale.

"Conditioning" of the COMPOSITE MPX OUTPUT signal consists of low-pass filtering and peak-excursion limiting. The low-pass filter is amplitude- and phase-flat to 100kHz, serving mainly to eliminate noise components outside the baseband spectrum. A peak clipping circuit in the output signal path is factory-set to restrict program peaks in excess of 130% modulation (±100kHz deviation). This restricts deviation of the re-broadcast transmission in the event of gross overdeviation or other problems with the off-air feed.

THE STEREO PROGRAM LINE OUTPUT

The demodulated left- and right-channel stereo line outputs appear at a 6-position terminal block on the rear panel. This connector is labeled PROGRAM LINE OUTPUT with the LEFT and RIGHT channels identified, as well as the + and – signal terminals and a G (ground) terminal for each of the stereo channels. The screw-terminal part of the block may be unplugged from the chassis; simply grab the portion which protrudes and pull it straight out. Having a removable terminal block makes connecting easier and affords a quick disconnect for servicing.

The PROGRAM LINE OUTPUT is active-balanced with a resistive source impedance of 200 ohms. At 100% modulation (±75kHz deviation) this output will drive a 600-ohm load to approximately 0dBm. This is a *fixed* level and is *not* affected by the front-panel MPX OUTPUT LEVEL control.

The PROGRAM LINE OUTPUT may be connected to transformer-balanced or active-balanced inputs. Should you require an *unbalanced* output from the 630, use only the + and G terminals from each channel, *do not ground* the unused – terminal.

REMOTE CONTROL INPUTS AND ALARM OUTPUTS

A 16-position terminal block affords access to the various logic inputs and outputs of the 630 Receiver. Like the PROGRAM LINE OUTPUT connector, this terminal block unplugs from the chassis.

Alarm Outputs

The 630 has alarm output "tallies" for two major fault conditions: loss of program audio (AUDIO LOSS) and loss of carrier (LOW SIG). The alarm outputs are redundant to the similarly-designated front-panel LED indicators. The fault conditions are detailed in Section III under Panel Controls and Indicators, starting on Page 13.

Each alarm output is an open-collector NPN transistor which saturates to ground when an alarm condition occurs. The transistor has a breakdown of at least 40 volts and can sink up to 100 milliamps. Whatever is connected to the alarm output must supply its own voltage and "seek" chassis ground from the 630. Adjacent GND (ground) terminals establish the ground reference. If the output represents more than a 100-milliamp load, the use of an intermediate relay is recommended. Any inductive load (such as a relay coil) should include its own protection against induced back-EMF. This usually takes the form of a parallel diode properly connected with regard to polarity.

Remote Control Inputs

Four of the operating options may be remotely selected. These are: the narrow IF bandwidth (IF NAR), defeat of the "mute" function (MUTE DEF), defeat of the "blend" function (BLEND DEF), and "forced monaural" operation (STER DEF). These options are discussed in Section III: Panel Controls and Indicators.

Each of the remote control inputs has a 10K-ohm "pullup" resistor to an internal +9-volt supply rail. A contact closure (or NPN transistor saturation) to ground will initiate the command. Adjacent GND terminals furnish a ground reference.

Analog Metering Outputs

To help locate and align the receive antenna, two analog DC voltages have been brought to the rear panel. These are labeled SIG LVL and MPTH LVL and are proportional to the front-panel multimeter measurements of signal strength and multipath distortion, respectively. The DC levels at these outputs are in the 1-volt range.

Like the front-panel meter indications, the DC levels at these terminals reflect *relative* measurements of the signal and multipath values. The idea is to temporarily run these lines to the antenna site where they can be monitored with a hand-held multimeter. As the antenna is aimed (rotated and angled up and down) the direct effect on signal strength and multipath distortion can be conveniently factored into the alignment procedure.

Section III

PANEL CONTROLS AND INDICATORS

This section describes the function and operation of all front-panel controls as they appear, left-to-right, on the front of the 630. Discussions in this section also explain how and when certain functions are used, plus other factors which apply to everyday operation. Please, at least skim this section to verify that our terminology agrees with your understanding, and to see what we had in mind when certain functions were incorporated into the 630 design.

POWER

Rather than risk insulting our esteemed, technically-adept users, we have chosen to omit an explanation of this switch function.

"MULTIMETER"

A 27-segment bargraph display monitors several parameters of the incoming signal. Metering exhibits peak response to signal waveforms for all measurements.

The up/down switch to the right of the display cycles the metering circuit among the measurement selections. A row of LEDs below the bargraph indicates the function being measured. These are:

L — Left program channel audio*.

R — Right program channel audio.*

L+R — Left-plus-right (stereo sum) program audio.*

> * <u>*PLEASE NOTE*</u> that L, R and L+R program audio measurements will have a 100%-modulation, 0dB reference *only* when the incoming carrier is deviated to ±75kHz by a *monaural* test signal with a frequency *below* the influence of transmission de-emphasis. Stereo transmissions will have a –1dB reference, assuming 10% modulation of the carrier by the 19kHz stereo pilot.

L–R — Left-minus-right (stereo difference) program audio. This measurement will generally remain below –10dB with typical stereo programming.

	MPX TOTAL MOD %	This is a *fixed* measurement of carrier modulation and references the upper (percentage modulation) scale. While the 630 lacks the accuracy, resolution and proper ballistics of a true FM "Mod-Monitor," this reading will give a quite accurate indication of incoming carrier deviation to the nearest 5%.
	MPX OUTPUT VOLTS P-P	This measurement shows the *loaded* peak-to-peak voltage at the rear-panel COMPOSITE MULTIPLEX OUTPUT connector. This voltage level is read on the lower (volts) meter scale and reflects the setting of the front-panel MPX OUTPUT LEVEL control. Though this reading will follow program modulation, the peak value shown will be useful in setting the MPX OUTPUT LEVEL to an approximate figure required by the re-broadcast exciter input.
	SIGNAL	Signal strength of the incoming carrier is shown with this metering selection. This is a *relative measurement only* and none of the meter scales applies. Use this measurement to align the receive antenna for maximum signal and to monitor signal variations due to weather, other miscellaneous acts of God, and totally inexplicable phenomena.
	MULTI- PATH	This selection gives a quantitative readout of multipath distortion in the received signal. Like, the SIGNAL measurement, MULTIPATH is a *relative* reading. This measurement is useful in orienting the antenna to minimize multipath effects.
FAULT	LOW SIGNAL	Whenever the received signal falls to a level of approximately 10μV, a LOW SIGNAL alarm is registered. This lights the LOW SIGNAL front-panel FAULT indicator and provides a remote-alarm ground at the rear-panel LOW SIG terminal. Alarm logic also operates the optional MUTE function. This circuit has a certain amount of built-in hysteresis. Once a low-signal condition is sensed, the incoming carrier must return to approximately 20μV to reset the alarm and un-mute the outputs.

AUDIO LOSS An extended loss of program audio will light the AUDIO LOSS indicator. L+R (stereo sum) program audio must remain below –20dB (10% modulation) for the 1, 2 or 4 minute pre-programmed delay. (See Audio Loss Delay Jumpering on Page 10.) Loss of audio also applies ground to the rear-panel AUDIO LOSS terminal for a remote alarm.

MULTI-PATH This indicator is associated with multipath distortion measurement circuitry. It is calibrated to light whenever the level of multipath distortion exceeds a value which has been shown to compromise acceptable stereo (and subcarrier) performance.

STEREO

The STEREO switch simply defeats the stereo decoder circuitry for the left- and right-channel program line outputs *only*. It has *no effect* on the composite-multiplex output signal. A ground applied to the rear-panel STER DEF terminal will also place the 630 in a forced-mono reception mode. The front-panel DEFEAT and ENABLE LEDs will always indicate the actual reception mode, whether selected by the front-panel switch or by the rear-panel terminal.

In normal STEREO / ENABLE operation, the yellow LED at the far-right of the STEREO switch lights when a stereo broadcast is received.

BLEND

This feature is part of the stereo decoder circuitry. It has *no effect* on the composite-multiplex output, only on the *demodulated* left and right program audio outputs.

This "blend" function is a bit more sophisticated than the similar feature incorporated into consumer automobile FM receivers. Most simple circuits merely blend stereo programming to monaural as the carrier *level* drops. The 630 decoder instead samples *noise* in the 53kHz to 100kHz composite spectrum to determine how much of the stereo program should be blended to mono to lessen the audible noise in the demodulated output. This feature can help maintain audio quality when conditions deteriorate due to weather, etc. It can be locally defeated by the BLEND switch, or remotely by grounding the rear-panel BLND DEF terminal. In either case, the ENABLE and DEFEAT indicators will show the function status.

MUTE

With the MUTE switch set to ENABLE, both the composite-multiplex output and the left- and right-channel program line outputs are muted when a fading carrier triggers a LOW SIGNAL alarm. (See discussion under FAULT indicators.)

This MUTE function may be locally disabled by setting the front-panel switch to DEFEAT, or remotely by grounding the rear-panel MUTE DEF terminal. The ENABLE and DEFEAT indicators confirm circuit status. The yellow LED to the far-right of the switch signals a "muted" condition.

IF BANDWIDTH

IF bandwidth, nominally WIDE or NARROW, determines receiver selectivity. WIDE is the normal operating mode with best distortion and stereo separation specifications. (See Specifications, Page 4.)

NARROW bandwidth should be used only when strong adjacent-channel interference is encountered. The NARROW mode degrades stereo separation to about 20dB! Also, harmonic distortion in NARROW can reach 2% or more, and intermodulation between program audio and any subcarriers may render the subcarrier service unusable.

The front-panel IF BANDWIDTH switch sets the selectivity characteristics with LED verification of selection. When the switch is left in the WIDE position, a ground applied to the rear-panel IF NAR terminal will change the selectivity to NARROW and light the appropriate LED.

MPX OUTPUT LEVEL

This multi-turn control sets the level of the composite-multiplex output signal at the rear-panel COMPOSITE MPX OUTPUT connector. The peak-to-peak output level may be observed with the bargraph multimeter (as it is being adjusted) by selecting MPX / OUTPUT VOLTS P-P metering.

PHONES

Buffered left- and right-channel program audio is fed to the front-panel PHONES jack. This level is preset for a headphone volume which should be adequate for identifying and qualifying the received program signal. Either 8-ohm or medium-impedance "professional" headphones may be plugged into this jack.

Section IV

CALIBRATION

The Model 630 Relay Receiver does not require routine calibration. In normal operation the 630 can be expected to maintain its specification over an indefinite period.

Should a catastrophic failure occur, necessitating replacement of component parts in critical circuits, return to proper operation may be confirmed by following the adjustment procedure given below.

Equipment Required

- **Dual-Trace Oscilloscope** — 5mV sensitivity, 20Mhz bandwidth, 10:1 probe.
- **RF Generator** — FM-stereo test signal source with internal audio modulation, accurate deviation readout, and a variable, calibrated RF output. This should be a "laboratory-grade" instrument, not some dusty old derelict from a TV repair shop.
- **Digital Multimeter**
- **AC Voltmeter** — with dB scaling.
- **Audio Distortion (THD) Analyzer**
- **Audio Generator** — 20Hz–20kHz range; variable output.
- **Frequency Counter** — capable of exact frequency measurement to 5Mhz.
- **"Precision" FM-Stereo Demodulator** — station Mod-Monitor with input for composite-baseband signal. (Must be able to resolve separation to at least 50dB.)

Power Supply Check

1. Apply power to the 630.
2. Check that the positive and negative 9-volt regulated supplies are between 8.5V and 9.0V. You can check these on pin 8 (positive) and pin 4 (negative) of any 8-pin IC, *except IC38.*
3. Check the +5-volt supply on pin 3 of the synthesizer IC, IC39. This should measure between 4.5V and 5.0V.
4. Check for +3V on pin 8 of the prescaler IC, IC38. This should measure between 2.9V and 3.2V.
5. Check the LED supply. Measure between pin 3 (+) and pin 2 (–) of IC2. The voltage should read between 20V and 24V.

Synthesizer PLL Frequency

Using a low-capacitance 'scope probe, monitor pin 26 of IC39 with the frequency counter. Adjust C96 for exactly 3.2000MHz.

Tuner and IF Adjustments

1. Turn the front-panel MUTE and BLEND switches to DEFEAT and the IF BANDWIDTH to WIDE.
2. Set the receive frequency to mid-band: 98.1MHz. From top-to-bottom (A through K) of programming DIP switch S7, this is: 11111101110. ("1" is ON, or down-to-the-right; "0" is OFF, or down-to-the-left)
3. Set the RF Generator to the same frequency of 98.1MHz and feed it to the antenna input of the Model 630.
4. Set the bargraph metering to read SIGNAL (RF signal strength) and apply full output from the RF Generator. This should drive the bargraph display to the 0dB point. Then *decrease* the output until the 0dB LED just goes out.
5. Modulate the RF Generator with a 400Hz *monaural* test signal at 100% modulation (±75kHz deviation). (This must be *monaural* modulation *without* the 19kHz stereo pilot.)
6. Monitor the rear-panel COMPOSITE MPX OUTPUT with the Oscilloscope and Audio Distortion Analyzer. Set the front-panel MPX OUTPUT LEVEL control for an output of 4 volts p-p.
7. Adjust quadrature coil L3 for a peak in the waveform level and a null in the indicated THD. Distortion at full modulation should be under 0.25%.

Mute Level Cal

This adjustment procedure directly follows the preceding one.

1. Set the front-panel MUTE switch to ENABLE.
2. Reduce the RF Generator output to exactly 10μV. Make sure that this is the *loaded* level which is actually applied to the rear-panel 75-OHM ANTENNA connector.
3. Set trim control R149 at a point where the MUTE and the LOW SIGNAL indicators just come on. Check circuit hysteresis. As the RF Generator output level is turned up and down, the indicators should turn on at 10μV and off at approximately 20μV.

Composite-Baseband Equalization

1. Reset the RF Generator to the "nearly full" RF output level (just under 0dB SIGNAL bargraph indication) and 100% monaural modulation at 400Hz. Monitor pin 14 of the stereo decoder, IC29, with the AC Voltmeter.
2. Adjust R187 for 400mV r.m.s. After this is adjusted disconnect the ACVM.
3. Connect the rear-panel COMPOSITE MPX OUTPUT of the Model 630 to the composite-baseband input of the Modulation Monitor. Adjust the MPX OUTPUT LEVEL control of the Model 630, and/or the input level control of the Mod-Monitor, for a Total (peak) Modulation indication of 100% (±75kHz deviation).
4. Reset the RF Generator for stereo transmission, audio modulation frequency to 1.5kHz. The 630 should indicate stereo reception. If

necessary, decrease the *audio modulation level* of the RF Generator to maintain 100% total modulation (±75kHz deviation).

5. Set the RF Generator for left-channel-only modulation, and the Mod-Monitor to show stereo separation.
6. Adjust R195 and R176 for best L-into-R separation at 1.5kHz as shown by the Mod-Monitor. These controls do interact, so keep repeating the adjustments for the best reading.
7. Check separation also at 150Hz and at 15kHz. The optimum setting at 1.5kHz should be good at all frequencies. Nonetheless, if separation is not quite flat with frequency, R195 and R176 may be adjusted to a "compromise" setting for best overall separation performance.
8. Check R-into-L separation also. Since there is nothing in the Model 630 circuitry (to this point) which could cause asymmetrical separation, *question the instrumentation* if separation is *not* symmetrical.
9. Following this series of adjustments you may disconnect the Mod-Monitor.

Demodulation Separation

This next procedure should directly follow the preceding one. The adjustments which have just been completed (best stereo separation in the composite-baseband signal as measured with an external, "precision" demodulator) ensure frequency and phase flatness at the COMPOSITE MPX OUTPUT. The following adjustment optimizes separation performance of the internal stereo decoder circuitry only and does not affect the COMPOSITE MPX OUTPUT.

1. Reset the RF Generator for 100% left-channel-only modulation at 1.5kHz.
2. Monitor the driven channel at the rear-panel LEFT PROGRAM LINE OUTPUT with the AC Voltmeter using the + and G (ground) output terminals for an unbalanced feed to the ACVM. The unloaded left-channel output should measure approximately –5dBu.
3. Shift the AC Voltmeter to the undriven, right-channel output (+ and G). Adjust trimmer capacitor C52 for best separation (lowest right-channel measurement).
4. Check right-into-left separation also. If necessary, C52 may be trimmed for a "compromise" adjustment which gives a symmetrical midrange (1.5kHz) separation measurement.

Line Output and Meter Calibration

1. With the RF Generator output set to the "nearly full" point, apply 100% (±75kHz) *monaural* modulation at 400Hz. 100%-modulation of the RF Generator should be trustworthy since metering precision depends on this accuracy.
2. Monitor both the LEFT and the RIGHT channels of the PROGRAM LINE OUTPUT with the AC Voltmeter. Use the + and G (ground)

terminals for an unbalanced feed to the ACVM. At 100% *monaural* modulation each channel should measure about –4dBu.

3. R117 trims the gain of the left program channel. Adjust R117 so that both channels measure precisely the same value. The absolute figure is not terribly important; just make sure that both channels are matched in level.
4. Adjust R46 for a front-panel L meter reading of 0dB. R46 should be set to the point where the 0dB meter segment just stays on steadily.
5. Similarly, adjust R47 for a 0dB R meter reading.
6. *NOTE:* L+R and L–R metering requires no adjustment. The L+R level should read 0dB with 100% monaural modulation, L–R should remain off-scale (below –20dB).
7. Adjust R48 for 100% in the MPX / TOTAL MOD % metering mode. R48 should be set to the point where the 100% meter segment just stays on steadily.
8. Monitor the rear-panel COMPOSITE MPX OUTPUT connector with the oscilloscope. Adjust the front-panel MPX OUTPUT LEVEL control for a 4-volt peak-to-peak output waveform. Adjust R49 for a reading of 4V on the front panel in the MPX / OUTPUT VOLTS P-P metering mode.
9. While observing the front-panel meter in the SIGNAL mode, advance the output of the RF Generator to maximum. This should cause, at most, one additional bargraph segment to light. From this maximum output level, it should be possible to *decrease* the output of the RF Generator by *at least 10dB* before the top-most segment goes out. With the output level of the RF Generator reset at maximum, adjust R50 for a 0dB meter indication. (*NOTE:* the measurement of incoming RF signal level is only *relative*, dB-scaling does not apply. 0dB is just an arbitrary reference which denotes a maximum input level.)
10. *NOTE:* The MULTI-PATH metering function is factory-calibrated with a special multipath simulator. R51 may safely be left as factory-set, or adjusted so that the MULTI-PATH measurement goes just off-scale (below –20dB) when the Model 630 is tuned to a *very*-nearby, lightly-processed station received with a directional antenna.

Multipath Filter Tuning

1. Disconnect the RF Generator from the input of the Model 630 Receiver. With the MUTE switch set to ENABLE, both the MUTE indicator and the FAULT / LOW SIGNAL indicators should be on.
2. Using clip leads, connect the "high" side of the Audio Generator output to the left-hand end of R53. This is the end of the 20k-ohm resistor closest to the cluster of six meter calibration trimpots. Clip the "low" side of the Audio Generator output to chassis ground.

3. Using the Frequency Counter, set the Audio Generator to exactly 18.9kHz. Adjust the Audio Generator output level to approximately –20dBu, or about 220mV p-p as measured with the Oscilloscope at the clip lead connection.

4. Monitor the right-hand end of R80 with the Oscilloscope using the 10:1 probe. The is rectified DC from the filter circuit and will be on the order of +3 volts.

5. Adjust R52 for a peak in the DC level.

6. Increase the Audio Generator frequency to exactly 19.1kHz. Adjust R68 for a peak in the DC level.

7. Slowly tune the Audio Generator between 18kHz and 20kHz. The DC level should indicate that the filter passband is symmetrically centered around the 19kHz stereo pilot frequency.

Section V

CIRCUIT DESCRIPTIONS

This section details circuitry of the Inovonics Model 630 FM "Relay" Receiver. Circuit descriptions refer to the three pages of Schematic Diagrams contained in the Appendix, Section VI, Pages 33, 34 and 35.

Component Annotation

Component reference designations on the schematics at first may appear to be annotated in a somewhat haphazard manner. Rather than annotate the *schematic* in a logical sequence, we have instead chosen to designate the *components on the circuit board* following their physical placements, top-to-bottom, left-to-right. It is our expectation that this practice will prove most useful during any required troubleshooting, making it easier to locate the physical part or test point from an analysis of the circuit diagram.

RF / IF / DETECTOR SECTION (Schematic Sheet 1)

Tuner Module

TUN1 is a commercially-produced FM "front end" chosen for its good stability and dynamic performance. It is varactor-tuned and includes RF amplification, a low-noise local oscillator, a balanced mixer and wideband filters at the 10.7MHz IF frequency. The dense and critical internal construction of this module rather precludes field servicing. We recommend complete replacement of the module in the very unlikely event of its failure.

Frequency Synthesizer

Synthesizer IC39 supports a 3.2MHz crystal reference oscillator which is internally divided to the 12.5kHz synthesizer loop frequency. Prescaler IC38 and additional divider stages in the synthesizer IC similarly divide the tuner's local oscillator frequency to the 12.5kHz loop value, based on the programming of DIP switch S7. Because prescaler IC38 has a fixed divide-by-8 factor, 100kHz is a "lowest common denominator," hence the narrowest channel spacing for receiver tuning. We extend our heartfelt apologies and condolences to those few surviving broadcasters in far-away places who must contend with 50kHz (or even 25kHz!) transmission offsets.

The Phase-Locked-Loop within IC39 generates the varactor tuning voltage for the front-end module. This DC value is conditioned and buffered by IC36B and associated R/C filter components.

IF Amplifier/ Detector

IC33 is a monolithic IC "IF strip" including 10.7MHz amplification and a linearized quadrature detector. An initial gain stage within IC33 is buffered by emitter follower Q11 to drive narrowband ceramic filter CF1. Analog switch sections IC32B and IC32C switch CF1 into, or out of, the IF signal path in response to local or remote IF NARROW or IF WIDE selections, respectively. Quadrature detector coil L3 utilizes unique linearization circuitry within IC33 to assure a low distortion figure for the demodulated baseband signal. The output of FM detector chip IC33 is buffered by emitter-follower Q12.

Overmodulation Clipper

IC34B imparts additional broadband gain to the composite-baseband signal. Gain of this stage is set by R187. Diodes CR29 and CR30 are biased to a figure equivalent to ±100kHz carrier deviation, or about 130% modulation. Should the incoming carrier, on-channel noise or other interference cause deviation beyond this value, IC34B will soft-clip, limiting the composite-baseband signal to prevent gross overmodulation of the translator exciter.

Low-Pass Filter, Equalization and Phase Compensation

IC34B feeds a passive low-pass filter comprising R196, L4, C85, L3, R177 and C84. This simple 4-pole filter has negligible effect below 100kHz. It is included only to remove any 10.7MHz IF leakage and to reduce noise components above 100kHz.

Gain in IC35B makes up for the 6dB loss in the low-pass filter. In addition, C83 and R195 in the feedback path of this stage give a variable first-order high-frequency boost to correct for passband droop from the ceramic IF filters and the fourth-order low-pass.

IC35A is a unity-gain stage incorporating a variable phase equalizer. This equalizer helps correct filter phase response deficiencies.

DC Servo

Since the output of FM detector IC33 is not ground-referenced, servo techniques are used to re-center the composite-baseband signal to zero-volts. IC34A compares the mean DC output level from the frequency and phase equalizers to zero-volts (ground) and applies an offsetting bias to IC34B.

MUTE Logic

IC33 yields a DC output which is (indirectly) proportional to the incoming carrier level. IC28B buffers this voltage and drives the bargraph display in the SIGNAL measurement position. This voltage is also fed to the rear-panel SIG LVL terminal to aid in orienting the receiving antenna.

IC28A compares the carrier-level DC with a fixed voltage equivalent to a 10μV carrier input. When the actual carrier level falls below 10μV, the output of IC28A toggles positive. R132 adds hysteresis to the comparator so that a 20μV carrier input is required to re-toggle the output of IC28A negative. When its output is positive, IC28A lights the front-panel LOW SIGNAL indicator, grounds the rear-panel LOW SIG terminal through Q5, and opens analog switch IC32A to mute both the composite-multiplex and the decoded stereo audio outputs.

MPX Output Amplifier

IC30B is the variable-gain output amplifier stage which includes "current booster" emitter-followers Q8 and Q9. The output amplifier drives the load through R173 which establishes the 75-ohm output impedance. Metering of the COMPOSITE MPX OUTPUT follows the buildout resistor so the effects of output loading are reflected in the front-panel bargraph reading.

STEREO DECODER (Schematic Sheet 2)

IC29 is a monolithic FM stereo decoder IC of advanced design. "Walsh Function" decoding yields very good separation, somewhat lower noise than other decoder ICs, and improved freedom from crosstalk between the stereo program and auxiliary data or audio subcarriers.

The composite-multiplex signal is fed to IC29 through R139. R139 is shunted by variable capacitor C52, a separation trim adjustment. L1, C58 and C57 set the PLL free-run frequency which quickly locks to the 19kHz stereo pilot.

Stereo Defeat

A "forced mono" mode is enabled with the front-panel switch or by a remote command. When IC21 toggles positive, Q7 turns on and inhibits PLL operation.

"Blend"

"Blend" is a technique commonly employed in consumer FM receivers to minimize noise under adverse reception conditions. Since the L–R stereo difference signal is an amplitude-modulated component of the composite baseband, stereo reception is invariably noisier than mono, even under ideal reception conditions. "Blend" merely mixes the stereo program gradually to mono as reception conditions deteriorate.

A common and elementary blending approach simply narrows the stereo image as the input carrier level drops. While this is satisfactory for car radios, it does not take into consideration other mechanisms which may compromise receiver noise performance in stereo. IC29 monitors noise in the composite-baseband spectrum above the L+R and L–R stereo program components. As the noise level increases, IC29 proportionally blends the stereo program to mono.

The "blend" function may be defeated with the front-panel switch or by a remote command. When the output of IC21B toggles positive, Q6 turns on. This upsets the bias level of the blending circuitry and prevents its operation.

De-Emphasis, Filtering and Stereo Program Outputs

European 50-microsecond and U.S. 75-microsecond de-emphasis characteristics are both supported by the Model 630. The appropriate characteristic is selected by circuit-board jumpering; this procedure is covered on Page 9 under Installation and Connection.

The de-emphasized program signal undergoes further low-pass filtering to remove residual 19kHz stereo pilot and any subcarriers. IC24, IC25, IC26 and IC27 comprise a fifth-order, active/elliptic low-pass filter network with a cutoff just above the 15kHz audio passband.

IC23 buffers the output of the low-pass filters and drives one side of the balanced line output. IC23B, the buffer for the left-channel output, includes R117. This is a trim adjustment to balance the two stereo channels. The complementary phase for the balanced outputs is supplied by inverter IC22.

IC40 gives additional gain to the stereo program signal, specifically to provide adequate headphone volume at the front-panel jack.

AUDIO LOSS AND MULTIPATH ALARMS (Schematic Sheet 2)

Audio Loss Alarm

The composite-baseband signal is fed to IC30A. This amplifier stage includes a first-order band-pass filter to isolate the L+R (mono) program audio component. The band-pass characteristic favors frequencies in the voice range, eliminating most non-legitimate program components.

Band-passed audio is presented to comparator IC31A. So long as legitimate program audio remains above approximately 10% modulation, the output of the comparator stays high. This gives a continuous reset to the counter section of IC20, an oscillator/counter which times the program audio loss. If audio remains below the 10% modulation threshold for more than the 1-, 2- or 4-minute period jumpered (see Page 10), flip-flop IC19A is set. This initiates the front-panel and remote alarms.

Multipath Measurement

The composite-baseband signal is delivered to IC14, IC15 and IC16. These comprise a two-stage, stagger-tuned bi-quad filter centered at 19kHz. The output of this filter is full-wave-rectified by CR17 and CR18. The resultant DC is low-passed by the R76/C21 and R77/C22 passive networks, and further filtered by active low-pass stage IC18B. This filtering effectively removes any traces of the 19kHz pilot, plus higher-order audio components still within the passband of the bi-quad filter.

One manifestation of multipath distortion is that it causes intermodulation between program audio frequencies and the 19kHz stereo pilot. In other words, the pilot is envelope (amplitude) modulated by program audio. Filtered DC from the rectified pilot should have no AC component when the received carrier is free from multipath. One exception involves "composite clipping" ahead of the FM exciter, this clipping acting on the stereo pilot as well as on audio processor and filter overshoots. Some early composite clippers did not provide pilot protection; modern composite processors do.

The filtered DC derived from the stereo pilot is AC-coupled through C18 to full-wave, averaging rectifier IC17. The output of IC17B assumes a DC value proportional to multipath distortion. Multipath is quantitatively displayed by the front-panel bargraph meter. Comparator IC18A lights the front-panel warning indicator when multipath exceeds an "acceptable" value.

The output of IC17B is also fed to the rear-panel MPTH LVL terminal. This voltage, proportional to multipath distortion, may be monitored at the antenna site to aid in orienting the antenna.

BARGRAPH METER (Schematic Sheet 3)

Metering Selection Front-panel selector switch S2 controls up/down counter IC12. "Up" or "down" pulses from the switch are de-bounced by Schmitt NAND gates IC13C and IC13D, and fed to the clock input of the counter. IC13B, active only on "down" pulses, determines the counter's direction. IC13A gives a "power-on reset" pulse to preset the counter to the center (MPX / TOTAL MOD %) position.

The binary address from IC12 is decoded by two one-of-eight analog multiplexers. IC1 illuminates an LED indicating the function being metered, IC11 routes the selected signal to the metering circuit. IC9A and IC9B matrix left- and right-channel program audio, yielding L+R and L–R stereo sum-and-difference signals, respectively.

Meter Rectifier IC10A buffers the selected input signal and imparts broadband gain. IC5A, IC5B, associated diodes and buffer IC7A constitute a full-wave, peak-responding rectifier. The peak value is held by C9 with R19 determining the discharge (meter fallback) rate. The peak value is buffered by IC7B and delivered to the bargraph display drivers, IC2, IC3 and IC8.

Bargraph Display Cascaded display drivers (IC2, IC3 and IC8) are operated in the "dot," rather than the "bar" display mode. This means that only *one* output of each IC sinks current at any given time. The fact that the LEDs are in *series* means that the entire string of LEDs associated with any driver draws no more current than when a single LED is lighted. This clever trick saves a good deal of power! Hey, are we Green, or what?

A small amount of 60Hz AC from the power transformer secondary is mixed-in with the DC value fed to the display drivers. This "dithers" the display between adjacent bargraph segments, making some degree of measurement interpolation possible and giving a smoother visual effect.

POWER SUPPLIES (Schematic Sheet 1)

Most of the Model 630 Receiver circuitry operates from a bipolar 9-volt supply. The positive and negative supplies are regulated by linear "three-terminal" IC voltage regulators: IC4 for the +9-volt supply, IC6 for the –9-volt supply.

IC37 is an additional 3-terminal positive voltage regulator providing +5 volts for the synthesizer prescaler chip.

Q1 and Q2 maintain a 24-volt differential supply nominally labeled +12V and –12V. This elevated voltage is required to illuminate the series-connected LED bargraph segments.

The Model 630 power transformer has dual primary windings which may be switched in parallel or in series for 115V or 230V mains, respectively.

Section VI

APPENDIX

The following section of this Manual contains a copy of the Frequency Programming Chart for the Inovonics 630 Relay Receiver, Parts Lists, Schematic Diagrams of all electronic circuitry, and an explanation of Inovonics' Warranty Policy.

MODEL 630 FREQUENCY PROGRAMMING CHART

The following tabulation gives the frequency-selection DIP-switch programming code for each FM channel between 87.9MHz and 108.1MHz. This chart also appears on the inside of the top cover of the Model 630. See the instructions for frequency programming on Pages 8 and 9.

Freq..	A	B	C	D	E	F	G	H	I	J	K
87.9	1	0	1	0	0	1	0	0	0	0	1
88.0	0	0	1	0	0	1	0	0	0	0	1
88.1	1	1	0	0	0	1	0	0	0	0	1
88.2	0	1	0	0	0	1	0	0	0	0	1
88.3	1	0	0	0	0	1	0	0	0	0	1
88.4	0	0	0	0	0	1	0	0	0	0	1
88.5	1	1	1	1	1	0	0	0	0	0	1
88.6	0	1	1	1	1	0	0	0	0	0	1
88.7	1	0	1	1	1	0	0	0	0	0	1
88.8	0	0	1	1	1	0	0	0	0	0	1
88.9	1	1	0	1	1	0	0	0	0	0	1
89.0	0	1	0	1	1	0	0	0	0	0	1
89.1	1	0	0	1	1	0	0	0	0	0	1
89.2	0	0	0	1	1	0	0	0	0	0	1
89.3	1	1	1	0	1	0	0	0	0	0	1
89.4	0	1	1	0	1	0	0	0	0	0	1
89.5	1	0	1	0	1	0	0	0	0	0	1
89.6	0	0	1	0	1	0	0	0	0	0	1
89.7	1	1	0	0	1	0	0	0	0	0	1
89.8	0	1	0	0	1	0	0	0	0	0	1
89.9	1	0	0	0	1	0	0	0	0	0	1
90.0	0	0	0	0	1	0	0	0	0	0	1
90.1	1	1	1	1	0	0	0	0	0	0	1
90.2	0	1	1	1	0	0	0	0	0	0	1
90.3	1	0	1	1	0	0	0	0	0	0	1
90.4	0	0	1	1	0	0	0	0	0	0	1
90.5	1	1	0	1	0	0	0	0	0	0	1
90.6	0	1	0	1	0	0	0	0	0	0	1
90.7	1	0	0	1	0	0	0	0	0	0	1
90.8	0	0	0	1	0	0	0	0	0	0	1
90.9	1	1	1	0	0	0	0	0	0	0	1

Freq.	A	B	C	D	E	F	G	H	I	J	K
91.0	0	1	1	0	0	0	0	0	0	0	1
91.1	1	0	1	0	0	0	0	0	0	0	1
91.2	0	0	1	0	0	0	0	0	0	0	1
91.3	1	1	0	0	0	0	0	0	0	0	1
91.4	0	1	0	0	0	0	0	0	0	0	1
91.5	1	0	0	0	0	0	0	0	0	0	1
91.6	0	0	0	0	0	0	0	0	0	0	1
91.7	1	1	1	1	1	1	1	1	1	1	0
91.8	0	1	1	1	1	1	1	1	1	1	0
91.9	1	0	1	1	1	1	1	1	1	1	0
92.0	0	0	1	1	1	1	1	1	1	1	0
92.1	1	1	0	1	1	1	1	1	1	1	0
92.2	0	1	0	1	1	1	1	1	1	1	0
92.3	1	0	0	1	1	1	1	1	1	1	0
92.4	0	0	0	1	1	1	1	1	1	1	0
92.5	1	1	1	0	1	1	1	1	1	1	0
92.6	0	1	1	0	1	1	1	1	1	1	0
92.7	1	0	1	0	1	1	1	1	1	1	0
92.8	0	0	1	0	1	1	1	1	1	1	0
92.9	1	1	0	0	1	1	1	1	1	1	0
93.0	0	1	0	0	1	1	1	1	1	1	0
93.1	1	0	0	0	1	1	1	1	1	1	0
93.2	0	0	0	0	1	1	1	1	1	1	0
93.3	1	1	1	1	0	1	1	1	1	1	0
93.4	0	1	1	1	0	1	1	1	1	1	0
93.5	1	0	1	1	0	1	1	1	1	1	0
93.6	0	0	1	1	0	1	1	1	1	1	0
93.7	1	1	0	1	0	1	1	1	1	1	0
93.8	0	1	0	1	0	1	1	1	1	1	0
93.9	1	0	0	1	0	1	1	1	1	1	0

Freq.	A	B	C	D	E	F	G	H	I	J	K
94.0	0	0	0	1	0	1	1	1	1	1	0
94.1	1	1	1	0	0	1	1	1	1	1	0
94.2	0	1	1	0	0	1	1	1	1	1	0
94.3	1	0	1	0	0	1	1	1	1	1	0
94.4	0	0	1	0	0	1	1	1	1	1	0
94.5	1	1	0	0	0	1	1	1	1	1	0
94.6	0	1	0	0	0	1	1	1	1	1	0
94.7	1	0	0	0	0	1	1	1	1	1	0
94.8	0	0	0	0	0	1	1	1	1	1	0
94.9	1	1	1	1	1	0	1	1	1	1	0
95.0	0	1	1	1	1	0	1	1	1	1	0
95.1	1	0	1	1	1	0	1	1	1	1	0
95.2	0	0	1	1	1	0	1	1	1	1	0
95.3	1	1	0	1	1	0	1	1	1	1	0
95.4	0	1	0	1	1	0	1	1	1	1	0
95.5	1	0	0	1	1	0	1	1	1	1	0
95.6	0	0	0	1	1	0	1	1	1	1	0
95.7	1	1	1	0	1	0	1	1	1	1	0
95.8	0	1	1	0	1	0	1	1	1	1	0
95.9	1	0	1	0	1	0	1	1	1	1	0
96.0	0	0	1	0	1	0	1	1	1	1	0
96.1	1	1	0	0	1	0	1	1	1	1	0
96.2	0	1	0	0	1	0	1	1	1	1	0
96.3	1	0	0	0	1	0	1	1	1	1	0
96.4	0	0	0	0	1	0	1	1	1	1	0
96.5	1	1	1	1	0	0	1	1	1	1	0
96.6	0	1	1	1	0	0	1	1	1	1	0
96.7	1	0	1	1	0	0	1	1	1	1	0
96.8	0	0	1	1	0	0	1	1	1	1	0
96.9	1	1	0	1	0	0	1	1	1	1	0

Freq.	A	B	C	D	E	F	G	H	I	J	K
97.0	0	1	0	1	0	0	1	1	1	1	0
97.1	1	0	0	1	0	0	1	1	1	1	0
97.2	0	0	0	1	0	0	1	1	1	1	0
97.3	1	1	1	0	0	0	1	1	1	1	0
97.4	0	1	1	0	0	0	1	1	1	1	0
97.5	1	0	1	0	0	0	1	1	1	1	0
97.6	0	0	1	0	0	0	1	1	1	1	0
97.7	1	1	0	0	0	0	1	1	1	1	0
97.8	0	1	0	0	0	0	1	1	1	1	0
97.9	1	0	0	0	0	0	1	1	1	1	0
98.0	0	0	0	0	0	0	1	1	1	1	0
98.1	1	1	1	1	1	1	0	1	1	1	0
98.2	0	1	1	1	1	1	0	1	1	1	0
98.3	1	0	1	1	1	1	0	1	1	1	0
98.4	0	0	1	1	1	1	0	1	1	1	0
98.5	1	1	0	1	1	1	0	1	1	1	0
98.6	0	1	0	1	1	1	0	1	1	1	0
98.7	1	0	0	1	1	1	0	1	1	1	0
98.8	0	0	0	1	1	1	0	1	1	1	0
98.9	1	1	1	0	1	1	0	1	1	1	0
99.0	0	1	1	0	1	1	0	1	1	1	0
99.1	1	0	1	0	1	1	0	1	1	1	0
99.2	0	0	1	0	1	1	0	1	1	1	0
99.3	1	1	0	0	1	1	0	1	1	1	0
99.4	0	1	0	0	1	1	0	1	1	1	0
99.5	1	0	0	0	1	1	0	1	1	1	0
99.6	0	0	0	0	1	1	0	1	1	1	0
99.7	1	1	1	1	0	1	0	1	1	1	0
99.8	0	1	1	1	0	1	0	1	1	1	0
99.9	1	0	1	1	0	1	0	1	1	1	0
100.0	0	0	1	1	0	1	0	1	1	1	0
100.1	1	1	0	1	0	1	0	1	1	1	0
100.2	0	1	0	1	0	1	0	1	1	1	0
100.3	1	0	0	1	0	1	0	1	1	1	0
100.4	0	0	0	1	0	1	0	1	1	1	0
100.5	1	1	1	0	0	1	0	1	1	1	0
100.6	0	1	1	0	0	1	0	1	1	1	0
100.7	1	0	1	0	0	1	0	1	1	1	0
100.8	0	0	1	0	0	1	0	1	1	1	0
100.9	1	1	0	0	0	1	0	1	1	1	0

Freq.	A	B	C	D	E	F	G	H	I	J	K
101.0	0	1	0	0	0	1	0	1	1	1	0
101.1	1	0	0	0	0	1	0	1	1	1	0
101.2	0	0	0	0	0	1	0	1	1	1	0
101.3	1	1	1	1	1	0	0	1	1	1	0
101.4	0	1	1	1	1	0	0	1	1	1	0
101.5	1	0	1	1	1	0	0	1	1	1	0
101.6	0	0	1	1	1	0	0	1	1	1	0
101.7	1	1	0	1	1	0	0	1	1	1	0
101.8	0	1	0	1	1	0	0	1	1	1	0
101.9	1	0	0	1	1	0	0	1	1	1	0
102.0	0	0	0	1	1	0	0	1	1	1	0
102.1	1	1	1	0	1	0	0	1	1	1	0
102.2	0	1	1	0	1	0	0	1	1	1	0
102.3	1	0	1	0	1	0	0	1	1	1	0
102.4	0	0	1	0	1	0	0	1	1	1	0
102.5	1	1	0	0	1	0	0	1	1	1	0
102.6	0	1	0	0	1	0	0	1	1	1	0
102.7	1	0	0	0	1	0	0	1	1	1	0
102.8	0	0	0	0	1	0	0	1	1	1	0
102.9	1	1	1	1	0	0	0	1	1	1	0
103.0	0	1	1	1	0	0	0	1	1	1	0
103.1	1	0	1	1	0	0	0	1	1	1	0
103.2	0	0	1	1	0	0	0	1	1	1	0
103.3	1	1	0	1	0	0	0	1	1	1	0
103.4	0	1	0	1	0	0	0	1	1	1	0
103.5	1	0	0	1	0	0	0	1	1	1	0
103.6	0	0	0	1	0	0	0	1	1	1	0
103.7	1	1	1	0	0	0	0	1	1	1	0
103.8	0	1	1	0	0	0	0	1	1	1	0
103.9	1	0	1	0	0	0	0	1	1	1	0
104.0	0	0	1	0	0	0	0	1	1	1	0
104.1	1	1	0	0	0	0	0	1	1	1	0
104.2	0	1	0	0	0	0	0	1	1	1	0
104.3	1	0	0	0	0	0	0	1	1	1	0
104.4	0	0	0	0	0	0	0	1	1	1	0
104.5	1	1	1	1	1	1	1	0	1	1	0
104.6	0	1	1	1	1	1	1	0	1	1	0
104.7	1	0	1	1	1	1	1	0	1	1	0
104.8	0	0	1	1	1	1	1	0	1	1	0
104.9	1	1	0	1	1	1	1	0	1	1	0

Freq.	A	B	C	D	E	F	G	H	I	J	K
105.0	0	1	0	1	1	1	1	0	1	1	0
105.1	1	0	0	1	1	1	1	0	1	1	0
105.2	0	0	0	1	1	1	1	0	1	1	0
105.3	1	1	1	0	1	1	1	0	1	1	0
105.4	0	1	1	0	1	1	1	0	1	1	0
105.5	1	0	1	0	1	1	1	0	1	1	0
105.6	0	0	1	0	1	1	1	0	1	1	0
105.7	1	1	0	0	1	1	1	0	1	1	0
105.8	0	1	0	0	1	1	1	0	1	1	0
105.9	1	0	0	0	1	1	1	0	1	1	0
106.0	0	0	0	0	1	1	1	0	1	1	0
106.1	1	1	1	1	0	1	1	0	1	1	0
106.2	0	1	1	1	0	1	1	0	1	1	0
106.3	1	0	1	1	0	1	1	0	1	1	0
106.4	0	0	1	1	0	1	1	0	1	1	0
106.5	1	1	0	1	0	1	1	0	1	1	0
106.6	0	1	0	1	0	1	1	0	1	1	0
106.7	1	0	0	1	0	1	1	0	1	1	0
106.8	0	0	0	1	0	1	1	0	1	1	0
106.9	1	1	1	0	0	1	1	0	1	1	0
107.0	0	1	1	0	0	1	1	0	1	1	0
107.1	1	0	1	0	0	1	1	0	1	1	0
107.2	0	0	1	0	0	1	1	0	1	1	0
107.3	1	1	0	0	0	1	1	0	1	1	0
107.4	0	1	0	0	0	1	1	0	1	1	0
107.5	1	0	0	0	0	1	1	0	1	1	0
107.6	0	0	0	0	0	1	1	0	1	1	0
107.7	1	1	1	1	1	0	1	0	1	1	0
107.8	0	1	1	1	1	0	1	0	1	1	0
107.9	1	0	1	1	1	0	1	0	1	1	0
108.0	0	0	1	1	1	0	1	0	1	1	0
108.1	1	1	0	1	1	0	1	0	1	1	0

PARTS LIST

EXPLANATION OF PARTS LISTINGS

This section contains listings of component parts used in the Inovonics 630 FM Relay Receiver. These are listed either *en-masse,* or by schematic component reference designation. The listing may, or may not, specify a particular manufacturer. When no manufacturer is called-out, the term "open mfgr." advises that any manufacturer's product is acceptable, so long as it carries the proper part number.

If a particular component is not listed at all, this means that we do not consider it a typical replacement item. Should you need to order an unlisted part, call, write or FAX the factory with a brief description and we'll do our best to figure out what you need and get it on its way to you.

PARTS LISTING

Unless specifically noted by component reference designation below, **capacitors** are specified as follows:

a) **Under 100pF** are the "dipped," or "silver" mica type; DM-15 (or CM-05 military series) size designation; "P" value is picofarads, ±5%, 200VDC; (open mfgr.).

b) **100pF to 0.47μF** are of the metalized mylar or polyester variety. Whole number "P" values are picofarads, decimal values are microfarads, ±5%, 50VDC or better. The style used in the 630 is the "minibox" package with a lead spacing of 0.2 inch. **Preferred mfgr.:** Wima MKS-2 or FKC-2 series. **Alternates:** CSF-Thompson IRD series or Roederstein KT-1808 or KT-1817 series.

c) **1.0μF and above** are radial-lead electrolytics, value per schematic, 25VDC; (open mfgr.).

C1,2	Capacitor, Ceramic Disc "Safety" Mains Bypass, .0047μF, 440VAC; Murata/Erie DE7150 F 472M VA1-KC (preferred)
C5,6	Capacitor, Electrolytic, axial leads, 1000μF, 35VDC; (open mfgr.)
C15,16,19,20, 26-37,47,48,65	Capacitor, "High-Q," .0033μF, 2.5%, 100VDC; Wima FKC-2 (Polycarbonate) preferred, any equivalent *must* have identical characteristics.
C38,78,87, 89,92,93,94	Capacitor, Monolithic Ceramic, 0.1μF, 50VDC; (open mfgr.)
C52,96	Capacitor, Variable, 5-50pF; Mouser 24AA024
CF1	"Narrow" Ceramic Filter; *SPECIAL - Inovonics Part No. 1428*
CR1-5,11	Diode, Silicon Rectifier; (open mfgr.) 1N4005
CR6-9,12-34	Diode, Silicon Signal; (open mfgr.) 1N4151 or equiv.
CR10	Diode, Zener, 22V; (open mfgr.) 1N5251

F1	Fuseholder, PC-mounting; Littlefuse 345-101-010 with 345-101-020 Cap for ¼-inch (U.S.) fuses, or 345-121-020 Cap for 5mm (European) fuses. (Fuse is normal "fast-blow" type in value specified on rear panel with reference to mains supply.)
I1-8,14,19	LED Indicator, diffused yellow, T-1 package; Stanley MAY 3378S
I9-12,15,17,20	LED Indicator, diffused pastel red, T-1 package; Stanley MVR 3378S
I,13,16,18,21	LED Indicator, diffused pastel green, T-1 package; Stanley MPG 3878S
BAR1,2	10-Segment LED-bar display module, green; Kingbright DC-10GWA
BAR3	10-segment LED-bar display module, yellow; Kingbright DC-10YWA
—	Right-angle socket for BAR1-3 (630 requires two, 14-pin and two, 16-pin.); Circuit Assembly Corp. CA-14SE-10RAC3-01 (14-pin), CA-16SE-10RAC3-01 (16-pin)
—	Pin-strip sockets for BAR1-3; E-CAM 250-1-2510-1208 (630 requires three, broken into two strips of 30)
IC1,11	Integrated Cct.; (open mfgr.) CMOS 4051B
IC2,3,8	Integrated Cct.; National Semi. LM3914N
IC4	Integrated Cct.; (open mfgr.) LM317-T (Uses Aavid 574602 B03700 Heat Fin)
IC5,7,10, 30,34,35	Integrated Cct.; Motorola MC34082P
IC6	Integrated Cct.; (open mfgr.) LM337-T (Uses Aavid 574602 B03700 Heat Fin)
IC9,14-18, 22-28, 31,36,40	Integrated Cct.; (open mfgr.) LF353N
IC12	Integrated Cct.; (open mfgr.) CMOS 4029B
IC13	Integrated Cct.; (open mfgr.) CMOS 4093B
IC19	Integrated Cct.; (open mfgr.) CMOS 4013B
IC20	Integrated Cct.; (open mfgr.) CMOS 4060B
IC21	Integrated Cct.; (open mfgr.) LM324
IC29	Integrated Cct.; Allegro A3828EA
IC32	Integrated Cct.; (open mfgr.) CMOS 4053B
IC33	Integrated Cct.; National LM1865N
IC37	Integrated Cct.; (open mfgr.) LM78L05
IC38	Integrated Cct.; NEC UPB587C
IC39	Integrated Cct.; Motorola MC145151P
J1	AC Mains Connector, PC-mounting; Switchcraft EAC303
J2	16-Position Barrier Block; PCD Co. ELFH16210 PC-mounting header with ELFP116210 plug-in screw-terminal block.
J3	6-Position Barrier Block; PCD Co. ELFH06210 PC-mounting header with ELFP06210 plug-in screw-terminal block.
J4	PC-mounting Stereo Headphone Jack; Switchcraft RN112BPC
J601	Connector, chassis-mounting male "BNC"; Amphenol 31-221
J602	Connector, chassis-mounting male "F"; Mouser 16SF062
JMP1-3	Shorting "Shunt" for 0.1-inch header strip (open mfgr.)
L1,4	Inductor, fixed, 220μH; J.W. Miller 9210-92
L2	Inductor, fixed, 10μH; Mouser 43LS105
L3	Quadrature Detector Coil; Toko BKAC-K2318HM
L5	Inductor, fixed, 560μH; J.W. Miller 9250-564

Q1,3-7,9,10,12	Transistor, NPN; (open Mfgr.) 2N3904
Q2,8,11	Transistor, PNP; (open mfgr.) 2N3906

All resistors are specified as follows:

a) **Fixed resistors** with values carried to decimal places implying a 1% tolerance (*example:* 3.01K, 10.0K, 15.0K, 332K) are ¼-watt, 1% metal film type.

b) **Fixed resistors** with values typical of 5% tolerance (example: 220, 3.3k, 10K, 270K) are ¼-watt, 5% carbon film type.

c) **Multi-Turn Trimming Potentiometers** (front-panel adjustable) are Beckman 89PR series, Tokos RJC097P series, or equivalent "cermet" types.

d) **Single-Turn Trimmers** (circuit board) are Tokos GF06U1 series or Beckman 91AR series.

S1	Switch, DPDT Slide, Voltage Selector; C&K V202-12-MS-02-QA
S2	Switch, 3-position SPDT "Center Off" Miniature Toggle; C&K 7105-S-D9-A-B-E
S3-6	Switch, 2-position SPDT Miniature Toggle; C&K 7101-M-D9-A-B-E
S7	12-position "DIP" Programming Switch; Grayhill 76SB12
S501	Switch, Power Rocker; Carling RA 911-RB-O-N
T1	Power Transformer, PC-mounting; Signal LP-20-600 or direct cross-reference
TUN1	FM "Front-End"; *SPECIAL - Inovonics Part No. 1248*
Y1	Crystal 3.200MHz; *SPECIAL - Inovonics Part No. 1238*

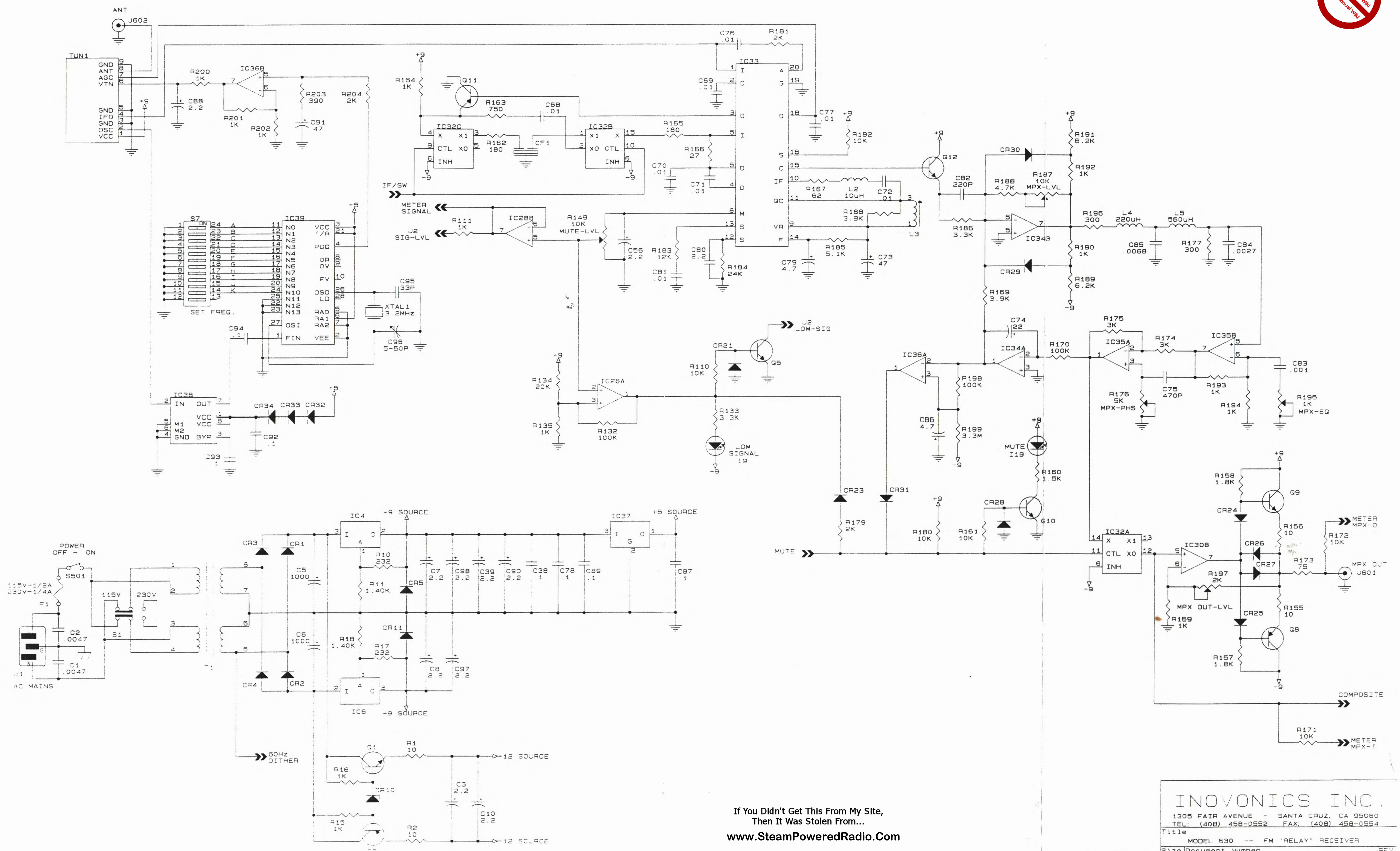
MAIL-ORDER COMPONENT SUPPLIERS

The following electronic component distributors have proven to be reputable suppliers of both large and small quantities of parts. Any semiconductor, IC, capacitor, resistor or connector used in the Model 630 is *probably* available from one or more of these firms. Each supplier publishes a full-line catalog available free for the asking.

Mouser Electronics — Call (800) 346-6873

Digi-Key Corporation — Call (800) 344-4539

ACTIVE (div. of Future Electronics) — Call (800) 677-8899



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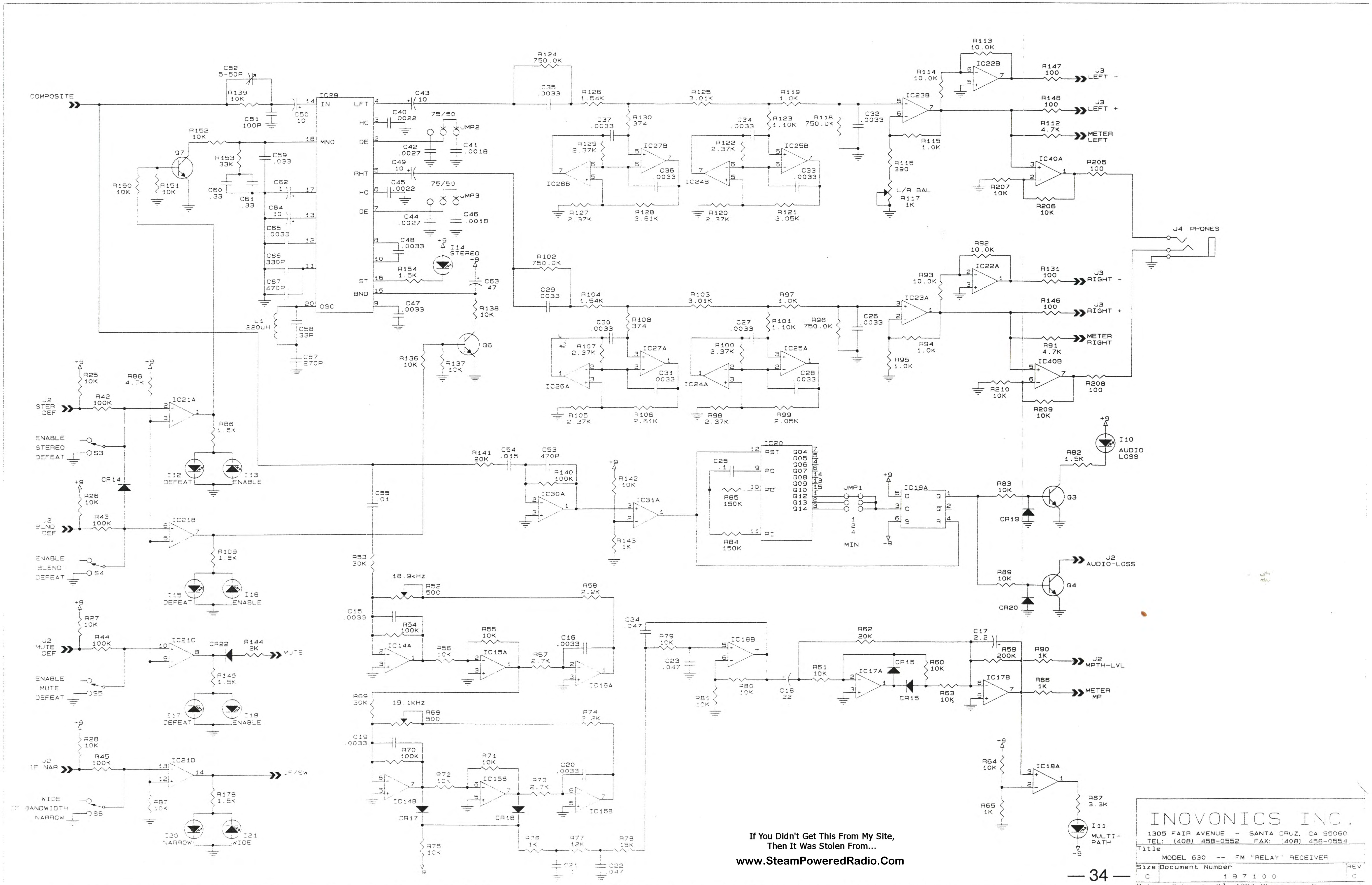

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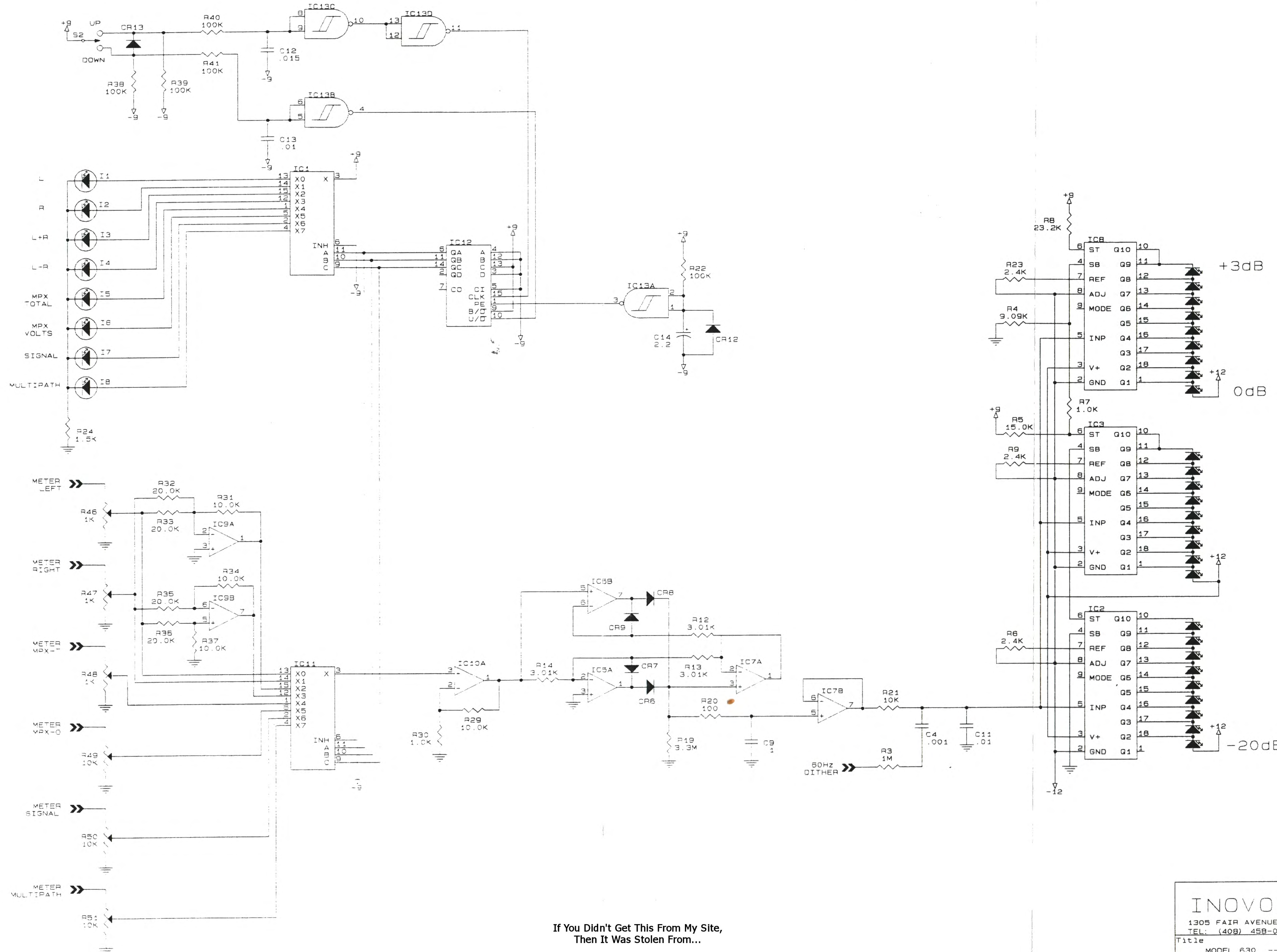

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INOVONICS WARRANTY

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.