INSTRUCTION MANUAL

MODEL 210

FREQUENCY SELECTIVE / BROADBAND PEAK LIMITER

June 1974

INOVONICS INCORPORATED
1630 DELL AVENUE CAMPBELL, CA 95008

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SECTION 1.0 GENERAL INFORMATION

The Inovonics 210 is a dual purpose gain limiting device for use in broadcast and recording applications requiring independent control of both high frequency program energy and broadband program peaks. Such applications include FM and TV (audio) broadcasting, and preparation of duplicator running masters for 8-track cartridge and cassette tapes.

Features, some unique to the Model 210, include:

Fast peak limiting with variable control of INPUT GAIN, PEAK CEILING, ATTACK, and RELEASE.

A separate frequency-selective limiter with plug-in inserts to complement a variety of high frequency overload characteristics.

Very low distortion, even at low frequencies, assured by unique open-loop gain control and ripple-cancelling circuitry.

Instant display of limiting action by peak-responding indicators. An optional remote-mounting Gain Reduction Meter may be located at the console.

1.1 SPECIFICATIONS

Frequency Response:

±0.5dB 20Hz - 20kHz

Noise:

Better than 75dB below +4dBm line output level

Distortion (THD @ +4dBm line output level with 15dB peak limiting or 10dB high freq. reduction):

	50Hz - 200Hz	200Hz - 20kHz
Peak Limiter		
SLOW Release:	0.5% max.	0.3% max.
FAST Release:	0.8% max.	0.4% max.
Freq. Sel. Limiter:	-	0.5% max.
Limiters OFF:	0.15% max., 20Hz - 20kHz @ +23dBm	

Limiter Timing:

Peak Limiter

ATTACK: Variable between 1μs and 1ms/dB-limiting

RELEASE: Variable between 6ms and 30ms/dB-limiting

Frequency Selective Limiter

ATTACK: Better than 1μs/dB-limiting

RELEASE: 50ms (max.) for any degree of reduction

Stereo Coupling:

Two or more units may be interconnected for ganged gain reduction.

Input:

Sensitivity: Accommodates program levels between -15 and +10 VU.

Impedance: 100K, unbalanced (transformer optional)

Output:

Feeds 600 ohm line or bridging input at +4 or +8dBm.

Clipping level +24dBm.

Frequency Selective Limiting Characteristic:

Plug-in inserts accommodate a wide range of common high frequency overload characteristics, or may be custom tailored to user specifications. Stock inserts include 50μs (TV audio), 75μs (FM broadcast), TAPE (1-7/8 - 3-3/4ips formats), or DE-ESS.

Power Requirement:

105 - 130VAC, 50/60Hz, 10 watts

Size and Weight:

1-3/4" X 19" X 6-1/2", 7 lbs.

Accessories:

Line Input Transformer

Remote Gain Reduction Meter

SECTION 2.0 INSTALLATION

2.1 Upon receipt of the equipment, inspect for shipping damage. If any such damage is found, notify the carrier at once; if not, proceed as outlined below. Save the original shipping carton and materials for future shipment.

2.2 The Model 210 Broadband Peak / Frequency Selective Limiter is packaged to mount in a standard 19-inch rack, requiring only 1-3/4 inches of rack space per channel.

2.3 A screw-terminal barrier strip provides connections for input, output, and optional remote-mounting Gain Reduction Meter. An additional jack permits interconnection of two or more units for ganged gain reduction.

2.4 As shipped, the Model 210 is calibrated for a +4dBm line level. Should operation with a +8dBm line be required, see Section 4.0 for recalibration procedures.

2.5 No line termination switch is provided or necessary, as the very low source impedance obviates any shift in characteristics, whether or not the output is terminated in 600 ohms. Should the equipment which feeds the Model 210 require output loading, an external 600 ohm resistor may be placed across the input terminals; otherwise, the imput impedance is a nominal "Hi-Z bridging".

SECTION 3.0 OPERATION AND FUNCTIONAL DESCRIPTION

3.1 INTRODUCTION

3.1.1 Broadcast Pre-emphasis

In order to improve the signal-to-noise ratio of FM broadcasts, and to a lesser extent that of TV audio, some degree of high frequency pre-emphasis is utilized ahead of the transmitter modulator. To restore flat frequency response, a de-emphasis network is incorporated in the reciever. Although the degree of pre-emphasis is not nearly as great in these transmission systems (75us, FM; 50us, TV) as in some magnetic recording formats, high frequency program energy can be boosted to such a level as to cause high frequency overmodulation ("splatter"), even when the the VU-indicated average level is within specified limits.

3.1.2 Tape Distortion

In order to maintain a flat frequency response with an acceptable signal-to-noise ratio at low tape speeds, it is necessary to incorporate a good deal of high frequency recording pre-emphasis. If, for instance, a 3-3/4ips recorder/reproducer is adjusted for flat overall frequency response, then input VS. output curves at various frequencies can be graphed to show the frequency selective nature of the tape saturation. Results of such a test are shown in Fig. 3-1. As can be seen in the graph, saturation occurs at a lower and lower input level as the frequency is increased. Furthermore, the saturation characteristic is in the form of a "peak", above which an input signal level increase results in an output decrease due to signal self-erasure. When this takes place superimposed on lower frequency program information (which may be well within the capability of the tape to handle) the result is severe audible distortion.

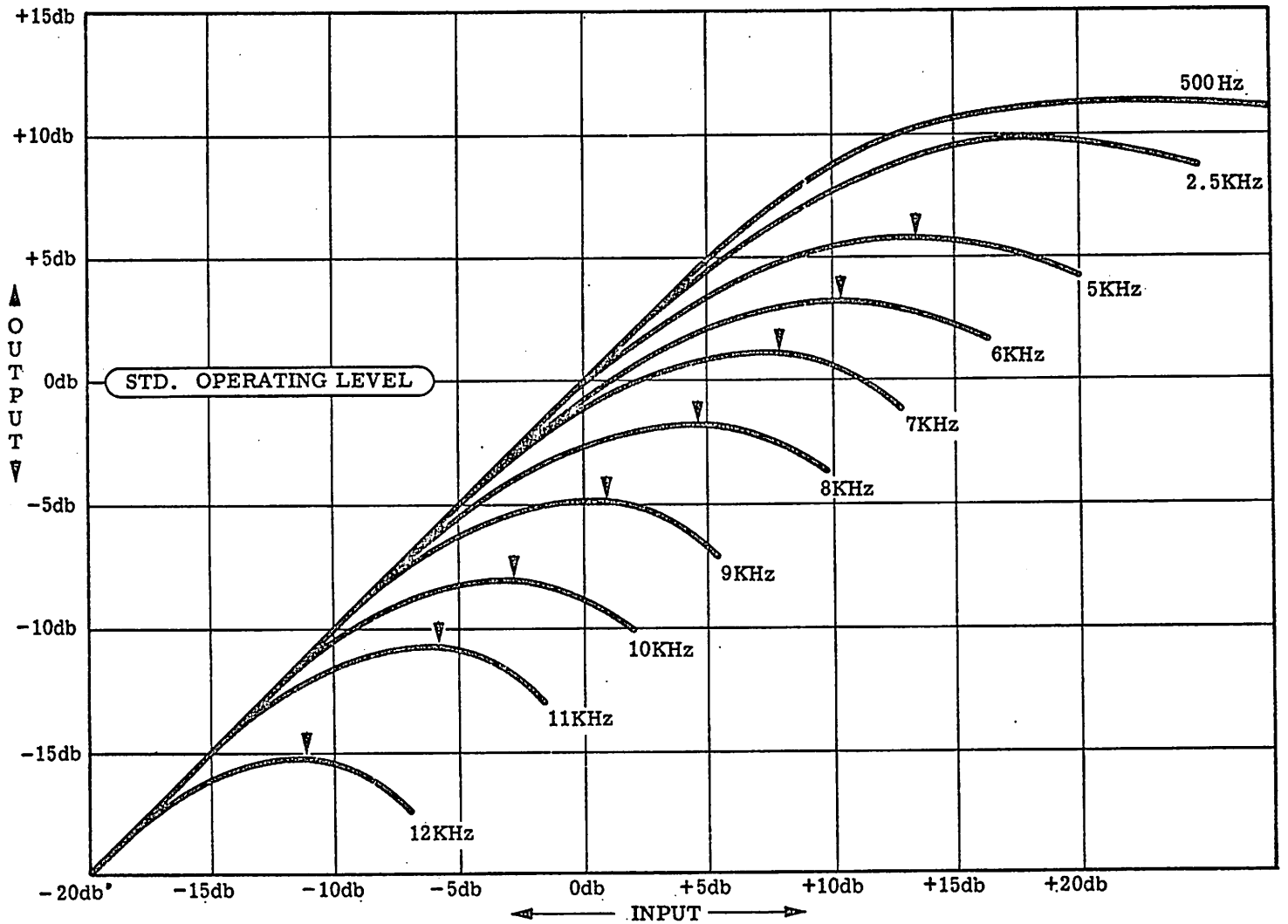


Fig. 3-1

Slow Speed Tape Saturation Characteristic

The tape saturation curves shown in Fig. 3-1 are fairly typical of characteristics encountered in both 3-3/4 and 1-7/8ips tape systems utilizing iron oxide tapes.

In both the aforementioned cases, some form of frequency selective limiting must be employed to restrict high frequency program energy to a value established by the overload characteristic of the transmission or recording system; this frequency selective limiting is in addition to the normal broadband limiting used to contain the usual program peak excursions.

Figures 3-2, 3-3, and 3-4 graph the Inovonics 210 output ceiling characteristics when adjusted to correct for high frequency overload curves of FM, TV, and slow speed tape systems. "0 VU" in these cases refers to 100% modulation or "Standard Operating Level".

3.2 OPERATION

3.2.1 The operating controls for both the broadband peak and frequency selective limiting functions are appropriately identified; however, as terminology relating to audio limiters varies, a brief description of control functions and typical use situations follows.

3.2.2 INPUT GAIN

This control is used to set the overall circuit gain at unity. Range of this control is such to adjust for program input levels between 15dB below, and 10dB above a "0 VU" program level of +4 or +8dBm. By turning this control clockwise from a unity gain setting, some degree of signal compression can be realized. However, the Inovonics 210 is intended for use as a protective device

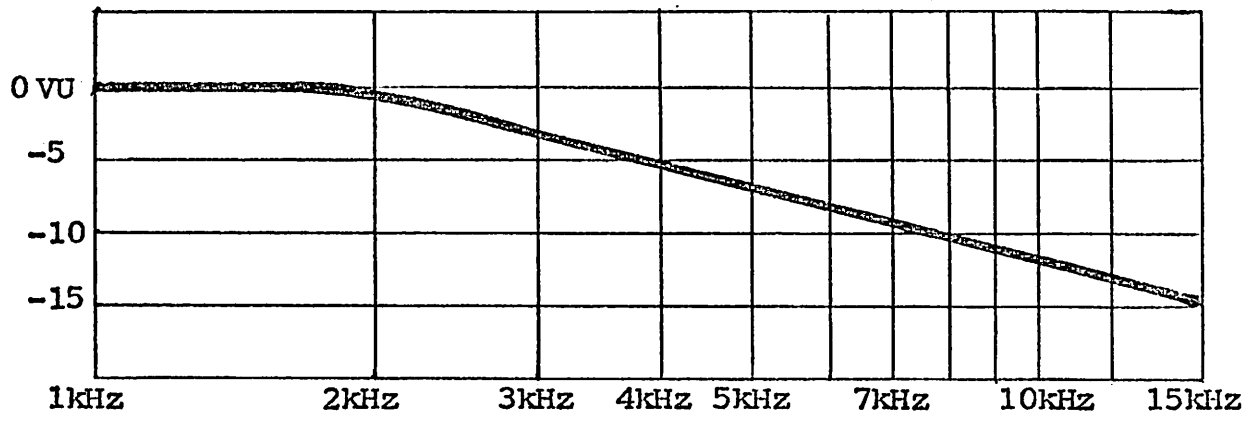


Fig. 3-2

Limiter Ceiling, 75us (FM Broadcast)

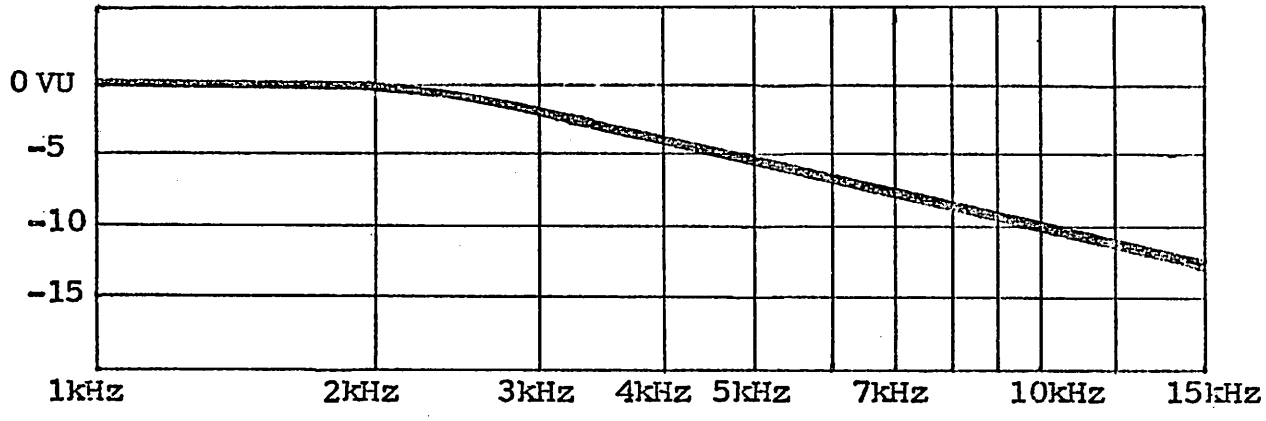


Fig. 3-3

Limiter Ceiling, 50us (TV Audio)

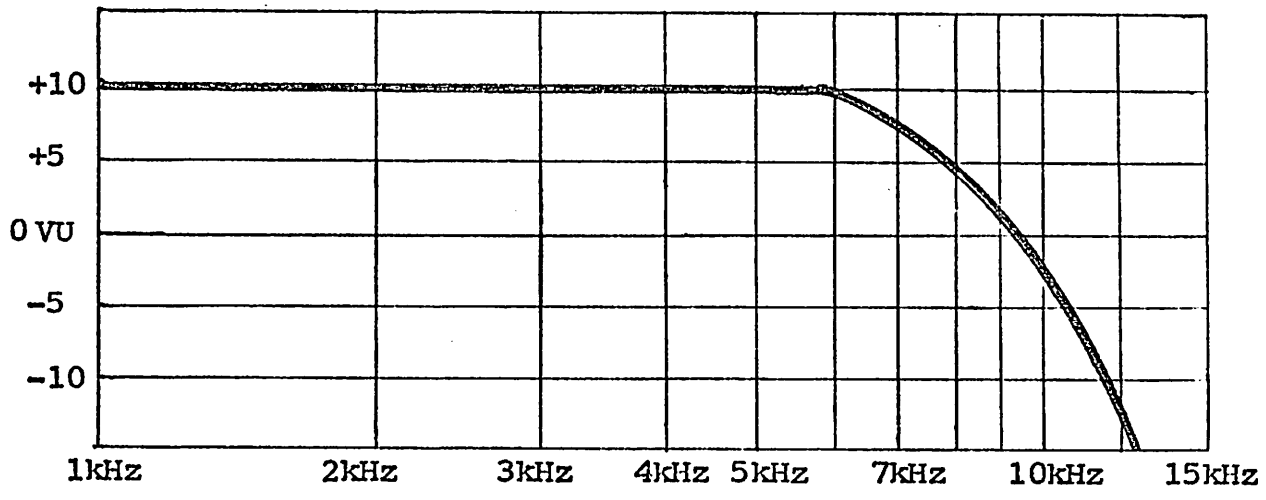


Fig. 3-4

Limiter Ceiling, 1-7/8, 3-3/4ips Tape Formats

and not as a dynamic range compressor for increasing apparent loudness.

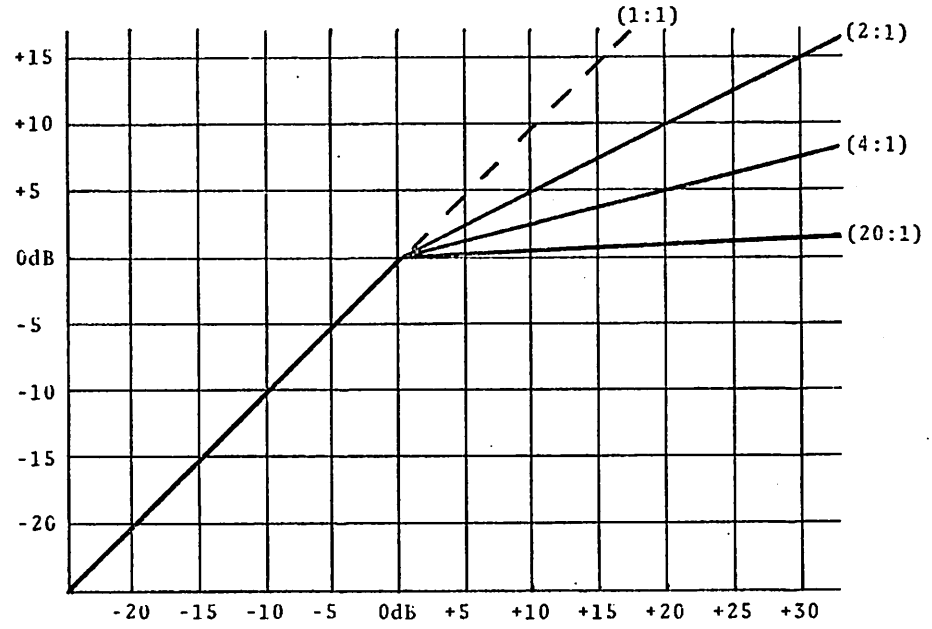
3.2.3 PEAK LIMITER CONTROLS

Unlike conventional limiters operating in a closed-loop configuration, the "knee" of the Inovonics Model 210 broadband limiter curve is not abrupt (see Fig. 3-5); rather, it is a gentle transition from a linear to a limited condition.

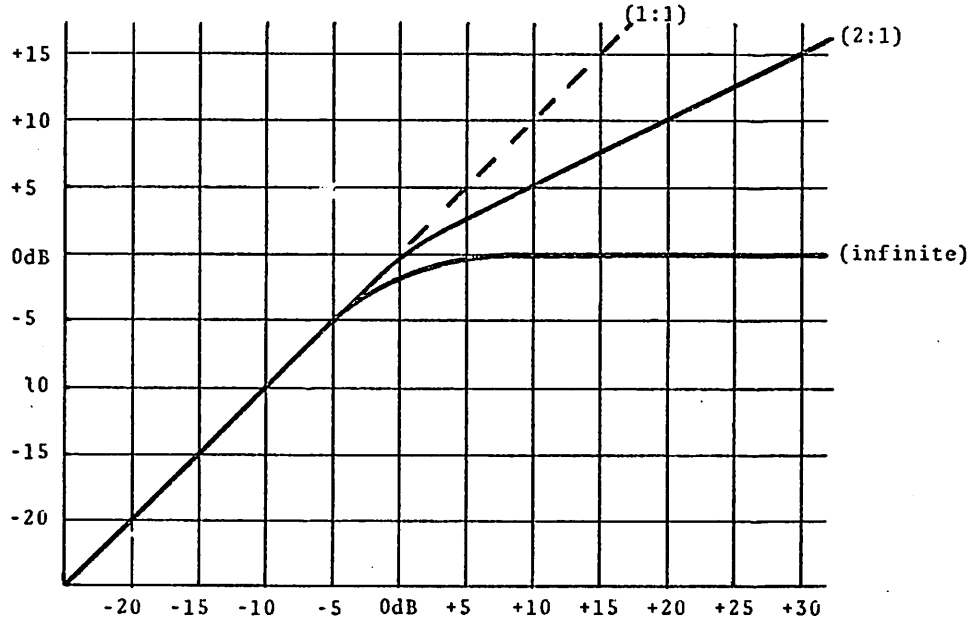
The small amount of increasing-ratio compression prior to the infinite ratio afforded by the optimally-flat ceiling of the Model 210, decreases the audibility of limiter operation.

The PEAK CEILING control sets the absolute upper limit of program peaks; even those of such short duration as to be unmeasurable by conventional VU meters. The setting of this control is dictated by the dynamic range capability of the recording or transmission system. This usually corresponds to 100% modulation of a carrier, or maximum permitted tape-generated distortion.

ATTACK and RELEASE timing is adjusted by the two appropriately labeled controls. Generally, ATTACK is set at the fastest (F) position, and RELEASE between (S) and mid rotation of the control. These settings will provide absolute protection from even the fastest program transients with the least audible effect. Settings of the ATTACK control other than fully clockwise (F) should be used only when very fast transients are subsequently clipped, or can otherwise be tolerated. Settings of the RELEASE control between mid rotation and (F) return the circuit gain to the unlimited value very quickly, at the expense of a certain degree of low frequency signal distortion. Nevertheless, the unique



Conventional (closed-loop) Limiter



Inovonics Model 210 Limiter

Figure 3-5

Comparison of Conventional Limiter
and Inovonics Model 210 Transfer Curves

distortion-reducing circuits of the Model 210 permit much shorter release times than conventional limiters for a given value of distortion.

3.2.4 FREQUENCY SELECTIVE LIMITER OPERATION

With the proper Frequency Insert installed for the system overload characteristic, the F.S. LIMIT THRESH. control can be adjusted to precisely complement the overload curve. This adjustment may be made in either of two ways; with a plot of the curve to be complemented and an oscillator and VTVM, or with a source of wide range program material and a broadcast modulation monitor, or listening tests in the case of tape systems. The use of test instruments is to be preferred, as the high frequency content of program material varies widely.

3.2.5 GAIN REDUCTION INDICATORS

Front panel lamps indicate action of the two limiting functions. The PEAK LIMIT lamp lights whenever program peaks are reduced to the ceiling value. The H.F. GAIN REDUCTION lamp indicates reduction of high frequency energy to the limits set by the transmission or recording system.

3.3 CIRCUIT DESCRIPTIONS

3.3.1 The Signal PCB contains all elements in the audio signal path, as well as additional eircuits for the frequency selective limiter. Input amplifier, IC 1, receives the attenuated (INPUT GAIN control) input signal, and feeds the Gain Reduction Module. The output of IC 1 is also routed via the PEAK CEILING control to the Control PCB.

The encapsulated Module contains the circuit elements

that (1) reduce broadband program peaks, and (2) provide the frequency selective limiting function. The Module output drives Q1 and Q2, the Class AB output stage. Diodes CR 3 and CR 4 provide output short circuit protection.

A portion of the output signal is routed to the Frequency Insert, where a pre-emphasis network imparts a rising frequency characteristic identical to the system overload curve. The weighted signal passes through the F.S. LIMIT THRESH. control to IC 2, a voltage gain stage. IC 3 is a unity-gain inverter, and diodes CR 5 and CR 6 provide full wave rectification of the weighted signal. This results in a negative DC output proportional to high frequency program energy.

In the absence of high frequency energy, the output of IC 4 is driven positive by a small current through R 17. When the h.f. energy rises to the forward-bias value of CR 5 and CR 6, the output of IC 4 goes negative. CR 7 passes the negative output voltage to the frequency selective gain reduction element within the Module. C6 and R3 comprise a filter for the control voltage, and Q3, Q4, and associated components drive the front panel H.F. GAIN REDUCTION indicator.

The Module gain reduction element is placed in series with additional components on the Frequency Insert to impart an attenuation curve which is the reciprocal of the system overload characteristic. Thus the circuitry on the Signal PCB functions as a closed-loop, frequency-weighted gain control.

3.3.2 Amplified input signals pass through the PEAK CEILING control to the Control PCB, and to IC 1 and IC 2, connected in a precision full wave rectifier configuration. The negative DC output, integrated by C3, is proportional to the peak value of the input signal. Additional filtering

(and establishment of limiter time constants) is provided by the ATTACK and RELEASE controls, and capacitor C4. IC 3 is a unity-voltage-gain buffer amplifier. LINEARITY control, R11, converts the voltage output to a proper current for linear broadband gain reduction. The output of IC 3 is also inverted by IC 4, AC-coupled through C7, and clamped by CR7 and CR8. This signal is fed out of phase with the gain-controlling current to the Gain Reduction Module. The purpose of this circuit is to null the DC control signal ripple component and substantially reduce the generation of harmonic distortion, particularly at low frequencies.

The output of IC 3 also drives the remote meter, and the PEAK LIMIT lamp driver circuit comprised of IC 5, Q1, and associated components.

SECTION 4.0 ALIGNMENT AND CALIBRATION

NOTE: The following steps must be performed in the order given.

4.1 Gain Calibration

With the INPUT GAIN, F.S. LIMIT THRESH., and PEAK CEILING controls set fully clockwise, feed a 500Hz signal to the Limiter input at a level 15dB below the nominal "0 VU" line level of +4 or +8dBm (-11 or -7dBm). Adjust GAIN CAL control, R4 on the Signal PCB, for a "0 VU" program level of +4 or +8dBm, as measured with a VTVM connected across the Limiter output terminals. If the Limiter is to feed a terminated input, load the unit with a 600 ohm resistor at this time.

4.2 Linearity Adjustment

Set the INPUT GAIN control to mid-rotation, F.S. LIMIT THRESH. fully clockwise, PEAK CEILING to "0 VU", ATTACK to F, and RELEASE to S. Monitor the Limiter output with a VTVM and feed a 500Hz signal to the Limiter input at a "0 VU" level of +4 or +8dBm. Turn the INPUT GAIN control slowly clockwise. At some point the PEAK LIMIT indicator will light, and the output signal should stop increasing, even as the INPUT GAIN control is advanced. If the output continues to increase, turn the LINEARITY control, R11 on the Control PCB, counterclockwise. If the output increases to a point and then decreases as the INPUT GAIN control is advanced, turn the LINEARITY control clockwise. The proper adjustment of this control will yield a curve similar to the "infinite" curve plotted in Fig. 3-5. An optimally-flat ceiling will actually drop about 0.5dB when the INPUT GAIN control is fully clockwise.

4.3 Peak Limiter Calibration

Upon completion of step 4.2, and with the INPUT GAIN control fully clockwise, adjust the PEAK LIMIT CAL. control, R7 on the Control PCB, for a Limiter output of "0 VU" (+4 or +8dBm).

4.4 Meter Calibration

If the optional remote meter is used, it may be calibrated to indicate 15dB of Gain Reduction with conditions as in 4.3. Use METER CAL control, R8, on the Control PCB.

4.5 Distortion Null Adjustment

Set the RELEASE control to F, and the test oscillator frequency to 50Hz. Other levels and control settings should remain as in 4.3. Monitor the Limiter output with a Total Harmonic Distortion Analyzer, and adjust RIPPLE NULL control, R13 on the Control PCB, for a minimum reading.

4.6 Frequency Selective Limiter Calibration

There are no internal calibration controls for the frequency selective limiting function of the Model 210. See 3.2.4 for adjustment procedure.

This completes calibration of the Model 210 Limiter

SCHEMATIC REF. NO.	PART NUMBER	DESCRIPTION	MFG.	MANUFACTURER PART NUMBER
	111800A	CONTROL PCB ASS'Y (SCHEMATIC 112000A)		
	2602	Transistor Pad	Jermyn	TO5-001
C 1,2	0801	Capacitor, 10pF mica	Elmenco	DM15-100J
C 3	0867	" 0.1uF, 100V	Sprague	225P10491
C 4	0870	" 0.47uF, 200V	Sprague	225P47492
C 5,6,9	0803	" 22pF, mica	Elmenco	DM15-220J
C 7	0901	" 5uF, 25V	Sprague	TE 1202
C 8	0904	" 25uF, 25V	Sprague	TE 1207
CR 1-12	1100	Diode, Silicon, 1N4009	Fairchild	
IC 1-5	1300	Integrated Circuit, Type 748	Signetics	5748V
Q 1	1205	Transistor, 2N3645	National	
R 1,2,5	0089	Resistor, ¼W, 5% 20K		
R 3	0083	" " " 10K		
R 6	0177	" " 10% 22K		
R 7	0563	Resistor, Variable, 100K	Helipot	91A100K

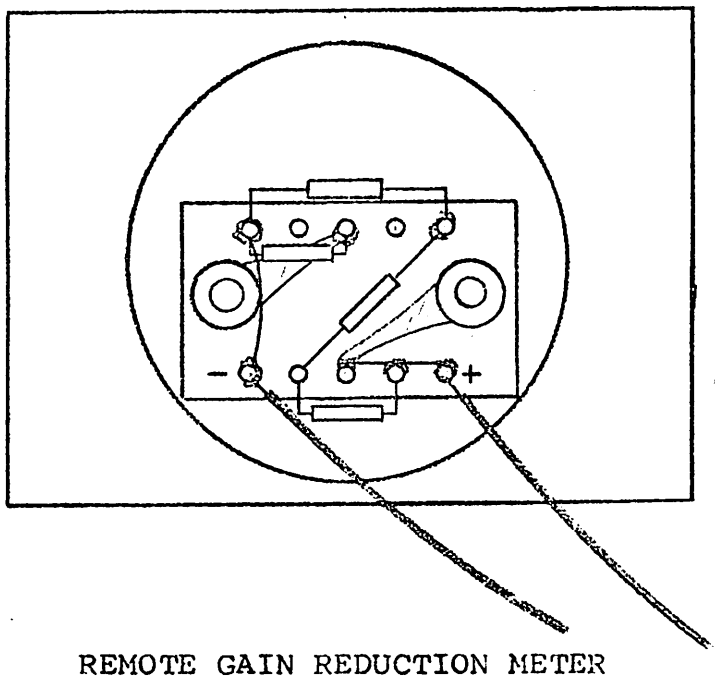
SCHEMATIC REF. NO.	PART NUMBER	DESCRIPTION	MFG.	MANUFACTURER PART NUMBER
	111800A	CONTROL PCB ASS'Y (SCHEMATIC 112000A)		
R 8,13	0559	Resistor, Variable, 10K	Helipot	91A 10K
R 9	0161	" ¼W, 10% 1K		
R 10,15	0169	" " " 4.7K		
R 11	0560	Resistor, Variable, 20K	Helipot	91A 20K
R 12,14	0173	" ¼W, 10% 10K		
R 16,17	0180	" " " 39K		
R 18	0176	" " " 18K		
R 19	0374	Resistor, ½W, 10% 150 ohms		
	111300A	SIGNAL PCB ASS'Y (SCHEMATIC 110900A)		
	2602	Transistor Pad	Jermyn	T05-001
	109100	GAIN CONTROL MODULE		
C 1	0870	Capacitor, 0.47uF 200V	Sprague	225P47492
C 2,3,4,5	0801	" 10pF mica	Elmenco	DM15-100J
C 6	1050	" 4.7pF 35V	Kemet	K4R7C35K
CR 1-7	1100	Diode, 1N4009	Fairchild	

SCHEMATIC REF. NO.	PART NUMBER	DESCRIPTION	MFG.	MANUFACTURER PART NUMBER
	111300A	SIGNAL PCB ASS'Y (SCHEMATIC 110900A)		
IC 1-4	1300	Integrated Circuit, Type 748-C	Signetics	5748V
Q 1,3	1204	Transistor, 2N3567	National	
Q 2,4	1205	Transistor, 2N3645	National	
R 1,18	0185	Resistor, ¼W, 10% 100K		
R 2	0186	" " " 120K		
R 3	0161	" " " 1K		
R 4	0558	Resistor, Variable 10% 5K	Helipot	91A 5K
R 5,6	0168	Resistor, ¼W, 10% 3.9K		
R 7,8	0137	" " " 10 ohms		
R 9	0169	" " " 4.7K		
R 11-13,16,20	0173	" " " 10K		
R 10	0141	" " " 22 ohms		
R 14	0083	" " 5% 10K		
R 17	0209	" " 10% 10 meg		
R 19,21	0149	" " " 100 ohms		

SCHEMATIC REF. NO.	PART NUMBER	DESCRIPTION	MFG.	MANUFACTURER PART NUMBER
	110300A	POWER SUPPLY PCB ASS'Y (SCHEMATIC 109900A)		
	2600	Heat Dissipating Fins	Wakefield	207-AB
	2602	Transistor Pad	Jermyn	TO5-001
C 1,2	0904	Capacitor, 25uF, 25V	Sprague	TE 1207
C 3,4	0901	Capacitor, 5uF, 25V	Sprague	TE 1202
CR 1-4	1125	Rectifier, Silicon, 600V, 1A	Motorola	1N4005
CR 5,6	1101	Diode, Zener, 22V, 5%	Motorola	1N5250B
Q 1	1212	Transistor, 40319	RCA	
Q 2	1204	Transistor, 2N3567	National	
Q 3	1205	Transistor, 2N3645	National	
Q 4	1200	Transistor, 2N2102	RCA	
R 1,2	0165	Resistor, ¼W, 10% 2.2K		
R 3,4	0169	" " " 4.7K		

SCHEMATIC REF. NO.	PART NUMBER	DESCRIPTION	MFG.	MANUFACTURER PART NUMBER
		CHASSIS (SCHEMATIC 115100A)		
C 1,2	0910	Capacitor, 500uF, 50V	Sprague	TVA 1315
F 1	2702	Fuse ½A 3AG		
I 1,2	2001	Indicator RED	Dialco	507-3918-1431-600
I 3	2002	Indicator AMBER	Dialco	507-3918-1433-600
	2003	Retainer	Eldema	Q-081-905
	2004	Rubber Washer	Eldema	Q-145-008
R 1	0603	Resistor, Variable 100K	Allen Bradley	JA1Lo40S104UC
R 2	0170	Resistor, ¼W, 10% 5.6K		
R 3	0602	Resistor, Variable 10K	Allen Bradley	JA1L040S103UC
R 4	0605	Resistor, Variable 50JK	Allen Bradley	WA2L040S504UC
R 5	0185	Resistor, ¼W, 10% 100K		
R 8	0379	" ½W, " 390 ohms		
R 6	0604	" Variable, 10K	Allen Bradley	WA2L040S103UC

SCHEMATIC REF. NO.	PART NUMBER	DESCRIPTION	MFG.	MANUFACTURER PART NUMBER
		CHASSIS (SCHEMATIC 115100A)		
S 1	1808	Switch, SPST Bat Handle	Cutler-Hammer	7580-K6
T 1	109000	Transformer, Output		
T 2	1502	Transformer, Input (Optional)	UTC	O-37
	1503	Shield for T2	UTC	O-17
T 3	1501	Transformer, Power	Triad	F-90X
	1757	Terminal Strip, 2 Lug	H.H. Smith	863



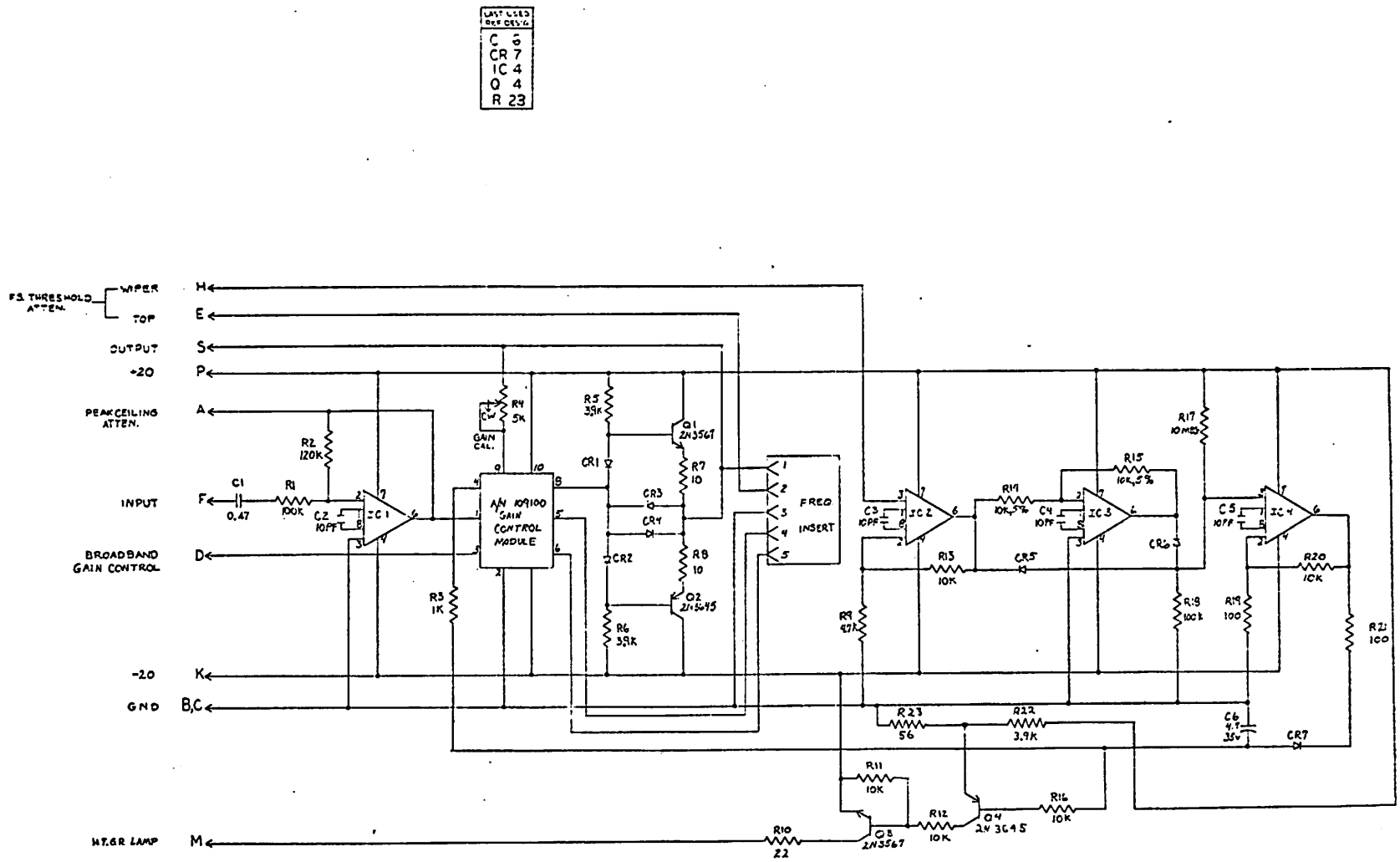
REMOTE GAIN REDUCTION METER

INOVONICS 200 / 210

Instructions:

Modutec bezel-mounting meter requires 1.6" X 3.0" cutout.

Attach leads of appropriate length to + and - terminals on meter network as shown above. Connect to + and - terminals of limiter.



NOTES:
UNLESS OTHERWISE SPECIFIED
1. ALL IC'S TYPE 748-C
2. ALL DIODES IN 4009
3. ALL RESISTORS ¼W, 10%

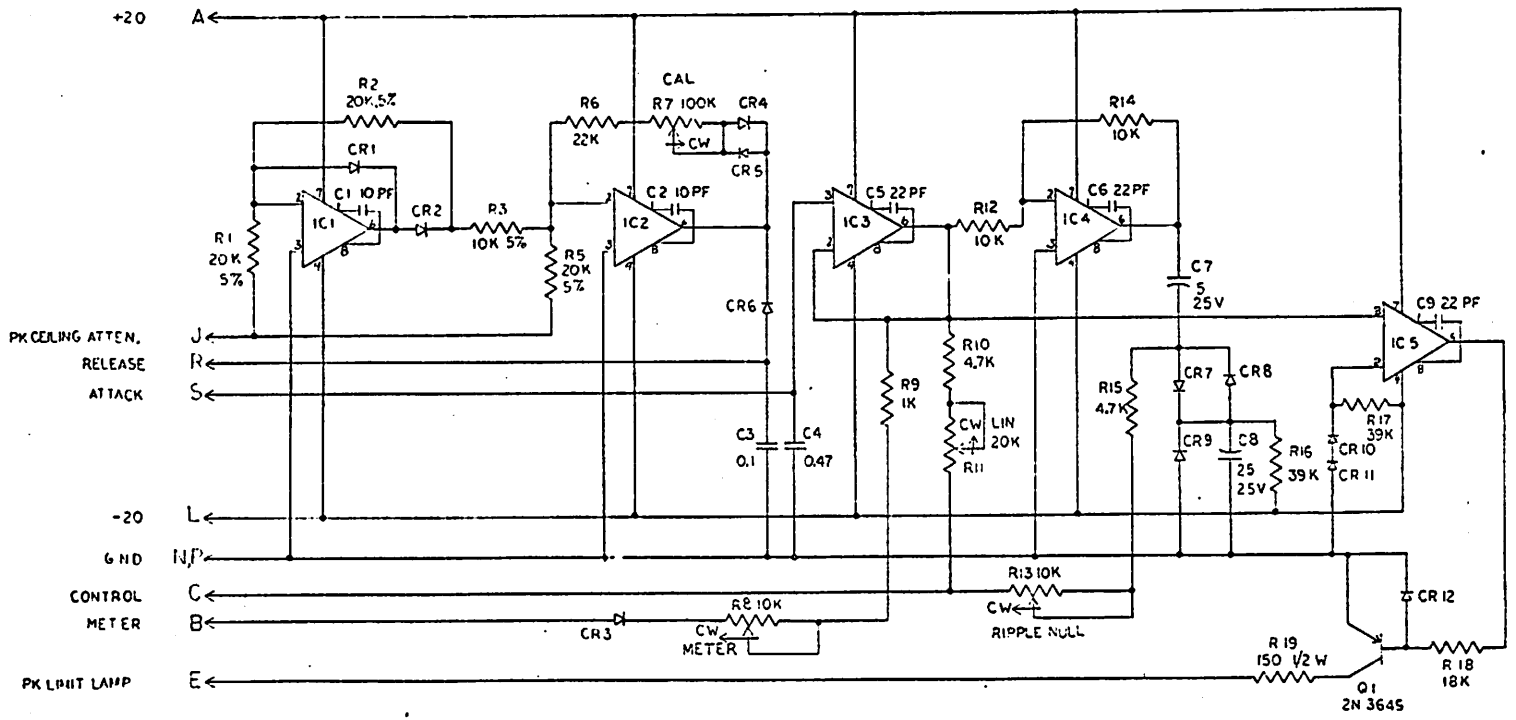
SCHEMATIC, A/N 111300C

SIGNAL BOARD

Fig. 5-1

LAST USED REF DESIG
C 9
CR 12
IC 5
Q 1
R 19

REF DESIG NOT USED
R 4



NOTES:

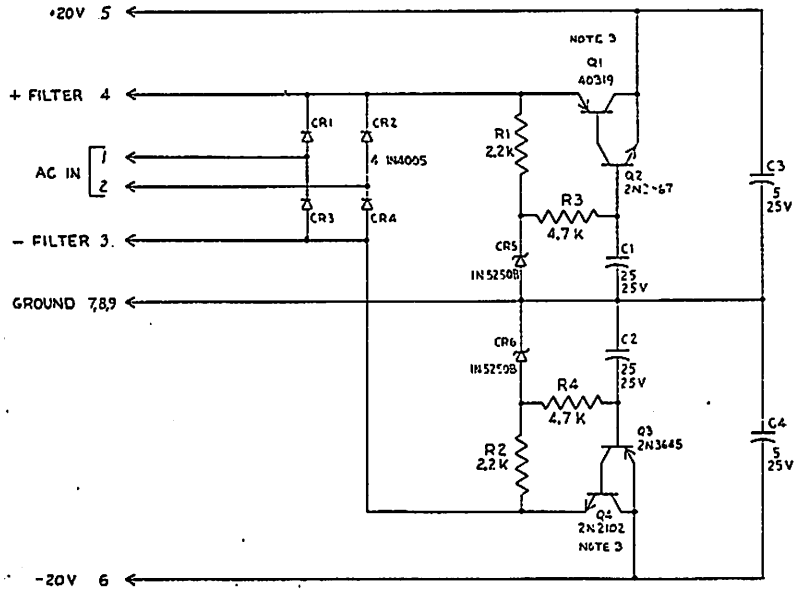
UNLESS OTHERWISE SPECIFIED

1. ALL IC'S TYPE 74H-C
2. ALL DIODES IN 4009
3. ALL RESISTORS 1/4W 10%

SCHEMATIC, A/N 111800A

CONTROL BOARD

Fig. 5-2



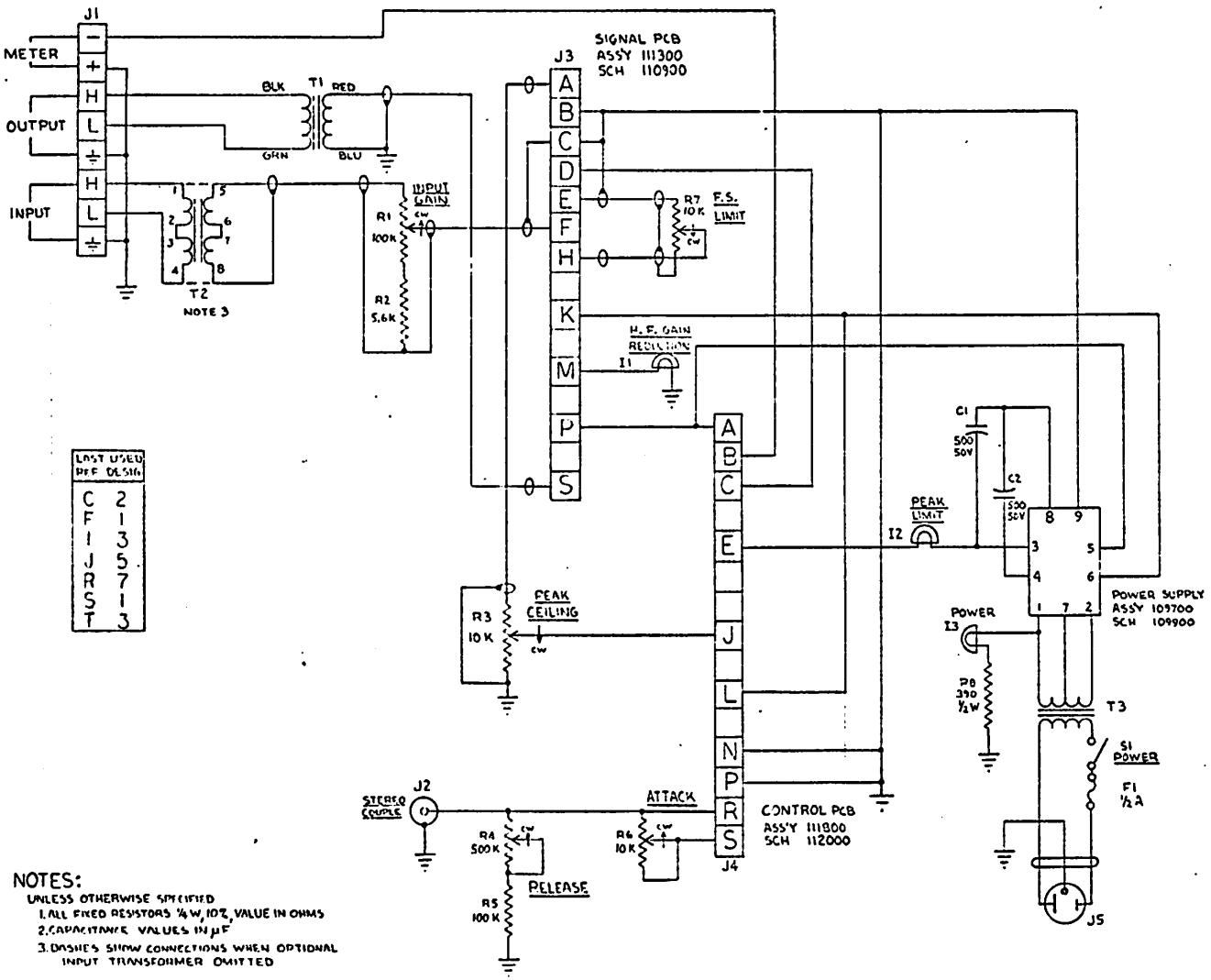
NOTES:

1. ALL RESISTORS ¼ W 10%, VALUE IN OHMS
2. CAPACITANCE VALUES IN μF
3. Q1 AND Q4 REQUIRE HEAT DISSIPATORS

SCHEMATIC, A/N 110300A

P.S. REGULATOR BOARD

Fig. 5-3



NOTES:

UNLESS OTHERWISE SPECIFIED

1. ALL FIXED RESISTORS ¼W, 10%, VALUE IN OHMS
2. CAPACITANCE VALUES IN μF
3. DASHES SHOW CONNECTIONS WHEN OPTIONAL INPUT TRANSFORMER OMITTED

SCHEMATIC,

MODEL 210 CHASSIS

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.