INSTRUCTION MANUAL

MODEL 230

"MULTIBAND AUDIO PROCESSOR"

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INOVONICS
INCORPORATED

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I. GENERAL INFORMATION AND SPECIFICATIONS

The Inovonics 230 is a broadcast audio processor for both AM and FM service, designed specifically to enhance perceived signal loudness and thus extend the effective area of station coverage. When properly adjusted, the 230 will so process the audio program signal as to increase transmitter modulation density to a figure approaching theoretical maximum, while still maintaining a high value of program listenability.

General Specifications

The Inovonics 230 is comprised of two primary functional sections; the gated 8-band Compressor, and the Peak Limiter section which also includes the Phase Follower (AM), and independent Frequency-Selective Limiter circuitry (FM). Specifications relative to overall 230 performance, and data specific to the Compressor and Limiter sections are tabulated separately.

Frequency Response (below Compressor threshold): ±1dB, 20Hz - 20kHz.

Noise Level: Better than 65dB below 100% modulation.

Distortion: <1% THD for any degree of compression and limiting of steady-state signals 20Hz - 20kHz.

Input: Balanced-bridging; accepts program levels between -20 and +10dBm.

Output: Balanced output feeds 600-ohm lines or terminating inputs at levels between 0 and +20dBm, corresponding to 100% modulation.

Stereo Interconnection: Two units may be interconnected by means of an accessory cable to duplicate compression on a band-for-band basis. (Also see pg. 8, "AM Stereo")

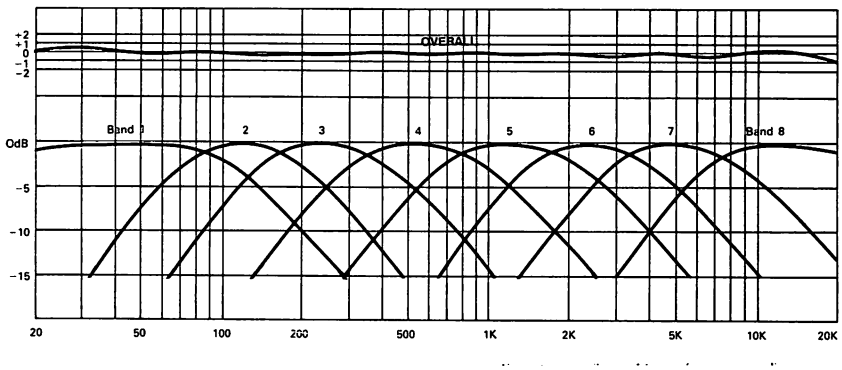
Power Requirement: 105 - 130VAC (230V available), 50/60Hz; 1/2A.

Size and Weight: 7" X 19" X 9"; 16 lbs.

8-Band Compressor Specifications

The input audio program signal is first divided into eight frequency bands, each approximately one octave wide with 12dB-per-octave skirts. Within each band the signal undergoes r.m.s. compression with full flexibility of control over compression parameters. User adjustment of Compression Threshold and Compression Ratio in each of the eight bands permits program response to be dynamically shaped in a manner similar to that afforded by a separate Graphic Equalizer to complement a particular programming format.

Frequency Division (Hz): 20-60, 60-150, 150-300, 300-700, 700-1.5k, 1.5k-3.5k, 3.5k-7.5k, 7.5k-20k.



Compression Ratio: 2:1, 4:1, 8:1; switch-selectable in each band.

Compression Threshold: Variable over 15dB range in each band.

Attack and Release Timing: Optimized for each band consistent with rapid operation, r.m.s. response and low distortion.

Gated Expansion (DEFEATABLE FUNCTION): (See pg. 7)

Peak Limiter Specifications

Following compression the input program is recombined into broadband form. At this point the fast Peak Limiter acts on the signal to reduce program peaks to the desired absolute value for 100% modulation. The Peak Limiter can be adjusted for Phase-Following, Asymmetrical operation in AM service, or an independent Frequency-Selective Limiter enabled for FM broadcast use.

Compression Ratio: $>$100:1

Limiting Threshold: Variable over 25dB range.

Attack Time: <1us for any degree of limiting.

Release Time: Complex function of program peak content; release characteristic can be set for single, dual or triple RC function.

Peak Symmetry (DEFEATABLE FUNCTION): Positive peak value can be adjusted from 100% to 150% of negative peak value.

Phase Follower (DEFEATABLE FUNCTION): (See pg. 7)

Frequency-Selective Limiter (DEFEATABLE FUNCTION): Switchable to complement either 75us or 25us FM pre-emphasis characteristics to prevent overmodulation from high frequency program energy. Circuit provides totally independent limiting of high frequencies.

II. DESIGN PHILOSOPHY AND FUNCTIONAL DESCRIPTION

Multiband Compression

The Inovonics 230 Multiband Audio Processor represents a significant departure in design and operating philosophies from the usual family of broadcast compressor/limiters. The most obvious difference is the individual processing of signals within multiple frequency bands.

The majority of audio level compressors act on the broadband signal, regulating circuit gain as a function of program level. This is generally accomplished by deriving a DC control voltage from the audio signal, and utilizing this voltage to regulate circuit gain.

In order to remain unobtrusive in its action, a compressor must be relatively fast-acting; that is it must follow the envelope of the audio program quickly enough to reduce sudden input increases, and must release quickly to avoid audio "holes" and audible fade-up when the input level returns to normal. Unfortunately, this fast action is not consistent with low distortion, particularly at low frequencies, as a necessarily short rectifier filter time constant results in amplitude modulation of the program by its own harmonic products.

The obvious alternative is to independently compress high and low frequencies, tailoring the rectifier filter time constants to the subject portions of the spectrum. In this manner, low frequency distortion could remain at an acceptably low level, while, at the same time, compression could be rapid at voice frequencies and above.

In its utilization of this multiband approach, the Inovonics 230 divides the audio spectrum into eight separate bands. While this might seem an unnecessary number of divisions, the advantage is twofold. First, broadband energy can be concentrated and maintained at a high level, as no loud, single tone or musical note can reduce gain in any other than its own band. Secondly, by providing manual adjustment over both the Compression Ratio and Compression Threshold in each of the eight bands, the spectral distribution of the program can be tailored to impart a specific "sound" to the program, almost regardless of the nature of the program source. This can be nearly as important an advantage as perceived loudness in an already loud, competitive marketplace.

Gated Expansion

As a compressor reduces the dynamic range of a program, so it also reduces the program-to-noise ratio. Noises that were once far below the average program level (teletype printers, air conditioners, etc.) are now clearly audible when the average program level drops.

To lessen this annoyance, the 230 features an optional Gated Expansion mode, which simultaneously reduces the gain in all eight bands once the program level falls below a predetermined Gating Threshold value. In order for the gating circuit to properly differentiate between legitimate program material and spurious noise, frequency weighting restricts gating sensitivity to mid-band frequencies.

Peak Limiter

The 230 employs a fast, true peak limiter rather than a clipping circuit. The apparent increase in average modulation afforded by a clipper, a result of the greater r.m.s. value of the clipper's squared output waveform, is likely to suffer substantial loss through phase shift and overshoot in the AM transmitter modulator or FM stereo generator. The 230 preserves signal waveshape as much as possible, consistent with instantaneous reduction of fast program peaks. The advantage of true peak limiting in terms of audible signal distortion is obvious, even in casual listening situations.

Asymmetrical Modulation

In AM broadcast use of the 230, the value of positive modulation peaks may be continuously adjusted to assume up to 150% of the negative peak value. Although positive modulation is legally restricted to 125%, many plate-modulated transmitters require drive in excess of +125% to reach the legal maximum. It must be warned, however, that transmitters which fall into this category are incapable of linear operation up to +125%, and the very slight gain in perceived signal loudness must be weighed against probable high signal distortion.

Phase-Follower

Asymmetrical modulation of positive and negative peaks yields a modulation advantage only when the program material is asymmetrical in nature. Most music, because it is a blend of complex waveforms which are not phase-related, has a very even balance of peak energies. Solo instruments and the human voice, on the other hand, possess a more or less fixed relationship between the phase of the fundamental tone and

the harmonics. This leads to an appreciable and consistent imbalance between positive and negative peaks, and can be used to modulation advantage.

The 230 Phase-Follower circuit monitors mean peak energy balance and instantly inverts program phase to maintain maximum positive AM transmitter modulation. The program inversion is effected only at signal zero-crossings, however, to reduce audibility of the switching action. Nevertheless, an instantaneous second harmonic product is generated each time the phase is inverted, and may be distracting with some types of program material. Sensitivity of the Phase-Follower circuit is adjustable so that a compromise between advantage and annoyance can usually be reached.

AM Stereo

As of this writing, the subject of stereophonic AM broadcasting is receiving a good deal of attention. Although no standard has been adopted, the most promising system utilizes a combination of carrier amplitude and phase modulation. In this system, a L+R audio signal amplitude modulates the transmitter in a conventional manner, assuring monaural compatibility. The L-R audio signal phase-modulates the carrier, and is independently demodulated and matrixed by the AM stereo receiver to yield Left and Right information.

When interconnected for FM stereo operation, the 230 Phase-Follower circuit is automatically disabled. Nonetheless, when two 230's are interconnected, and the Phase-Follower in one unit manually enabled, the other Phase-Follower circuit will be slaved to the first. If the first 230 should process the L+R signal which amplitude-modulates the carrier, and the second unit the phase-modulating L-R information, the result will be a fully modulated AM carrier with the stereo matrix phase properly maintained.

Frequency-Selective Limiter

Standard FM broadcasts utilize a 75μs pre-emphasis time constant for signal-to-noise improvement; Dolby-encoded broadcasts a 25μs characteristic. As a result of this signal pre-emphasis, the amount of transmitter input drive to achieve 100% modulation is much less at high than at low frequencies. An effective FM limiter must therefore effect greater reduction of high frequency program peaks.

The Inovonics 230 incorporates a separate Peak Limiter to control the energy of high frequency program peaks independently of the normal broadband limiting action. The high frequency limiter can be switched between 75μs and 25μs limiting characteristics.

III. INSTALLATION

Unpacking and Inspection

Upon receipt of the equipment, inspect at once for shipping damage. Should any such damage be observed, notify the carrier at once; if not, proceed as outlined below. It is suggested that the original shipping carton and materials be retained should future re-shipment become necessary. 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 important that the Warranty Registration card found at the front of this manual be returned; not only does this assure coverage of the equipment by the Warranty, but the user will automatically receive specific servicing or modification information if and when it should become available.

Mounting

The 230 is packaged to mount in a standard 19-inch equipment rack, requiring 7 inches of rack space per unit. The 230 generates negligible heat, and itself is unaffected by wide variations in the ambient operating temperature.

RFI

The 230 is specifically designed to operate in close proximity to broadcast transmitters; nevertheless, care should be exercised in locating the unit away from abnormally high RF fields.

In some installation situations, an RF ground loop may be formed between the input or output cable shield grounds and the AC power cord ground. Use of a "ground-lifting" AC adapter should remedy any problem.

In/Out Connection

The 230 input and output connections are brought out to a rear panel screw-terminal barrier strip. Both the input and output are balanced (transformer-isolated), with ground terminals provided for cable shields.

Polarity

The input and output of the 230 are each marked with + and - designations to aid in maintaining proper phase in stereo applications, or proper asymmetrical modulation of program peaks. In the latter case, the + output terminal will be positive-going with positive modulation peaks.

Line Considerations

Should the equipment which feeds the 230 require output loading, an external 600 ohm resistor should be placed across the 230 input terminals; otherwise the input is "balanced-bridging" with a characteristic input impedance of 10K or greater.

The source impedance of the 230 output amplifier (ahead of the line output transformer) is virtually zero. However, as the output transformer has some reactance, it is important that the 230 output be terminated in 600 ohms to minimize output overshoot.

IV. OPERATION AND ADJUSTMENT

The Inovonics 230 is a fundamentally more complex device than most other broadcast audio processors, and hosts a full complement of accessible controls which materially affect both the technical composition and the subjective audio quality of the transmitted program signal.

The various adjustments are identified on the inside of the removable front adjustment cover. Despite the seemingly obvious meanings of the control function descriptions, it is highly recommended that the outlined procedure be carefully followed for initial setup. Subsequent readjustment to secure a desired effect should be made only after it has been established that the 230 functions properly and predictably in accordance with the initial setup procedure.

All adjustments are made "on the air," utilizing a typical program feed and the station Modulation Monitor.

Basic Adjustments

1. Preset controls as follows:
   COMPRESSION THRESHOLD (all 8) - fully "up" (0dB)
   COMPRESSION RATIO (all 8) - 4:1
   FUNCTION - Ungated
   LIMITER MODE - Flat
   PEAK LIMITER RELEASE - "DUAL"

2. With a normal program feed from the console, adjust the INPUT GAIN (COMPRESSION) control for 10 - 15dB of compression in the most active bands.

3. Adjust PEAK LIMITER DRIVE for 5 - 10dB Peak Limiting.

4. Adjust OUTPUT LEVEL control for 100% modulation on peaks as indicated by the Modulation Monitor.

5. Proceed with specific AM or FM adjustments.

AM Adjustments (Asymmetrical Modulation)

1. Set the LIMITER MODE switch to Asymmetrical, and adjust the POS. PEAK AMPLITUDE (ASYMMETRY) control for desired positive peak modulation per the Modulation Monitor.

2. With the LIMITER MODE switch in the Phase-Following position,

the 230 will invert the signal at zero-crossings to maintain maximum positive modulation. The PHASE-FOLLOWER SENSITIVITY control can be left fully clockwise to enable inversion with the least amount of signal asymmetry, or rotated counterclockwise to invert with correspondingly greater asymmetry, thereby reducing inversion incidence. (See warning on pg. 8)

FM Adjustments (Frequency-Selective Limiting)

With the LIMITER MODE switch in either the 75μs (normal FM) or 25μs (Dolby FM) positions, high frequency program peaks will be independently attenuated to prevent overmodulation due to transmitter pre-emphasis. The OUTPUT LEVEL control will require readjustment from the initial setting made under Basic Adjustments to insure full FM carrier modulation.

SUBJECTIVE ADJUSTMENTS

Peak Limiter Release Timing

The attack time of the Peak Limiter is necessarily rapid to insure instantaneous reduction of even the fastest program peaks. Aside from the amount of peak limiting one chooses to employ, the only other variable parameter of this final processing link is the limiter release timing. A three-position switch provides control over this function, giving a choice of SINGLE, DUAL or TRIPLE RC timing characteristics. This departs somewhat from the usual single section, variable RC time constant used in most Peak Limiter circuits, but yields a greater range of subjective results.

The DUAL position is probably the best compromise between loudness and listenability, and can be used with up to 10 or 15dB of limiting without annoying audible effect.

Maximum program density can be realized in the SINGLE position, but greater amounts of limiting will result in correspondingly greater audible distortion and listening fatigue.

The TRIPLE release function is the most gentle of the three, but when used with as much as 10dB of limiting can result in some "pumping." It is thus recommended that no more than 5dB of limiting be used in the TRIPLE position.

Gated Expansion Function

With the FUNCTION switch in the Gated Expansion position, Compressor gain will reduce by a nominal 10dB figure when no legitimate input signal is present. This serves to reduce background noise by the same 10dB. The GATING THRESHOLD control sets the point at which an input signal will open the gate and return Compressor gain to maximum. The control should be advanced sufficiently clockwise to keep the GATE OPEN indicator illuminated constantly during music, but not so far as to prevent gating action during pauses in speech.

Program Response Shaping

Since the 230 has independent control over both Compression Threshold and Compression Ratio in each band, frequency characteristics may be tailored to complement a specific programming format in much the same manner as with a Graphic Equalizer.

Regardless of THRESHOLD and RATIO setting, 230 response at low levels (below Compression Threshold) will remain flat. The control settings will, however, directly influence the amount of energy in each band at normal program levels. When all eight bands are adjusted similarly, the 230 will impart a "bright" sound to the program; this is due to spectral energy distribution in typical music and speech signals, and the tendency of the 230 to bring up the higher frequency bands which are by nature lower in energy level.

If it is desired to maintain spectral balance and prevent response coloration by the 230, the COMPRESSION RATIO switches should be set identically, and the THRESHOLD controls adjusted for approximately equal compression in all bands with typical program material.

Response may be tailored by adjusting either the RATIO switch or the THRESHOLD control (or both), to yield the desired "sound." It is advised, however, that the following precautions be observed:

1. Make all changes in small steps, listening carefully to the results each time.

2. If it is desired to emphasize certain bands, keep the THRESHOLD controls of these bands at 0dB, and the Compression Ratio lower than in the others.

3. Avoid differences of more than 5dB in the THRESHOLD settings of adjacent bands. Violation of this warning can lead to very undesirable "phasing" or "swishing" effects.

V. CIRCUIT DESCRIPTIONS

Input Amplifier

The 230 program input is transformer-isolated by T1 on the "mother" circuit board and routed to the Program Amplifier assembly and Input Amplifier IC1. Current gain stages Q1 and 2 provide additional output drive to feed all eight Bandpass Compressor assemblies, the inputs of which are paralleled at the Compressor Input Bus. Gain of the Input Amplifier can be adjusted over a 30dB range by the INPUT GAIN (COMPRESSION) control R4 to accommodate different input line levels.

Bandpass Compressors

In each of these assemblies, signals from the Compressor Input Bus are fed to IC1, a voltage-variable gain stage. This circuit, the "Santana" configuration, utilizes FET Q1 as an active variable resistance across the inverting input of the operational amplifier. Q2, a parameter-matched "dummy" FET, is placed across the non-inverting amplifier input and cancels the channel non-linearities of Q1. This permits control of the audio signal at levels which would otherwise be above the low-distortion operating range of FET's.

Q3 and associated components form the high-pass section of the bandpass filter, Q4 the low-pass section. Both sections are second-order active filters with 12dB-per-octave rolloff. The output of the filter circuit is fed to the common Combining Bus through the BAND GAIN calibration control R25. Amplitude and phase characteristics of the eight individual filters are such that the combined outputs yield a flat signal with minimum phase distortion.

A portion of the bandpass filter output also passes through THRESHOLD control R13 to IC2, a voltage gain stage. Q5 and 6 comprise a "Baxandall" full-wave rectifier. The positive-going portion of the input waveform is amplified by common-emitter stage Q5, the negative by common-base stage Q6. Thus equal positive and negative information cause similar currents at the junction of the Q5 and 6 collectors. Q7 is a non-linear current-source collector load for Q5 and 6, and imparts a logarithmic characteristic to the resultant DC voltage. This log transfer function creates the desired linear compression of signals exceeding the preset Compression Threshold.

Further DC amplification of the rectified bandpass signal is performed by Q8 and IC3. The combined gain of these stages establishes overall Compression Ratio which can be varied with COMPRESSION RATIO switch S1 and calibration pot R22. Compression is inhibited for test purposes

when the Program Amplifier FUNCTION switch is placed in the "Proof" position. This clamps the anode of CR1 slightly negative, shunting Q8 collector current to ground.

A positive current is fed through R27 to the inverting input of IC3, generating a negative DC offset at the output of this stage. It is this offset which ultimately appears across R36 and is adjusted by this calibration control to "pinch off" FET Q1. As rectified signal reaches the non-inverting input of IC3, the DC offset is reduced, thus causing signal compression. The offset current through R27 can be varied by the Gating circuit to simultaneously reduce gain in all eight channels, lowering background noise when no input signal is present.

The components between the output of IC3 and the base of Q9 filter the DC control voltage. Compressor Attack and Release timing are a function of these component values, which are optimized for the range of frequencies specific to each band to insure rapid operation, low distortion and minimum audibility of Compressor action. Complementary emitter-followers Q9 and 10 isolate the filter from metering and other loads.

Gating Circuit

A portion of the "raw" 230 program input signal present on the Program Amplifier assembly is routed through GATING THRESHOLD control R1 to voltage amplifier IC2. This stage is bandwidth-limited, with -3dB points at 300Hz and 3kHz. This insures that the signal at the output will consist mostly of legitimate program material, rather than spurious noises. IC3, a unity-gain inverter, and diodes CR1 and 2 provide full-wave rectification of the weighted signal.

With FUNCTION switch S1 in the Gated position, capacitor C8 charges to the positive supply through R12. When the weighted and rectified input signal reaches the predetermined threshold value, Q3 begins to conduct, discharging C8. IC4 adds DC gain and hysteresis to the circuit, and its output toggles negative when program is present, positive when the program level falls below the threshold level. Transistors Q4 and 5 and the RC combination of R18 and C10 integrate the gating logic to provide a smooth level transition between the gated and ungated, or "gate open" states.

Combining Amplifier / Program Phase Detector

The outputs of the eight Bandpass Compressors are combined by the operational summing amplifier IC5 on the Program Amplifier assembly. Drive to the Peak Limiter (and thus the amount of program peak limiting employed) is set by the gain of this stage, variable over a 25dB range by

PEAK LIMITER DRIVE control R26.

Positive and negative output excursions of IC5 are also independently rectified by diodes CR8 and 7, respectively; the peak values held by capacitors C16 and 15. Polarity of the DC voltage across C17 indicates the predominant polarity of program peaks and controls the automatic program phase reversal feature to maintain maximum positive AM carrier modulation. IC7 adds DC gain and hysteresis to the switching signal. FET Q8, normally off, prevents IC7 from changing state except when momentarily turned on at signal zero-crossings. A zero-crossing detector is comprised of amplifier stages IC6 and Q7, and diodes CR9 and 10. PHASE FOLLOWER SENSITIVITY adjustment R34 selects the degree of peak polarity imbalance required to effect a program phase reversal.

Peak Limiter Circuits

Input signals to the Peak Limiter assembly are fed to IC1, a variable gain stage of the Santana configuration (See pg.14). IC1, acting as the broadband peak-controlling element, drives IC2, a second Santana circuit. In this instance, however, capacitors C3 and 4 are introduced in series with the variable-resistance FET Q4 to impart a frequency-selective nature to the gain reduction characteristic. This totally independent control of high frequencies is utilized in the 75μs and 25μs FM limiting modes. In AM use, IC2 functions only as a unity-gain inverter.

A broadband peak-reducing DC control voltage is derived from the output signal of the Peak Limiter assembly. In AM processing applications this can be either the output of IC1, or the inverted output of IC2. In the Phase-Following mode, the two switching FET's Q5 and 6 are controlled by logic from the Program Amplifier assembly, selecting the program phase which results in maximum positive modulation. In the other operating situations, Q6 is kept on to maintain overall 230 phase integrity and to permit frequency-selective limiting for FM by the high frequency limiting circuit of IC2.

Transistors Q9 and 10 comprise a Baxandall full-wave rectifier configuration (See pg. 14) driven by buffer stage IC3. Q9 and 10 can be balanced for symmetrical peak rectification with a variable DC offset from calibration control R25. When asymmetrical rectification is desired, the sensitivity of the rectifier to negative-going program peaks is decreased by biasing the base of Q10 negative with POSITIVE PEAK AMPLITUDE control R30. Since buffer stage IC3 inverts, this decreased sensitivity of the rectifier to negative peaks corresponds to an increase in the level of positive program peaks at the 230 output. The value of positive peaks can be varied from 100% to 150% of the negative peak value. Transistor Q11 multiplies the gain of the

Baxandall rectifier, resulting in a very high compression ratio (on the order of 100:1 or more) above the peak limiting threshold.

The peak rectifier filter consists of capacitors C7, 8 and 18, resistors R37, 38, 39 and 40, and diodes CR4, 15 and 16. Emitter-follower Q12 provides the current gain required to charge C18 instantaneously (through CR4) for reduction of even the fastest program peaks. The discharge path for C18 is through R40 into C8 in the SINGLE mode. With a DUAL release characteristic, C8 is charged through CR16 simultaneously with C18. Now the discharge of C18 lags behind the discharge of C8 through R38 into C7. With a TRIPLE function, C7 (charged through CR15) delays the discharge of both C18 and C8. In each release mode, the DC gain-control voltage at the gate of Q1 assumes a differently shaped decay characteristic as well as a different overall decay time. The multiple RC filter network results in a complex release function controlled by program peak content, peak incidence and peak duration.

The Peak Reduction meter is driven by a sample-and-hold circuit consisting of IC's 4 and 5 and transistor Q13. Peak holding time of the metering circuit is fixed by the time constant of C11 and R44, and at about two seconds permits an accurate display of even the fastest program peaks.

The independent high frequency limiter functions similarly to the broadband peak reduction circuit just discussed. The output of IC2 is equalized to the 75μs or 25μs characteristic by C12 and R48 and 49. IC6 is a gain stage driving the Baxandall rectifier comprised of Q14, 15, 16 and 17. The resultant DC is applied to Q4 to reduce the higher frequencies. CR11, C14 and R61 and 62 form a dual release filter similar to that used in the broadband circuit.

Output Amplifier

The Output Amplifier is part of the Program Amplifier assembly and consists of IC8, with Q9 and 10 as current-gain stages. Gain is set by OUTPUT LEVEL control R43. The 230 line output is isolated by the chassis-mounted transformer T2.

Power Supply

Power transformer T3, rectifier diodes CR1-4 and filter capacitors C1 and 2 deliver "raw" DC to the two "three-terminal" voltage regulators, IC's 1 and 2. Dual operational amplifier IC3 is connected to provide additional AC feedback around the two regulators, further reducing ripple and noise on the ±18-volt regulated supplies.

VI. CALIBRATION

General

The Inovonics 230 has been carefully calibrated at the factory and "burned-in" to verify circuit stability prior to shipment. There is no requirement for routine instrument calibration, and the only reason which might necessitate adjustment of the various calibration controls would be a catastrophic failure and subsequent replacement of critical components. A calibration procedure is nonetheless given, but should be attempted only by qualified individuals who have read the Circuit Descriptions and who understand the various circuit functions.

Equipment Required

1. Printed circuit Extender Card: Inovonics A/N 137300 (Available from Inovonics, $25, postpaid)

2. Audio Oscillator: Hewlett-Packard 200CD or equivalent.

3. AC Voltmeter: Hewlett-Packard 400H or equivalent.

Bandpass Compressor

Preliminary

1. The Bandpass Compressor assemblies are adjusted one-at-a-time in their own respective sockets, with all other Bandpass Compressor assemblies removed.

2. AC voltmeter access to the Compressor Input Bus and the output of the Combining Amplifier is made by temporarily soldering short "pigtail" leads to the INPUT GAIN (COMPRESSION) and PEAK LIMITER DRIVE controls on the Program Amplifier assembly. In both cases connection is made to the control pin nearest the front edge of the board. Hereafter, these monitor points are referred to as "input" and "output," respectively.

3. Set the Program Amplifier FUNCTION switch to Ungated, and rotate the PEAK LIMITER DRIVE control fully CCW. Settings of other controls are unimportant.

4. Connect the oscillator to the 230 input.

FET Balance / Threshold Cal.

1. Insert the assembly to be calibrated into the Extender Card, and the Extender Card into the proper socket.

2. Set the oscillator to the midband frequency for the assembly under test. Adjust the oscillator output level for a reading of -10dBm at the "input" monitor point.

3. Connect the voltmeter to the "output" monitor point. Turn R36 and R15 fully CCW, and set the THRESHOLD control fully "up." Adjust R2 for a minimum reading (null) on the AC voltmeter.

4. Turn R36 fully CW. Adjust the BAND GAIN control for a voltmeter reading of -19.6dBm.

5. Slowly rotate R36 CCW until the voltmeter drops 0.2dB, to -19.8dBm.

6. Turn R15 slowly CCW, setting for an additional drop of 0.2dB, to -20dBm. At this point set R37 for a front-panel Compression meter reading of zero.

Ratio Cal.

1. Set the RATIO switch to 2:1. With the AC voltmeter connected to the "input" monitor point, increase the oscillator output level for a reading of +6dBm.

2. Reconnect the AC voltmeter to the "output" monitor point. Adjust R22 for a voltmeter reading of -12dBm.

3. Set the RATIO switch to 4:1; the output should fall to -16dBm. At 8:1 the reading should fall to -18dBm.

Repeat this procedure for each Bandpass Compressor assembly. It is suggested that the calibration pots be resealed with a small amount of white glue (Elmer's, etc.). When all assemblies have been adjusted, remove the two monitor access leads from the Program Amplifier assembly.

Program Amplifier

There are no calibration adjustments on this assembly.

Peak Limiter

Preliminary

1. Plug the Peak Limiter assembly into the Extender Card, and the Extender Card into the Peak Limiter assembly socket.

2. This assembly is calibrated with all other assemblies installed, the Program Amplifier FUNCTION switch in the "Proof" position and the OUTPUT LEVEL control fully CCW.

3. The oscillator should be connected to the 230 input, the AC voltmeter to the 230 output.

4. Turn the POS. PEAK AMPLITUDE (ASYMMETRY) control fully CCW and set the RELEASE FUNCTION switch in the DUAL position.

Q1/Q2 Balance / R34 Adjustment

1. Set the Peak Limiter MODE switch to Flat. Set the oscillator to a frequency of 500Hz and adjust the oscillator output level for a reading of -10dBm on the AC voltmeter.

2. Rotate R34 fully CCW. Adjust R1 for a minimum reading (null) on the AC voltmeter.

3. Turn R34 fully CW and note the output reading. Slowly rotate R34 CCW until the output decreases by 0.1dB.

4. Set R45 for a front-panel Peak Reduction meter reading of zero.

Q3/Q4 Balance / R58 Adjustment

1. Increase the oscillator frequency to 20kHz.

2. Rotate R58 fully CCW. Adjust R5 for a minimum reading (null) on the AC voltmeter.

3. Turn R58 fully CW and note the output reading. Slowly rotate R58 CCW until the output decreases by 0.1dB.

H.F. Limiter Calibration

1. Set the Peak Limiter MODE switch to 75μs and reset the oscillator frequency to 500Hz.

2. Increase the oscillator output amplitude for an indicated Peak Reduction of 10 - 15dB. Note the output reading.

3. Increase the oscillator frequency to 2.3kHz. Adjust R50 for an output reading 3dB below the 500Hz figure.

Rectifier Balance

1. Set the Peak Limiter MODE switch to Asymmetrical and reset the oscillator frequency to 500Hz. The front-panel meter should indicate 10 - 15dB of Peak Reduction. Note the exact output reading.

2. Connect one end of a short clip lead to the anode of CR1 (end nearest Q13). As the other end of the clip lead is touched to +18V (top end of R29), the POLARITY indicators should toggle from + to -.

3. Adjust R25 so that there is no output level shift when the POLARITY indicators change state.

It is suggested that the calibration pots be resealed with a small amount of white glue (Elmer's, etc.) following calibration.

VII. APPENDIX

SCHEMATIC REF. NO.	PART NUMBER	DESCRIPTION	MFG.	MANUFACTURER PART NUMBER
	134700	BANDPASS COMPRESSOR ASS'Y.		
C1, 7, 8	0801	Capacitor, 10pF	Arco	DM15-100J
C6	1053	" 2.2uF	Matsuo	DTSA-2002-225M
(AS REQUIRED PER VERSION)	0850	" .001uF	Sprague	225P10291
"	0854	" .0022uF	Sprague	225P22291
"	0858	" .0047uF	Sprague	225P47291
"	0862	" .01uF	Sprague	225P10391
"	0863	" .022uF	Sprague	225P22391
"	0865	" .047uF	Sprague	225P47391
"	0867	" .1uF	Sprague	225P10491
"	1065	" .22uF	Matsuo	DTSA-3502-224M
"	1066	" .47uF	Matsuo	DTSA-3502-474M
CR 1-4	1100	Diode, 1N4151	G.E.	
IC 1-3	1300	Integrated Circuit, Type 748-C	Signetics	5748V

SCHEMATIC REF. NO.	PART NUMBER	DESCRIPTION	MFG.	MANUFACTURER PART NUMBER
Q1, 2	1211	Transistor, MPF 111	National	
Q3, 5, 6	1204	" 2N3567	National	
Q4,7,8,10	1205	" 2N3645	National	
Q9	1210	" SE4010	Fairchild	
R2,15,37,36	0559	Resistor, Variable 10K	Beckman	91AR10K
R13	0616	" " 10K		
R22	0558	" " 5K	Beckman	91AR5K
R25	0510	" " 10K	"	89PR10K
		All fixed resistors are 1/4w carbon, value and tolerance per schematic.		
S 1	1826	Switch, 2 pole, 3 position "slide"		
	134900	PROGRAM AMPLIFIER ASS'Y.		
C1,4,7,9,13, 14,18,19	0801	Capacitor, 10pF	Arco	DM15-100J
C2, 12	0803	" 22pF	Arco	DM15-220J
C3, 11	0810	" 100pF	Arco	DM15-101J

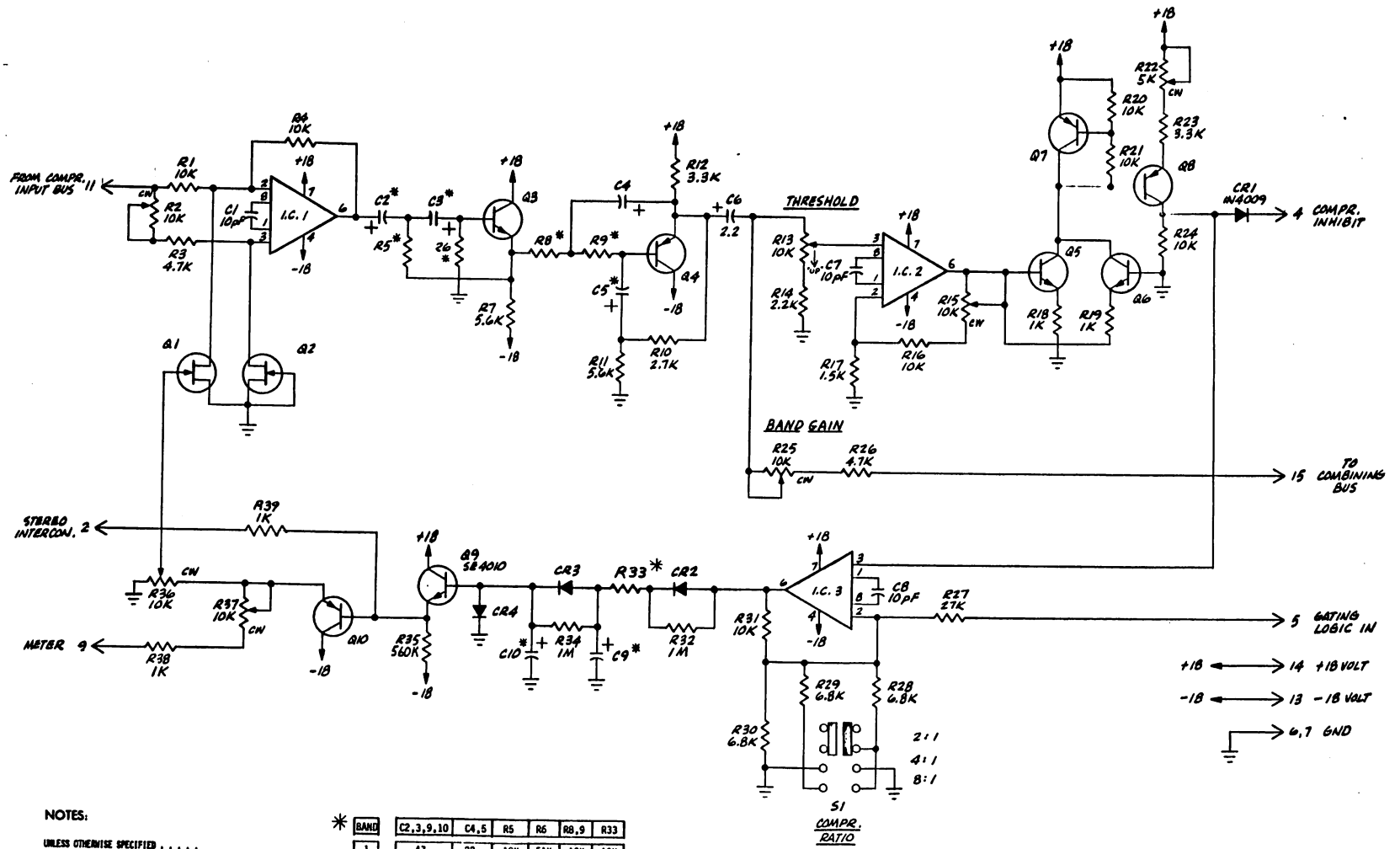
SCHEMATIC REF. NO.	PART NUMBER	DESCRIPTION	MFG.	MANUFACTURER PART NUMBER
C5	1054	Capacitor, 4.7, 10v	Matsuo	DTSA-2002-475M
C6	0858	" .0047, 100v	Sprague	225P47291
C8, 17	0867	" .1, 100v	Sprague	225P10491
C10	1067	" 1.0, 35v	Matsuo	DTSA-3502-105M
C15, 16	1053	" 2.2, 20v	Matsuo	DTSA-2002-225M
CR1-15	1100	Diode, 1N4151	G.E.	
IC 1-8	1300	Integrated Circuit, Type 748-C	Signetics	5748V
Q1,3,5,9	1204	Transistor, 2N3567	National	
Q2,6,7,10	1205	" 2N3645	National	
Q4	1210	" SE4010	Fairchild	
Q8	1211	" MPF111	National	
R1, 4	0514	Resistor, Variable 100K	Beckman	89PR100K
R26	0513	" " 50K	Beckman	89PR50K
R34,43	0510	" " 10K	Beckman	89PR10K

SCHEMATIC REF. NO.	PART NUMBER	DESCRIPTION	MFG.	MANUFACTURER PART NUMBER
		All fixed resistors are 1/4w carbon, value and tolerance per schematic.		
S1	1827	Switch, Rotary, 4 position		
	2502	Knob, Skirted		
	135100	PEAK LIMITER ASS'Y.		
C1,2,6,9,13	0801	Capacitor, 10pF	Arco	DM15-100J
C7,10,11	1053	" 2.2uF, 20v	Matuso	DTSA-2002-225M
C5	1054	" 4.7uF, 20v	Matsuo	DTSA-2002=475M
C12	0850	" .001uF, 100v	Sprague	225P10291
C14	0867	" .1uF, 100v	Sprague	225P10491
C15, 3	1065	" .22uF, 35v	Matsuo	DTSA-3502-224M
C4,18	1066	" .47uF, 35v	Matsuo	DTSA-3502-474M
C16	1068	" 22uF, 3v	Matsuo	DTSA-0302-226M
C8	1067	" 1.0uF, 35v	Matsuo	DTSA-3502-105M
CR1-15	1100	Diode, 1N4151	G.E.	

SCHEMATIC REF. NO.	PART NUMBER	DESCRIPTION	MFG.	MANUFACTURER PART NUMBER
IC 1-4, 6	1300	Integrated Circuit, Type 748-C	Signetics	5748V
IC 5	1310	" " Type 1458	National	LM1458
Q 1-6	1211	Transistor, MPF111	National	
Q7,8,9,10,12,13 14,15,17,18	1204	" 2N3567	National	
Q11, 16	1205	" 2N3645	National	
R1	0558	Resistor, Variable 5K	Beckman	91AR5K
R5,34,45,50,58	0559	" " 10K	Beckman	91AR10K
R25	0563	" " 100K	Beckman	91AR100K
R30	0510	" " 10K	Beckman	89PR10K
		All fixed resistors are 1/4w carbon, value and tolerance per schematic.		
S1	1828	Switch, Rotary, 5 position		
S2	1826	" 2 pole, 3 position "slide"		
	2502	Knob, Skirted		

SCHEMATIC REF. NO.	PART NUMBER	DESCRIPTION	MFG.	MANUFACTURER PART NUMBER
		CHASSIS ASS'Y.		
C1, 2	0910	Capacitor, 500uF, 50v	Sprague	TVA 1315
C3-6,11,12	1064	" .005uF, 1kv	Sprague	5GA-D50
C7-10	1053	" 2.2uF, 20v	Matsuo	DTSA-2002-225M
CR 1-4	1125	Diode, 1N4005 Rectifier	Motorola	
F1	2702	Fuse, 1/2A	Littlefuse	
	2700	Fuseholder for F1		
I 1, 2	2015	LED, green	Monsanto	MV5253
I 3, 4	2014	" red	Litronix	RL4850
IC 1	1311	Integrated Circuit, Type 7818	National	LM7818C
IC 2	1312	" " Type 7918	National	LM7918C
IC 3	1310	" " Type 1458	National	LM1458

SCHEMATIC REF. NO.	PART NUMBER	DESCRIPTION	MFG.	MANUFACTURER PART NUMBER
J 1-10	1708	PC Connector, 15 pin single edge		
J 11	1781	Barrier Strip, 6 terminal		
J 12,13,(J1)	1683	IC Socket, 14 pin dual-inline		
M 1-8	2803	Meter, Edgewise "COMPRESSION"		
M 9	2804	" Bezel-mounting "PEAK REDUCTION"		
T 1	1502	Transformer, Input		
T 2	109000	" Output		
T 3	130100	" Power		
	1503	Shield for T1		
	1682	Cable Ass'y. 14 conductor		



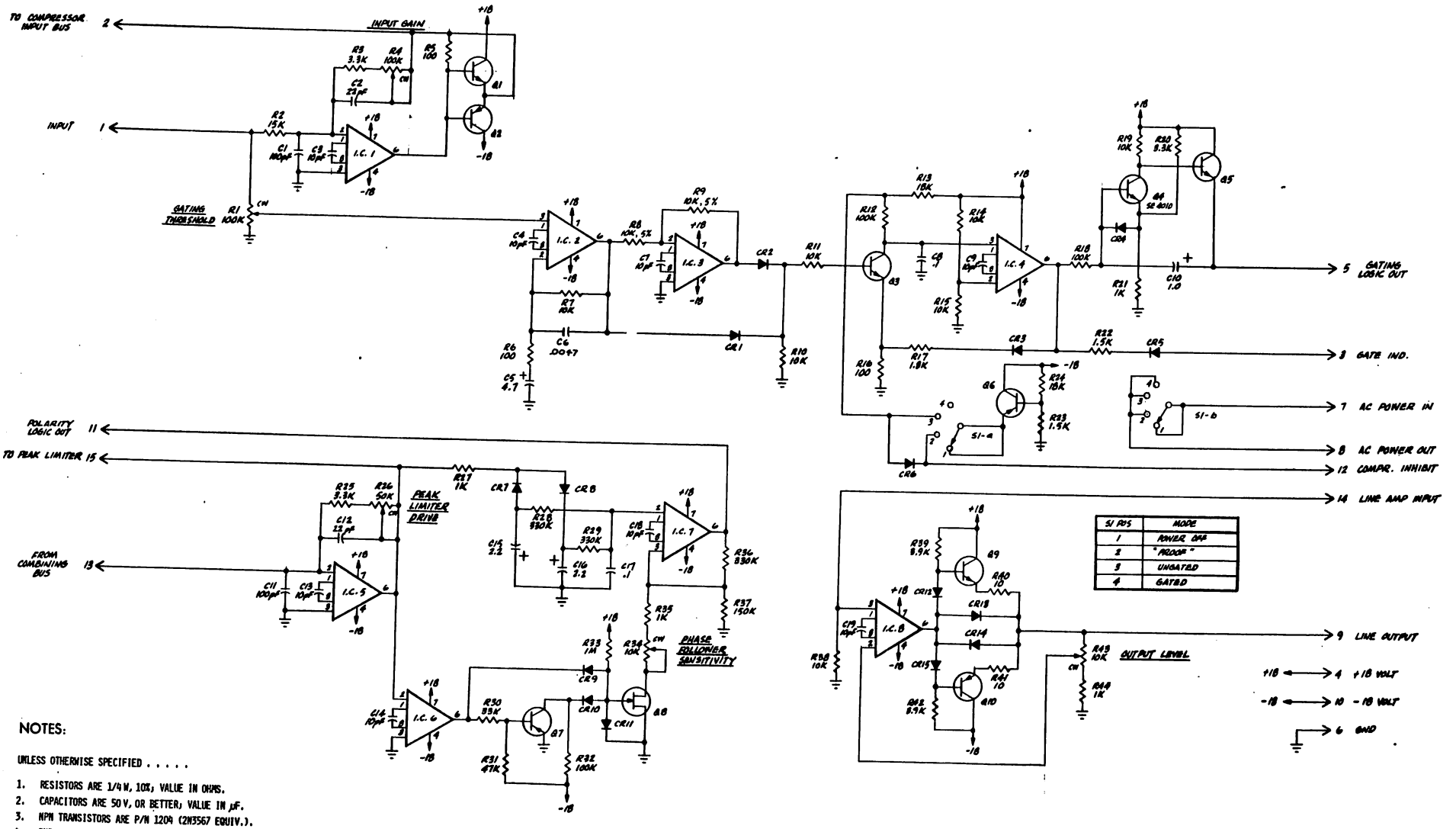
NOTES:

UNLESS OTHERWISE SPECIFIED . . . . .

1. RESISTORS ARE 1/4 W, 10%; VALUE IN OHMS.
2. CAPACITORS ARE 50 V, OR BETTER; VALUE IN μF.
3. NPN TRANSISTORS ARE P/N 1200 (2N3567 EQUIV.).
4. PNP " " P/N 1205 (2N3645 ").
5. FET " " P/N 1211 (NPF 111 ").
6. DIODES ARE P/N 1100 (1N4009 EQUIV.).
7. IC'S ARE P/N 1300 (TYPE 748-C).

* BAND	C2,3,9,10	C4,5	R5	R6	R8,9	R33
1	.47	.22	18K	51K	13K	10K
2	.22	.1	6.2K	18K	15K	22K
3	.1	.047	6.2K	18K	15K	47K
4	.047	.022	6.2K	18K	13K	100K
5	.022	.01	6.2K	18K	13K	100K
6	.01	.0047	5.6K	18K	16K	100K
7	.0047	.0022	6.2K	20K	15K	100K
8	.0022	.001	5.6K	18K	8.2K	100K

230	GWT 10-6-76	SCHEMATIC, BANDPASS COMPRESSOR	
		1 · 1	136300 C



S1 POS	MODE
1	POWER OFF
2	"PROGRAM"
3	UNGATED
4	GATED

NOTES:

UNLESS OTHERWISE SPECIFIED . . . . .

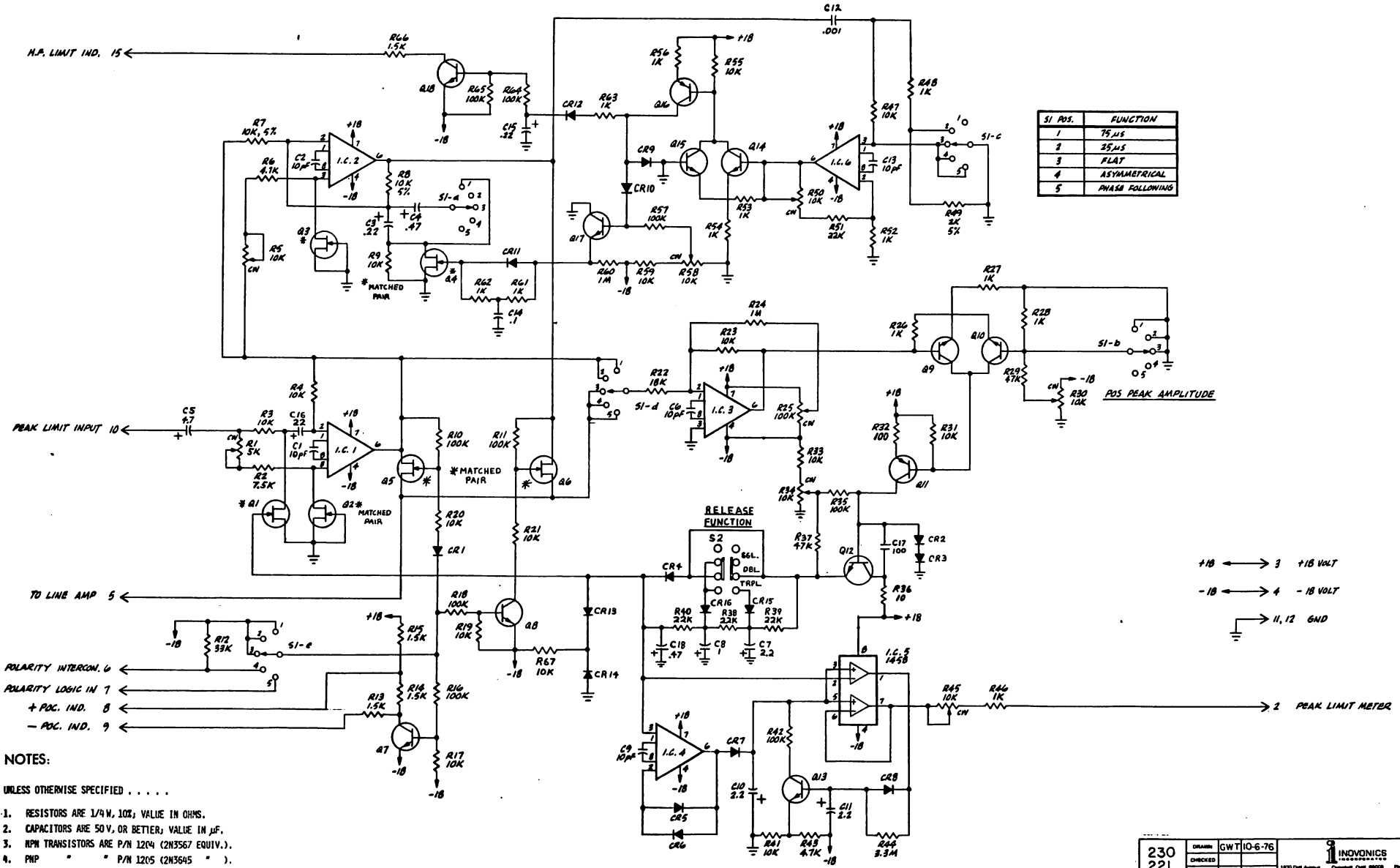
1. RESISTORS ARE 1/4 W, 10%; VALUE IN OHMS.
2. CAPACITORS ARE 50 V, OR BETTER; VALUE IN μF.
3. NPN TRANSISTORS ARE P/N 1204 (2N3567 EQUIV.).
4. PNP " " P/N 1205 (2N3645 ").
5. FET " " P/N 1211 (MPF 111 ").
6. DIODES ARE P/N 1100 (1N4009 EQUIV.).
7. IC'S ARE P/N 1300 (TYPE 748-C).

230 221	DRAWN	GWT	10-6-78
	CHECKED		
	APPROVED		
TOLERANCES	MATERIAL		
	FINISH		

INNOVONICS

SCHEMATIC, PROGRAM AMPLIFIER

SIZE A | DWG NO. 136400 | REV A | SCALE 1 of 1



NOTES:

UNLESS OTHERWISE SPECIFIED . . . . .

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230 221	DRAWN	GWT	10-6-76	INOVONICS
	CHECKED			
	APPROVED			
TOLERANCES	MATERIAL			TITLE SCHEMATIC, PEAK LIMITER
	FINISH			PAGE 1 of 1 · DWG NO 136500 · SCALE J

SCHEMATIC FOR "H" ISSUE BOARD