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I. GENERAL INFORMATION AND SPECIFICATIONS

The Inovonics 221 is a broadband audio processing unit for AM, FM and TV broadcast use. Included is a slow-acting, gated A.G.C. function to correct for long-term variations in input program level, and the exclusive Inovonics "open loop" averaging compressor, also gated, for a wide range of control over program dynamics. The 221 peak limiter circuit is phase-following and capable of asymmetrical modulation for AM, and a separate 25- or 75µs frequency-selective limiter can be enabled for FM or TV.

Specifications

Frequency Response: ±1dB, 20Hz - 20kHz.

Noise Level: Better than 70dB below 100% modulation.

Distortion: <1% THD for any degree of compression and limiting of steady-state signals 200Hz - 20kHz; distortion rises 6dB/octave below 200Hz at fastest compression and limiting release times.

A.G.C. Capture Range: ±10dB

A.G.C. Correction Rate: 0.5dB/second

Averaging Compression: Variable to 20dB

Avg. Comp. Ratio: Variable - increases as a function of compression (See Fig. 1)

Avg. Comp. Attack Time: 1ms/dB-compression

Avg. Comp. Release Time: 5, 15 or 50ms/dB-compression

Gating Feature (DEFEATABLE): (See pg. 6)

Peak Limiting: Variable to 15dB

Limiter Compression Ratio: >100:1

Limiter Attack Time: <1µs for any degree of limiting.

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

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

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

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

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 for slaved compression.

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

Size and Weight: 3-1/2" x 19" x 9"; 11 lbs.

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II. DESIGN PHILOSOPHY AND FUNCTIONAL DESCRIPTION

A.G.C. Amplifier

The program output from a broadcast console is subject to level variations for any of a number of reasons. A change in operators, for example, may result in several dB change in program level, even with close attention to the chore of manual gain-riding. VU meter ballistics account for up to 10dB difference in the true r.m.s. value of signals yielding similar meter indications. Automated programming, largely an unattended operation, and TV audio, the much neglected portion of that medium, present additional problems beyond the usual control of duty personnel.

These level discrepancies, generally classed as "long term" variations, need to be dealt with in a manner analogous to close manual gain-riding, rather than simply compressed in dynamic range. Indeed, if subsequent compression and limiting are ultimately intended, the input to these dynamic range restrictors must be held more or less constant to maintain their restriction at a constant value.

The A.G.C. system utilized in the Inovonics 221 is a slow, average-responding level controller. The rate of control is about 0.5dB/second, and the circuit is "gated" to prevent its slowly raising non-program background noises to an annoying level during extended pauses in the program.

Open Loop Compression

Unlike most conventional Compressors operating in a closed-loop configuration, the "knee" or "breakaway point" of the Inovonics 221 is a very gentle transition from a linear to a compressed condition. (See Fig. 1.) The compression ratio is therefore a function of the amount of compression in effect, and the "increasing-ratio" prior to the final infinite value characteristic of open-loop operation is responsible for the reduced audibility of gain control action.

Like the A.G.C. amplifier, the Compressor is "gated" to prevent undesirable "pumping" or "breathing" due to pauses in the program. Because of this feature, and the inherently gentle action of the "open-loop" design, far more compression without audible side effects is possible than with conventional devices.

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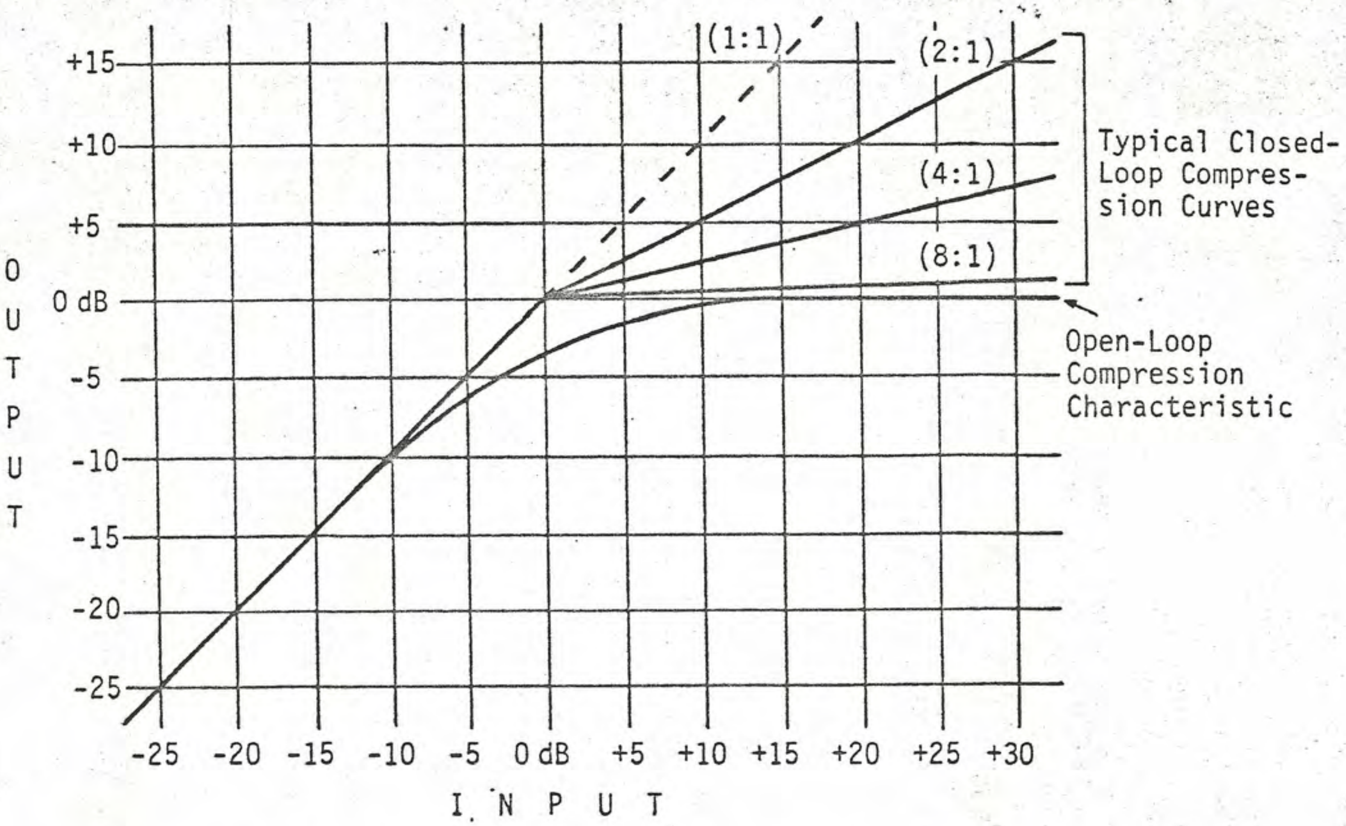

Figure 1 - Open- vs. Closed-Loop Compression Characteristics

Gating Circuit

No matter how "tight" they may be, all programming formats have occasional pauses. These may only seldom occur, as during a telephone news interview, or frequently, as during lulls in the dialog on a movie soundtrack. Without a means to inhibit A.G.C. action and/or compression release, background noises present during such pauses could attain unnatural proportions; man-eating crickets, "killer" teletype machines, etc.

The Inovonics 221 incorporates a "gating" circuit, the action of which is twofold; in the absence of legitimate program material, the A.G.C. gain is slowly returned to a nominal 0dB figure, and compression is held at the previous average value. In order for the gating circuit to accurately differentiate between legitimate program and extraneous noise, frequency weighting reduces sensitivity below 300Hz and above 3kHz.

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Peak Limiter

The 221 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 221 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 221, 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 221 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.

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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 221 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.

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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 221 is packaged to mount in a standard 19-inch equipment rack, requiring 3-1/2 inches of rack space per unit. The 221 generates negligible heat, and itself is unaffected by wide variations in the ambient operating temperature.

RFI

The 221 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 221 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.

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Polarity

The input and output of the 221 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 221 require output loading, an external 600 ohm resistor should be placed across the 221 input terminals; otherwise the input is "balanced-bridging" with a characteristic input impedance of 10K or greater.

The source impedance of the 221 output amplifier (ahead of the line output transformer) is virtually zero. However, as the output transformer has some reactance, it is important that the 221 output be terminated in 600 ohms to minimize output overshoot.

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IV. OPERATION AND ADJUSTMENT

The Inovonics 221 hosts a full complement of accessible controls which materially affect both the average-to-peak-ratio 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 221 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:
   FUNCTION - Gating, A.G.C. On
   GATING THRESHOLD - fully clockwise
   LIMITER MODE - Flat
   PEAK LIMITER RELEASE - "DUAL"
   METER - A.G.C.
   COMPR. RELEASE - Norm.

2. With a normal program feed from the console, slowly adjust the INPUT GAIN control for a consistent midscale reading on the COMPRESSION/A.G.C. meter.

3. Switch the METER to COMPR. and adjust the COMPRESSION control for an indication of 5 - 10dB.

4. Adjust the PEAK LIMITER DRIVE control for an indicated 5 - 10dB Peak Limiting.

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

6. 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 (ASYM.) control for desired positive peak

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modulation per the Modulation Monitor.

2. With the LIMITER MODE switch in the Phase-Following position, the 221 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. 7)

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

Critical listening over an extended period will best determine final control settings dictating the amount of compression and limiting. In addition, release characteristics of both control functions must be determined from subjective evaluation.

Compressor Realease

The NORM. position of this switch is designed as probably the best "compromise" setting. The FAST position will yield greater program density, but may promote listening fatigue. The SLOW position, although intended for the more conservative, quieter formats, must be used with care, as interaction between this timing characteristic and the release function of the Peak Limiter may occur if too much compression and limiting are employed.

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.

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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.

Gating Threshold Adjustment

The GATING THRESHOLD control sets the point at which an input signal will open the gate, enabling compression release and A.G.C. action. The control should be advanced (CW) sufficiently to keep the GATE OPEN indicator illuminated constantly during music, but not so far as to prevent gating action during pauses in speech.

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V. CIRCUIT DESCRIPTIONS

Input Amplifier

The 221 program input is transformer-isolated by T1 on the "mother" circuit board and routed to the Program Amplifier assembly and Input Amplifier IC1. Gain of this amplifier can be adjusted over a 30dB range by the INPUT GAIN control R4 to accommodate different input line levels.

A.G.C. Amplifier

Referring to the schematic for the A.G.C./Compressor card, the pre-amplified input signal is fed to IC1, a voltage-variable gain stage of the "Santana" configuration. FET Q1 is 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 the FET's.

Q3 and 4 comprise a "Baxandall" full-wave rectifer. The positive-going portion of the output of IC1 is amplified by common-emitter stage Q3, the negative-going by common-base stage Q4. Thus equal positive and negative information cause similar currents at the junction of the Q3 and 4 collectors. Q5 imparts additional DC gain to the rectified signal which is then filtered by the network consisting of R12 and 13 and C3 and 4. The long time constant of this filter prevents the A.G.C. circuit from acting too quickly, insuring control over only long-term signal variations. IC2, a unity-gain buffer amplifier, isolates the filter from its load.

Switch transistor Q6, controlled by the gating logic, returns the A.G.C. amplifier to a nominal 0dB gain figure when the program signal falls below Gating Threshold. This prevents the circuit from slowly raising residual noise to an annoying level during program pauses.

Averaging Compressor

From the A.G.C. circuit, the program signal passes through COMPRESSION control R19 to both the compression amplifier, comprised of Q7, 8 and 9 and associated components, and to a "precision" full-wave rectifier IC3.

Q8, with its current-source collector load Q9, is, in effect, a single-stage operational amplifier. Gain of this stage is roughly set by the

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value ratio between input resistor R21 and feedback resistor R23. Amplifier gain is varied by Q7, the saturation resistance shunting the amplifier summing mode to ground.

Transistor saturation resistance is not symmetrical, if a transistor were placed in the ground leg of a typical resistance voltage divider, an AC signal would be severely distorted. The single stage operational amplifier, on the other hand, is simultaneously depleted of loop gain as the input signal is shunted, assuming a non-linear characteristic cancelling that of the saturation transistor. Gain reduction is thus effected without distortion.

The program signal rectified by IC3 charges filter capacitor C9 through R44 and current gain stages Q11 and 12. Discharge of C9 is through resistors R40, 41 and 42 as selected by COMPR. RELEASE switch S2. Unity-gain stage IC4 buffers the rectified voltage for application to the gain control transistor Q7. The rectified voltage, further integrated by R49 and C50, is buffered by half of IC5 and diverted through Q13 to the discharge path of C9 when gating logic requires compression to be held at the previous average value. C9 is thus prevented from further discharge until the program signal again rises above the Gating Threshold value.

Gating Circuit

A portion of the "raw" 221 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.

Program Phase Detector

Drive to the Peak Limiter (and thus the amount of program peak limiting employed) is set by the gain of amplifier IC5, variable over a 25dB range by PEAK LIMITER DRIVE control R26.

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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 221 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 221 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.

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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.

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VI. CALIBRATION

General

The Inovonics 221 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.

Program Amplifier

There are no calibration adjustments on this assembly.

A.G.C. / Compressor Assembly

Preliminary

1. Plug this P.C. assembly into the Extender Card, and the Extender Card into the A.G.C./Comp. socket.
2. Connect the oscillator to the 221 input, set oscillator frequency to 500Hz.
3. Turn the INPUT GAIN and GATING THRESHOLD controls fully CW.

Q1/Q2 Balance / R14 Adjustment

1. Set the FUNCTION switch to GATING, A.G.C. ON, METER switch to A.G.C.
2. Monitor pin 6 of IC1 with the AC voltmeter. The top of R5 is convenient access to this monitor point.

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3. With a clip lead, short R7. This will inhibit A.G.C. gating.

4. Turn R14 fully CW and adjust the oscillator output amplitude for a meter reading of 0dBm.

5. Turn R14 fully CCW and adjust R2 for a minimum reading (null) on the AC voltmeter.

6. Turn R14 fully CW and note the exact meter reading. Slowly rotate R14 CCW until the reading decreases by 0.1dB.

7. Remove the AC voltmeter connection, the shorting strap from across R7, and disconnect the oscillator from the 221 input. The GATE OPEN lamp should now be off and the COMPRESSION/A.G.C. meter slowly swinging to the left, eventually coming to rest near mid-scale.

8. Adjust R16 so that the front panel meter reads in the center of the central shaded area.

Compression Linearity

1. Reconnect the oscillator to the 221 input and set oscillator frequency to 500Hz.

2. Set the FUNCTION switch to UNGATED/A.G.C. OFF, METER switch to COMPR., COMPRESSION control fully CW.

3. Monitor the junction of R28 and 29 with the AC voltmeter. The top of R29 is convenient access to this point.

4. With a clip lead, interconnect test points TP1 and TP2.

5. Advance the oscillator amplitude, noting the AC voltmeter reading. As the oscillator level is increased, the output should follow to a point, level-off for a period, then finally resume following the oscillator. Compressor "Linearity" control, R46, should be adjusted for the 0.25dB maximum droop in the flat portion of the above-indicated compressor transfer curve shown in Figure 2, next page.

Compression Meter Calibration

1. With the same test conditions as in the "Linearity" adjustment, increase the oscillator amplitude until the AC voltage indicates a 1dB increase from the flat, compressor "ceiling" value. At this point, adjust R48 for a panel meter indication of 20dB compression.

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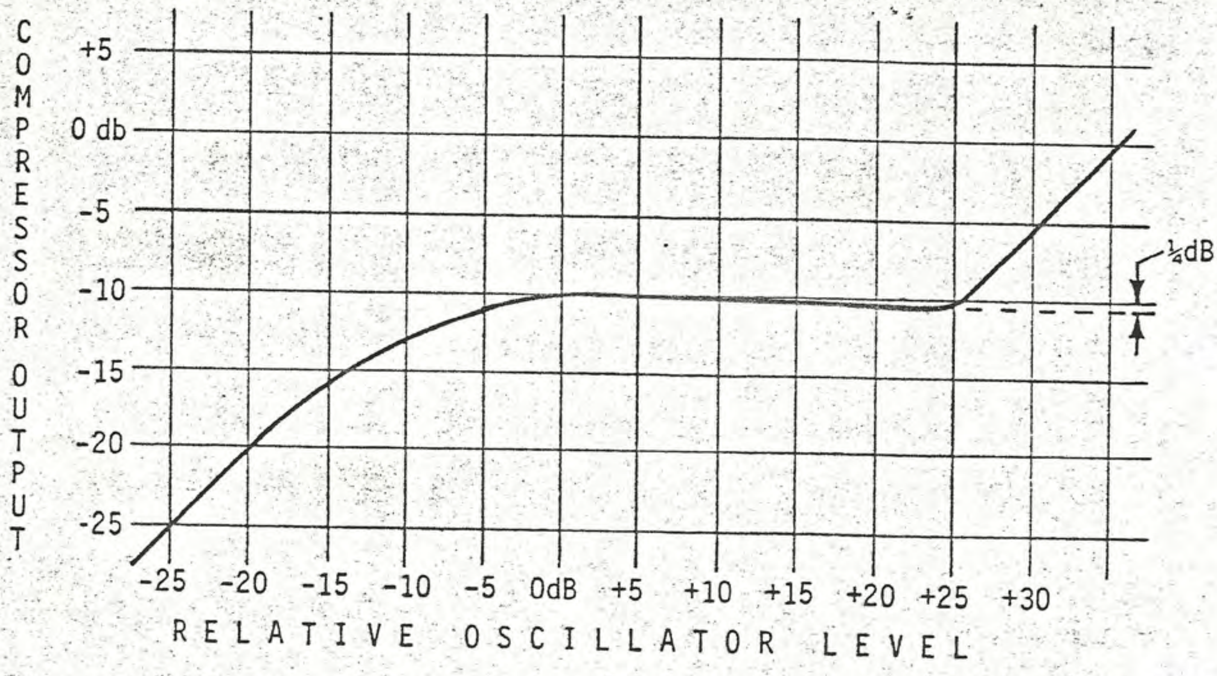

Figure 2 - Compression Linearity Adjustment

2. Decrease the oscillator level for a Compression Meter reading of 10dB.

3. Adjust R36 for an AC voltmeter indication of -10dBm.

4. Remove the shorting clip lead.

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 221 input, the AC voltmeter to the 221 output.

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

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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 -.

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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.

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VII. APPENDIX

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INOVONICS WARRANTY

Inovonics, Inc. products are warranted to be free from defects in material and workmanship. Any discrepancies noted within 90 days of the date of purchase will be repaired free of charge. Additionally, parts for repairs required between 90 days and one year from the date of purchase will be supplied free of charge, with installation billed at normal rates. It will be the responsibility of the purchaser to return equipment for warranty service to the dealer from whom it was originally purchased unless prior arrangement is made with the dealer to inspect or repair at the user's location.

This warranty is subject to the following conditions:

1. Warranty card supplied with the equipment must be completed and returned to the factory within 10 days of purchase.

2. Warranty is void if unauthorized attempts at repair or modification have been made, or if serial identification has been defaced, removed, or altered.

3. Warranty does not apply to damage caused by misuse, abuse, or accident.

4. Warranty valid only to original purchaser.

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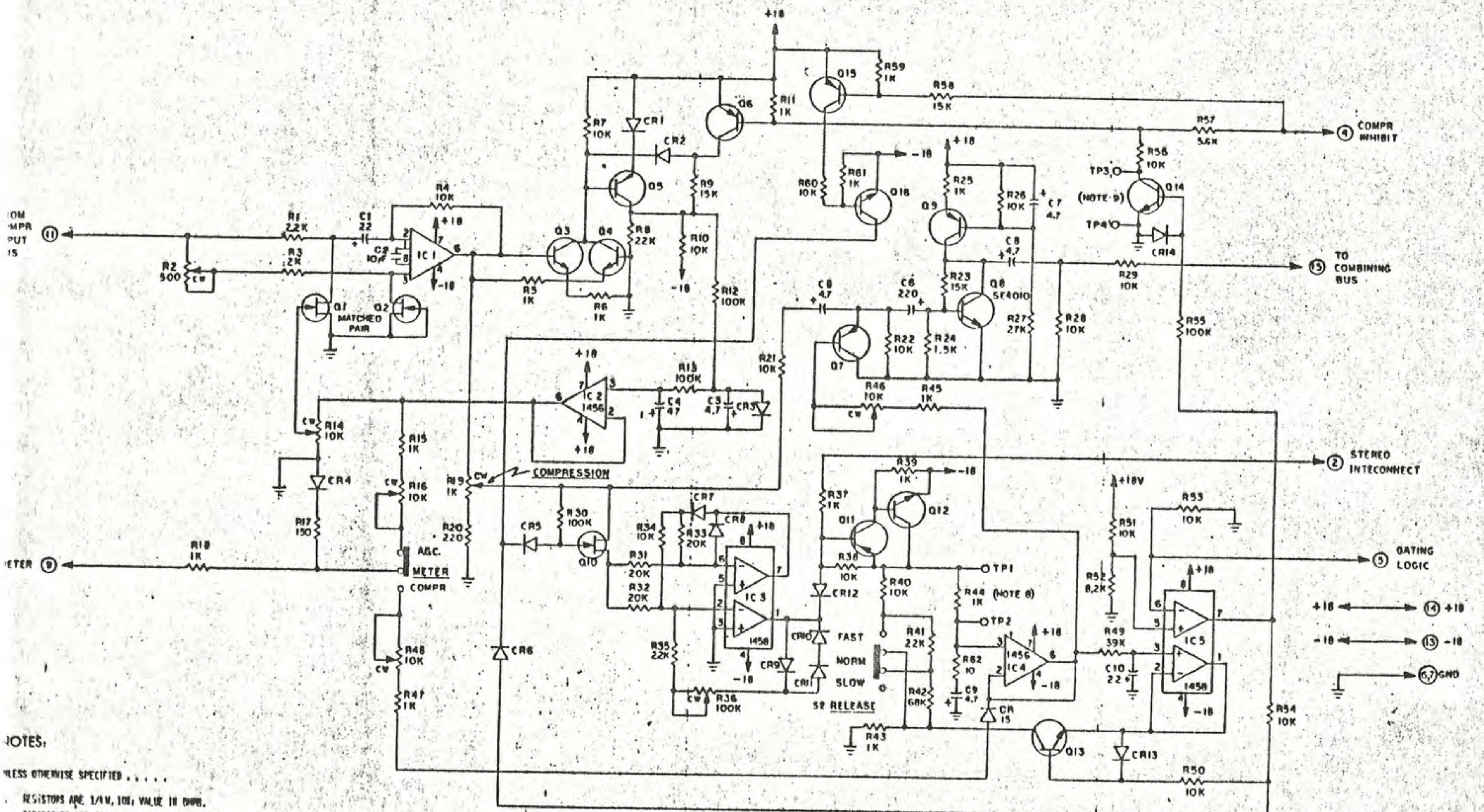

NOTES:

UNLESS OTHERWISE SPECIFIED . . . . .

- RESISTORS ARE 1/4W, 10%; VALUE IN OHMS.
- CAPACITORS ARE 50V, OR BETTER; VALUE IN µF.
- NPN TRANSISTORS ARE P/N 1204 (2N3567 EQUIV.).
- PNP " " P/N 1205 (2N3645 ").
- FET " " P/N 1211 (MPF 111 ").
- DIODES ARE P/N 1100 (1N4009 EQUIV.).
- IC'S ARE P/N 1300 (TYPE 748-C).
- TP 1 & 2 SHORTED TO ENABLE PEAK LIMITING OPTION.
- TP 3 & 4 SHORTED TO DISABLE A.G.C. FUNCTION.

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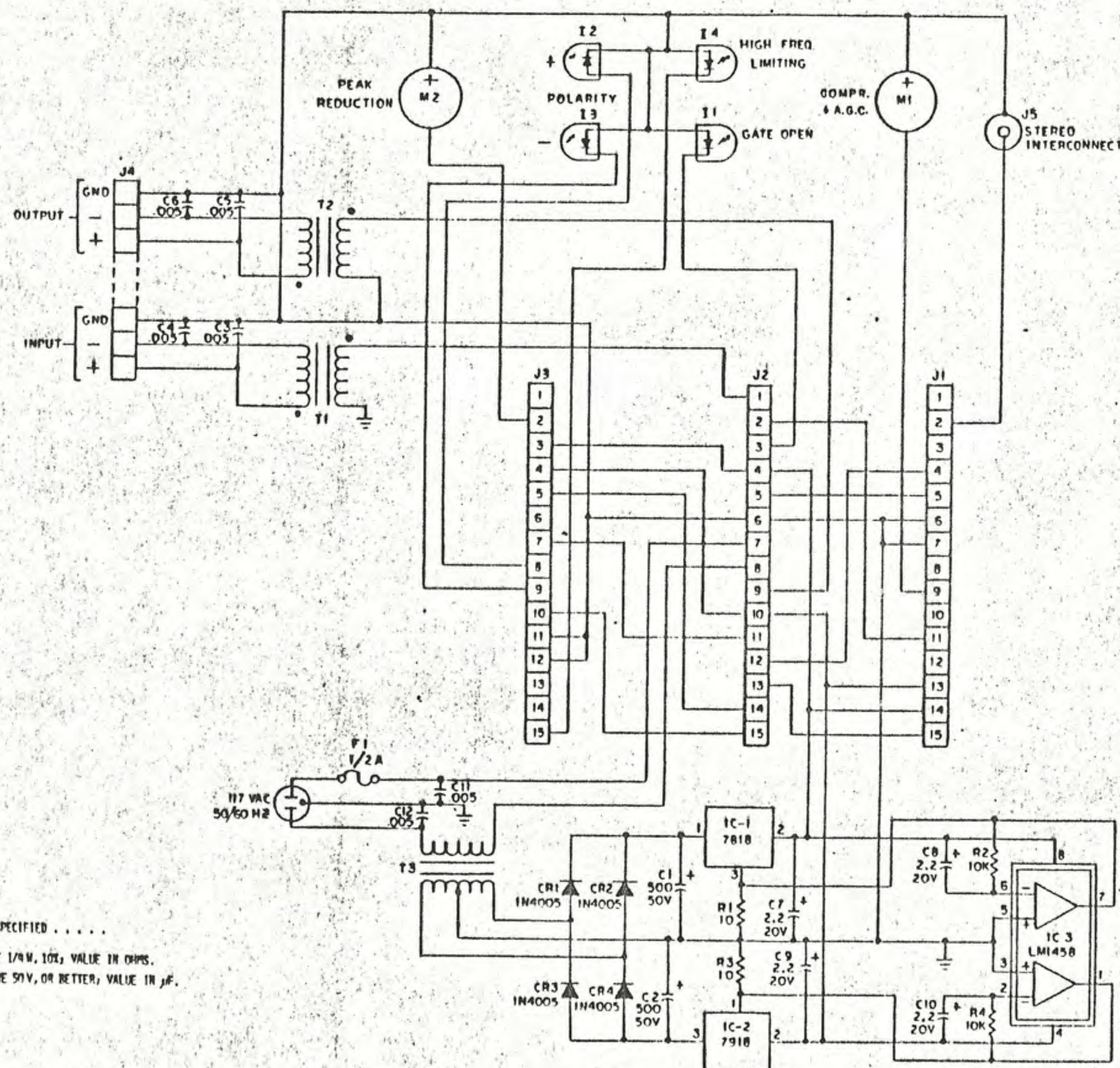
221	WD 1-24-78	INOVONICS	SCHEMATIC COMPRESSOR/AGC ASSY
	JRW 1-25-78		



NOTES:

UNLESS OTHERWISE SPECIFIED . . . . .

1. RESISTORS ARE 1/4 W, 10%, VALUE IN OHMS.
2. CAPACITORS ARE 50V, OR BETTER; VALUE IN μF.

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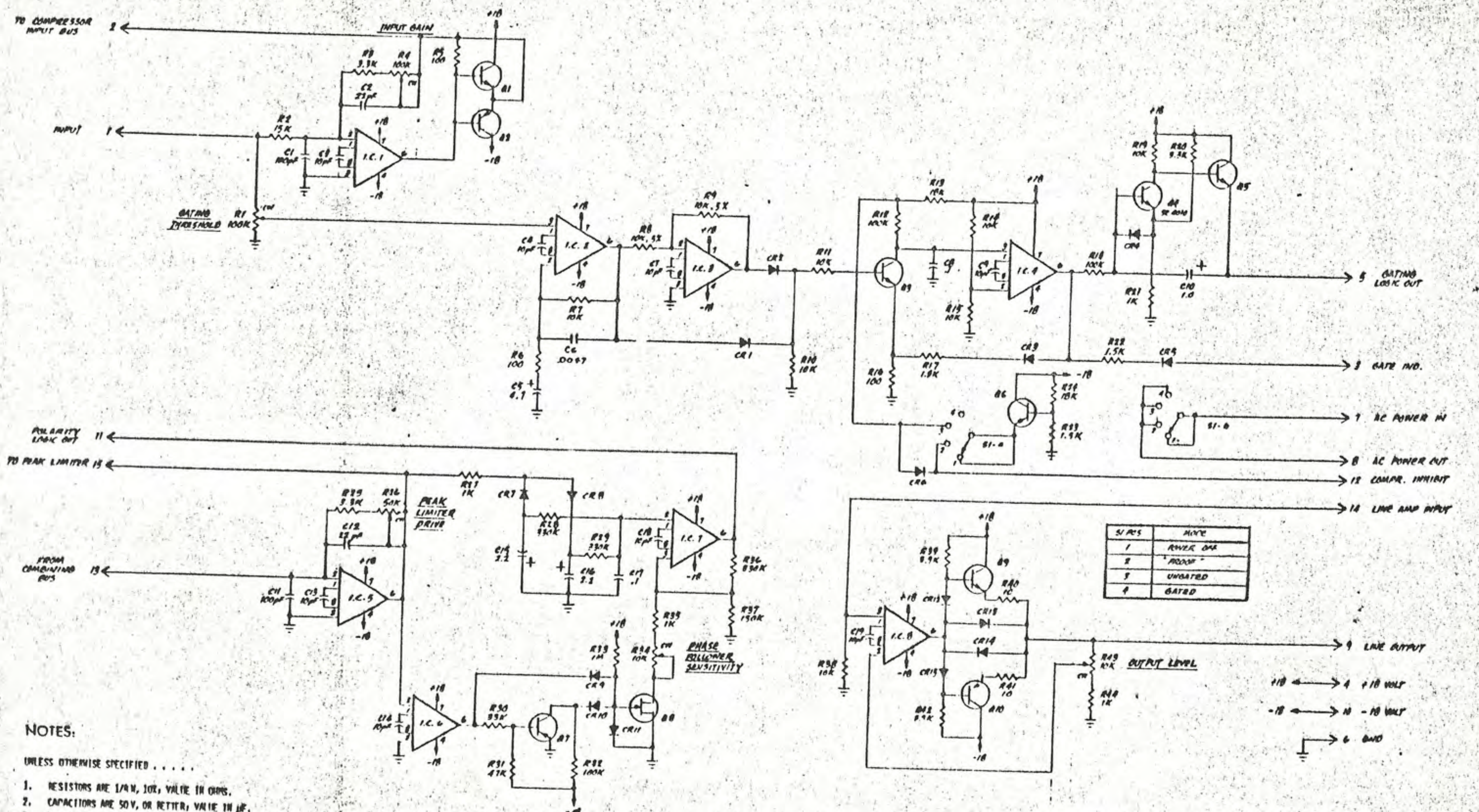
221 | W.D. 1-24-78 | JBW 1-25-78

SCHEMATIC, CHASSIS



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 1[illegible] ([illegible] EQUIV.)

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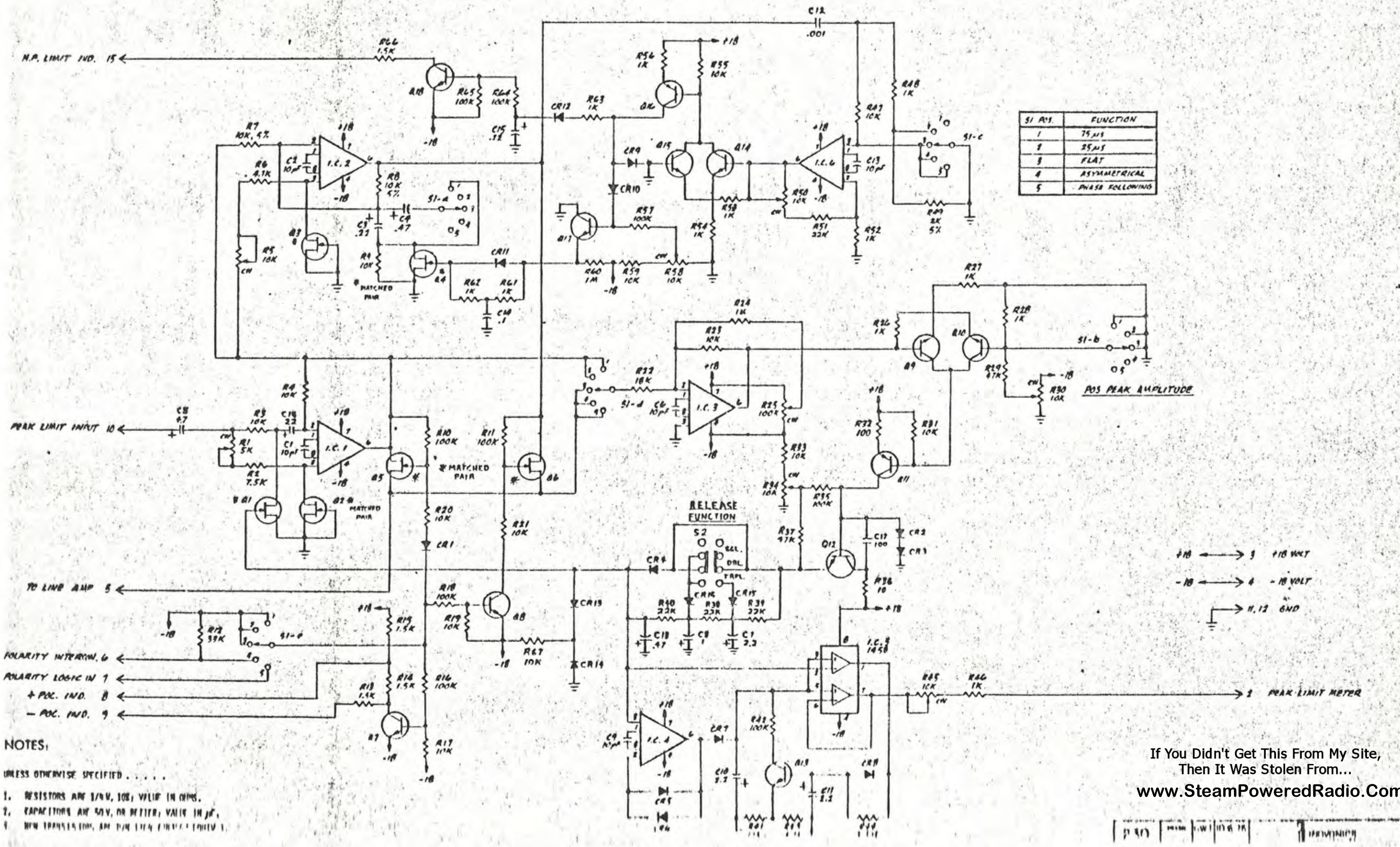

NOTES:

UNLESS OTHERWISE SPECIFIED . . . . .

1. RESISTORS ARE 1/4W, 10%; VALUE IN OHMS.
2. CAPACITORS ARE 50V, OR BETTER; VALUE IN µF.
3. [illegible]

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MATIC . NO.	PART NUMBER	DESCRIPTION	MFG.	MANUFACTURER PART NUMBER
	1708	PC Connector, 15 pin single edge	S.A.E.	SAC-15S/2-2
	1781	Barrier Strip, 6 terminal	Cinch	6-140-Y
	1633	Phono Jack	Switchcraft	3501FP
	1683	IC Socket, 14 pin dual-inline	Circuit Assembly	CA-14S TSD
	2805	Meter, "COMPRESSION/A.G.C."		
	2804	" "PEAK REDUCTION"		
	1502	Transformer, Input	Microtran	MT11-A
	109000	" Output		
	130100	" Power		
	1503	Shield for T1	Microtran	M90
	1682	Cable Assy., 14 conductor		

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MATIC . NO.	PART NUMBER	DESCRIPTION	MFG.	MANUFACTURER PART NUMBER
	1828	Switch, Rotary, 5 position		
	1826	" 2 pole, 3 position "slide"		
	2502	Knob, Skirted		
		<u>CHASSIS ASSY.</u>		
	0910	Capacitor, 500uF, 50v	Sprague	TVA 1315
1,12	1064	" .005uF, 1kv	Sprague	5GA-D50
	1053	" 2.2uF, 20v	Matsuo	DTSA-2002-225M
	1125	Diode, 1N4005 Rectifier	Motorola	
	2702	Fuse, 1/2A	Littlefuse	
	2700	Fuseholder for F1		
	2015	LED, green	Monsanto	MV5253
	2014	" red	Litronix	RL4850
	1311	Integrated Circuit, Type 7818	National	LM7818C
	1312	" " Type 7918	National	LM7918C
	1310	" " Type 1458	National	LM1458

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EMATIC F. NO.	PART NUMBER	DESCRIPTION	MFG.	MANUFACTURER PART NUMBER
3	1065	Capacitor, .22uF, 35v	Matsuo	DTSA-3502-224M
3	1066	" .47uF, 35v	Matsuo	DTSA-3502-474M
	1068	" 22uF, 3v	Matsuo	DTSA-0302-226M
	1067	" 1.0uF, 35v	Matsuo	DTSA-3502-105M
15	1100	Diode, 1N4151	G.E.	
4,6	1300	Integrated Circuit, Type 748-C	Signetics	5748V
	1310	" " Type 1458	National	LM1458
	1211	Transistor, MPF111	National	
,12-15,17,18	1204	" 2N3567	National	
6	1205	" 2N3645	National	
	0558	Resistor, Variable 5K	Beckman	91AR5K
,45,50,58	0559	" " 10K	Beckman	91AR10K
	0563	" " 100K	Beckman	91AR100K
	0510	" " 10K	Beckman	89PR10K
		All fixed resistors are 1/4w carbon, value and tolerance per schematic.		

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..MATIC .. NO.	PART NUMBER	DESCRIPTION	MFG.	MANUFACTURER PART NUMBER
5,9	1204	Transistor, 2N3567	National	
7,10	1205	" 2N3645	National	
	1210	" SE4010	Fairchild	
	1211	" MPF111	National	
	0514	Resistor, Variable 100K	Beckman	89PR100K
	0513	" " 50K	Beckman	89PR50K
3	0510	" " 10K	Beckman	89PR10K
		All fixed resistors are 1/4w carbon, value and tolerance per schematic.		
	1827	Switch, Rotary, 4 position		
	2502	Knob, Skirted		
	135100	PEAK LIMITER ASSY.		
,9,13	0801	Capacitor, 10pF	Arco	DM15-100J
,11	1053	" 2.2uF, 20v	Matsuo	DTSA-2002-225M
	1054	" 4.7uF, 20v	Matsuo	DTSA-2002-475M
	0850	" .001uF, 100v	Sprague	225P10291
	0867	" .1uF, 100v	Sprague	225P10491

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EMATIC F. NO.	PART NUMBER	DESCRIPTION	MFG.	MANUFACTURER PART NUMBER
	0507	Resistor, Variable 1K	Beckman	89PR1K
	0563	" " 100K	Beckman	91AR100K
	1829	Switch, DPDT		
	1826	" DP3P		
	134900	PROGRAM AMPLIFIER ASSY.		
7,9,13,14, 9	0801	Capacitor, 10pF	Arco	DM15-100J
	0803	" 22pF	Arco	DM15-220J
	0810	" 100pF	Arco	DM15-101J
	1054	" 4.7, 10v	Matsuo	DTSA-2002-475M
	0858	" .0047, 100v	Sprague	225P47291
	0867	" .1, 100v	Sprague	225P10491
	1067	" 1.0, 35v	Matsuo	DTSA-3502-105M
6	1053	" 2.2, 20v	Matsuo	DTSA-2002-225M
5	1100	Diode, 1N4151	G.E.	
8	1300	Integrated Circuit, Type 748-C	Signetics	5748V

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MATIC . NO.	PART NUMBER	DESCRIPTION	MFG.	MANUFACTURER PART NUMBER
	144700	A.G.C. / COMPRESSOR ASSY.		
)	1071	Capacitor, 22uF, 20v	Matsuo	22IL-2202-226M7
	0801	" 10pF	Arco	DM15-100J
',8,9	1054	" 4.7uF, 20v	Matsuo	DTSA-2002-475M
	1070	" 47uF, 20v	Matsuo	22IL-2002-476M7
	1069	" 220uF, .6v	Matsuo	22IL-6301-227M7
5	1100	Diode, 1N4151	G.E.	1N 4151
	1300	Integrated Circuit, Type 748-C	Signetics	5748V
	1305	" " " 1456 CG	Motorola	MC1456CG
	1310	" " " 1458	National	LM1458
0	1211	Transistor, MPF111	Siliconix	MPF111
2,13,14,16	1204	" 2N3567	Fairchild	2N3567
,9,11,15	1205	" 2N3645	Fairchild	2N3645
	1210	" SE4010	Fairchild	SE4010
	0555	Resistor, Variable 500 ohms	Beckman	91AR500
,46,48	0559	" " 10K	Beckman	91AR10K

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