INSTRUCTION MANUAL

"MAP II"

MULTIBAND AUDIO PROCESSOR - MODEL 231

Bryan Sogerty (Eng.)
408-374-8300

INSTRUCTION MANUAL

"MAP II"

MULTIBAND AUDIO PROCESSOR - MODEL 231

Serial # 141

July, 1979

INOVONICS INCORPORATED
503-B Vandell Way, Campbell, CA 95008
(408) 374-8300

TABLE OF CONTENTS

I. GENERAL INFORMATION

The Inovonics MAP II is a second-generation multiband broadcast audio processor designed primarily for AM and AM-stereo service. The MAP II functions to enhance perceived signal loudness and thus extend the effective area of station coverage. When properly adjusted, the MAP II will so process the audio program as to increase transmitter modulation density to a figure approaching theoretical maximum, while still maintaining an unusually high value of program listenability.

This manual is divided into various sections that best describe the operation, design philosophies and set-up of the MAP II. It is highly recommended that this manual be thoroughly read prior to putting the MAP II into service.

II. FUNCTIONAL DESCRIPTION AND SPECIFICATIONS

The MAP II is comprised of several interrelated, but functionally-unique subsections. Rather than simply to list performance specifications, a detailed functional description of MAP II operation is given, "specs" relative to the described subsection appearing in the text. An accompanying block diagram of the MAP II appears on page 3. Data not expressed or implied in the descriptions or drawings is tabulated at the end of this section.

Selectable High-Pass Filter

It is generally acknowledged that program components below a particular frequency contribute nothing to perceived program quality and, in fact, may sabotage intelligibility and both perceived and measured program loudness. The choice of a low-end cutoff frequency is, nevertheless, a matter for subjective consideration; thus the MAP II offers three: 50, 70 and 100Hz. Actual rolloff characteristics are graphed in Figure 2. The L.F. cutoff frequency is

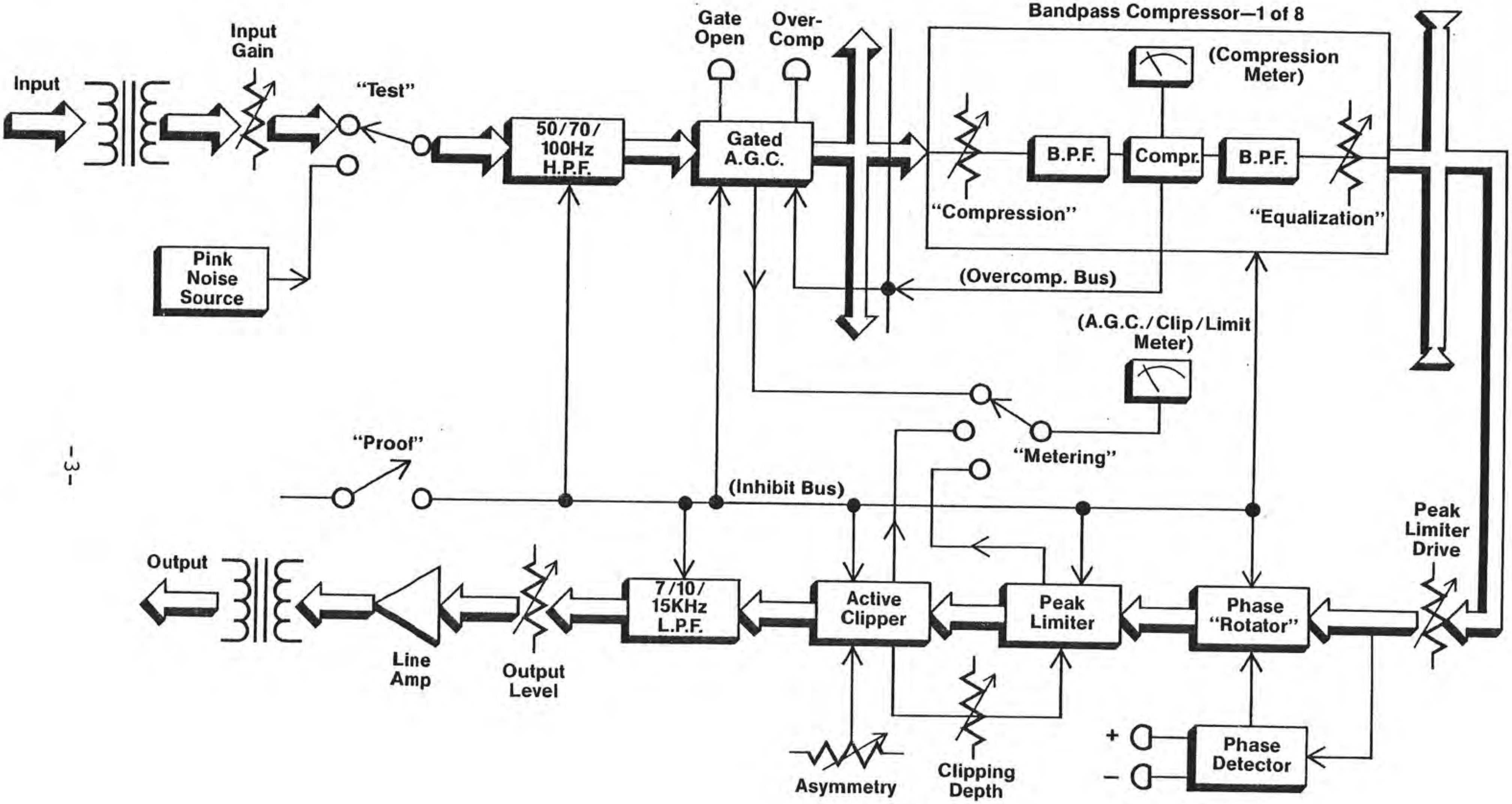


Fig. 1 MAP II Block Diagram

selected with a series of straps on the A.G.C. Amplifier board. Strapping instructions are given on page 12.

Gated A.G.C.

In the typical broadcast situation, program levels tend to wander up and down a bit, frequently as a result of operator inattention, personnel shift changes or from other, usually human influences. Thus the first major functional block of the MAP II is a slow, gain-riding A.G.C. This effectively erases long-term input level variations and presents subsequent processing stages with a constant r.m.s. input value. Capture range of the A.G.C. is ±10dB, and A.G.C. gain may be selectively displayed on the front panel meter. Correction rate (response time) is about 0.5dB/second, slow enough not to alter program dynamics.

A frequency-weighted "gating" feature inhibits A.G.C. action during program pauses, and slowly returns gain to 0dB in event of extended signal loss. The gating circuit has -3dB sensitivity points at 300Hz and 3kHz to guard against erroneous gain "hunting" caused by non-program noises. Gating threshold sensitivity is preset at a value which will open the gate when midband program energy rises above -25dB relative to nominal program "zero" level.

Multiband Compression

The "heart" of the MAP II and, indeed, the key to its operation is the division and processing of the program signal within multiple frequency bands.

The majority of audio level compressors act on the broad-band 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 "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 remains at an acceptably low level while, at the same time, compression is rapid at voice frequencies and above.

In its utilization of this multiband approach, the MAP II divides the audio spectrum into eight separate bands. While this might seem an unnecessary number of divisions, the advantage is several-fold. In the first place, many of the undesirable side-effects of dynamic range compression are automatically eliminated. For instance, low frequency components cannot "punch holes" in the program if they are processed separately in the initial compression stage. Secondly, the greater the number of bands of program division, the higher the energy/bandwidth product, or "program density." Thirdly, with multiple frequency bands and flexibility of compression parameters, program response may be "shaped" in a manner similar to that afforded by a graphic equalizer. Both the input and output level of each of the eight MAP II Bandpass Compressor assemblies is variable over a 24dB range for optimum static and dynamic response tailoring. Moreover, the tailored sound will remain consistent almost regardless of the program source: "automatic equalization," as it were. Figure 2 plots the Bandpass Compressor characteristics and overall MAP II response.

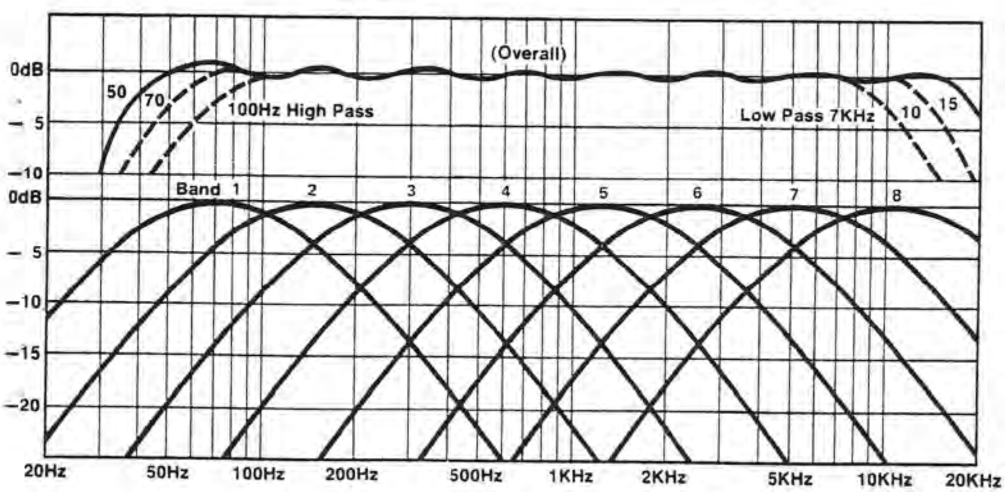


Fig. 2

Multiband compression is not without its own family of potential problems. If it is not handled properly, audible side-effects can range from simply "curious" to "downright awful." A significant difference in actual level compression between adjacent bands can cause an audible "swishing" or "phasing" effect. To guard against this, each of the MAP II Bandpass Compressors monitors its neighbors, changing gain as necessary to keep compression differences within limits. Also, the Compressors utilize gain-control circuitry yielding a "soft knee," or gentle transition from linear to compressed operation. In fact, the actual compression ratio increases as more compression is employed. With 10dB or so of indicated compression the ratio is about 2:1, increasing to 4:1 at 15dB. The result of this program-controlled compression ratio is an exceedingly smooth sound, even with considerable compression in effect. Nevertheless, a control loop from each of the Bandpass Compressors back to the A.G.C. circuit guards against overcompression by reducing A.G.C. gain and flashing a warning indicator when any of the Compressors works too hard.

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.

To maintain optimum asymmetrical modulation of an AM carrier, program peaks should be predominantly positive-going. Current practice is to switch program phase whenever necessary to assure the highest incidence of positive modulation. Common phase-switching techniques usually cause an annoying "click" or "pop" at the instant of reversal. The Phase-Follower of the MAP II, on the other hand, features a novel "phase-rotation" circuit which gently and inaudibly "rolls" the phase through a 180-degree shift when required for maximum positive modulation. Sensitivity of the phase-detection circuit of the Phase-Follower is fixed, yet a function of the degree of peak limiting/clipping in effect. With a consistent 10dB of peak reduction, asymmetry of 10% will cause a phase reversal. With 15dB peak reduction, 5% asymmetry will initiate a "roll."

"Integrated" Peak Controller

The MAP II Peak Controller represents the most radical departure from previous processor peak reduction systems. To satisfy the particular requirements for optimum AM carrier modulation, an interrelated peak limiter/clipper circuit functions without compromising the features of either. Here is the basic principle of its operation: the output from the Phase-Follower is fed to a true, low-distortion peak limiter of the Santana configuration. This is followed by an active hard clipper with the unique ability to quantitatively monitor the degree of clipping it performs. This information is routed back to the peak limiter through a control loop which allows adjustment of the limiting/clipping ratio. "Clipping Depth" may be set to a desired value, and once set will remain constant regardless of program content. An optimum operating peak-to-average ratio may thus be selected, from a very clean signal without audible clipping, to a slight degree of clipping for a definite gain in loudness with negligible sacrifice in listenability, or even heavier clipping for decided modulation advantage with an attendant audible harshness, particularly on voice.

Because of the interrelated limiter/clipper circuit, Peak Controller attack time is virtually instantaneous. Even the first half-cycle of a 20kHz, 20dB overload is reduced to the final limited peak value. The release time is fixed at a value which yields less than 1% distortion at 50Hz with 10dB limiting. Nevertheless, a strap on the Peak Controller board permits a speed-up in release time by a factor of 4. The result is a tradeoff: an audible modulation advantage against an increase in low frequency distortion. The 1% distortion frequency moves up to 200Hz, and distortion at 50Hz increases to about 3%. Both Peak Limiting and Clipping Depth may be selectively displayed on the front panel meter.

Asymmetrical Modulation

The MAP II permits the value of positive modulation peaks to be continuously adjusted 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%. The very slight gain in perceived signal loudness must be weighed against probable high signal distortion in these cases.

Remoting the Peak Controller, etc.

The Peak Controller can be unplugged from the MAP II, and with an accessory chassis may be operated at a remote transmitter site. The MAP II then remains at the studio with a "bypass" card in the Peak Controller slot.

The "bypass" card allows the MAP II to be used in services other than AM broadcast. With appropriate external provision for overmodulation protection, the MAP II can be used for FM; two for stereo. Other uses include "maximum-loudness" signal processing in the production room or recording studio.

Selectable Low-Pass Filter

An active Low-Pass Filter follows the Peak Controller and serves to restrict the bandwidth of the MAP II output. Higher-order harmonics generated in the limiting/clipping process are significantly attenuated, thus substantially reducing the tendency for the modulated carrier to "splatter" into adjacent frequencies. Moreover, transmitter power is not wasted in modulating those audio frequencies normally lost in the AM broadcast receiver. An H.F. cutoff frequency of 7, 10 or 15kHz may be selected, actual rolloff characteristics are graphed in Figure 2. Selection is made with a series of straps on the Peak Controller board, and instructions are given on page 13.

Pink Noise Source

A digitally-generated, pseudo-random Pink Noise generator is an integral part of the MAP II. Pink Noise is a very useful audio test signal; its constant-power-per-octave (or equal fractions thereof) energy distribution and characteristic crest factor more closely approximate program meterial than do discrete oscillator tones. A switch substitutes this test signal for the input program in any operating mode to aid in system setup and maintenance.

"Proof" Mode

A single button places the MAP II in "Proof." The A.G.C. is defeated and Bandpass Compressors are inhibited, with their input and output slide pots electronically zeroed. The Peak Controller is similarly defeated, and both the High- and Low-Pass Filters are electronically set to their obvious extremes. All signal-path circuitry is otherwise active.

Stereo Interconnection

Two MAP II's may be interconnected for stereo operation. The eight Bandpass Compressors are slaved for identical operation on a band-for-band basis, and one Phase Follower may be slaved to the other or both defeated, depending on which system of AM-stereo transmission is ultimately approved.

MAP II Specifications

This is a tabulation of those specifications which are not specifically expressed in the text of the discussion or obviously implied in the drawings.

Frequency Response (when set "flat"): ±1dB, 50Hz-15kHz

Distortion (at any operating point): <0.3% above 200Hz; <1.0% at 50Hz

Noise: Better than 65dB below 100% modulation

Input: Balanced, -30 to +10dBm

Output: Balanced, 0 to +20dBm; +24dBm clipping level

Power: 100/120/220/240VAC, 30W; 50/60Hz

Physical: 7" x 19" x 9"; 16 lbs.

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 reshipment 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; for not only does this assure coverage of the equipment under terms of the Warranty, but the user will automatically receive specific servicing or modification information should it be issued.

Mounting

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

Connection to AC Power

The MAP II may be operated at any of the four common international AC power mains voltages: 100, 120, 220 and 240VAC. The power cord supplied is fitted with a U.S.-standard male connector, but the cord conductors are color-coded in accordance with IEC standards.

Before connecting the MAP II to a source of AC power, verify that the voltage-selector PC card in the fuseholder/power connector assembly is oriented appropriately and that the proper fuse is installed as specified on the rear panel.

RFI

The MAP II 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 the problem, but the chassis of the unit should somehow be returned to earth ground for safety.

In / Out Connection and Considerations

The MAP II 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.

Should the equipment shich feeds the MAP II require output loading, an external 600-ohm resistor should be placed across the processor's input terminals; otherwise the input is "balanced-bridging" with a characteristic input impedance of 10K or more.

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

The output clipping level of the MAP II is +24dBm. To permit positive peak excursions to reach +125%, the nominal 100%-modulation sine wave output level should be kept at +18dBm or below.

Polarity

The input and output of the MAP II 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.

IV. OPERATION AND ADJUSTMENT

The Inovonics MAP II 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 unit 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.

Preliminary - P.C.B. Strapping Options

Input Gain Range

The MAP II accommodates line input levels between -30 and +10dBm. To extend resolution of the INPUT GAIN control, the overall 40dB range is broken into two, 20dB ranges selected by a strap on the A.G.C. Amplifier P.C.B., position #10.

For line input levels between -30 and -10dBm, a strap should be placed across terminals A and B. For input levels between -10 and +10dBm, the strap should be removed.

High-Pass Filter

Strapping to select the MAP II low-end rolloff frequency is afforded on the A.G.C. Amplifier P.C.B., position #10. The three cutoff frequencies are 50, 70 and 100Hz, the actual rolloff characteristics graphed in Figure 2.

For 50Hz cutoff, no strap is required. For 70Hz, strap

C to D. For 100Hz cutoff, strap C to D to E. The H.P.F. is automatically defeated in the "Proof" mode.

Low-Pass Filter

Strapping to select the high-end rolloff frequency is afforded on the Peak Controller P.C.B., position #9. The three cutoff frequencies are 7, 10 and 15kHz, the actual rolloff characteristics graphed in Figure 2.

For 15kHz rolloff, strap E to F to H and, separately, J to ~~K to~~ L. For 10kHz rolloff, strap E to F and, separately, J to K. For 7kHz rolloff, no strap is required. The L.P.F. is automatically defeated in the "Proof" mode.

Peak Limiter Release

The limiter portion of the Peak Controller has a release time selected and fixed at a value which is an optimum compromise between high perceived loudness (fast release) and low signal distortion (slow release). With 10dB limiting, the compromise release value yields about 1% distortion of a 50Hz sine wave; correspondingly less distortion at higher frequencies.

An alternate, faster limiter release time is provided in the MAP II; its optional use can result in a perceptible increase in program loudness, but at the expense of greater low frequency signal distortion. Because the selectable high-pass filter is provided, however, a user can opt to roll the low frequencies off and utilize the faster release with no apparent program degradation.

The faster release time is enabled by strapping terminals M and N on the Peak Controller P.C.B., position #9. As just cautioned, however, this should be done in conjunction with 70Hz or, preferrably, 100Hz low-end rolloff.

Suggested Initial Setup Procedure

This procedure is performed with the MAP II in the program chain, "on the air" and fed with typical program material. For convenience, this procedure also appears inside the front cover of the unit.

1. Set the individual COMPRESSION and EQUALIZATION slide pots to center (0dB). Turn all trim controls fully counterclockwise. The PROOF and PINK NOISE buttons should be "out" (normal operation).

2. Depress the A.G.C. RANGE metering button. With a normal program input, advance the INPUT GAIN control for a center-scale meter indication.

3. Individual COMPRESSION meters should be indicating up to 10dB compression in the most active bands. Adjust the individual COMPRESSION slide pots for about 10dB compression in each band.

4. Depress the PEAK LIMITING metering button. Advance the PEAK DRIVE control for an indicated 5-10dB of peak reduction.

5. Advance the OUTPUT LEVEL control for negative modulation peaks of 95-100% as indicated by the Modulation Monitor.

6. Advance the POSITIVE PEAK AMPLITUDE control for desired positive peak modulation to 125% as indicated by the Modulation Monitor.

Program Response Shaping

Since the MAP II affords independent control over both the input to, and output from each of the eight Bandpass Compressors, frequency characteristics of the program may be tailored to complement a specific programming format in much the same manner as with a Graphic Equalizer.

Even with all controls set to the 0dB mid-position, the MAP II 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 multiband processing to bring up the higher frequency bands which are by nature lower in energy level. Should it be desired to counteract this phenomenon, the input COMPRESSION controls should be adjusted for a similar amount of indicated compression in each band, and the output EQUALIZATION controls set for a complementary gain or loss. Thus, if Band 6 COMPRESSION control is set to +6dB for 10dB indicated common compression, the EQUALIZATION control should be set to -6dB. This will result in minimum response change or "coloration" of the program material.

If, as anticipated, it is desired to modify the program response to achieve a particular "sound," then both the COMPRESSION and EQUALIZATION controls can be used to effect the change. It is advised that the COMPRESSION controls still be used to obtain a similar degree of indicated compression in each band, and the EQUALIZATION controls then set for the desired program response. Although both the COMPRESSION and EQUALIZATION controls have identical action below compression threshold, once the threshold has been exceeded the action of the COMPRESSION control is reduced by the factor of the compression ratio. Thus the EQUALIZATION adjustment gives the maximum range and most predictable and flexible control over actual response shaping.

Some Cautions

1. Starting with the MAP II set as per the Suggested Initial Procedure, make all changes for subjective purposes in small steps, listening carefully to the results each time.

2. Avoid large differences between the adjustments in adjacent bands. The EQUALIZATION settings between adjacent bands should not exceed 6dB, and indicated compression should remain close to the same value in each band.

3. Monitor the OVERCOMP indicator and back-down compression if the LED flashes more than just occasionally.

4. REMEMBER: Increasing compression in a particular band will not make that portion of the spectrum particularly louder except at low program levels. Use the EQUALIZATION control to shape response.

Clipping Depth

The degree of program clipping which the user wishes to employ in is made variable with the CLIP DEPTH control. This adjustment is made subjectively, and the final setting should be arrived at only after sampling all types of program material.

By depressing the CLIPPING DEPTH metering button, a more-or-less quantative indication of clipping depth is displayed on the front panel meter.

With the pointer remaining in the "white" zone, clipping is very light and inaudible with any program material. When the pointer indicates in the "gray" area, clipping is heavier and yields a definite modulation advantage. Some "harshness" may be audible on voice, however. When the meter indicates in the "black", clipping is quite heavy and will certainly be audible, probably objectionable on voice and even some music.

V. CIRCUIT DESCRIPTIONS

A.G.C. Amplifier

Input signals to the MAP II are isolated by input transformer T2 on the "mother" board, then fed to input amplifier IC2 on the A.G.C. Amplifier assembly. The 40dB input gain range is divided into two 20dB segments by strapping R1 in or out, and the INPUT GAIN control R4 gives 20dB variable control over the input signal.

TEST switch S1 selects between the normal program input and the internal Pink Noise test signal generator. IC1 is a monolithic, pseudo-random, digital "white" noise source. The filter comprised of R6-9 and C2-5 imparts a 3dB/octave falling characteristic to the noise, yielding "Pink Noise" with constant-power-per-octave bandwidth.

The second section of IC2 is the active, selectable high-pass filter. The 50, 70 or 100Hz rolloff frequency is selected by strapping terminal D, or both D and E to terminal C, essentially at ground via FET Q8. Q8 is turned off in the "Proof" mode to return the filter to 50Hz, "full bandwidth" response.

The first half of IC3 is the active gain control element of the A.G.C. Amplifier. This circuit, the "Santana" configuration, utilizes FET Q1A as an active variable resistance across the inverting input of the operational amplifier. Q1B, a parameter-matched "dummy" FET, is placed across the non-inverting amplifier input and cancels the channel non-linearities of Q1A. This permits control of the audio signal at levels which would otherwise be above the low distortion operating range of the FETs.

Q4 and 5 comprise a "Baxandall" full-wave rectifier. The positive-going portion of the output of variable-gain stage IC3 is amplified by common-emitter stage Q4, the negative-going by common-base stage Q5. Thus equal positive and negative information cause similar currents at the collector junction. Q6 imparts additional DC gain to the rectified signal which is then filtered by the network R31/C16 and R32/C17. The long time constant of this dual filter prevents the A.G.C. circuit from following the program envelope, insuring control over only long-term signal variations. IC5, a unity-gain buffer amplifier, isolates the filter from R33, the FET pinchoff calibration adjustment.

Output from the A.G.C. variable-gain stage is sampled by the Gating Circuit. The first half of IC4 is a bandwidth-limited voltage amplifier stage with -3dB points at 300Hz and 3kHz. This insures that the amplified signal will primarily consist of legitimate program material, rather than non-program noise. This signal is rectified by CR5 and 6, the resultant DC presented to one input of a comparator utilizing the second half of IC4. The other comparator input is held at a fixed DC potential by divider R41/42 with a small amount of positive feedback through R43 to impart hysteresis to the Gating function.

Gating logic is fed back to the Baxandall rectifier circuit to return the A.G.C. amplifier to a nominal 0dB gain figure when the program signal falls below the Gating threshold. The circuit is thus prevented from slowly raising residual noise to an annoying level during program pauses.

IC6 is a comparator which constantly monitors the Bandpass Compressor "overcomp" bus. Should any of the eight Bandpass Compressors afford more than about 15dB compression, IC6 will toggle to illuminate the OVERCOMP indicator and to override A.G.C. action and reduce circuit gain. The A.G.C. amplifier and Gating circuits are inhibited in the "Proof" mode via CR10 and 11.

The second half of IC3 and transistors Q2 and 3 form the output stage which feeds the eight Bandpass Compressors. The R/C networks ahead of this amplifier compensate for Bandpass Compressor gain inequality at the passband limits of 50Hz and 15kHz.

Bandpass Compressor

Circuitry for each of the eight Bandpass Compressor assemblies is identical; only filter and rectifier time constant values differ for the various passband frequencies.

The input signal from the A.G.C. Amplifier is bused to the inputs of all eight compressors. R3, the COMPRESSION slide control is a variable input gain attenuator which feeds the first bandpass filter section through FET Q2. In the "Proof" mode Q2 is turned off and an input signal with fixed gain from the R1/R2 divider is routed to the filter through Q1.

The first half of IC1 is a single bandpass filter stage centered at mid-band. Because it is rather broadly tuned, the subsequent compressor section reacts not only to in-band frequencies, but to a somewhat lesser extent to signals from adjacent bands as well. This prevents any one compressor assembly from differing markedly in its action from that of its neighbors and creating peculiarities in overall response.

Q5, with its current-source collector load Q6, is, in effect, a single-stage operational amplifier. Gain of this stage is roughly set by the value ratio between input resistor R13 and feedback resistor R15. Amplifier gain is varied by Q4, 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 output from the compressor is buffered by half of IC2 and fed to a "precision" full-wave rectifier composed of IC3 and associated components. Q3, normally on, is turned off in the "Proof" mode to inhibit compression.

The rectified signal is buffered by Q9 and filtered by C10 and R44. The time constant is selected for optimum response vs. distortion figures for the frequencies involved. Half of IC2 further buffers the filtered DC to drive both the gain-controlling transistor Q4 and the front-panel meter through its linearizing network of CR13 and 14, R48 and 49.

The compressed signal encounters the second, EQUALIZATION slide control R23, which is paralleled by a second fixed divider for the "Proof" mode. R23 affords the user control over the contribution of any specific band to the final recombined "mix."

The second half of IC1 is a second bandpass filter section identical to the first. The compound, "net" response of the two filter sections gives the bandpass characteristic graphed on page 5.

Peak Controller

The Bandpass Compressor output bus represents the summing node of the Peak Controller input amplifier IC1. The one half of IC1 functions solely to actively combine the eight compressor outputs. Variable feedback resistor R4 is the LIMITER DRIVE control and affords a 20dB drive adjustment.

The other half of IC1 provides additional voltage gain for the Phase Follower detector and control circuit. Positive and negative peaks are rectified by CR1 and 2, respectively, and held by associated capacitors C5 and 6. R17 and 18 sum the peak levels such that the polarity of DC across C7 will represent program peak predominance. One half of IC5 monitors this DC and toggles (with a certain fixed hysteresis) to provide polarity switching logic.

FET-input IC2 performs the phase "rotation" function. With the non-inverting input held at ground through FET Q1, IC2 inverts the program signal. When Q1 is off, the program polarity is not inverted. Q1 is turned on and off slowly through the RC network of R28 and C8 to provide an inaudible 180-degree program phase reversal. IC3 buffers the signal appearing across Q1 to "linearize" the FET DC control voltage for minimum signal distortion during the actual period of phase "rotation." The remaining half of IC5 drives the front-panel POLARITY indicators.

Q2 and one half of IC4 comprise a "Santana" configuration, the linear gain-control portion of the Peak Controller. The Santana circuit is described on page 17. The output of this circuit is fed to the bases of transistors Q6 and 7. The emitters of these devices are biased a few volts positive and negative, respectively, and the base-emitter junctions provide hard clipping of the program signal. The emitter bias of Q7 can be varied to provide asymmetrical peak clipping for increased positive modulation.

In addition to their clipping duties, Q6 and 7 further perform a rectification function to control gain of the Santana Circuit. Q8, a unity-gain inverter, follows Q7 to provide the same polarity of collector current for negative-going peaks as Q6 does for positive. Q9 gives additional control loop gain which is made variable with CLIPPING DEPTH control R57. Thus a signal composed of (and proportional to) the clipped portion of the program signal is rectified, filtered by R63, 64 and C14, buffered by one half of IC4 and used to vary program gain prior to clipping. In this way the degree of program clipping can be kept constant regardless of program content. When R57 is fully CCW (minimum resistance) control loop gain is at maximum so that virtually no measurable clipping at all results in linear gain reduction. Increasing the value of R57 reduces control loop gain so that Q6 and 7 must conduct harder to effect gain reduction; this increases clipping action.

Output from the limiter/clipper is routed to the variable low-pass filter. This consists of one half of IC6, C9 and 10 and the various resistors which can be strapped for high-end cutoff frequencies of 7kHz (no straps), 10kHz (E to F and J to K), or 15kHz (E to F to H and J to K to L.)

The remaining half of IC6, along with Q4 and 5 and associated circuitry, makes up the line output amplifier. Gain is variable over a 20dB range with OUTPUT LEVEL control R38. Chassis-mounted output transformer T3 permits "balanced" operation.

Power Supply

The MAP II Power Supply consists of chassis-mounted power transformer T1 and rectifier and regulator components mounted on the Power Supply PC board. The primary of T1 is tapped for operation at 100/120/220/240 Volts, the voltage selector is a part of the rear-panel line cord connector and fuseholder assembly.

Diodes CR1-4 and filter capacitors C1 and 2 provide the raw positive and negative DC supplies. Total supply regulation is the function of two "three-terminal" monolithic regulators, IC1 and 2.

The Power Supply assembly also includes the pushbutton switches for power, "Proof" mode and metering selection.

VI. CALIBRATION PROCEDURES

NOTE: Prior to shipment from the factory, the MAP II was "burned-in" for an appropriate period and carefully aligned utilizing calibrated test gear and special fixtures to facilitate adjustment. As the MAP II contains no components suseptable to ageing, routine alignment is discouraged. Field calibration should be restricted to those instances in which a circuit failure has necessitated replacement of critical components.

EQUIPMENT REQUIRED

1. Stable Audio Oscillator, H.P. 200 CD or equivalent.
2. AC Voltmeter with dB scale, H.P. 400 D or equiv.
3. Oscilloscope with 1mHz bandwidth.
4. MAP II Extender Card

A.G.C. Amplifier Assembly

A. Preliminary

1. Connect the oscillator to the MAP II input.
2. Extend the A.G.C. Amplifier assembly.
3. Make a temporary connection to the "top" of R24. This is the A.G.C. assembly output and should be connected to the AC voltmeter. Be sure the other side of the voltmeter input is returned to ground.
4. Conncet clip leads or other temporary shorts across R27, R32 and R47.

B. FET Null and Pinchoff

1. Turn R33 fully CW.
2. Apply 1 kHz at a level which yields 0dBm output.
3. Turn R33 fully CCW and adjust R18 for a null. The null should reach at least -60dBm.
4. Turn R33 fully CW. The reading should return to about 0dBm. Turn R55 CCW for a 0.25dB decrease in the actual voltmeter indication
5. Remove the shorts from R27 and R47 only.

C. Meter Cal.

1. Disconnect the oscillator. The GATE lamp should go out.
2. Depress the A.G.C. RANGE button. When the meter reaches equilibrium, adjust R34 for a center-scale (center of grey area) indication.

D. Pink Noise Cal.

1. Remove the short from across R32.
2. Depress the PINK NOISE button and adjust R12 for a center-scale indication on the A.G.C. meter. Circuit action will be slow, so wait for the indication to stabilize during adjustment.

E. R21 Adjustment

R21 is adjusted after all Bandpass Compressor assemblies have been calibrated. With all COMPRESSION slide pots set at 0dB, R21 is adjusted for 10dB indicated compression with the Pink Noise test signal. R21 can otherwise be left in the center of its rotation.

<u>Bandpass Compressor Assemblies</u>

A. Preliminary

1. Remove the A.G.C. Amplifier assembly from the MAP II during calibration of the eight Bandpass Compressor assemblies.
2. Remove all eight Bandpass Compressor assemblies. Each is calibrated in its own slot, but with all others removed.
3. Attach a temporary connection to the "bottom" of R5 on the Peak Controller assembly. This is the output of the combining amplifier and should be fed to the AC voltmeter. Be sure the other side of the voltmeter input is returned to ground. R4 (PEAK DRIVE) on the Peak Controller assembly should be fully CW for Bandpass Compressor calibration.
4. The oscillator is fed to the top terminal of the COMPRESSION slide pot R3. Be sure the other side of the oscillator output is returned to ground.

B. Output Level Adjustment

1. Set the oscillator frequency to band-center for the assembly under test, oscillator output level to -10dBm.
2. Place the MAP II in "Proof."
3. Adjust R32 for a reading of 0dBm from the combining amplifier.
4. Remove the MAP II from the "Proof" mode.

C. Compression Ratio Cal. and Meter Cal

1. Center both slide controls, R3 and R23.
2. With -10dBm input at band-center from the oscillator, adjust R45 for 0dBm at the output of the combining amplifier.
3. Adjust R47 for a panel COMPRESSION meter indication of 10dB.
4. After all Bandpass Compressor assemblies have been calibrated and the A.G.C. Amplifier card reinstalled, R21 on the A.G.C. Amplifier card can be adjusted as described on page 23 for an average of 10dB indicated compression, then all COMPRESSION meter calibration controls (R47 on the Bandpass Compressor assemblies) can te trimmed for exactly 10dB indicated compression in all bands using the Pink Noise test signal.

Peak Controller Assembly

A. Preliminary

1. Remove the eight Bandpass Compressor assemblies from the MAP II.
2. Extend the Peak Controller assembly and make temporary connection to terminal A. There should be <u>no</u> jumper between terminals A and B. Terminal A serves as the signal input for calibration purposes and should be connected to the oscillator output. Be sure the other side of the oscillator output is returned to ground.
3. Connect the AC voltmeter to the MAP II output.

B. FET Null and Pinchoff

1. Place the MAP II in "Proof." Turn both the LIMIT DRIVE control R4 and the OUTPUT LEVEL control R38 fully CCW.

2. Apply 1 kHz to the terminal A input point at a level of -8dBm.

3. Turn R65 fully CW. The monitored output should measure 0dBm ±1dB. Reset the oscillator output for a reading of exactly 0dBm.

4. Turn R65 fully CCW and adjust R9 for a null. The null should reach at least -40dBm.

5. Turn R65 fully CW. The reading should return to 0dBm. Turn R65 CCW for a 0.25dB decrease in the actual voltmeter indication.

C. Meter Calibration

1. Depress the PEAK LIMITING meter selector button and adjust R67 for a full-scale "zero" indication.

2. Depress the CLIPPING DEPTH button and adjust R60 for a full-scale "zero" indication.

3. Remove the MAP II from the "Proof" mode.

D. Rectifier Balance

1. Turn both the POS. PEAK AMPL. control R53 and the CLIP DEPTH control R57 fully CCW.

2. Depress the PEAK LIMITING button and advance the 1 kHz oscillator amplitude for an indicated 10dB of limiting.

3. Connect the 'scope probe to the "top" of R61. A baseline of about -6V with a positive-going pulse train should be observed.

4. Rotate R52 through its range. At one point near the center of rotation the pulse repetition rate should double. Set R52 at this "doubling" point and for equal successive peaks.

VII. APPENDIX

ADDENDUM TO MAP II MANUAL

FM PEAK CONTROLLER OPTION

I. GENERAL INFORMATION

Although primarily intended for AM broadcast applications, the unique audio processing potentials of the MAP II have been found desirable in other services, such as FM broadcast and certain recording situations. For this reason, an alternate Peak Controller card has been made available without the phase-following, asymmetrical modulation features of the AM card, but with optional pre-limiting pre-emphasis and post-limiting de-emphasis to accommodate both the standard 75µs and "Dolby" 25µs FM broadcast characteristics.

II. INSTALLATION AND ADJUSTMENT

Strapping Options

Two sets of three terminals each select the complementary pre- and de-emphasis characteristic. Unstrapped, the limiting curve is "flat." With C strapped to D, and J strapped to K, the characterisitc conforms to the 25µs curve. With C strapped to D and E, and J strapped to K and L, the limiting characteristic conforms to the standard 75µs curve.

Peak Limiting Release

FM Peak Controller release timing is selectable as is the timing for the AM Peak Controller. Refer to page 13 of the manual for a discussion of this option. Terminals F and H are strapped for the faster release on the FM board.

Adjustment

With typical program material and 10dB or so of compression in the most active bands, depress the PEAK LIMITING metering button and advance the PEAK DRIVE control for an indicated 5 - 10dB of peak reduction. The OUTPUT LEVEL control can now be adjusted for 100% peak modulation as indicated by the Modulation Monitor. Both these adjustments should be performed with the CLIPPING DEPTH control fully counterclockwise. See page 15 of the manual for a discussion of Clipping Depth adjustment.

III. CIRCUIT DESCRIPTION

The Bandpass Compressor output bus represents the summing node of the Peak Controller input amplifier IC1. The one half of IC1 functions solely to actively combine the eight compressor outputs. Variable feedback resistor R4 is the LIMITER DRIVE control and affords a 20dB drive adjustment.

The second half of IC1 provides pre-limiting pre-emphasis. Proper strapping of terminals C,D and E selects either a 25 or 75µs characteristic.

Q1 and one half of IC2 comprise a "Santana" configuration, the linear gain-control portion of the Peak Controller. The Santana circuit is described on page 17. The output of this circuit is fed to the bases of transistors Q5 and 6. The emitters of these devices are biased a few volts positive and negative, respectively, and the base-emitter junctions provide hard clipping of the program signal. In addition to their clipping duites, however, Q5 and 6 further perform a rectification function to control gain of the Santana circuit. Q7, a unity-gain inverter, follows Q6 to provide the same polarity of collector current for negative-going peaks as Q5 does for positive. Q8 gives additional control loop gain which is made variable with CLIPPING DEPTH control R34. Thus a signal composed of (and proportional to) the clipped portion of the program signal is rectified, filtered by R40, 41 and C13, buffered by one half of IC2 and used to vary program gain prior to clipping. In this way the degree of program clipping can be kept constant regardless of program content. When R34 is fully CCW (minimun resistance), control loop gain is at maximum so that virtually no measurable clipping at all results in linear gain reduction. Increasing the value of R34 reduces control loop gain so that Q5 and 6 must conduct harder to affect gain reduction; this increases clipping action.

Output from the limiter/clipper is routed to the low-pass filter comprised of R15 and 16, C6 and 7 and one half of IC3. This filter begins its high-end rolloff just above 15kHz. The remaining half of IC3, along with Q3 and 4 and associated circuitry makes up the line output amplifier. Gain is variable over a 20dB range with OUTPUT LEVEL control R17. Capacitors C8 and 9 can be selectively strapped across feedback resistor R40 to provide 25 or 75µs de-emphasis, complementary to the pre-limiting pre-emphasis.

IV. CALIBRATION PROCEDURE

A. Preliminary

1. Remove the eight Bandpass Compressor assemblies from the MAP II.
2. Extend the Peak Controller assembly and make temporary connection to terminal A. There should be no jumper between terminals A and B. Terminal A serves as the signal input for calibration purposes and should be connected to the oscillator output. Be sure the other side of the oscillator output is returned to ground.
3. Connect the AC voltmeter to the MAP II output.

B. FET Null and Pinchoff

1. Place the MAP II in "Proof." Turn both the LIMIT DRIVE control R4 and the OUTPUT LEVEL control R17 fully CCW.
2. Apply 1 kHz to the terminal A input point at a level of -8dBm.
3. Turn R42 fully CW. The monitored output should measure 0dBm, ±1dB. Reset the oscillator output for a reading of exactly 0dBm.
4. Turn R42 fully CCW and adjust R8 for a null. The null should reach at least -40dBm.
5. Turn R42 fully CW. The reading should return to 0dBm. Turn R42 CCW for a 0.25dB decrease in the actual voltmeter indication.

C. Meter Calibration

1. Depress the PEAK LIMITING meter selector button and adjust R44 for a full-scale "zero" indication.
2. Depress the CLIPPING DEPTH button and adjust R37 for a full-scale "zero" indication.
3. Remove the MAP II from the "Proof" mode.

D. Rectifier Balance

1. Turn the CLIP DEPTH control R34 fully CCW.
2. Depress the PEAK LIMITING button and advance the 1kHz oscillator amplitude for an indicated 10dB of limiting.
3. Connect the 'scope probe to the "top" of R38. A baseline of about -6V with a positive-going pulse train should be observed.

4. Rotate R29 through its range. At one point near the center of rotation the pulse repetition rate should double. Set R29 at this "doubling" point and for equal successive peaks.

SCHEMATIC REF. NO.	PART NUMBER	DESCRIPTION	MFG.	MANUFACTURER PART NUMBER
		A.G.C. BOARD (A/N 147700)		
C1,17	1070	Capacitor, Tantalum 47uF, 20v	Matsuo	22IL-2002-476M7
C2	0863	" Mylar .022uF, 100v	Sprague	225P22391
C3,8,9	0867	" Mylar .1uF, 100v	"	225P10491
C4,10,14,15	1065	" Tantalum .22uF, 35v	Matsuo	DTSA-3502-224M
C5	1067	" Tantalum 1uF, 35v	"	DTSA-3502-105M
C6,18,19	1053	" Tantalum 2.2uF, 20v	"	DTSA-2002-225M
C7	0801	" Mica 10pF	Arco	DM15-100J
C11	0816	" Mica 330pF	Arco	DM15-331J
C12	0858	" Mylar .0047uF, 100v	Sprague	225P47291
C13,16	1054	" Tantalum 4.7uF, 20v	Matsuo	DTSA-2002-475M
CR 1-13	1100	Diode, Silicon	G.E.	1N4151
IC1	1351	Integrated Circuit, Type MM5837	National	
IC2-4, 6	1313/ 1314	" " Type RC4558NB/ NE5535N	Raytheon/ Signetics	
IC5	1352	" " Type LF355N	National	
J1-5	1685	IC Sockets, 8 pin DIP	Augat	308-AG37-D
Q1A,1B,8	1211	Transistor, FET MPF111	Siliconix	
Q2,4,5	1204	" 2N3567	Fairchild	
Q3,6,7	1205	" 2N3645	Fairchild	

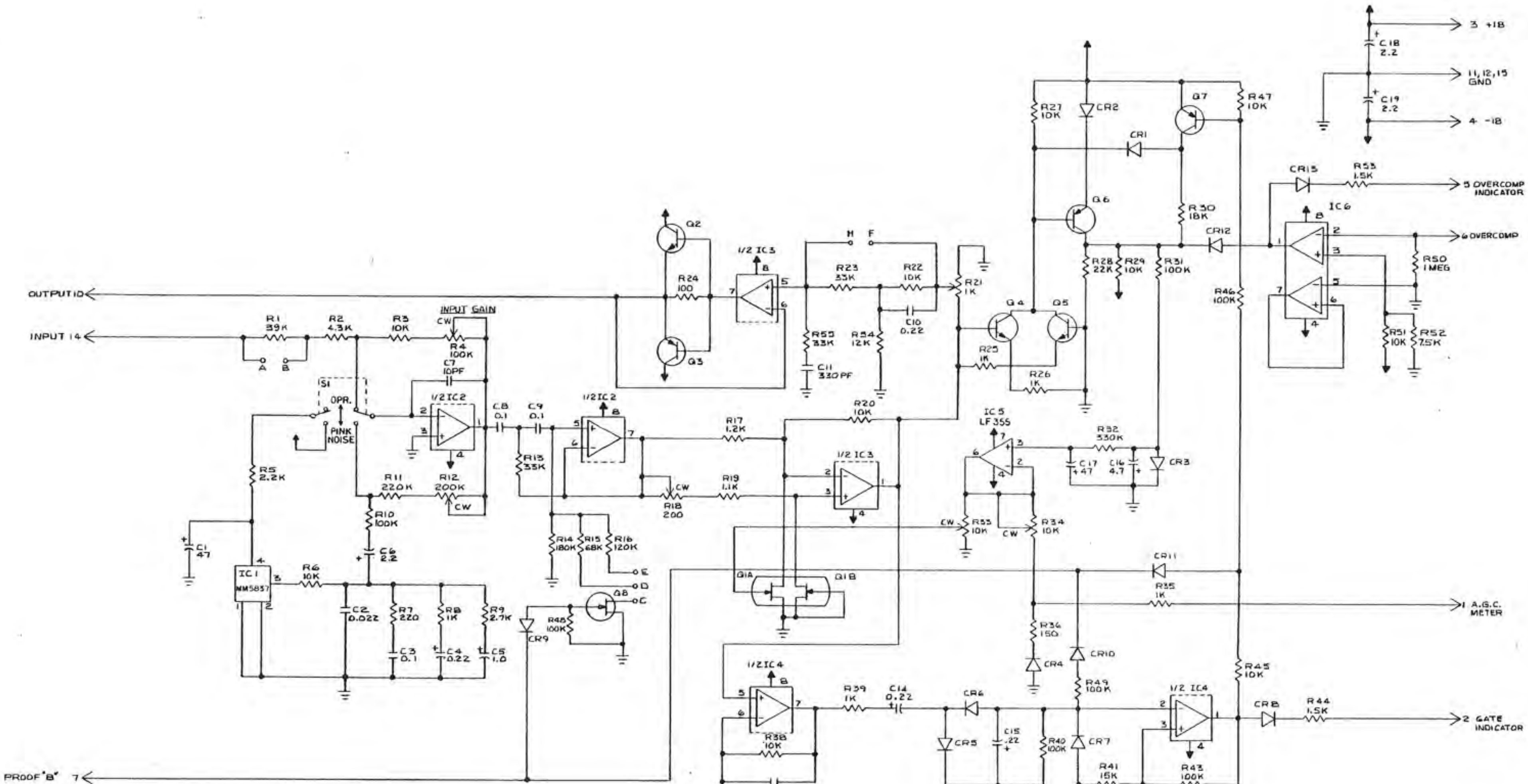
SCHEMATIC REF. NO.	PART NUMBER	DESCRIPTION	MFG.	MANUFACTURER PART NUMBER
R4	0514	Resistor, Variable 100K	Beckman	89PR100K
R12	0564	" " 200K	"	91AR200K
R18	0554	" " 200 ohm	"	91AR200
R21	0556	" " 1K	"	91AR1K
R33,34	0559	" " 10K	"	91AR10K
		All fixed resistors are 1/4w carbon, value and tolerance per schematic.		
S1	1841	Switch, Single Pushbutton	Schadow	FG EE FG/Wht
		<u>BANDPASS</u> <u>COMPRESSOR</u> <u>BOARD</u> (A/N 147501-147508)		
C1,2,7,8	0893	Capacitor, Polystyrene 15000pF	Mallory	SXL 115
(AS REQUIRED	0892	" " 4700pF	"	SXM 247
PER VERSION)	0891	" " 1000pF	"	SXM 210
"	0890	" " 470pF	"	SXM 347
"	0814	" Mica 220pF	Arco	DM15-221J
C3,5,6,10	1054	" Tantalum 4.7uF, 35v	Matsuo	DTSA-2002-475M
C4	1069	" Tantalum 220uF, 6.3v	"	22IL-6301-227M7
C9,10-12	1053	" Tantalum 2.2uF, 20v	"	DTSA-2002-225M
(AS REQUIRED	1067	" Tantalum 1uF, 35v	"	DTSA-3502-105M
PER VERSION)	1066	" " .47uF, 35v	"	DTSA-3502-474M
"	1065	" " .22uF, 35v	"	DTSA-3502-224M
CR 1-14	1100	Diode, Silicon	G.E.	1N4151

SCHEMATIC REF. NO.	PART NUMBER	DESCRIPTION	MFG.	MANUFACTURER PART NUMBER
IC 1-3	1314	Integrated Circuit, Type RC4558NB/ NE5535N	Raytheon/ Signetics	
J 1-3	1685	IC Socket, 8 pin DIP	Augat	308-AG37-D
Q1-3,7,8	1211	Transistor, FET MPF111	Siliconix	
Q4,6,9	1205	" 2N3645	Fairchild	
Q5	1210	" SE4010	"	
R3,23	0616	Resistor, Variable, Slide 10K	CTS	LM2842
R32, 45	0563	" " Trim 100K	Beckman	91AR100K
R47	0559	" " " 10K	"	91AR10K
		All fixed resistors are 1/4w carbon, value and tolerance per schematic.		
		<u>PEAK CONTROLLER ASSEMBLY</u> (A/N 147000)		
C1	0801	Capacitor, Mica 10pF	Arco	DM15-100J
C2	0850	" Mylar .001uF, 100v	Sprague	225P10291
C3,4	1070	" Tantalum 47uF, 20v	Matsuo	22IL-2002-476M7
C5,6,15,16	1053	" Tantalum 2.2uF, 20v	"	DTSA-2002-225M
C7	0867	" Mylar .1uF, 100v	Sprague	225P10491
C8,13	1054	" Tantalum 4.7uF, 20v	Matsuo	DTSA-2002-475M
C9	0827	" Mica 300pF	Arco	DM15-301J
C10	0812	" Mica 150pF	Arco	DM15-151J

SCHEMATIC REF. NO.	PART NUMBER	DESCRIPTION	MFG.	MANUFACTURER PART NUMBER
C11,12	1069	Capacitor, Tantalum 220uF, 6.3v	Matsuo	22IL-6301-227M7
C14	1067	" Tantalum 1uF, 35v	"	DTSA-3502-105M
CR 1-13	1100	Diode, Silicon	G.E.	1N4151
IC1,4-6	1313/ 1314	Integrated Circuit, Type RC4558NB/ NE5535N	Raytheon/ Signetics	
IC2,3	1352	" " Type LF355N	National	
J1-4	1685	IC Sockets, 8 pin DIP	Augat	308-AG37-D
Q1,2A,2B,3	1211	Transistor, FET MPF111	Siliconix	
Q4,6,8,11	1204	" 2N3567	Fairchild	
Q5,7,9,10	1205	" 2N3645	"	
R4,38	0514	Resistor, Variable 100K	Beckman	89PR100K
R9,52	0554	" " 200 ohm	"	91AR200
R53	0506	" " 500 ohm	"	89PR500
R57	0510	" " 10K	"	89PR10K
R60,65,67	0559	" " 10K	"	91AR10K
		All fixed resistors are 1/4w carbon, value and tolerance per schematic.		

SCHEMATIC REF. NO.	PART NUMBER	DESCRIPTION	MFG.	MANUFACTURER PART NUMBER
		POWER SUPPLY BOARD (A/N 147300), LED BOARD (A/N 147900), MOTHER BOARD (A/N148100) and CHASSIS ASSY.		
C1,2	0910	Capacitor, Electrolytic 500uF, 50V	Sprague	TVA 1315
C3,4	1053	" Tantalum 2.2uF, 20V	Matsuo	DTSA-2002-225M
C5-10	1064	" Ceramic 0.005uF, 1kV	Sprague	5GA-D50
CR1-4	1125	Diode, Silicon	Motorola	1N4005
CR5	1100	" "	G.E.	1N4151
I1,2	2015	LED Indicator, Green	Litronix	GL 4850
I3,4	2014	" " Red	"	RL 4850
IC1	1311	Integrated Circuit, Type 7818	National	LM7818C
IC2	1312	" " Type 7918	Signetics	uA7918C
J1 (P.S./LED), J11,13,14 (M.B.)	1686	IC Socket, 16 Pin DIP	Augat	316-AG37D
J1-10 (M.B.)	1708	PC Socket, 15 Pin Single-edge	SAE	SAC-15S / 2-2
J2 (P.S.)	1692	Connector, 2 Pin Male	Molex	09-88-2021
J12 (M.B.)	1781	Barrier Strip, 6 Terminal	Cinch	6-140-Y
J15 (CH.)	1671	Power Connector and Fuseholder	Corcom	6J1
M1-8	2806	Meter, Edgewise "Compression"	-	-
M9	2807	" "Limiting - Clipping - A.G.C."	-	-
R1,2	-	All fixed resistors are 1/4 W carbon, value and tolerance per schematic.		

SCHEMATIC REF. NO.	PART NUMBER	DESCRIPTION	MFG.	MANUFACTURER PART NUMBER
S1	1840	Switch, Multi-station Pushbutton	Schadow	5FA15FA201 / BLK-GRN 2UGR
T1	148200	Transformer, Power	-	-
T2	1502	" Input	Microtran	MT11-A
	1503	Shield for T2	"	M90
T3	109000	Transformer, Output	-	-



NOTES:

UNLESS OTHERWISE SPECIFIED . . . . .

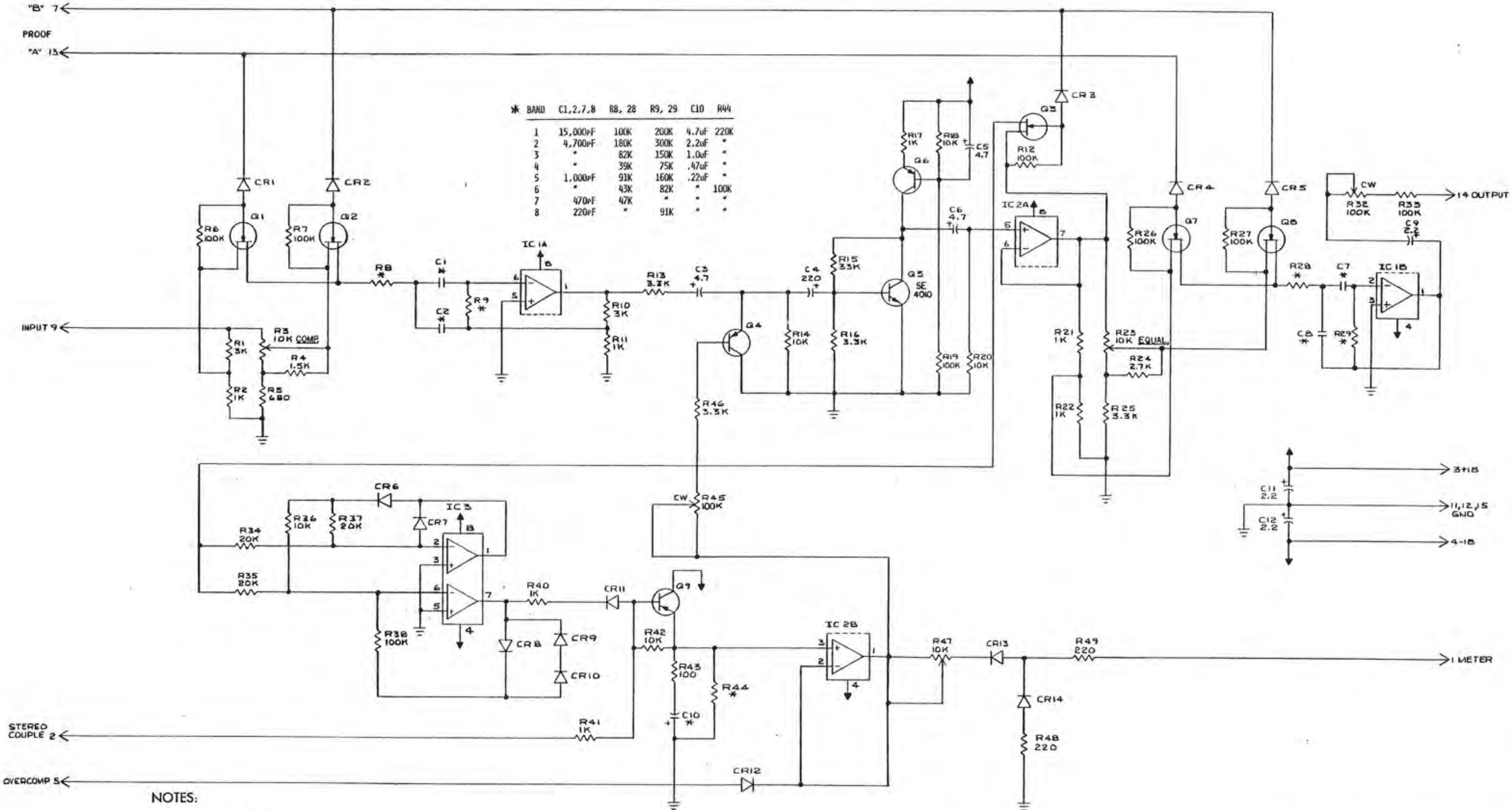
1. RESISTORS ARE 1/4W, 10%; VALUE IN OHMS.
2. CAPACITORS ARE 20V, OR BETTER; VALUE IN µF.
3. NPN TRANSISTORS ARE P/N 1204 (2N3567 EQUIV.).
4. PNP " " P/N 1205 (2N3645 ").
5. FET " " P/N 1211 (MPF111 ").
6. DIODES ARE P/N 1100 (1N4005 EQUIV.).
7. IC'S ARE P/N 1315 (TYPE 5535/4558

215 231	DRAWN	FAK	1-25-79
	CHECKED		
	APPROVED		
TOLERANCES	MATERIAL/FINISH		

INOVONICS INCORPORATED

TITLE SCHEMATIC, A.G.C. AMPLIFIER

PAGE 1 of 1 — DWG NO 150000 — ISSUE C



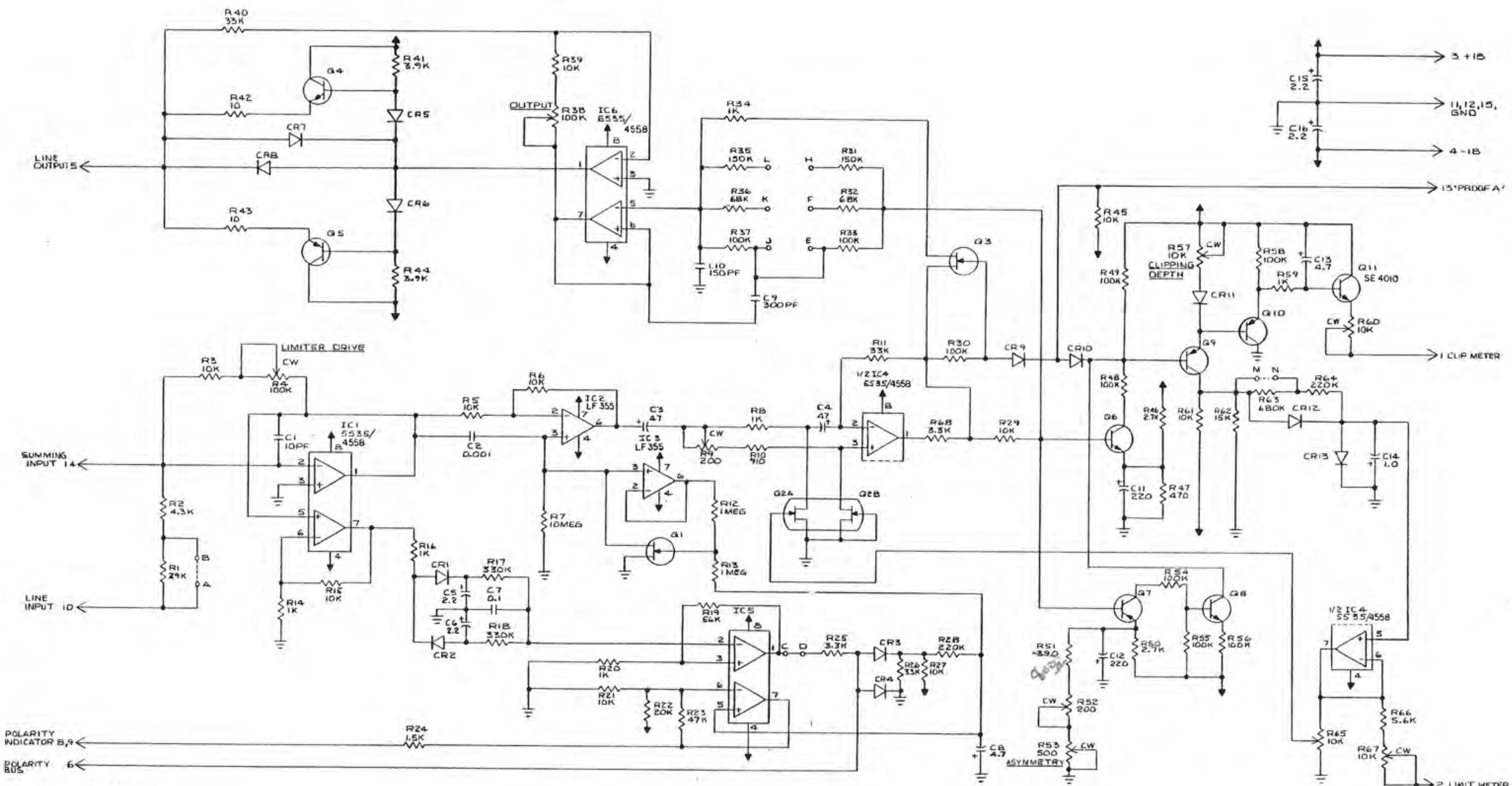
* BAND	C1,2,7,8	R8, 28	R9, 29	C10	R44
1	15,000pF	100K	200K	4.7uF	220K
2	4,700pF	180K	300K	2.2uF	"
3	"	82K	150K	1.0uF	"
4	"	39K	75K	.47uF	"
5	1,000pF	91K	160K	.22uF	"
6	"	43K	82K	"	100K
7	470pF	47K	"	"	"
8	220pF	"	91K	"	"

NOTES:

UNLESS OTHERWISE SPECIFIED . . . . .

1. RESISTORS ARE 1/4 W, 10%; VALUE IN OHMS.
2. CAPACITORS ARE 20 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 1315 (TYPE 5535/4558)

231	DRAWN	FAK	1-25-79	INOVONICS INCORPORATED
	CHECKED	JBW	2-12-79	TITLE SCHEMATIC, BANDPASS COMPRESSOR
TOLERANCES	APPROVED / MATERIAL/FINISH —			PAGE 1 of 1 · DWG NO 150100 · ISSUE C

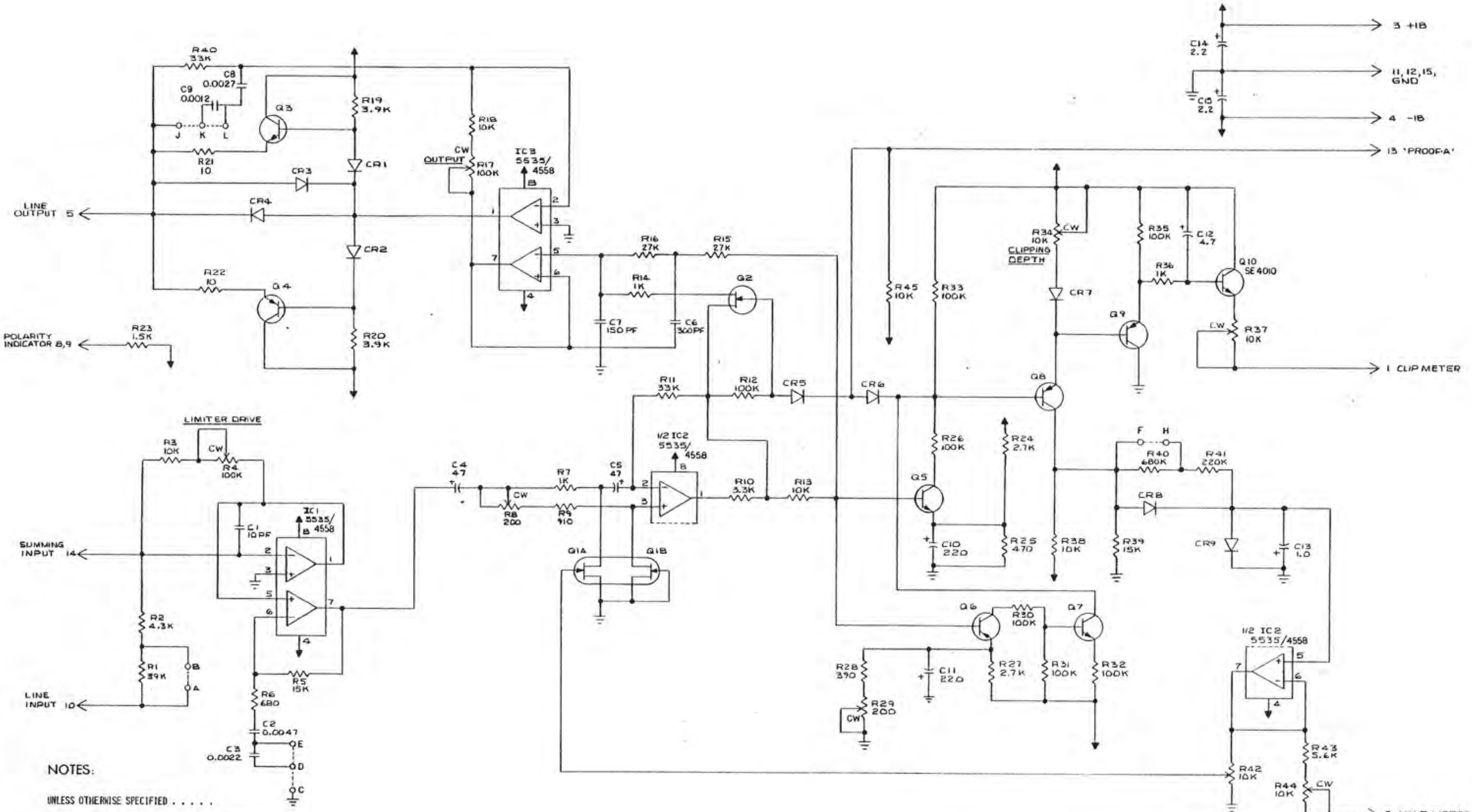


NOTES:

UNLESS OTHERWISE SPECIFIED . . . . .

1. RESISTORS ARE 1/4W, 10%; VALUE IN OHMS.
2. CAPACITORS ARE 20V, 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 (MPF111 ").
6. DIODES ARE P/N 1100 (1N4009 EQUIV.).

215 231	DRAWN	FAK	1-25-79	INOVONICS INCORPORATED
	CHECKED	JBW	2-8-79	
	APPROVED			TITLE SCHEMATIC, AM PEAK CONTROLLER
TOLERANCES	MATERIAL / FINISH			PAGE 1 of 1 · DWG NO 150200 · ISSUE B



NOTES:

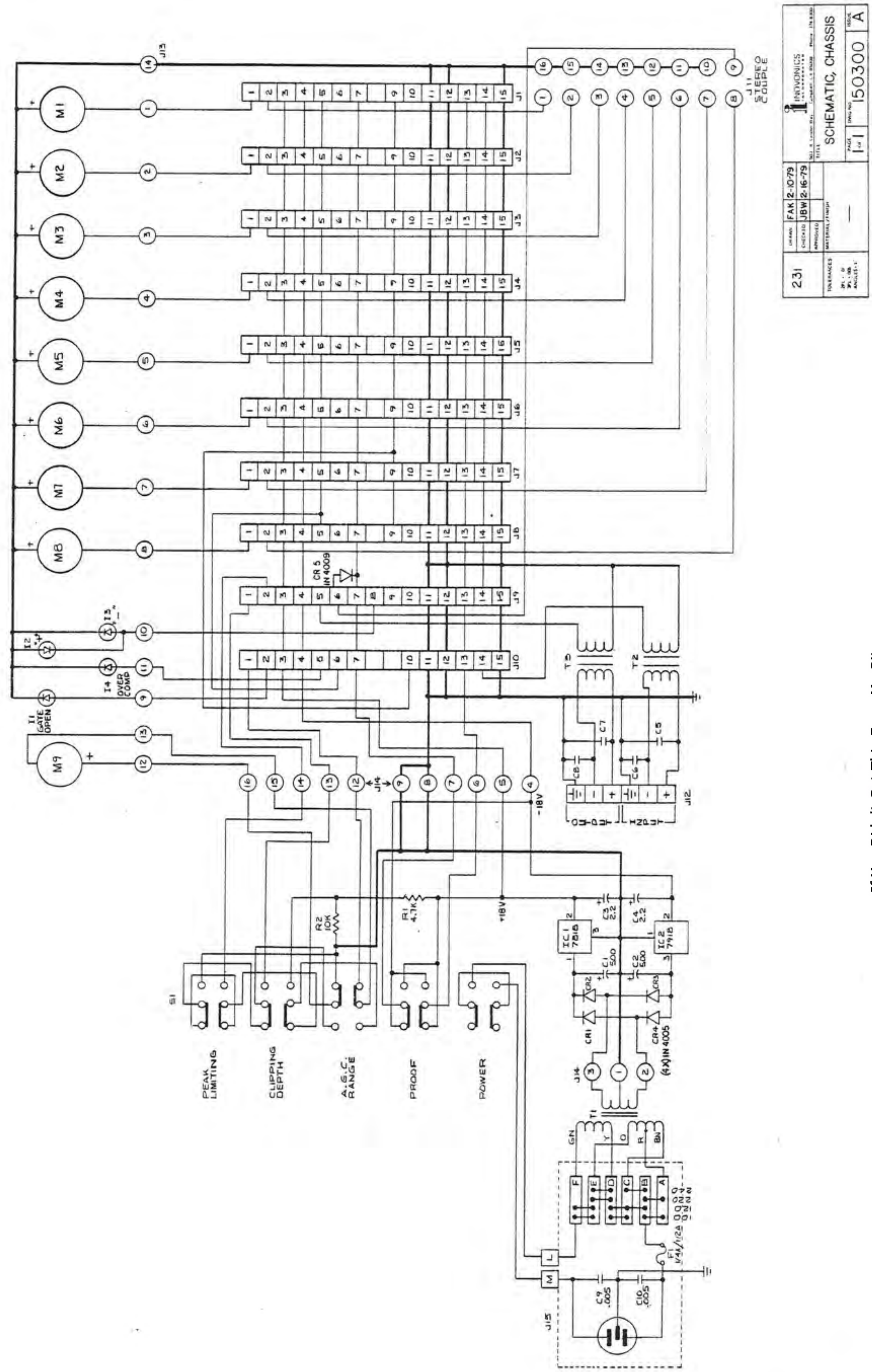
UNLESS OTHERWISE SPECIFIED . . . . .

1. RESISTORS ARE 1/4W, 10%; VALUE IN OHMS.
2. CAPACITORS ARE 50V, 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 (MPF111 ").
6. DIODES ARE P/N 1100 (1N4005 EQUIV.).

215 231	DRAWN	FAK	4-3-79	INOVONICS
	CHECKED	JBW	4-4-79	
	APPROVED			TITLE F M PEAK CONTROLLER
TOLERANCES	MATERIAL / FINISH	—		PAGE 1 of 1 · DWG NO 151000 · ISSUE A

If You Didn't Get This From My Site,
Then It Was Stolen From...

www.SteamPoweredRadio.Com


PEAK LIMITING
CLIPPING DEPTH
A.G.C. RANGE
PROOF
POWER
GATE OPEN
OVER COMP
STEREO COUPLE
INPUT
OUTPUT
CR5 1N4009
(4X)1N4005
INNOVONICS
SCHEMATIC, CHASSIS
231
FAK 2-10-79
JBW 2-16-79
150300
A

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.

INOVONICS INCORPORATED