Model AMM-2C
AM Modulation Monitor

Guide to Operations

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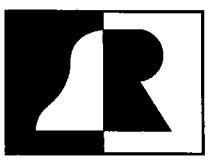

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WARRANTY AND ASSISTANCE

All Belar products are warranted against defects in materials and workmanship. This warranty applies for one year from the date of delivery, FOB factory or, in the case of certain major components listed in the instruction manual, for the specified period. Belar will repair or replace products which prove to be defective during the warranty period provided that they are returned to Belar prepaid. No other warranty is expressed or implied. Belar is not liable for consequential damages.

For any assistance, contact your Belar Sales Representative or Customer Engineering Service at the Belar factory.

1 General Information

1-1 General Description

The Belar AMM-2C AM Modulation Monitor is an all solid-state precision AM demodulator which exceeds the US Federal Communications Commission standards for measuring the total modulation characteristics of medium-frequency AM broadcast transmitters. The detector circuitry of the AMM-2C is non-frequency discriminating, so the unit is suitable for use with shortwave transmitters as well. A push-button switch selects between indications of positive or negative modulation polarity for display on the modulation meter and the adjustable peak indicator. Two additional peak indicators continuously indicate negative peaks in excess of 99% and positive peaks in excess of 125% modulation. The AMM-2C incorporates a carrier level alarm to indicate when there is insufficient carrier level to guarantee accuracy of the peak flasher indications. Also included are an adjustable modulation level alarm, and a calibration reference to check the accuracy of the readings at any time. An internal jumper can be set to apply the US NRSC de-emphasis characteristic to the audio outputs.

1-2 Physical Description

The AMM-2C is constructed on a standard EIA 5¼ × 19 inch rack mount. Calibration adjustments are located within the unit. The AC power input, RF input, and monitor outputs are located at the rear of the AMM-2C chassis on individual connectors and the rear panel card-edge connector. The AMM-2C is completely solid state, utilizing all silicon transistors and integrated circuits for long, trouble free service. LED's (light-emitting diodes) are used for the indicators to eliminate lamp burnout. The individual circuits are constructed on a military grade glass-epoxy, plated and masked printed circuit board. High reliability industrial grade components are used throughout.

1-3 Electrical Description

The AMM-2C is a solid state, low sensitivity, precision AM demodulator incorporating a highly linear biased-diode detector. The detector circuit will accurately demodulate AM envelopes of carriers from 260 kHz to 50 MHZ. Various metering and testing provisions are contained within the monitor to measure transmitter output characteristics. These provisions include a zero-center carrier level deviation meter; a semi-peak-reading modulation meter, switchable to either positive or negative modulation polarity; a peak modulation LED, adjustable from 40% to 130% peak modulation (following the meter in indicating either positive or negative modulation); a peak modulation LED that responds to negative modulation peaks in excess of 99%; a peak modulation LED that responds to positive peaks in excess of 125%; a DC type modulation calibrator to check the ratio between the carrier level and the peak modulation readings; and a carrier level LED that lights when the carrier is less than 70% of nominal value.

Outputs provided by the monitor include an active-balanced audio output, a high level output for aural monitoring, and a test output for connecting a distortion meter or other test equipment. An internal jumper permits easy application of the NRSC de-emphasis characteristic to all three audio outputs. A modulation alarm, with an adjustable modulation threshold and a fixed time-out of approximately 15 seconds, is also provided. The alarm output, in the form of a set of single-pole, double-throw (SPDT) relay contacts, is accessible at the rear panel card-edge connector. The same card-edge connector provides access to the SPDT relay contacts for the carrier level alarm, as well as open-collector transistor outputs for remote connections of the carrier level alarm and each of the three peak LED's. The output of the chassis +5 VDC power supply also appears on the card-edge connector. This is provided for driving external indicating devices connected to the monitor.

The AMM-2C will drive a remote modulation meter and a remote carrier level meter via the rear card-edge connections.

1-4 Electrical Specifications

RF Frequency Range ..... 260 kHz to 50 MHZ
RF Sensitivity ..... 5 Vrms to 10 Vrms
RF Input Impedance ..... 1000 Ω standard,
50 Ω optional
RF Input ..... Rear panel BNC connector
Modulation Meter Range ..... 0% to 133%
(switchable to indicate either positive or negative modulation peaks)
Carrier Level Deviation Meter Range ..... ±30%
Modulation Meter Accuracy ..... ±2%
100% Negative Indicator* ..... Adjustable
125% Positive Indicator* ..... Adjustable
Carrier Level Alarm ..... Alarms with a 30% drop from nominal carrier level
Audio Frequency Response ..... +0.0 dB, −0.5 dB from 20 Hz to 15 kHz
(detector response −3 dB at 50 kHz)
Envelope Pulse Response ..... Overshoot less than 1%
Harmonic Distortion ..... 0.25% maximum at 99% modulation
Signal-to-Noise Ratio ..... ≥ 80 dB (de-emphasis out)
Remote Metering ..... Meters may be used with lines of up to 8 kΩ total loop resistance
Audio Monitoring Output ..... +10 dBu (2.45 Vrms), 600 Ω, active-balanced
Audio Test Output (proof-of-performance) ..... 5 Vrms, rear panel BNC connector
Auxiliary Detector Output ..... 5 Vrms
Carrier Reference Output ..... +5 VDC for 100% carrier level
Power Consumption ..... 6 watts, 100–240 VAC, 50–60 Hz, IEC-320 AC line inlet
Operating Temperature ..... 0°C to +50°C.

1-5 Mechanical Specifications

Dimensions ..... 5¼" H × 19" W × 7" D
(133mm × 483mm × 178mm)
(EIA rack mount)
Allow 9" (23 cm.) depth behind panel for connections.
Net Weight ..... 5½ pounds (2.5 kg)
Shipping Weight ..... 11 pounds (5 kg)

The AMM-2C is shipped with one Belden #17250 molded AC line cable, one double-readout 36 contact printed-circuit card-edge connector (Cinch 50-36SN-9 or equivalent), four beige rack mounting screws, and an operating manual.

1-6 Instrument Identification

The instrument is identified by the model number and a six digit serial number. The model number and serial number appear on the rear panel of the monitor. This model number and the complete serial number should be referenced in all communications with your Belar representative or with the Belar factory.

*The 100% negative, 125% positive, and adjustable peak flasher indications are based on true ratios and remain accurate over a ±30% variation in carrier input level.

1-7 Accessories

The Belar AMM-2C Modulation Monitor permits remote monitoring of an AM transmitter when used in conjunction with the Belar MP-6C Remote Meter Panel, or the Belar RFA-2 AM RF amplifier.

The Belar MP-6C Remote Meter Panel completely replicates the front panel display of the AMM-2C AM Modulation Monitor (with the exception of the Carrier Level LED). The MP-6C Remote Meter panel contains a carrier level deviation meter, a modulation meter, and 3 peak indicators (LED's), and requires an eight-conductor cable for connection to the AMM-2C. The MP-6C accepts a 115 or 230 VAC line connection to power the lamps which backlight the two meters.

In cases where full duplication of the AMM-2C front panel indications is not required, or where interconnection wiring precludes the use of the MP-6C Remote Meter Panel, an unmounted modulation meter, identical to the meter used in the monitor, may be ordered from Belar. The modulation meter requires only a single pair of wires to connect to the AMM-2C and may provide adequate remote monitoring capability in lieu of the MP-6C.

When the AMM-2C is located where an RF sample cannot be obtained directly from the transmitter, the Belar RFA-2 AM RF Amplifier may be used to provide the required RF signal. The RFA-2 takes the low level AM signal from an appropriate receiving antenna and provides the necessary selectivity and amplification for *off-air* monitoring with the AMM-2C. *NOTE: When the RFA-2 is used as the RF signal source for the AMM-2C, the input impedance of the AMM-2C must be set to 1000 Ω to prevent damage to the RF amplifier.*

2 Installation

2-1 Initial Inspection

Check the shipping carton for external damage. If the carton exhibits evidence of abuse in handling (holes, broken corners, etc.) ask the carrier's agent to observe unpacking of the unit. Carefully unpack the AMM-2C to avoid damaging the unit. Inspect all of the equipment for physical damage immediately after unpacking. Bent or broken parts, dents, and scratches should be noted. If damage is found, refer to paragraph 2-2 (below) for the recommended claim procedure. Keep all packing material for proof of damage claims, or, if no damage is evident, for possible future shipment of the instrument.

The AMM-2C is shipped with an instruction book, a three conductor line cord, a 36 contact mating card-edge connector, and four beige rack mounting screws.

2-2 Claims

If the unit has been damaged, notify the carrier immediately. File a claim with the carrier or transportation company and advise Belar of such action. This will allow Belar to arrange for the repair or replacement of the unit without waiting for a claim to be settled with the carrier.

2-3 Repacking for Shipment

It is necessary to obtain a return authorization number from Belar before returning the unit to the factory for repair or recalibration. Authorization may be obtained by calling Belar at 610-687-5550 between 8 AM and 5 PM Eastern Time. Before packing the unit for return, attach a tag to it showing the name and address of the owner. A description of the service required should be included on the tag. The original shipping carton and packaging

materials should be used for return shipment. If they are not available, or are not reusable, a shipping carton may be obtained from Belar. Otherwise, the unit should be repackaged in the following manner:

a. Use a double-walled carton with a minimum bursting strength of 275 pounds per square inch (190 newtons per square centimeter).
b. Use heavy paper or sheets of cardboard to protect all surfaces.
c. Use at least 4 inches (10 cm) of tightly packed, industry approved shock absorbing material, such as extra firm polyurethane foam or rubberized hair, to line all six sides of the shipping carton. **Newspaper is not sufficient for cushioning material!**
d. Use heavy duty shipping tape to secure the outside of the carton.
e. Use large **FRAGILE** labels on each surface.
f. Return the unit, freight prepaid. Be sure to insure the unit for full original purchase price.

2-4 Preparation for Use

Environment, AC Line Power, & RF Input Level

The AMM-2C AM Modulation Monitor is designed to be mounted in a standard 19 inch electronic equipment rack with EIA standard spacing. When mounted in a rack, some air space should be provided above and below the unit for cooling. When the monitor is mounted above equipment generating a high amount of heat, such as power supplies and amplifiers, provisions must be made to insure the free movement of cool air around the AMM-2C. In no instance should the ambient chassis temperature be allowed to rise above 50°C (122°F). Mount the AMM-2C to the rack using the four beige 10-32 rack mounting screws provided.

The AMM-2C uses a switching power supply that accepts line voltages in the range of 100–240 VAC, 50–60 Hz. No adjustment is necessary as long as the line voltage falls within this range. The fuse in the rear panel AC input module should be only a type 3A–250V (UL/CSA) fuse or a type T3.15A–250V (IEC) fuse. A spare fuse is stored in the removable fuse compartment in the module.
The rear panel AC power entry module conforms to the IEC-320 standard and accepts a PH-386 grounded AC connector. The AMM-2C is supplied with a three-conductor power cord with a PH-386 connector on one end and a type 290B connector on the other end. When the power cord is plugged into an appropriate AC outlet, the unit is grounded. (The offset pin on the power cable's three-prong connector is the ground contact.) To preserve the grounding feature when operating the unit from a two-contact outlet, use a three-prong-to-two-prong adaptor and connect the green pigtail on the adaptor to a good electrical ground.

The AMM-2C does not have an internal power switch. When the power cord is attached, the unit is operating. Position the supplied power cable but leave one end disconnected.

BEFORE APPLYING ANY RF INPUT, TURN THE CARRIER LEVEL CONTROL MAXIMUM COUNTERCLOCKWISE!

CAUTION: DO NOT APPLY MORE THAN 15 VOLTS RF TO THE MONITOR OR THE RF INPUT MAY BE DAMAGED!

Damage as a result of excessive RF input is **not** covered under the warranty.

Verify by some independent means (such as a wideband oscilloscope or RF voltmeter) that the voltage of the RF sample falls in the range between 5 and 10 Vrms (between 14 V peak-to-peak and 28 V p-p for an ***unmodulated*** AM carrier). If necessary, adjust the RF sample voltage to fall within this range.

The AMM-2C is normally shipped with the RF input configured for 1000 Ω input impedance. If a 50 Ω input impedance is required, remove the unit cover and solder the free lead of the 56 Ω resistor mounted on the rear panel to the center pin of the RF INPUT BNC connector (J2).

NOTE: When the RFA-2 is used as the RF signal source for the AMM-2C, the input impedance of the AMM-2C must be set to 1000 Ω to prevent damage to the RF amplifier.

Check that the front panel CARRIER SET potentiometer is at its extreme counterclockwise (minimum) position. With the RF input voltage in the proper range and the CARRIER SET potentiometer at its minimum, connect a coaxial cable between the monitoring probe on the transmitter (or RF amplifier) and the BNC RF INPUT connector J2 on the rear panel of the AMM-2C.

To apply power and begin operating the AMM-2C, skip forward to *Section 3-1, Initial Operation.*
The following subsections present important information regarding other external connections to the AMM-2C, as well as suggestions for obtaining full benefit of the capabilities of the AMM-2C.

Card-Edge Connector / Connector Designations

Many of the external electrical connections to the AMM-2C are made via P1, an array of plated printed circuit board card-edge contacts that project out from the rear of the unit. A 36 pin mating connector with solder eyelet terminals is supplied with the AMM-2C to facilitate interconnection with external circuitry. Permanent remote connections are soldered to the mating connector, allowing the AMM-2C to be removed from its rack mounting by simply pulling the connector from the projection of the A1 card at the rear of the unit. The audio output, remote metering, peak flasher, and relay contacts listed below make use of the P1 card-edge connector. The wiring to each of these circuits is soldered to the supplied connector, which is then pushed onto the projection of the A1 card at the rear of the monitor. (The part number of the connector is printed in the parts list in *Section 7* of this manual if replacement becomes necessary.) Note that each of the lower row of alphabetically designated contacts may be used for connections to the AMM-2C chassis ground (by soldering to the appropriate eyelets on the supplied mating connector).

P1-1	Remote MODULATION meter
P1-2	Remote % CARRIER LEVEL DEVIATION meter (positive)
P1-3	Remote % CARRIER LEVEL DEVIATION meter (negative)
P1-4	+5 VDC supply
P1-5	Remote Carrier Level Alarm open collector
P1-6	Remote -100% peak indicator open collector
P1-7	Remote PEAK MOD indicator open collector
P1-8	Remote +125% peak indicator open collector
P1-9	Modulation Level Alarm contact (normally closed—shorted to the relay common in the alarm condition)
P1-10	Modulation Level Alarm contact (normally open—shorted to the relay common with the alarm off)
P1-11	Modulation Level Alarm relay contact common
P1-12	Carrier Level Alarm contact (normally closed—shorted to the relay common in the alarm condition)
P1-13	Carrier Level Alarm contact (normally open—shorted to the relay common with the alarm off)
P1-14	Carrier Level Alarm relay contact common
P1-15	DC carrier level reference
P1-16	Balanced Aural Monitor Output, + polarity output
P1-17	Balanced Aural Monitor Output, - polarity output
P1-18	Auxiliary Detector Output
P1-A through P1-V (bottom side of A1 board)	Chassis ground

NRSC De-emphasis

The AMM-2C includes provisions for de-emphasizing the audio signals which appear at the Audio Test Output (rear panel BNC jack J3), and the Aural Monitoring and the Auxiliary Detector outputs (both of which appear on rear panel card-edge connector P1). The de-emphasis curve conforms to the standard set by the National Radio Systems Committee (NRSC), a joint group of the Electronic Industries Association and the National Association of Broadcasters (EIA/NAB). It consists of a 75 microsecond de-emphasis with a zero placed at 8700 Hz to complement the breakpoint in the transmission pre-emphasis network. Transmission using NRSC pre-emphasis in the main channel (L+R) is mandatory for stations broadcasting AM Stereo in the United States, and elective for monaural stations in the US. (Note that use of the de-emphasis network in the AMM-2C does not affect the AMM-2C modulation readings in any way. The de-emphasis network is provided for the characterization of the transmission pre-emphasis curve, as well as the subjective evaluation of audio that would be recovered by an NRSC standard receiver.)

Insertion and removal of the de-emphasis is made by changing the position of the blue circuit board jumper P2 on the AMM-2C A1 board The procedure requires removal of the unit's top cover. The AMM-2C is shipped with the de-emphasis disabled. To place the NRSC de-emphasis network in the circuit, remove the top cover of the AMM-2C by removing the 6 Philips screws. The blue jumper is located at the front of the A1 board, just behind the MODULATION meter. Pull the blue jumper off the front and center pins (labeled "FLAT") and replace it in the rearmost position (labeled "NRSC"), connecting the center and rear pins of the P2 assembly. Replace the cover.

Audio Output Connections

Three audio outputs are provided. All appear at the rear of the unit. The Auxiliary Detector Output and the Audio Test Output both provide 5 Vrms at 100% modulation into high impedance loads. The Audio Test Output appears at BNC connector J3 and is intended primarily for attaching test equipment. The Auxiliary Detector Output appears at card-edge contacts P1-18 and P1-V (ground). This is intended for permanently connecting low sensitivity equipment such as distribution or power amplifiers. The Aural Monitor Output provides an active balanced output for driving 600 Ω loads and long audio cables at +10 dBu (2.45 Vrms) at 100% modulation. The positive (+) output appears at P1-16, and the negative (−) at P1-17. (The output sense of P1-16 and the other two audio outputs is the same—the crest of a positive peak of AM modulation produces a positive voltage at the outputs.) Either P1-16 or P1-17 may be used to drive unbalanced 600 Ω loads at 2.45 Vrms. When driving unbalanced loads, the alternate output of the active balanced pair should be grounded at the card-edge connector. (Note that while the two outputs of the active balanced pair may be used to drive separate unbalanced loads, the line balancing mechanism of the circuit results in interaction between the two outputs due to loading. Therefore, this arrangement is strongly discouraged.)

Connection of Remote Meters

One remote carrier level deviation meter and one remote modulation meter may be connected to the AMM-2C via contacts on the card-edge connector P1 at the rear of the monitor. (A mating connector is supplied with the AMM-2C to facilitate the wiring.) The remote metering circuits are activated when the REMote button is depressed. For proper operation of the remote meters, the equivalent series resistances of the external metering circuits must be set to prescribed values. In addition, proper operation of the internal carrier level deviation meter of the AMM-2C requires that the total external loop resistance of the remote carrier meter circuit be 5.11 kΩ whenever the REMote button is depressed.

Connection of a remote carrier level deviation meter will be discussed first. (Connections for using the MP-6C remote meter panel are discussed below.) The conductor connected to the positive terminal of the remote carrier meter should be connected to contact P1-2 of the card-edge connector; the conductor to the meter's negative

terminal goes to P1-3. If the total series resistance of the external wiring and carrier meter (total loop resistance) is less than 5.11 kΩ, resistors must be added in series with the line to obtain this value. When remoting meters (either modulation or carrier level) via DC telephone pairs or long exterior cable runs, it is advisable to split the added resistance equally between the two legs of the external loop and to place the added resistances at the monitor end. This helps balance the line and provides additional protection for the monitor from line transients, such as lightning.

The case for a remote modulation meter is somewhat different. For proper ballistics, the remote modulation meter should see a ***source resistance*** of approximately 5.1 kΩ. Since the AMM-2C provides a low source resistance for the remote modulation meter, the external modulation meter circuit must be built out to provide the proper source resistance. If the remote meter is shunted by a resistance between 13 kΩ and 15 kΩ at its terminals, the total series resistance of the ***conductors*** connecting the shunted meter to contacts P1-1 ("+") and P1-A ("−", or ground) of the AMM-2C should be approximately 8 kΩ. If the total conductor resistance is less than 8 kΩ, sufficient resistance should be added (roughly in equal measure) to both conductors of the circuit at the monitor end. (See the above discussion concerning the location and the splitting of the added resistance in the remote carrier meter circuit.)

NOTE 1: Remote modulation meters should be obtained from Belar to guarantee proper ballistics.

NOTE 2: If a modulation meter is to be used remotely, without a remote carrier meter connected to the AMM-2C, it is necessary to solder a dummy 5.11 kΩ resistor to contacts #2 and #3 of the supplied card-edge mating connector. This is so the proper current passes through the internal carrier level deviation meter when the REMote button is depressed.

Once any remote meters are connected, their calibration may be checked as follows. Proper operation of the AMM-2C can be confirmed by adjusting the resistance of the external carrier deviation meter circuit (or dummy resistor) so that no change in the reading of the chassis carrier meter occurs when the REMote button is alternately depressed and released. Since the carrier meter for the AMM-2C is a zero center type and reads "0" with no current applied, the carrier level must be set to "−30%" before performing this check. (Carrier level is adjusted using the front panel CARRIER SET potentiometer.) The reading of the remote carrier meter should automatically be within 2% of the reading on the chassis carrier meter. The remote modulation meter may be checked by modulating the transmitter with a steady tone, or by operating the AMM-2C in the CALibrate mode and comparing the internal and remote meters. (Only minor adjustment of the external resistances should ever be necessary to bring the remote modulation meter into agreement with the internal meter.)

The Belar MP-6C Remote Meter Panel greatly simplifies setting up a remote display. A carrier deviation meter, a modulation meter, 3 LED's, and interconnection facilities are provided. The required meter build-out networks are provided, along with a series potentiometer for each meter to facilitate adjustment. Interconnection instructions are provided with the meter panel.

Connection of Remote Peak and Alarm Indicators

Remote indicators duplicating the three AMM-2C front panel peak flasher LED's and the CARRIER LEVEL LED are brought out to contacts of the card-edge connector P1 at the rear of the chassis. The AMM-2C outputs at P1 are transistor open-collectors that are pulled to ground when the respective front panel LED's are lit. Terminal P1-4 provides a +5 VDC source to power the external indicators. If LED's are used as external indicators, a series resistor for each LED must be used to limit current to an appropriate value. As an example, a remote −100% peak modulation *lamp* (drawing less than 100 milliamps) would be connected between P1-4 and P1-6. If an *LED* were used as the remote indicator, a series resistance of approximately 200 Ω would be connected between P1-4 and the anode of the diode. The cathode of the LED would be connected to P1-6.

Sensitive relays (relays with low actuating current—those drawing less than 20 milliamps coil current) may be used to isolate other heavy loads from the monitor's remote indicator circuits. Reverse biased shunt diodes must be paralleled across relay coils to protect the transistor collectors from the back-EMF generated by the collapsing field of the coils when the relays are de-energized.

The Carrier Level Alarm and Modulation Level Alarm each provide a single-pole, double-throw relay (SPDT, form C contacts) within the chassis to control external alarm devices. The contacts are rated at maximums of 0.5 amp, 28 VDC, and 3 watts. The relays are operated in a fail-safe mode—the coils are de-energized in the alarm condition. (The schematic for the A1 board shows the relays de-energized.) Card-edge contact P1-14 is shorted to P1-12 during carrier level alarms, and P1-11 is shorted to P1-9 during modulation level alarms.

3 Operation

3-1 Initial Operation

1. Verify that the physical installation, the AC line voltage, and the voltage of the RF sample conform to the requirements of *Section 2-4* of this manual.

2. Turn the CARRIER SET control maximum counterclockwise. Depress the ZERO switch and release the REMOTE switch.

3. Note the reading of the MODULATION meter. If it does not rest at zero, use a small screwdriver to turn the zero adjustment counterclockwise so the meter indicates slightly downscale from zero. Then turn the adjustment screw clockwise to bring the pointer just to zero. Finally, turn the zero set a few degrees counterclockwise to take pressure off the meter's internal adjustment fork. Likewise, check that the % CARRIER LEVEL DEVIATION meter reads zero. If necessary, zero the carrier meter following the same procedure as for the MODULATION meter.

4. Attach the power cable between the AMM-2C and the power line receptacle. This turns the unit on. Note that the % CARRIER LEVEL DEVIATION meter indicates to the extreme left, the CARRIER LEVEL alarm LED is on, and the MODULATION meter reads 0.0%, ±0.5%. Turn the CARRIER SET potentiometer clockwise to verify that setting the potentiometer in the top third of its range brings the carrier level deviation to a 0% reading. NOTE: if the % CARRIER LEVEL DEVIATION indication comes up to 0% when the CARRIER SET potentiometer is at **¼ or less** of its full rotation, immediately remove the coaxial cable carrying the RF sample to the RF INPUT jack J2 and reduce the voltage of the RF sample at its source. Otherwise, damage to the AMM-2C may result.

5. After allowing a few minutes for the AMM-2C to warm up, turn the CARRIER SET potentiometer fully counterclockwise. The MODULATION meter will read 0.0%, ±0.5%. The CARRIER LEVEL LED will be lit.

6. Rotate the CARRIER SET potentiometer clockwise again to raise the carrier level so it reads 0% on the % CARRIER LEVEL DEVIATION meter. This is the SET point for the carrier level. The CARRIER LEVEL LED will extinguish when the carrier level is above approximately -30% relative to the SET point. With a low noise, unmodulated transmitter, the MODULATION meter should read less than 1%.

7. Depress the CALibration pushbutton. The MODULATION meter will read 100% to verify the accuracy of the AMM-2C's calibration. The +125% LED will be on. (The -100% LED will not light in the CALibration mode.)

8. Adjust the PEAK MOD potentiometer to the point where the PEAK MOD LED first comes on. This setting corresponds to 100% positive modulation.

9. Depress either the POSitive or NEGative switch to obtain positive or negative modulation indications on the PEAK LED and MODULATION meter. The unit is ready for regular operation.

3-2 Normal Operation

Adjust the CARRIER SET potentiometer so the % CARRIER LEVEL DEVIATION meter reads 0% deviation. The fixed -100% and +125% peak LED's always indicate the negative and positive peaks at their respective legal limits. The POSitive and NEGative pushbuttons select which polarity of modulation is indicated by both the MODULATION meter and the PEAK MOD LED.

Normal changes in carrier level (less than 30%) will not affect the accuracy of the indications of the -100%, +125%, and PEAK MOD LED's. Accurate MODULATION meter readings, however, require the % CARRIER LEVEL DEVIATION meter to be reading 0%.

Under normal operating conditions, and depending on the operating environment for modulation, the AMM-2C may be set to either the POSitive or NEGative operating mode. By setting the PEAK MOD control somewhat below the legal limit, say 95% for negative indications or 120% for positive indications, a modulation "window" is created to insure the maximum level of modulation without exceeding the limits set by the FCC.

Percent carrier shift is read directly on the % CARRIER LEVEL DEVIATION meter with changes in the modulation intensity.

3-3 Transmitter Measurements

Transmitter proof-of-performance measurements may be made with the AMM-2C. Accurate readings of system frequency response, distortion, and noise may be made at the rear panel AUDIO TEST jack J3 using external measuring equipment. The audio output level at J3 is 5 Vrms at 100% modulation, so most distortion and noise analyzers may be used. Modulation percentages are read directly from the MODULATION meter, and the percentage of carrier shift is read directly from the % CARRIER LEVEL DEVIATION meter.

NOTE: The frequency response of all three audio outputs is controlled by the setting of A1-P2, the internal NRSC de-emphasis jumper. Meaningful distortion and noise measurements require an audio passband with flat frequency response. If P2 has been set to the "NRSC" position, it will be necessary to move it to the "FLAT" position before making transmitter measurements. See the two paragraphs under *NRSC De-emphasis* in *Section 2-4, Preparation for Use.*

3-4 Modulation Level Alarm

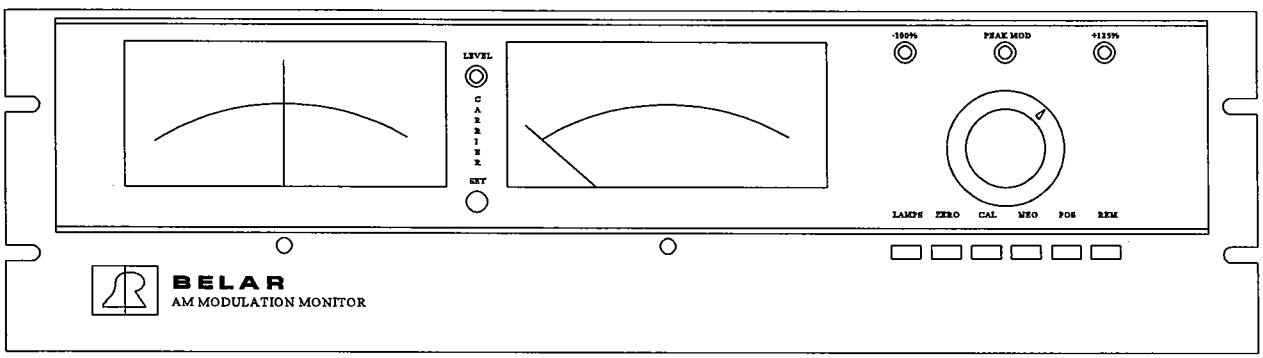
The modulation level alarm indicates when the transmitter modulation level remains below the user set modulation threshold for approximately 15 seconds. The modulation threshold for the alarm is adjusted by R85, a multiturn potentiometer accessible at the rear of the AMM-2C through a cutout in the cover. The adjustment range is approximately 30% modulation to 100% modulation.

The alarm is driven by the output of the MODULATION meter rectifier. Therefore, the alarm senses modulation of the same polarity as set by the front panel POSitive and NEGative pushbuttons and as displayed by the MODULATION meter and PEAK MOD LED. Note, that like the indications of the peak flashers, the Modulation Level Alarm operates accurately over more than a ±30% variation in carrier level.

Following is a suggested adjustment procedure for the Modulation Level Alarm:

Place the AMM-2C in the same operating mode that the monitor normally operates (POSitive or NEGative). Check that transmitter modulation is in its normal range. Locate the MODULATION ALARM THRESHOLD potentiometer, A1-R85, in the AMM-2C cover cutout, between the card-edge connector and the AUDIO TEST jack J3 at the rear of the unit. Using an adjustment screwdriver, turn A1-R85 clockwise until the modulation alarm is activated. (The status of the alarm, of course, must be monitored using an external indication device connected to the alarm relay RL2 via card-edge connector contacts P1-9–P1-11.) Now, *slowly* turn R85 counterclockwise until the Modulation Alarm turns off. At this point, a modulation peak just exceeded the threshold set by R85. It is suggested that the pot be turned one or two additional turns counterclockwise so the alarm does not fire inadvertently, or fire during intervals when the alternate modulation polarity is selected for display. (The potentiometer changes the alarm threshold by slightly more than 4% modulation for each turn of the adjustment screw.)

4 AMM-2C Front Panel



FRONT PANEL CONTROLS

Below are short functional descriptions for each of the AMM-2C front panel controls. The controls are illustrated in the AMM-2C Front View drawing above. The pushbuttons are described first. The LAMPS button is a *push-push* type acting independently of the others. The ZERO, CAL, NEG, and POS pushbuttons are mechanically interlocked so only one mode of operation may be selected at a time. The REM button is also *push-push*, and operates independently of the others.

LAMPS This is a multifunction *push-push* type push-button switch. As set at the factory, depressing this button increases the intensity of the backlighting of the two front panel meters. Releasing the button dims the meter backlighting. By moving an internal wire from contact 2 to contact 1 on the S1 switch assembly, the LAMPS button allows selection between dim backlighting (button released) and backlighting off (button depressed).

ZERO: The ZERO mode grounds the input to the metering circuitry of the monitor. When depressed, the MODULATION meter should read zero and all peak LED's should be extinguished. This provides a check of DC offsets in the measurement circuits.

CALibrate: This button applies a test voltage derived from the carrier level DC to the metering and peak indicator circuits. When the % CARRIER DEVIATION METER is set to 0% and CAL is depressed, the MODULATION meter should read 100% and the +125% LED should be lit. With the PEAK MOD control set to 100%, the PEAK MOD LED should be lit. Note that the -100% LED does **not** light in CALibrate.

NEGative: This is the standard operating mode for the AMM-2C. When depressed, the MODULATION meter reads negative AM modulation. The PEAK MOD LED lights to indicate negative modulation peaks which equal or exceed the setting of the PEAK MOD control.
Note: Negative AM modulation is defined as the instantaneous *decrease* in amplitude of the carrier envelope measured from, and relative to, the average amplitude (or the unmodulated amplitude) of the carrier envelope. Shutoff of the AM carrier represents 100% negative modulation. (This is often referred to as -100% modulation.)

POSitive: In this mode, the AMM-2C MODULATION meter indicates positive AM modulation. The PEAK MOD LED lights to indicate peaks of positive modulation which equal or exceed the setting of the PEAK MOD control.
Note: Positive AM modulation is defined as the instantaneous *increase* in amplitude of the carrier envelope measured from, and relative to, the average amplitude (or unmodulated amplitude) of the carrier envelope. Positive modulation of 100% corresponds to an instantaneous envelope amplitude equal to twice the average amplitude (or unmodulated amplitude) of the carrier envelope. (This is often referred to as +100% modulation.)

REMote: When released, both of the front panel meters operate independently of any external meters connected at the rear of the AMM-2C. When depressed, remote meters attached to P1 at the rear of the monitor are activated. (See *Section 2-4, Preparation for Use* for information about the connection of remote meters.) When released, the internal circuitry of the AMM-2C is isolated from voltage surges which may occur on circuits connecting remote meters to the monitor. Therefore, it is best to release the REMote button when the remote meters are not in use, or when lightning presents a risk.

CARRIER (LEVEL) SET: The shaft of this potentiometer (chassis R2) protrudes from the AMM-2C panel between and just below the two meters. It is used to adjust the carrier level for a 0% indication on the % CARRIER LEVEL DEVIATION meter. This is the setting required for proper operation and correct MODULATION meter indications.

PEAK MOD (adjustment): This is the large black knob on the panel. It rotates across the range from "40" to "130" percent, setting the modulation threshold above which the PEAK MOD LED is lit. (The knob controls chassis potentiometer R1.)

FRONT PANEL INDICATORS

% CARRIER LEVEL DEVIATION Meter: This meter indicates the input level of the transmitter's or RF amplifier's RF carrier signal to the monitor. The center reading of 0% is the required setting for accurate MODULATION meter indications. Readings of *-XX% and +XX%* indicate percentage deviations of the carrier from the prescribed level.

MODULATION Meter: This meter indicates the *semi-peak* AM modulation of the RF carrier applied to the monitor. To be accurate, the RF input level must be set to indicate 0% on the % CARRIER LEVEL DEVIATION meter. The polarity of the modulation indicated is determined by which of the NEGative or POSitive pushbuttons is depressed.

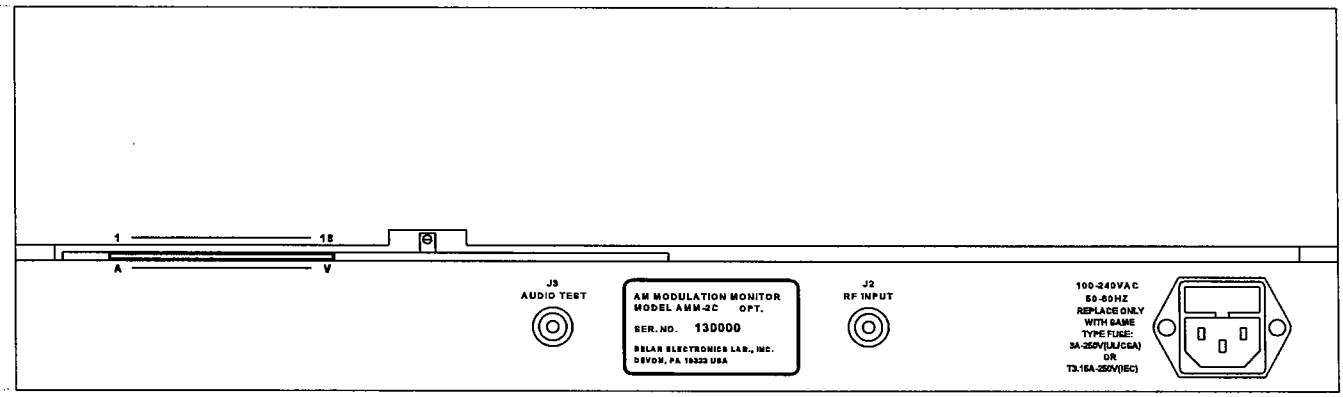
CARRIER LEVEL (LED): This red indicator is lighted when the carrier level falls more than about 30% below the prescribed input level. An open-collector output and relay contacts accessible at P1 on the rear panel parallel this indication.

-100% (LED): This red indicator lights when negative AM modulation excursions of the applied carrier exceed 99% negative modulation. Minimum duration of the *indication* of *any* negative modulation peak is approximately 150 milliseconds and is extended by repeated peaks. Accuracy of indications is maintained over changes in carrier level exceeding ±30%.

PEAK MOD (LED): This yellow indicator lights when the AM modulation excursions of the applied carrier exceed the setting of the PEAK MOD adjustment potentiometer. The polarity of the modulation indicated is determined by which of the NEGative or POSitive pushbuttons is depressed. Minimum duration of any *indication* is approximately 150 milliseconds and is extended by repeated peaks. Accuracy of indications is maintained over changes in carrier level exceeding ±30%.

+125% (LED): This red indicator lights when the positive AM modulation excursions of the applied carrier exceed 125% positive modulation. Minimum duration of any *indication* is approximately 150 milliseconds and is extended by repeated peaks. Accuracy of indications is maintained over changes in carrier level exceeding ±30%.

5 AMM-2C Rear Panel



Features of the rear panel are illustrated in the AMM-2C Rear View drawing above.

Power Entry Module: This module accepts the AC power line input and mates with the three-conductor PH-386/IEC 320-C-13 connector of the power cord supplied with the AMM-2C. Acceptable AC power ranges from 100 VAC to 240 VAC and from 50 to 60 Hz. A fuse compartment in the Power Entry Module houses one 3A-250V (UL/CSA) or T3.15A-250V (IEC) fuse, along with a spare. Both are contained in the removable fuse compartment in the module. The fuses are accessed by first removing the power cord, then using a small common screwdriver to pull out the small tab at the bottom of the plastic insert located just above the AC connector in the module.

RF INPUT (J2): This is a BNC jack that accepts an AM RF sample in range of 5 Vrms to 10 Vrms. It presents a 1000 Ω load (optionally 50 Ω) to the input line.

AUDIO TEST OUTPUT (J3): This BNC jack provides the detected audio signal of the AM carrier applied to the AMM-2C input. Its level is 5 Vrms at into a high impedance load for 100% AM modulation. The output may be de-emphasized following the NRSC characteristic by setting of internal jumper P2. (See *NRSC De-emphasis* in *Section 2-4, Preparation for Use.*)

REMOTE CONNECTOR (P1): This set of 36 plated circuit board traces extends out the back of the AMM-2C. It provides external connections for remote meters, modulation peak indicators, alarms, and detected audio and carrier samples. Connections are made through the mating 36 contact connector provided with the AMM-2C.

MODULATION ALARM THRESHOLD ADJUST (A1-R85): This multiturn potentiometer sets the modulation threshold below which the Modulation Alarm is activated after the fixed fifteen second time-out. Range of adjustment is approximately 30% to 100% modulation. The polarity of modulation sensed by the alarm is controlled by the position of the front panel NEGative and POSitive pushbuttons.

6 Calibration/Maintenance

6-1 Test Equipment Required

1. An amplitude modulation (AM) test source (or transmitter) with an RF output of 5 Vrms to 10 Vrms and capable of less than 1% total harmonic envelope distortion above 90% sine wave modulation.*
2. A low distortion audio oscillator (≤ 0.1% total harmonic distortion.)
3. An oscilloscope with a 3 dB bandwidth at least twice the carrier frequency of test.
4. An audio frequency AC voltmeter with either a 3½ digit display, or with linearity of voltage indications of better than 1%.

6-2 Modulation Monitor Alignment Procedure

1. Remove AC line power to the AMM-2C by removing the power cord. Set the mechanical zero on the carrier and modulation meters. (If adjustment is required, turn the meter adjustment screw counterclockwise until the pointer goes slightly below zero. Then, turn the adjustment screw clockwise until the pointer just reaches zero. Finally, turn the adjustment screw a very small amount counterclockwise to remove pressure from the zeroing fork in the meter mechanism.)

2. Connect AC power to the monitor and allow the unit to warm up for 15 minutes.

3. Press the ZERO button on the front panel. Verify that the AMM-2C modulation meter reads zero. If the modulation meter reading is below -0.5% or above +0.5%, the unit requires repair. Consult with Belar.

4. Set the output voltage of the AM test source to 5 to 10 Vrms and connect its output to the AMM-2C rear panel RF INPUT jack J2. Simultaneously monitor the RF signal at J2 with an oscilloscope having an operating bandwidth at least double the carrier frequency of the AM modulator. Make sure the front panel REMote meter button is released. Adjust the front panel CARRIER SET potentiometer to obtain a "0%" carrier level deviation reading on the carrier level meter. (Alternately, the output sample of a well functioning AM transmitter may be used in the calibration procedure. The harmonic distortion of the transmitter AM output envelope should not exceed 1% at high modulation levels.)

5. Apply a 1 kHz sine wave of less than 0.1% harmonic distortion to the AM modulation input of the test source and adjust the oscillator level to obtain 99% negative AM modulation (onset of carrier shutoff) as observed on an expanded scale of the oscilloscope. Check that the carrier deviation still indicates "0%". On the A-1 board of the AMM-2C, adjust R50, the 100% NEGative ADJUST potentiometer so the front panel -100% LED just remains lit. (It is necessary to remove the AMM-2C cover to gain access to the A1 circuit board. This is done by removing the six 4-40 Phillips head screws which fasten the cover to the chassis.)

6. With negative AM modulation of the test signal still greater than 99%, measure the AC output voltage of the audio oscillator connected to the modulation input of the AM test source (or transmitter) using an accurate AC voltmeter. Lower the oscillator output level to exactly 90% of this voltage so the test source produces 90% negative AM modulation.

7. Depress the NEGative button on the AMM-2C. Then, adjust the METER CAL potentiometer (A1-R94) for an indication of 90.0% on the AMM-2C modulation meter.

8. With the negative AM modulation of the test source still 90% as indicated on the modulation meter, press the POSitive button on the AMM-2C. Verify that the AMM-2C modulation meter indicates 90%, ±1%.* (No independent adjustment of the positive modulation indication is possible. If meter indication is less than 89% or greater than 91%, consult with Belar for possible repair.)

9. Remove modulation from the AM test source. Set the front panel CARRIER LEVEL SET potentiometer for an indication of -30% or less on the % CARRIER LEVEL DEVIATION meter. The CARRIER LEVEL LED should be on. There is no adjustment for this indication.

10. Readjust the CARRIER LEVEL SET potentiometer for "0%" carrier deviation. Press the CALibration button on the AMM-2C. If necessary, adjust the CAL REF ADJUST (calibration reference adjust) potentiometer, R26, for a 100% indication on the AMM-2C MODULATION meter. (This provides a reference voltage for positive modulation indications of the MODULATION meter, the PEAK MOD LED, and the +125% LED.)

11. With the carrier level remaining at "0%" and the CALibrate button depressed, adjust R75, the +125% ADJUST potentiometer so the +125% LED just remains lit.

12. This step sets the adjustable PEAK MOD indicator. Apply 1 kHz modulation to the AM modulator connected to J2 of the AMM-2C. With the POSitive button depressed, adjust the modulation of the AM source for a 90% indication on the AMM-2C modulation meter.*
    a) If necessary, adjust the position of the front panel PEAK MOD indicator adjustment knob on the shaft of front panel potentiometer R1 so that the PEAK MOD LED just remains lit when the knob is set to "90%". Adjustment requires loosening the knob on the shaft using a 5/64" Allen key, then tightening the knob in its new position.
    b) The span of the PEAK MOD potentiometer may be checked by noting the ***difference*** in the PEAK MOD knob settings required to keep the PEAK MOD LED just lit when the modulation is changed from 90% to 40%, as noted on the modulation meter. Adjust R67, the MOD SPAN potentiometer, so that the PEAK MOD knob settings differ by 50% when the POSitive modulation readings, as read on the meter, change between 40% and 90%. After the span has been properly set, adjust the position of the knob on the shaft of R1 as described above in step (a) to correct the indication at 90% modulation.

*NOTE: The modulation meter and the peak LED's respond to the peak values of modulation. If there is distortion in the modulator (or test transmitter), the peak indications will be the true peak values of the envelope, i.e. the sum of the fundamental and the harmonics, or distortion products. A common mistake made in calibrating AM monitors is to adjust both negative and positive modulation indications at carrier shutoff. Carrier shutoff does represent 100% negative modulation. However, due to the presence of distortion products in the modulator, the positive modulation at carrier shutoff is not necessarily 100%. If the harmonic distortion of the envelope at carrier shutoff is 2% and even-order (typical of many transmitters), the actual positive modulation may be anywhere from 98% to 102%, depending on the phases of the harmonics. The monitor will indicate this. For this reason, we suggest the monitor be calibrated at 100% only for negative indications. For calibration of positive indications, modulation should be reduced to 90% positive, so the settings may be made in a region where the source (or transmitter) is more linear.

6-3 Maintenance

The AMM-2C is a highly stable instrument. Other than verifying that the unit is clean and that free air circulation is maintained, no regular maintenance is required.

6-4 Theory of Operation

Chassis Power Supply

The chassis of the AMM-2C contains of a self contained triple-output power supply, the A1 printed circuit board, and a small number of individually mounted electrical and electronic components.

Line power enters the chassis through the fused power entry module and passes directly to the self contained chassis mounted power supply via a Molex® connector. This switching mode power supply produces regulated outputs at ±15 VDC for analog circuitry on the A1 card, and at +5 VDC for the two A1 relays, two chassis meter lamps, four LED's, and external loads connected to card-edge contact P1-4. A chassis mounted fuse (2 amp, AGC) protects the +5 VDC supply output from possible overload. (The power supply module is not user serviceable. Due to the voltages present in the module, field repair of the power supply should not be attempted.)

Power from the chassis power supply enters the A1 card via A1 board connector pins 17–21. Shunt diodes CR15, CR16, and CR17 protect the board from accidental reversal of supply voltages. Capacitors C48–C53 bypass each of the supply buses. Positive 5 VDC for driving the logic on the A1 card is produced by A1 board regulator U13 from the card's +15 VDC bus.

RF Detector

The RF sample is applied to chassis BNC jack J2 and passes, via coaxial cable, through the CARRIER LEVEL SET potentiometer (chassis R2) and to pins 1 and 2 (2 for ground) of the A1 circuit board.

The attenuated AM RF sample applied to pins 1 and 2 of the A1 card is detected by a shunt, biased-diode AM detector. The detector consists of a biased diode, a linear phase low-pass filter and a protection circuit. Detector diode CR2 is biased on by the current passing through the diode from the +15 VDC supply through R3. The RF input is coupled to CR2 by capacitors C1 and C2, which also form part of the detector's low-pass filter.

Shunt diode CR1 offers protection to CR2 from large negative voltage impulses at the RF input, possibly caused by lightning or similar disturbances. Under normal conditions, CR1 is biased off by connections through R1 and R2 to the positive and negative supplies. The cathode of CR1 is held at +15 VDC by R1, while the anode is maintained at −15 VDC by R2. Negative impulses at the RF input which exceed about 30 volts in amplitude momentarily turn on CR1, and charge C1. C3 momentarily holds the anode of CR1 at −15 VDC, and the network composed of R2 and C4 isolate the negative supply from the transient.

Detector diode CR2 feeds the carrier filter composed of C1, C2, C5–C7, L1–L3, and the resistive termination formed by the R4-R5 combination. The filter is a 7th-order Bessel-Thomson (constant-delay) low-pass, with a −3 dB frequency of 50 kHz. This filter passes the AM envelope with minimum overshoot. Carrier frequency components in the rectified envelope above 250 kHz are greatly attenuated (more than 60 dB). The divider formed by R4 and R5 attenuates the detector output before application to buffer amplifier U1A.

At this point in the circuit, the detected AM signal consists of an AC waveform superimposed on a DC voltage. Peaks in the envelope of the AM signal result in negative voltage excursions in the filter and at the output of U1A. Increases in average carrier level cause larger negative DC voltages to appear at the detector output.

Diode CR3 is biased to the same DC current as CR2 by R8. The differential amplifier formed by U1B and R6, R7, R9, and R10 effectively subtracts the turn-on voltage of CR3 from the detector output, canceling the DC offset of detector diode CR2. Simultaneously, the output of U1B is inverted, giving the detector a positive sense (larger carrier levels produce larger positive voltages). At the output of U1B, positive swings correspond to positive modulation peaks of the AM envelope, and negative voltage swings correspond to negative modulation peaks. The average DC voltage at the U1B output corresponds to the average carrier level of the signal applied to the A1 board—increased carrier levels increase the average DC voltage.

The upright AC/DC detector output signal at pin 7 of U1B is applied to the low-pass filter composed of R11 and C10, as well as the high-pass filter of C11 and R14. The modulation envelope is removed by the low-pass filter, leaving a DC voltage at the junction of R11-C10 which is proportional to the applied carrier level. This DC voltage is amplified and buffered by amplifier U2B, and then distributed to the carrier level meter, the reference inputs for the adjustable, negative, and positive peak comparators, the modulation alarm comparator, the carrier level alarm, and the Carrier Reference output at P1-15. The carrier DC is blocked by C11, and the AC component of the AM carrier envelope is buffered by U2A before being passed to the measurement circuitry and the audio output circuitry. The low-pass and high-pass R-C filters have matching time constants and cutoff frequencies of 0.7 Hz. This extreme frequency is required to minimize tilt of clipped envelope waveforms passed to the metering circuits by C11-R14. Tilt results in erroneously high peak modulation readings. The peak flasher comparators reference their indications to the DC reference distributed by U2B. With the time constants of the high-pass and low-pass networks matched, the indication error due to the AC tilt for *negative* peaks is canceled by the low frequency drift of the carrier DC low-pass network.

% CARRIER DEVIATION METER Circuit

The carrier DC at the output of U2B drives the chassis and remote % CARRIER LEVEL DEVIATION meters through resistors R24, R28 and R29, the REMote section of panel switch S1, and finally, the output of +5 VDC regulator U13. Front panel and remote % CARRIER LEVEL DEVIATION meters are center zero types. When pin 7 of U2B is larger than +5 VDC (and the front panel REMote pushbutton is released), current flows from U2B, through R24 and R29, the panel carrier meter, and then through R28 to the A1 +5 VDC supply (U13). The panel % CARRIER LEVEL DEVIATION then reads above 0%. When the output of U2B drops below +5 VDC, the direction of the meter current is reversed, flowing from the +5 VDC regulator output into the output of U2B. The panel carrier meter then indicates negative carrier deviation. It can be seen that U13 provides the operating carrier level reference for the AMM-2C. When the DC voltage at the output of U2B is exactly equal to the output voltage of U13, no current flows through the center zero carrier meter, and its indication is 0% deviation.

Depressing the front panel REMote pushbutton of A1-S1 breaks the internal series carrier metering circuit by removing R29 and substitutes for it the external circuit connected between card-edge contacts P1-2 and P1-3. External meters with the same current sensitivity as the panel meter (100 microamps for full scale) will duplicate the reading of the front panel meter. When the total resistance of the external circuit, including the remote carrier meter, is 5.11 kΩ, the internal carrier meter indicates correctly and the monitor's calibration is maintained.

Carrier Meter Clamp

An active meter clamping circuit prevents overdriving the % CARRIER LEVEL DEVIATION meters when carrier at the input of the AMM-2C is lost. The clamp is formed by PNP transistor Q1 resistors R21–R24, and diode CR4. Regulator U4 provides +8 VDC for the clamping circuit. When the carrier DC output at U2B falls below about +3.4 VDC, corresponding to approximately 68% of the nominal carrier level, the base of Q1 falls 0.55 volts below the emitter, and the transistor begins to source current through its collector. The collector current opposes the current flowing back through the carrier meter(s) from the +5 VDC bus to the U2B output, reducing the effective

drive to the meter(s). Diode CR4 prevents the collector-base junction of Q1 from conducting current away from the meter circuit when the carrier level rises above the nominal level.

Peak Flasher Circuits

Two peak flasher circuits independently indicate -100% and +125% modulation peaks. A third circuit indicates modulation peaks over a range of 40% to 130% modulation. Polarity of this indication is determined by the setting of the front panel NEGative and POSitive pushbuttons in switch assembly S1.

Basic operation of the three circuits is the same. Each flasher is triggered when the modulation (AC) component of the detected signal reaches the threshold of a DC reference voltage. At that instant, the output of a voltage comparator changes state, going low. This *enables* triggering of a monostable multivibrator. The output pulse of the monostable turns on a driver transistor, which then draws current through the appropriate LED and any attached external load.

Only the operation of the -100% flasher will be described in detail. The detected modulation waveform at the output of U2A passes through the CAL and ZERO sections of switch S1, buffer amplifier U3A, and finally, inverting amplifier U3B. At the output of U3B, the modulation waveform is inverted—higher *negative* modulation causes the instantaneous voltage to increase. The waveform is applied to the inverting input (pin 4) of comparator U5B. The triggering threshold of the comparator is set by the reference voltage applied to the noninverting input (pin 5). By employing a reference voltage that is proportional to the carrier level of the AM signal, the triggering point of the flasher circuit—measured as a specific ratio of modulation voltage to carrier voltage, i.e. modulation percentage—is independent of absolute carrier level. Such a reference voltage is derived from the DC carrier level (at U2B) and the voltage divider formed by R49–R51. Potentiometer R50 is set so the voltages at pins 4 and 5 of U5B are equal at 99+% negative modulation.

The comparator output at U5B pin 2 is normally high. When the modulation signal at U5B pin 4 reaches the carrier derived reference voltage at pin 5, the open collector output of U5B pulls pin 2 low. Resistor R55, in combination with the resistance of the reference divider, produces positive feedback around the comparator, resulting in a hysteresis equivalent to approximately 0.5% modulation at its input. This minimizes oscillation in the comparator for slowly changing modulation signals near the triggering threshold.

Monostable multivibrator U9A is *enabled* by a low at the output of comparator U5B. Actual *triggering* of the monostable is controlled by the logic states of both its triggering inputs (pins 4 and 5). An explanation follows.

The output period of each of the three monostables is approximately 150 milliseconds. In U9A, the interval is set by R57 and C30. The monostables are retriggered by peaks occurring before the end of the 150 millisecond interval. This extends the duration of the output pulse. However, if the peak indicator relied solely on the output *transition* of the comparator for triggering, modulation peaks longer than 150 ms. would allow the peak indicator LED's to extinguish before the peak had ended. To prevent this possibility, the second, inverting trigger input of each peak monostable (at either pin 5 or 11) is driven by a 200 kHz square wave generated by inverters U6A through U6C. Pins 4 and 5 of monostable U9A and pins 12 and 11 of U9B are inputs to an internal OR gate. (It is the rising edge at the output of the internal OR gate that actually initiates the monostable's output pulse.) Under normal conditions, the comparator output is high. This holds the output of the internal OR high, initially firing the monostable, but then locking out any subsequent retriggering of the monostable by the square wave applied to pin 5 by holding the OR gate output high. When the modulation signal exceeds the threshold, the comparator output goes low. The next falling edge of the clock signal from U6C at U9A pin 5 then triggers the monostable. While the comparator output remains low, every falling edge of the clock at U9A pin 5 retriggers the monostable and extends the output pulse another 150 milliseconds. While the Q output at U9A pin 6 is high, current flows through current limiting resistor R58 into the base of Q4. Q4 saturates, sinking current from the chassis +5 VDC supply

through the -100% LED, chassis CR3, and current limiting resistor A1-R59. Current also flows through Q4 from card-edge contact P1-6. Ceramic capacitor C32 provides a low impedance path to ground for RF current coupled into P1-6 by external circuitry.

The clock oscillator common to the four monostables on the A1 board is formed using three Schmitt-input inverters. The 200 kHz clock frequency is set by R60, R61, and C29. A three-inverter circuit is guaranteed to be self-starting, even without the hysteresis of the device inputs. Edge speed of the distributed clock signal is slowed by R62 and the distributed capacitance of the circuit board traces.

The +125% flasher is controlled by comparator U5A. A fixed voltage divider composed of R18, R19, and R20 provides the two different signals used to drive U5A through unity gain buffer amplifier U10A. The CALibrate section of switch S1 determines which signal is passed to U5A. When the AMM-2C is operating in ZERO, NEGative, or POSitive modes, the input to U5A is taken from the R19-R20 junction. When in CALibrate, the DC calibration voltage passing to U5A from U3A is taken from the junction of R18 and R19. This voltage is 1.25 times the voltage at the R19-R20 junction, providing the voltage differential necessary to calibrate the 125% LED using a reference signal with a nominal level of +100%. Buffer amplifier U10A eliminates loading of the divider by U5A and its input protection diode CR9. The divider formed by R74–R76 provides the carrier reference for the +125% flasher. The flasher is calibrated by R75, the +125% ADJust potentiometer.

The PEAK MOD flasher circuit differs from the other two in that the reference voltage, and therefore the indicated modulation percentage, is controlled by front panel potentiometer R2, in conjunction with A1 board resistors R63 and R64. The reference voltage is again derived from the carrier voltage at U2B, so the PEAK MOD indications are nearly independent of RF carrier level. The modulation input to comparator U5D is selected from the output of either amplifier U3A or U3B by the NEGative and ZERO sections of switch S1. When the NEGative button is depressed, the comparator is driven by the inverted modulation signal at the output of U3B. When the POSitive button is depressed, the NEGative button is released and the uninverted modulation signal is taken from buffer amplifier U3A. The voltage divider formed by R66, R68, and MOD SPAN potentiometer R67, permits adjustment of the scale of the modulation signal applied to comparator U5D. This is so the PEAK MOD indications set by the front panel potentiometer R2 correspond to the actual modulation percentages across the range from 40% to 130%.

Meter Rectifier

Operational amplifiers U12A and U12B form an active, half-wave peak rectifier which provides semi-peak meter indications of the AM modulation. The input to the rectifier is taken from the output of the NEGative pushbutton. The divider formed by R93, R95, and METER CAL potentiometer R94 adjusts sensitivity of the rectifier for proper indications. Modulation signals with positive voltage appearing at the noninverting input of U12A are amplified and pass through signal diode CR14 to charge metering capacitor C42. Unity gain buffer U12B isolates C42 from external loads and provides negative feedback for U12A. The output voltage of U12A rises until the feedback voltage from the output of U12B just equals the input voltage at pin 3 of U12A. At this point, the rectifier output voltage is equal to the peak voltage at the input to the rectifier. As the input voltage drops from this peak, the charge on C42 (combined with the high input impedance of JFET-input op-amp U12B) holds the rectifier output and thus the inverting input of U12A momentarily constant. The large open loop gain of U12A causes its own output to slew lower until diode CR13 turns on. The U12A output, shifted lower by the forward cut-in voltage of CR13, then tracks the falling rectifier input voltage. Discharge of the rectifier is controlled by the time constant of C42–R97. When the rectifier input again exceeds the voltage on C42 (and thus U12A, pin 2), the output of U12A then slews positive until CR14 turns on and the feedback path is again completed through U12B. A divider network composed of R98 and R99 provides a small negative bias voltage to R97. This permits the meter rectifier to discharge to below 0% so that any negative offset that might exist in the circuitry can be read on the MODULATION meter when the monitor is operating in the ZERO mode. The meter build-out network composed of R102 and R103 provides the proper source resistance and attenuation to drive chassis MODULATION meter

M2. Resistors R100 and R101, combined with C44 provide protection to the internal circuitry of the AMM-2C from transients that may occur on the external modulation metering circuit attached to P1-1.

Audio Outputs

The three audio outputs of the AMM-2C are taken from the AC coupled and buffered detector output signal at pin 1 of U2A. The setting of internal jumper P2 determines whether or not the NRSC de-emphasis characteristic is applied to the output audio. With jumper P2 in the "OUT" position, the audio from U2A passes to the noninverting input of isolation amplifier U7A without alteration. With P2 set at "IN", the network composed of R39–R42 and C20 provides the NRSC response characteristic. (The network produces a 75 microsecond de-emphasis. The combination of R41, R42, and C20 produce the required break in the curve at 8700 Hz.) Noninverting amplifier U7A raises the audio level to 5 Vrms at 100% modulation for output to the AUDIO TEST OUTPUT jack J3 and the AUXILIARY DETECTOR OUTPUT P1-18. Both of these outputs are current limited by 2.2 kΩ resistors R45 and R46. The AUXILIARY output employs a 10 microfarad nonpolarized capacitor to block any DC in the output due to possible DC offsets in U2A or U7A. The output of U7A is padded down to 1.22 Vrms by resistive divider R47 and R48 for input to unity gain buffer U7B. U7B provides a low impedance source for the active balanced output driver U8. The *differential* output level of this device at contacts P1-16 and P1-17 is 2.45 Vrms, or +10 dBu, at 100% sine wave modulation.

Carrier Level Alarm

The DC carrier reference from carrier buffer U2B is applied to comparator section U5C. The CR5-R30 combination prevents negative voltages from damaging the comparator in the unlikely event that the U2B output goes below ground potential. The comparator threshold, which is approximately 70% of nominal carrier level, is set by the voltage divider formed by R31 and R32, in conjunction with the output of +5 VDC regulator U13. Resistor R33 provides sufficient hysteresis to prevent transmitter carrier shift due to modulation from causing the CARRIER LEVEL LED (chassis CR4) to blink on and off. Schmitt-input inverters U6D and U6E isolate the comparator output from the loads of transistors Q2 and Q3. Resistors R35 and R36 limit the base currents of the two output transistors to about 1 milliamp.

When the DC carrier level is above approximately +3.4 VDC, U5C output is low. The output of U6D is high, turning on Q2, and in turn activating the coil of carrier level alarm relay RL1. The carrier level alarm operates in a "fail-safe" mode: with the carrier level above 68% and the coil of RL1 active, the alarm is inactive. Accordingly P1-14 is shorted to P1-13 through the relay contacts. The output of U6E is low; Q3 and chassis CR4 (the CARRIER LEVEL LED) are off. When the carrier level drops below about 68%, the comparator output goes high, turning off Q2 (via U6D). Current to the coil of RL1 is removed. (Back-EMF in the relay coil is shunted away from the collector of Q2 by diode CR6.) P1-12 is now shorted to P1-14. This represents the carrier level alarm condition. The high output of U5C turns on Q3 on through U6E. Transistor Q3 draws current through chassis red CARRIER LEVEL LED CR4 and current limiting resistor R37, lighting the LED.

Modulation Alarm

The AMM-2C modulation alarm senses when modulation of the RF input falls below a user adjustable level for longer than approximately 15 seconds. The alarm output is in the form of dry SPDT relay contacts which are accessible at the rear panel card-edge connecter P1. The alarm operates by comparing the output of the peak metering rectifier, at pin 7 of U12B, with an adjustable reference voltage. As in the peak flasher circuits, the reference voltage is derived from the carrier level DC voltage at the output of U2B. As a result, the modulation alarm threshold, in terms of modulation percentage, is independent of the input level of the RF carrier. The alarm reference level is set by the voltage divider consisting of R84, R86, and MODULATION ALARM THRESHOLD potentiometer R85. (R85 is accessible through an opening at the rear of the AMM-2C.)

The reference voltage is applied to the inverting input of operational amplifier U10B, which is employed as a comparator. The output of the metering rectifier is applied to the noninverting input of U10B through R87. The combination of R87 and R88 provides positive feedback around U10B and the hysteresis necessary for clean output transitions at pin 7 of U10B. The voltage divider formed by R89 and R90 reduce the positive output swing applied to the inverting input of monostable U11B to approximately 4 volts. Diode CR11 prevents the input to U11B from exceeding -0.6 volt when the output of U10B goes negative. R104 maintains a small positive DC voltage on the inverting input of U10B when there is no AM carrier. As a result, pin 7 of U10 becomes negative when the carrier is lost, guaranteeing activation of the modulation alarm.

The modulation alarm operates in a "fail-safe" mode: the nonalarm condition requires that the entire circuit chain be operating properly. Monostable multivibrator U11B receives the 200 kHz clock signal from U6C, like the peak flasher monostables, but here the two triggering inputs are reversed. As long as the modulation level exceeds the user set reference at pin 6 of U10B, pin 11 of U11B is held high. As a result, U11B is continuously retriggered by the clock signal at pin 12. Pin 10 of U11B is held high, turning on Q7, and continuously drawing current through the coil of relay RL2. When modulation falls below the set threshold, the U10B output goes low and further retriggering of U11B by the clock signal is inhibited. The 15 second time-out, initiated by the last falling transition at pin 12 of U11B, has already begun. If the desired modulation level is restored, before U11B times out, retriggering of U11B again occurs, extending the high output at pin 10. If modulation remains below the threshold for the full 15 seconds, U11B is allowed to time out, at which point its Q output (pin 10) falls to logic low. Transistor Q7 and relay RL2 then become inactive, and connector contact P1-9 is shorted to P1-11. Timing of the delay is set by R91 and C40. Diode CR10 prevents residual charge on C40 from damaging the analog timing input of U11B.

Operational Switching and Calibration

All operational switching in the AMM-2C is made via front panel push-button switch assembly S1. The switch assembly is fastened to the front panel with two screws, but is held captive to the A1 circuit board. The LAMPS switch is discussed above in relation to the internal power supply in the second paragraph of this section, *Theory of Operation*. The REMote button and related circuitry is discussed above in the paragraph labeled *% CARRIER DEVIATION METER Circuit*.

The four center pushbuttons of S1 are interlocked—pushing any one of the four releases the button depressed previously. The POSitive and NEGative buttons select the polarity of the modulation signal input to the peak metering rectifier (at U12A) and the PEAK MOD flasher comparator U5D. With either of these buttons depressed, the positive sense AC modulation signal (positive modulation swings producing positive signal voltages) from the output of U2A appears at the output of buffer amplifier U3A (via contacts 16 & 17 and 10 & 11 of the CALibrate and ZERO buttons respectively). The modulation signal from the output of U3A, is inverted by amplifier U3B. With POSitive depressed, the modulation component from U3A passes through contacts 7 & 8 of the ZERO button to contact 19 of the released NEGative button, where it is passed on to the measurement circuits. When NEGative is depressed, contact 20 is shorted to contact 21, and the switch output to the measuring circuits is taken directly from inverting amplifier U3B.

In ZERO mode, the ground potential modulation "test" signal from contacts 12 and 11 of switch S1 passes through *both* amplifiers U3A and U3B, then contacts 9 & 8 of the ZERO section, and finally contacts 19 & 20 of the released NEGative button on its way to the metering and PEAK MOD circuits. This allows any significant DC offset occurring in either amplifier to appear in the meter reading during the ZERO check.

In CALibrate mode, the AMM-2C takes a scaled voltage from the carrier level DC at the U2B output and applies it (via contacts 18 & 17 of the CALibrate button and contacts 10 & 11 of the ZERO button) to all the measurement circuits through buffer U3A and inverter U3B. Since the NEGative button is released, the meter and PEAK MOD

flasher are operating so as to indicate positive modulation. The actual calibrate reference voltage is supplied to contact 18 by the divider formed by R25, R27, and CAL REFerence ADJUST potentiometer R26. As during normal operation, MODULATION meter readings depend on absolute carrier level. So, the % CARRIER LEVEL DEVIATION reading must be 0% for a proper calibration check of the monitor.

As described above under *Peak Flasher Circuits*, during normal operation the positive sense modulation signal from U3A is passed from the R19–R20 junction through contacts 13 & 14 of the CALibrate button to the +125% peak comparator. With CALibrate depressed, the signal is taken from the R18–R19 junction through contacts 15 & 14 of the switch. This voltage is 1.25 times the peak voltage at 100% positive modulation, providing an accurate reference voltage for checking adjustment of the +125% peak flasher. The carrier derived calibration voltage is positive. Therefore, in CALibrate, the signal input to the -100% comparator U9A receives an inverted, negative "signal" voltage from the output of U3B. This prevents checking calibration of the -100% flasher in the CALibrate mode.

7 Diagrams, Schematics, and Parts Lists

Replaceable Parts. This page contains information for ordering replaceable parts for the unit. The tables that follow list the parts in alphanumeric order by reference designation and provides a description of the part with the Belar part number.

Ordering Information. To order a replacement part from Belar, address the order or inquiry to Belar and supply the following information:

a. Model number and serial number of unit.
b. Description of part, *including the reference designation and location.*

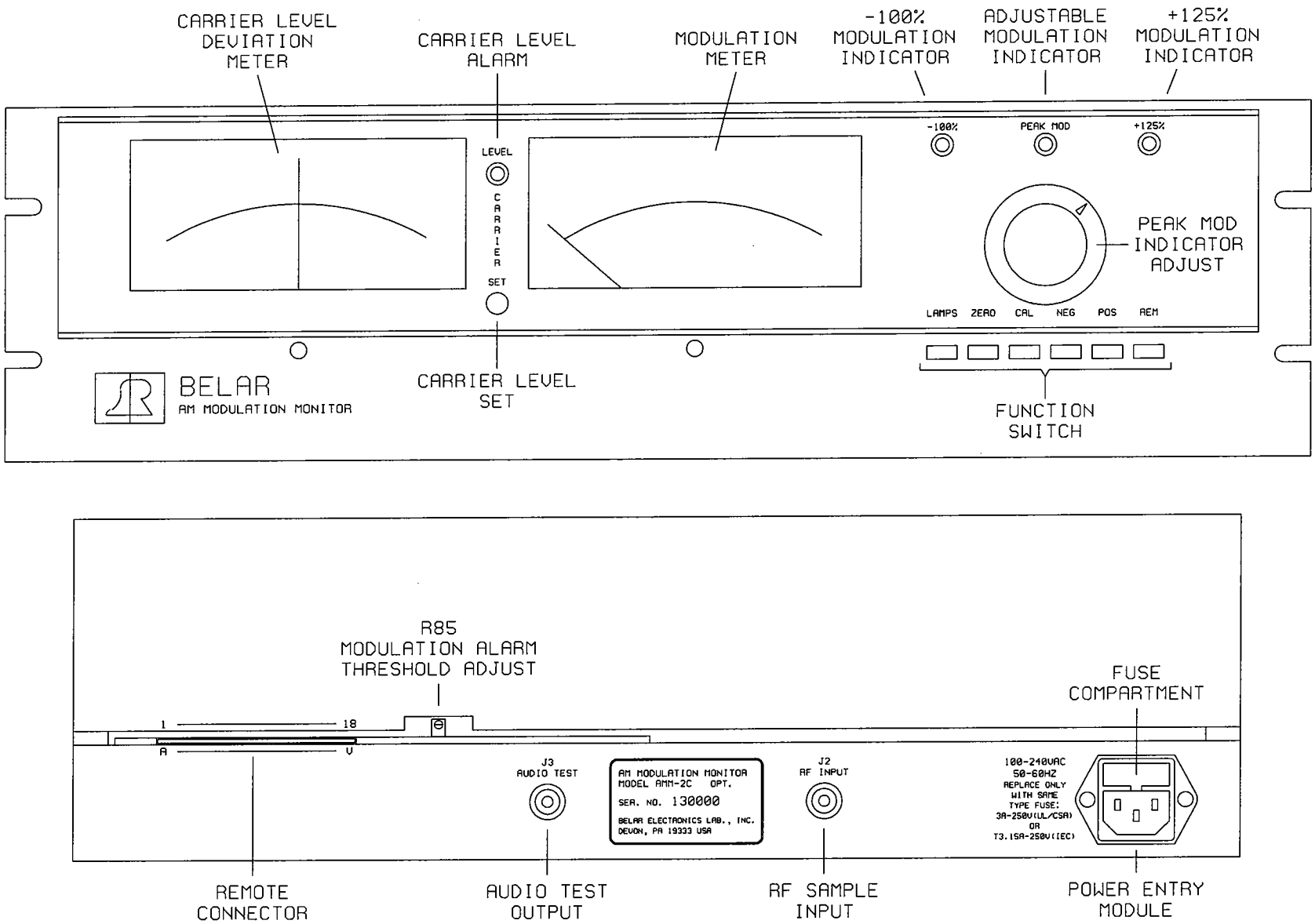
Orders may also be taken over the telephone. Parts orders can be put on your VISA, MasterCard, or American Express card, or we can ship them COD.

REFERENCE DESIGNATORS

A	= assembly	J	= jack	S	= switch
BR	= diode bridge	L	= inductor	T	= transformer
C	= capacitor	M	= meter	TB	= terminal block
CR	= diode or LED	P	= plug	U	= integrated circuit
DS	= display or lamp	Q	= transistor	W	= cable
F	= fuse	R	= resistor	X	= socket
FL	= filter	RL	= relay	Y	= crystal
HDR	= header connector	RN	= resistor network		

ABBREVIATIONS

BCD	= binary coded decimal	PIV	= peak inverse voltage
CER	= ceramic	POLY	= polystyrene
COMP	= composition	PORC	= porcelain
CONN	= connector	POT	= potentiometer
DPM	= digital panel meter	SEMICON	= semiconductor
ELEC	= electrolytic	SI	= silicon
GE	= germanium	TANT	= tantalum
IC	= integrated circuit	uF	= microfarads
k	= kilo = 1,000	V	= volt
M	= meg = 1,000,000	VAR	= variable
MOD	= modulation	VDCW	= dc working volts
MY	= Mylar	W	= watts
PC	= printed circuit	WW	= wirewound
pF	= picofarads		



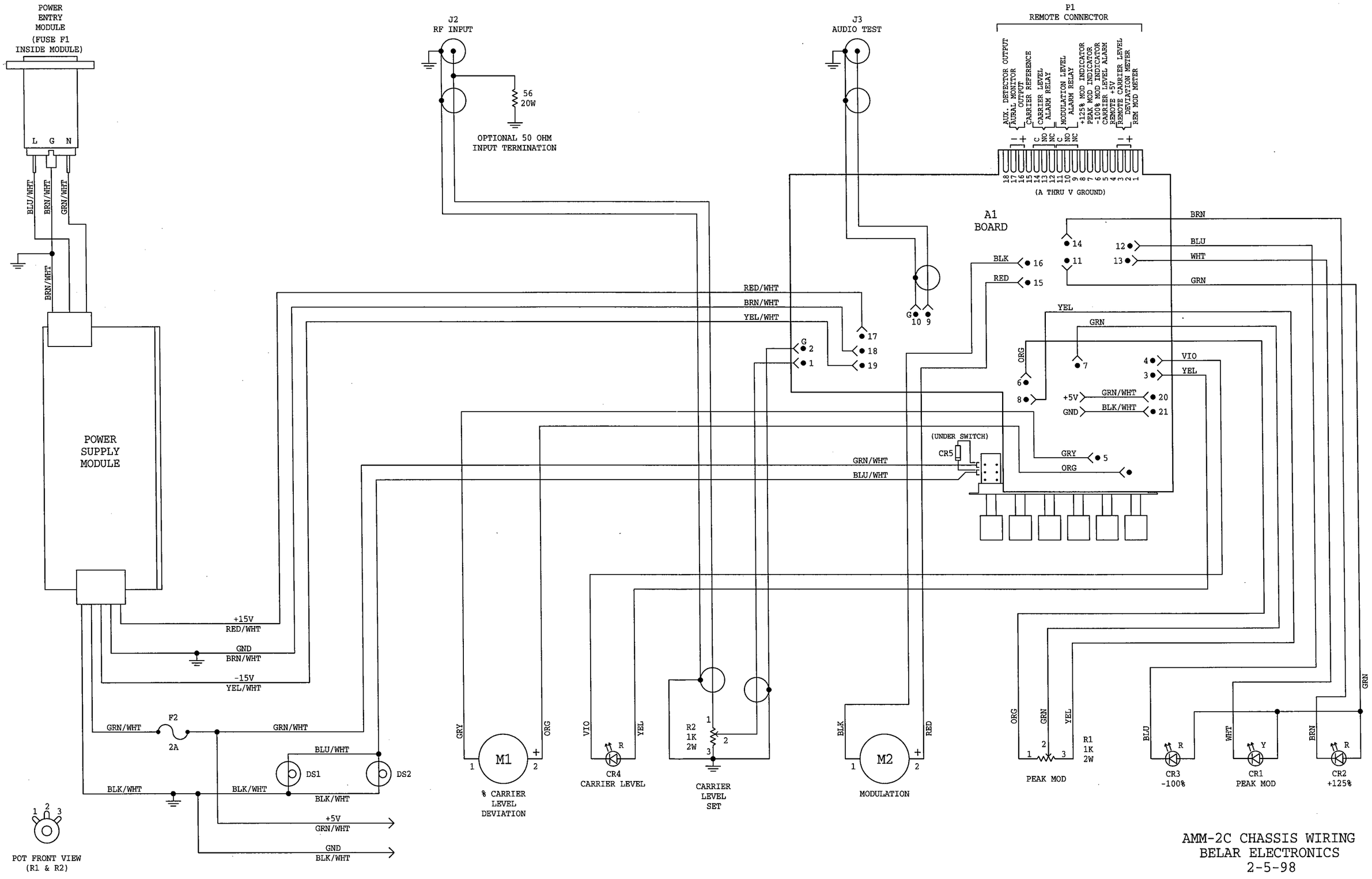
AMM-2C FRONT & REAR VIEWS
BELAR ELECTRONICS
2-5-98

AMM-2C PARTS LISTS

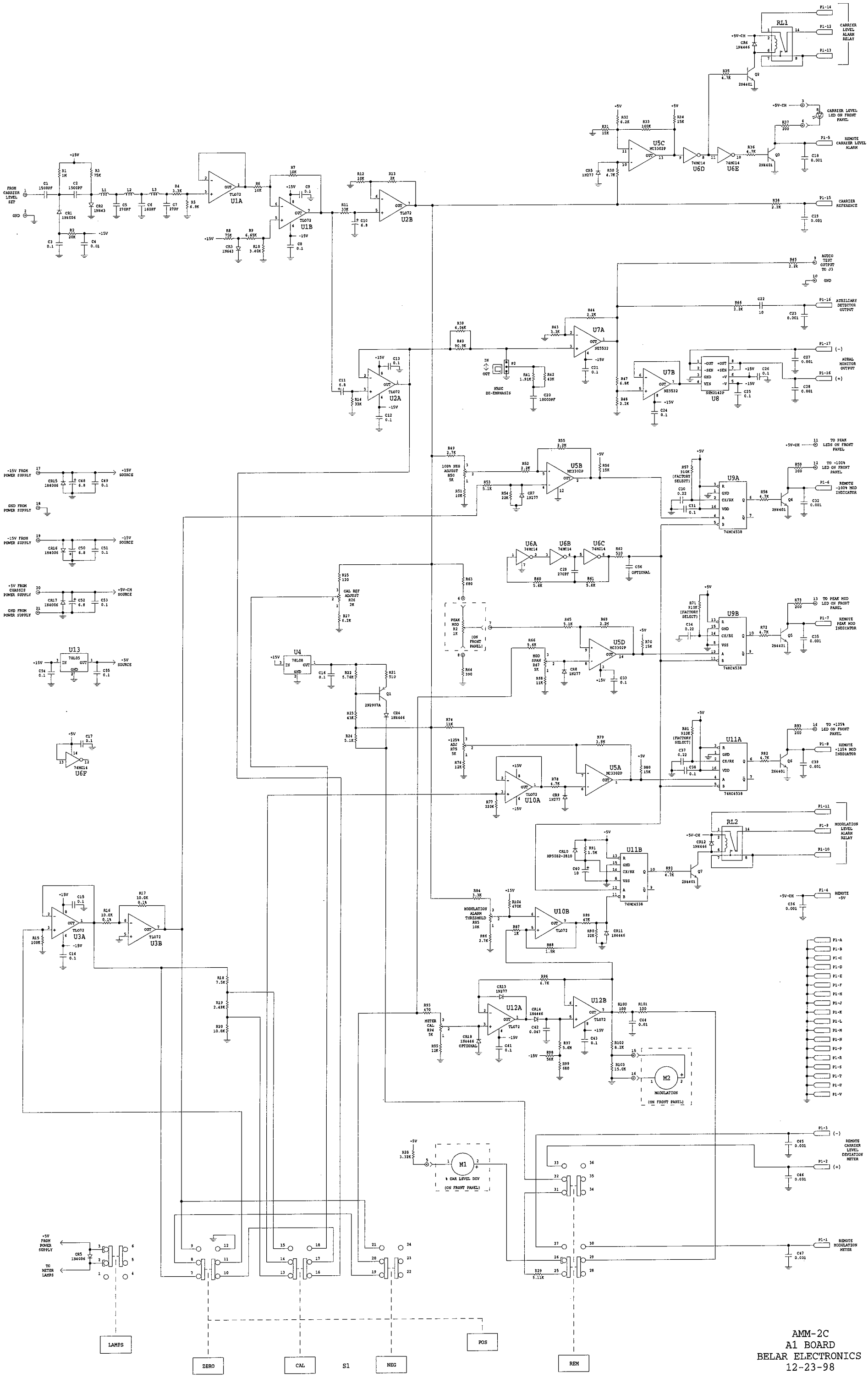
MAIN CHASSIS

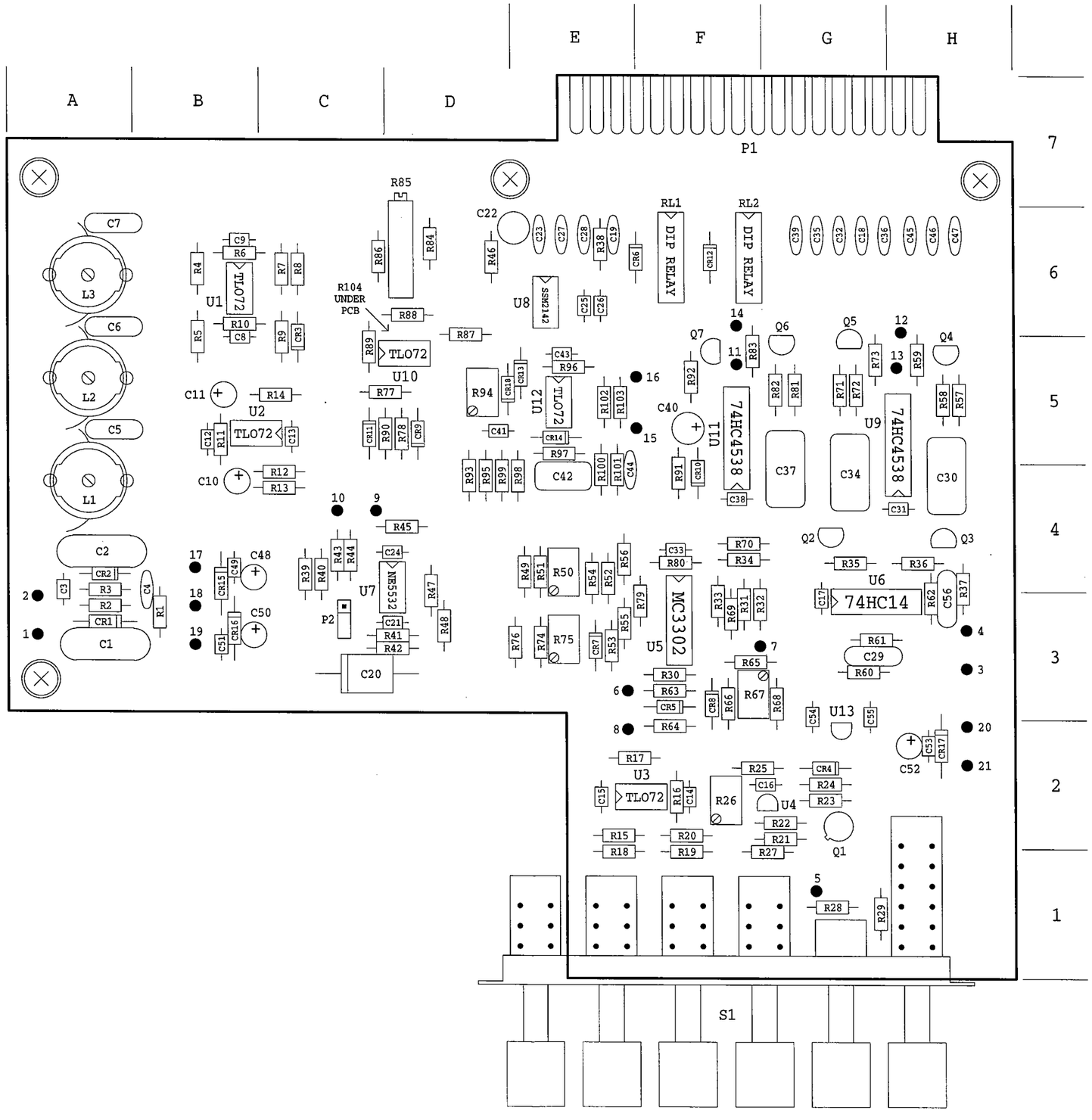
Reference Designation	Description		Part Number
--	POWER SUPPLY MODULE: 15W		4005-0019A
CR1	LED: YELLOW		1910-0002
CR2 thru CR4	LED: RED		1910-0001
CR5	DIODE: 1N4006		1900-0016
DS1,DS2	LAMP: 755		2140-0005
--	SOCKET: LAMP		1450-0012
F1	FUSE: GMA-3A 250V(UL/CSA) or T3.15A-250V(IEC)		2110-0009
--	FUSE HOLDER: CHASSIS MOUNT		2110-0010
F2	FUSE: AGC-2A 250V		2110-0006
J1	POWER ENTRY MODULE: 6EGG1-1		0360-0021
J2,J3	JACK: BNC		0360-0005
M1	METER: CARRIER LEVEL		1120-0013
M2	METER: MOD 0-133%		1120-0012
R1	R: VAR WW 1K 2W		2100-0001
R2	R: VAR COMP 1k 2W		2100-0017
--	R: FIXED NON-IND 56 20W	(NOTE 1)	0811-0021
--	LINE CORD (115 Vac line voltage)		8120-0002
--	LINE CORD (230 Vac line voltage)		8120-0004
--	CONNECTOR: CARD EDGE, 36 PIN (CINCH 50-36SN-9 or equivalent)		0365-0055

NOTE 1: Optional 50 ohm input termination.



AMM-2C CHASSIS WIRING
BELAR ELECTRONICS
2-5-98


FROM CARRIER LEVEL SET
GND
+15V
-15V
+5V
+5V-CH
+5V-CH
GND
U1A
U1B
U2A
U2B
U3A
U3B
U4
U5A
U5B
U5C
U5D
U6A
U6B
U6C
U6D
U6E
U6F
U7A
U7B
U8
U9A
U9B
U10A
U10B
U11A
U11B
U12A
U12B
U13
RL1
RL2
Q1
Q2
Q3
Q4
Q5
Q6
Q7
P2
S1
M1
M2
CR1 1N4006
CR2 1N643
CR3 1N643
CR4 1N4446
CR5 1N4006
CR6 1N4446
CR7 1N277
CR8 1N277
CR9 1N277
CR10 HP5082-2810
CR11 1N4446
CR12 1N4446
CR13 1N277
CR14 1N4446
CR15 1N4006
CR16 1N4006
CR17 1N4006
CR18 1N4446 OPTIONAL
CR5 1N277
2N3907A
2N4401
74HC14
74HC4538
TLO72
MC3302P
NE5532
SSM2142P
78L05
78L08
IN
OUT
GND
NRSC DE-EMPHASIS
CARRIER LEVEL ALARM RELAY
CARRIER LEVEL LED ON FRONT PANEL
REMOTE CARRIER LEVEL ALARM
CARRIER REFERENCE
AUDIO TEST OUTPUT TO J3
AUXILIARY DETECTOR OUTPUT
AURAL MONITOR OUTPUT
(-)
(+)
REMOTE -5V
MODULATION LEVEL ALARM RELAY
TO PEAK LEDS ON FRONT PANEL
TO -100% LED ON FRONT PANEL
REMOTE -100% MOD INDICATOR
TO PEAK MOD LED ON FRONT PANEL
REMOTE PEAK MOD INDICATOR
TO +125% LED ON FRONT PANEL
REMOTE +125% MOD INDICATOR
REMOTE MODULATION METER
REMOTE CARRIER LEVEL DEVIATION METER
CAL REF ADJUST R26 2K
(ON FRONT PANEL)
MODULATION
% CAR LEVEL DEV
-15V FROM POWER SUPPLY
+15V SOURCE
GND FROM POWER SUPPLY
-15V SOURCE
+5V FROM CHASSIS POWER SUPPLY
+5V-CH SOURCE
+5V SOURCE
+5V FROM POWER SUPPLY
TO METER LAMPS
LAMPS
ZERO
CAL
S1
NEG
POS
REM
OPTIONAL
AMM-2C
A1 BOARD
BELAR ELECTRONICS
12-23-98

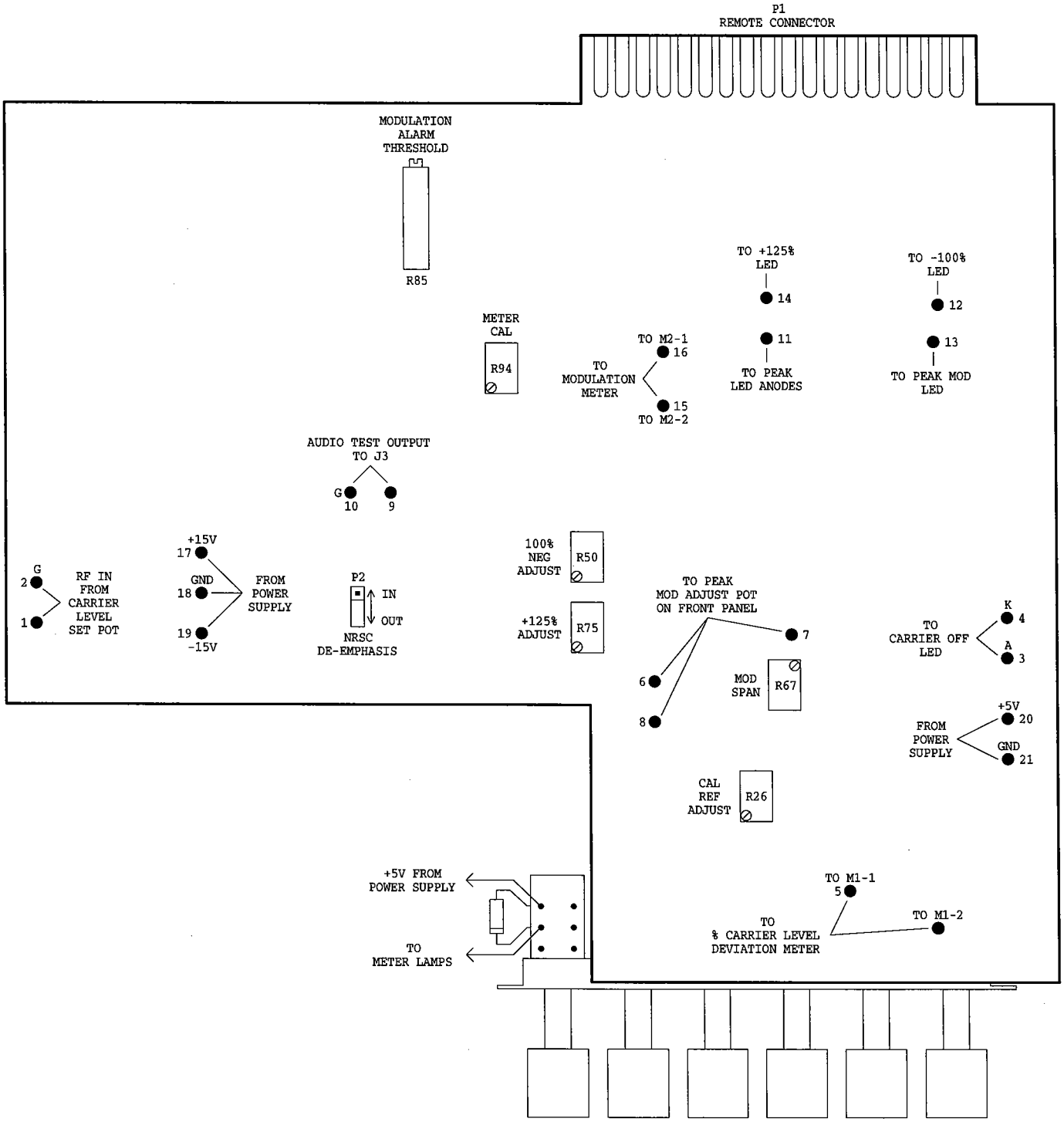


AMM-2C A1 BOARD
COMPONENT LAYOUT
BELAR ELECTRONICS

AMM-2C A1 BOARD
PART LOCATIONS

Desig/Loc		Desig/Loc		Desig/Loc		Desig/Loc		Desig/Loc		Desig/Loc	
C1	A3	C41	D5	P1	F7	R31	F3	R71	G5	U1	B6
C2	A4	C42	E4	P2	C3	R32	F3	R72	G5	U2	B5
C3	A4	C43	E5	Q1	G2	R33	F3	R73	G5	U3	F2
C4	B3	C44	E4	Q2	G4	R34	F4	R74	E3	U4	G2
C5	A5	C45	H6	Q3	H4	R35	G4	R75	E3	U5	F3
C6	A6	C46	H6	Q4	H5	R36	H4	R76	E3	U6	G3
C7	A6	C47	H6	Q5	G5	R37	H4	R77	D5	U7	D4
C8	B5	C48	B4	Q6	G5	R38	E6	R78	D5	U8	E6
C9	B6	C49	B4	Q7	F5	R39	C4	R79	F3	U9	H5
C10	B4	C50	B3			R40	C4	R80	F4	U10	D5
C11	B5	C51	B3	R1	B3	R41	D3	R81	G5	U11	F5
C12	B5	C52	H2	R2	A3	R42	D3	R82	G5	U12	E5
C13	C5	C53	H2	R3	A4	R43	C4	R83	F5	U13	G2
C14	F2	C54	G3	R4	B6	R44	C4	R84	D6		
C15	E2	C55	G3	R5	B5	R45	D4	R85	D6	pins	
C16	G2	C56	H3	R6	B6	R46	D6	R86	C6	1	A3
C17	G3			R7	C6	R47	D4	R87	D5	2	A3
C18	G6	CR1	A3	R8	C6	R48	D3	R88	D6	3	H3
C19	E6	CR2	A4	R9	C5	R49	E4	R89	C5	4	H3
C20	C3	CR3	C5	R10	B6	R50	E4	R90	D5	5	G1
C21	D3	CR4	G2	R11	B5	R51	E4	R91	F4	6	E3
C22	E6	CR5	F3	R12	C4	R52	E4	R92	F5	7	F3
C23	E6	CR6	F6	R13	C4	R53	E3	R93	D4	8	E2
C24	D4	CR7	E3	R14	C5	R54	E4	R94	D5	9	C4
C25	E6	CR8	F3	R15	E2	R55	E3	R95	D4	10	C4
C26	E6	CR9	D5	R16	F2	R56	E4	R96	E5	11	F5
C27	E6	CR10	F4	R17	E2	R57	H5	R97	E5	12	H6
C28	E6	CR11	C5	R18	E1	R58	H5	R98	E4	13	H5
C29	G3	CR12	F6	R19	F1	R59	H5	R99	D4	14	F6
C30	H4	CR13	E5	R20	F2	R60	G3	R100	E4	15	F5
C31	H4	CR14	E5	R21	G2	R61	G3	R101	E4	16	F5
C32	G6	CR15	B4	R22	G2	R62	H3	R102	E5	17	B4
C33	F4	CR16	B3	R23	G2	R63	F3	R103	E5	18	B3
C34	G4	CR17	H2	R24	G2	R64	F2	R104	D5*	19	B3
C35	G6	CR18	D5	R25	F2	R65	F3			20	H2
C36	G6			R26	F2	R66	F3	RL1	F6	21	H2
C37	G4	L1	A4	R27	G1	R67	F3	RL2	F6		
C38	F4	L2	A5	R28	G1	R68	G3				
C39	G6	L3	A6	R29	G1	R69	F3	S1	F1		
C40	F5			R30	F3	R70	F4				

*R104 is on pc bottom.



AMM-2C A1 BOARD
CONNECTIONS & ADJUSTMENTS
BELAR ELECTRONICS

A1 BOARD AMM-2C

Reference Designation	Description	Part Number
C1,C2	C: FIXED MICA 1500pF 5%	0141-1525
C3	C: FIXED CERAMIC 0.1uF 50V	0151-0006
C4	C: FIXED CERAMIC 0.01uF 100V	0151-0003
C5	C: FIXED MICA 270pF 5%	0140-2715
C6	C: FIXED MICA 160pF 5%	0140-1615
C7	C: FIXED MICA 27pF 5%	0140-2705
C8,C9	C: FIXED CERAMIC 0.1uF 50V	0151-0006
C10,C11	C: FIXED TANT 6.8uF 25V	0185-0002
C12 thru C17	C: FIXED CERAMIC 0.1uF 50V	0151-0006
C18,C19	C: FIXED CERAMIC 0.001uF 1kV	0151-0002
C20	C: FIXED POLY 10,000pF 2.5% 160V	0130-1032
C21	C: FIXED CERAMIC 0.1uF 50V	0151-0006
C22	C: FIXED ELEC 10uF 35V NON-POLAR	0180-0029
C23	C: FIXED CERAMIC 0.001uF 1kV	0151-0002
C24 thru C26	C: FIXED CERAMIC 0.1uF 50V	0151-0006
C27,C28	C: FIXED CERAMIC 0.001uF 1kV	0151-0002
C29	C: FIXED MICA 270pF 5%	0140-2715
C30	C: FIXED POLY 0.22uF 10% 100V	0122-2241
C31	C: FIXED CERAMIC 0.1uF 50V	0151-0006
C32	C: FIXED CERAMIC 0.001uF 1kV	0151-0002
C33	C: FIXED CERAMIC 0.1uF 50V	0151-0006
C34	C: FIXED POLY 0.22uF 10% 100V	0122-2241
C35,C36	C: FIXED CERAMIC 0.001uF 1kV	0151-0002
C37	C: FIXED POLY 0.22uF 10% 100V	0122-2241
C38	C: FIXED CERAMIC 0.1uF 50V	0151-0006
C39	C: FIXED CERAMIC 0.001uF 1kV	0151-0002
C40	C: FIXED TANT 10uF 16V	0185-0007
C41	C: FIXED CERAMIC 0.1uF 50V	0151-0006
C42	C: FIXED POLY 0.047uF 10% 100V	0122-4731
C43	C: FIXED CERAMIC 0.1uF 50V	0151-0006
C44	C: FIXED CERAMIC 0.01uF 100V	0151-0003
C45 thru C47	C: FIXED CERAMIC 0.001uF 1kV	0151-0002
C48	C: FIXED TANT 6.8uF 25V	0185-0002
C49	C: FIXED CERAMIC 0.1uF 50V	0151-0006
C50	C: FIXED TANT 6.8uF 25V	0185-0002
C51	C: FIXED CERAMIC 0.1uF 50V	0151-0006
C52	C: FIXED TANT 6.8uF 25V	0185-0002
C53 thru C55	C: FIXED CERAMIC 0.1uF 50V	0151-0006
C56	C: FIXED MICA 5% (select by test)	
CR1	DIODE: 1N4006	1900-0016
CR2,CR3	DIODE: 1N643	1900-0017
CR4	DIODE: 1N4446	1900-0002
CR5	DIODE: 1N277 GERMANIUM	1900-0001
CR6	DIODE: 1N4446	1900-0002
CR7 thru CR9	DIODE: 1N277 GERMANIUM	1900-0001
CR10	DIODE: HP5082-2810	1900-0032
CR11,CR12	DIODE: 1N4446	1900-0002
CR13	DIODE: 1N277 GERMANIUM	1900-0001
CR14	DIODE: 1N4446	1900-0002

A1 BOARD AMM-2C cont.

Reference Designation	Description	Part Number
CR15 thru CR17	DIODE: 1N4006	1900-0016
CR18	DIODE: 1N4446 (optional)	1900-0002
L1	INDUCTOR:	Belar
L2	INDUCTOR:	Belar
L3	INDUCTOR:	Belar
P2	PLUG: 3 PIN, PC MOUNT	0365-0030
--	JUMPER: 2 PIN (USED WITH P2)	0365-0028
Q1	TRANSISTOR: 2N2907A	1850-0027
Q2 thru Q7	TRANSISTOR: 2N4401	1850-0028
R1	R: METAL FILM 1M 2% 1/4W	0751-1052
R2	R: METAL FILM 20k 2% 1/4W	0751-2032
R3	R: METAL FILM 75k 2% 1/4W	0751-7532
R4	R: METAL FILM 3.3k 2% 1/4W	0751-3322
R5	R: METAL FILM 6.8k 2% 1/4W	0751-6822
R6,R7	R: METAL FILM 10k 2% 1/4W	0751-1032
R8	R: METAL FILM 75k 2% 1/4W	0751-7532
R9	R: METAL FILM 6.65k 1%	0721-6651
R10	R: METAL FILM 3.40k 1%	0721-3401
R11	R: METAL FILM 33k 2% 1/4W	0751-3332
R12	R: METAL FILM 10k 2% 1/4W	0751-1032
R13	R: METAL FILM 2k 2% 1/4W	0751-2022
R14	R: METAL FILM 33k 2% 1/4W	0751-3332
R15	R: METAL FILM 100k 2% 1/4W	0751-1042
R16,R17	R: METAL FILM 10.0k 0.1%	0711-1002
R18	R: METAL FILM 7.5k 2% 1/4W	0751-7522
R19	R: METAL FILM 2.49k 1%	0721-2491
R20	R: METAL FILM 10.0k 1%	0721-1002
R21	R: METAL FILM 510 2% 1/4W	0751-5112
R22	R: METAL FILM 5.76k 1%	0721-5761
R23	R: METAL FILM 43k 2% 1/4W	0751-4332
R24	R: METAL FILM 5.1k 2% 1/4W	0751-5122
R25	R: METAL FILM 120 2% 1/4W	0751-1212
R26	R: VAR COMP 2k, 10 TURN	2100-0031
R27	R: METAL FILM 6.2k 2% 1/4W	0751-6222
R28	R: METAL FILM 3.32k 1%	0721-3321
R29	R: METAL FILM 5.11k 1%	0721-5111
R30	R: METAL FILM 4.7k 2% 1/4W	0751-4722
R31	R: METAL FILM 15k 2% 1/4W	0751-1532
R32	R: METAL FILM 6.2k 2% 1/4W	0751-6222
R33	R: METAL FILM 100k 2% 1/4W	0751-1042
R34	R: METAL FILM 15k 2% 1/4W	0751-1532
R35,R36	R: METAL FILM 4.7k 2% 1/4W	0751-4722
R37	R: METAL FILM 200 2% 1/4W	0751-2012
R38	R: METAL FILM 2.2k 2% 1/4W	0751-2222
R39	R: METAL FILM 6.04k 1%	0721-6041
R40	R: METAL FILM 90.9k 1%	0721-9092

A1 BOARD AMM-2C cont.

Reference Designation	Description	Part Number
R41	R: METAL FILM 1.91k 1%	0721-1911
R42	R: METAL FILM 43k 2% 1/4W	0751-4332
R43	R: METAL FILM 3.3k 2% 1/4W	0751-3322
R44 thru R46	R: METAL FILM 2.2k 2% 1/4W	0751-2222
R47	R: METAL FILM 6.8k 2% 1/4W	0751-6822
R48	R: METAL FILM 2.2k 2% 1/4W	0751-2222
R49	R: METAL FILM 2.7k 2% 1/4W	0751-2722
R50	R: VAR COMP 5k, 10 TURN	2100-0020
R51	R: METAL FILM 10k 2% 1/4W	0751-1032
R52	R: METAL FILM 2.2k 2% 1/4W	0751-2222
R53	R: METAL FILM 5.1k 2% 1/4W	0751-5122
R54	R: METAL FILM 22k 2% 1/4W	0751-2232
R55	R: FIXED CARBON 2.2M 5% 1/4W	0683-2255
R56	R: METAL FILM 15k 2% 1/4W	0751-1532
R57*	R: METAL FILM 910k 2% 1/4W	0751-9142
(*Note: R57 is factory select, nominal value shown.)		
R58	R: METAL FILM 4.7k 2% 1/4W	0751-4722
R59	R: METAL FILM 200 2% 1/4W	0751-2012
R60,R61	R: METAL FILM 5.6k 2% 1/4W	0751-5622
R62	R: METAL FILM 510 2% 1/4W	0751-5112
R63	R: METAL FILM 680 2% 1/4W	0751-6812
R64	R: METAL FILM 330 2% 1/4W	0751-3312
R65	R: METAL FILM 5.1k 2% 1/4W	0751-5122
R66	R: METAL FILM 5.6k 2% 1/4W	0751-5622
R67	R: VAR COMP 5k, 10 TURN	2100-0020
R68	R: METAL FILM 11k 2% 1/4W	0751-1132
R69	R: FIXED CARBON 2.2M 5% 1/4W	0683-2255
R70	R: METAL FILM 15k 2% 1/4W	0751-1532
R71*	R: METAL FILM 910k 2% 1/4W	0751-9142
(*Note: R71 is factory select, nominal value shown.)		
R72	R: METAL FILM 4.7k 2% 1/4W	0751-4722
R73	R: METAL FILM 200 2% 1/4W	0751-2012
R74	R: METAL FILM 11k 2% 1/4W	0751-1132
R75	R: VAR COMP 5k, 10 TURN	2100-0020
R76	R: METAL FILM 12k 2% 1/4W	0751-1232
R77	R: METAL FILM 220k 2% 1/4W	0751-2242
R78	R: METAL FILM 4.7k 2% 1/4W	0751-4722
R79	R: FIXED CARBON 3.9M 5% 1/4W	0683-3955
R80	R: METAL FILM 15k 2% 1/4W	0751-1532
R81*	R: METAL FILM 910k 2% 1/4W	0751-9142
(*Note: R81 is factory select, nominal value shown.)		
R82	R: METAL FILM 4.7k 2% 1/4W	0751-4722
R83	R: METAL FILM 200 2% 1/4W	0751-2012
R84	R: METAL FILM 3.3k 2% 1/4W	0751-3322
R85	R: VAR COMP 10k, 10 TURN	2100-0018
R86	R: METAL FILM 2.7k 2% 1/4W	0751-2722
R87	R: METAL FILM 1k 2% 1/4W	0751-1022
R88	R: FIXED CARBON 1.5M 5% 1/4W	0683-1555
R89	R: METAL FILM 47k 2% 1/4W	0751-4732
R90	R: METAL FILM 22k 2% 1/4W	0751-2232

A1 BOARD AMM-2C cont.

Reference Designation	Description	Part Number
R91	R: FIXED CARBON 1.5M 5% 1/4W	0683-1555
R92	R: METAL FILM 4.7k 2% 1/4W	0751-4722
R93	R: METAL FILM 470 2% 1/4W	0751-4712
R94	R: VAR COMP 5k, 10 TURN	2100-0020
R95	R: METAL FILM 12k 2% 1/4W	0751-1232
R96	R: METAL FILM 4.7k 2% 1/4W	0751-4722
R97	R: FIXED CARBON 5.6M 5% 1/4W	0683-5655
R98	R: METAL FILM 56k 2% 1/4W	0751-5632
R99	R: METAL FILM 680 2% 1/4W	0751-6812
R100,R101	R: METAL FILM 100 2% 1/4W	0751-1012
R102	R: METAL FILM 8.2k 2% 1/4W	0751-8222
R103	R: METAL FILM 15.0k 1%	0721-1502
R104*	R: METAL FILM 470k 2% 1/4W *(R104 is under pc board.)	0751-4742
RL1,RL2	RELAY: JWD-172-1	1600-0006
S1	SWITCH: PUSHBUTTON (6 BUTTON)	3101-0013
U1 thru U3	IC: TLO72	1826-0038
U4	IC: 78LO8CP	1826-0058
U5	IC: MC3302	1826-0005
U6	IC: 74HC14	1822-0042
U7	IC: NE5532	1826-0037
U8	IC: SSM2142P	1827-0005
U9	IC: 74HC4538	1822-0076
U10	IC: TLO72	1826-0038
U11	IC: 74HC4538	1822-0076
U12	IC: TLO72	1826-0038
U13	IC: 78LO5CP	1826-0012