Model TVM-210
BTSC REFERENCE MONITOR

Belar TV Stereo Modulation Monitor System

Guide to Operations

BELAR ELECTRONICS LABORATORY, INC.
119 LANCASTER AVENUE
P.O. BOX 76
DEVON, PA 19333-0076 USA
(610) 687-5550 • FAX (610) 687-2686

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.

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1 General Information

1-1 General Description

The Belar TVM-210 BTSC Reference Monitor is an all solid state stereo demodulator designed to operate in conjunction with the Belar TVM-100 (or Belar TVM-101) TV Aural Modulation Monitor and the Belar TVM-220 BTSC Program Monitor to provide all of the stereo monitoring capabilities set forth in "Multichannel Television Sound, BTSC System Recommended Practices" (EIA TV Systems Bulletin #5, issued July 1985). When used in conjunction with the Belar TVM-220 BTSC Program Monitor, the Belar TVM-200 TV Stereo Modulation Monitor System provides the dynamic modulation level indication required to insure compliance with FCC requirements as specified in OST Bulletin No. 60, "Multichannel Television Sound Transmission and Audio Processing Requirements for the BTSC System" (issued April 1984). In addition, the TVM-210 may be used as a low distortion, low noise TV stereo demodulator for driving audio monitors and associated test equipment. The TVM-210 when used in conjunction with the TVM-100 and the TVM-220, provides complete monitoring and test functions to meet the daily requirements for stereo monitoring and provides additional facilities for proof of performance measurements to insure maximum performance from BTSC stereo transmission systems.

1-2 Physical Description

The TVM-210 is constructed on a standard EIA 5¼ X 19 inch rack mount panel. Routinely used operational controls and all oscilloscope outputs are mounted on the front panel. Two pushbuttons for performing system tests are located at the rear of the chassis along with individual connectors for the AC power input, the composite baseband input, and the pilot frequency output. Also located at the rear of the chassis is a board edge connector for the de-emphasized audio outputs and remote pilot indicator output, and an amphenol connector for the TVM-220 interconnection cable.

1-3 Electrical Description

The TVM-210 is a solid state stereo demodulator designed to accurately demodulate BTSC stereo composite baseband signals. Various metering and testing provisions are contained within the monitor to measure the stereo signal characteristics. These provisions include two selectable semi-peak or average reading meters; function switches to measure total modulation, L+R modulation, L-R modulation, pilot subcarrier level, pilot phase null, 31.5 kHz suppression, left channel modulation, right channel modulation, auto-ranging meter controls and a de-emphasis switch. Additionally, provisions have been made to measure system stereo performance in a 1:1 equivalent mode (flat baseline), as well as in the BTSC prescribed 2:1 mode. Measurements in the 2:1 mode can be made with or without dbx companding. The TVM-210 employs an

expander board manufactured by dbx, Inc. to properly decode the BTSC composite signal. Displays include two meter range indicators and light emitting diodes to indicate the presence of pilot and operation in one of the three test modes. Outputs obtained from the monitor include individual left and right channel test jacks, meter function oscilloscope jacks, balanced and unbalanced audio outputs, composite output (less pilot) jack, and a pilot frequency test jack. A front panel BNC jack parallels the input to the dbx decoder board to permit precise monitor normalization using an external AC voltmeter. Remote outputs include a +5 Vdc source and a pilot indicator.

As a test instrument, the TVM-210 permits the following measurements:

1. Crosstalk into the L+R channel
2. Crosstalk into the L-R channel
3. Suppression of the 31.5 kHz carrier
4. Separation - right into left channel
5. Separation - left into right channel
6. Left channel noise
7. Right channel noise
8. Left channel response
9. Right channel response
10. Left and right channel distortion (with appropriate external analyzer)
11. Pilot frequency (with appropriate external frequency counter)

1-4 Electrical and Mechanical Specifications

Input Level . . . . . nominally 1.46 Vrms for 73 kHz peak deviation (20 mVrms/kHz or 56.6 mV pk-pk/kHz). Adjustable from 0.45 Vrms to 1.75 Vrms for 73 kHz peak deviation

Input Impedance . . . . . 220 kΩ, unbalanced, BNC connector

Metering: Two semi-peak or average responding metering circuits

Left Meter . . . . . selectable: total modulation, L+R, pilot or left channel modulation

Right Meter . . . . . selectable: pilot phase, L-R, 31.5 kHz suppression or right channel modulation

Auto-Range Attenuator . . . . . 0 to -60 dB in 10 dB steps, calibrated full range readings: +3 dB to -80 dB

Modulation Meter Range . . . . . 0 to 133%

Meter Accuracy . . . . . better than 2% at all modulation levels

Measurement Capabilities:

Total Modulation . . . . . ±0.3 dB, 50 Hz to 120 kHz

Main Channel (L+R) . . . . . ±0.2 dB, 50 Hz to 14 kHz
(L-R) Channel . . . . . ±0.2 dB, 17.5 kHz to 45.5 kHz
Pilot Injection Level . . . . . deviation: 5 kHz ±150 Hz
2H Suppression . . . . . -60 dB (less than 50 Hz deviation)
Left and Right Channels . . . . . ±0.25 dB, 50 Hz to 14 kHz

Separation:
L to R, R to L . . . . . equivalent mode: 60 dB, 50 Hz to 14 kHz
DBX encoded (100% Eq. Level) . . . . . 36 dB: 50 Hz to 8 kHz
30 dB: 8 kHz to 14 kHz

Crosstalk:
L+R to L-R . . . . . better than 60 dB, 50 Hz to 14 kHz
L-R to L+R . . . . . better than 60 dB, 50 Hz to 14 kHz
SAP to L+R . . . . . Greater than 65 dB
SAP to L-R . . . . . Greater than 65 dB
PRO to L+R . . . . . Greater than 80 dB
PRO to L-R . . . . . Greater than 80 dB

Outputs:
Left and Right Channel Program Audio . . . . . +10 dBm, 600 Ω, balanced
Left and Right Channel Program Test . . . . . 5 Vrms, 10 kΩ, unbalanced
Left and Right Channel Scope Outputs . . . . . 94 mVrms, 10 kΩ, unbalanced
Composite (less pilot) . . . . . 3 Vpk-pk, 2.2 kΩ, unbalanced, for 50 kHz deviation

dbx . . . . . 10 Vpk-pk for 50 kHz deviation

Pilot . . . . . 3 Vpk-pk, 27 kΩ source

Audio Output Specifications:
Frequency Response . . . . . ±0.25 dB, 50 Hz to 14 kHz
Signal to Noise Ratio, Left and Right . . . . . better than 70 dB
Harmonic Distortion . . . . . 0.1% max, 50 Hz to 14 kHz
Intermodulation Distortion . . . . . 0.1% max (SMPTE)

Remote Outputs:
Pilot Presence Indicator . . . . . NPN transistor collector and +5 Vdc

Dimensions . . . . . 5¼" H x 11½" X 19" W
(EIA Rack Mount)

Power Consumption . . . . . 15 watts, 115/230 Vac 50/60 Hz
Shipping Weight . . . . . 16 lb
(7.3 kg)

1-5 Accessories

The Belar TVM-220 BTSC Program Monitor expands the monitoring capabilities of the TVM-210 to include continuous monitoring of the main channel (L+R) and the stereo composite portions of the BTSC signal. The TVM-220 provides both semi-peak metering and a peak flasher system to help insure compliance with FCC modulation requirements as well as an indication of synchronization of the pilot subcarrier with horizontal sync.

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 be present when the unit is unpacked. Carefully unpack the unit to avoid damaging the equipment through use of careless procedures. Inspect all 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 for the recommended claim procedure. Keep all packing material for proof of damage claim or for possible future use.

The TVM-210 is shipped with an instruction book, three wire line cord, four beige rack-mount screws with integral non-marring washers, and a 10 position dual readout printed circuit board edge connector.

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 to arrange the repair or replacement of the unit without waiting for a claim to be settled with the carrier.

2-3 Repacking for Shipment

If the unit is to be returned to Belar, attach a tag to it showing owner and owner's address. A description of the service required should be included on the tag. The original shipping carton and packaging materials should be used for reshipment. If they are not available or reusable, the unit should be repackaged in the following manner:

a. Use a double-walled carton with a minimum test strength of 275 pounds.

b. Use heavy paper or sheets of cardboard to protect all surfaces.

c. Use at least 4 inches of tightly packed, industry approved, shock absorbing material such as extra firm polyurethane foam or rubberized hair. NEWSPAPER IS NOT SUFFICIENT FOR CUSHIONING MATERIAL.

d. Use heavy duty shipping tape to secure the outside to the carton.

e. Use large FRAGILE labels on each surface.

f. Return the unit, freight prepaid, via air freight. Be sure to insure the unit for full value.

2-4 Preparation for Use

The TVM-210 BTSC Reference Monitor is designed to be mounted in a standard 19 inch rack. The monitor may be mounted below the companion Model TVM-220 BTSC Program Monitor. When the monitor is mounted above high heat generating equipment such as and power amplifiers, consideration should be given to cooling requirements which allow a free movement of cooler air around the TVM-210. In no instance should the ambient chassis temperature be allowed to rise above 50 degrees C (122 degrees F). Mount the TVM-210 to the rack mount using the screws provided.

The Model TVM-210 can be operated from either a 105 to 125 Vac or 210 to 250 Vac single phase, 50 to 60 Hz power source. Make sure the unit is set for the proper voltage as follows:

Units with serial number 210190 and lower:
Unplug the line cord. Slide the voltage selector switch (S1) to the 115V or 230V position. Ensure that the fuse (F1) is the proper current rating for selected voltage (½A 250V for 115Vac, ¼A 250V for 230Vac). Plug the line cord back in.

Units with serial number 210191 and higher:
Unplug the line cord. Open the fuse compartment door and pull lever to remove fuse. Using needlenose pliers, pull the voltage select board straight out of the power entry module. While facing the rear of the unit, orient the voltage select board so the desired line voltage is face up and reads correctly ("120" for 115Vac operation, "240" for 230Vac operation. The "100" and "220" positions on the bottom of the board are not used.) Reinsert the board into the power entry module, install the proper fuse (½A 250V for 115Vac, ¼A 250V for 230Vac), close the fuse door, and plug the line cord back in.

Connect the three wire grounded line cord provided, or if a substitute line cord is used, be sure that the ground lead is connected to "G" on the line cord receptacle.

The Model TVM-210 accepts a composite baseband signal from the Belar TVM-100 or Belar TVM-101 TV Aural Modulation Monitor or other high quality, wideband aural demodulators. Connect the BNC wideband composite output jack on the TVM-100 to the BNC composite input jack, J4, on the TVM-210. Use a coaxial cable with a maximum length of 36 inches. When the TVM-210 is used with aural demodulators with 50 or 75 Ω composite outputs, longer lengths of coax may be used. For cable runs over 50 feet, it is recommended that an appropriate thru-line termination be connected to J4 of the TVM-210 and that the cable run be made with coax of matching impedance.

If desired, connect an external stereo aural monitoring amplifier to pins 2 and 3 (right) and pins 5 and 6 (left) of the printed circuit board connector P1. These are de-emphasized, balanced, 600 Ω outputs. Pins 1 (right) and 4 (left) may also be used; however note that these outputs are 10 kΩ unbalanced, with pins A and D serving as the ground connections.

A remote LED pilot indicator may be wired between pins 9 or 10 (+5Vdc) and pins 7 or 8 (NPN transistor collector) of connector P1. The anode of the LED should be oriented towards the +5Vdc and the external circuit must contain a current limiting resistor of at least 150 Ω.

2-5 Interconnections

MODEL TVM-210 REAR PANEL JACKS

Jack	Function
J1	IEC standard AC power receptacle
J2	TVM-220 interface connector, Amphenol 57-40140 (See chassis wiring diagram for connections.)
J3	Pilot output, 3 Vpk-pk open-circuit, 27 kΩ source, BNC connector.
J4	Stereo composite input, 4.13 Vpk-pk for 73 kHz peak deviation, 220 kΩ. (Adjustable from 1.27 Vpk-pk to 4.95 Vpk-pk.) BNC connector

MODEL TVM-210 REMOTE CONNECTOR (P1)

P1 is a 10 position, dual readout PC board edge connector with 0.156 inch lead spacing for 1/16" boards. (Cinch 50-20SN-9)

Pin	**Function**
1	Left channel de-emphasized audio output, 2.5 Vrms open-circuit, 10 kΩ, unbalanced
2	Left channel de-emphasized audio output, +10 dBm, 600 Ω, positive polarity connection
3	Left channel de-emphasized audio output, +10 dBm, 600 Ω, negative polarity connection
4	Right channel de-emphasized audio output, 2.5 Vrms open-circuit, 10 kΩ, unbalanced
5	Right channel de-emphasized audio output, +10 dBm, 600 Ω, positive polarity connection
6	Right channel de-emphasized audio output, +10 dBm, 600 Ω, negative polarity connection

7, 8	Remote pilot indicator LED. Contact is NPN transistor collector. Transistor is saturated when pilot is present.
9, 10	+5Vdc
A thru L	Ground

MODEL TVM-210 FRONT PANEL JACKS

Jack	Function
J5	dbx input voltage. This jack parallels the L-R input connection to dbx expander board. When the monitor is properly normalized, this voltage is 10 Vpk-pk (3.5355 Vrms) for 50 kHz deviation (53.5 kHz deviation including pilot). 200 Ω source resistance.
J6	Composite output. This jack provides the composite signal, *minus the pilot*, for oscilloscope observation of the stereo composite envelope. The level is approximately 3 Vpk-pk for 50 kHz deviation. Source resistance is 2200 Ω.
J7, J8	Right and left channel oscilloscope outputs. These jacks provide the signals selected by the right and left meter function switches. Outputs are autoranged with 94 mVrms open circuit output signal for 100% meter indication. Source resistance is 10 kΩ.
J9, J10	Right and left channel audio test jacks. These jacks provide the right and left audio outputs, respectively, for evaluation by external test equipment. The open circuit output is 5 Vrms at full right or full left. Source impedance is 10 kΩ. Outputs are de-emphasized when the dbx is in operation, flat otherwise.

3 Operation

3-1 Initial Operation and System Level Normalization

1. Place the TVM-100 modulation monitor into normal operation as outlined in the TVM-100 instruction book.

2. Depress the TVM-210 left meter function switch to TOTAL, the right meter function switch to PHASE, the meter selector switch to PEAK, and allow a 30 minute warm-up period.

   The TVM-210 is designed to accommodate input levels across a range of about 0.45 Vrms to 1.75 Vrms for sine waves of 73 kHz peak deviation. This allows the monitor to operate with the broadband outputs of most aural demodulators, with or without output termination, as well as with the TVM-100. A blue jumper on P1, which is located next to R1, the input level pot on the A2 board, sets the input level range. For the TVM-100 aural demodulator, which has an unterminated output level of 1.46 Vrms for 73 kHz deviation (or 20 mVrms/kHz), or other demodulators with outputs of more than 1.40 Vrms, the jumper should be positioned towards the rear of the monitor. For a terminated TVM-100 and other demodulators with lower output levels, the jumper should be in its forward position. (This position is appropriate for demodulators with terminated output levels of 10 mV peak/kHz or unterminated output levels of 20 mV peak/kHz.)

3. While the unit is warming, make a coarse level normalization of the TVM-210. Any of the following three ways is satisfactory. (1) Using the 73 kHz deviation calibrator on the TVM-100, adjust the input sensitivity so that the left meter reads 100% in the TOTAL mode with the meter switch in PEAK. (2) This technique could also be used with a sine wave modulating the aural transmitter to 73 kHz deviation. (3) Finally, if the pilot subcarrier is known to have 5 kHz deviation, the input sensitivity can be adjusted so the left meter reads 68.5% on the "-20dB" range in the PILOT mode with the meter switch in AUTO (DE-EMP out). Adjust R1 from the rear of the unit to obtain the appropriate reading. (R1 is rightmost trimmer visible through a cutout on the monitor cover when viewing the unit from the rear.) If the end of adjustment range is reached, the cover of the TVM-210 must be removed and the blue jumper on P1, next to R1, must be moved to its alternate position. Replace the cover for the remainder of the warm-up period.

4. With just the pilot as input, place the LEFT METER FUNCTION switch in the PILOT mode, the RIGHT METER FUNCTION switch in the PHASE mode and the meter switch in AUTO. The pilot reading should be 68.5% on the "-20dB" range of the left meter. With a small common screwdriver adjust the PHASE ADJUST control

on the front panel to null the right meter indication. The reading should be less than -70 dB.

The presence of level dependent companding in the L-R channel of the BTSC system makes stereo separation performance directly dependent on the level match between the compressor output in the stereo generator and expander input in the stereo demodulator. For optimum operation of the TVM-210 stereo demodulator, and for best separation, it is important that the dbx expander in the unit be driven at an input level as close to that prescribed as possible. In the TVM-210 this is achieved by finely adjusting the input sensitivity to obtain the correct relationship between aural carrier deviation due to the L-R and L-R signal level at the input to the dbx expander.

Listed below, in order of preference (most preferable first), are the reference conditions for setting the input sensitivity and the reading required to confirm proper adjustment for each case.

	Reference	**Reading**
A.	50 kHz deviation L-R (pilot not included)	3.5355 Vrms at DBX jack, J5, measured with high accuracy AC voltmeter
B.	50 kHz deviation L-R (pilot not included)	100% on right meter in L-R mode
C.	25 kHz deviation L+R (sine wave)	100% on left meter in L+R mode
D.	73 kHz deviation L+R (sine wave)	100% on left meter in TOTAL mode

5. Using the internal calibrator, check the calibration of the discriminator and metering of the companion TVM-100 aural monitor. If necessary, perform the adjustment procedure described in the TVM-100 manual.

   To fine adjust monitor sensitivity, establish one of the reference conditions above. For cases A and B, apply a low distortion 1 kHz sine wave to the stereo generator with pilot turned off. Place stereo generator in test mode to produce an L-R signal (subchannel only). Adjust the audio level to the stereo generator to produce exactly 50 kHz deviation as indicated on the digital deviation indicator on the TVM-100. Turn on the pilot. (Because the pilot and the subcarrier do not reach their maximum values simultaneously, the peak deviation will now be approximately 53.6 kHz.) For method A, use a voltmeter whose input impedance is at least 1 Meg Ω

and whose AC accuracy is better than 0.5% at 1 kHz. For method B, the L-R meter should be in the PEAK mode. Adjust R1 at the rear panel for the specified reading.

For methods C and D, apply a low distortion 1 kHz sine wave to the aural exciter. After checking the calibration of the TVM-100 as described above, adjust the level of the sine wave to achieve the prescribed deviation as indicated on the digital deviation indicator on the TVM-100. Read the appropriate meter on the TVM-210 and adjust R1, at the rear panel, for the specified reading.

NOTE: Methods B, C, and D rely on initial factory set-up procedures and voltmeter stability to be effective. For this reason, method A is far superior to the other methods and is likely to result in a level normalization that is much more precise.

This procedure is not recommended if you have a Belar TVM-101 instead of a TVM-100. The TVM-101 does not have a digital deviation indicator.

Normalization of the TVM-220 BTSC Program Monitor with reference to the TVM-210 is described in *Section 3 - Initial Operation and Level Normalization* in the TVM-220 operating manual.

6. Depress the OPERate button on the TVM-100, and LEFT and RIGHT meter pushbuttons on the TVM-210 and the monitors are ready for normal operation.

3-2 Normal Operation

To monitor normal stereo programming, it is recommended that the LEFT and RIGHT function switches be depressed to indicate left and right channel levels, with the meter switch PEAK pushbutton depressed.

3-3 Monitor Functions

1. PILOT INDICATOR - Indicates when the 15734 Hz (1H) pilot subcarrier is present on the composite stereo signal. The indicator comes on when the pilot level exceeds approximately 2.5 kHz deviation of the aural carrier, or one half the nominal level. Also indicates operation of the stereo demodulator in the TVM-210.

2. TEST INDICATOR - When on, indicates that the monitor is not properly configured to demodulate the companded BTSC stereo signal. Indicator comes on when the monitor is operating in equivalent mode (flat baseline) or when the dbx expander and sum-channel-compensator circuits have been disabled by rear-panel switches.

3. LEFT METER - Measures TOTAL, L+R, PILOT or LEFT channel levels, depending on the setting of the LEFT METER FUNCTION SWITCH.

4. LEFT METER FUNCTION SWITCH -

   A. TOTAL - When depressed, the left meter indicates the total, composite modulation level.

   B. L+R - When depressed, the left meter indicates the L+R modulation level that is filtered by a 15 kHz lowpass filter.

   C. PILOT - When depressed, the left meter indicates the 15734 Hz pilot subcarrier level.

   D. LEFT - When depressed, the left meter indicates the left channel modulation level.

5. RIGHT METER - Measures pilot PHASE null, L-R level, 31.5 kHz suppression or right channel level, depending on the setting of the RIGHT METER FUNCTION SWITCH.

6. RIGHT METER FUNCTION SWITCH -

   A. PHASE - When depressed, the right meter indicates the depth of the 15734 Hz null produced by the pilot cancellation circuits. This null is optimized by the front panel PHASE ADJUST control. (See Function **10**)

   B. L-R - When depressed, the right meter indicates the L-R modulation level. In the TVM-210, this reading represents L-R components actually detected by the stereo demodulator and therefore requires the presence of pilot and operation of the stereo demodulator for correct indication.

   C. 31.5 KHZ - When depressed, the right meter indicates the 31.5 kHz (2H) subcarrier suppression that is filtered by a 2 kHz wide bandpass filter centered at 31.5 kHz.

   D. RIGHT - When depressed, the right meter indicates the right channel modulation level.

7. METER SWITCH - Selects the mode of operation of the left and right meters.

   A. PEAK - When the meter switch is depressed to PEAK, both left and right meters are in the semi-peak reading mode.

B. AUTO - When the meter switch is depressed to AUTO, both left and right meters are in the auto-ranging mode. In this mode, the meter sensitivities are individually and automatically adjusted in 10 dB steps to obtain meter readings between -10 dB and +0.5 dB on each range. The algebraic sum of the meter reading and the range indication is the reading. For example, -1 dB indication on the meter with a range indication of -60 dB yields a reading of -61 dB. Note that in the AUTO and HOLD modes, the meter is average reading.

C. HOLD - When the meter switch is depressed to HOLD, both meter *ranges* are held to their indicated settings.

D. DE-EMP - When the meter switch is depressed to DE-EMP, both meter readings are de-emphasized in the AUTO or HOLD settings. The PEAK position is not de-emphasized.

8. LEFT METER RANGE INDICATOR - Indicates the operating range, in -dB, of the LEFT meter. (0 in PEAK and 0 to -60 dB in AUTO and HOLD).

9. RIGHT METER RANGE INDICATOR - Indicates the operating range, in -dB, of the RIGHT meter. (0 in PEAK and 0 to -60 dB in AUTO and HOLD).

10. PHASE ADJUST - Adjusts the depth of the 15734 kHz null produced by the pilot cancellation circuits.

11. MTS/EQUIV SWITCH (REAR PANEL) - When depressed, sets the L-R sensitivity to 100% for 50 kHz deviation of the aural carrier for proper demodulation of BTSC stereo signals (with or without dbx companding). When released, the L-R sensitivity is 25 kHz. In this "equivalent" mode, the monitor demodulates a stereo composite signal similar to a conventional FM signal (flat baseline for single channel inputs) to facilitate evaluation of system separation limitations.

12. DBX SWITCH (REAR PANEL) - When depressed, activates the dbx expander in the L-R channel and the de-emphasis and sum channel compensator circuits in the L+R channel for proper demodulation of the BTSC signal. When released, the expander, de-emphasis, and sum channel compensator circuits are disabled for test purposes.

13. INPUT LEVEL ADJUST (R1, REAR PANEL) - Allows fine level normalization between the TVM-100 or other baseband source and the TVM-210 input. This is required for proper operation of the dbx expander circuitry located in the TVM-210. This trimpot is mounted on the A2 board and is the rightmost trimpot visible through the cutout on the cover as viewed from the rear of the unit.

14. PILOT AMPLITUDE NULL (R26, REAR PANEL) - Adjusts the depth of the 15734 Hz null produced by the pilot cancellation circuits. This potentiometer works in conjunction with the PHASE ADJUST control on the front panel but rarely needs adjustment. This trimpot is mounted on the A2 board and is the leftmost trimpot visible through the cutout on the cover as viewed from the rear of the unit.

3-4 Stereo Measurements

1. TOTAL MODULATION

Depress the LEFT METER FUNCTION switch TOTAL pushbutton and the meter switch PEAK pushbutton. The left meter will measure TOTAL composite modulation. A 100% reading corresponds to 73 kHz peak deviation of the aural carrier.

2. LEFT CHANNEL MODULATION

Depress the LEFT METER FUNCTION switch to LEFT and the meter switch to PEAK. A fully modulated left channel signal will indicate 100% on the left meter. This corresponds to 12.5 kHz deviation of the aural carrier due to the main channel, or L+R.

3. RIGHT CHANNEL MODULATION

Depress the RIGHT METER FUNCTION switch to RIGHT and the meter switch to PEAK. A fully modulated right channel signal will indicate 100% on the right meter. This corresponds to 12.5 kHz deviation of the aural carrier due to the main channel, or L+R.

4. L+R MODULATION

Depress the LEFT METER FUNCTION switch to L+R and the meter switch to PEAK. A full scale reading of 100% on the left meter corresponds to 25 kHz peak deviation of the aural carrier due to the L+R, or main channel. This is a fully modulated L=R signal. A fully modulated left channel only will indicate 50% and an L=-R signal will indicate 0%.

5. L-R MODULATION

Depress the RIGHT METER FUNCTION switch to L-R and the meter switch to PEAK. With the MTS/EQUIV pushbutton depressed (for normal operation) a reading of 100% on the right meter corresponds to 50 kHz deviation of the aural carrier due to the stereo subchannel and a fully modulated L=-R signal. A fully modulated left channel only will indicate 50% and an L=R signal will indicate 0%. When the MTS/EQUIV pushbutton

is released, the meter normalization is changed so that 100% corresponds to 25 kHz carrier deviation.

6. PILOT SUBCARRIER MODULATION LEVEL

Depress the LEFT METER FUNCTION switch to PILOT and the meter switch to AUTO. The left meter will indicate the pilot subcarrier modulation level with a 73 kHz deviation reference level (100% reading on the "0" dB range). The prescribed 5 kHz deviation for the pilot subcarrier corresponds to a reading of 68.5% on the "-20 dB" range. Since the left meter is normalized to 73 kHz peak deviation in PILOT mode, in the "-20 dB" range full scale corresponds to 7.3 kHz deviation. Five kilohertz is 68.5% of 7.3 kHz. Hence the reading.

7. 31.5 KHZ SUBCARRIER SUPPRESSION

Apply a 5 to 14 kHz modulating signal to either the left or right channel of the stereo transmitter and adjust the level to 100%. Depress the RIGHT METER FUNCTION switch to 31.5 KHZ and the meter switch to AUTO. The algebraic sum of the meter reading and the range indicator is the 31.5 kHz subcarrier suppression normalized to 100% total modulation. For example, a meter reading of -8 dB and a range indicator display of -40 dB yields a 31.5 kHz suppression of -48 dB below 100% modulation.

8. STEREO SEPARATION

Apply a 50 Hz to 14 kHz modulating signal to the left channel of the stereo transmitter and adjust the level to 100% as read on the left meter with the LEFT METER FUNCTION switch depressed to LEFT. Depress the RIGHT METER FUNCTION switch to RIGHT and the meter switch to AUTO. The algebraic sum of the meter reading and the range indicator is the separation from left channel into right channel. For example, a meter reading of -6 dB and a range indicator display at -30 dB yields -36 dB. Standard levels for evaluation of separation with companding are 10% and 100%

9. CROSSTALK (MAIN CHANNEL TO SUBCHANNEL)

To measure crosstalk from main channel (L+R) into the subchannel (L-R), apply an L=R modulating signal to the stereo transmitter and adjust the level for 100% L+R reading with the LEFT METER FUNCTION switch set to L+R and the meter switch to AUTO. Now depress the RIGHT METER FUNCTION switch to L-R. The algebraic sum of the meter reading and the range indicator display is the crosstalk. Note that since this reading is a function of L being exactly equal to R, the amplitude and phase of one or the other may be adjusted to minimize the reading in the L-R channel. Also note that any harmonic distortion in the L+R channel may appear as a reading in the L-R channel. For

example, the second and third harmonics of 14 kHz are 28 and 42 kHz and may appear as a crosstalk reading.

10. CROSSTALK (SUBCHANNEL TO MAIN CHANNEL)

To measure crosstalk from subchannel (L-R) into main channel (L+R), apply an L=-R modulating signal to the stereo transmitter and adjust the level for 100% L-R reading with the RIGHT METER FUNCTION switch set to L-R and the meter switch to AUTO. Now set the LEFT METER FUNCTION switch to L+R. The algebraic sum of the meter reading and the range indicator is the crosstalk. Note that since this reading is a function of L being exactly equal to R in amplitude but opposite in phase, the amplitude and phase of one or the other may be adjusted to minimize the reading in the L+R channel. Also note that any distortion in the transmitter's stereo modulator may appear as a reading in the L+R channel.

> NOTE: The dual auto-ranging voltmeters greatly simplify separation and crosstalk measurements at other modulation levels, as well. For example, if a separation reading is being made, the LEFT and RIGHT pushbuttons on the meter function switches would be depressed. If the left meter reads 0 dB on the "-10 dB" range and the right meter reads -5 dB on the "-40 dB" range, the separation would be -10 dB minus -45 dB, or 35 dB.

11. FREQUENCY RESPONSE

Frequency response of the aural transmission system may be measured by applying a modulating signal to the aural exciter and measuring the input signal level from the audio oscillator with an AC audio voltmeter, such as one contained in a distortion analyzer. For monaural, adjust the level at 400 Hz to indicate the desired modulation as read on the TVM-210, usually 100%, 50% or 25% modulation. Change the frequency of the audio oscillator to all the frequencies to be measured, adjusting the audio oscillator output to keep the total modulation constant. The ac voltmeter indication of the oscillator output should follow the standard FCC 75 μsec de-emphasis curve. Standard modulating frequencies used are 50, 100, 400, 1000, 5000, 7500, 10,000 and 14,000 Hz.

To measure frequency response of the left and right channels, repeat the above steps, but apply the modulating signal to the left and right channels of the stereo generator respectively. Standard levels are 100%, 50%, and 25%.

12. DISTORTION MEASUREMENTS

Distortion measurements may be made by connecting an external distortion analyzer to the L or R audio output on the front panel, J10 or J9, and applying appropriate modulating signals to the respective channel of the stereo generator. The L

and R audio outputs are de-emphasized during normal operation. When the DBX button is released, these outputs have a flat frequency response characteristic.

Monaural distortion measurements may be made using the AUDIO TEST jack on the TVM-100 or TVM-101 monitor in the same manner.

13. LEFT CHANNEL NOISE MEASUREMENT

Left channel noise can be measured by applying a 400 Hz modulating signal to the left channel of the stereo generator and adjusting the level for 100% modulation. (The LEFT METER FUNCTION switch should be depressed to LEFT and the meter switch depressed to AUTO. Remove the modulation. The resultant as measured on the left meter and meter range indicator, will be the left channel noise figure.

NOTE: The LEFT and RIGHT meter functions provide flat metering characteristics in all monitoring modes (MTS or EQUIValent, DBX IN or DBX OUT). If it is desired to measure the de-emphasized signal to noise ratio, depress the DE-EMP meter pushbutton.

Left channel noise may also be measured using the L audio output jack, J10, on the front panel. This output is de-emphasized during normal operation and has a flat frequency response when the DBX button is released. Apply a 400 Hz modulating signal to the left channel of the stereo generator and adjust the level for 100% modulation as before. Normalize the voltmeter in the distortion analyzer, remove the modulation, and take the noise reading in the conventional manner.

14. RIGHT CHANNEL NOISE MEASUREMENT

Right channel noise may be measured as above by substituting right for left.

15. INTERMODULATION

Intermodulation may be measured with the TVM-210 by using the internal L-R and 31.5 kHz bandpass filters. The principle of the measurement is that when two tones are used to modulate a transmitter whose stereo modulator is nonlinear, difference frequencies will be produced that are equal in frequency to the difference between the two modulating frequencies. These difference frequencies appear in the L+R channel in addition to appearing as sidebands around 31.5 kHz.

The ratio of the desired sidebands (due to modulation) to the unwanted sidebands (due to the difference frequencies) is the intermodulation. The amplitudes of the desired sidebands are measured with the L-R filter and the amplitudes of the unwanted sidebands are measured with the 31.5 kHz filter. The frequencies of the two modulating signals

must be greater than 5 kHz so that the 31.5 kHz filter will reject the desired sidebands. The difference between the two modulating signals must be less than 1000 Hz so that the 31.5 kHz filter will pass the unwanted sidebands.

For example, apply a 10 kHz modulating signal to the left channel, adjusting its level for 100% left channel modulation. Apply an 11 kHz modulating signal to the right channel, adjusting its level for 100% right channel modulation. Depress the RIGHT METER FUNCTION switch to L-R and the meter switch to AUTO and note the reading on the right meter. Depress the RIGHT METER FUNCTION switch to 31.5 KHZ. The algebraic sum of the meter reading and the range indicator is the measurement of the unwanted intermodulation sidebands. The difference between the L-R and 31.5 kHz readings is the ratio between the desired sidebands and unwanted sidebands, or the intermodulation between the left and right channels. The decibel difference can easily be converted to an IMD percentage, i,e., -40 dB is 1%, -60 dB is 0.1%, etc.

There are no standards for this measurement, but it is a useful test since the harmonic distortion of stereo signals above 5 kHz is partially removed by the 15 kHz filters, rendering a harmonic distortion test invalid.

16. PILOT FREQUENCY

To measure the pilot frequency, attach the input of an appropriate frequency counter to the PILOT output, J3, on the rear panel with a coaxial cable. Since the FCC requires the pilot subcarrier to be phase locked to horizontal sync (1H), the counter should read 15734.264 Hz ±0.044 Hz. For monochrome transmission the frequency should be 15734 ±2 Hz. If the horizontal frequency is known to be correct, phase lock can be verified by setting up any X-Y display on an oscilloscope. One input would be horizontal sync and the other would be the PILOT output. The narrow bandpass of the internal pilot filter makes all of these measurements possible under normal program conditions.

17. PILOT SUBCARRIER-TO-INTERFERENCE RATIO

This measurement determines the noise level in a 1 kHz band centered at the pilot frequency (1H). It is referenced to the nominal pilot level of 5 kHz deviation. With the transmission system set up for normal operation, place the LEFT METER FUNCTION switch in the PILOT mode and the meter switch in AUTO. A 5 kHz pilot should indicate 68.5% on the "-20 dB" range, or approximately 23 dB below the 73 kHz peak deviation meter reference (see *Section 3-4 - 6. PILOT SUBCARRIER MODULATION LEVEL*). Turn off the pilot on the stereo generator. The reading on the left meter is the residual pilot interference. The pilot subcarrier to interference ratio is the difference between -23 dB and the residual reading. If the residual reading is -51 dB, the pilot subcarrier to interference ratio would be -23 dB minus -51 dB, or 28 dB.

3-5 Field Changes

Two blue internal jumpers are used to accommodate changes in equipment associated with the TVM-210. The top cover of the unit must be removed to change these jumpers.

P1 Input Level Range jumper. This is located next to R1, the Input Level adjust potentiometer on the A2 board. When positioned towards the rear of the chassis, sensitivity is reduced. When moved towards the front of the chassis, sensitivity is increased. Input levels for the rear position range from 1.4 Vrms to 1.75 Vrms, depending on the setting of R1. In the forward position, input levels range from 0.45 Vrms to 1.4 Vrms. Levels are for sine waves of 73 kHz peak deviation.

P2 Pilot LED Control jumper. This is located between U8 and U11 on the A2 board. When positioned towards the left end of P2 as one looks towards the monitor from the front, the jumper connects the front panel pilot LED directly to the pilot presence sensing circuitry.

Moving the jumper to the right position allows the LED to be controlled by the horizontal sync/pilot phase lock detection circuitry located in the TVM-220 chassis. (Connection to the TVM-220 is made by the interface cable supplied with the TVM-220.)

With the circuit activated on the TVM-220, the LED normally turns on in the presence of pilot. But, when synchronism between the pilot and horizontal sync is lost, the pilot LED blinks.

4 Theory of Operation

4-1 TVM-210 A1 Voltmeter Board

PEAK AND AVERAGE VOLTMETERS

The following description covers operation of the left channel semi-peak and average voltmeters and refers to integrated circuits U8 through U14. The discussion is directly applicable to right channel operation with the appropriate substitution of integrated circuit numbers U21 through U27.

U9 is the input amplifier and has adjustable gain to compensate for circuit tolerances. It drives both the semi-peak and average voltmeter circuits. U10 and U11 make up a half wave peak detector with controlled decay characteristics. If the cathode of the series output diode of U10 were connected back to the inverting input of the

amplifier, U10 would act as a half wave rectifier. With the parallel R-C network connected to the output diode and feedback supplied via U11, U10 acts as a half wave peak rectifier with FCC required decay characteristics. The output of U11 is connected to the left channel meter through the PEAK switch and a series resistor which controls meter damping. The output of U11 is also available through a current limiting resistor to drive external meters.

U9 also drives the average voltmeter through a multi-tap voltage divider network and analog multiplexer U8. In the AUTO mode, readings of the average voltmeter are kept within a 10 dB indication range by autoranging circuitry. The circuitry selects which input to the multiplexer (tap point on the voltage divider) is connected to the multiplexer output, and thus to the average voltmeter.

U14, U13 and U12 form a full wave average voltmeter circuit. U14 is a non-inverting amplifier with 36 dB gain and switchable de-emphasis. When the DE-EMPhasis switch is depressed, the feedback resistor is shunted by a 3900 pF capacitor, giving the prescribed 75 μsec de-emphasis characteristic. U13 and U12 form an active full wave rectifier. Since the rectifying diodes are in the feedback path of U13, the effect of diode cut-in voltage is minimized. Differential amplifier U12 combines the two polarities of the rectified waveform. The left channel chassis meter is driven by the output of U12 through a resistive divider, which controls meter damping, and the PEAK pushbutton (which is released in the AUTO mode).

AUTO-RANGING CIRCUITRY

The following description covers operation of the left channel auto-ranging circuitry and refers to integrated circuits U1 through U8. The discussion is directly applicable to right channel operation with the appropriate substitution of integrated circuit numbers U15 through U21.

Basically, in the AUTO mode the overall gain of the average voltmeter circuit is determined by which tap point on a voltage divider network is connected to the meter circuit by analog multiplexer U8. Selection of the tap point is controlled by the BCD code generated by an up/down counter. (This code is also used to drive a seven segment display decoder/driver used to indicate gain range.) The half wave rectified signal from U12 is smoothed by an R-C network and applied to two limit comparators which, with associated logic, control the ranging of the up/down counter. All range changes are controlled by either a clock signal or a reset signal applied to the up/down counter U5. In the PEAK mode, the front panel switching applies a high to pin 9 of U5 (the reset line) holding the count at zero. Note that the count held by U5 corresponds directly to the operating range of the voltmeter. (A count of "1" corresponds to the -10 dB range, a count of "2" corresponds to -20 dB, etc.) In the AUTO mode, a gated astable multivibrator composed of sections C and D of U4 initiates individual range changes by clocking the

up/down counter U5. Comparators in U1 and associated logic in U2, U3 and U4 activate the astable multivibrator and set counter direction and range limits.

In the AUTO Mode, the trip points at which range changes occur are set by two adjustable voltage dividers associated with the two comparators in U1. When the meter indication falls between 0 dB and -10 dB on the meter scale, both comparator outputs are low. The output of U1A is applied through invertor U4A to the counter direction control line on U5. So, when meter indication falls in the desired range, the counter is set to count up. When the smoothed rectified meter signal exceeds the upper trip point (when the meter indication goes above 0 dB), the output of U1A goes high which, in turn, sets the counter direction to down. When meter indication falls below -10 dB, the output of comparator U1B goes high and the counter direction remains up. In the AUTO mode, the astable multivibrator is activated only when the output of either U1A or U1B goes high. U3B is a four input NOR gate which prevents the astable multivibrator from being activated when the count is zero and the direction is down. (This sets the lower gain limit of the average voltmeter at "0" dB.) NAND gate U4B is interconnected with NOR gate U2B so that the astable multivibrator may not be activated when count is "6" (corresponding to the -60 dB range) and the counter direction is up. Subject to the above conditions, NOR gate U2A allows either comparator to activate the clocking astable multivibrator. NOR gate U3A combines the control logic elements as required.

A flip-flop composed of U2C and U2D prevents clocking of the up/down counter in the PEAK and HOLD modes. When either the PEAK or HOLD button is depressed, the output of U2D is latched high, making the output of NOR gate U3A low and thus disabling the astable multivibrator clock. When the AUTO button is depressed, the flip-flop output is latched low, allowing U2A, U2B, and U3B to assume control of the astable multivibrator. (This single flip-flop controls metering functions for both meter channels.) The reset line to the up/down counter is held high by supply voltage through both the AUTO and HOLD switches and series resistor R88. When either the AUTO or HOLD button is depressed, the supply connection is broken and the reset line is pulled to ground by shunt resistor R87. This allows the counter to hold counts other than "0". The series and shunt resistances in conjunction with shunt capacitor C13 in the reset line introduce a slight delay in any counter range changes that may occur as a result of operating mode changes.

4-2 TVM-210 A2 Stereo Demodulator Board

INPUT AND PILOT CANCELLATION CIRCUITS

The stereo composite signal is applied to the A2 Stereo Demodulator board through non-inverting operational amplifier U3. Gain can be adjusted by the setting of R1 and the position of the jumper on P1 to compensate for variations in input level and normal circuit tolerances. The output of U3 drives the pilot cancellation amplifier U6 and

the pilot cancellation filter. In addition, U3 drives an adjustable voltage divider (consisting of R6, R7, and R8) which supplies a signal to the A1 metering board for TOTAL readings. The pilot cancellation filter has a bandwidth of about 750 Hz and passes only the pilot with a phase shift of zero degrees. The output of the filter is amplified by non-inverting amplifier U4 and inverting amplifier U5. So, at the output of U5 the pilot signal is 180 degrees out of phase with the incoming pilot. This pilot signal is summed with the composite signal in U6 with the proper amplitude so that the pilot signal is canceled from the composite signal appearing at the output of U6. It is this pilotless signal which is chopped by the analog switches in U17 and U18 to recover the left and right channels. This pilotless signal is also buffered by U7 and applied to the 31.5 kHz test filter, the 15734 Hz measuring filter and to the front panel COMPOSITE jack. The 31.5 kHz filter is a 2700 Hz wide bandpass filter with a center frequency of 31468 Hz, the frequency of the stereo subcarrier. It is used to measure the suppression of the stereo subcarrier component of the BTSC signal. To minimize the output load on U7, the filter is normally not connected to U7. The RIGHT METER FUNCTION switch connects both the output of U7 to the filter input through source resistor R38, and the output of the filter to the input of the voltmeter board when the 31.5 KHZ mode is selected. Chassis R2 and R3, mounted on the frame with the filter, provide proper termination for the filter. Potentiometer R2 adjusts the output level for proper meter sensitivity.

The 15734 Hz measuring filter is a bandpass filter centered at the Pilot frequency which minimizes the pickup of extraneous noise when measuring the depth of pilot null produced by the pilot cancellation circuit. The measuring filter is also used in the PHASE position to check the phase of the regenerated 31.5 kHz stereo subcarrier. This is done, with the pilot cancellation circuit disabled, by comparing the amplitudes of the chopped pilot signals at the outputs of U19 and U24. (Input connection to the filter is made by a wire jumper.)

Varicap diode CR4 in the pilot cancellation filter provides a means for fine adjustment of filter output phase and precise cancellation of the pilot in U6. The front panel PHASE adjust pot, chassis mounted R1, controls the voltage applied to the anode of CR4. Resistors R13, R14, and R15 linearize the phase adjustment characteristic. Potentiometer R26 adjusts the amplitude of the pilot signal applied to U6 for best cancellation.

A voltage divider at the output of U4 consisting of R19, R20, and R21 controls the pilot level available for front panel metering. Two more pilot outputs, one feeding J3 and the other feeding the TVM-220 interface connector J2 on the back panel are taken from the output of U5 through resistors R28 and R29. The output of U5 also feeds pilot sensing comparator U8 and pilot limiter U9 (see the next section).

PHASE-LOCKED LOOP AND STEREO DEMODULATOR

The TVM-210 uses a switch type stereo demodulator. It alternately passes the composite (minus pilot) to one channel amplifier and then the other. The phase relationship between the pilot signal and the switch control signal determines which stereo channel is demodulated. To minimize the effects of circuit capacity, the amplifier inputs are shunted to ground during the interval that they are not driven with the composite signal.

Cross coupling is added between the left and right channel amplifiers to compensate for the difference between the amplitudes of the L+R and L-R components in the left and right outputs resulting from the switching function. Two pairs of lowpass filters following the output of the stereo demodulator remove products above 15 kHz generated by the switching process.

A second square wave switching function operating at three times the stereo subcarrier (6H) has been added to the demodulator to minimize sensitivity to components of the composite that fall in the region between 78.7 kHz and 110.1 kHz. Otherwise, sidebands of the second audio program (SAP) and professional channel (PRO) would be demodulated and appear in the left and right outputs.

The stereo demodulator is operated as a conventional FM type, recovering left and right audio when the L+R and L-R components are equal. An audio matrix following the first pair of lowpass filters derives the audio L+R and L-R signal components of the composite. When fed a BTSC stereo signal for which the L-R component has twice the amplitude of the L+R component, the gain of the L-R amplitude is cut in half in an amplifier, so that the two successive audio matrices are able to recover left and right audio for both types of composite signals.

Control signals for the demodulating switches in U17 and U18 are generated by a voltage controlled oscillator and logic elements in integrated circuits U10 through U16. Phase-locked-loop circuitry in U10 maintains the correct phase relationship between the pilot and the switch control signals for proper demodulation.

The pilot signal for the PLL is obtained from the pilot cancellation filter via U5. To minimize the effects of pilot level fluctuations and noise on the regenerated stereo subcarrier phase, limiting amplifier U9 is placed ahead of the phase-locked-loop. It consists of an overdriven differential pair with a constant current source. Pins 1 and 5 of U9 are the inputs to the differential pair. The collector output at pin 6 is buffered by emitter follower Q2 to provide a low source impedance to the PLL in U10. By adjusting the DC operating point at pin 5 of U9, the point in the pilot waveform at which the output of the limiter changes state may be controlled. Potentiometer R57 facilitates this adjustment and, by compensating for circuit delays in the stereo demodulator, makes it

possible to simultaneously achieve a pilot phase null and the correct regenerated stereo subcarrier phase.

The 15734 Hz output of emitter follower Q2 is applied to the reference input of the edge controlled phase comparator in U10. The VCO section of U10 is set to run at a center frequency of 188.8 kHz (12H) by R61, R62, and C35 when the VCO control voltage at pin 9 is approximately 2.5 volts.

The VCO output of U10 is used as a clock for the following synchronous divider chain consisting of dual J-K flip-flops in U12 and U13 and NOR gates in U11. The flip-flops in U12 provide a synchronous divide-by-three output with a 67% duty cycle appearing at pin 9. One flip-flop in U13 is wired to toggle on each falling edge of the VCO output signal, producing two 94.4 kHz (6H) square waves. They appear at the Q and $\overline{Q}$ outputs of the flip-flop, pins 12 and 13 of U13. These square waves are combined with the divide-by-three signal from pin 9 of U12 in nor gates U11B and U11A TO control the j and k inputs of the second flip-flop in U13. Both the J and K inputs to the second flip-flop are high for only one count in six of the clock. Because the NOR'S are fed by the Q and $\overline{Q}$ signals of U13A, the J input of U13B Goes high three clock cycles after the K input and vice versa. The output state of U13B, therefore, changes on every third clock pulse, developing a 31.5 kHz (2H) square wave. Control of the J and K inputs of U13B guarantees that the correct phase relationship between the 31.5 kHz and the 94.4 kHz square waves is maintained to allow cancellation of the third-order product of the 31.5 kHz switching demodulator.

The 31.5 kHz $\overline{Q}$ output of U13B clocks U14A. The Q output of U14A is then a 15734 Hz (1H) square wave which is applied to the comparison input of the edge controlled phase comparator in U10. This connection completes the feedback connection required for operation of the PLL.

NAND and NOR gates in U15 and U16 pass the four square waves from the divider chain to the demodulating switches in U17 and U18. The chopped fundamental and third-order components are summed via R90 and R94 for the left channel and R69 and R65 for the right. During stereo operation, when the composite signal from U6 is not being passed through to the summing amplifiers U24 and U19, the inputs to the appropriate summing resistors are grounded by shunt analog switches. This is to minimize the effects of stray circuit capacity. The gates in U15 and U16 allow two logic lines from the pilot sensing circuit to turn on all series and turn off all shunt switch elements for monaural operation.

The presence of pilot is sensed in comparator U8 and associated circuitry. Germanium rectifier CR6 feeds a smoothing network formed by R42 and C25, which in turn drives the non-inverting input of comparator U8. The reference voltage for U8 is established by R46 and R47 and applied to the inverting input. When the pilot level

exceeds approximately 2.5 kHz deviation and the pilot voltage at the cathode of CR6 reaches approximately 610 millivolts rms (corresponding to a pilot deviation of about 2.5 kHz) the DC voltage applied to pin 2 of U8 drops below the -0.71 volt reference voltage at pin 3 and the output of the comparator goes low. This activates the stereo demodulator. R43 and R45 provide comparator hysteresis. The direct comparator output is coupled to the TVM-220 pilot sync detection logic via J2, pin 5.

The comparator output is coupled to the stereo demodulator and PLL by different paths. Resistor R48 and R49 provide logic level conversion for both paths. The output of the voltage divider is connected to the vco inhibit line of U10 so that the VCO is activated immediately upon detection of pilot. A timing network consisting of R50 and C26 delays activation of the demodulator switches by inhibiting the NAND's and NOR's in U15 and U16 until the PLL has sufficient time to lock on the pilot signal. NOR gates U11C and U11D provide buffering of the timing network and logic inversion. Diode CR7 bypasses the timing network so that both the VCO and the switches are deactivated immediately when pilot falls below threshold.

Transistor Q3 controls the front panel and remote pilot LED's. A circuit jumper at P2 selects whether the control is direct from the inverted pilot comparator signal at pin 10 of U11 or from the pilot sync logic in an associated TVM-220 BTSC Program Monitor. In the presence of pilot, the high at pin 10 and the low at pin 13 of U11 activate the NAND's and NOR's respectively in U15 and U16 for stereo demodulation by the analog switches. Additionally, the output of U11D also drives Q1. During monaural operation, pin 13 of U11D is high, turning on Q1 through R54. This activates normally open relay RL1, shorting R36 to ground. With R36 grounded, R35 and R36 behave as a voltage divider, cutting the composite level from U6 appearing at the switch inputs in half. This compensates for the level change between monaural and stereo operation occurring in the stereo demodulator.

Operational amplifiers U24 and U19 buffer and sum the fundamental (2H) and the third-order (6H) switch outputs from U17 and U18. Trimming potentiometers R93 and R66 adjust the ratio of the products for cancellation of the 94.4 kHz sidebands picked up by the demodulator. Differential amplifiers U25 and U20 provide the cross coupling necessary to compensate for the excess L-R component generated by the switching function in the demodulator. Potentiometer R101 adjusts the cancellation of right channel signals in the left channel output; R76 adjusts the cancellation of left channel signals in the right output.

Lowpass pre-filters consisting of L9 through L14, C50 through C59, and associated resistors, remove signal components of the switch outputs above 15 kHz. When the monitor is fed an equivalent mode composite signal in which the L+R amplitude is equal to the L-R amplitude, buffer amplifiers U21A and U21B provide left and right outputs of negative polarity (-L and -R), respectively. Circuit board jumpers P3 and P4 simplify the

checking of pre-filter response tracking. Three terminal voltage regulators U1 and U2 provide +5 Vdc and -5 Vdc for the pilot limiter, the PLL and associated logic and the analog switches in the stereo demodulator.

SUM AND DIFFERENCE CHANNEL MATRIX AND FILTER CIRCUITRY

The outputs of the left and right channel pre-filter buffer amplifiers in U21 are applied to an audio matrix to derive the demodulated sum (L+R) and difference (L-R) channels.

This is to accommodate difference channel expansion and sum channel compensation circuitry required by the BTSC system. Inverting amplifier U22 provides a right channel signal of positive polarity for matrix summing in U23B. Variable capacitor C62 tailors the high frequency phase response of the invertor for best cancellation of L+R components in U23. Potentiometer R83 sets the amplitude null of L+R components in the L-R output. The gain of U23B is controlled by the MTS/EQUIV switch and relay RL2. When the MTS/EQUIV button (S1) at the rear of the unit is released, the normally closed contact of RL2 is opened. This removes a shunt resistance equal to R66 from the feedback network on U23B, doubling the gain. Inverting amplifier U23A sums -L and -R to produce the sum channel and operates at a gain equal to that of U23B with the shunt resistance removed. Thus, when the MTS/EQUIV button is depressed, the difference channel is operating at one half the gain of the sum channel, compensating for the 2:1 ratio of L-R to L+R in the BTSC system, and maintaining appropriate normalization for front panel L-R metering. Potentiometer R88 sets the gain ratio to precisely 2:1 and R106 nulls the difference channel components from the sum channel matrix amplifier. Circuit board jumpers P5 and P6 allow the left and right signals to pass directly to the post filters to facilitate setup.

The L+R and L-R amplifiers drive a second stage of lowpass filters on the A3 Postfilter Board. These remove any residual high frequency components from the audio signals. The filter outputs are buffered by two non-inverting amplifiers in U26 and applied to adjustable voltage divider networks for application to the front panel metering system. Potentiometer R144 adjusts the meter sensitivity for the L+R output and R117 adjusts the L-R meter sensitivity. The L+R output is fed to a TVM-220 via J2, pin 1 and R146. The L-R output is connected to the front panel DBX jack through R119.

DBX AND SUM-CHANNEL COMPENSATION CIRCUITRY

The BTSC stereo system requires 75 μsec pre-emphasis in the L+R channel and dbx companding in the L-R. Compensation circuits in the L+R are employed to compensate for inaccuracies in the companding circuitry. Additionally, in a demodulating monitor, provision must be made to evaluate system performance with the de-emphasis, expansion, and compensation circuitry bypassed. To allow this, the L+R and L-R outputs

of U26 feed the matrices used to derive the left and right monitor outputs via two paths. The first path connects the L+R output to a precision de-emphasis network consisting of R147 and C63. This is buffered by U27A and applied to the sum channel compensation network consisting of U28, R148 through R153, and C64. The first path connects the L-R output through a dbx manufactured BTSC expander board mounted at the right end of the chassis. The second path connects the L+R and L-R audio signals directly to the left and right audio output matrix. Switch S1, the DBX switch on the rear panel, determines whether processed or unprocessed audio is applied to the matrix. When depressed, a standard BTSC system composite signal is decoded.

The MTS/EQUIV and DBX pushbuttons are interwired so that if either button is released, indicating operation of the monitor in a non-standard mode, current is applied to the base of Q4 through R111. When Q4 is turned on, the red front panel TEST LED is lit.

LEFT AND RIGHT MATRIX AND OUTPUT CIRCUITRY

The DBX pushbutton, S1, determines whether or not audio processed by the BTSC expander is applied to the output matrix. Inverting amplifier U27B provides an inverted L+R signal for matrix summing in U31B. Variable capacitor C65 provides adjustment of the high frequency phase response for best cancellation of left channel signal components in the right channel output. Inverting summing amplifier U31B combines the L-R and inverted L+R audio to obtain the right channel output. Potentiometer R158 adjusts the L+R input for best amplitude null of left channel audio components in the right output.

Inverting summing amplifier U29 sums the L+R and L-R to obtain the left output. Potentiometer R122 nulls right channel components. Inverting amplifier U30B restores proper polarity to the left channel output signal. Left and right channel test outputs for the front panel are taken from the outputs of U30B and U31B through resistors R126 and R160.

The left and right signals are applied to metering amplifiers U30A and U31A as well as audio output amplifiers U32A, U32B, U33A, and U33B. Levels for left and right signals are referenced to the peak amplitude of the resulting L+R component of the composite signal. Therefore, when the L+R is de-emphasized in the monitor during operation in the BTSC mode, a means must be provided to indicate channel levels independent of modulating frequency. This is the "75 μsec equivalent input level". Bypassing the left and right signals through amplifiers which closely follow the 75 μsec pre-emphasis curve before applying them to the metering circuitry, the 75 μsec equivalent input level will be indicated.

Non-inverting amplifiers U30A and U31A receive left and right audio from attenuators consisting of R138, R139, R163, and R164. They have feedback networks which are changed by contacts on S1, the DBX switch. When the DBX button is released, the amplifiers have unity gain and flat frequency response. When the DBX button is depressed, activating the de-emphasis circuitry in the L+R and L-R channels, capacitors C71 and C72 are shorted to ground through R136 and R161. The capacitors combine with the feedback resistors to give the required rising response characteristic. Resistors R136 and R161 place a high frequency stop to the characteristic to maintain stability.

Left and right signals are amplified differentially for use in the 600 Ω rear panel monitoring outputs. The following description is referenced to the left channel output, but it applies to the right channel output with appropriate substitution of part designators. Left channel audio is applied to a 2:1 voltage divider and pin 3 of non-inverting amplifier U32A. This amplifier operates at unity gain and provides 2.45 Vrms open circuit to 300 Ω resistor R131 and 10 kΩ resistor R130 through blocking capacitor C69. The left audio is also applied to inverting amplifier U32B which operates at a gain of one half. Its output passes through 300 Ω resistor R135 and blocking capacitor C70. Open circuit voltage is 2.45 Vrms. A 600 Ω load connected between the two outputs will see an effective 600 Ω source impedance and a terminated level of 2.45 Vrms, or +10 dBm. The blocking capacitors prevent any offset voltages from saturating the cores of transformer loads. The high impedance output permits simultaneously driving bridging loads.

4-3 TVM-210 A3 Post Filter Board

This board consists entirely of two matched passive filter assemblies, less the source and termination resistors. It removes residual signal components above 15 kHz from the L+R and L-R signals derived from the stereo demodulator.

4-4 TVM-210 Chassis Power Supplies

AC power is applied to the TVM-210 chassis through the power entry module, at the rear of the chassis. Bypass circuitry suppresses high frequency energy from the power line. The fuse in the power entry module provides power shutdown in the event of major increases in load current. Note that the fuse rating is dependent on operating voltage. A voltage select board in the power entry module configures the primary windings of the power transformer T1 for operation at either 115 Vac or 230 Vac.

Two secondaries of T1 provide the required unregulated AC voltages for application to the full wave bridges BR1 and BR2. The first secondary provides about 9 Vac unloaded and about 8 Vac loaded to bridge rectifier BR1. Filter capacitor C3 smooths the rectified AC for application to three terminal regulator U1. (This is the top capacitor in the shelf assembly.) Input to the regulator is about 7.5 Vdc. Nominal

regulator output voltage is +5 Vdc. This is supplied to the A1 and A2 boards to power LED displays and some logic. It is also available to the user at the board edge connector of the A2 board.

Secondary number two provides about 36 Vac to bridge rectifier BR2. Both positive and negative outputs are taken from the bridge. Filter capacitors C5 and C4 (the bottom and middle capacitors in the shelf assembly) smooth the rectified AC for application to three terminal regulators U3 and U2. Input voltages to the two regulators are approximately +22 Vdc and -22 Vdc. The nominal output voltage for U3 is +15 Vdc and the nominal output voltage for U2 is -15 Vdc. The outputs of these two regulators primarily power analog circuitry on the A1, A2, and dbx circuit boards. Note that the case for C4 is floating at -22 Vdc.

The third secondary of T1 drives the meter lamps DS1 and DS2 with approximately 6 Vac.

5 Diagrams, Schematics and Parts Lists

Replaceable Parts. This page contains information for ordering replaceable parts for the monitor. 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.*

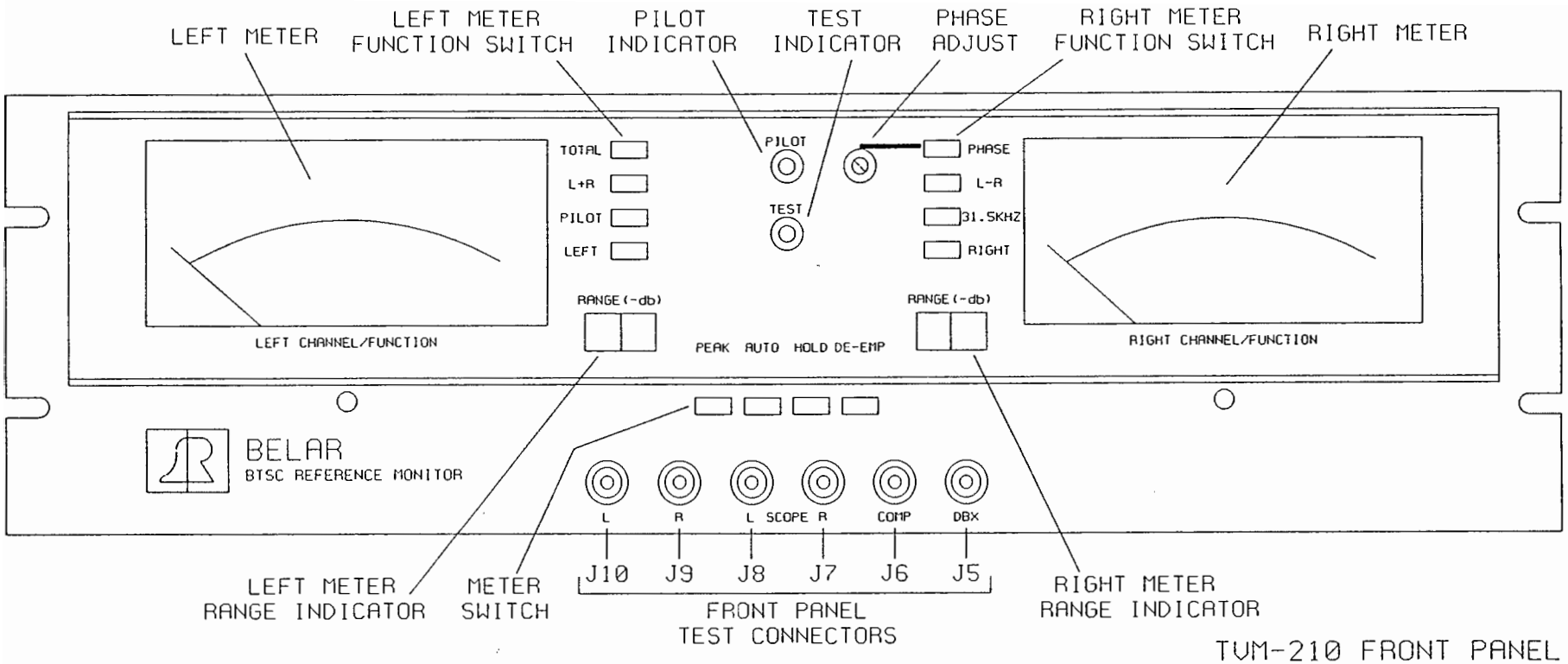
Orders may also be taken over the telephone. Parts orders can be put on your VISA, MasterCard, or American Express card, or we can ship them COD.

REFERENCE DESIGNATORS

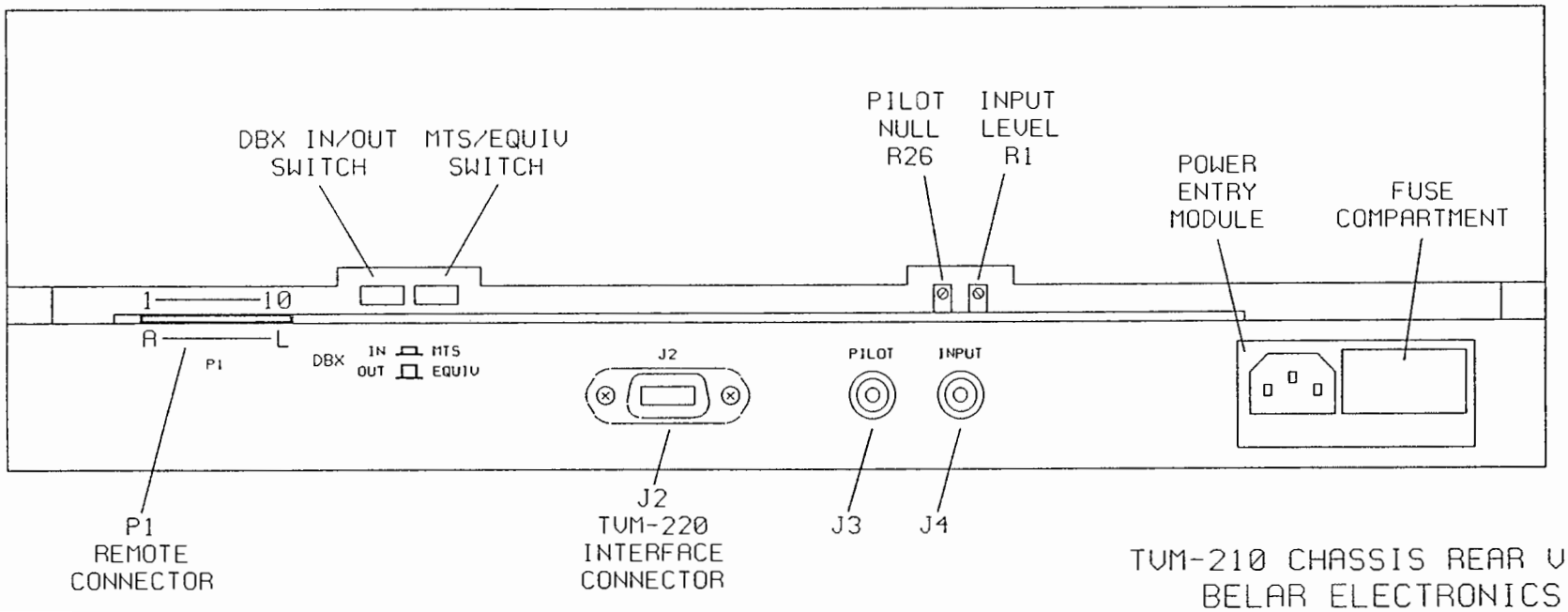
A	= assembly	J	= jack	S	= switch
BR	= diode bridge	L	= inductor	T	= transformer
C	= capacitor	M	= meter	TB	= terminal block
CR	= diode or LED	P	= plug	U	= integrated circuit
DS	= display or lamp	Q	= transistor	W	= cable
F	= fuse	R	= resistor	X	= socket
FL	= filter	RL	= relay	Y	= crystal
HDR	= header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



TVM-210 FRONT PANEL



TVM-210 CHASSIS REAR VIEW

BELAR ELECTRONICS

TVM-210 CHASSIS WIRING
BELAR ELECTRONICS
11-19-93

WHT/GRN
WHT/BRN
POWER ENTRY MODULE
T1
A5 POWER SUPPLY BOARD
BR2
BR1
7815
7915
7805
U3
U2
U1
C5 3500
C4 3500
C3 3500
C8 0.1
C7 0.1
C6 0.1
+15V
RED/WHT
-15V
YEL/WHT
+5V
VIO
GND
BRN/WHT
CHASSIS
WHT/BLK
YEL/BLK
BLK
BLK/RED
DS1
DS2
INPUT J4
PILOT J3
J2
TVM-220 INTERFACE CONNECTOR
P1
REMOTE CONNECTOR
REMOTE +5V
REMOTE PILOT LED
RIGHT CHANNEL + 600 OHM BAL OUT
RIGHT CHAN UNBAL OUT
LEFT CHANNEL + 600 OHM BAL OUT
LEFT CHAN UNBAL OUT
CR1 PILOT
CR2 TEST
BRN/WHT CHASS GND
GRN/WHT
BLU/WHT
GRY
ORG
TOTAL
L+R
PILOT
LEFT
LEFT METER FUNCTION SWITCH
S2
A2 STEREO DEMODULATOR BOARD
PHASE R1 100K
DBX DECODER BOARD
PHASE
L-R
31.5 KHZ
RIGHT
RIGHT METER FUNCTION SWITCH
S3
FL1 31.5KHZ FILTER
R2 1K
R3 1.00K
A3 POST FILTER BOARD
A1 VOLTMETER BOARD REV. A
M1
M2
J10 L
J9 R
J8 L
J7 R
J6 COMP
J5 DBX
SCOPE
POT-REAR VIEW (R1,R2)
DENOTES COLOR BAND ON COAXIAL CABLE

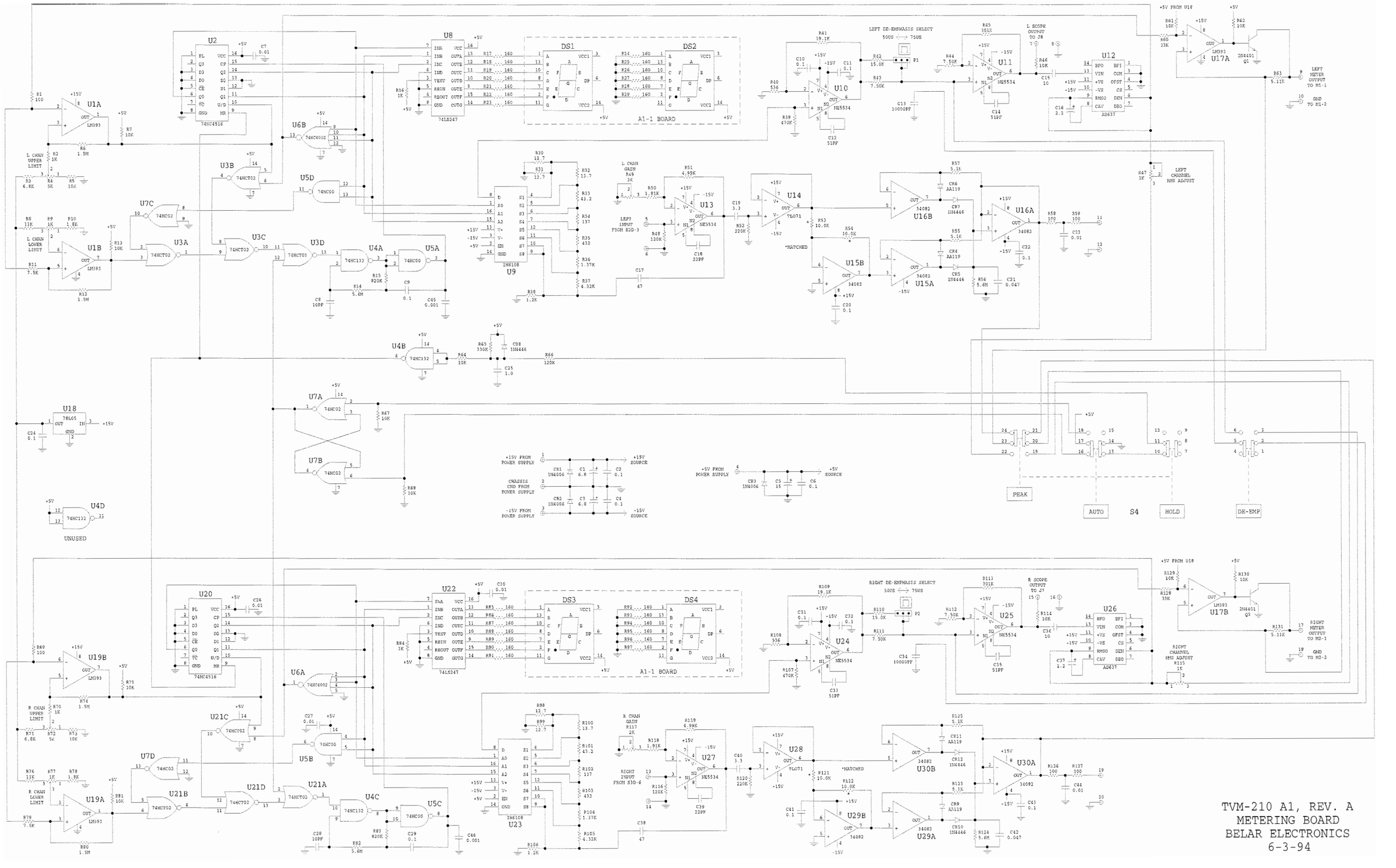
TVM-210 PARTS LISTS

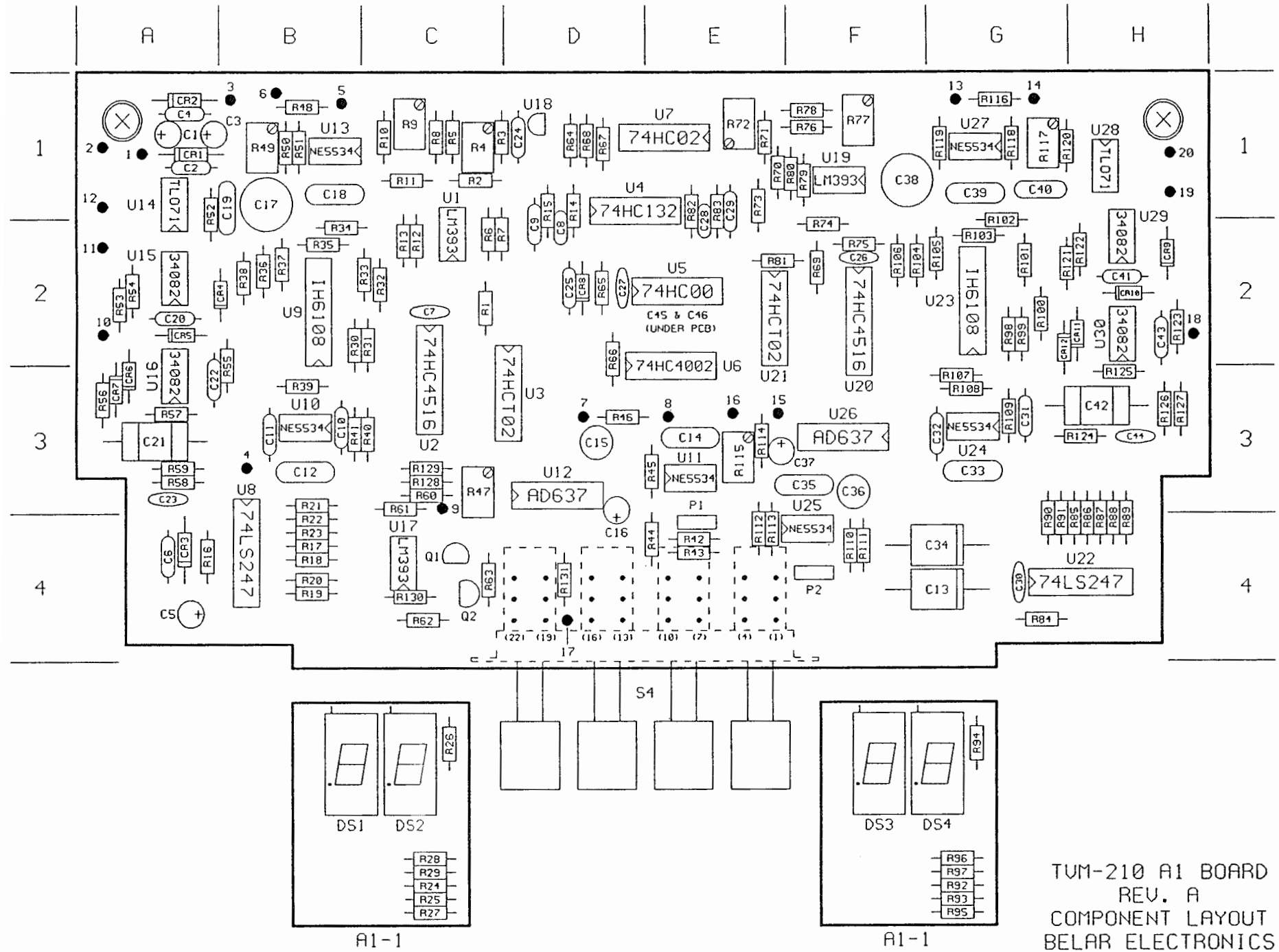
MAIN CHASSIS

Reference Designation	Description		Part Number
BR1,BR2	DIODE: BRIDGE KBPC602 GI		1900-0025
C1,C2	C: FIXED CERAMIC 0.01uF 1.4kV	(NOTE 2)	0151-0010
C3 thru C5	C: FIXED ELECT 3500uF 40V	(NOTE 1)	0180-0026
C6 thru C8	C: FIXED CERAMIC 0.1uF 50V	(NOTE 1)	0151-0006
CR1	LED: GREEN MV5253		1910-0003
CR2	LED: RED MV5053		1910-0001
DS1,DS2	LAMP: 1847		2140-0005
--	SOCKET: LAMP		1450-0012
F1	FUSE: AGC 1/2A 250V (115 Vac line voltage)		2110-0001
	AGC 1/4A 250V (230 Vac Line voltage)		2110-0002
--	FUSEHOLDER:	(NOTE 2)	2110-0003
FL1	FILTER: BANDPASS 31.5 kHz, BELAR		9120-0013
J1	JACK: POWER	(NOTE 2)	0360-0010
J2	RECEPTACLE: AMPHENOL 14 PIN		0365-0026
J3 thru J10	JACK: BNC		0360-0005
M1,M2	METER: MOD 0-133%		1120-0012
R1	R: VAR COMP 100k 2W		2100-0011
R2	R: VAR COMP 1k 2W		2100-0007
R3	R: METAL FILM 1.00k 1%		0721-1001
S1	SWITCH: SLIDE 115/230V SELECTOR	(NOTE 2)	3102-0002
S2,S3	SWITCH: PUSHBUTTON (Meter, 4 button)		3101-0017
T1	TRANSFORMER: POWER		9100-0010
U1	IC: 7805C		1826-0014
U2	IC: 7915C		1826-0033
U3	IC: 7815C		1826-0031
--	LINE CORD		8120-0002

NOTE 1: Prior to serial number 210144 - C3 thru C5 were 1000uF 50v (0180-0002) and C6 thru C8 were not used.

NOTE 2: Beginning serial number 210191, these parts are replaced by the 6J4 power entry module (0360-0020).

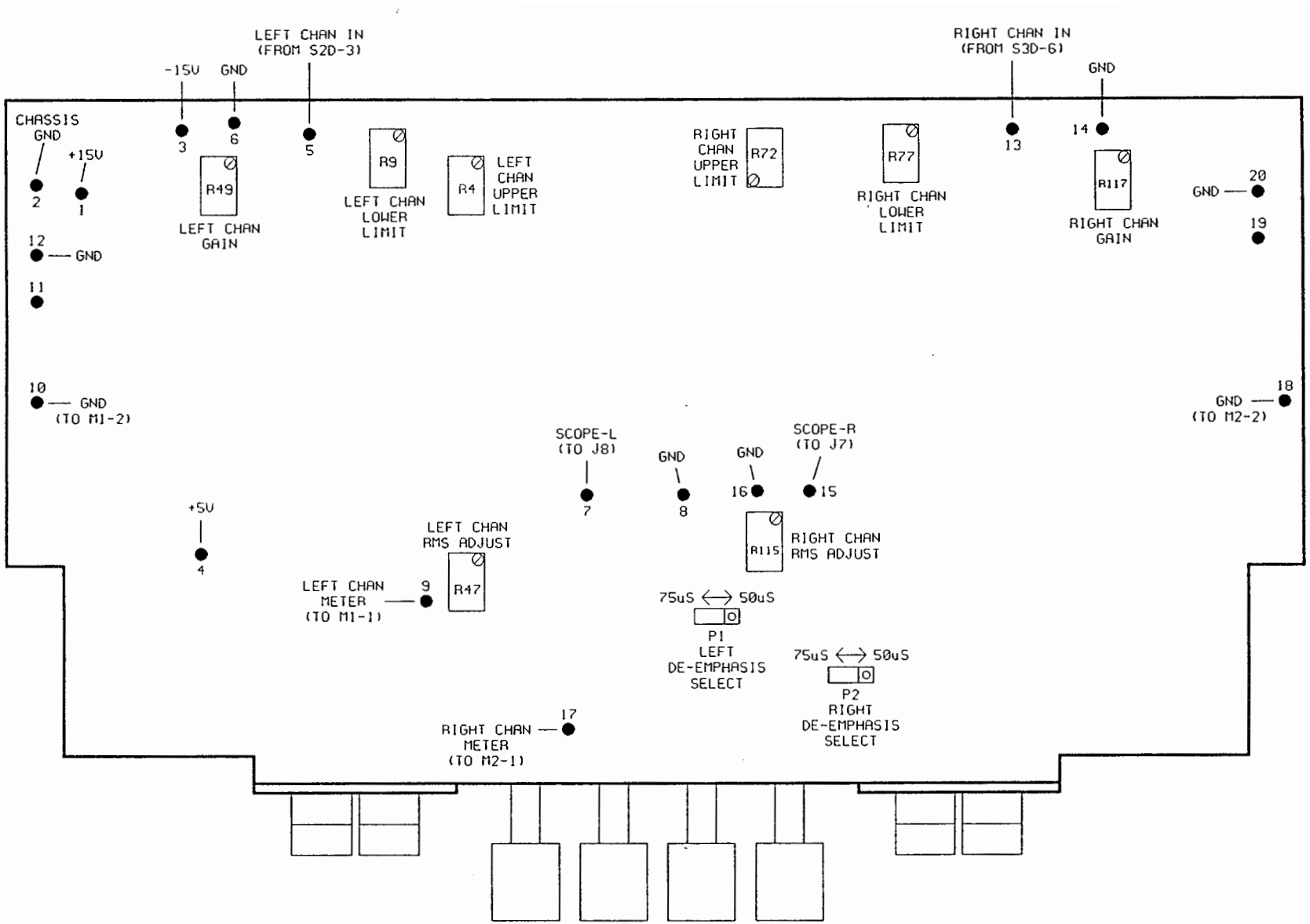

U1A
U1B
U2
74HC4516
U3A
U3B
U3C
U3D
U4A
U4B
U4C
U4D
UNUSED
U5A
U5B
U5C
U5D
U6A
U6B
U7A
U7B
U7C
U7D
U8
74LS247
U9
1H6108
U10
NE5534
U11
U12
AD637
U13
U14
TL071
U15A
U15B
U16A
U16B
34082
U17A
LM393
2N4401
U18
78L05
U19A
U19B
U20
U21A
U21B
U21C
U21D
U22
U23
U24
U25
U26
U27
U28
U29A
U29B
U30A
U30B
U17B
DS1
DS2
DS3
DS4
A1-1 BOARD
L CHAN UPPER LIMIT
L CHAN LOWER LIMIT
L CHAN GAIN
LEFT INPUT FROM S2D-3
*MATCHED
LEFT DE-EMPHASIS SELECT
50US
75US
L SCOPE OUTPUT TO J8
LEFT CHANNEL RMS ADJUST
LEFT METER OUTPUT TO M1-1
GND TO M1-2
+5V FROM U18
R CHAN UPPER LIMIT
R CHAN LOWER LIMIT
R CHAN GAIN
RIGHT INPUT FROM S3D-6
RIGHT DE-EMPHASIS SELECT
R SCOPE OUTPUT TO J7
RIGHT CHANNEL RMS ADJUST
RIGHT METER OUTPUT TO M2-1
GND TO M2-2
+15V FROM POWER SUPPLY
CHASSIS GND FROM POWER SUPPLY
-15V FROM POWER SUPPLY
+15V SOURCE
-15V SOURCE
+5V FROM POWER SUPPLY
+5V SOURCE
PEAK
AUTO
S4
HOLD
DE-EMP
TVM-210 A1, REV. A
METERING BOARD
BELAR ELECTRONICS
6-3-94


A
B
C
D
E
F
G
H
1
2
3
4
74HC02
74HC132
74HC00
74HC4002
74HCT02
74HC4516
AD637
LM393
TL071
NE5534
74LS247
IH6108
34082
S4
DS1
DS2
DS3
DS4
A1-1
A1-1
TVM-210 A1 BOARD
REV. A
COMPONENT LAYOUT
BELAR ELECTRONICS

TVM-210 A1 BOARD Rev. A
PART LOCATIONS

Desig/Loc		Desig/Loc		Desig/Loc		Desig/Loc		Desig/Loc		Desig/Loc	
										pins	
C1	A1	CR1	A1	R24	A1-1	R71	E1	R118	G1	1	A1
C2	A1	CR2	A1	R25	A1-1	R72	E1	R119	G1	2	A1
C3	A1	CR3	A4	R26	A1-1	R73	E1	R120	G1	3	B1
C4	A1	CR4	B2	R27	A1-1	R74	F2	R121	G2	4	B3
C5	A4	CR5	A2	R28	A1-1	R75	F2	R122	H2	5	B1
C6	A4	CR6	A3	R29	A1-1	R76	F1	R123	H2	6	B1
C7	C2	CR7	A3	R30	B2	R77	F1	R124	H3	7	D3
C8	D2	CR8	D2	R31	C2	R78	F1	R125	H3	8	E3
C9	D2	CR9	H2	R32	C2	R79	F1	R126	H3	9	C3
C10	B3	CR10	H2	R33	C2	R80	F1	R127	H3	10	A2
C11	B3	CR11	H2	R34	B2	R81	E2	R128	C3	11	A2
C12	B3	CR12	G2	R35	B2	R82	E1	R129	C3	12	A1
C13	G4			R36	B2	R83	E1	R130	C4	13	G1
C14	E3	DS1	A1-1	R37	B2	R84	G4	R131	D4	14	G1
C15	D3	DS2	A1-1	R38	B2	R85	H4			15	E3
C16	D3	DS3	A1-1	R39	B3	R86	H4	S4	D4	16	E3
C17	B1	DS4	A1-1	R40	C3	R87	H4			17	D4
C18	B1			R41	B3	R88	H4	U1	C2	18	H2
C19	B1	P1	E4	R42	E4	R89	H4	U2	C3	19	H1
C20	A2	P2	F4	R43	E4	R90	G4	U3	D3	20	H1
C21	A3			R44	E4	R91	G4	U4	D1		
C22	A3	Q1	C4	R45	E3	R92	A1-1	U5	E2		
C23	A3	Q2	C4	R46	D3	R93	A1-1	U6	E2		
C24	D1			R47	C3	R94	A1-1	U7	E1		
C25	D2	R1	C2	R48	B1	R95	A1-1	U8	B4		
C26	F2	R2	C1	R49	B1	R96	A1-1	U9	B2		
C27	D2	R3	C1	R50	B1	R97	A1-1	U10	B3		
C28	E2	R4	C1	R51	B1	R98	G2	U11	E3		
C29	E1	R5	C1	R52	A1	R99	G2	U12	D3		
C30	G4	R6	C2	R53	A2	R100	G2	U13	B1		
C31	G3	R7	C2	R54	A2	R101	G2	U14	A1		
C32	G3	R8	C1	R55	B2	R102	G2	U15	A2		
C33	G3	R9	C1	R56	A3	R103	G2	U16	A3		
C34	G4	R10	C1	R57	A3	R104	F2	U17	C4		
C35	F3	R11	C1	R58	A3	R105	G2	U18	D1		
C36	F3	R12	C2	R59	A3	R106	F2	U19	F1		
C37	E3	R13	C2	R60	C3	R107	G3	U20	F2		
C38	F1	R14	D1	R61	C3	R108	G3	U21	E2		
C39	G1	R15	D1	R62	C4	R109	G3	U22	H4		
C40	G1	R16	A4	R63	C4	R110	F4	U23	G2		
C41	H2	R17	B4	R64	D1	R111	F4	U24	G3		
C42	H3	R18	B4	R65	D2	R112	E4	U25	F4		
C43	H2	R19	B4	R66	D2	R113	E4	U26	F3		
C44	H3	R20	B4	R67	D1	R114	E3	U27	G1		
C45	E2*	R21	B3	R68	D1	R115	E3	U28	H1		
C46	E2*	R22	B4	R69	F2	R116	G1	U29	H2		
		R23	B4	R70	E1	R117	G1	U30	H2		

* C45 & C46 ARE UNDER PC BOARD



TVM-210 A1 BOARD
REV. A
CONNECTIONS & ADJUSTMENTS
BELAR ELECTRONICS

A1 BOARD TVM-210 Rev. A

Reference Designation	Description	Part Number
C1	C: FIXED TANT 6.8uF 25V	0185-0002
C2	C: FIXED CERAMIC 0.1uF 50V	0151-0006
C3	C: FIXED TANT 6.8uF 25V	0185-0002
C4	C: FIXED CERAMIC 0.1uF 50V	0151-0006
C5	C: FIXED TANT 15uF 15V	0185-0003
C6	C: FIXED CERAMIC 0.1uF 50V	0151-0006
C7	C: FIXED CERAMIC 0.01uF 100V	0151-0003
C8	C: FIXED MICA 10pF 5%	0142-1005
C9 thru C11	C: FIXED CERAMIC 0.1uF 50V	0151-0006
C12	C: FIXED MICA 51pF 5%	0140-5105
C13	C: FIXED POLY 10000pF 2.5% 160V	0130-1032
C14	C: FIXED MICA 51pF 5%	0140-5105
C15	C: FIXED ELEC 10uF 35V NON-POLAR	0180-0029
C16	C: FIXED TANT 2.2uF 35V	0185-0009
C17	C: FIXED ELEC 47uF 35V NON-POLAR	0180-0036
C18	C: FIXED MICA 22pF 5%	0140-2205
C19	C: FIXED CERAMIC 3.3uF 50V	0151-0011
C20	C: FIXED CERAMIC 0.1uF 50V	0151-0006
C21	C: FIXED FILM 0.047uF 10% 200V	0120-4731
C22	C: FIXED CERAMIC 0.1uF 50V	0151-0006
C23	C: FIXED CERAMIC 0.01uF 100V	0151-0003
C24	C: FIXED CERAMIC 0.1uF 50V	0151-0006
C25	C: FIXED CERAMIC 1.0uF 50V	0151-0008
C26,C27	C: FIXED CERAMIC 0.01uF 100V	0151-0003
C28	C: FIXED MICA 10pF 5%	0142-1005
C29	C: FIXED CERAMIC 0.1uF 50V	0151-0006
C30	C: FIXED CERAMIC 0.01uF 100V	0151-0003
C31,C32	C: FIXED CERAMIC 0.1uF 50V	0151-0006
C33	C: FIXED MICA 51pF 5%	0140-5105
C34	C: FIXED POLY 10000pF 2.5% 160V	0130-1032
C35	C: FIXED MICA 51pF 5%	0140-5105
C36	C: FIXED ELEC 10uF 35V NON-POLAR	0180-0029
C37	C: FIXED TANT 2.2uF 35V	0185-0009
C38	C: FIXED ELEC 47uF 35V NON-POLAR	0180-0036
C39	C: FIXED MICA 22pF 5%	0140-2205
C40	C: FIXED CERAMIC 3.3uF 50V	0151-0011
C41	C: FIXED CERAMIC 0.1uF 50V	0151-0006
C42	C: FIXED FILM 0.047uF 10% 200V	0120-4731
C43	C: FIXED CERAMIC 0.1uF 50V	0151-0006
C44	C: FIXED CERAMIC 0.01uF 100V	0151-0003
C45,C46	C: FIXED CERAMIC 0.001uF 1kV	0151-0002
CR1 thru CR3	DIODE: 1N4006	1900-0016
CR4	DIODE: AA119	1900-0001
CR5	DIODE: 1N4446	1900-0002
CR6	DIODE: AA119	1900-0001
CR7,CR8	DIODE: 1N4446	1900-0002
CR9	DIODE: AA119	1900-0001
CR10	DIODE: 1N4446	1900-0002
CR11	DIODE: AA119	1900-0001
CR12	DIODE: 1N4446	1900-0002

A1 BOARD TVM-210 Rev. A cont.

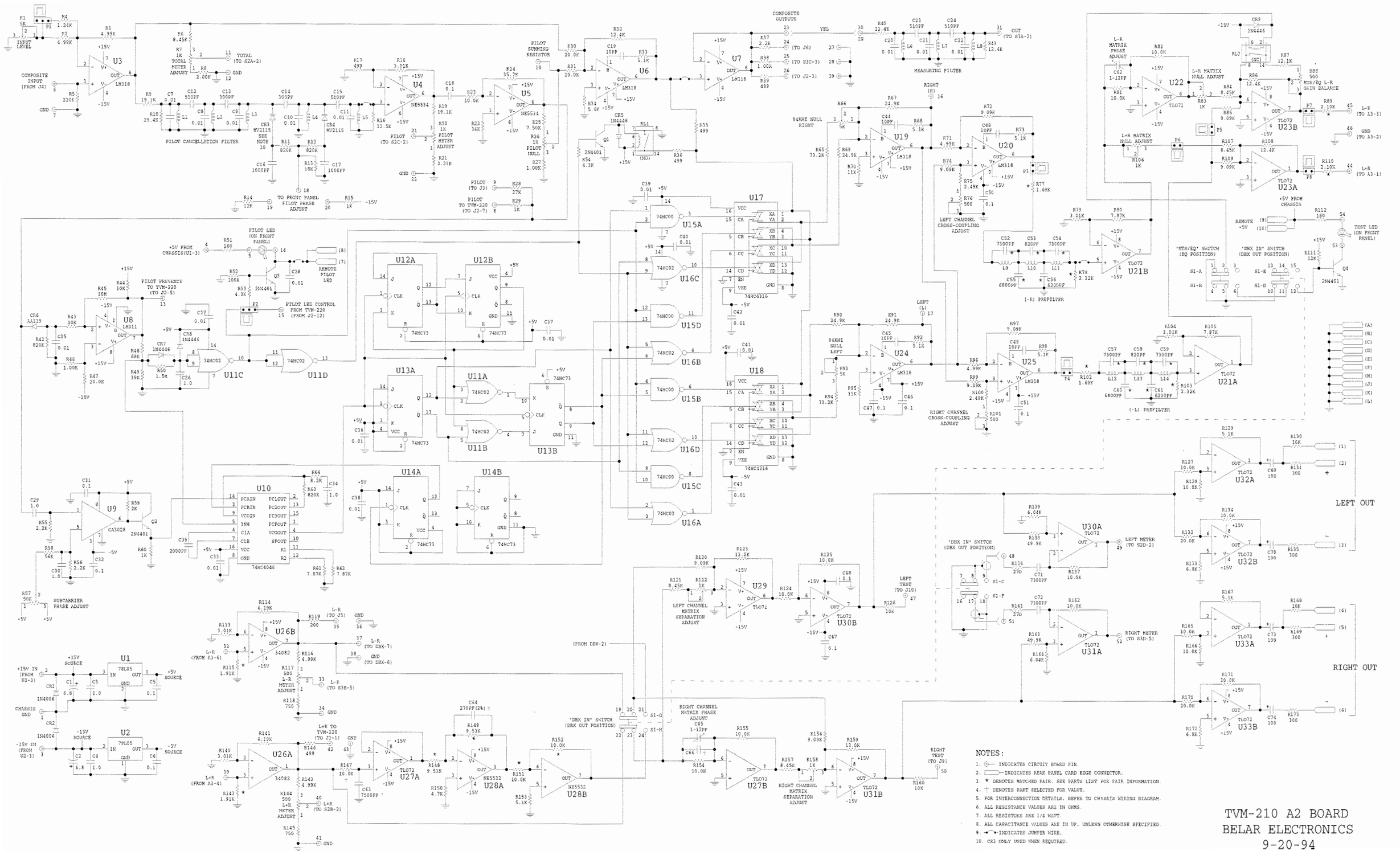
Reference Designation	Description	Part Number
DS1 thru DS4	DISPLAY: MAN3820A	1930-0004
P1,P2	PLUG: 3 PIN, PC MOUNT	0365-0030
--	JUMPER: 2 POSITION (USED WITH P1 & P2)	0365-0028
Q1,Q2	TRANSISTOR: 2N4401	1850-0028
R1	R: METAL FILM 100 2% 1/4W	0751-1012
R2	R: METAL FILM 1k 2% 1/4W	0751-1022
R3	R: METAL FILM 6.8k 2% 1/4W	0751-6822
R4	R: VAR COMP 5k, 10 TURN	2100-0020
R5	R: METAL FILM 10k 2% 1/4W	0751-1032
R6	R: FIXED CARBON 1.5M 5% 1/4W	0683-1555
R7	R: METAL FILM 10k 2% 1/4W	0751-1032
R8	R: METAL FILM 11k 2% 1/4W	0751-1132
R9	R: VAR COMP 1k, 10 TURN	2100-0021
R10	R: METAL FILM 1.8k 2% 1/4W	0751-1822
R11	R: METAL FILM 7.5k 2% 1/4W	0751-7522
R12	R: FIXED CARBON 1.5M 5% 1/4W	0683-1555
R13	R: METAL FILM 10k 2% 1/4W	0751-1032
R14	R: FIXED CARBON 5.6M 5% 1/4W	0683-5655
R15	R: METAL FILM 820k 2% 1/4W	0751-8242
R16	R: METAL FILM 1k 2% 1/4W	0751-1022
R17 thru R29	R: METAL FILM 160 2% 1/4W	0751-1612
R30,R31	R: METAL FILM 12.7 1%	0721-12R7
R32	R: METAL FILM 13.7 1%	0721-13R7
R33	R: METAL FILM 43.2 1%	0721-43R2
R34	R: METAL FILM 137 1%	0721-1370
R35	R: METAL FILM 432 1%	0721-4320
R36	R: METAL FILM 1.37k 1%	0721-1371
R37	R: METAL FILM 4.32k 1%	0721-4321
R38	R: METAL FILM 1.2k 2% 1/4W	0751-1222
R39	R: METAL FILM 470k 2% 1/4W	0751-4742
R40	R: METAL FILM 536 1%	0721-5360
R41	R: METAL FILM 19.1k 1%	0721-1912
R42	R: METAL FILM 15.0k 1%	0721-1502
R43,R44	R: METAL FILM 7.50k 1%	0721-7501
R45	R: METAL FILM 301k 1%	0721-3013
R46	R: METAL FILM 10k 2% 1/4W	0751-1032
R47	R: VAR COMP 1k, 10 TURN	2100-0021
R48	R: METAL FILM 120k 2% 1/4W	0751-1242
R49	R: VAR COMP 2k, 10 TURN	2100-0031
R50	R: METAL FILM 1.91k 1%	0721-1911
R51	R: METAL FILM 4.99k 1%	0721-4991
R52	R: METAL FILM 220k 2% 1/4W	0751-2242
R53,R54*	R: METAL FILM 10.0k 1%	0721-1002
	*R53 & R54 ARE A MATCHED PAIR	
R55	R: METAL FILM 5.1k 2% 1/4W	0751-5122
R56	R: FIXED CARBON 5.6M 5% 1/4W	0683-5655
R57	R: METAL FILM 5.1k 2% 1/4W	0751-5122

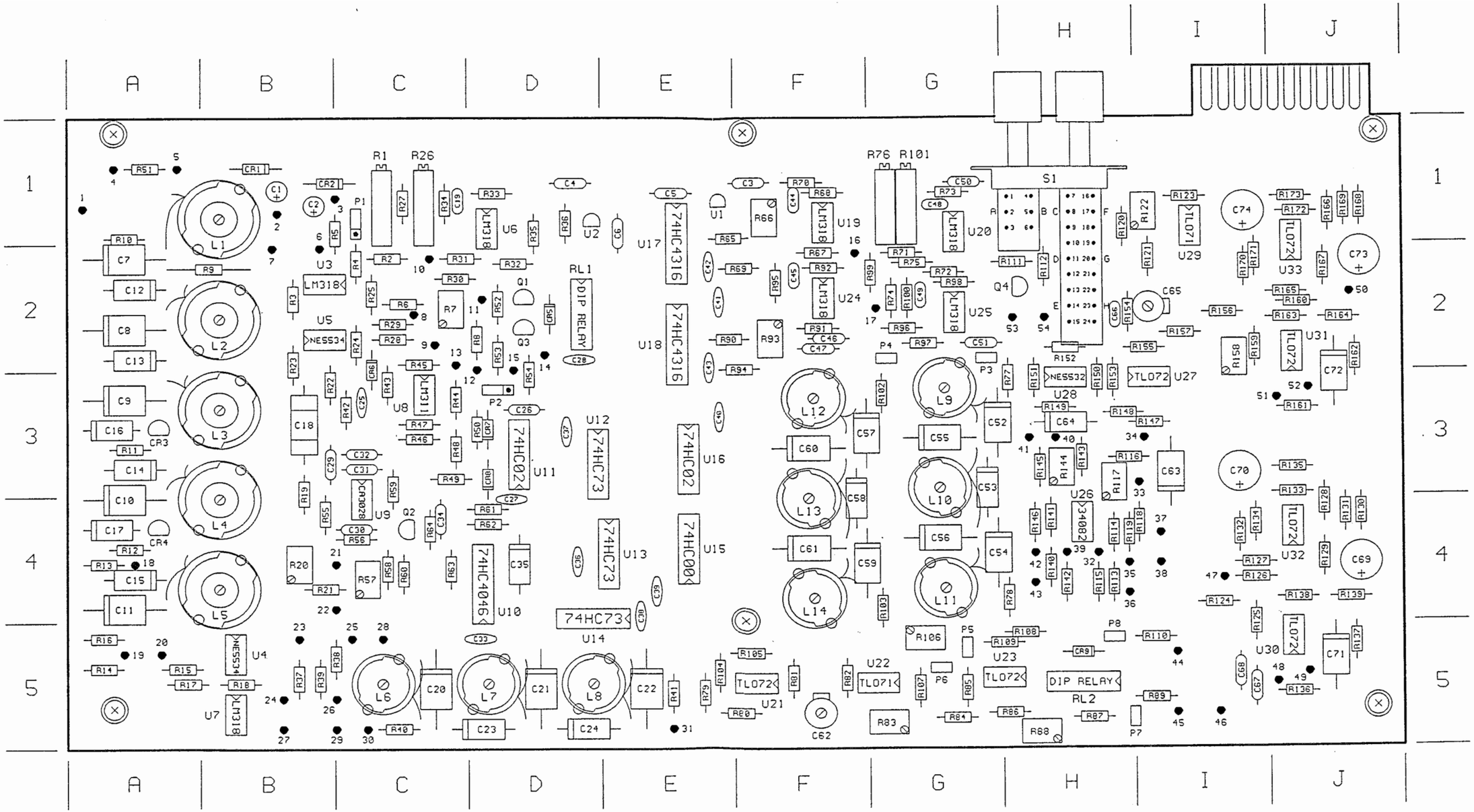
A1 BOARD TVM-210 Rev. A cont.

Reference Designation	Description	Part Number
R58,R59	R: METAL FILM 100 2% 1/4W	0751-1012
R60	R: METAL FILM 33k 2% 1/4W	0751-3332
R61,R62	R: METAL FILM 10k 2% 1/4W	0751-1032
R63	R: METAL FILM 5.11k 1%	0721-5111
R64	R: METAL FILM 10k 2% 1/4W	0751-1032
R65	R: METAL FILM 330k 2% 1/4W	0751-3342
R66	R: METAL FILM 120k 2% 1/4W	0751-1242
R67,R68	R: METAL FILM 10k 2% 1/4W	0751-1032
R69	R: METAL FILM 100 2% 1/4W	0751-1012
R70	R: METAL FILM 1k 2% 1/4W	0751-1022
R71	R: METAL FILM 6.8k 2% 1/4W	0751-6822
R72	R: VAR COMP 5k, 10 TURN	2100-0020
R73	R: METAL FILM 10k 2% 1/4W	0751-1032
R74	R: FIXED CARBON 1.5M 5% 1/4W	0683-1555
R75	R: METAL FILM 10k 2% 1/4W	0751-1032
R76	R: METAL FILM 11k 2% 1/4W	0751-1132
R77	R: VAR COMP 1k, 10 TURN	2100-0021
R78	R: METAL FILM 1.8k 2% 1/4W	0751-1822
R79	R: METAL FILM 7.5k 2% 1/4W	0751-7522
R80	R: FIXED CARBON 1.5M 5% 1/4W	0683-1555
R81	R: METAL FILM 10k 2% 1/4W	0751-1032
R82	R: FIXED CARBON 5.6M 5% 1/4W	0683-5655
R83	R: METAL FILM 820k 2% 1/4W	0751-8242
R84	R: METAL FILM 1k 2% 1/4W	0751-1022
R85 thru R97	R: METAL FILM 160 2% 1/4W	0751-1612
R98,R99	R: METAL FILM 12.7 1%	0721-12R7
R100	R: METAL FILM 13.7 1%	0721-13R7
R101	R: METAL FILM 43.2 1%	0721-43R2
R102	R: METAL FILM 137 1%	0721-1370
R103	R: METAL FILM 432 1%	0721-4320
R104	R: METAL FILM 1.37k 1%	0721-1371
R105	R: METAL FILM 4.32k 1%	0721-4321
R106	R: METAL FILM 1.2k 2% 1/4W	0751-1222
R107	R: METAL FILM 470k 2% 1/4W	0751-4742
R108	R: METAL FILM 536 1%	0721-5360
R109	R: METAL FILM 19.1k 1%	0721-1912
R110	R: METAL FILM 15.0k 1%	0721-1502
R111,R112	R: METAL FILM 7.50k 1%	0721-7501
R113	R: METAL FILM 301k 1%	0721-3013
R114	R: METAL FILM 10k 2% 1/4W	0751-1032
R115	R: VAR COMP 1k, 10 TURN	2100-0021
R116	R: METAL FILM 120k 2% 1/4W	0751-1242
R117	R: VAR COMP 2k, 10 TURN	2100-0031
R118	R: METAL FILM 1.91k 1%	0721-1911
R119	R: METAL FILM 4.99k 1%	0721-4991
R120	R: METAL FILM 220k 2% 1/4W	0751-2242
R121,R122*	R: METAL FILM 10.0k 1%	0721-1002
	*R121 & R122 ARE A MATCHED PAIR	
R123	R: METAL FILM 5.1k 2% 1/4W	0751-5122
R124	R: FIXED CARBON 5.6M 5% 1/4W	0683-5655

A1 BOARD TVM-210 Rev. A cont.

Reference Designation	Description	Part Number
R125	R: METAL FILM 5.1k 2% 1/4W	0751-5122
R126,R127	R: METAL FILM 100 2% 1/4W	0751-1012
R128	R: METAL FILM 33k 2% 1/4W	0751-3332
R129,R130	R: METAL FILM 10k 2% 1/4W	0751-1032
R131	R: METAL FILM 5.11k 1%	0721-5111
S4	SWITCH:PUSHBUTTON (DISPLAY,4 BUTTON)	3101-0016
U1	IC: LM393	1826-0011
U2	IC: 74HC4516	1822-0064
U3	IC: 74HCT02	1822-0027
U4	IC: 74HC132	1822-0065
U5	IC: 74HC00	1822-0039
U6	IC: 74HC4002	1822-0066
U7	IC: 74HC02	1822-0040
U8	IC: 74LS247	1826-0026
U9	IC: IH6108	1827-0002
U10,U11	IC: NE5534	1826-0025
U12	IC: AD637	1827-0003
U13	IC: NE5534	1826-0025
U14	IC: TL071	1826-0004
U15,U16	IC: MC34082	1826-0042
U17	IC: LM393	1826-0011
U18	IC: 78L05CP	1826-0012
U19	IC: LM393	1826-0011
U20	IC: 74HC4516	1822-0064
U21	IC: 74HCT02	1822-0027
U22	IC: 74LS247	1826-0026
U23	IC: IH6108	1827-0002
U24,U25	IC: NE5534	1826-0025
U26	IC: AD637	1827-0003
U27	IC: NE5534	1826-0025
U28	IC: TL071	1826-0004
U29,U30	IC: MC34082	1826-0042


INPUT LEVEL
COMPOSITE INPUT (FROM J4)
PILOT CANCELLATION FILTER
TOTAL METER ADJUST
TOTAL (TO S2A-2)
PILOT SUMMING RESISTOR
PILOT (TO S2C-2)
PILOT METER ADJUST
TO FRONT PANEL PILOT PHASE ADJUST
PILOT (TO J3)
PILOT TO TVM-220 (TO J2-7)
COMPOSITE OUTPUTS
YEL
(TO J6)
(TO S3C-3)
(TO J2-3)
MEASURING FILTER
OUT (TO S3A-21)
94KHZ NULL RIGHT
RIGHT (R)
LEFT CHANNEL CROSS-COUPLING ADJUST
(-R) PREFILTER
94KHZ NULL LEFT
LEFT (L)
RIGHT CHANNEL CROSS-COUPLING ADJUST
(-L) PREFILTER
L-R MATRIX PHASE ADJUST
L-R MATRIX NULL ADJUST
MTS/EQ BAL L-R GAIN BALANCE
L-R (TO A3-3)
GND (TO A3-2)
L+R (TO A3-1)
+5V FROM CHASSIS
REMOTE +5V
TEST LED (ON FRONT PANEL)
'MTS/EQ' SWITCH (EQ POSITION)
'DBX IN' SWITCH (DBX OUT POSITION)
PILOT LED (ON FRONT PANEL)
+5V FROM CHASSIS(U1-3)
REMOTE PILOT LED
PILOT PRESENCE TO TVM-220 (TO J2-5)
PILOT LED CONTROL FROM TVM-220 (FROM J2-12)
SUBCARRIER PHASE ADJUST
+15V IN (FROM U3-3)
+15V SOURCE
CHASSIS GND
-15V IN (FROM U2-3)
-15V SOURCE
-5V SOURCE
L-R (FROM A3-6)
L-R METER ADJUST
L-R (TO S3B-5)
GND (TO DBX-6)
L-R (TO DBX-7)
L+R (FROM A3-4)
L+R METER ADJUST
L+R (TO S2B-2)
L+R TO TVM-220 (TO J2-1)
(FROM DBX-2)
'DBX IN' SWITCH (DBX OUT POSITION)
RIGHT CHANNEL MATRIX PHASE ADJUST
RIGHT CHANNEL MATRIX SEPARATION ADJUST
LEFT CHANNEL MATRIX SEPARATION ADJUST
LEFT METER (TO S2D-2)
RIGHT METER (TO S3D-5)
LEFT TEST (TO J10)
RIGHT TEST (TO J9)
LEFT OUT
RIGHT OUT
NOTES:
1. ⊖ INDICATES CIRCUIT BOARD PIN.
2. ▭ INDICATES REAR PANEL CARD EDGE CONNECTOR.
3. * DENOTES MATCHED PAIR. SEE PARTS LIST FOR PAIR INFORMATION.
4. ⊤ DENOTES PART SELECTED FOR VALUE.
5. FOR INTERCONNECTION DETAILS, REFER TO CHASSIS WIRING DIAGRAM.
6. ALL RESISTANCE VALUES ARE IN OHMS.
7. ALL RESISTORS ARE 1/4 WATT.
8. ALL CAPACITANCE VALUES ARE IN UF, UNLESS OTHERWISE SPECIFIED.
9. ◄⌒► INDICATES JUMPER WIRE.
10. CR3 ONLY USED WHEN REQUIRED.
TVM-210 A2 BOARD
BELAR ELECTRONICS
9-20-94



TVM-210 A2 BOARD
COMPONENT LAYOUT
BELAR ELECTRONICS

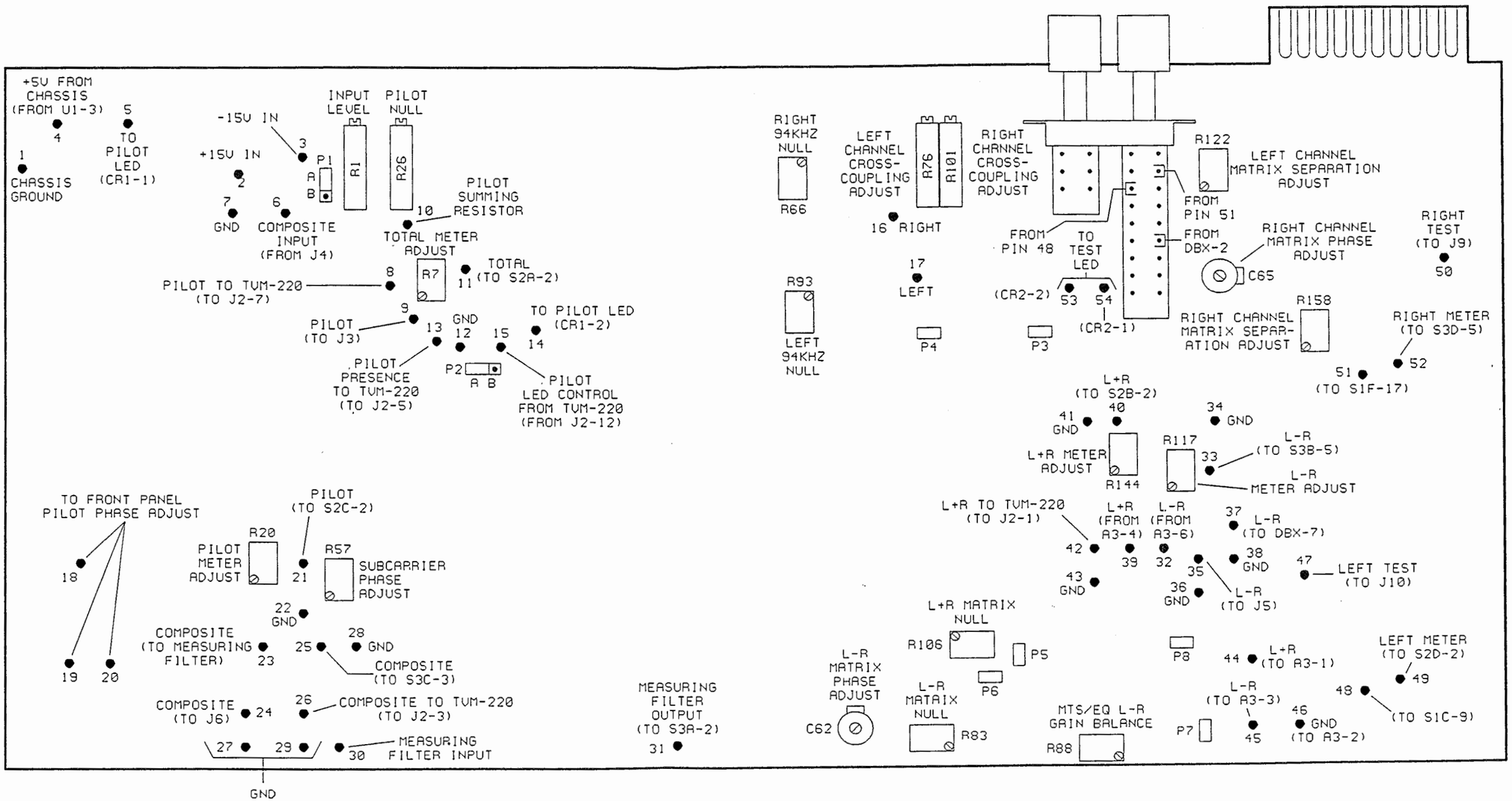
TVM-210 A2 BOARD
PART LOCATIONS

Desig/Loc		Desig/Loc		Desig/Loc		Desig/Loc		Desig/Loc		Desig/Loc	
C1	B1	C50	G1	L14	F4	R34	C1	R83	G5	R132	I4
C2	B1	C51	G2			R35	D1	R84	G5	R133	J3
C3	F1	C52	G3	P1	C1	R36	D1	R85	G5	R134	I4
C4	D1	C53	G3	P2	D3	R37	B5	R86	H5	R135	J3
C5	E1	C54	G4	P3	G2	R38	C5	R87	H5	R136	J5
C6	E1	C55	G3	P4	G2	R39	B5	R88	H5	R137	J5
C7	A2	C56	G4	P5	G5	R40	C5	R89	I5	R138	J4
C8	A2	C57	F3	P6	G5	R41	E5	R90	E2	R139	J4
C9	A3	C58	F4	P7	H5	R42	C3	R91	F2	R140	H4
C10	A4	C59	F4	P8	H5	R43	C3	R92	F2	R141	H4
C11	A4	C60	F3			R44	C3	R93	F2	R142	H4
C12	A2	C61	F4	Q1	D2	R45	C2	R94	F2	R143	H3
C13	A2	C62	F5	Q2	C4	R46	C3	R95	F2	R144	H3
C14	A3	C63	I3	Q3	D2	R47	C3	R96	G2	R145	H3
C15	A4	C64	H3	Q4	H2	R48	C3	R97	G2	R146	H4
C16	A3	C65	I2			R49	C3	R98	G2	R147	I3
C17	A4	C66	H2	R1	C1	R50	D3	R99	G2	R148	H3
C18	B3	C67	I5	R2	C2	R51	A1	R100	G2	R149	H3
C19	C1	C68	I5	R3	B2	R52	D2	R101	G1	R150	H3
C20	C5	C69	J4	R4	C2	R53	D2	R102	G3	R151	H3
C21	D5	C70	I3	R5	C1	R54	D3	R103	G4	R152	H2
C22	E5	C71	J5	R6	C2	R55	B4	R104	E5	R153	H3
C23	D5	C72	J3	R7	C2	R56	C4	R105	F5	R154	H2
C24	D5	C73	J2	R8	D2	R57	C4	R106	G5	R155	I2
C25	C3	C74	I1	R9	B2	R58	C4	R107	G5	R156	I2
C26	D3			R10	A1	R59	C3	R108	H5	R157	I2
C27	D4	CR1	B1	R11	A3	R60	C4	R109	H5	R158	I2
C28	D2	CR2	B1	R12	A4	R61	D4	R110	I5	R159	I2
C29	B3	CR3	A3	R13	A4	R62	D4	R111	H2	R160	J2
C30	C4	CR4	A4	R14	A5	R63	C4	R112	H2	R161	J3
C31	C3	CR5	D2	R15	A5	R64	C4	R113	H4	R162	J2
C32	C3	CR6	C2	R16	A5	R65	E1	R114	H4	R163	J2
C33	D5	CR7	D3	R17	A5	R66	F1	R115	H4	R164	J2
C34	C4	CR8	D3	R18	B5	R67	F2	R116	H3	R165	J2
C35	D4	CR9	H5	R19	B3	R68	F1	R117	H3	R166	J1
C36	D4			R20	B4	R69	F2	R118	I4	R167	J2
C37	D3	L1	B1	R21	B4	R70	F1	R119	H4	R168	J1
C38	E4	L2	B2	R22	B3	R71	G2	R120	H1	R169	J1
C39	E4	L3	B3	R23	B2	R72	G2	R121	I2	R170	I2
C40	E3	L4	B4	R24	C2	R73	G1	R122	I1	R171	I2
C41	E2	L5	B4	R25	C2	R74	G2	R123	I1	R172	J1
C42	E2	L6	C5	R26	C1	R75	G2	R124	I4	R173	J1
C43	E2	L7	D5	R27	C1	R76	G1	R125	I5		
C44	F1	L8	D5	R28	C2	R77	H3	R126	I4	RL1	D2
C45	F2	L9	G3	R29	C2	R78	H4	R127	I4	RL2	H5
C46	F2	L10	G3	R30	C2	R79	E5	R128	J4		
C47	F2	L11	G4	R31	C2	R80	F5	R129	J4	S1	H1
C48	G1	L12	F3	R32	D2	R81	F5	R130	J4		
C49	G2	L13	F4	R33	D1	R82	F5	R131	J4		

TVM-210 A2 BOARD
PART LOCATIONS
cont.

Desig	Loc
U1	E1
U2	D1
U3	B2
U4	B5
U5	B2
U6	D1
U7	B5
U8	C3
U9	C4
U10	D4
U11	D3
U12	D3
U13	E4
U14	D4
U15	E4
U16	E3
U17	E1
U18	E2
U19	F1
U20	G1
U21	F5
U22	G5
U23	H5
U24	F2
U25	G2
U26	H4
U27	I3
U28	H3
U29	I1
U30	J5
U31	J2
U32	J4
U33	J1

pins	
1	A1
2	B1
3	C1
4	A1
5	A1
6	B2
7	B2
8	C2
9	C2
10	C2
11	D2
12	D2
13	C2
14	D2
15	D2
16	F2
17	G2
18	A4
19	A5
20	A5
21	C4
22	C4
23	B5
24	B5
25	C5
26	C5
27	B5
28	C5
29	C5
30	C5
31	E5
32	H4
33	I3
34	I3
35	H4
36	H4
37	I4
38	I4
39	H4
40	H3
41	H3
42	H4
43	H4
44	I5
45	I5
46	I5
47	I4
48	J5
49	J5
50	J2
51	J3
52	J3
53	H2
54	H2



TVM-210 A2 BOARD
CONNECTIONS & ADJUSTMENTS
BELAR ELECTRONICS

A2 BOARD TVM-210

Reference Designation	Description	Part Number
C1,C2	C: FIXED TANT 6.8uF 25V	0185-0002
C3,C4	C: FIXED CERAMIC 1.0uF 50V	0151-0008
C5,C6	C: FIXED CERAMIC 0.1uF 50V	0151-0006
C7 thru C11	C: FIXED POLY 10000pF 2.5% 160V	0130-1032
C12	C: FIXED POLY 510pF 2.5% 160V	0130-5112
C13,C14	C: FIXED POLY 300pF 2.5% 160V	0130-3012
C15	C: FIXED POLY 510pF 2.5% 160V	0130-5112
C16,C17	C: FIXED POLY 1000pF 2.5% 160V	0130-1022
C18	C: FIXED FILM 0.1 uF 10% 80V	0120-1041
C19	C: FIXED MICA 10pF 5%	0142-1005
C20 thru C22	C: FIXED POLY 10000pF 2.5% 160V	0130-1032
C23,C24	C: FIXED POLY 510pF 2.5% 160V	0130-5112
C25	C: FIXED CERAMIC 0.01uF 100V	0151-0003
C26	C: FIXED CERAMIC 1.0uF 50V	0151-0008
C27,C28	C: FIXED CERAMIC 0.01uF 100V	0151-0003
C29,C30	C: FIXED CERAMIC 1.0uF 50V	0151-0008
C31,C32	C: FIXED CERAMIC 0.1uF 50V	0151-0006
C33	C: FIXED CERAMIC 0.01uF 100V	0151-0003
C34	C: FIXED CERAMIC 1.0uF 50V	0151-0008
C35	C: FIXED POLY 2000pF 2.5% 160V	0130-2022
C36 thru C43	C: FIXED CERAMIC 0.01uF 100V	0151-0003
C44,C45	C: FIXED MICA 10pF 5%	0142-1005
C46,C47	C: FIXED CERAMIC 0.1uF 50V	0151-0006
C48,C49	C: FIXED MICA 10pF 5%	0142-1005
C50,C51	C: FIXED CERAMIC 0.1uF 50V	0151-0006
C52	C: FIXED POLY 7300pF 2.5% 160V	0130-7322
C53	C: FIXED POLY 820pF 2.5% 160V	0130-8212
C54	C: FIXED POLY 7300pF 2.5% 160V	0130-7322
C55	C: FIXED POLY 6800pF 2.5% 160V	0130-6822
C56	C: FIXED POLY 6200pF 2.5% 160V	0130-6222
C57	C: FIXED POLY 7300pF 2.5% 160V	0130-7322
C58	C: FIXED POLY 820pF 2.5% 160V	0130-8212
C59	C: FIXED POLY 7300pF 2.5% 160V	0130-7322
C60	C: FIXED POLY 6800pF 2.5% 160V	0130-6822
C61	C: FIXED POLY 6200pF 2.5% 160V	0130-6222
(Prefilter matched pairs;C52/C57,C53/C58,C54/C59,C55/C60,C56/C61)		
C62	C: VARIABLE MICA 1-12pF	0121-0005
C63	C: FIXED POLY 7500pF 2.5% 160V (C63 selected for value)	0130-7522
C64	C: FIXED POLY 270pF 2.5% 160V	0130-2712
C65	C: VARIABLE MICA 1-12pF	0121-0005
C66	SELECTED BY MANUFACTURER	
C67,C68	C: FIXED CERAMIC 0.1uF 50V	0151-0006
C69,C70	C: FIXED ELEC 100uF 35V	0180-0018
C71,C72	C: FIXED POLY 7300pF 2.5% 160V	0130-7322
C73,C74	C: FIXED ELEC 100uF 35V	0180-0018

A2 BOARD TVM-210 CONT.

Reference Designation	Description	Part Number
CR1,CR2	DIODE: 1N4006	1900-0016
CR3*,CR4	DIODE: MV2115	1900-0024
	*CR3 only used when required	
CR5	DIODE: 1N4446	1900-0002
CR6	DIODE: AA119	1900-0001
CR7 thru CR9	DIODE: 1N4446	1900-0002
L1 thru L14	COIL:	Belar
P1,P2	PIN: 3 POSITION	0365-0030
P3 thru P8	PIN: 2 POSITION	0365-0029
--	JUMPER: 2 POSITION (USED WITH P1 thru P8)	0365-0028
Q1 thru Q4	TRANSISTOR: 2N4401	1850-0028
R1	R: VAR COMP 5k, 10 TURN	2100-0026
R2,R3	R: METAL FILM 4.99k 1%	0721-4991
R4	R: METAL FILM 1.24k 1%	0721-1241
R5	R: METAL FILM 220k 2% 1/4W	0751-2242
R6	R: METAL FILM 8.45k 1%	0721-8451
R7	R: VAR COMP 1k, 10 TURN	2100-0021
R8	R: METAL FILM 2.00k 1%	0721-2001
R9	R: METAL FILM 19.1k 1%	0721-1912
R10	R: METAL FILM 29.4k 1%	0721-2942
R11,R12	R: METAL FILM 820k 2% 1/4W	0751-8242
R13	R: METAL FILM 18k 2% 1/4W	0751-1832
R14	R: METAL FILM 12k 2% 1/4W	0751-1232
R15	R: METAL FILM 1k 2% 1/4W	0751-1022
R16	R: METAL FILM 11.5k 1%	0721-1152
R17	R: METAL FILM 499 1%	0721-4990
R18	R: METAL FILM 3.01k 1%	0721-3011
R19	R: METAL FILM 19.1k 1%	0721-1912
R20	R: VAR COMP 1k 10 TURN	2100-0021
R21	R: METAL FILM 2.21k 1%	0721-2211
R22	R: METAL FILM 36k 2% 1/4W	0751-3632
R23	R: METAL FILM 10.0k 1%	0721-1002
R24	R: METAL FILM 35.7k 1%	0721-3572
R25	R: METAL FILM 7.50k 1%	0721-7501
R26	R: VAR COMP 1k, 10 TURN	2100-0023
R27	R: METAL FILM 1.00k 1%	0721-1001
R28	R: METAL FILM 27k 2% 1/4W	0751-2732
R29	R: METAL FILM 1k 2% 1/4W	0751-1022
R30,R31	R: METAL FILM 20.0k 1%	0721-2002
R32	R: METAL FILM 12.4k 1%	0721-1242
R33	R: METAL FILM 5.1k 2% 1/4W	0751-5122
R34	R: METAL FILM 5.6k 2% 1/4W	0751-5622
R35,R36	R: METAL FILM 499 1%	0721-4990
R37	R: METAL FILM 2.2k 2% 1/4W	0751-2222
R38	R: METAL FILM 1.00k 1%	0721-1001

A2 BOARD TVM-210 CONT.

Reference Designation	Description	Part Number
R39	R: METAL FILM 499 1%	0721-4990
R40,R41	R: METAL FILM 12.4k 1%	0721-1242
R42	R: METAL FILM 820k 2% 1/4W	0751-8242
R43,R44	R: METAL FILM 10k 2% 1/4W	0751-1032
R45	R: FIXED CARBON 10M 5% 1/4W	0683-1065
R46	R: METAL FILM 1.00k 1%	0721-1001
R47	R: METAL FILM 20.0k 1%	0721-2002
R48	R: METAL FILM 68k 2% 1/4W	0751-6832
R49	R: METAL FILM 39k 2% 1/4W	0751-3932
R50	R: FIXED CARBON 1.5M 5% 1/4W	0683-1555
R51	R: METAL FILM 160 2% 1/4W	0751-1612
R52	R: METAL FILM 100k 2% 1/4W	0751-1042
R53,R54	R: METAL FILM 4.3k 2% 1/4W	0751-4322
R55,R56	R: METAL FILM 2.2k 2% 1/4W	0751-2222
R57	R: VAR COMP 50k, 10 TURN	2100-0025
R58	R: METAL FILM 56k 2% 1/4W	0751-5632
R59	R: METAL FILM 2k 2% 1/4W	0751-2022
R60	R: METAL FILM 1k 2% 1/4W	0751-1022
R61,R62	R: METAL FILM 7.87k 1%	0721-7871
R63	R: METAL FILM 820k 2% 1/4W	0751-8242
R64	R: METAL FILM 8.2k 2% 1/4W	0751-8222
R65	R: METAL FILM 73.2k 1%	0721-7322
R66	R: VAR COMP 5k, 10 TURN	2100-0020
R67	R: METAL FILM 24.9k 1%	0721-2492
R68	R: METAL FILM 5.1k 2% 1/4W	0751-5122
R69	R: METAL FILM 24.9k 1%	0721-2492
R70	R: METAL FILM 11k 2% 1/4W	0751-1132
R71	R: METAL FILM 4.99k 1%	0721-4991
R72	R: METAL FILM 9.09k 1%	0721-9091
R73	R: METAL FILM 5.1k 2% 1/4W	0751-5122
R74	R: METAL FILM 9.09k 1%	0721-9091
R75	R: METAL FILM 2.49k 1%	0721-2491
R76	R: VAR COMP 500, 10 TURN	2100-0028
R77	R: METAL FILM 1.69k 1% (R77 matched with R102)	0721-1691
R78	R: METAL FILM 2.32k 1% (R78 matched with R103)	0721-2321
R79	R: METAL FILM 3.01k 1%	0721-3011
R80	R: METAL FILM 7.87k 1%	0721-7871
R81,R82	R: METAL FILM 10.0k 1%	0721-1002
R83	R: VAR COMP 1k, 10 TURN	2100-0021
R84	R: METAL FILM 8.45k 1%	0721-8451
R85	R: METAL FILM 9.09k 1%	0721-9091
R86	R: METAL FILM 12.4k 1%	0721-1242
R87	R: METAL FILM 12.1k 1%	0721-1212
R88	R: VAR COMP 500, 10 TURN	2100-0027
R89	R: METAL FILM 2.10k 1% (R89 matched with R110)	0721-2101
R90,R91	R: METAL FILM 24.9k 1%	0721-2492

A2 BOARD TVM-210 CONT.

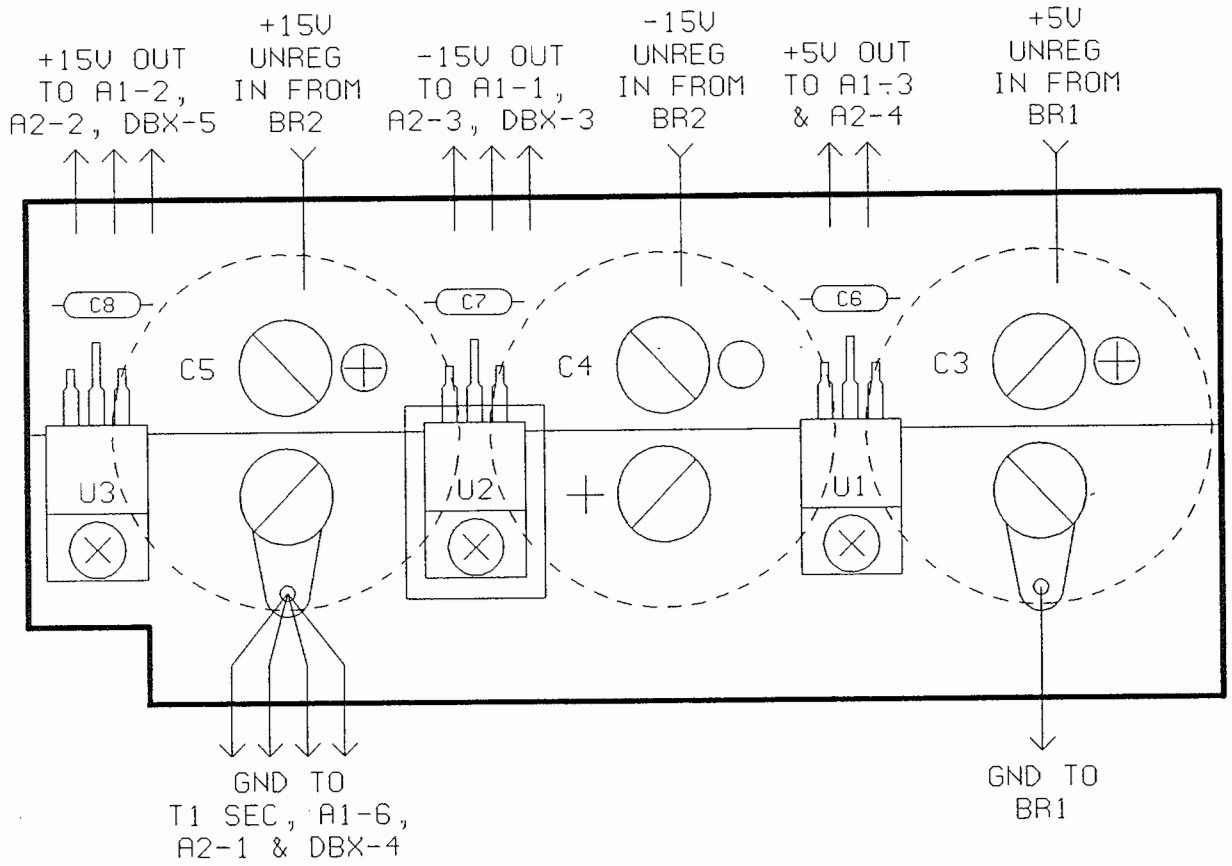
Reference Designation	Description	Part Number
R92	R: METAL FILM 5.1k 2% 1/4W	0751-5122
R93	R: VAR COMP 5k, 10 TURN	2100-0020
R94	R: METAL FILM 73.2k 1%	0721-7322
R95	R: METAL FILM 11k 2% 1/4W	0751-1132
R96	R: METAL FILM 4.99k 1%	0721-4991
R97	R: METAL FILM 9.09k 1%	0721-9091
R98	R: METAL FILM 5.1k 2% 1/4W	0751-5122
R99	R: METAL FILM 9.09k 1%	0721-9091
R100	R: METAL FILM 2.49k 1%	0721-2491
R101	R: VAR COMP 500, 10 TURN	2100-0028
R102	R: METAL FILM 1.69k 1% (R102 matched with R77)	0721-1691
R103	R: METAL FILM 2.32k 1% (R103 matched with R78)	0721-2321
R104	R: METAL FILM 3.01k 1%	0721-3011
R105	R: METAL FILM 7.87k 1%	0721-7871
R106	R: VAR COMP 1k, 10 TURN	2100-0021
R107	R: METAL FILM 8.45k 1%	0721-8451
R108	R: METAL FILM 12.4k 1%	0721-1242
R109	R: METAL FILM 9.09k 1%	0721-9091
R110	R: METAL FILM 2.10k 1% (R110 matched with R89)	0721-2101
R111	R: METAL FILM 12k 2% 1/4W	0751-1232
R112	R: METAL FILM 160 2% 1/4W	0751-1612
R113	R: METAL FILM 3.01k 1%	0721-3011
R114	R: METAL FILM 6.19k 1%	0721-6191
R115	R: METAL FILM 1.91k 1% (R115 matched with R142)	0721-1911
R116	R: METAL FILM 4.99k 1%	0721-4991
R117	R: VAR COMP 500, 10 TURN	2100-0027
R118	R: METAL FILM 750 1%	0721-7500
R119	R: METAL FILM 200 2% 1/4W	0751-2012
R120	R: METAL FILM 9.09k 1%	0721-9091
R121	R: METAL FILM 8.45k 1%	0721-8451
R122	R: VAR COMP 1k, 10 TURN	2100-0021
R123	R: METAL FILM 13.0k 1%	0721-1302
R124,R125	R: METAL FILM 10.0k 1%	0721-1002
R126	R: METAL FILM 10k 2% 1/4W	0751-1032
R127,R128	R: METAL FILM 10.0k 1%	0721-1002
R129	R: METAL FILM 5.1k 2% 1/4W	0751-5122
R130	R: METAL FILM 10k 2% 1/2W	0771-1032
R131	R: METAL FILM 300 2% 1/4W	0751-3012
R132	R: METAL FILM 20.0k 1%	0721-2002
R133	R: METAL FILM 6.8k 2% 1/4W	0751-6822
R134	R: METAL FILM 10.0k 1%	0721-1002
R135	R: METAL FILM 300 2% 1/4W	0751-3012
R136	R: METAL FILM 270 2% 1/4W	0751-2712
R137	R: METAL FILM 10.0k 1%	0721-1002
R138	R: METAL FILM 49.9k 1%	0721-4992

A2 BOARD TVM-210 CONT.

Reference Designation	Description	Part Number
R139	R: METAL FILM 6.04k 1%	0721-6041
R140	R: METAL FILM 3.01k 1%	0721-3011
R141	R: METAL FILM 6.19k 1%	0721-6191
R142	R: METAL FILM 1.91k 1% (R142 matched with R115)	0721-1911
R143	R: METAL FILM 4.99k 1%	0721-4991
R144	R: VAR COMP 500, 10 TURN	2100-0027
R145	R: METAL FILM 750 1%	0721-7500
R146	R: METAL FILM 499 1%	0721-4990
R147	R: METAL FILM 10.0k 1% (R147 selected for exact value)	0721-1002
R148,R149	R: METAL FILM 9.53k 1% (R148-R149 are a matched pair)	0721-9531
R150	R: METAL FILM 4.7k 2% 1/4W	0751-4722
R151,R152	R: METAL FILM 10.0k 1% (R151-R152 are a matched pair)	0721-1002
R153	R: METAL FILM 5.1k 2% 1/4W	0751-5122
R154,R155	R: METAL FILM 10.0k 1%	0721-1002
R156	R: METAL FILM 9.09k 1%	0721-9091
R157	R: METAL FILM 8.45k 1%	0721-8451
R158	R: VAR COMP 1k, 10 TURN	2100-0021
R159	R: METAL FILM 13.0k 1%	0721-1302
R160	R: METAL FILM 10k 2% 1/4W	0751-1032
R161	R: METAL FILM 270 2% 1/4W	0751-2712
R162	R: METAL FILM 10.0k 1%	0721-1002
R163	R: METAL FILM 49.9k 1%	0721-4992
R164	R: METAL FILM 6.04k 1%	0721-6041
R165,R166	R: METAL FILM 10.0k 1%	0721-1002
R167	R: METAL FILM 5.1k 2% 1/4W	0751-5122
R168	R: METAL FILM 10k 2% 1/4W	0751-1032
R169	R: METAL FILM 300 2% 1/4W	0751-3012
R170	R: METAL FILM 20.0k 1%	0721-2002
R171	R: METAL FILM 10.0k 1%	0721-1002
R172	R: METAL FILM 6.8k 2% 1/4W	0751-6822
R173	R: METAL FILM 300 2% 1/4W	0751-3012
RL1	RELAY: DA1a-12V	1600-0003
RL2	RELAY: JWD-171-14	1600-0004
S1	SWITCH: PUSHBUTTON - 2 POSITION	3101-0018

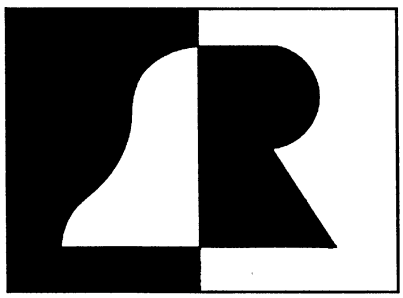
A2 BOARD TVM-210 CONT.

Reference Designation	Description	Part Number
U1	IC: 78L05CP	1826-0012
U2	IC: 79L05CP	1826-0017
U3	IC: LM318	1826-0010
U4,U5	IC: NE5534	1826-0025
U6,U7	IC: LM318	1826-0010
U8	IC: LM311	1826-0009
U9	IC: CA3028	1826-0022
U10	IC: 74HC4046	1822-0049
U11	IC: 74HC02	1822-0040
U12 thru U14	IC: 74HC73	1822-0044
U15	IC: 74HC00	1822-0039
U16	IC: 74HC02	1822-0040
U17,U18	IC: 74HC4316	1822-0051
U19,U20	IC: LM318	1826-0010
U21	IC: TL072	1826-0038
U22	IC: TL071	1826-0004
U23	IC: TL072	1826-0038
U24,U25	IC: LM318	1826-0010
U26	IC: MC34082	1826-0042
U27	IC: TL072	1826-0038
U28	IC: NE5532	1826-0037
U29	IC: TL071	1826-0004
U30 thru U33	IC: TL072	1826-0038



TVM-210
A5 POWER SUPPLY BOARD
COMPONENT LAYOUT

(USED BEGINNING SERIAL NUMBER 210143)



BELAR

ELECTRONICS LABORATORY, INC.

119 LANCASTER AVENUE
P.O. BOX 76
DEVON, PA 19333-0076 USA
VOICE (610) 687-5550 • FAX (610) 687-2686

http://www.belar.com
sales@belar.com
service@belar.com
parts@belar.com
support@belar.com