

# **Model TVM-220 BTSC PROGRAM MONITOR**

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## **Belar TV Stereo Modulation Monitor System**

### **Guide to Operations**

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**BELAR ELECTRONICS LABORATORY, INC.**

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## **WARRANTY AND ASSISTANCE**

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

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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-220 BTSC Program Monitor is a precision, solid state monitor, which when used in conjunction with the Belar TVM-210 BTSC Reference Monitor and TVM-100 or TVM-101 Precision TV Aural Monitor, provides all of the measurement capabilities necessary for TV stations engaged in multiplex stereo sound transmission.

The TVM-220 provides full time monitoring of L+R and stereo composite signal modulation levels. Both functions include digitally selectable peak indicators along with fixed 100% peak modulation indicators.

Exclusive microprocessor programmed Peaks-of-Frequent-Recurrence indicators allow extremely accurate measurement of preselected L+R and stereo composite modulation peaks occurring within a moving one minute window.

The TVM-220 includes circuitry to monitor the frequency lock of the stereo pilot signal to the horizontal scanning frequency of the video signal. These circuits illuminate a pilot LED on the TVM-210 to indicate frequency lock. A remote output is also available to drive a sync alarm LED to indicate loss of lock. If desired, these circuits may be disabled using a switch on the rear panel of the TVM-220.

Remote meter, peak flasher LED, pilot sync LED and +5 Vdc outputs are also included in the TVM-220. Provision is also made in the TVM-220 to automatically maintain the accuracy of the stereo composite meter and flasher readings in the presence of the SAP and/or PRO signals when they are sensed by the companion TVM-100 or TVM-101. Note: the TVM-100/101 must be equipped with the optional SAP/PRO injection board for the automatic offset feature to operate.

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The combined features of the TVM-100, 210 and 220 insure maximum performance from a BTSC TV Stereo Transmission System.

## **1-2 Physical Description**

The TVM-220 is constructed on a standard EIA 5-¼ X 9 inch rack mount panel. The meters, fixed and adjustable modulation level indicators, and their adjustment thumbwheels are located on the front panel. Factory adjustments are located within the unit. The sync input, sync detector switch, TVM-210 interface connector, power connection and remote outputs are located on individual connectors and a board edge connector on the rear panel of the TVM-220.

### 1-3 Electrical Description

L+R, Composite and Pilot Inputs . . . . . shielded multi-conductor cable from TVM-210

#### Sync Loop-Thru Input:

Impedance . . . . . 150k  $\Omega$  min.  
Return Loss . . . . . -45 dB min. @ 6 MHz  
Input Level . . . . . 1V pk-pk composite video  
4V pk-pk horizontal sync

#### Measurement Capabilities:

Main Channel (L+R) . . . . .  $\pm 0.1$  db, 50 Hz to 15 kHz  
Composite Signal (less pilot) . . . . .  $\pm 0.1$  db, 50 Hz to 45.5 kHz

#### Modulation Metering - Dedicated L+R and Stereo Composite Modulation Levels:

Deviation Indication . . . . . L+R: 100% @  $\pm 25$  kHz  
Stereo Composite: 100% @ 50 kHz  
Range . . . . . 0 to 133% modulation

Accuracy . . . . .  $\pm 2\%$  at all modulation levels

Characteristics . . . . . FCC defined semi-peak

#### Peak Modulation Indicators:

Fixed L+R . . . . . 100% @  $\pm 25$  kHz deviation  
Fixed Stereo Composite . . . . . 100% @  $\pm 50$  kHz deviation  
Adjustable L+R . . . . . adjustable in 1% increments from  
1% to 199%, 100% =  $\pm 25$  kHz deviation  
Adjustable Stereo Composite . . . . . adjustable in 1% increments from  
1% to 199%, 100% =  $\pm 50$  kHz deviation  
L+R PFR . . . . . measures within a moving one minute window.  
Follows setting of adjustable L+R indicator.

Stereo Composite PFR . . . . . measures within a moving one minute window.  
Follows setting of adjustable stereo composite indicator.

#### Remote Outputs:

L+R and COMP Meters . . . . . nominal loop resistance: 5 k  $\Omega$

Peak Modulation, Sync Alarm, and Pilot Sync LED's provide "open collector" outputs,  
capable of sinking 20 mA @ +5 Vdc

Dimensions . . . . . 5 $\frac{1}{4}$ "H X 9 $\frac{1}{4}$ "D X 19"W

Power . . . . . 15 watts, 117/234 Vac, 50/60 Hz

Shipping Weight . . . . . 13 lbs.

## **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-220 is shipped with an instruction book, three wire line cord, TVM-210 interface cable, 4 beige rack-mount screws with integral non-marring washers, and a 10 position, dual readout remote 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-220 Frequency and Modulation Monitor is designed to be mounted in a standard 19 inch rack. The program monitor may be mounted above the companion model TVM-210 Reference Monitor. When mounted in a rack, a slight air space should be provided above and below the unit. When the monitor is mounted above high heat generating equipment such as power amplifiers, consideration should be given to cooling requirements which allow a free movement of cooler air through and around the TVM-220. In no instance should the ambient chassis temperature be allowed to rise above 50 degrees C (122 degrees F). Mount the TVM-220 to the rack using the screws provided.

The Model TVM-220 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 220154 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 ( $\frac{1}{2}$ A 250V for 115Vac,  $\frac{1}{4}$ A 250V for 230Vac). Plug the line cord back in.

*Units with serial number 220155 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 ( $\frac{1}{2}$ A 250V for 115Vac,  $\frac{1}{4}$ A 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.

Connect the interface cable between J2 on the rear of the TVM-220 and J2 on the rear of the TVM-210. Either end of the cable may be connected to either unit. If it is desired to have the TVM-210/220 pair monitor the frequency lock of the 15,734 Hz stereo pilot to the horizontal sync frequency, connect either a 1V pk-pk composite video signal or a 4V pk-pk horizontal sync signal to J3 or J4 on the rear of the TVM-220 using a 75  $\Omega$  coaxial cable (RG-59). (Since J3 and J4 are a bridging loop-thru input, the video (sync) line may either be looped to another destination or

terminated at the TVM-220 with an external line termination.) Place the Sync Detector Switch (S2) on the rear of the TVM-220 in the ON position. If the frequency lock monitoring feature will not be used, place the Sync Detector Switch (S2) on the TVM-220 rear in the OFF position.

A remote Composite stereo modulation meter may be connected to pin 10 on the board edge connector and a remote L+R modulation meter may be connected to pin 9. The total loop resistance of each meter circuit (including the nominal 2300  $\Omega$  meter resistance) should be approximately 7.6 k  $\Omega$ .

Pins A, B, and 1 thru 6 may be connected to remote LED's. A current limiting resistor, typically 150  $\Omega$ , should be connected in series with each LED. A +5 VDC source is available on pins C and D. Ground is available on pins E thru L. (See section 2-5 for the individual LED pin-outs.)

If the Second Audio Program (SAP) and/or the Professional (PRO) channel are being used, the offset enable pin(s) on the TVM-220 must be connected to the TVM-100/101 baseband monitor to preserve accurate stereo composite meter and flasher indications on the TVM-220. The SAP offset enable is pin 8 and the PRO offset enable is pin 7. (See the TVM-100 or TVM-101 manual for the appropriate tie-point on the TVM-100 or 101.) Note: the TVM-100 or TVM-101 baseband monitor must be equipped with the optional SAP/PRO injection board in order for the automatic offset feature to work.



## 2-5 Interconnections

### TVM-220 REAR PANEL JACKS

Jack	Function
Power Entry Module	115 Vac (or 230 Vac) power input
J2	TVM-210 interconnect jack
J3/J4	1V pk-pk composite video or 4V pk-pk horizontal sync loop-thru input

### TVM-220 BOARD EDGE CONNECTOR

Pin	Function
1	Remote Stereo Composite PFR LED
2	Remote Adjustable Stereo Composite Peak LED
3	Remote 100% Stereo Composite Peak LED
4	Remote L+R PFR LED
5	Remote Adjustable L+R Peak LED
6	Remote 100% L+R Peak LED
7	PRO Offset Enable (from TVM-100)
8	SAP Offset Enable (from TVM-100)
9	Remote L+R Modulation Meter
10	Remote Stereo Composite Modulation Meter
A	Remote Pilot Sync LED
B	Remote Sync Alarm LED
C,D	+5 Vdc
E-L	Ground

### **3 Operation**

#### **3-1 Initial Operation**

1. Place the TVM-100 or TVM-101 Aural Monitor and the TVM-210 Reference Monitor into normal operation as outlined in their instruction books.
2. Depress the TVM-210 left meter function switch to TOTAL, the meter selector switch to PEAK and allow a 30 minute warm-up period.
3. Depress the CAL, SEMI and MTS pushbuttons on the TVM-100 or TVM-101. The TVM-100/101 meter and the TVM-210 left meter should read the same (100%). If not, refer to the TVM-210 initial operation section for the adjustment procedure to normalize the TVM-210 with the TVM-100/101. This procedure will only be necessary during the initial set-up or installation.
4. Once the TVM-100/101 and TVM-210 are properly normalized, the TVM-100/101 meter, and the left TVM-210 meter should read 100%.
5. The TVM-220 must be normalized to the TVM-210 so that the modulation indication of the two units agree. Depress the L+R pushbutton on the left meter function switch of the TVM-210. Apply a 1 kHz sinewave either to the aural exciter or directly to the TVM-210 so that the left meter indicates 100%. Adjust the L+R potentiometer on the rear panel of the TVM-220 so that the yellow 100% L+R LED on the front panel just remains lit. The L+R meter on the TVM-220 should now read 100%. With the L+R thumbwheel set at 100%, the adjustable L+R LED should just remain lit. With the thumbwheel set for 101%, the LED should extinguish.
6. Depress the L-R pushbutton on the right meter function switch of the TVM-220. Make sure the MTS/EQ switch on the back of the TVM-210 is depressed. Apply a L-R signal of 50 kHz deviation to the aural exciter or an L-R signal directly to the TVM-210 so the L-R meter on the TVM-210 reads exactly 100%. (This corresponds to a level at the DBX test jack on the front of the TVM-210 of 3.536 Vrms.) Adjust the Composite potentiometer on the rear panel of the TVM-220 so the 100% Composite LED just stays on. The Composite meter on the TVM-220 should now read 100%. With the Composite thumbwheel set at 100%, the Composite LED should just remain lit. With the thumbwheel set for 101%, the LED should extinguish.

### 3-2 Normal Operation

To monitor normal MTS programming, depress the QUASI-P, MTS, OPER and SEMI pushbuttons on the TVM-100 and the LEFT, RIGHT and PEAK push buttons on the TVM-210. (Note that the TVM-101 is not equipped with Quasi-P detection.)

### 3-3 Monitor Functions

1. L+R METER - Measures the modulation level of the L+R (or mono) channel. A 100% reading corresponds to  $\pm 25$  kHz deviation.
2. L+R 100% INDICATOR - Flashes when the L+R modulation level equals or exceeds 100% ( $\pm 25$  kHz deviation). The minimum flash duration is 150 ms.
3. L+R ADJUSTABLE INDICATOR - Flashes when the L+R modulation equals or exceeds the setting of the L+R thumbwheel. The minimum flash duration is 150 ms.
4. L+R PFR INDICATOR - Turns on when the L+R modulation level equals or exceeds the setting of the L+R thumbwheel more than 10 times within a moving one minute time window. The indicator remains on for one minute after the last overmodulation burst has been sensed or just until the modulation peak count for the previous 60 seconds drops below 10. It should be noted that, for the purposes of peak counting, successive peaks within a modulation burst are ignored if they occur within 5 milliseconds of the initial peak.
5. L+R THUMBWHEEL - Determines the modulation level at which the L+R ADJUSTABLE and PFR indicators flash. The thumbwheel range is 0 to 199%, with a 100% setting corresponding to  $\pm 25$  kHz deviation.
6. STEREO COMP METER - Measures the modulation level of the stereo composite signal (main channel plus stereo subchannel) less pilot. A 100% reading corresponds to  $\pm 50$  kHz deviation.
7. STEREO COMP 100% INDICATOR - Flashes when the stereo composite modulation level equals or exceeds 100% ( $\pm 50$  kHz deviation). The minimum flash duration is 150 ms.
8. STEREO COMP ADJUSTABLE INDICATOR - Flashes when the stereo composite modulation level equals or exceeds the setting of the STEREO COMP thumbwheel. The minimum flash duration is 150 ms.

9. STEREO COMP PFR INDICATOR - Turns on when the stereo composite modulation level equals or exceeds the setting of the STEREO COMP thumbwheel. The flasher characteristics are the same as the L+R PFR indicator except that 100% is  $\pm 50$  kHz deviation.
10. STEREO COMP THUMBWHEEL - Determines the modulation level at which the STEREO COMP ADJUSTABLE and PFR indicators flash. The thumbwheel range is 0 to 199%, with a 100% setting corresponding to  $\pm 50$  kHz deviation.
11. PILOT SYNC SENSING - When activated, the sync detector circuits in the TVM-220 sense the frequency lock between the stereo pilot and the horizontal scanning rate and illuminate the PILOT indicator on the TVM-210 front panel. Loss of lock causes the TVM-210 pilot indicator to blink. If a remote SYNC ALARM LED is tied to pin B, it will illuminate only when pilot is detected by the TVM-210 and it is not synchronized with horizontal sync.

### **3-4 Transmitter Measurements**

When making transmitter proof-of-performance measurements, remember that the TVM-220 metering and flasher circuits have a flat frequency response. 100% modulation corresponds to  $\pm 25$  kHz deviation.

The indications of the STEREO COMP meter and flashers depend on the transmitter mode.

In the transmitter MONO and EQUIV modes a L=R signal causing 100% modulation of the main channel will yield a 50% STEREO COMP meter reading. In MONO, this reading has no significance.

In the transmitter MTS mode the STEREO COMP meter reads the sum of the 75  $\mu$ sec pre-emphasized main channel and the BTSC compressed difference channel. Since the BTSC compressor follows a complex frequency and level dependant algorithm and the interleaving effects of the sum of the main and difference channels are complex, predicting the STEREO COMP steady state meter reading is a very involved process. Because of this, most transmitter proof measurements are made in the EQUIV mode.

## 4 Theory of Operation

### TVM-220 A1 Board

#### L+R METERING CIRCUITS

The demodulated L+R signal from the TVM-210 is fed through the interface cable to buffer amplifier U3. U3's output is fed to an adjustable voltage divider made up of R35, R36 and R37. This divider is used to calibrate the 100% modulation point on the L+R meter.

U16 and U17 make up a half wave peak detector with a controlled decay characteristic. With the parallel R-C network (R40/C23) connected to the cathode of output diode CR7 and feedback supplied via U17, U16 and U17 act as a half wave peak rectifier with FCC-defined "semi-peak" characteristics. The output of U17 is connected to the L+R meter through a series-parallel resistor network which controls meter damping. The output of U17 is also available through an RF isolation network to drive a remote L+R meter.

U3 also drives the L+R 100% modulation peak flasher circuits. U6 and U7 comprise a peak level comparator. An adjustable negative reference voltage is produced by voltage divider R7, R8 and R9. This reference is fed directly to U7 which senses negative-going signal peaks. U5 is a unity-gain inverting amplifier which supplies a positive reference voltage to U6 which senses positive-going signal peaks.

Since U5 produces a positive reference of exactly the same magnitude as the negative reference, very accurate peak level sensing occurs, independent of the modulation polarity.

If the reference voltage of U6 or U7 is exceeded by the modulation peaks, the output of U6 and/or U7 goes low triggering retriggerable monostable multivibrator in U14. U14's output goes high which turns on the front panel 100% L+R LED through Q1. R27 and C13 keep U14's output high for a minimum of 150 ms. so even the shortest duration overmodulation peak will be clearly displayed. Q1's output is also available at the board edge connector to drive a remote LED.

U3's output is also fed to the L+R adjustable and PFR flasher circuits. U8 and U9 are the positive and negative peak level comparators respectively.

A positive 5 volts is produced by voltage regulator U2 and fed to the inverting input of amplifier U4A through the variable resistance of the L+R thumbwheel switch. As the dialed modulation percentage on the thumbwheel is increased, the series resistance of the thumbwheel switch decreases. With decreased input resistance, the

gain of inverting amplifier U4A is increased, resulting in a more negative reference voltage at the output of U4A. Trimpot R4 calibrates the 100% modulation reference point on the thumbwheel.

The negative reference voltage at U4A's output is connected directly to U9 which senses negative going signal peaks. U4B is a unity gain inverting amplifier which supplies a positive reference voltage to U8 which senses positive going signal peaks. Since U4B produces a positive reference voltage of exactly the same magnitude as the adjustable negative reference voltage, very accurate peak level sensing occurs.

If the thumbwheel selected reference voltage of U8 or U9 is exceeded by the modulation peaks, the output of U8 and/or U9 goes low. This low initiates a non-retriggerable monostable multivibrator in U10A.

### STEREO COMPOSITE METERING CIRCUITS

The inverted, stereo composite signal (minus pilot) from the TVM-210 is amplified by inverting buffer amplifier U25, which brings it to the proper level for the composite peak flasher circuits.

U25's output goes to an adjustable voltage divider (R80, R81 & R82) and half wave peak rectifier (U26 and 27) which operates in the same manner as the L+R meter circuit explained previously. U27's output drives summing amplifier U35. R120 and R121 set U35's gain at unity for the composite signal. Since U35 is a summing amp, it inverts the composite signal.

## 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:

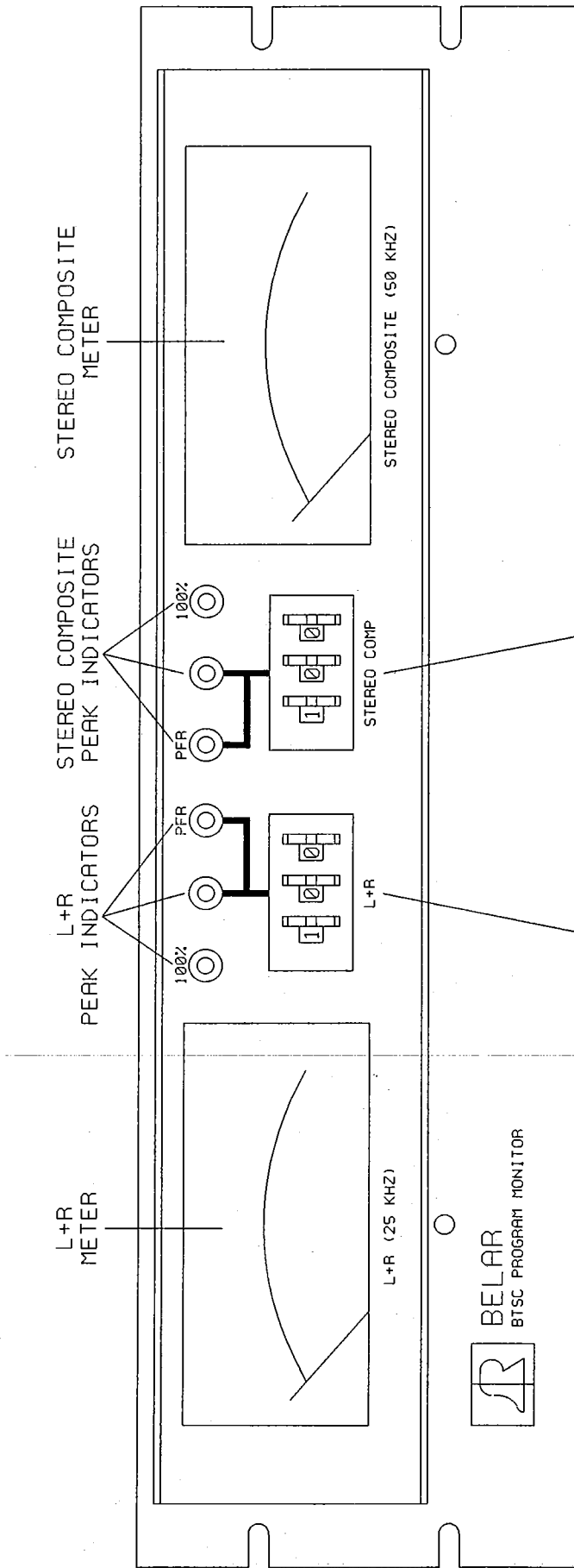
- a. Model number and serial number of unit.
- b. Description of part, *including the reference designation and location.*

### REFERENCE DESIGNATORS

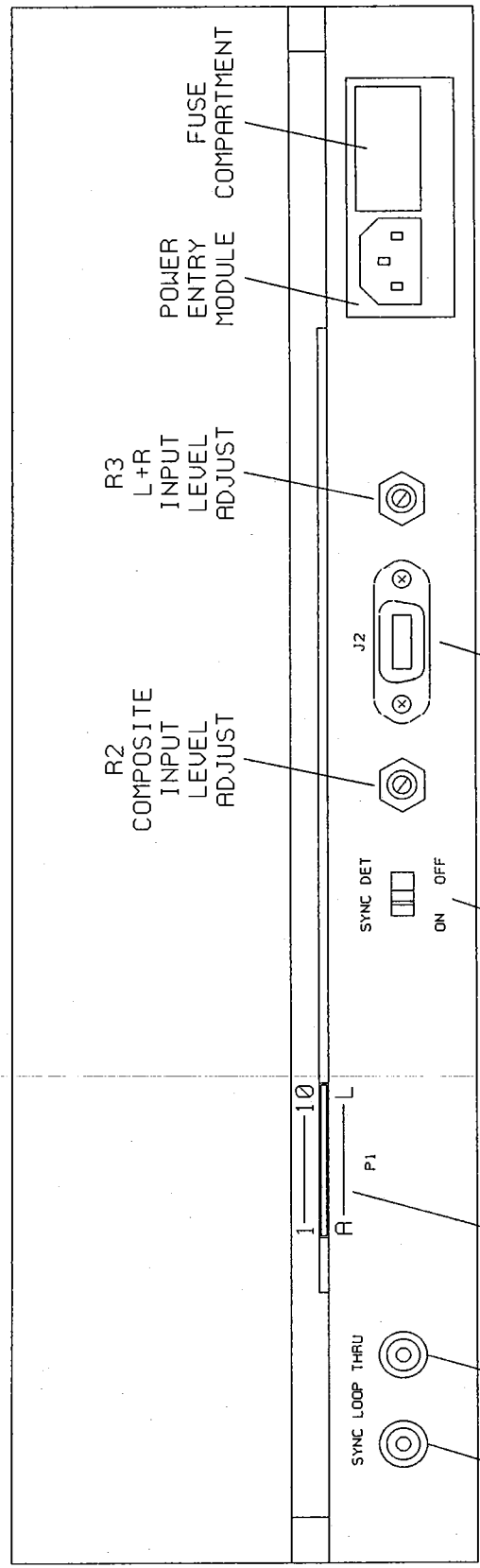
A	= assembly	J	= jack	S	= switch
BR	= diode bridge	L	= inductor	T	= transformer
C	= capacitor	M	= meter	TB	= terminal block
CR	= diode or LED	P	= plug	U	= integrated circuit
DS	= display or lamp	Q	= transistor	W	= cable
F	= fuse	R	= resistor	X	= socket
FL	= filter	RL	= relay	Y	= crystal
HDR	= header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

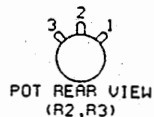
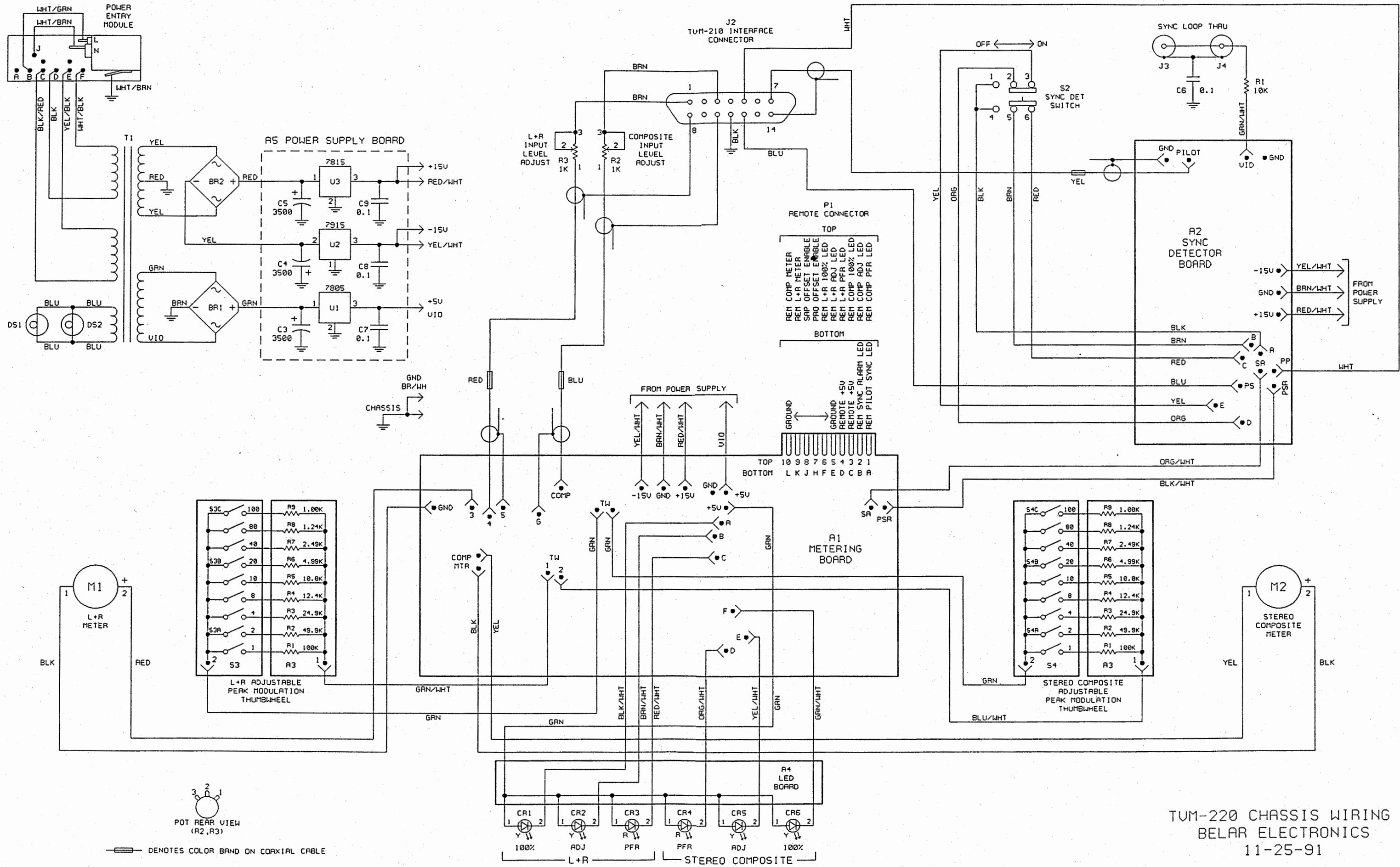


TUM-220 FRONT PANEL



TUM-220 CHASSIS REAR VIEW  
BELAR ELECTRONICS





— DENOTES COLOR BAND ON COAXIAL CABLE

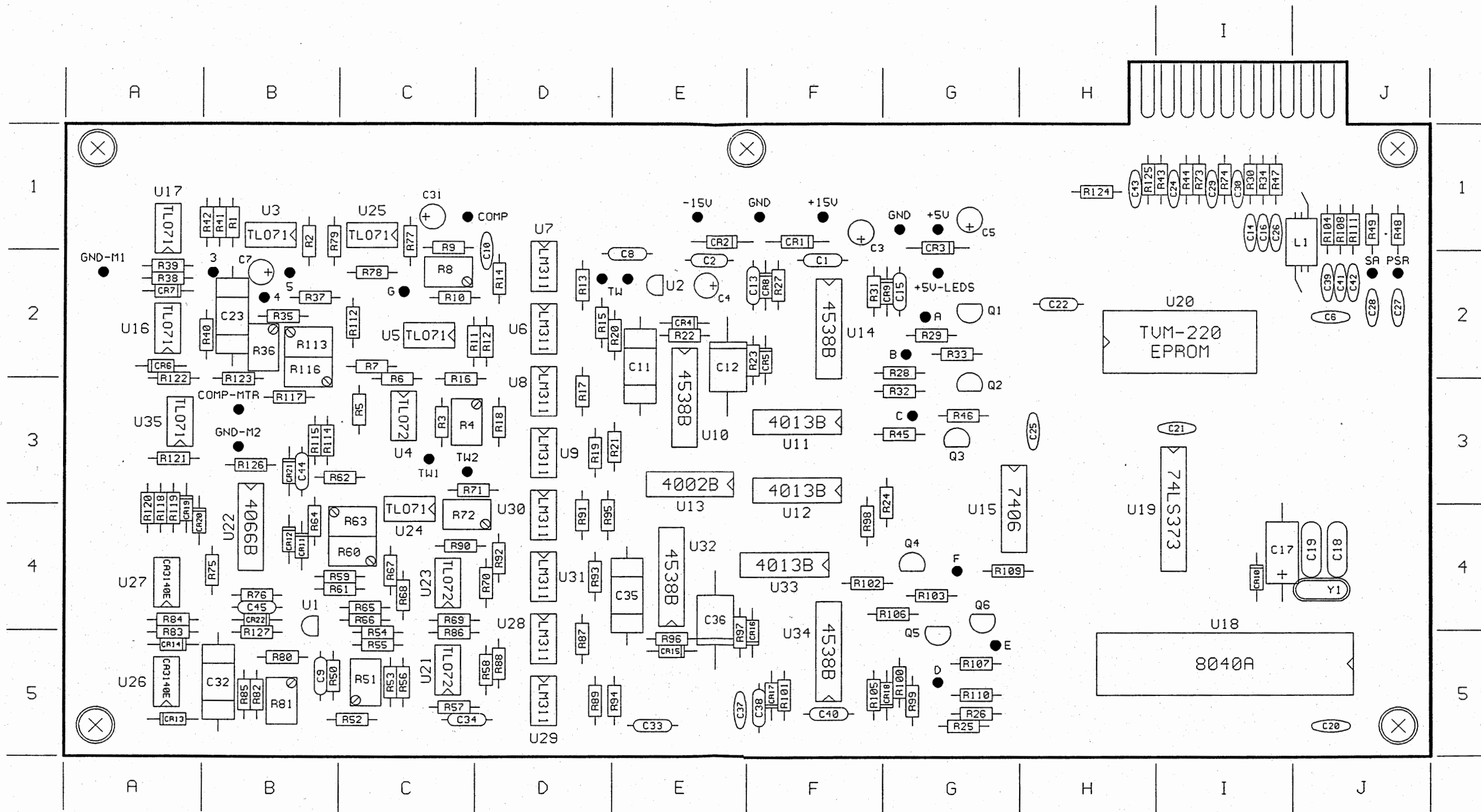
TVM-220 PARTS LISTS

MAIN CHASSIS

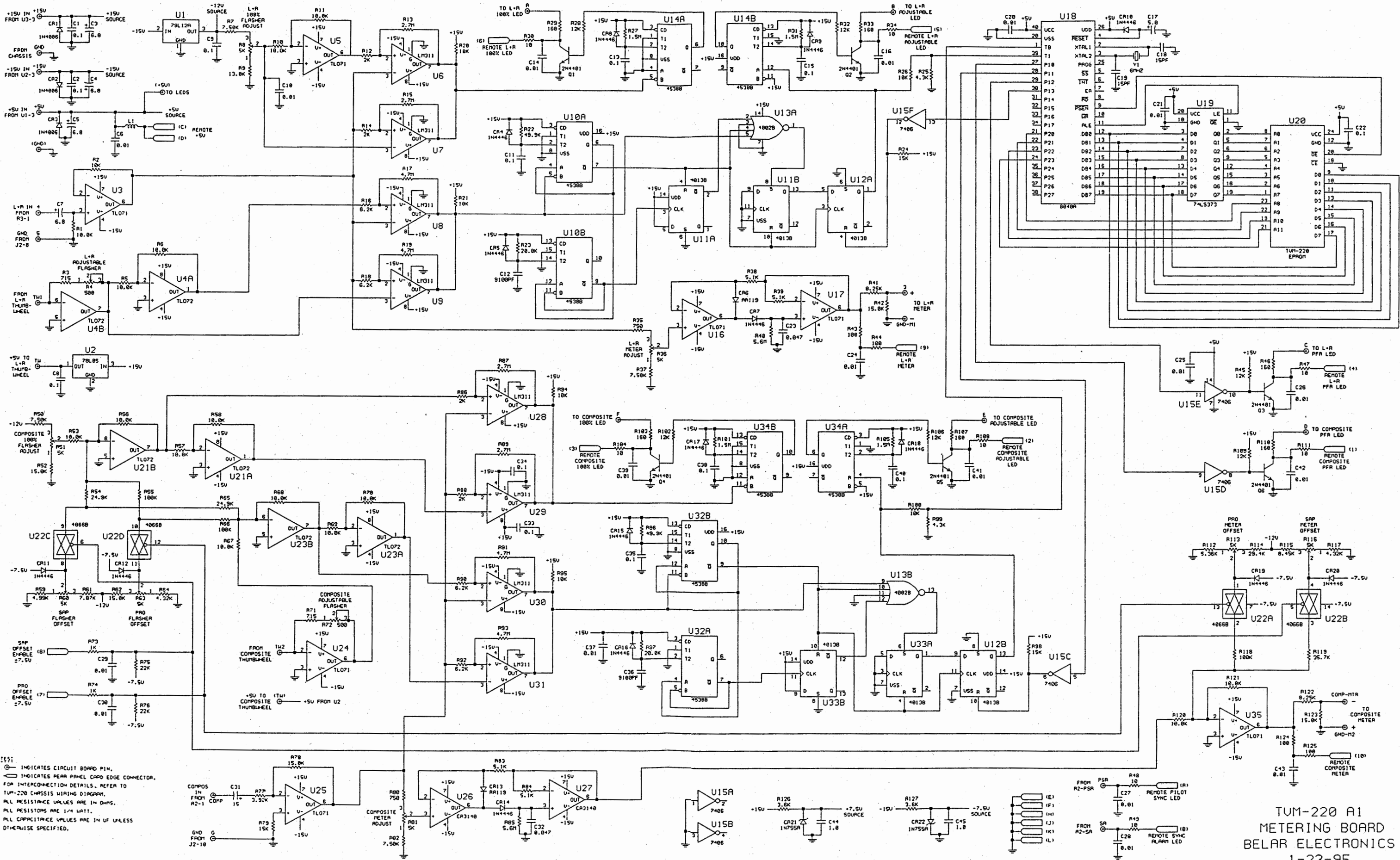
Reference Designation	Description	Part Number
BR1, BR2	DIODE: BRIDGE KBPC602 GI	1900-0025
C1, C2	C: FIXED CERAMIC 0.01uF 1.4kV (NOTE 2)	0151-0010
C3 thru C5	C: FIXED ELECT 3500uF 40V (NOTE 1)	0180-0026
C6	C: FIXED CERAMIC 0.1uF 50V	0151-0006
C7 thru C9	C: FIXED CERAMIC 0.1uF 50V (NOTE 1)	0151-0006
CR1, CR2	LED: YELLOW MV5353	1910-0002
CR3, CR4	LED: RED MV5053	1910-0001
CR5, CR6	LED: YELLOW MV5353	1910-0002
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
J1	JACK: POWER (NOTE 2)	0360-0010
J2	RECEPTACLE: AMPHENOL 14 PIN	0365-0026
J3, J4	JACK: BNC, INSULATED	0360-0006
M1, M2	METER: MOD 0-133%	1120-0012
R1	R: METAL FILM 10k 2% 1/4W	0751-1032
R2, R3	R: VAR COMP 1k 2W	2100-0007
S1	SWITCH: SLIDE 115/230V SELECTOR (NOTE 2)	3102-0002
S2	SWITCH: SLIDE	3102-0001
S3, S4	SWITCH ASSY: 3 DIGIT BCD THUMBWHEEL	3103-0002A
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 220127 - C3 thru C5 were 1000uF 50v (0180-0002) and C7 thru C9 were not used.

NOTE 2: Beginning serial number 220155, these parts are replaced by the 6J4 power entry module (0360-0020).



TUM-220 A1 BOARD  
 COMPONENT LAYOUT  
 BELAR ELECTRONICS

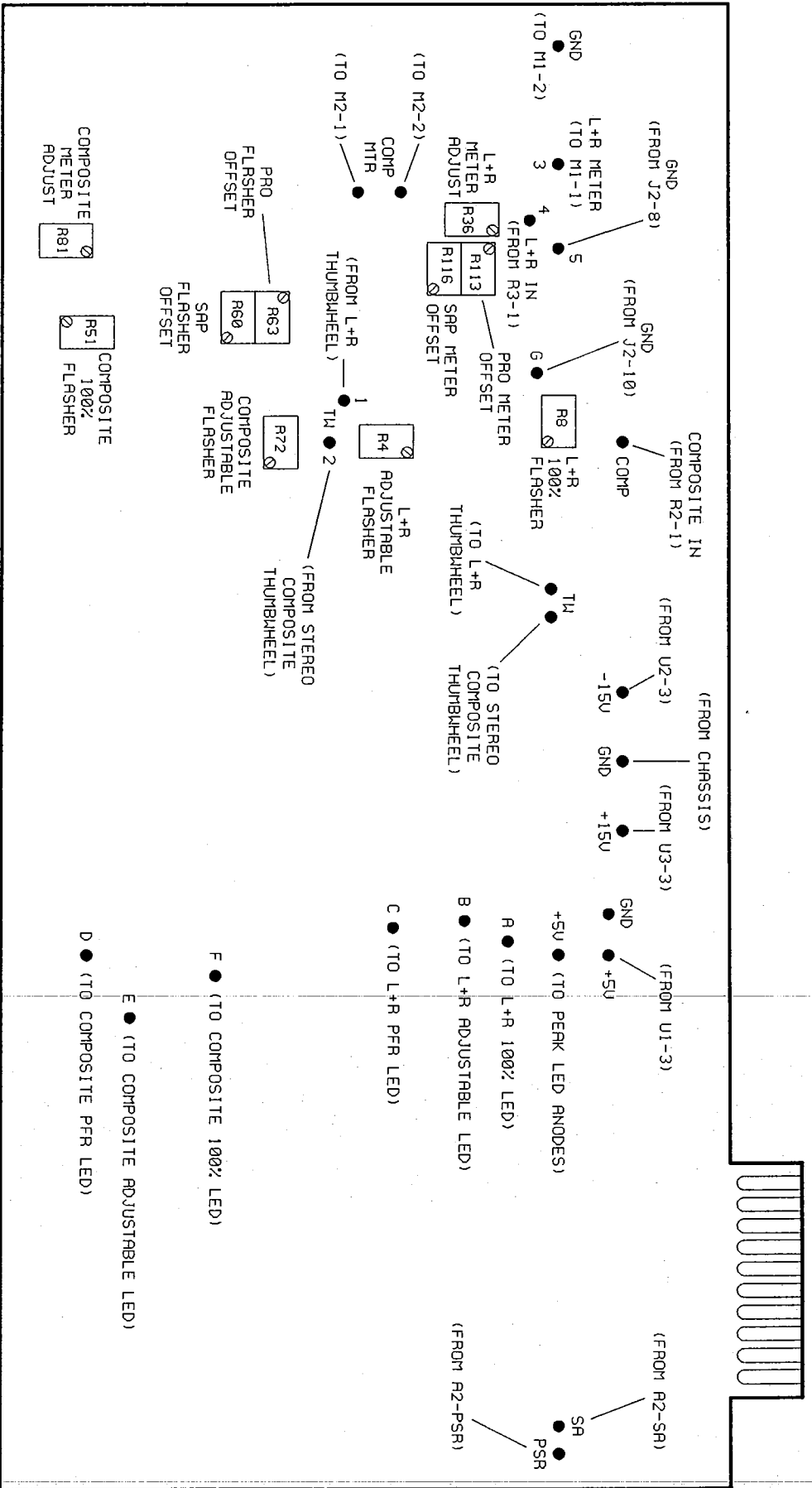


- NOTES:
1. INDICATES CIRCUIT BOARD PIN.
  2. INDICATES REAR PANEL CARD EDGE CONNECTOR.
  3. FOR INTERCONNECTION DETAILS, REFER TO TUM-220 CHASSIS WIRING DIAGRAM.
  4. ALL RESISTANCE VALUES ARE IN OHMS.
  5. ALL RESISTORS ARE 1/4 WATT.
  6. ALL CAPACITANCE VALUES ARE IN UF UNLESS OTHERWISE SPECIFIED.

TUM-220 A1  
 METERING BOARD  
 BELAR ELECTRONICS  
 1-23-95

TVM-220 A1 BOARD  
PART LOCATIONS

Desig/Loc		Desig/Loc		Desig/Loc		Desig/Loc		Desig/Loc		Desig/Loc	
C1	F2	CR3	G1	R19	D3	R67	C4	R115	B3	U35	A3
C2	E2	CR4	E2	R20	E2	R68	C4	R116	B2		
C3	F1	CR5	F2	R21	E3	R69	C4	R117	B3	Y1	J4
C4	E2	CR6	A2	R22	E2	R70	D4	R118	A4		
C5	G1	CR7	A2	R23	F2	R71	C3	R119	A4		pins
C6	J2	CR8	F2	R24	G3	R72	C4	R120	A4		----
C7	B2	CR9	G2	R25	G5	R73	I1	R121	A3	GND-M1	A2
C8	E2	CR10	I4	R26	G5	R74	I1	R122	A3	3	B2
C9	B5	CR11	B4	R27	F2	R75	B4	R123	B3	4	B2
C10	D1	CR12	B4	R28	G2	R76	B4	R124	H1	5	B2
C11	E2	CR13	A5	R29	G2	R77	C1	R125	H1	COMP-MTR	B3
C12	E2	CR14	A5	R30	I1	R78	C2	R126	B3	GND-M2	B3
C13	F2	CR15	E5	R31	F2	R79	B1	R127	B5	COMP	C1
C14	I1	CR16	F5	R32	G3	R80	B5			G	C2
C15	G2	CR17	F5	R33	G2	R81	B5	U1	B4	TW1	C3
C16	I1	CR18	G5	R34	I1	R82	B5	U2	E2	TW2	C3
C17	I4	CR19	A4	R35	B2	R83	A5	U3	B1	TW	D2
C18	J4	CR20	A4	R36	B2	R84	A4	U4	C3	TW	E2
C19	J4	CR21	B3	R37	B2	R85	B5	U5	C2	-15V	E1
C20	J5	CR22	B4	R38	A2	R86	C5	U6	D2	GND	F1
C21	I3			R39	A2	R87	D5	U7	D2	+15V	F1
C22	H2	L1	J1	R40	B2	R88	D5	U8	D3	GND	G1
C23	B2			R41	B1	R89	D5	U9	D3	+5V	G1
C24	I1	Q1	G2	R42	B1	R90	C4	U10	E3	+5V-LEDS	G2
C25	H3	Q2	G3	R43	I1	R91	D4	U11	F3	A	G2
C26	I1	Q3	G3	R44	I1	R92	D4	U12	F3	B	G2
C27	J2	Q4	G4	R45	G3	R93	D4	U13	E3	C	G3
C28	J2	Q5	G5	R46	G3	R94	E5	U14	F2	D	G5
C29	I1	Q6	G4	R47	I1	R95	D4	U15	G4	E	G5
C30	I1			R48	J1	R96	E5	U16	A2	F	G4
C31	C1	R1	B1	R49	J1	R97	E5	U17	A1	SA	J2
C32	B5	R2	B1	R50	B5	R98	F4	U18	I5	PSR	J2
C33	E5	R3	C3	R51	C5	R99	G5	U19	I4		
C34	C5	R4	C3	R52	C5	R100	G5	U20	I2		
C35	E4	R5	C3	R53	C5	R101	F5	U21	C5		
C36	E4	R6	C3	R54	C5	R102	F4	U22	B4		
C37	E5	R7	C2	R55	C5	R103	G4	U23	C4		
C38	F5	R8	C2	R56	C5	R104	J1	U24	C4		
C39	J2	R9	C1	R57	C5	R105	F5	U25	C1		
C40	F5	R10	C2	R58	D5	R106	G4	U26	A5		
C41	J2	R11	C2	R59	C4	R107	G5	U27	A4		
C42	J2	R12	D2	R60	C4	R108	J1	U28	D5		
C43	H1	R13	D2	R61	C4	R109	G4	U29	D5		
C44	B3	R14	D2	R62	C3	R110	G5	U30	D4		
C45	B4	R15	D2	R63	C4	R111	J1	U31	D4		
		R16	C3	R64	B4	R112	C2	U32	E4		
CR1	F1	R17	D3	R65	C4	R113	B2	U33	F4		
CR2	E1	R18	D3	R66	C4	R114	B3	U34	F5		



TUM-220 A1 BOARD  
 CONNECTIONS & ADJUSTMENTS  
 BELAR ELECTRONICS

## A1 BOARD TVM-220

Reference Designation	Description	Part Number
C1,C2	C: FIXED CERAMIC 0.1uF 50V	0151-0006
C3 thru C5	C: FIXED TANT 6.8uF 25V	0185-0002
C6	C: FIXED CERAMIC 0.01uF 100V	0151-0003
C7	C: FIXED TANT 6.8uF 25V	0185-0002
C8,C9	C: FIXED CERAMIC 0.1uF 50V	0151-0006
C10	C: FIXED CERAMIC 0.01uF 100V	0151-0003
C11	C: FIXED FILM 0.1uF 10% 80V	0120-1041
C12	C: FIXED POLY 9100pF 2.5% 160V	0130-9122
C13	C: FIXED CERAMIC 0.1uF 50V	0151-0006
C14	C: FIXED CERAMIC 0.01uF 100V	0151-0003
C15	C: FIXED CERAMIC 0.1uF 50V	0151-0006
C16	C: FIXED CERAMIC 0.01uF 100V	0151-0003
C17	C: FIXED ELEC 5.0uF 25V	0180-0007
C18,C19	C: FIXED MICA 15pF 5%	0140-1505
C20,C21	C: FIXED CERAMIC 0.01uF 100V	0151-0003
C22	C: FIXED CERAMIC 0.1uF 50V	0151-0006
C23	C: FIXED FILM 0.047uF 10% 200V	0120-4731
C24 thru C30	C: FIXED CERAMIC 0.01uF 100V	0151-0003
C31	C: FIXED TANT 15uF 15V	0185-0003
C32	C: FIXED FILM 0.047uF 10% 200V	0120-4731
C33,C34	C: FIXED CERAMIC 0.1uF 50V	0151-0006
C35	C: FIXED FILM 0.1uF 10% 80V	0120-1041
C36	C: FIXED POLY 9100pF 2.5% 160V	0130-9122
C37	C: FIXED CERAMIC 0.01uF 100V	0151-0003
C38	C: FIXED CERAMIC 0.1uF 50V	0151-0006
C39	C: FIXED CERAMIC 0.01uF 100V	0151-0003
C40	C: FIXED CERAMIC 0.1uF 50V	0151-0006
C41 thru C43	C: FIXED CERAMIC 0.01uF 100V	0151-0003
C44,C45	C: FIXED CERAMIC 1.0uF 50V	0151-0008
CR1 thru CR3	DIODE: 1N4006	1900-0016
CR4,CR5	DIODE: 1N4446	1900-0002
CR6	DIODE: AA119	1900-0001
CR7 thru CR12	DIODE: 1N4446	1900-0002
CR13	DIODE: AA119	1900-0001
CR14 thru CR20	DIODE: 1N4446	1900-0002
CR21,CR22	DIODE: 1N755A	1900-0023
L1	CHOKE: RF	9140-0011
Q1 thru Q6	TRANSISTOR: 2N4401	1850-0028

## A1 BOARD TVM-220 CONT.

Reference Designation	Description	Part Number
R1	R: METAL FILM 10.0k 1%	0721-1002
R2	R: METAL FILM 10k 2% 1/4W	0751-1032
R3	R: METAL FILM 715 1%	0721-7150
R4	R: VAR COMP 500, 10 TURN	2100-0027
R5,R6	R: METAL FILM 10.0k 1%	0721-1002
R7	R: METAL FILM 7.50k 1%	0721-7501
R8	R: VAR COMP 5k, 10 TURN	2100-0020
R9	R: METAL FILM 13.0k 1%	0721-1302
R10,R11	R: METAL FILM 10.0k 1%	0721-1002
R12	R: METAL FILM 2k 2% 1/4W	0751-2022
R13	R: FIXED CARBON 2.7M 5% 1/4W	0683-2755
R14	R: METAL FILM 2k 2% 1/4W	0751-2022
R15	R: FIXED CARBON 2.7M 5% 1/4W	0683-2755
R16	R: METAL FILM 6.2k 2% 1/4W	0751-6222
R17	R: FIXED CARBON 4.7M 5% 1/4W	0683-4755
R18	R: METAL FILM 6.2k 2% 1/4W	0751-6222
R19	R: FIXED CARBON 4.7M 5% 1/4W	0683-4755
R20,R21	R: METAL FILM 10k 2% 1/4W	0751-1032
R22	R: METAL FILM 49.9k 1%	0721-4992
R23	R: METAL FILM 20.0k 1%	0721-2002
R24	R: METAL FILM 15k 2% 1/4W	0751-1532
R25	R: METAL FILM 4.3k 2% 1/4W	0751-4322
R26	R: METAL FILM 10k 2% 1/4W	0751-1032
R27	R: FIXED CARBON 1.5M 5% 1/4W	0683-1555
R28	R: METAL FILM 12k 2% 1/4W	0751-1232
R29	R: METAL FILM 160 2% 1/4W	0751-1612
R30	R: METAL FILM 10 2% 1/4W	0751-1002
R31	R: FIXED CARBON 1.5M 5% 1/4W	0683-1555
R32	R: METAL FILM 12k 2% 1/4W	0751-1232
R33	R: METAL FILM 160 2% 1/4W	0751-1612
R34	R: METAL FILM 10 2% 1/4W	0751-1002
R35	R: METAL FILM 750 1%	0721-7500
R36	R: VAR COMP 5k, 10 TURN	2100-0020
R37	R: METAL FILM 7.50k 1%	0721-7501
R38,R39	R: METAL FILM 5.1k 2% 1/4W	0751-5122
R40	R: FIXED CARBON 5.6M 5% 1/4W	0683-5655
R41	R: METAL FILM 8.25k 1%	0721-8251
R42	R: METAL FILM 15.0k 1%	0721-1502
R43,R44	R: METAL FILM 100 2% 1/4W	0751-1012
R45	R: METAL FILM 12k 2% 1/4W	0751-1232
R46	R: METAL FILM 160 2% 1/4W	0751-1612
R47 thru R49	R: METAL FILM 10 2% 1/4W	0751-1002
R50	R: METAL FILM 7.50k 1%	0721-7501
R51	R: VAR COMP 5k, 10 TURN	2100-0020
R52	R: METAL FILM 15.0k 1%	0721-1502
R53	R: METAL FILM 10.0k 1%	0721-1002
R54	R: METAL FILM 24.9k 1%	0721-2492
R55	R: METAL FILM 100k 1%	0721-1003
R56 thru R58	R: METAL FILM 10.0k 1%	0721-1002

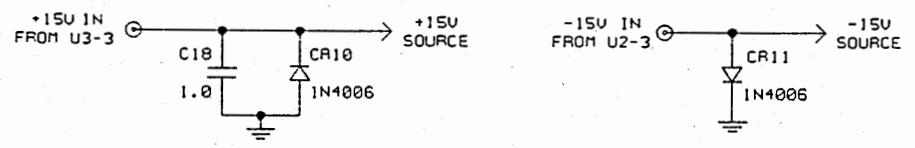
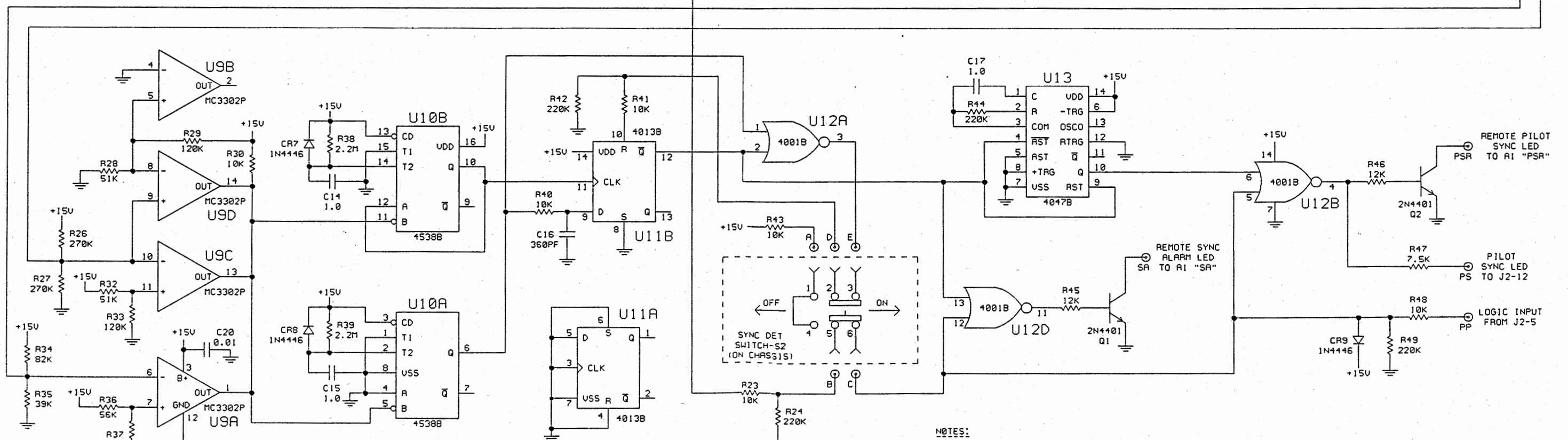
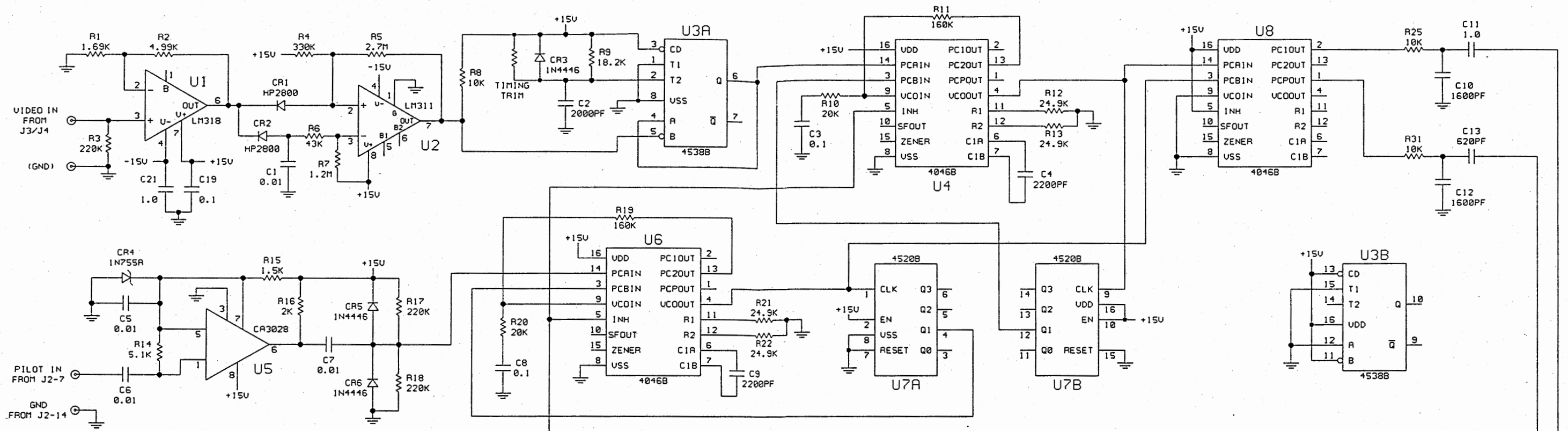


## A1 BOARD TVM-220 CONT.

Reference Designation	Description	Part Number
R59	R: METAL FILM 4.99k 1%	0721-4991
R60	R: VAR COMP 5k, 10 TURN	2100-0020
R61	R: METAL FILM 7.87k 1%	0721-7871
R62	R: METAL FILM 15.0k 1%	0721-1502
R63	R: VAR COMP 5k, 10 TURN	2100-0020
R64	R: METAL FILM 4.32k 1%	0721-4321
R65	R: METAL FILM 24.9k 1%	0721-2492
R66	R: METAL FILM 100k 1%	0721-1003
R67 thru R70	R: METAL FILM 10.0k 1%	0721-1002
R71	R: METAL FILM 715 1%	0721-7150
R72	R: VAR COMP 500, 10 TURN	2100-0027
R73,R74	R: METAL FILM 1k 2% 1/4W	0751-1022
R75,R76	R: METAL FILM 22k 2% 1/4W	0751-2232
R77	R: METAL FILM 3.92k 1%	0721-3921
R78	R: METAL FILM 15.0k 1%	0721-1502
R79	R: METAL FILM 15k 2% 1/4W	0751-1532
R80	R: METAL FILM 750 1%	0721-7500
R81	R: VAR COMP 5k, 10 TURN	2100-0020
R82	R: METAL FILM 7.50k 1%	0721-7501
R83,R84	R: METAL FILM 5.1k 2% 1/4W	0751-5122
R85	R: FIXED CARBON 5.6M 5% 1/4W	0683-5655
R86	R: METAL FILM 2k 2% 1/4W	0751-2022
R87	R: FIXED CARBON 2.7M 5% 1/4W	0683-2755
R88	R: METAL FILM 2k 2% 1/4W	0751-2022
R89	R: FIXED CARBON 2.7M 5% 1/4W	0683-2755
R90	R: METAL FILM 6.2k 2% 1/4W	0751-6222
R91	R: FIXED CARBON 4.7M 5% 1/4W	0683-4755
R92	R: METAL FILM 6.2k 2% 1/4W	0751-6222
R93	R: FIXED CARBON 4.7M 5% 1/4W	0683-4755
R94,R95	R: METAL FILM 10k 2% 1/4W	0751-1032
R96	R: METAL FILM 49.9k 1%	0721-4992
R97	R: METAL FILM 20.0k 1%	0721-2002
R98	R: METAL FILM 15k 2% 1/4W	0751-1532
R99	R: METAL FILM 4.3k 2% 1/4W	0751-4322
R100	R: METAL FILM 10k 2% 1/4W	0751-1032
R101	R: FIXED CARBON 1.5M 5% 1/4W	0683-1555
R102	R: METAL FILM 12k 2% 1/4W	0751-1232
R103	R: METAL FILM 160 2% 1/4W	0751-1612
R104	R: METAL FILM 10 2% 1/4W	0751-1002
R105	R: FIXED CARBON 1.5M 5% 1/4W	0683-1555
R106	R: METAL FILM 12k 2% 1/4W	0751-1232
R107	R: METAL FILM 160 2% 1/4W	0751-1612
R108	R: METAL FILM 10 2% 1/4W	0751-1002
R109	R: METAL FILM 12k 2% 1/4W	0751-1232
R110	R: METAL FILM 160 2% 1/4W	0751-1612
R111	R: METAL FILM 10 2% 1/4W	0751-1002
R112	R: METAL FILM 5.36k 1%	0721-5361
R113	R: VAR COMP 5k, 10 TURN	2100-0020
R114	R: METAL FILM 29.4k 1%	0721-2942

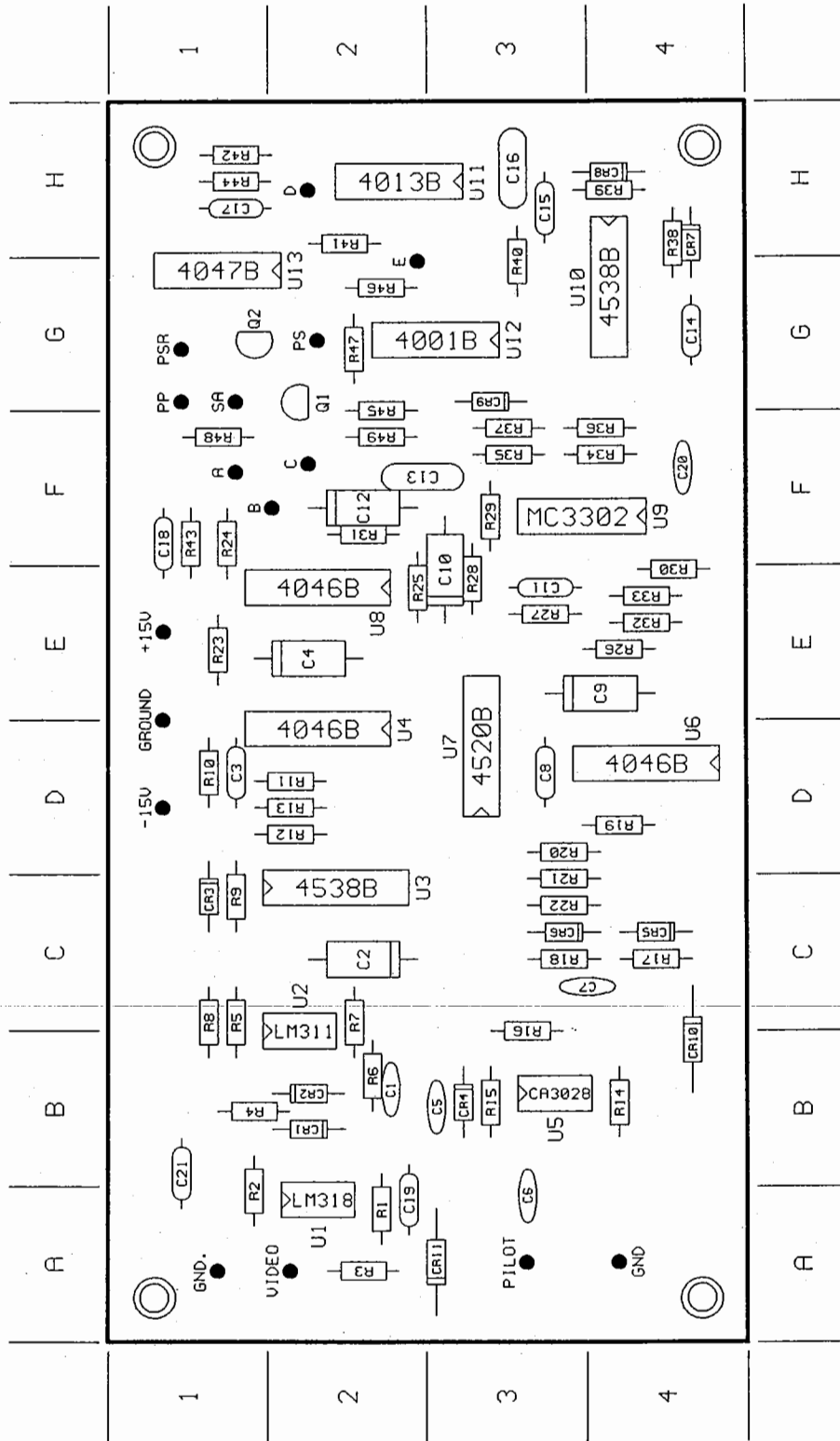
A1 BOARD TVM-220 CONT.

Reference Designation	Description	Part Number
R115	R: METAL FILM 8.45k 1%	0721-8451
R116	R: VAR COMP 5k, 10 TURN	2100-0020
R117	R: METAL FILM 4.32k 1%	0721-4321
R118	R: METAL FILM 100k 1%	0721-1003
R119	R: METAL FILM 35.7k 1%	0721-3572
R120,R121	R: METAL FILM 10.0k 1%	0721-1002
R122	R: METAL FILM 8.25k 1%	0721-8251
R123	R: METAL FILM 15.0k 1%	0721-1502
R124,R125	R: METAL FILM 100 2% 1/4W	0751-1012
R126,R127	R: METAL FILM 3.6k 2% 1/4W	0751-3622
U1	IC: 79L12CP	1826-0019
U2	IC: 78L05CP	1826-0012
U3	IC: TL071	1826-0004
U4	IC: TL072	1826-0038
U5	IC: TL071	1826-0004
U6 thru U9	IC: LM311	1826-0009
U10	IC: 4538	1822-0023
U11,U12	IC: 4013	1822-0003
U13	IC: 4002	1822-0001
U14	IC: 4538	1822-0023
U15	IC: 7406	1821-0028
U16,U17	IC: TL071	1826-0004
U18	IC: 8040A	1840-0006
U19	IC: 74LS373	1821-0032
U20	IC: TVM-220 EPROM	1840-0001A
U21	IC: TL072	1826-0038
U22	IC: 4066	1822-0018
U23	IC: TL072	1826-0038
U24,U25	IC: TL071	1826-0004
U26,U27	IC: CA3140E	1826-0001
U28 thru U31	IC: LM311	1826-0009
U32	IC: 4538	1822-0023
U33	IC: 4013	1822-0003
U34	IC: 4538	1822-0023
U35	IC: TL071	1826-0004
Y1	XTAL: 6.000MHZ	0411-0004



- NOTES:**
- ⊙ INDICATES CIRCUIT BOARD PIN.
  - FOR INTERCONNECTION DETAILS REFER TO TUM-220 CHASSIS WIRING DIAGRAM.
  - ALL RESISTANCE VALUES ARE IN OHMS.
  - ALL RESISTORS ARE 1/4 WATT.
  - ALL CAPACITANCE VALUES ARE IN UF UNLESS OTHERWISE SPECIFIED.
  - "TIMING TRIM" RESISTOR ONLY USED WHERE NEEDED.

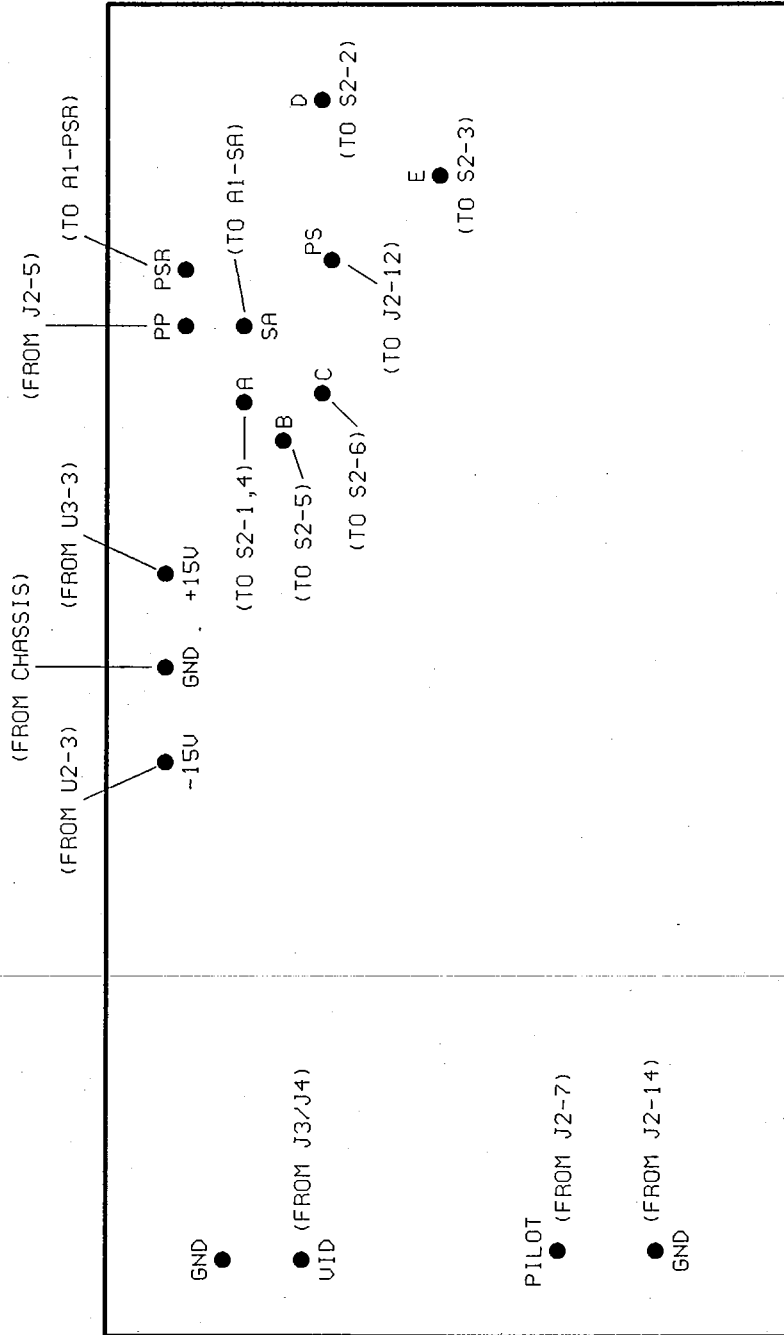
TUM-220 A2 BOARD  
 PILOT SYNC DETECTOR  
 & DRIVER BOARD  
 BELAR ELECTRONICS  
 2-21-94



TUM-220 A2 BOARD  
 COMPONENT LAYOUT  
 BELAR ELECTRONICS

TVM-220 A2 BOARD  
PART LOCATIONS

Desig/Loc	Desig/Loc	Desig/Loc	Desig/Loc	Desig/Loc	Desig/Loc	Desig/Loc	Desig/Loc	Desig/Loc	Desig/Loc	
C1	B2	C21	B1	R4	B1	R24	F1	R44	H1	pins
C2	C2			R5	C1	R25	E2	R45	F2	----
C3	D1	CR1	B2	R6	B2	R26	E4	R46	G2	GND-VID A1
C4	E2	CR2	B2	R7	C2	R27	E3	R47	G2	VIDEO A2
C5	B3	CR3	C1	R8	C1	R28	E3	R48	F1	PILOT A3
C6	A3	CR4	B3	R9	C1	R29	F3	R49	F2	GND A4
C7	C3	CR5	C4	R10	D1	R30	E4			-15V D1
C8	D3	CR6	C3	R11	D2	R31	F2	U1	A2	GROUND D1
C9	E4	CR7	H4	R12	D2	R32	E4	U2	C2	+15V E1
C10	E3	CR8	H4	R13	D2	R33	E4	U3	C2	A F1
C11	E3	CR9	G3	R14	B4	R34	F4	U4	D2	B F2
C12	F2	CR10	B4	R15	B3	R35	F3	U5	B3	C F2
C13	F2	CR11	A3	R16	B3	R36	F4	U6	D4	D H2
C14	G4			R17	C4	R37	F3	U7	D3	E G2
C15	H3	Q1	G2	R18	C3	R38	H4	U8	E2	PP G1
C16	H3	Q2	G1	R19	D4	R39	H4	U9	F3	PSR G1
C17	H1			R20	D3	R40	G3	U10	G4	SA G1
C18	F1	R1	A2	R21	C3	R41	H2	U11	H2	PS G2
C19	A2	R2	A1	R22	C3	R42	H1	U12	G3	
C20	F4	R3	A2	R23	E1	R43	F1	U13	G1	



TUM-220 A2 BOARD  
 CONNECTIONS  
 BELAR ELECTRONICS

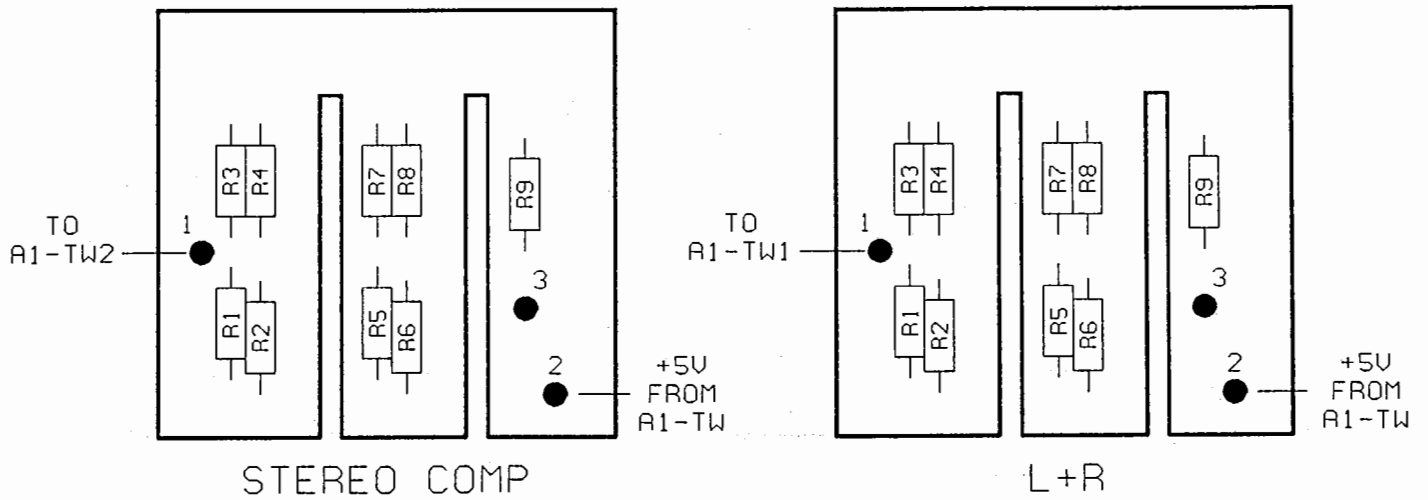
## A2 BOARD TVM-220

Reference Designation	Description	Part Number
C1	C: FIXED CERAMIC 0.01uF 100V	0151-0003
C2	C: FIXED POLY 2000pF 2.5% 160V	0130-2022
C3	C: FIXED CERAMIC 0.1uF 50V	0151-0006
C4	C: FIXED POLY 2200pF 2.5% 160V	0130-2222
C5 thru C7	C: FIXED CERAMIC 0.01uF 100V	0151-0003
C8	C: FIXED CERAMIC 0.1uF 50V	0151-0006
C9	C: FIXED POLY 2200pF 2.5% 160V	0130-2222
C10	C: FIXED POLY 1600pF 2.5% 160V	0130-1622
C11	C: FIXED CERAMIC 1.0uF 50V	0151-0008
C12	C: FIXED POLY 1600pF 2.5% 160V	0130-1622
C13	C: FIXED MICA 620pF 5%	0140-6215
C14, C15	C: FIXED CERAMIC 1.0uF 50V	0151-0008
C16	C: FIXED MICA 360pF 5%	0140-3615
C17, C18	C: FIXED CERAMIC 1.0uF 50V	0151-0008
C19	C: FIXED CERAMIC 0.1uF 50V	0151-0006
C20	C: FIXED CERAMIC 0.01uF 100V	0151-0003
C21	C: FIXED CERAMIC 1.0uF 50V	0151-0008
CR1, CR2	DIODE: HP5082-2800	1900-0026
CR3	DIODE: 1N4446	1900-0002
CR4	DIODE: 1N755A	1900-0023
CR5 thru CR9	DIODE: 1N4446	1900-0002
CR10, CR11	DIODE: 1N4006	1900-0016
Q1, Q2	TRANSISTOR: 2N4401	1850-0028
R1	R: METAL FILM 1.69k 1%	0721-1691
R2	R: METAL FILM 4.99k 1%	0721-4991
R3	R: METAL FILM 220k 2% 1/4W	0751-2242
R4	R: METAL FILM 330k 2% 1/4W	0751-3342
R5	R: FIXED CARBON 2.7M 5% 1/4W	0683-2755
R6	R: METAL FILM 43k 2% 1/4W	0751-4332
R7	R: FIXED CARBON 1.2M 5% 1/4W	0683-1255
R8	<del>R: METAL FILM 10k 2% 1/4W</del>	<del>0751-1032</del>
R9	R: METAL FILM 18.2k 1%	0721-1822
R10	R: METAL FILM 20k 2% 1/4W	0751-2032
R11	R: METAL FILM 160k 2% 1/4W	0751-1642
R12, R13	R: METAL FILM 24.9k 1%	0721-2492
R14	R: METAL FILM 5.1k 2% 1/4W	0751-5122
R15	R: METAL FILM 1.5k 2% 1/4W	0751-1522
R16	R: METAL FILM 2k 2% 1/4W	0751-2022
R17, R18	R: METAL FILM 220k 2% 1/4W	0751-2242
R19	R: METAL FILM 160k 2% 1/4W	0751-1642
R20	R: METAL FILM 20k 2% 1/4W	0751-2032
R21, R22	R: METAL FILM 24.9k 1%	0721-2492
R23	R: METAL FILM 10k 2% 1/4W	0751-1032
R24	R: METAL FILM 220k 2% 1/4W	0751-2242
R25	R: METAL FILM 10k 2% 1/4W	0751-1032
R26, R27	R: METAL FILM 270k 2% 1/4W	0751-2742

## A2 BOARD TVM-220 CONT.

Reference Designation	Description	Part Number
R28	R: METAL FILM 51k 2% 1/4W	0751-5132
R29	R: METAL FILM 120k 2% 1/4W	0751-1242
R30, R31	R: METAL FILM 10k 2% 1/4W	0751-1032
R32	R: METAL FILM 51k 2% 1/4W	0751-5132
R33	R: METAL FILM 120k 2% 1/4W	0751-1242
R34	R: METAL FILM 82k 2% 1/4W	0751-8232
R35	R: METAL FILM 39k 2% 1/4W	0751-3932
R36	R: METAL FILM 56k 2% 1/4W	0751-5632
R37	R: METAL FILM 82k 2% 1/4W	0751-8232
R38, R39	R: FIXED CARBON 2.2M 5% 1/4W	0683-2255
R40, R41	R: METAL FILM 10k 2% 1/4W	0751-1032
R42	R: METAL FILM 220k 2% 1/4W	0751-2242
R43	R: METAL FILM 10k 2% 1/4W	0751-1032
R44	R: METAL FILM 220k 2% 1/4W	0751-2242
R45, R46	R: METAL FILM 12k 2% 1/4W	0751-1232
R47	R: METAL FILM 7.5k 2% 1/4W	0751-7522
R48	R: METAL FILM 10k 2% 1/4W	0751-1032
R49	R: METAL FILM 220k 2% 1/4W	0751-2242
U1	IC: LM318	1826-0010
U2	IC: LM311	1826-0009
U3	IC: 4538	1822-0023
U4	IC: 4046	1822-0016
U5	IC: CA3028AE	1826-0034
U6	IC: 4046	1822-0016
U7	IC: 4520	1822-0055
U8	IC: 4046	1822-0016
U9	IC: MC3302P	1826-0005
U10	IC: 4538	1822-0023
U11	IC: 4013	1822-0003
U12	IC: 4001	1822-0015
U13	IC: 4047	1822-0017



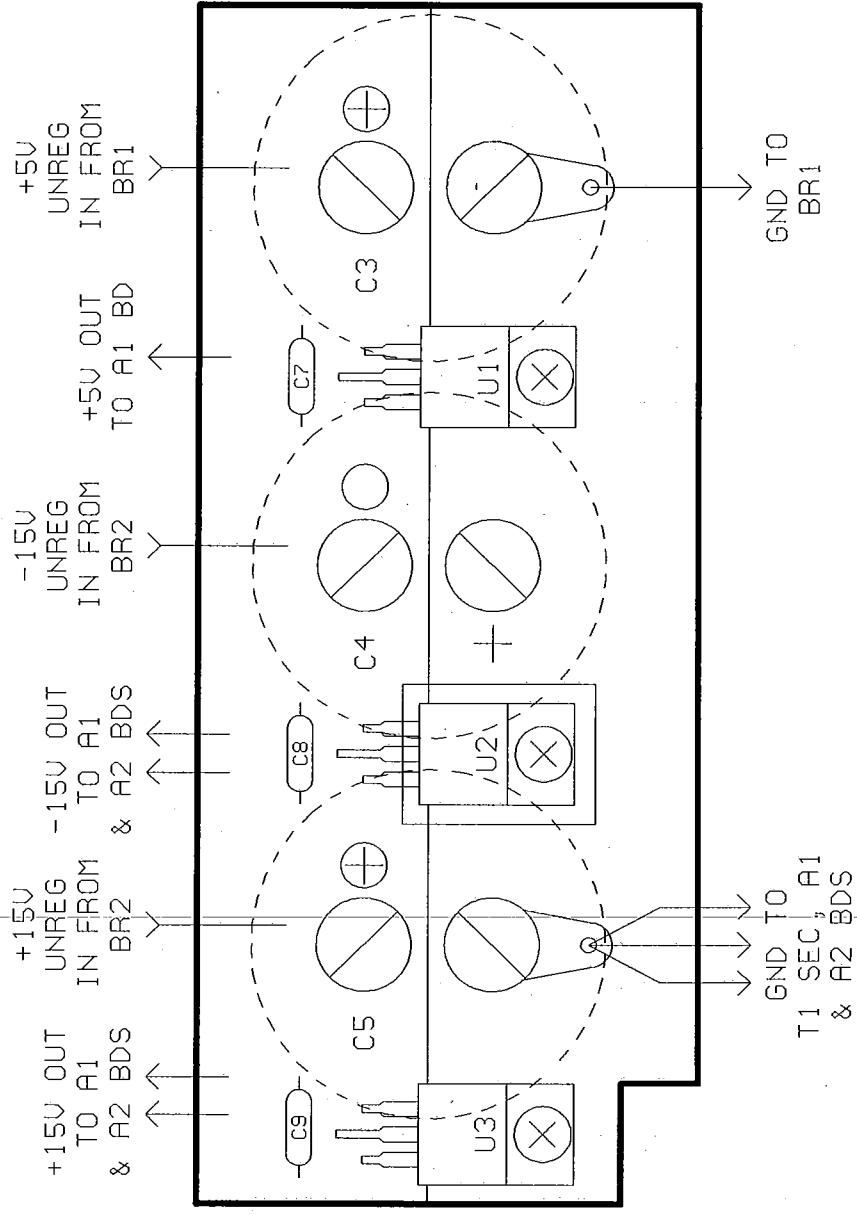


### TVM-220 A3 BOARDS

SEE TVM-220 CHASSIS WIRING DRAWING FOR A3 BOARD SCHEMATIC

#### TVM-220 - A3 BOARD

Reference Designation	Description	Part Number
R1	R: METAL FILM 100k 1%	0721-1003
R2	R: METAL FILM 49.9k 1%	0721-4992
R3	R: METAL FILM 24.9k 1%	0721-2492
R4	R: METAL FILM 12.4k 1%	0721-1242
R5	R: METAL FILM 10.0k 1%	0721-1002
R6	R: METAL FILM 4.99k 1%	0721-4991
R7	R: METAL FILM 2.49k 1%	0721-2491
R8	R: METAL FILM 1.24k 1%	0721-1241
R9	R: METAL FILM 1.00k 1%	0721-1001



TUM-220  
 A5 POWER SUPPLY BOARD  
 COMPONENT LAYOUT