

TU-170

RTTY Terminal Unit



FLESHER CORP., 507 JACKSON STREET, TOPEKA, KANSAS 66603

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TU-170

RTTY Terminal Unit

Assembly Manual

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TU-170 CONSTRUCTION NOTE

To provide fuse protection for the loop power supply, a 1/8 amp fuse, a fuseholder, and hardware to mount fuseholder have been supplied. To install fuse and holder, please make the following changes or additions to the instruction manual:

- A. Page 3 (4th Instruction): Do not install R74. Discard the 47 ohm resistor supplied.
- B. Page 3, after instruction reading "() Install transformers T1 and T2", add this step:
 - () Mount a fuseholder with #6 hardware on the circuitboard-side of the heatsink in the hole provided above T1.
- C. Page 5, add these steps:
 - () Prepare a 4" length of red wire. Solder one end to one of the holes marked for R74. Connect the other end to the nearest terminal of the heatsink mounted fuse holder.
 - () Prepare a 6" length of red wire. Solder one end to the remaining hole marked for R74. Connect the other end to the remaining terminal of the heatsink mounted fuse holder.
 - () Install the 1/8 amp fuse in the heatsink mounted fuse holder.

Introduction

In some instructions, you are to "prepare" a length of wire. In each case, cut the wire to the length specified, and strip 1/4" of insulation from each end. Tin each end and connect as instructed. For striped wires, white/blue means a white wire with a blue stripe.

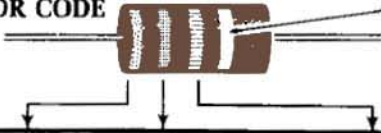
Soldering abbreviations are given in the steps. [NS] means not to solder because other wires will be added later. [S3] means to solder the connection. The number following the "S" tells how many wires are to be soldered at the connection.

Components which mount to the chassis are identified in the pictorial labeled CHASSIS ASSEMBLY. The numbers beside each component indicate the numbering of their terminals. This pictorial is a view from above with the front and rear panels "unfolded". Connections to the components are identified with the component designation followed by the terminal number, such as SW2(3), meaning switch SW2, terminal number three.

Due to the small foil area around the circuit board holes and the small areas between conductor paths, it will be necessary to use upmost care to prevent solder bridges between adjacent foil areas. Use only a minimum amount of solder and do not use larger than a 25 watt soldering iron with a small tip, and apply heat only long enough to make a good solder connection.

In these instructions, the circuit board will be assembled first, then set aside while the cabinet components are mounted and wired. In the last series of steps, the circuit board will be wired into the cabinet. Alignment instructions follow final assembly.

RESISTOR COLOR CODE



TOLERANCE
Gold 5%
Silver 10%
No Band 20%

COLOR	1st DIGIT	2nd DIGIT	MULTIPLY BY
BLACK	0	0	1
BROWN	1	1	10
RED	2	2	100
ORANGE	3	3	1,000
YELLOW	4	4	10,000
GREEN	5	5	100,000
BLUE	6	6	1,000,000
VIOLET	7	7	10,000,000
GRAY	8	8	100,000,000
WHITE	9	9	1,000,000,000
GOLD			.1
SILVER			.01

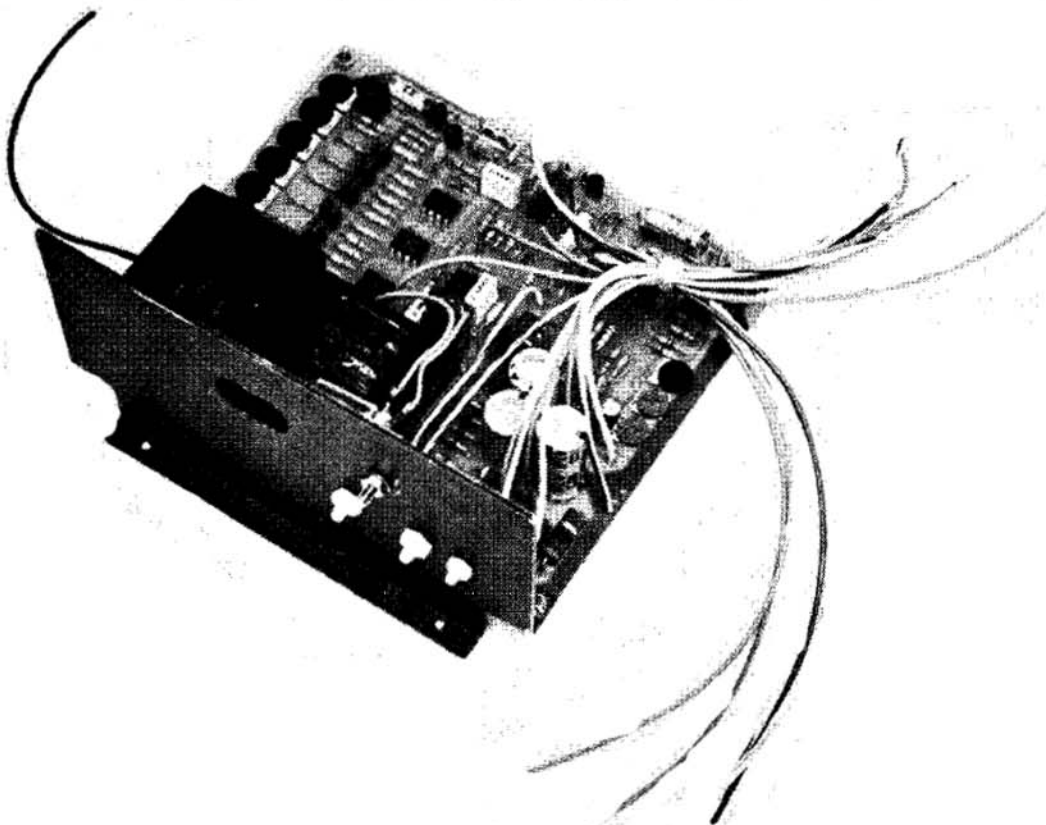
Circuit Board Assembly

Use the component location drawing and the parts list (page 12 & 13) to assemble the circuit board. Follow the sequence below for easy assembly.

- () Install all jumper wires on the board. (There are 8.)
- () Install all diodes.
- () Install all resistors except R58, R59, and R74
- () Install resistors R58, R59
- () Verify that all resistors are installed correctly.
- () Install all integrated circuits except IC9, and IC10.
- () Install all trimmer potentiometers.
- () Install all capacitors except C33, C34, and C35.
- () Install all transistors except Q6.
- () Mount the heatsink to the circuit board with the mounting tabs of the heatsink on the component side of the circuit board. Use #6 hardware.
- () Fasten the threaded spacers to the circuit board at the remaining two corner mounting holes. Use 4-40 by 1/4" screws.
- () Bend the leads of IC 10 so that the metal side will be flat against the heatsink when it is installed. Use a mylar insulator and #6 nylon hardware to mount the IC. Be careful not to over tighten the nylon hardware. Solder the IC leads to the board.
- () Bend the leads of IC9 in a similar manner, and install it just as IC10.
- () Bend the leads of Q6 in a similar manner, and install it using #4 nylon hardware and an insulator.
- () Install transformers T1 and T2.
- () Install capacitors C33, C34, and C35. Observe polarity.
- () Mount the lamp holder to the heatsink as shown with #6 hardware. Also mount the fuseholder.
- () Prepare a 3" length of tan wire. Solder one end to circuit board terminal Y, and the other end to LH(1) [S1].
- () Prepare a 3 1/2" length of tan wire. Solder one end to circuit board terminal X, and the other end to LH(2) [S1].

- () Prepare a 4" length of white/blue wire. Solder one end to circuit board terminal G, and the other end to circuit board terminal P.
- () Prepare a 10 1/2" of white/blue wire. Solder one end to circuit board terminal N. Leave the other end free.
- () Prepare a 6" length of white wire. Solder one end to circuit board terminal L1. Leave the other end free.
- () Prepare a 5 1/2" length of black wire. Solder one end to circuit board terminal L2. Leave the other end free.
- () Prepare a 9" length of white/red wire. Solder one end to circuit board terminal R. Leave the other end free.
- () Prepare a 8" length of white/orange wire. Solder one end to circuit board terminal S. Leave the other end free.
- () Prepare a 7 1/2" length of orange wire. Solder one end to circuit board terminal T. Leave the other end free.
- () Prepare a 9 1/2" length of red wire. Solder one end to circuit board terminal U. Leave the other end free.
- () Prepare a 6" length of white/black wire. Solder one end to circuit board terminal G1. Leave the other end free.
- () Prepare a 7" length of white/yellow wire. Solder one end to circuit board terminal M. Leave the other end free.
- () Prepare a 5 1/2" length of pink wire. Solder one end to circuit board terminal L. Leave the other end free.
- () Prepare a 9 1/2" length of green wire. Solder one end to circuit board terminal A. Leave the other end free.
- () Prepare a 8 1/2" length of white/green wire. Solder one end to circuit board terminal B. Leave the other end free.
- () Prepare a 12 1/2" length of grey wire. Solder one end to circuit board terminal C. Leave the other end free.
- () Prepare a 6" length of brown wire. Solder one end to circuit board terminal D. Leave the other end free.
- () Prepare a 9 1/2" length of violet wire. Solder one end to circuit board terminal E. Leave the other end free.
- () Prepare a 10" length of light blue wire. Solder one end to circuit board terminal F. Leave the other end free.

- () Prepare a 15 1/2" length of white/violet wire. Solder one end to circuit board terminal J. Leave the other end free.
- () Prepare a 5" length of dark blue wire. Solder one end to circuit board terminal H. Leave the other end free.
- () Prepare a 5" length of tan wire. Solder one end to circuit board terminal K. Leave the other end free.
- () Verify all connections and examine closely for solder bridges, poor connections, etc.
- () Route all of the free wires, except the white and the black wires, as shown in the photograph. Make sure the bundle of wires does not interfere in adjusting potentiometers P7, P8, and P9. Use a cable tie to secure the bundle.
- () Separate the bundle of wires so that the following wires are routed toward the heatsink:
 white/blue, violet, white/violet, grey
- () The remaining wires should be routed in the opposite direction.
- () This completes the wiring of the circuit board. Temporarily set the board aside.



Chassis Assembly

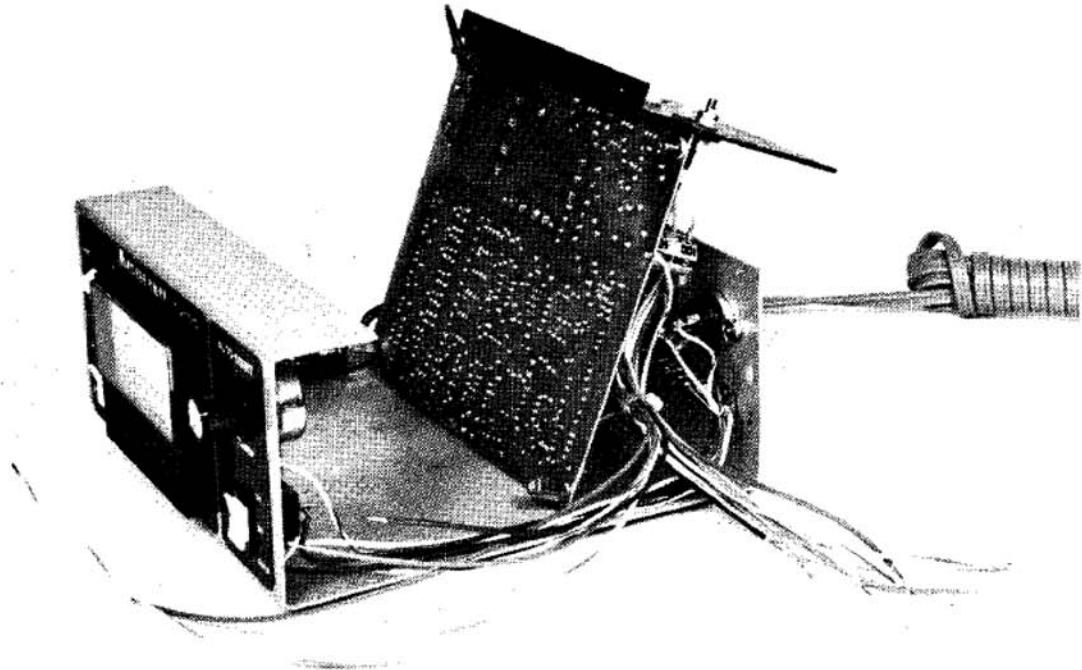
- () Refer to the CHASSIS ASSEMBLY drawing to locate the position of the parts to be installed on the chassis in the next few instructions.
- () Mount the two position rocker switch in location SW1.
- () Mount the paddle switch in location SW2.
- () Mount the three position rocker switch in location SW3.
- () Place the thick spacer supplied over the shaft of the panel mount potentiometer, and mount it in location P10.
- () Rotate the shaft of P10 full counter-clockwise, and fasten the knob with the pointer in the 7 O'clock position.
- () Mount the fuse holder in position FU using #6 hardware.
- () Mount the three lug solder terminal in position TS. Use #6 hardware.
- () Mount the nine-lug screw terminal on the outside of the chassis. Use #6 hardware and use a ground lug under each nut.
- () Mount the five-pin socket as shown in position J1. Use #4 hardware with no lock washers.
- () Mount the single circuit 1/4" phone jack in the position J2. Use a flatwasher under the nut.
- () Mount the two circuit 1/4" phone jack in position J3. Use a flatwasher under the nut.
- () Mount the solid state relay in position SSR. Mount with the "output" terminals nearest the square cut-out. Use #4 hardware with lockwashers under the nuts.
- () Snap the auxilliary AC power receptical in the square hole with the black and white wires at the top.
- () Mount the meter using #4 hardware.
- () Cut a 1 1/2" length of bare wire and connect from TB(1) [S1] to GG1 [NS].
- () Cut another 1 1/2" length of bare wire and connect from TB(9) [S1] to GG2 [NS].
- () Prepare a 1 1/2" length of white/black wire and connect from SSR(2) [S1] to GG2 [S2]

- () Prepare a 2" length of white/black wire. Connect it from J1(1) [S1] to GG1 [NS].
- () Prepare a 8" length of white/black wire. Connect it from GG1 [NS] to P10(1) [NS].
- () Prepare a 4" length of white/black wire. Connect it from P10(1) [S2] to M(2) [S1].
- () Prepare a 7 1/2" length of white/blue wire. Connect it from SW2(3) [S1] to SW3(3) [NS].
- () Prepare a 15" length of brown wire. Connect it from SW2(6) [S1] to J1(4) [S1].
- () Prepare a 15" length of yellow wire. Connect it from SW2(5) [S1] to J1(3) [S1].
- () Prepare a 12" length of violet wire. Connect it from SW3(2) [S1] to SSR(1) [S1].
- () Prepare a 2 1/2" length of black wire. Connect it from SW1(3) [S1] to FU(1) [S1].
- () Prepare a 5 1/2" length of black wire. Connect it from SW1(2) [S1] to TS(1) [NS].
- () Prepare a 4" length of white wire. Connect it from TS(3) [NS] to SSR(3) [S1].
- () Install the line cord with the plastic strain relief. Use a pair of pliers to close the strain relief around the cord approximately 3" from the end. Press the strain relief and cord through the oval hole.
- () Connect the ribbed grey wire of the line cord to TS(3) [NS].
- () Connect the green wire of the line cord to TS(2) [NS].
- () Connect the remaining grey wire of the line cord to TS(1) [NS].
- () Cut the green wire from J4 to 3 1/3" length. Strip back 3/8" of insulation and tin with solder. Connect this wire to TS(2) [NS].
- () Cut the white wire from J4 to 2" length, and strip 3/8" of insulation from the end. Tin the wire with solder, and connect to SSR(4) [S1].
- () Cut the black wire from J4 to 4 1/2" length, and strip 3/8" of insulation from the end. Tin the wire, and connect it to FU(2) [NS].

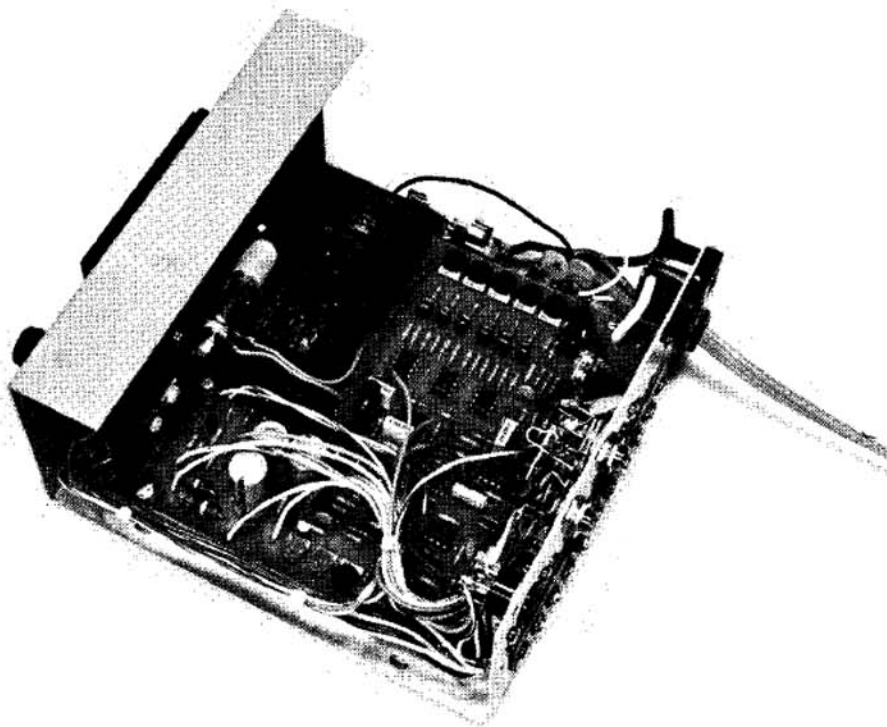
- () Cut the leads of a .01 mfd, 1000 volt capacitor to 1/2". Connect one lead of the capacitor to TS(1) [S3], and the other to TS(2) [NS].
- () Cut the leads of another .01 mfd, 1000 volt capacitor to 1/2". Connect one lead to TS(2) [S4], and the other to TS(3) [NS].
- () Cut the leads of another .01 mfd, 1000 volt capacitor to 1/2". Connect one lead to J3(2) [S1], and the other to J3(1) [NS].
- () Refer to photo WIRING THE FRONT PANEL, and position the circuit board as shown.
- () Connect the white/blue wire from the circuit board to SW3(3) [S2].
- () Connect the violet wire from the circuit board to SW3(1) [S1].
- () Connect the light blue wire from the circuit board to P10(2) [S1].
- () Connect the grey wire from the circuit board to M(1) [S1].
- () Connect the white/violet from the circuit board to SW2(2) [S1].
- () Place the circuit board on the cabinet bottom and fasten it in place with the two #4 x 1/4" sheet metal screws at the front, and two 4-40 machine screws at the rear. Be sure no wires are pinched under the heatsink.
- () Connect the remaining wires from the circuit board as indicated:

() white/black	to	GG1 [S4]
() brown	to	TB(2) [S1]
() dark blue	to	TB(3) [S1]
() orange	to	TB(4) [S1]
() white/orange	to	TB(5) [S1]
() white/yellow	to	TB(6) [S1]
() white/green	to	TB(7) [S1]
() green	to	TB(8) [S1]
() pink	to	J1(2) [S1]
() tan	to	J2(1) [S1]
() red	to	J3(3) [S1]
() white/red	to	J3(1) [S2]
() black	to	FU(2) [S2]
() white	to	TS(3) [S4]
- () Use the remaining cable ties to neatly bundle the wires. (Refer to the photo.)

- () Install the 3 amp fuse.
- () Install the 28 volt pilot lamp in its socket. Slip the white rubber diffuser over the bulb.



WIRING THE FRONT PANEL



COMPLETED WIRING

Alignment

- () Inspect all wiring. Make sure all connections are soldered properly and there are no shorts.
- () Plug the TU-170 into a 115 VAC, 60 Hz. outlet and turn the power switch on. The pilot lamp should light.
- () Connect a frequency counter to pin 2 of J1. Connect the frequency counter ground to the chassis of the TU-170.
- () Temporarily connect a jumper wire from SW3(3) to TB(6)
- () Adjust P8 for a frequency reading of 2125 Hz.
- () Remove the temporary jumper from TB(6).
- () Adjust P7 for a frequency of 2295 Hz.
- () Connect an oscilloscope or AC voltmeter to J1(2).
- () Alternately connect and disconnect the jumper from SW3(3) to TB(6), and adjust P9 until there is no difference in the amplitude of the output signal as seen on the oscilloscope or voltmeter.
- () Connect a temporary jumper between J1(2) and TB(2).
- () Set P1, P2, P3, P4, P5, and P6 to mid-rotation.
- () Connect the temporary jumper from SW3(3) to TB(6).
- () Adjust P1, P2, and P3 for maximum deflection of the tuning meter.
- () Disconnect the temporary jumper from TB(6).
- () Adjust P4, P5, and P6 for maximum deflection of the tuning meter.
- () Remove all temporary jumpers and test equipment.
- () Fasten the side panels in place with #4 sheet metal screws. Slide the cabinet top in place from rear and secure with #4 sheet metal screws.
- () Install the rubber feet on the bottom of the chassis.
- () Use the short links supplied to jumper TB(3) to TB(4) and TB(5) to TB(6).

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TU 170 OWNER:

WHEN WIRING THE 4-PIN PLUG FOR TRANSMITTER
CONNECTION (AS INSTRUCTED ON PG.11 OF THE MANUAL)
DISREGARD THE PIN NUMBERS MOLDED ON THE PLUG ITSELF--
REFER TO THE LEGEND ON THE CABINET REAR PANEL FOR
PIN ORIENTATION.

900 039

Station Connections

TRANSMITTER: Make up a short cord to connect the TU-170 to your transmitter. Use three conductor shielded wire and the 4 pin plug supplied. Connect pin 1 to the shield. Pin 2 is the audio output and will connect to your transmitter microphone input. Pins 3 and 4 are to connect to your transmitter push-to-talk connections.

RECEIVER: Connect the TU-170 to your receiver speaker connections, or the headphone jack. The connections should be made with shielded wire, with the shield connected to pin 1 of the screw terminal strip on the rear apron (ground). The audio connection is made on terminal 2.

If no other accessory equipment is to be used with the TU-170, use the two jumper straps supplied to jumper the "DEMODO. OUTPUT" (terminal 3) to "LOOP KEYING" (terminal 4), and the "LOOP MONITOR" (terminal 5) to "AFSK KEYING" (terminal 6).

TUNING OSCILLOSCOPE: If a tuning oscilloscope is to be used, connections are provided on terminals 7, 8, and 9. The output level is approximately 15 volts peak-to-peak for each channel. Connect "SCOPE MARK" to the scope horizontal channel, and the "SCOPE SPACE" to the scope vertical channel.

CW KEY: A CW key may be used for approximately 100 Hz shift identification by plugging it into the "CW KEY" jack on the rear apron.

PRINTER: Use the three conductor (tip, ring, sleeve) jack supplied to connect the TU-170 to your printer. The positive loop connection is the jack tip, and the negative connection is the ring. The sleeve should be connected to the printer ground. Note: most printers will not operate if the loop polarity is reversed. The printer selector magnets should be set for 60 ma loop current, and the keyboard contacts should be in series with the magnets.

For autostart operation, the printer power cord may be plugged into the accessory outlet on the rear apron of the TU-170.

Make sure all equipment is properly grounded to a good earth ground to prevent transmitted RF from interfering with proper operation of the terminal unit.

OTHER EQUIPMENT: If other equipment is to be interfaced with the TU-170, such as a microprocessor, speed converter, etc., TTL compatible outputs are available on the terminal strip on the rear apron. Their operating description follows:

<u>TERMINAL</u>	<u>DESCRIPTION</u>
DEMOD. OUTPUT	TTL output from the demodulator. Output will drive one standard TTL load. "Mark" is high, "Space" is low.
LOOP KEYING	TTL input to key the loop. Mark is high, "Space" is low.
LOOP MONITOR	TTL output monitors loop current. "Mark" is high, "Space" is low.
AFSK KEYING	TTL input for keying audio frequency shift oscillator. Mark (2125 Hz) is high, "Space" (2295 Hz) is low.

NOTE: When no auxilliary equipment is being used, the DEMOD OUTPUT should be jumpered to LOOP KEYING, and the LOOP MONITOR should be jumpered to AFSK KEYING.

Parts List

CAPACITORS

C1	.1 mfd (12V 104Z)	C31	.005 mfd mylar
C2	.1 mfd (12V 104Z)	C32	.1 mfd (12V 104Z)
C3	4.7 mfd	C33	47 mfd, 100V
C4	.1 mfd (12V 104Z)	C34	220 mfd, 25V
C5	.05 mfd mylar (100V 503K)	C35	220 mfd, 25V
C6	.05 mfd mylar (100V 503K)	C36	10 mfd, 15V
C7	.005 mfd mylar	C37	10 mfd, 15V
C8	" "	C38	.01 mfd, 1000V
C9	" "	C39	.01 mfd, 1000V
C10	" "	C40	.01 mfd, 1000V
C11	" "		
C12	" "		
C13	" "		
C14	" "		
C15	" "		
C16	" "		
C17	" "		
C18	" "		
C19	" "		
C20	" "		
C21	4.7 mfd		
C22	.22 mfd mylar (50V 224K)		
C23	.01 polyester		
C24	.22 mfd mylar (50V 224K)		
C25	4.7 mfd		
C26	.01 mfd polystyrene		
C27	.001 mfd		
C28	.01 mfd 25V disk		
C29	.1 mfd		
C30	.005 mfd mylar		

DIODES

D1	1N4148
D2	"
D3	"
D4	"
D5	"
D6	"
D7	"
D8	"
D9	"
D10	"
D11	"
D12	"
D13	"
D14	"
D15	"

D16 1N4003
 D17 "
 D18 "
 D19 "
 D20 "
 D21 "

IC's

IC 1 MC1458CP1
 IC 2 "
 IC 3 "
 IC 4 "
 IC 5 "
 IC 6 "
 IC 7 "
 IC 8 555 / MC1455
 IC 9 MC7812
 IC 10 MC7912

POTS

P1 200 ohms
 P2 "
 P3 "
 P4 "
 P5 "
 P6 "
 P7 50K ohms
 P8 10K ohms
 P9 1K ohms
 P10 50K ohms

TRANSISTORS

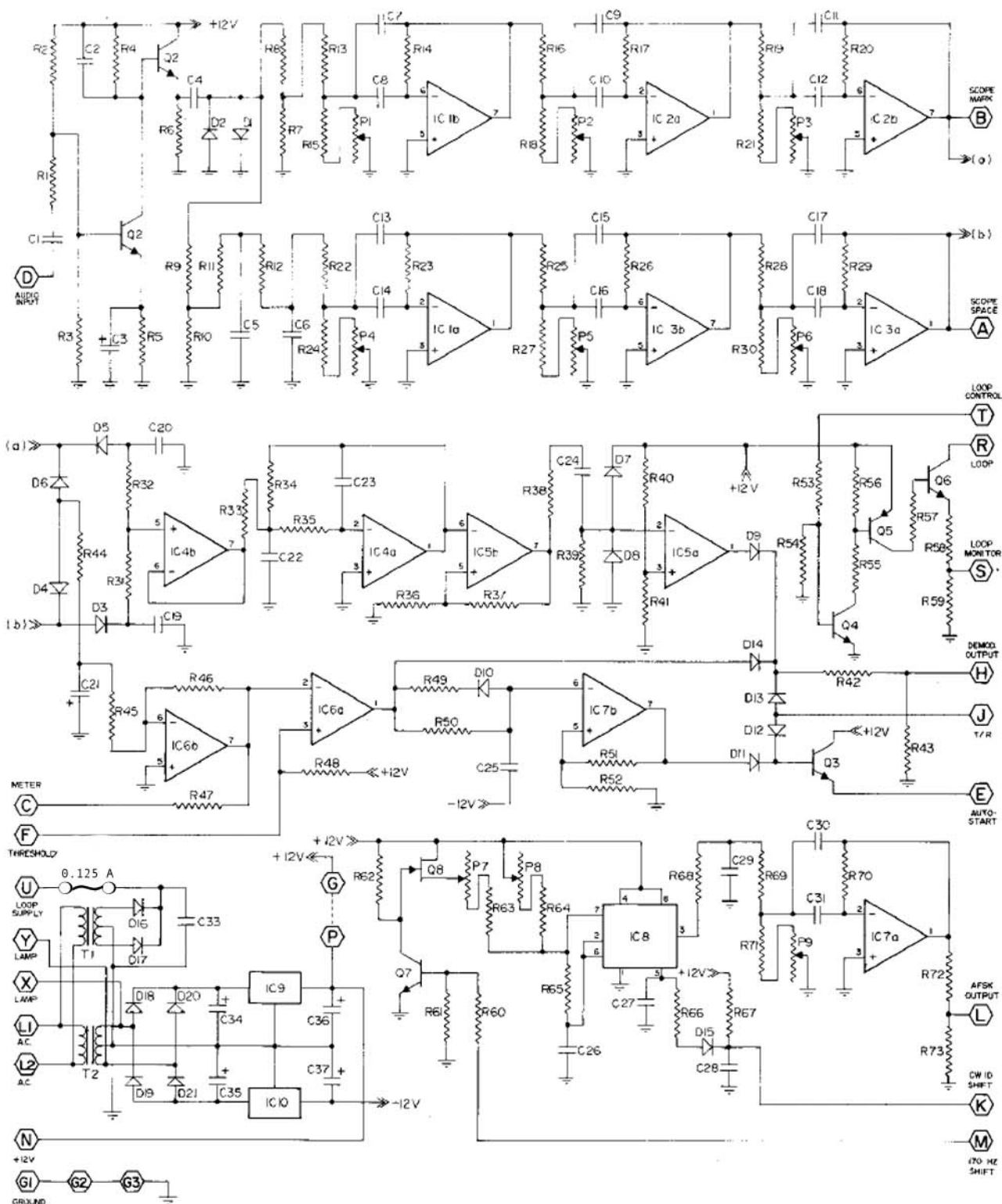
Q1 2N4123
 Q2 2N4123
 Q3 2N4123
 Q4 2N4123
 Q5 2N4125
 Q6 MJE340
 Q7 2N4123
 Q8 MPF111

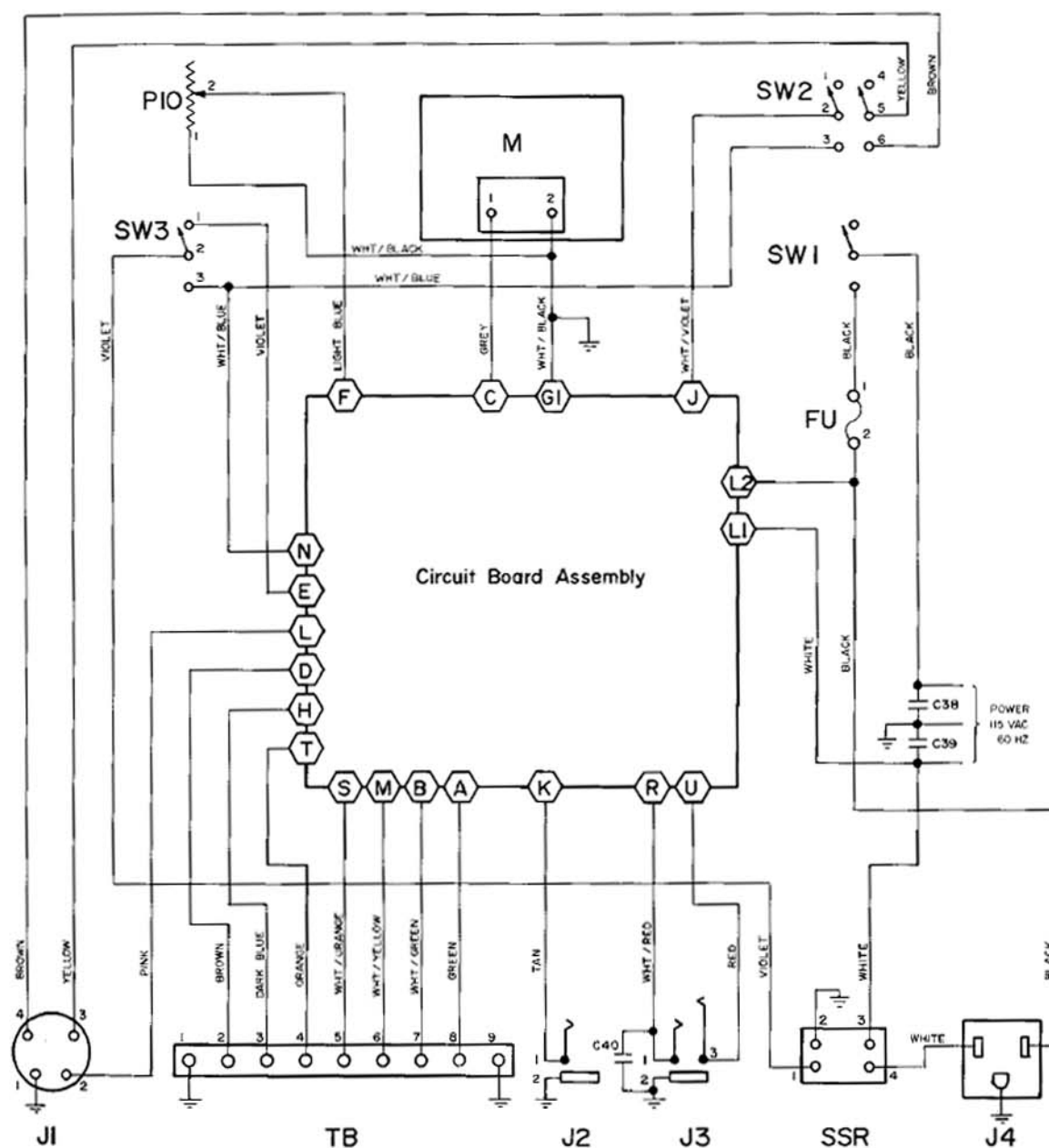
RESISTORS

R1 330	R38 2.2K
R2 12K	R39 390K
R3 2.2K	R40 39K
R4 2.2K	R41 3.9K
R5 330	R42 1.5K
R6 1K	R43 1K
R7 560	R44 2.2K
R8 2.2K	R45 100K
R9 330	R46 100K
R10 1K	R47 8.2K
R11 1.8K	R48 39K
R12 1.5K	R49 100K
R13 39K	R50 390K
R14 390K	R51 3.9K
R15 470	R52 12K
R16 39K	R53 2.2K
R17 390K	R54 2.2K
R18 470	R55 2.2K
R19 39K	R56 2.2K
R20 390K	R57 1K
R21 470	R58 100,
R22 39K	R59 82, 1
R23 390K	R60 2.2K
R24 390	R61 2.2K
R25 39K	R62 39K
R26 390K	R63 24K
R27 390	R64 10K
R28 39K	R65 27K
R29 390K	R66 100K
R30 390	R67 2.2K
R31 100K	R68 10K
R32 100K	R69 15K
R33 390K	R70 150K
R34 390K	R71 1K
R35 24K	R72 10K
R36 2.2K	R73 1.5K
R37 12K	

FUSE

0.125 AMP 250V





Chassis Wiring Diagram

Operating Instructions

FRONT PANEL CONTROLS

ON/OFF Lower left switch turns on power to the terminal unit and the Autostart circuit.

ON/OFF/AUTO Lower right switch controls autostart function. In the ON position, the auxilliary power outlet is turned on regardless of whether a teletype signal is present. In the OFF position the outlet is turned off regardless of whether a teletype signal is present. In the AUTO position the outlet is controlled by the presence of a properly tuned teletype signal and upon the setting of the threshold control.

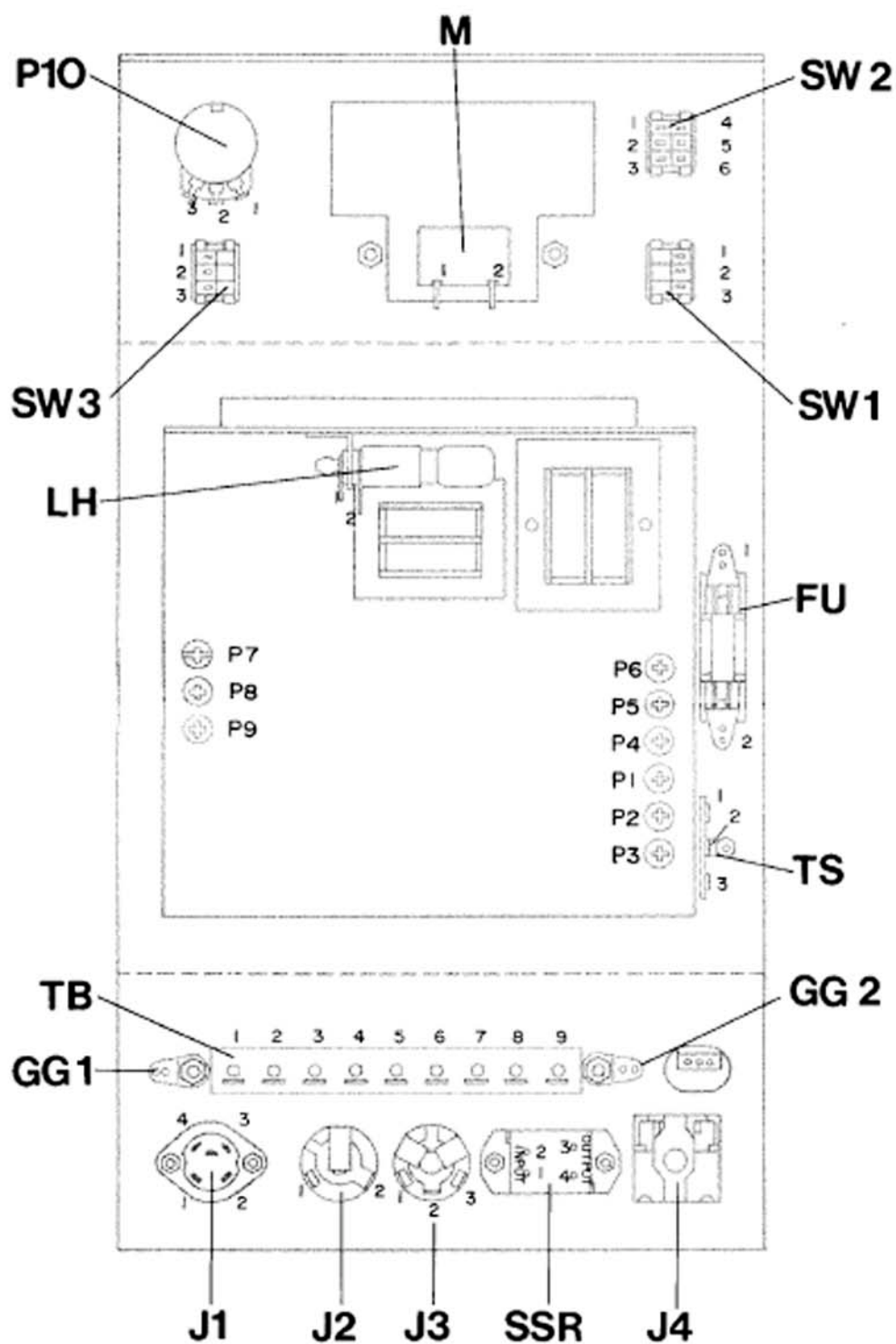
THRESHOLD Upper right control sets the signal strength required to turn on the auxilliary power outlet when the function switch is in the AUTO position. Also sets signal strength required to allow the demodulator to key the 60 ma loop. Full counter-clockwise rotation allows the weakest signals to be printed.

SEND/REC Upper left switch sets transmit/receive mode, and disables the demodulator output when in the SEND position.

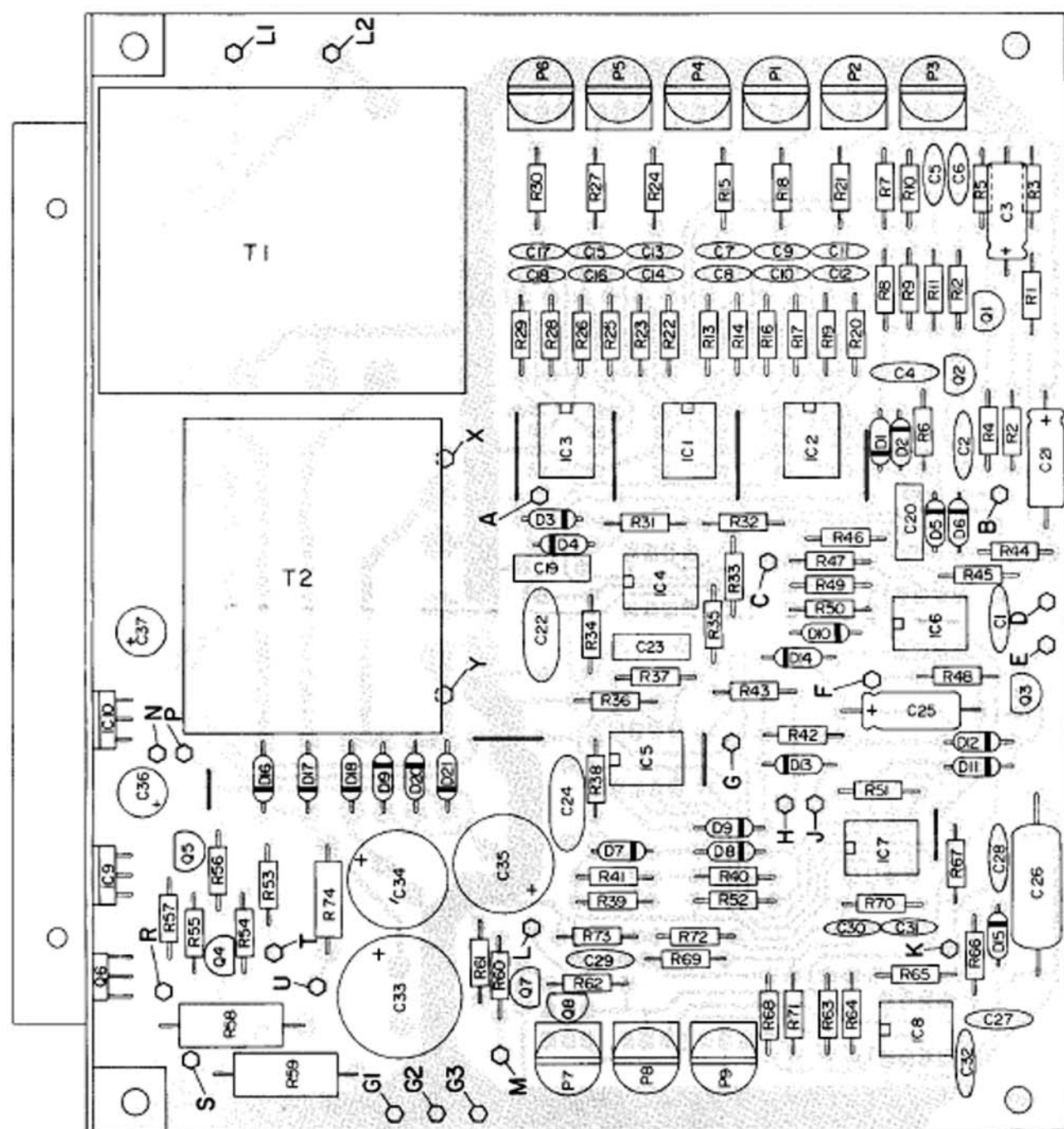
METER Indicates strength of filtered teletype signal.

TUNING Proper tuning of your receiver requires that the mark tone be 2125 Hz, and the space tone be 2295 Hz. When properly tuned, the meter on the TU-170 will indicate nearly full scale, and be relatively steady. Some practice may be required to be able to tune in a station quickly. Start with the receiver volume at a normal listening level and slowly tune the receiver past a RTTY signal. Three peaks on the meter may be noticed. On one, the meter is steady, and on the other two peaks, the meter will quiver. The steady peak is the proper tuning. Adjust the receiver audio gain control downward until the meter starts to drop, then set the gain just a little louder. This is the proper input level setting. If the signal is fading in and out, set the audio gain high enough so that the meter will hold steady even as the signal varies in strength.

Detailed operating practices, and procedures are available in many amateur radio handbooks, and periodicals. (ie: ARRL Specialized Communications Techniques for the Radio Amateur) The operator should familiarize himself with these, as well as applicable FCC rules and regulations before attempting to transmit RTTY signals.



Chassis Assembly



Component Location Drawing

VOLTAGE CHECK FOR TU-170

CONDITIONS:

SW1 - ON
 SW2 - REC
 SW3 - AUTO
 P-10 - CENTER OF ROTATION
 J3 - Tip and Ring shorted, do not use sleeve.
 Shorting straps in place on TB, NO SIG present
 on input.

IC No.	IC PIN No.						VDC APPROX.
	1	2	3	5	6	7	
1	0	0	0	0	0	0	
2	0	0	0	0	0	0	
3	0	0	0	0	0	0	
4	+0.1	0	0	-0.9	-0.6	-0.6	
5	+11	0	+1	+1.7	0	+11	
6	+11	0	+3.2	0	0	0	
7	0	0	0	-7.4	+10.5	-10	

TRANSISTOR No.	EMITTER	BASE	COLLECTOR
Q1	+1	+1.7	+4.5
Q2	+3.8	+4.5	+12
Q3	0	0	+12
Q4	0	+0.7	+0.1
Q5	+12	+11.3	+11.9
Q6	+11	+11.6	+79
Q7	0	+0.7	0

Voltage comparisons with your unit should be reasonably close ($\pm 20\%$). If voltage checks too far from spec., check for solder bridges, wrong component value or cold solder joints.

Warranty does not cover workmanship of builder, or components damaged as a result of improper assembly.

If you fail to find the problem, and you wish to send it in for repair, be sure you have placed the nylon hold down hardware in transformers, and make sure the unit is packed well. Include a note about the problem to the service dept.

If your unit is received damaged, you will be notified by mail and no work will be performed until we have been advised by you.

Expect more labor cost on modified units due to the problem in connecting to test sets.

None of the major credit card companies permit repair charges to be placed on credit card charges. Unless otherwise instructed by you, your unit will be returned COD.

SHIP TO: FLESHER CORP., 507 JACKSON STREET, TOPEKA, KANSAS 66603
 ATTN: SERVICE DEPT.

TROUBLE SHOOTING GUIDE

TROUBLE	POSSIBLE CAUSE	POSSIBLE CURE
Meter indicates or reads full scale without signal on input & lamp dim.	Loss of -12V, wrong IC Reg. in IC-10, IC-10 shorted to heat sink, -12V shorted to ground, possible solder bridge.	Check for correct Reg. for IC-10, pull away from heat sink and see if lamp goes normal, then check for sharp edge cutting through mylar insulator. File edge, turn mylar over, secure to heat sink. Check for -12V.
Meter indicates without signal on input, about half scale or more, with lamp normal.	Short or solder bridge on filter inputs, bad IC 1, 2, or 3. IC6 bad, or pin bent under IC.	Use voltage chart to isolate which IC; if bent under pins straighten and replace. If bad, replace IC, making sure there are no solder bridges.
One output will indicate on meter during alignment, but other output will not indicate on meter.	Bad connection on caps C-7 to C-12 on mark side, C-13 to C-18 on space side. Broken resistor.	With signal present, wiggle each cap in section where signal is missing on output until meter indicates. Solder that cap. Check with voltage chart to isolate problem area.
Loop is open all the time	R74 burned in half. No demod output voltage at TB 3&4. Transistor Q4, 5, or 6 reversed, bad connection, or bad component.	Check voltage chart to isolate component or troubled area, replace component. R74 will only blow if loop is shorted to ground and most times it is obviously broken or burned in half. Replace R74 & recheck external connections for caps to ground, shorts of some type.
While aligning the filters, you find all but one pot has effect on peaking meter.	Cold solder connection, solder bridge on pot leads, or bad pot.	Check board for good clear connection. If all is clear, replace pot.
Meter & loop current varies with threshold control.	Ripple or poor regulation from IC regulator	Replace bad regulator, may read good on VM, scope is needed to detect ripple.

TROUBLE SHOOTING GUIDE

TROUBLE	POSSIBLE CAUSE	POSSIBLE CURE
R74 goes up in smoke, possibly blowing T-1 Transformer	Shorted loop lead to ground or machine has polarity wise caps to ground. Nothing other than direct short to ground will blow these.	Replace bad components, clear loop line of shorts, caps, external loops, making sure loop circuit is floating.
AFSK output will vary with adjusting P-9, but will not balance.	Bad connection or bad C30 & C31.	Replace caps if connections are good.
No AFSK Output	IC 8 or IC 7, shorted or bad.	Replace
AFSK will not go to frequency before pot limits.	Wrong value pot, wrong value R-63, R-64	Check for right values of pot and resistors. Replace them.
AFSK will not shift during alignment.	Q7 or Q8 bad, reversed or poor connection.	Clear of shorts, replace bad component.
SSR will not turn motor on. All else working properly.	SSR open or Q3, IC 7, IC 6, D 11 bad. Solder bridge, cold solder connection.	Check with voltage chart, Isolate area & repair or replace bad device.
Motor will not turn on either with switch in auto or manual.	SSR, no +12V on switch, poor or incorrect AC connection.	Replace relay if connections are all good. Excessive heat soldering relay leads will damage relays. Poor ground on input side of relay.