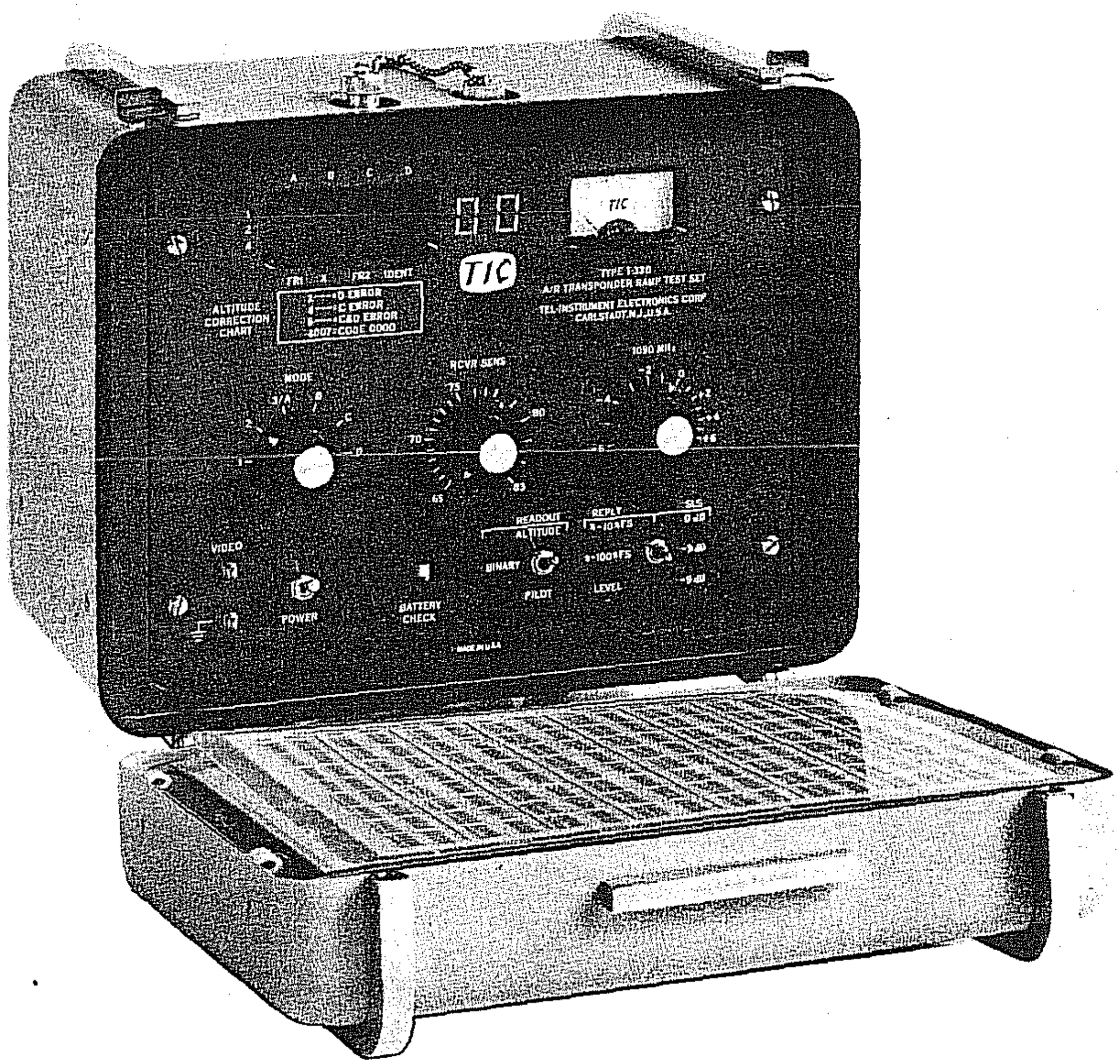
T-33B/C/D

A/R TRANSPONDER RAMP TEST SET

REV. A
October 26, 1998

TEL-INSTRUMENT ELECTRONICS CORP.

T-33B/C/D A/R TRANSPONDER RAMP TEST SET



WARRANTY

The Tel-Instrument Electronics Corporation warrants each new product manufactured by it to be free from defective material and workmanship and agrees to remedy any such defect or to furnish a new part in exchange for any part of any unit of its manufacture which under normal installation, use and service discloses such defect, provided the unit is delivered by the owner to us intact for our examination with all transportation charges prepaid to our factory within one year from the date of sale to original purchaser and provided such examination discloses, in our judgment, that it is thus defective. This warranty does not include tubes or batteries.

This warranty does not extend to any of our products which have been subjected to misuse, neglect, accident, incorrect wiring not our own, improper installation, or to use in violation of instructions furnished by us, nor extend to units which have been repaired or altered outside of our factory, nor to cases where the serial number thereof has been removed, defaced or changed, nor to accessories used herewith not of our own manufacture.

Repair parts will be made available for a minimum period of five (5) years after the manufacture of this equipment has been discontinued.

This warranty is in lieu of all other warranties expressed or implied and no representative or person is authorized to assume for us any other liability in connection with the sale of our products.

ADDITIONAL INFORMATION with regard to the applications and maintenance of this equipment will be available from time to time. Users of our instruments are urged to discuss their problems with us and to suggest such modifications as might make them more adaptable to their special requirements.

THANK YOU

TIC

AVIONIC TEST EQUIPMENT FOR BENCH AND RAMP

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N O T E

This combined manual covers both the Type T-33B and T-33C instruments. Performance and external appearance of these instruments are identical.

Due to the fact that manufacturers are discontinuing the 74L series of IC it was necessary to change over to the 74LS series. Since the pin connections on the 74L and 74LS series are different, printed circuit board changes were required on the Encoder, Decoder, Translator and Attenuator boards. A change of Model number from T-33B to T-33C is a logical way to differentiate between instruments using the two different series of IC's. We have a sizable stock of 74L series IC's to take care of repair requirements for the T-33B.

The circuit diagram in this manual is entitled T-33C; however, a pin connection diagram for the 74L series IC is shown at the right hand top corner of the schematic. The same circuit diagram is thus usable for both units.

Parts list change for the T-33C is as follows:

Page 4 - 26 Encoder Board

ITEM	DESCRIPTION			CIRCUIT DESIGNATION	QTY	TIC PART #
19	IC	SN74LS00N:	T-I	IC3	1	TSN74LS00N
20	IC	SN74LS04N:	T-I	IC2, 12	2	TSN74LS04N
21	IC	SN74LS10N:	T-I	IC11	1	TSN74LS10N
22	IC	SN74LS95BN:	T-I	IC4 - 10	7	TSN74LS95BN

Page 4 - 29 Decoder Board

ITEM	DESCRIPTION			CIRCUIT DESIGNATION	QTY	TIC PART #
8	IC	SN74LS00N:	T-I	IC13	1	TSN74LS00N
9	IC	SN74LS04N:	T-I	IC14	1	TSN74LS04N
10	IC	SN74LS95N:	T-I	IC15 - 19	5	TSN74LS95N

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ITEM	DESCRIPTION			CIRCUIT DESIGNATION	QTY	TIC PART #
3	IC	SN74LS00N:	T-I	IC34	1	TSN74LS00N
4	IC	SN74LS02N:	T-I	IC32, 35	2	TSN74LS02N
7	IC	SN74LS08N:	T-I	IC33	1	TSN74LS08N
9	IC	SN74LS83AN:	T-I	IC37, 38, 45	3	TSN74LS83AN
11	IC	SN74LS86N:	T-I	IC30, 31, 44	3	TSN74LS86N

Page 4 - 39 Attenuator Board

ITEM	DESCRIPTION		CIRCUIT DESIGNATION	QTY	TIC PART #
9	IC	SN74LS03N	IC52	1	TSN74LS03N

T-33B INSTRUCTION BOOK ADDENDUM

The following paragraphs provide additional information for use of the T-33B using the direct connection as outlined in section 2.2 of this manual.

Reference: Federal Aviation Administration Advisory Circular number 43-6 dated September 19, 1974, paragraph 6.

The transponder receiver sensitivity measurement (MTL) as outlined by Advisory Circular 43-6 is made with the transponder replying to 90% of the interrogations of the T-33B. Many transponders tend to delay the timing between P3 and Framing One pulses as the received interrogation approaches MTL. This shift in timing can be 0.5 microseconds or more, and may be sufficient to exceed the maximum permissible delay of 3.5 microseconds. Under this condition the T-33B decoding circuitry will not indicate the correct code or altitude. This is not a defect in the T-33B. The test set is indicating that Framing One pulse of the transponder reply is delayed more than 3.5 microseconds after P3 of the interrogation, and the transponder is out of spec. Note that paragraph 6 of Advisory Circular 43-6 does not require that any code checks be made when measuring receiver sensitivity.

It is recommended that all checks with respect to codes be made with the REPLY/SLS switch of the test set set to the LEVEL position. This will provide a signal strength of several dB above MTL.

The pulse timing between P3 and Framing One pulses can be conveniently measured by examining the waveform at the Video test point on the front panel of the test set. The T-33B I.F. circuit has a typical delay time of 0.15 microseconds, and this factor must be subtracted from the measured delay time to arrive at the actual delay time of the transponder. For example, if the measured delay as indicated by the oscilloscope was 3.3 microseconds, the actual delay time would be 3.3 - 0.15 or 3.15 microseconds.

TABLE OF CONTENTS

T-33B A/R TRANSPONDER

RAMP TEST SET

DESCRIPTION

1.1 GENERAL:

The T-33B is a battery powered, portable test set which enables one man to perform transponder operational checks directly from the cockpit of an aircraft. This is accomplished by radiating an interrogation signal to the antenna of the unit under test and observing the decoded reply on four Numitron display devices. The T-33B digital readouts can display the decoded reply in three forms, front panel selected: PILOT CODE, BINARY CODE, and ALTITUDE in feet.

The T-33B is also capable of making transponder receiver sensitivity measurements by means of a direct connection between the transponder and test set. A BNC connector, located next to the antenna connector, has been provided for this purpose. In addition, a video test point has been provided on the front panel which allows both interrogation and reply pulses to be displayed on an oscilloscope. This feature, together with the receiver sensitivity measurement capability of the T-33B, allows the unit to be used as a limited, but valuable bench test set.

The PILOT CODE readout is used on Mode A to enable the T-33B to display the transponder control head setting as set by the technician. It also finds use in Mode C operation for error checking. The ALTITUDE readout is used on Mode C when testing the altitude digitizer in the aircraft. In this case, the T-33B will indicate the altitude in feet as received by a ground station interrogating the transponder on Mode C. The BINARY CODE readout provides a display of the actual A, B, C and D pulses contained in the reply pulse train. The technician may select any of the three decoded forms on all modes, as desired.

In addition to the decoded reply, the display of the T-33B indicates the presence or absence of the Framing pulses, X pulse, and Ident pulse. These are the "decimal points" below the A, B, C and D digits.

All 4096 codes (8192 codes with X pulse) can be checked in a matter of seconds by setting the transponder to two complimentary codes. A pair of complimentary codes are those whose sum adds up to 7777, such as 3333 and 4444, or 0707 and 7070. This check will verify that all pulses can be turned on, and all pulses (except Framing) can be turned off.

The 1030 MHz R.F. interrogation signal is generated by a crystal controlled transmitter with a frequency accuracy of ± 0.01%. The 1090 MHz transponder transmitter frequency is checked by a direct reading dial calibrated to an accuracy of ± 0.5 MHz. This is accomplished by incorporating a superheterodyne type receiver with a tuneable integrated circuit I.F. section. Tuning range is ± 6 MHz.

The T-33B will interrogate a transponder on Modes A, B, C, D and military Modes 1, 2 and 3. The side lobe suppression pulse level is normally 9 dB below P1 and P3, and can be transmitted equal in amplitude to P1 and P3 (0 dB) to check the SLS circuits of the receiver. The front panel meter of the T-33B provides a percentage readout of transponder response to interrogations with the SLS pulse at -9 dB level and SLS pulse at 0 dB level. Full scale of the meter is automatically switched from 100% to 10% as the SLS pulse is activated.

[illegible] circuitry of the T-33B is entirely digital, providing extreme accuracy and reliability of operation. The unit is powered by rechargeable Ni-Cad cells with a built-in charger. IC voltage regulator circuits in the unit deliver constant voltage to the circuits thus eliminating deterioration of performance due to falling battery voltage. A front panel battery condition meter monitors the status of the voltage regulators and indicates when recharging is necessary. This permits the technician to check battery condition before transporting the unit to the check area. The battery can be completely recharged in 14 hours and the charger may be left in operation indefinitely with no damage to the battery or test set. The AC power supply in the T-33B will provide sufficient power to operate the unit while charging the battery. Thus, it is not necessary to charge the battery before operating the unit if AC power is available at the test site.

1.2 SPECIFICATIONS:

TRANSMITTER:
1030 MHz ± 0.01%, crystal controlled

TRANSMITTER PULSE RATE:
235 pps nominal

INTERROGATION PULSE SPACING:
3, 5, 8, 17, 21 and 25 μsec, corresponding to Modes 1, 2, 3/A, B, C, and D, front panel selected.

SLS PULSE:
SLS OFF - P2 9 dB below P1, 2 μsec pulse spacing
SLS ON - SLS pulse amplitude = P1 amplitude, 2 μsec pulse spacing

TRANSPONDER FREQUENCY CHECK:
1090 MHz ± 6 MHz, ± 0.5 MHz accuracy

TRANSPONDER SENSITIVITY MEASUREMENT:
-65 dBm to -83 dBm, accuracy ± 2 dB

REPLY RATE MEASUREMENT:
0-100% full scale with P2 9 dB below P1 (-9 dB)
0-10% full scale with P2 = P1 (0 dB)

VIDEO OUTPUT:
1 volt pulses into a 50 ohm load

POWER SUPPLY:
Seven 1.2 volt Ni-Cad cells with charger operated from 115/230 volt 50 - 400 Hz AC power source

TEMPERATURE RANGE:
10° to 40° C operational

SIZE:
10½" W x 8½" H z 8½" L (Less antenna and handle)

WEIGHT:
14 lbs.

1.3 FRONT PANEL CONTROLS

A. POWER Switch S5

A spring loaded toggle switch controls battery power to the unit.

B. BATTERY CHECK Meter (M1)

A miniature meter with the left half of the scale red and the right half white monitors the status of the voltage regulator, and indicates when battery recharging is necessary. When the battery is fully charged, the indicator will move to the extreme right hand side of the scale. As the battery terminal voltage falls the needle will move toward the left. When the needle enters the red area of the scale, the battery is exhausted and should be recharged.

C. READOUT Switch (S4)

This three position toggle switch controls the operation of the display circuitry of the unit. The FRAMING, X and IDENT readouts are not affected by the position of this switch. The T-33B display circuitry will not operate unless both Framing pulses are present in the reply pulse train. The PILOT position of this switch is used on Mode A and provides a display of the transponder control head setting. The ALTITUDE position is used on Mode C and indicates the altitude in feet. The BINARY CODE position is used on both Modes A and C and indicates the actual pulses in the respective reply pulse train.

D. RECEIVER SENSITIVITY Potentiometer

This control serves two functions in the unit. With the REPLY/SLS switch in the LEVEL position the RECEIVER SENSITIVITY potentiometer controls the gain of the T-33B receiver, and thus the level of receiver output. Adjustment of receiver output level as indicated by the meter allows the technician to peak the tuneable I. F. amplifier and read transmitter frequency.

With the REPLY/SLS switch in either PERCENT position the RECEIVER SENSITIVITY control provides an adjustment of the variable attenuator of the T-33B. This feature is used only when making transponder receiver sensitivity measurements with a direct connection between the T-33B and transponder under test.

E. 1090 MHz Potentiometer (R22)

This potentiometer varies the bias voltage on a pair of varactors in the I. F. amplifier, thus tuning the receiver over a range of 1090 MHz ± 6 MHz.

F. REPLY/SLS Switch

This is a three position toggle switch which controls both the meter readout and

SLS pulse of the T-33B. The lower position of this switch allows the meter to indicate the level of receiver output while transmitting interrogations with the SLS pulse 9 dB below P1 and P3. This position is used when making transponder frequency measurements and all checks with respect to codes.

The center position of this switch is used when it is desired to read the percentage reply of the transponder with the SLS pulse at 9 dB below P1 and P3. Full scale reading is 100%. If a direct connection to the transponder is being used it will be necessary to adjust the Receiver Sensitivity potentiometer to a point equal or greater than minimum triggering level (MTL) of the transponder.

The upper position of this switch, 10% reply/0 dB, increases the level of the SLS pulse so that it is equal in amplitude to P1 and P3. It also increases the sensitivity of the meter so that full scale is a reply rate of 10%. When the T-33B REPLY/SLS switch is operated in this position the transponder reply rate should not be more than 1.3%.

G. MODE Switch (S3)

This rotary switch selects the time delay between P1 and P3, and thus the interrogation Modes 1, 2, 3/A, B, C and D.

H. MICROAMMETER (M2)

This meter serves two functions depending upon the position of the REPLY/SLS switch. With the REPLY/SLS switch in the LEVEL position, the meter indicates relative T-33B receiver output. When making code checks the Receiver Sensitivity potentiometer should be set to the maximum clockwise position so that the meter reads full scale. This indicates that there is sufficient receiver output to activate the decoding circuitry of the T-33B. When transponder frequency measurement is desired, the Receiver Sensitivity potentiometer is adjusted so that the meter reads about 1/4 full scale. The 1090 MHz control can then be peaked to read transmitter frequency.

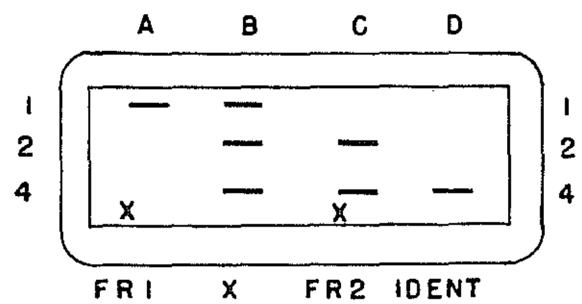
With the REPLY/SLS switch in the 100% or 10% position the meter will read the ratio of reply rate to interrogation rate expressed as a percentage. Full scale reading of the meter is 100% and 10% respectively.

I. VIDEO TEST POINT (Video and Gnd)

This test point provides means to display both interrogation and reply pulses on an oscilloscope. Connection to the oscilloscope may be made either by using a standard 10:1 divider probe, or by feeding directly to the oscilloscope through a coaxial cable. If a coaxial cable is used terminate the end of the cable at the oscilloscope end with a 50 ohm load resistor.

J. NUMITRON READOUTS (V1, V2, V3 and V4)

The Numitron readouts are digital display devices which provide a sharp, high brightness display consisting of a segmented digits. When the READOUT switch of the T-33B is set to the PILOT position, the readouts will display the decoded reply pulse train in the form of four digits. When the READOUT switch is set to the BINARY position the three horizontal segments of each readout will indicate the presence or absence of each binary reply pulse. Refer to Figure 1 - 1.



BINARY DISPLAY OF 1764 CODE
FIG. 1-1

Illumination of the uppermost horizontal segment of the readouts indicates the presence of the A1, B1, C1 and D1 reply pulse. Similarly, illumination of the center horizontal segments indicates A2, B2, C2 and D2 or the lower horizontal segments A4, B4, C4 and D4.

Illumination of the decimal point of the readouts indicates the presence of the FRAMING 1, X, FRAMING 2 and IDENT pulses, and will be indicated for any position of the READOUT switch.

When the READOUT switch is in the ALTITUDE position, the readouts will display the decoded altitude in hundreds of feet. Adding the two silk screened zeros on the front panel to the display provides the altitude reading in feet.

OPERATION

2.1 GENERAL:

A transponder with altitude reporting capabilities may be checked in only a few minutes with the T-33B. The interrogation signal may be radiated from the cockpit or directly fed into the transponder antenna connector with a 50 ohm coaxial cable. To make radiated checks remove the TNC protector cap at the top of the unit. Remove the antenna from the cover of the unit and attach it to the TNC antenna connector. If a direct connection is desired do not attach the antenna. Instead use a 50 ohm coaxial cable with a BNC plug at one end, and suitable connector at the other end for the transponder. The attenuation of this cable, at 1 GHz, must be known if accurate receiver sensitivity checks are to be made. When making checks with the 50 ohm cable be sure the TNC protector cap is attached to the TNC antenna connector. If this is not done the T-33B will radiate and may cause erroneous measurements.

Use the following procedure:

CAUTION: Do not dial any PILOT CODE starting with 77. To do so may activate a ground station alarm.

2.1.1 Mode A - B Tests:

A. Turn the transponder on and allow at least one minute warm-up. Connect the T-33B antenna or make a direct connection between the T-33B BNC jack and transponder antenna jack.

CAUTION: The TNC jack is to be used ONLY for radiated checks with the antenna. If a transponder is connected to this jack the T-33B will be damaged.

B. Set the T-33B controls as follows:

RECEIVER SENSITIVITY	-	maximum clockwise
1090 MHz	-	zero
REPLY/SLS	-	LEVEL
MODE	-	A or B
READOUT	-	PILOT

C. Turn the T-33B on. Ascertain that the BATTERY CHECK meter is in the white portion of the scale. If not, recharge the battery from a 115 VAC 50 - 400 Hz source. NOTE: It is permissible to operate the T-33B while the unit is being charged by any 115 volt, 50 - 400 Hz power source.

D. Adjust the location of the T-33B to obtain maximum deflection of the microammeter to determine if the transponder is being interrogated. If available, the reply lamp of the transponder can help to determine that the transponder is replying to the interrogation of the T-33B. Meter readings of less than full scale indicate that the T-33B antenna is in a weak signal area. Erratic meter readings indicate that the transponder is not replying to every interrogation of the T-33B and the transponder is receiving a weak signal. This can be verified by throwing the REPLY LEVEL switch to the 100% position. Readings under 100% indicate that the transponder is not replying to every interrogation of the T-33B. It may be necessary to change the position of the T-33B to achieve sufficient signal strength. The T-33B meter must read at least full scale for proper operation of the decoder circuitry.

E. Adjust the RECEIVER/SENSITIVITY control so that meter deflection is about 1/4 scale. Adjust the 1090 MHz control on the T-33B for maximum meter deflection. Best resolution of this adjustment is made at 1/4 scale or less; adjust the T-33B sensitivity accordingly. Read transmitter frequency error directly from the dial. Maximum error permissible is ± 3 MHz.

F. To check transponder reply rate throw the REPLY/SLS switch to the 100% position. The T-33B meter now indicates the reply rate as a percentage of the interrogation rate, with full scale of 100%. A properly operating transponder must reply with a rate of 90% or greater. Note that the T-33B readout indicates the presence of Framing pulses in the reply.

G. To check the SLS circuits of the transponder throw the REPLY/SLS switch to the 10%/0 dB position. The meter, with full scale equal to 10%, should read 1.3% or less for a properly operating transponder. Note that the T-33B readout extinguishes, indicating that the transponder is not replying to the interrogation.

CAUTION: Some transponders, when receiving a signal near MTL (minimum triggering level), may transmit a reply even though the SLS pulse is present in the interrogation. If a reply is received with the SLS pulse at 0 dB, repeat the SLS test with the T-33B placed closer to the transponder antenna to increase the signal strength.

H. Turn SLS to -9 dB. Push the READOUT switch to PILOT and note the indication of the presence of the Framing pulses. Push the transponder IDENT button and note the presence of the Ident (SPIP) pulse.

I. Rotate each dial of the transponder control head through all positions and note that the T-33B indicates the same as the control head setting.

CAUTION: Do not dial any code starting with 77. To do so may activate a ground station alarm.

2.1.2 Mode C: Altitude Reporting

A. To check the altitude reporting system, it is best to determine first if the Mode C portion of the transponder itself is properly operating. To do this, disconnect the altitude digitizer from the transponder and connect a pilot code switch box * in its place. Set the transponder and T-33B for Mode C or Altitude Reporting operation. Note the deflection of the T-33B meter and presence of Framing pulses indicating that the transponder is replying to the interrogation.

Set the T-33B READOUT switch to PILOT. Rotate each dial of the pilot code switch box through all positions and note that the T-33B indicates the same as the pilot code switch box setting.

B. Once step A is completed, the only component left is the altitude digitizer. Connect it to the transponder. Setup an Altitude/Airspeed Simulator to the static and pitot source. Throw the READOUT switch on the T-33B to the ALTITUDE position. Operate the vacuum pump to any desired altitude and note the display of the T-33B. The T-33B is capable of checking any altitude from -1200 feet to 126,700 feet.

If the vacuum is gradually increased from ground level pressure, the T-33B readout may be watched to determine if there are any errors, as the readings will increase in numerical order. Any numbers appearing out of order would indicate a digitizer error. (For example, readings of 145, 146, 147, 146, 145 would indicate a broken A1 wire, or defective A1 circuit in the digitizer.)

For smaller general aviation aircraft where an Air Data Computer is not used, only the aircraft's static source is connected to the Altitude Simulator's vacuum source. The pitot (pressure) lines need not be used for altimeter encoder checks.

By performing step A before step B, the fault in a defective altitude reporting transponder is thus isolated to the section where the problem lies - with the Altimeter/Encoder or the transponder itself. If step B is performed first, all that can be determined is that the transponder <u>or</u> digitizer is defective.

C. A pilots "squawk sheet" which includes the altitude at which the ground station reported erroneous altitude would reduce the fault isolation time. Dissemination of this information by the flight crew would provide the technician with valuable trouble shooting information. Those altitudes reported to be in error can be immediately selected and verification of their inaccuracies could be established. Needless to say, a system wired so that the Altimeter/Encoder's output is connected to either of two transponders is also an aid. Having eliminated the transponder as the

* Box and switch wired to activate A, B, C and D bits.

error source, the actual altitude or altitudes which the ground station reported as erroneous should give the technician a clue to the nature of the Altimeter/Encoder's malfunction.

D. In order to compare digitizer altitude with the readings of the pilot's altimeter, it is essential that the altimeter barometer correction be set to 29.92 in. Hg., as the digitizer is permanently set to that reference.

When the T-33B altitude readout in feet does not agree (within the acceptable limits) with the altitude readout of the Altitude Simulator or Altimeter/Encoder the READOUT switch should be set to the PILOT position. In Mode C this now reads the modified Grey (Altitude) code. All altitude points where disagreement occurs should be noted on paper. With the aid of the ALTITUDE-to-CODE and CODE-to-ALTITUDE charts supplied in the cover of the T-33B the error of the altimeter's encoder can be quickly determined. Example: Missing A, B, C, D bit info, additional bit info, or transposed bit, etc.

E. For your convenience the T-33B has been designed so that if invalid C 0, 5, or 7 codes are present 400,000 feet is added to the altitude reading. If invalid D 1, 3, 5, or 7 codes are present 200,000 feet is added to the altitude reading. Correspondingly if both erroneous C and D codes are present 600,000 feet will be added to the altitude reading.

When there is no Mode C information, such as would occur with a disconnected digitizer, the T-33B altitude readout will be 4007. This can be verified by setting the T-33B readout switch to PILOT. A display of 0000 will be indicated.

2.2 OPERATION USING DIRECT CONNECTIONS:

The T-33B may be operated using a direct connection between the T-33B BNC jack and the unit under test. The purpose of using a direct connection is twofold: It is necessary to use the direct connection when transponder receiver sensitivity checks are to be made, and the direct connection may be used when it is undersirable or not possible to make radiated checks. Caution: Never make a direct connection between the T-33B TNC jack and unit under test. To do so will damage the T-33B. To make a direct connection to the T-33B it will be necessary to gain access to the antenna jack or antenna cable of the transponder. Some units, such as the King KT-75, use cabinet mounted R.F. and power connectors. In order to make a direct connection to this type of installation it will be necessary to obtain a suitable jumper cable to make the power connection, and an R.F. connector and cable to mate with the antenna jack on the transponder and the T-33B. The attenuation of this cable, at 1 Gc, must be known if accurate receiver sensitivity checks are to be made. A four foot section of RG58/U cable, for example, will have an attenuation of about 0.7 dB. Also, R.F. connector must be properly assembled with correct lead lengths or additional attenuation may occur.

CAUTION: Do not make transponder frequency checks using the direct connection. The transponder frequency may be dependent upon the load that the transmitter sees. Frequency measurements must be made with the transponder operating into its own antenna.

Operate the T-33B with the REPLY/SLS switch in the 100% position, and adjust the RECEIVER/SENSITIVITY control for a meter reading between 90 and 100%. The RECEIVER/SENSITIVITY control will then indicate the sensitivity of the receiver. Verify that the difference in sensitivity between Mode A and Mode C does not exceed 1 dB.

Throw the REPLY/SLS switch to the 10% position and verify that the reply rate is 1.3% or less.

2.3 BATTERY RECHARGING

The BATTERY CHECK meter in the T-33B will give a constant indication of the condition of the battery in the unit when the POWER switch is on. A fully charged battery will deflect the meter to the right hand side of the scale. As the battery terminal voltage decreases with use, the needle will move towards the red area. When the needle enters the red area the battery is discharged and must be recharged.

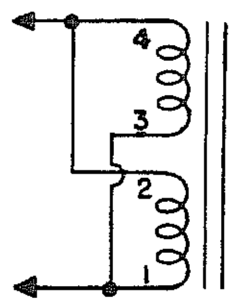
It is recommended that, for best battery life, the T-33B not be operated until the battery is exhausted. This is due to the fact that when the depth of discharge is very deep, some cells will be near a zero state of charge. In this condition the possibility of an internal short in the cell is much greater than in a partially charged cell, since a charged cell can vaporize a short circuit as it is forming.

It is especially important not to run the battery down to terminal voltage well below the point when the battery check meter enters the red area of the scale. This will occur if the spring loaded power switch is defeated so that the unit remains on even though the battery needs recharging. If this is allowed to happen the cells which become depleted first will be reverse charged by the remaining cells, and could be permanently damaged.

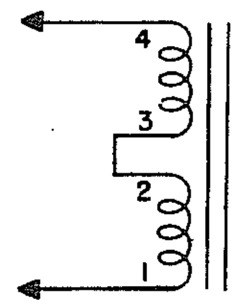
To recharge the battery plug the line cord into any 115 volt 50 - 400 Hz line. Full recharging takes about 14 hours. There is no danger of overcharging the battery if the charger is left on indefinitely.

The T-33B is supplied with seven 1.2 volt Ni-Cad cells, which will give about 3 hours continuous duty (with the readouts illuminated) before they must be recharged. A pilot lamp near the line cord connector indicates that the charger is operating. It is not necessary to charge the battery to operate the unit. Simply plug the line cord into any 50 - 400 Hz 115 volt power source and operate the unit in the normal way. The charging circuit will provide sufficient power to operate the unit while simultaneously charging the battery.

CAUTION: If it is desired to operate the unit from a 230 volt source, change the wiring to the primary of T2 as follows:



115 VOLT INPUT



230 VOLT INPUT

This change may not permit the T-33B to be charged in the aircraft as the majority of large airplanes supply 115 volts AC, not 230 volts. If the T-33B Ni-Cad cells are only partially charged the BATTERY CHECK meter will indicate satisfactory battery voltage because of their excellent voltage characteristics. Thus it is possible that the T-33B battery may have only 10 or 15 minutes of life remaining, and there would be no way to charge the unit in the aircraft and continue the test if the battery runs down. Result - wasted time.

SECTION 3
THEORY OF OPERATION

3.1 SYSTEM:

The T-33B consists of several printed circuit board assemblied which are broken down according to function. The transmitter receiver section forms one printed circuit board utilizing one integrated circuit as the I. F. amplifier. A separate R. F. board contains the attenuator circuitry required to make receiver sensitivity measurements. The encoder, decoder, and translator are each a separate printed circuit board. The Numitron driver circuit board and battery charger circuit board complete the unit.

Figure 3 - 1 is a block diagram of the unit. Refer to section 3.2 for detailed descriptions of the circuitry.

Figure 3 - 2 is a timing diagram with the T-33B set to Mode 3/A which will help in understanding what is happening during each interrogation period of the T-33B. Waveshape number one is the reference waveshape. A scope synchronized with this pulse can then be used to display all others.

3.2 FUNCTIONAL DESCRIPTION:

3.2.1 Q2, Crystal Oscillator

Q1 operates as a common base Colpitts oscillator with feedback taking place at the series resonant frequency of the crystal. The collector tank circuit is tuned to the fifth overtone of the crystal, 128.75 MHz, and prevents oscillation at the fundamental and third overtone crystal frequencies.

3.2.2 Q1, First R. F. Frequency Doubler

Q2 operates as a grounded base frequency doubler. The collector of Q2 is returned to B + through modulator Q4, so that Q2 operates only in the presence of pulses at the base of Q4. The output frequency of this stage is 257.5 MHz.

3.2.3 Q3, Second R. F. Frequency Doubler

Q3 is a common emitter frequency doubler. Since it has no forward bias there is conduction only in the presence of R. F. energy from Q2. The collector circuit is tuned to 515 MHz.

3.2.4 Q29, Third R. F. Frequency Doubler

R. F. energy at 515 MHz is coupled to the base of Q29 through C46. The output circuit of Q29, L7 and C4, is a parallel resonant circuit tuned to 1030 MHz. A 50 ohm transmission line carries R. F. energy from the tank circuit to the antenna of the unit. The output from this stage is also fed to Q5 as a local oscillator signal, and the R. F. attenuator printed circuit board.

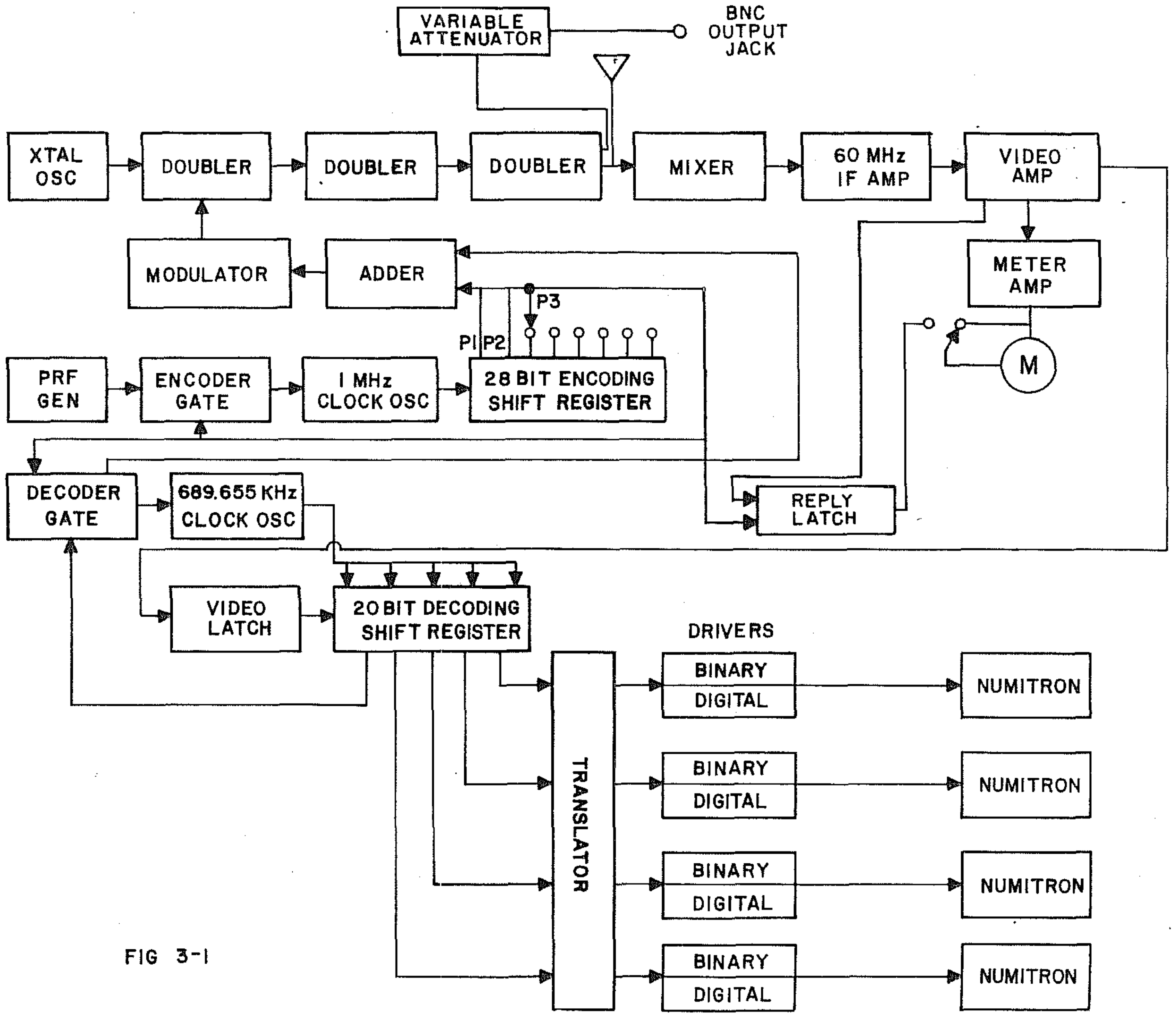

VARIABLE ATTENUATOR
BNC OUTPUT JACK
XTAL OSC
DOUBLER
DOUBLER
DOUBLER
MIXER
60 MHz IF AMP
VIDEO AMP
METER AMP
M
MODULATOR
ADDER
P1
P2
P3
PRF GEN
ENCODER GATE
1 MHz CLOCK OSC
28 BIT ENCODING SHIFT REGISTER
DECODER GATE
689.655 KHz CLOCK OSC
REPLY LATCH
VIDEO LATCH
20 BIT DECODING SHIFT REGISTER
TRANSLATOR
DRIVERS
BINARY
DIGITAL
NUMITRON
BINARY
DIGITAL
NUMITRON
BINARY
DIGITAL
NUMITRON
BINARY
DIGITAL
NUMITRON

FIG 3-1

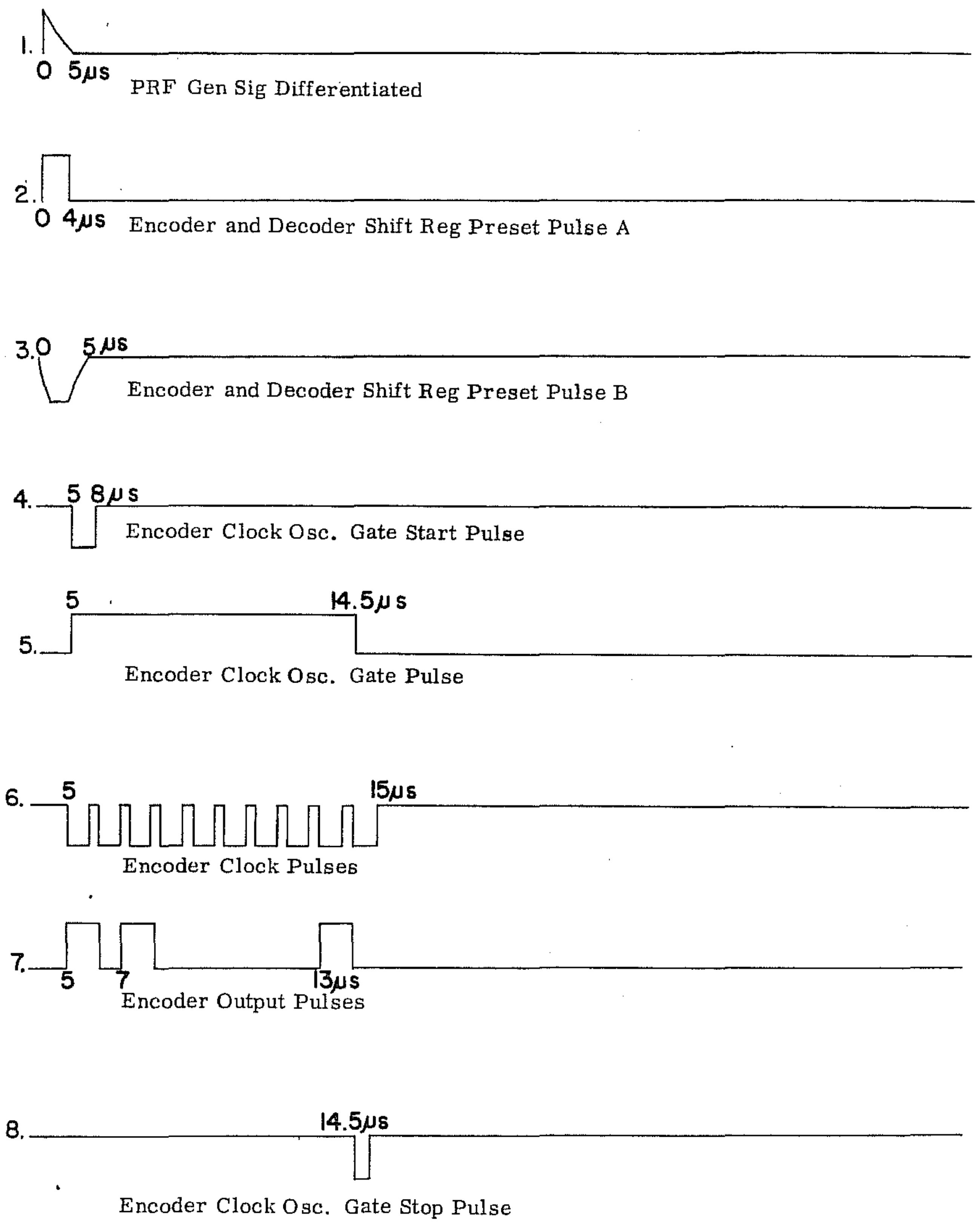

1.
0 5μs
PRF Gen Sig Differentiated
2.
0 4μs
Encoder and Decoder Shift Reg Preset Pulse A
3. 0 5μs
Encoder and Decoder Shift Reg Preset Pulse B
4. 5 8μs
Encoder Clock Osc. Gate Start Pulse
5 14.5μs
5.
Encoder Clock Osc. Gate Pulse
6. 5 15μs
Encoder Clock Pulses
7.
5 7 13μs
Encoder Output Pulses
8. 14.5μs
Encoder Clock Osc. Gate Stop Pulse

FIG 3-2

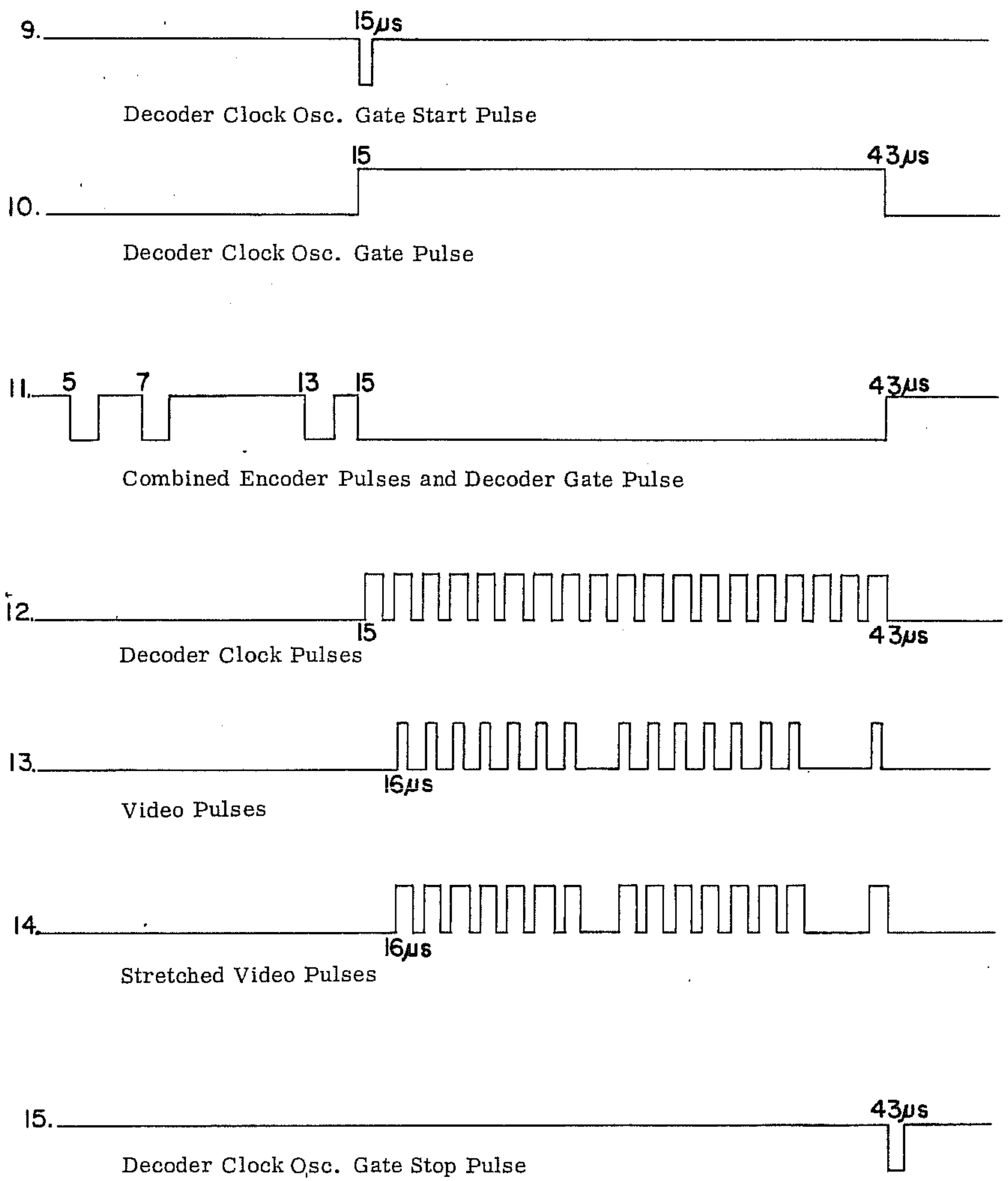

9. 15µs
Decoder Clock Osc. Gate Start Pulse
10. 15 43µs
Decoder Clock Osc. Gate Pulse
11. 5 7 13 15 43µs
Combined Encoder Pulses and Decoder Gate Pulse
12. 15 43µs
Decoder Clock Pulses
13. 16µs
Video Pulses
14. 16µs
Stretched Video Pulses
15. 43µs
Decoder Clock Osc. Gate Stop Pulse

FIG 3-2

3.2.5 Q4, Modulator

Q4 is an emitter-follower which provides collector current for Q2 whenever pulses are applied to Q4 base. A test switch in the base circuit of Q4 allows the R.F. section of the unit to operate in a cw mode, which is necessary for alignment of the tuned circuits.

3.2.6 Q5, Mixer

Q5 operates as a frequency mixer. Its base receives the crystal controlled 1030 MHz produced by Q29 and the 1090 MHz reply pulses from the transponder. Mixing of these frequencies produces a 60 MHz I.F. in the output of this stage. The 1030 MHz local oscillator signal is delayed 3 μsec from P3. It is turned on by the decoding shift register gate and remains on while the gate is open.

3.2.7 IC1, I.F. Amplifier

The 60 MHz output of Q5 is amplified by this IC. Since the transponder may be several MHz off frequency, the output circuit of the IC is tuned by voltage controlled diodes and has a tuning range of 54 to 66 MHz. This is controlled by the 1090 MHz potentiometer on the front panel. The gain of this IC is controlled by the RECEIVER SENSITIVITY control on the front panel when the SLS/REPLY switch is in the Level position. IC1 operates only during the gate time of the decoder clock so that the interrogation pulses of the T-43 do not come through the receiver video section.

Q22 and Q28 provide compensation to diodes CR2 and CR3 so that the frequency calibration of the I.F. amplifier remains essentially constant with changes in the sensitivity control on the front panel.

3.2.8 Q6, Emitter-Follower

Q6 acts as emitter-follower to drive Q7 with detected I.F. pulses.

3.2.9 Q7, Pulse Amplifier

Q7 amplifies and inverts the detected reply pulses.

3.2.10 Q8 and Q9, Emitter - Followers

Q8 and Q9 are cascaded emitter-followers. C26, connected from the emitter of Q9 to ground, acts as a pulse stretcher to provide sufficient energy to activate the microammeter, M1.

3.2.11 Q10, PRF Generator

Q10 together with R30 and C27 form a relaxation oscillator whose frequency is determined by the time constant R30, C27. When power is applied to the circuit Q10 is biased in the conducting region and C27 charges to the supply voltage very rapidly. This cuts off Q10, and C27 then discharges through R30 until the point is reached where Q10 conducts and charges C27 again. The signal produced is a saw tooth with a sharp rise and a decaying fall. The sharp rise time is differentiated and fed into two inverter clippers IC2D and IC2F.

3.2.12 IC2D and IC2C, Inverter Drivers for Gate IC3A

The two inverters IC2D and IC2C shape and delay the differentiated saw from the PRF Generator to generate a drive pulse for the gate IC3A terminal 1.

3.2.13 IC2F, IC2E, IC2A and IC2B, Inverter Preset Pulse Shaper

The four inverters IC2F, IC2E, IC2A and IC2B shape the differentiated saw from the PRF Generator to generate preset pulses for the 28 Bit Encoding Shift Register IC4 through IC10 and the Decoding Shift Register IC15 through IC19.

3.2.14 IC3A and IC3B, Clock Oscillator Gate

The clock oscillator gate is composed of two NAND gates IC3A and IC3B connected to form a latch circuit. The circuit has two stable states. When IC3A (terminal 1) receives a pulse from IC2C (terminal 6) the output IC3A (terminal 3) goes to logical one and remains there until a stop pulse is received at IC3B (terminal 5). When a stop pulse reaches IC3B (terminal 5) it resets IC3A (terminal 3) output to logical zero. This action turns the 1 MHz clock oscillator on and off by changing the bias on the base of the emitter-follower Q11.

3.2.15 Q12, 1 MHz Clock Oscillator

Q12 is a Colpitts oscillator which operates at a frequency of 1 MHz. Collector voltage for Q12 is fed through emitter-follower Q11 so that oscillation takes place only during the time the gate output of IC3A (terminal 3) is at logical one. The output of Q12 is fed to emitter-follower Q13 which drives an inverter pulse shaper IC12C to produce clock pulses which are fed to terminal 7 of the encoding shift register IC4 through IC9.

3.2.16 IC4 through IC10, 28 Bit Encoding Shift Register

The encoding shift register consists of twenty eight flip-flop circuits connected in cascade with provision to preset each of the flip-flops to logical one or logical zero output. The PRF rate generator initiates the pulse which presets the first output to logical zero and all other outputs to logical one. The PRF rate generator also initiates the pulse, which is delayed from the preset pulse, to open the gate and start the 1 MHz clock oscillator. The clock pulses then transfer logical zero through the entire shift register at a 1 MHz rate. By taking pulse outputs at specific points in the shift register it is possible to have pulses occuring at specific delay times. In this way timing for P1, P2, and P3 of the interrogation for all the modes, is produced.

3.2.17 IC11A, IC11B, IC11C, Adders

The outputs of the encoding shift register are added in a NAND gate IC11A to produce a three-pulse train consisting of P1, P2, and P3. These pulses are 1 microsecond wide. They are fed to NAND gate IC11B and inverted. The resultant output of this gate is the three pulse train with 1.0 microsecond pulse width. This train is fed to NAND gate IC11C along with a strobe pulse from IC3B (terminal 6). The purpose of the strobe pulse is to provide a local oscillator for the received reply pulses from the transponder. The combined pulse train is fed to an inverter IC12A and then an amplifier Q14. The output of Q14 drives the modulator Q4 in the R.F. section.

3.2.18 IC3C and D and IC12D, Stop Gate Pulse Delay

Two NAND gates IC3C and D are connected in a latch configuration. The selected P3 pulse is fed to one gate and the clock pulses to the other. The output of this combination is 0.5 microsecond wide and delayed by approximately 0.5 microsecond from P3. This pulse is differentiated and drives the inverter pulse shaper IC12D. The output from the inverter is delayed approximately 1 microsecond from P3 and acts as the gate stop pulse for IC3B to turn off the clock oscillator.

3.2.19 IC14F, Inverter Shaper

The gate stop pulse from IC12D is differentiated and fed to IC14F, an inverter and pulse shaper. The output is used as a start pulse for the decoder gate.

3.2.20 IC13A and IC13B, Decoder Gate

The decoder gate, IC13A and IC13B is composed of two NAND gates connected together to form a latch circuit. This gate turns the decoder clock oscillator on and off. When it receives a start pulse from terminal 12 of IC14F, approximately 1.5 microseconds after P3, it starts the decoder clock oscillator. When it receives a stop pulse from terminal 10 of IC14E it stops the clock oscillator.

3.2.21 Q17, 689.655 kHz Clock Oscillator

Q17 is a Colpitts oscillator operating at 689.655 kHz (period 1.45 microseconds). Collector voltage for Q17 is fed through emitter-follower Q16 so that oscillation takes place only during the time the decoder gate output of IC13A (terminal 3) is a logical one. The output of Q17 is fed to emitter-follower Q18 which drives an inverter pulse shaper, IC14B. IC14B drives inverter IC14C to produce clock pulses which are fed to terminal 7 of the decoding shift register IC15 through IC19.

3.2.22 IC13C and IC13D, Video Latch

In order for the decoder to record the video information, video information and a clock pulse must occur at the same time, the video pulse occurs at an indeterminate time with relation to the clock pulse. Therefore the video pulse must be held at the serial input of the shift register until a clock pulse occurs. This function is accomplished by the video latch. The circuit consits of two NAND gates (IC13D and IC13C), connected together to form a circuit which has two stable states. A logical zero video pulse fed into terminal 12 of IC13D will cause its outputs terminal 11, to become logical one and remain at logical one until a clock pulse (logical zero) occurs at terminal 10 of IC13C. This clock pulse resets the latch output to its original state of logical zero. In this manner the video information is held at terminal 1 of IC15 (shift register) until a clock pulse occurs.

3.2.23 SLS Modulator IC22A, IC22B, and Q32

Two Negative going pulses from the encoding shift register are combined in IC22A to produce a single positive pulse 2 microseconds wide occuring during the time of P2. IC22B is used as a gate to allow this wide pulse through to the base of Q32 when the REPLY/SLS switch calls for SLS to be 9 dB down. Q32 acts as an emitter follower and applies B + and SLS modulation to Q3 and Q29 through L6 and L7. A potentiometer in the base circuit of Q32 allows the SLS modulation to be set to 9 dB below P1 and P3.

3.2.24 Percent Reply Comparator IC22C, IC22D, and Q33

IC22C and IC22D are connected in a latch circuit configuration. This circuit has two stable states. At the start of the interrogation a negative going P1 pulse causes the output of IC22D to go to a logic one condition. If a transponder reply is received the output of IC22D is switched to a logic zero condition by the action of IC22C. Thus the output of IC22D is essentially zero during the interval between interrogations when the T-33B receives 100% transponder replies.

IC22D turns on constant current generator Q33 and causes the meter to read 100%. Should the transponder reply at a rate less than 100% the output of IC22D remains at logic one condition each time the interrogation is not followed by a reply, and the percent reply is the average current generated by Q33. Full scale of 10%, required when the SLS pulse is on, is provided by increasing the current of Q33 by a factor of ten. This is accomplished by changing the resistance in the emitter circuit of Q33.

3.2.25 Attenuator Current Generator Q34

Q34 is connected as a current generator with a variable resistance in the emitter circuit.

When the REPLY/SLS switch is in the 100% or 10% position current flows from the collector of Q34 through a diode CR35 and resistor R211 to the variable attenuator. The amount of current fed to the attenuator, and thus its attenuation, is controlled by the front panel RECEIVER SENSITIVITY control.

When the REPLY/SLS switch is set to the Level position current is allowed to pass through R203, CR37, R211, and the attenuator. This cuts off CR35 and at the same time maintains minimum attenuation. Current from Q34 then flows through CR36 and R210. This allows the front panel RECEIVER SENSITIVITY control to vary the voltage fed to IC1 in the T-33 receiver, and control its sensitivity.

3.2.26 Receiver Blanking Q35

A positive going pulse, occuring during the reply time of the transponder, is fed to the base of Q35. This cuts off Q35 and allows the RECEIVER SENSITIVITY control to set the gain of I. F. amplifier IC1. At all other times a Q35 is held in saturation causing a + 5 volt level to be applied to IC1, cutting it off. In this way the receiver is cut off at all times except during the reply time of the transponder.

3.2.27 Attenuator

The attenuator is actually composed of five separate attenuators: three fixed and two variable. The fixed attenuators are L or π sections which serve to isolate the variable attenuators while providing the required fixed attenuation. The variable attenuators are hot carrier diodes with variable resistance characteristics. The amount of resistance, and thus attenuation, is controlled by the level of current in each diode. CR38 and R215 is the variable attenuator which provides the transponder receiver sensitivity measurement. CR39 and R180 is an attenuator used for calibrating the front panel RECEIVER SENSITIVITY dial.

3.2.28 IC15 Through IC19, 20 Bit Decoding Shift Register

The purpose of the decoding shift register is to collect the video information and present it to the translator in proper sequence and at the proper time for readout. Preset pulses from the input and output of IC14A are initiated by the PRF generator Q10. These pulses, and the fixed bias on terminal 14* of IC15, presets terminal 13 of IC15 to logical one and all other outputs of the shift register to logical zero. Approximately 1.5 microseconds after P3 a start pulse from IC14F activates the decoder clock oscillator gate IC13A, IC13B and starts the decoder clock oscillator. The clock pulses advance the logical one preset into terminal 13 of IC15, through the shift register. Coincident with the second clock pulse the stretched video pulse (first Framing pulse) is applied to terminal 1 of IC15. This transfers a logical one to terminal 13 of IC15 which is then stepped through the shift register by sub-

* terminal 2 on T-33C instead of terminal 14

sequent clock pulses. In this manner each video reply pulse is entered into the register and stepped along. When the original preset logical one *arrives at terminal 9 of IC19 it drives inverter IC14E to produce a stop pulse for the decoder clock oscillator gate. The clock oscillator stops and the decoder retains the reply pulse information until it receives another preset pulse.

*terminal 10 on T-33C instead of terminal 9

3.2.29 IC28B, IC28E, and Q21, Framing Pulse Detector and Display Code Selector

The T-33B is designed so that no readout will be obtained unless both Framing pulses are preset in the reply train. This avoids the possibility of reading erroneous reply codes due to a lack of Framing pulses. When Q21 conducts, supply voltage is fed to the display code selector switch. Q21 will not conduct unless the output of both IC28B and IC28E are at logical one. IC28B receives its input signal from pin 1 on Numitron V1 and IC28E receives its input signal from pin 1 on Numitron V3. (These are the Numitron connections for displaying Framing pulse readouts.) The READOUT selector switch applies the supply voltage to the proper integrated circuits to provide the desired display. In addition it disconnects power to the translator circuitry when altitude readout is not required. This feature conserves battery power.

3.2.30 IC31B, IC31A, IC31C, IC31D, IC30D, IC30C and IC30B Gray to Binary Code Converter

Seven exclusive OR gates are used to convert the A, B, and D reply pulse information to 500, 1K, 2K, 4K, 8K, 16K, 32K, and 64K feet, using -1200 feet as a zero reference. This reference is necessary because the ICAO code start at -1200 feet using a mixed Gray binary and Gray decimal code. (A Gray code is one in which only one bit at a time changes. Thus, a 3 bit Gray code would be 000, 001, 011, 010, 110, 111, 101, 100.)

The C reply pulse information contains the 100 foot increments of the altitude. To utilize this information the C pulse sequence must be converted in several steps. As encoded by the digitizer, this sequence is 1, 3, 2, 6, 4, 4, 6, 2, 3, 1. The first conversion is to sequence 1, 3, 2, 6, 4, 1, 3, 2, 6, 4 or 4, 6, 2, 3, 1, 4, 6, 2, 3, 1 (depending upon the logic states of the negative altitude bus and 500 foot bus).

This is accomplished by IC30A, IC35A, IC44A, IC44C, and IC43. The three bit C information is then passed through IC44B and IC44C which form a Gray code to binary code converter. This results in the sequence 1, 2, 3, 4, 7, 1, 2, 3, 4, 7 or 7, 4, 3, 2, 1, 7, 4, 3, 2, 1. IC34D and

IC45 add 2 to each number of the sequence except 7, so that the sequence becomes 3, 4, 5, 6, 7, 3, 4, 5, 6, 7 or 7, 6, 5, 4, 3, 7, 6, 5, 4, 3. In addition, a logic one level from the 500 foot bus, through IC45, adds 5 to the second half of each sequence. Thus we have 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, or 12, 11, 10, 9, 8, 7, 6, 5, 4, 3. This information is passed through IC46, a binary to BCD converter, and then fed to the "D" Numitron to read hundreds of feet.

3.2.31 C and D Error Check

A binary to decimal decoder, IC43, is used to provide an output of logical one in the event of an invalid C Code (0, 5, or 7). This error signal is then used to add 400,000 feet to the altitude display so that the technician is alerted that the transponder has an invalid reply. The ICAO Code does not have any odd value for D, thus the D1 pulse must always be zero. The D1 output of the decoder is used to add 200,000 feet to the altitude display so that the technician is alerted that the transponder has an invalid reply. An error in both C and D Codes will add 600,000 feet to the altitude display.

3.2.32 Negative Altitude Determination

A total of nine gates are used to analyze the output of the Gray to Binary converter to determine if the transmitted reply represents a negative altitude. This is accomplished by first determing if the magnitude of the altitude is below 2,000 feet. Then, by analyzing the C4 pulse, 500 feet, and 1,000 feet components of the reply the negative altitude is determined. The output of IC35B is logical one for a negative altitude, causing the center segment of the "A" Numitron (V1) to be lit and show a minus sign.

3.2.33 -1200 Feet Correction

The ICAO Code starts at -1200 feet. Therefore, in order for the T-33B to display the correct altitude, this factor of -1200 must be added to the outputs of the Gray to Binary converter. This is accomplished by two 4 bit adders IC37 and IC38.

3.2.34 7 Bit Binary to BCD Converter

The 7 bit Binary to BCD conversion is accomplished by IC39, IC40 and IC41. These are 6 bit Binary to BCD converters connected in cascade to perform 7 bit Binary to BCD conversion. The function performed by these 6 bit Binary to BCD converters is analogous to the algorithm.

a. Examine the three most significant bits. If the sum is greater than four, add three and shift left one bit.

b. Examine each BCD decade. If the sum is greater than four, add three and shift left one bit.

c. Repeat step (b) until the least significant binary bit is in the least significant BCD location.

The output of the 7 bit converter is fed to the A, B, and C Numitrons to display the 100,000, 10,000 and 1,000 foot components of the decoded altitude.

The output of the 7 bit converter is fed to the A, B, and C Numitrons to display the 100,000, 10,000 and 1,000 foot components of the decoded altitude.

3.2.35 Numitron Readouts

Four identical Numitron readout circuits are used to display the reply readout. Thus the following description of the "A" Numitron, V1, applies also to V2, V3, and V4.

A1, A2, and A4 binary information stored in the decoding shift register is fed to the translator printed circuit board and ultimately appears at the input of the "A" Numitron decoder, IC22. This decoder translates the binary code information to the proper outputs to light up the segments of the Numitron and display the proper digit. When the T-33B READOUT switch is set to the PILOT or BINARY position the translator circuitry is disabled by removing the regulated 5 volt power to IC30 through IC46, except IC36 and IC42. The A1, A2, and A4 information is passed through buffers IC42D, 42F, and 42E to decoder IC22 and binary display inverters IC26F, 26A, and 26B. When pilot code is desired, IC22 is energized; when binary code is desired IC26 is energized. When the READOUT switch is in the ALTITUDE position the Binary to BCD decoders in the translator and the Numitron decoder IC22 are turned on; buffers IC42 and inverters IC26 are turned off.

DC power to the Numitron decoder IC22 and Binary display inverter IC26 is controlled by IC28B and IC28E through 5 volt regulator Q21, so that the display is blanked out if either or both Framing pulses are absent. IC28A, 28D, 28F, and 28C connect power to the Numitrons to indicate Framing, X, and Ident pulses.

3.2.36 Power Supply and Battery Charger

The T-33B utilizes seven 1.2 volt Ni-Cad cells as its' power source. Most of the power in the unit, at 5 volts, is required by the integrated circuits and Numitrons. This is provided by IC21 and Q20. A small portion of the power, at 9 volts, is required by the R.F. section of the unit. In order to operate IC20 as a 9 volt regulator the 8.4 volt terminal voltage of the battery is doubled. This is accomplished by generating an 8 volt peak-to-peak square wave and passing it through a voltage doubler, similar to that used on AC supplies. The output of the doubler, about 14 volts under load, is then fed to IC20.

The charger circuit performs two functions: It supplies a constant current of about 400 ma to the batteries at all times, and delivers full load current to the unit when the unit is in operation. In this way the unit may be operated continuously from the AC line, without drawing any current from the batteries.

The unit is protected by two fuses, a 1/2 ampere "SLO BLO" fuse connected in series with the AC line and a 3 ampere fuse connected in series with the batteries.

3.2.37 IC21, and Q20, Voltage Regulator for 5 Volt Supply

IC21, Q20 and their associated components form a 5V regulated supply. The load on this supply varies over a wide range since it furnishes current for the Numitrons as well as other circuitry. Depending upon the particular readout, current required by the Numitrons varies over the range of 50 ma to 700 ma. IC21, is a fixed 5 volt IC regulator circuit which is returned to ground through CR11 so that a fixed voltage of 5.7 volts is impressed on the base of Q20. The emitter of Q20 is thus held to 5.0 volts over the wide range of load current.

3.2.38 IC20, Voltage Regulator for 9 Volt Supply

IC20 and its associated components act as a 9V output regulator. As long as the input voltage to the regulator is 12.5 volts or greater the output will be a regulated 9 volts. Q19 monitors the + 14V bus and the 9V output. If the bus voltage drops to a level where the regulator can no longer produce 9 volts, the meter in the collector circuit of Q19 will indicate in the red portion of its scale. A red scale reading of this meter indicates that the batteries require recharging.

3.2.39 Video Emitter Follower, Q36

Interrogation video pulses from IC11 pin 12, and reply video pulses from Q8 emitter, are fed to Q36 which is an emitter follower. The output of Q8 is fed to the front panel video test point to provide a means for displaying both interrogation and reply pulses.

3.2.40 Directional Coupler Assembly

The directional coupler assembly is a separate printed circuit board mounted near the final R.F. amplifier of the transmitter. The purpose of the directional coupler is to attenuate the R.F. energy fed to the variable attenuator from the transmitter, while permitting the received signal from the transponder to reach the receiver with minimum attenuation. The use of a directional coupler for this purpose permits a high level of transmitter power in the T-33B without sacrificing the sensitivity of its receiver.

SECTION 4
TROUBLE SHOOTING AND MAINTENANCE

4.1 GENERAL:

The T-33B is completely solid state, with a large portion of the circuitry composed of TTL integrated circuits. Periodic maintenance requires recharging the Ni-Cad battery for at least 14 hours once a month. Annual recalibration is recommended. The battery check indicator on the front panel of the instrument shows the condition of the battery when the instrument is turned on. If the needle on this indicator enters the red area of the scale the battery is exhausted and must be recharged.

The T-33B is protected by two fuses, both located on the battery charger printed circuit board. A 1/2 ampere "SLO BLO" fuse, type MDL-1/2, is located in the transformer primary lead and a type AGC-3, three ampere, fuse is connected in series with Ni-Cad batteries. To determine if the fuses are good plug the line cord into a 115V 50-400 Hz outlet. If the charge indicator lamp lights, the fuses are good.

Do not fuse the unit with a larger value fuse since charged Ni-Cad cells can deliver over fifty amperes into a short circuit. This could result in serious damage to the wiring and printed circuit boards. Both board conductors and wiring can melt.

In the event a transponder does not check out with the T-33B, try the unit on another transponder, known to be in operating condition.

The T-33B utilizes several printed circuit boards in its construction. Most printed circuit boards are readily accessible by means of hinged assemblies. Most integrated circuits and transistors may be removed from the unit without unsoldering. Before attempting formal trouble shooting procedures it is recommended that the transistors or integrated circuits in the section showing trouble be checked. The quickest check is to replace the suspected transistor or integrated circuit with a new one.

4.2 DISASSEMBLY:

To remove the T-33B from its cabinet remove the antenna cap and the four binding head screws from the front panel. Swing the bottom of the front panel out while holding the top of the panel in place. This will permit the R.F. connectors in the top of the unit to clear the cabinet. The entire chassis will then lift out of the cabinet. Be careful to avoid putting a strain on the battery supply leads. The battery supply leads are terminated in a connector which plugs into a socket on the battery charger printed circuit board.

To gain access to the entire unit loosen two screws and remove two nuts. The assemblies will then swing apart to allow access to both sides of all printed circuits boards in the unit except the decoder and attenuator.

The attenuator printed circuit board is mounted over the decoder board. Remove two screws on the attenuator board and swing it aside to gain access to the decoder board.

4.3 MAINTENANCE ADJUSTMENTS:

This section covers all adjustments in the unit. Do not perform an adjustments unless the unit does not meet its performance specifications, and then only if proper equipment is available. The test equipment required is as follows:

A. Oscilloscope, two channel, triggered mode, bandwidth at least 10 MHz. (H.P. Model 180A or equivalent.)

B. VTVM (RCA Junior Volt Ohmyst or equivalent.)

C. Spectrum Analyzer. (H.P. Spectrum Analyzer 8554L/8552A or equivalent.)

D. Signal Generator for 1030/1090 MHz. (H.P. Model 612A or equivalent.)

E. R.F. Detector for 1020 MHz. (Modified General Radio 874 VQ or equivalent.)

F. DC Power Supply variable to 10V at 1.5 Amp. (Heathkit Model IP20 or equivalent.)

G. Counter (H.P. Model 5245L with 5254C Frequency Converter or equivalent.)

H. TIC Model T-14A ATC Pulse Generator.

I. Digital Voltemeter, Fluke 8000A or equivalent.

J. Adapters, GR874 to BNC and TNC.

Refer to illustrations for locations of the following adjustments:

4.3.1 R60, + 9 Volt Adjust

This potentiometer controls the output of IC20, the 9 volt regulator. Connect a Fluke or Digital Voltmeter between chassis and TP + 9V, on the encoder board. Adjust R60 on the encoder board for a reading of + 9 volts ± .1V.

4.3.2 R62, Battery Condition Indicator

This potentiometer sets the point at which the BATTERY CHECK meter needle enters the red portion of the scale. Connect a adjustable 10 volt, 1.5 ampere DC supply between chassis (negative lead) and the collector of

Q20 or Q21 power transistors. Do not operate the power switch. Connect a VTVM to TP + 9V on the encoder board. Reduce the output voltage of the supply and determine the input voltage at which the voltage at TP + 9V falls out of regulation. Set the power supply to 0.25 volt higher. Adjust R62 so that the battery check indicator is exactly on the dividing line between the red and white portion of the scale.

4.3.3 Transmitter Alignment

This section covers four tuned circuit adjustments on the R.F. board. These adjustments must be performed in sequence. An R.F. detector capable of detecting 1030 MHz pulses will be required to perform the R.F. alignment of the unit. A modified General Radio 874 VQ detector is recommended. To modify this detector, use the following procedure, which reduces the output capacitance of the detector.

a. Unscrew the detector output connector assembly from the body of the 874-VQ.

b. Remove the two screws holding the capacitor plate. Lift the capacitor plate and remove the mica sheet.

c. Remount the capacitor plate with a two 1/4" diameter insulating washers which are 0.016" thick and have a 0.125" hole. The washers may be made of any good insulating material. Do not use washers of greater thickness, since contact with diode will be lost.

d. If desired, the IN23 diode may be replaced with IN23Br diode to provide a positive pulse output.

e. Replace the detector output connector assembly to the body of the 874-VQ.

Transmitter Adjustments

a. C1, R.F. Oscillator

Set the test switch on the R.F. board to the cw position. Connect the common lead from the VTVM to TP3 and the other lead to TP1. Set the VTVM to read negative voltage. Adjust C1 for a maximum DC reading. WARNING: The power supply or the VTVM must be floating above ground or the 9V supply will be shorted out. Normal indication is about -2 volts.

b. C2, C3, and C4

These adjustments tune the tank circuits of Q3 and Q29, and are performed under pulse modulation conditions. To make these adjustments a detector capable of detecting R.F. pulses at 1030 MHz will be required. A modified General Radio 874 VQ detector, connected as shown in Figure 4 - 1 is recommended.

Set the T-33B test switch on the R. F. board to Normal. Set the vertical gain of the scope to 0.1 volt per centimeter, and synchronize the scope internally. Adjust C2 for maximum pulse height. If no pulse display is present, set C3 and C4 to midposition and readjust C2 for maximum pulse amplitude. Once C2 is adjusted, retune C3 and C4 alternately until maximum pulse amplitude is obtained. The final pulse amplitude should equal or exceed + 5 dBm. You may calibrate the detector at + 5 dBm by connecting it to a HP612A set to + 5 dBm output, CW function at 1030 MHz and observing the DC level displayed by the scope. This hookup is shown in Figure 4 - 2.

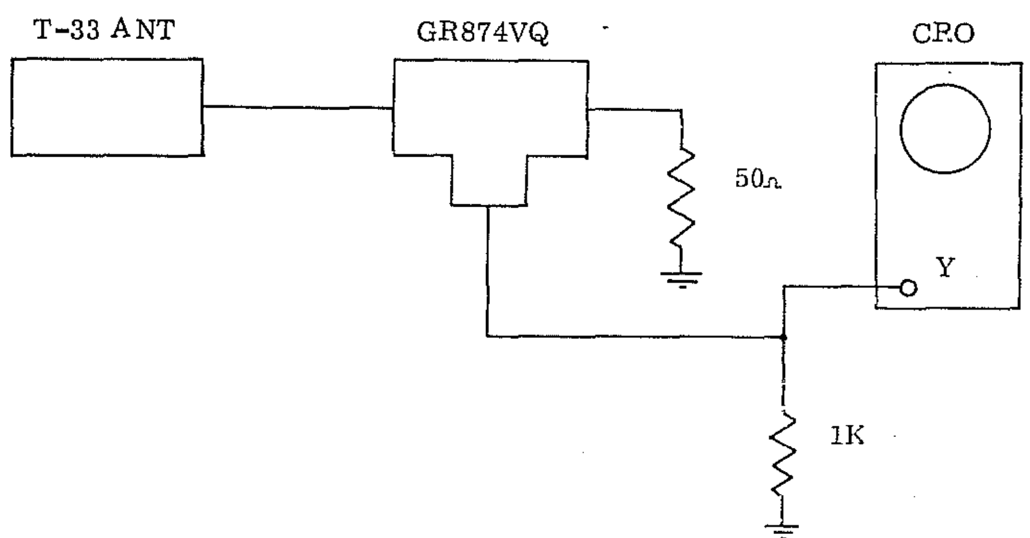


FIG. 4 - 1

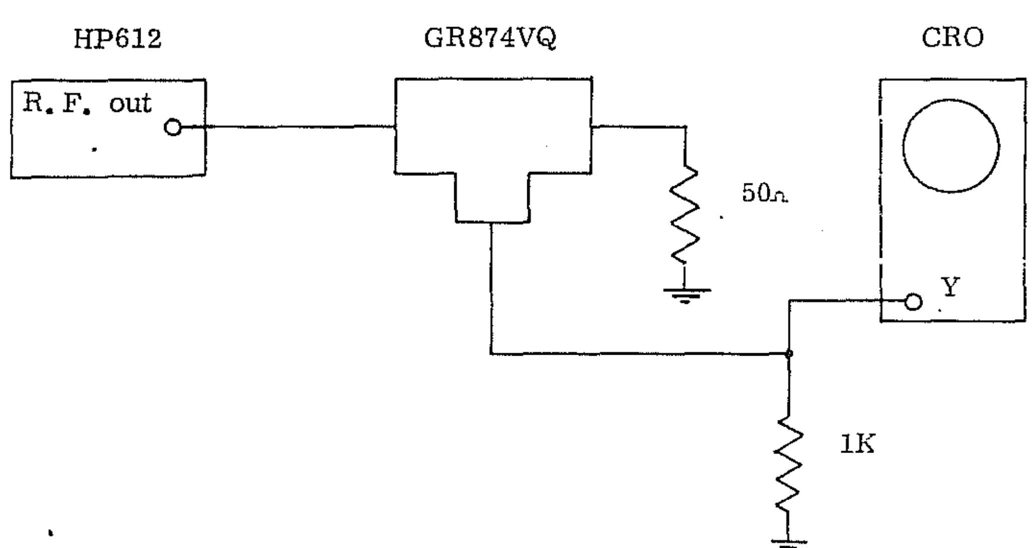


FIG. 4 - 2

4.3.4 Receiver Adjustments

This section covers adjustment of C13 mixer input, L8 mixer tank, and T1 I.F. transformer. For this adjustment a signal generator capable of delivering an accurate 1090 MHz CW signal will be required. Use a frequency counter to set the frequency. Note: The accuracy of the 1090 MHz dial on the T-33B will be determined by the accuracy of the 1090 MHz frequency.

Set the REPLY/SLS switch to Level. Connect the output of the signal generator to the TNC connector of the T-33B with a 50 ohm cable. Set the 1090 MHz control on the T-33B front panel to zero and adjust the output of the signal generator for the lowest level which results in a reading of the front panel meter. Adjust C13, L8, and T1 for maximum meter deflection.

4.3.5 R18, Receiver Threshold

Set the REPLY/SLS switch to the Level position. Turn the RECEIVER SENSITIVITY control on the T-33B to the maximum CW position. Adjust R18 so that the front panel meter just reads zero.

4.3.6 L10, 1 MHz Clock Oscillator

L10 is correctly set when P1 to P3 spacing in Mode D is 25.0 ± 0.1 microseconds. To make this adjustment the modulating pulse train at TP4 may be compared to the 1 microsecond crystal controlled markers of a T-14A.

Connect the Y input of one channel of the scope to TP4 on the R.F. board. Connect the marker output of a T-14A to the other Y channel of the scope. Set the T-14A marker control to 1.0 microsecond and adjust the scope for alternate sweep, positive internal sync so that both waveforms are displayed.

Set the T-33B to Mode D and the scope to 5 microseconds for centimeter sweep speed. Magnify the sweep ten times and adjust L10 so that the leading edge of P1 and P3 are 25.0 ± 0.1 microseconds apart.

Calibration of Mode D automatically calibrate all modes of the T-33B. Check all modes for proper spacing within ± 0.1 microsecond. Spacings are as follows: Mode 1, 3 microseconds; Mode 2, 5 microseconds; Mode A, 8 microseconds; Mode B, 17 microseconds; Mode C, 21 microseconds; and Mode D, 25 microseconds.

4.3.7 L11, 689.655 kHz Clock Oscillator

L11 is correctly set when the operating frequency of this clock oscillator is 689.655 kHz. To make this adjustment it will be necessary to compare the gated clock oscillator output against the 1.45 microsecond crystal controlled markers of a T-14 A.

Connect the Y input of one channel of the scope to TP14 on the decoder board. Connect the marker output of a T14A to the other Y channal of the scope. Set the T-14A marker control to 1.45 microsecond and adjust the scope for alternate sweep, positive internal sync so that both waveforms are displayed.

Adjust L11 on the decoder board so that the clock pulses and markers line up. For best accuracy set the sweep speed of the scope to 5 microseconds per centimeter and use the 10X sweep magnification.

4.3.8 R192, SLS Adjust

The SLS adjust potentiometer controls the level of the SLS pulse with reference to P1 and P3. To make this adjustment refer to paragraph C of section 4.3.3. Connect the detector to the output of the T-33B and note the pulse amplitude of P1 and P3. Connect the detector to the output of the H.P. 612A and set the signal generator to 1030 MHz at the same level as the T-33B. Reduce the output of the H.P. 612A 9 dB and note the new pulse amplitude. This is the -9 dB reference level. Reconnect the T-33B to the detector and adjust R192 so that P2 is at the -9 dB reference level.

4.3.9 R200, Reply Rate Calibrate

This potentiometer is adjusted by interrogating a transponder and setting R200 for a meter reading of 100% with the REPLY/SLS switch in the 100% position. Be sure there is sufficient signal strength between the T-33B and transponder so that 100% replies are generated. This can be verified by synchronizing the scope with the PRF pulse at TP7 and examining the video waveform at TP5. 100% reply rate will produce no baseline trace at each reply pulse.

4.3.10 R213, Level Set

This potentiometer calibrates the variable attenuator in the T-33B. It may be adjusted by comparing the receiver sensitivity measurement of the T-33B against a measurement made on the same transponder using properly calibrated bench equipment such as a TIC T-15C. Measure the sensitivity using the T-33B RECEIVER SENSITIVITY control and adjust R213, if necessary, so that the indicated sensitivity is equal to the known transponder sensitivity.

4.3.11 R205, Attenuator Calibrate

This potentiometer adjusts the range of attenuation of the RECEIVER SENSITIVITY control. It can be properly adjusted by comparing the R.F. output of the BNC jack, with the T-33B operating in CW function, against a calibrated spectrum analyzer or receiver at 1030 MHz. The output of the BNC jack should vary from -65 to -84 dBm as the RECEIVER SENSITIVITY control is adjusted over its indicated range. Accuracy of this dial should fall within ± 2 dB.

4.4 TROUBLE SHOOTING:

4.4.1 General

When the T-33B is inoperative it is best to isolate the fault to a particular section by using the procedure outlined in Section 4.4.2. This procedure will lead the technician in a logical and orderly fashion through the circuitry of the unit until the faulty section is isolated. Once this is done it is best to check all transistors and integrated circuits in the faulty section before proceeding further. The best test for a solid state device is to replace it with one known to be good. The use of transistor and IC sockets in the unit allows quick substitution. Use an IC puller to remove the IC's from their sockets. Do not unsolder any transistor on the R.F. board unless absolutely necessary, since the tuned circuits will be disturbed.

Refer to the schematic for pertinent voltage and waveshapes, and to the illustration for location of components. When making waveshape measurements always synchronize the scope externally with the positive PRF trigger at TP7.

4.4.2 Trouble Shooting Procedure

The T-33B is composed of seven major sections: Transmitter, receiver, attenuator, encoder, decoder, translator and readout. In order to simplify trouble shooting first determine if the T-33B initiates reply pulses from a known good transponder. If it does, the transmitter and encoder of the T-33B are operating, and the fault lies in the receiver, decoder, translator or readout.

Start the trouble shooting procedure with step 11. If the transponder does not reply at all, the fault lies in the transmitter or encoder. For this condition start the trouble shooting procedure with step 1.

If the T-33B operates correctly with the READOUT switch in the PILOT and BINARY positions, but the altitude decoding is incorrect, the fault lies in the translator board. Follow the trouble shooting procedure for this board in Section 4.4.3.

	PROCEDURE	NORMAL INDICATION	IF CONDITION UNSATISFACTORY
1.	Measure regulated +9 volts at TP3.	+9 ±0.1 volts. If normal proceed to step 2.	Check battery voltage. Check IC20. Reset +9V adj. pot. Check for shorts on +9 volt line. Check Q23, 24, 25, 26, 27.
2.	Measure regulated +5 volts at TP+5V.	+5 ±0.2 volts. If normal proceed to step 3.	Check IC21 and Q20. check for shorts on +5 volt line.
3.	Check PRF trigger at TP7.	+4 volt pulse, 2 μsec wide. If normal proceed to step 4.	Check Q10
4.	Using PRF trigger (TP7) as positive external scope sync check 1 MHz clock gate at TP10. Use PRF trigger at TP7 for subsequent scope measurements.	+4 volt pulse 5 to 27 μ sec wide depending upon mode switch. If normal proceed to step 8.	If a logical zero, Check IC2D, 2C, 3A, and 3B. If at logical one, check IC2A, 3B. Proceed to step 5.
5.	Check preset one and preset two pulses at pin 6 and pin 8 of IC4 through IC10.	Preset one, +4 volt pulse 4 μsec wide. Preset two, -4 volt pulse 4 μsec wide. If normal proceed to step 6.	Check IC2F, 2E, 2A, and 2B.

6.	Check 1 MHz clock oscillator by removing IC3 from its socket and connecting a jumper between TP10 and the 5 volt bus, (Fig. 4-8, 4-11).	5 volts P-P, 1 MHz clock pulse at TP9, (Fig. 4-8, 4-11). If normal proceed to step 7.	Check Q11, Q12, Q13 and IC12C, (Fig. 4-8, 4-11).
7.	Remove jumper and insert IC3 into its socket. Check IC3B pin 5 for presence of stop pulse, (Fig. 4-8, 4-11).	-5 volt pulse 8 to 30 µsec after PRF trigger depending upon mode switch. If normal proceed to step 8.	Check IC3C, 3D and 12D. With scope probe, follow shift of encoder preset pulse from pin 13 IC4 through pin 10 IC10, * (Fig. 4-8, 4-11). * pin 11 IC10 for T-33C
8.	Check Modulation pulse train at TP4, (Fig. 4-20).	+ 9 volt pulse train consisting of P1, P2, P3 and 28 µsec strobe pulse. If normal proceed to step 9.	Check test switch, S1. Should be in normal position. Check IC11A, 11B, 11C, 12A, and Q14, (Fig. 4-8, 4-11), and Q4 (Fig. 4-20).
9.	Throw test switch on R. F. board to CW. Measure voltage drop between TP1 and TP3, (Fig. 4-20).	About 2 volts DC. If normal proceed to step 10.	Oscillator not operating. Check Q1 and Q2, (Fig. 4-20).
10.	Measure R. F. output of TNC JACK with Spectrum Analyzer.	About + 5 dBm at 1030 MHz.	Adjust C2, C3 and C4. Q3 or Q29 inoperative, (Fig. 4-20).
11.	Check 689. 655 kHz clock gate at TP15, (Fig. 4-14).	+ 4 volt pulse 28 µsec wide. If normal proceed to step 15.	Check IC14F, 13A and 13B. Proceed to step 12, (Fig. 4-14).
12.	Check preset one and preset two at TP2, (Fig. 4-20) and pin 8 of IC15, (Fig. 4-14).	Preset one, + 4 volt pulse 4 µsec wide. Preset two, -4 volt pulse 4 µsec wide. If normal proceed to step 13.	Check IC14A, (Fig. 4-14) and IC2F, (Fig. 4-8, 4-11).
13.	Check 689. 655 kHz clock oscillator by removing IC13 from its socket and connecting a jumper between TP15 and + 5 volts, (Fig. 4-14).	5 volt P-P 689 kHz clock pulses at TP14, (Fig. 4-14). If normal proceed to step 14.	Check Q16, Q17, Q18, IC14B and IC14C, (Fig. 4-14).
14.	Remove jumper and insert IC13 in its socket. Check IC13B pin 5 for presence of stop pulse, (Fig. 4-14).	+ 4 volt pulse about 42 µsec wide. If normal proceed to step 15.	With scope probe, follow shift of decoder preset pulse from pin 13 IC15 through *pin 9 IC19. Check IC14E. (Fig. 4-14). * pin 10 IC19 for T-33C

15.	Set up transponder about 20 feet away from T-33. Operate units so that transponder is replying to T-33 interrogation. Check TP6 for presence of video pulses, (Fig. 4-20)	-1 volt pulses corresponding to reply pulse train of transponder. If normal proceed to step 16.	Set RECEIVER SENSITIVITY control maximum clockwise. Vary 1090 MHz control over its range. Check Q5, IC1, (Fig. 4-20).
16.	Check deflection of front panel microammeter with REPLY/ SLS switch in LEVEL POSITION.	Needle should pin full scale. If normal proceed to step 17.	Check setting of meter threshold control R18. Check Q6, Q7, Q8 and Q9. Check C26 and microammeter, (Fig. 4-20).
17.	Check TP13 of IC13D for presence of stretched video pulses, (Fig. 4-14).	+ 5 volt pulses corresponding to transponder reply pulse train. If normal proceed to step 18.	Check Q15, IC13D and IC13C, (Fig. 4-14).
18.	Set transponder to code 0707. Measure DC voltage at all output terminals of decoder IC15, 16, 17, 18, and *19; pins 13, 12, 10 and 9, (Fig. 4-14).	+ 5 volts at FRAMING 1 and 2, B1, D1, B2, D2, B4, D4 outputs. Less than 0. 5 volts at C1, A1, C2, A2, C4, A4, X and IDENT outputs. If normal proceed to step 19.	Replace the IC which develops incorrect output voltage.
19.	Set transponder to code 7070. Measure the DC voltage at all output terminals of decoder IC15, 16, 17, 18, and *19; pins 13, 12, 10 and 9, (Fig. 4-14).	+ 5 volts at FRAMING 1 and 2, C1, A1, C2, A2, C4 and A4 outputs. Less than 0. 5 volts at X, B1, D1, B2, D2, B4, D4 and IDENT outputs. If normal proceed to step 20.	Replace the IC which develops incorrect output voltage.
20.	Press IDENT switch (IDENT only lasts for approx. 20 seconds. It may be necessary to press the IDENT switch several times to make a reading).	+ 5V at pin 13 of IC15. If normal proceed to step 21, (Fig. 4-14).	Replace IC15.
21.	Check + 5 volt driver bus at emitter of Q21, (Fig. 4-14).	+ 5 volts. If normal proceed to step 22.	Check IC28B, 28E, 25 (Fig. 4-25) and Q21, (Fig. 4-14).
22.	Check voltage between pin 2 of each numitron and chassis, (Fig. 4-25)	+ 5 volts. If normal proceed to step 23.	Check + 5 volt connection from Q20 on ENCODER BOARD, (Fig. 4-8, 4-11) to + 5 volt bus on NUMITRON BOARD, (Fig. 4-25).

* pins 13, 12, 11, and 10 for T-33C

23.	If FRAMING 1, FRAMING 2, or IDENT display is absent, check voltage at terminal one of inoperative numitron.	Less than 0.5 volts DC. If F1, F2 and IDENT normal proceed to step 24.	Incorrect voltage, change IC28. Correct voltage, change Numitron. If corrective action solves problem proceed to step 24.
24.	Set the transponder to code 0000. If the display is correct proceed to step 26. Measure the voltage at terminals 3, 4, 5, 6, 7, 8 and 9 of inoperative numitron with code switch in PILOT position.	Less than 0.5 volts at terminals 3, 4, 5, 7, 8 and 9. + 5 volts at pin 6. If normal, replace numitron.	Incorrect voltage at one or more pins, replace IC22, 23, 24 or 25.
25.	Set transponder control head to activate numeral 7 in inoperative numitron. Throw READOUT switch on T-33B to BINARY position. Measure terminal voltage at pins 4, 1, 6 and 7 of inoperative numitron.	Less than 0.5 volts. Numitron should display 3 horizontal bars.	Incorrect voltage, change IC26 or 27. Correct voltage Change numitron.

4.4.4 Attenuator Trouble Shooting

If the T-33B operates normally when radiating a signal from the antenna, but is inoperative when making a direct connection from the BNC jack, the variable attenuator or its control circuitry may be defective. It is important to ascertain that the T-33B is defective, and not the transponder, since the T-33B attenuator signal level does not exceed -66 dBm. If you are using a transponder with less than -66 dBm sensitivity the T-33B will not interrogate it. Thus it would appear that the T-33B is defective when in reality it is not. Use a transponder with at least -69 dBm sensitivity.

If the attenuator is defective measure the DC current fed to CR38 and CR39 through C87 and C88. You may do this by disconnecting the leads at C87 and C88 and inserting a 0 - 10 ma DC milliammeter in series, or by using a clamp on milliammeter. Current through CR38 should vary from about zero to 2 milliamperes as the RECEIVER SENSITIVITY control is varied. Current through CR39 should be somewhere within the range of 0.3 and 4 ma. If a defective diode or other component in the attenuator is suspected, the shield over these components must be removed to get at the components. It is recommended that such servicing be referred to the factory.

4.4.5 Translator Trouble Shooting

In order to locate a fault on the translator circuit board it will be necessary to dial certain reply codes. This may be accomplished by operating the transponder on Mode A and using the transponder control head to simulate various altitude codes. Refer to the ALTITUDE-to-CODE CONVERSION CHART supplied with the unit.

1. Check Gray to Binary decoder, referenced to -1200 feet, according to the following truth table, TABLE 4 - 1. (0 = .4 volts or less. 1 = 2.4 volts or more.)

   Also check for the correct binary outputs when dialing any altitude code which results in an incorrect display. For example, if altitude 18,700 feet (code 3140) is dialed into the control head, the proper outputs of the Gray to Binary decoder should add up to 18,700 plus 1200 or 19,900 feet. Neglecting 100 foot increments, the logical one outputs should be 16K, 2K, 1K, and 500 feet.

ALTITUDE	ABSOLUTE ALTITUDE	DIAL SETTING	PIN 6 IC30B	PIN 8 IC30C	PIN 11 IC30D	PIN 11 IC31D	PIN 8 IC31C	PIN 3 IC31A	PIN 6 IC31B	PIN 2 IC29A
-1200	0	0040	0	0	0	0	0	0	0	0
-700	500	0410	1	0	0	0	0	0	0	0
-200	1K	0640	0	1	0	0	0	0	0	0
800	2K	0340	0	0	1	0	0	0	0	0
2800	4K	4140	0	0	0	1	0	0	0	0
6800	8K	6040	0	0	0	0	1	0	0	0
14800	16K	3040	0	0	0	0	0	1	0	0
30800	32K	1044	0	0	0	0	0	0	1	0
62800	64K	0046	0	0	0	0	0	0	0	1

TABLE 4 - 1

2. Check Negative Altitude Determination

Dial all negative codes from -100 feet to -1000 feet. These codes are as follows: 0020, 0030, 0010, 0410, 0430, 0420, 0460, 0440, 0640 and 0660. Check IC35B pin 4 for logical one. Dial several positive altitude codes. Check IC35B pin 4 for logical zero. Dial any code which results in an incorrect display. Check IC35B pin 4 for correct logic level.

3. Check Hundreds Decoder according to the following truth table, TABLE 4 - 2.

Also check for the correct binary outputs when dialing any altitude code which results in an incorrect display.

HUNDREDS	TRANSPONDER DIAL SETTING	PIN 9 IC45	PIN 1 IC46	PIN 2 IC46	PIN 3 IC46
100	0630	1	0	0	0
200	0610	0	1	0	0
400	0230	0	0	1	0
800	0340	0	0	0	1

TABLE 4 - 2

4. Check -1200 Feet Correction according to the following truth table, TABLE 4 - 3.

Also check for the correct binary outputs when dialing any altitude code which results in an incorrect display.

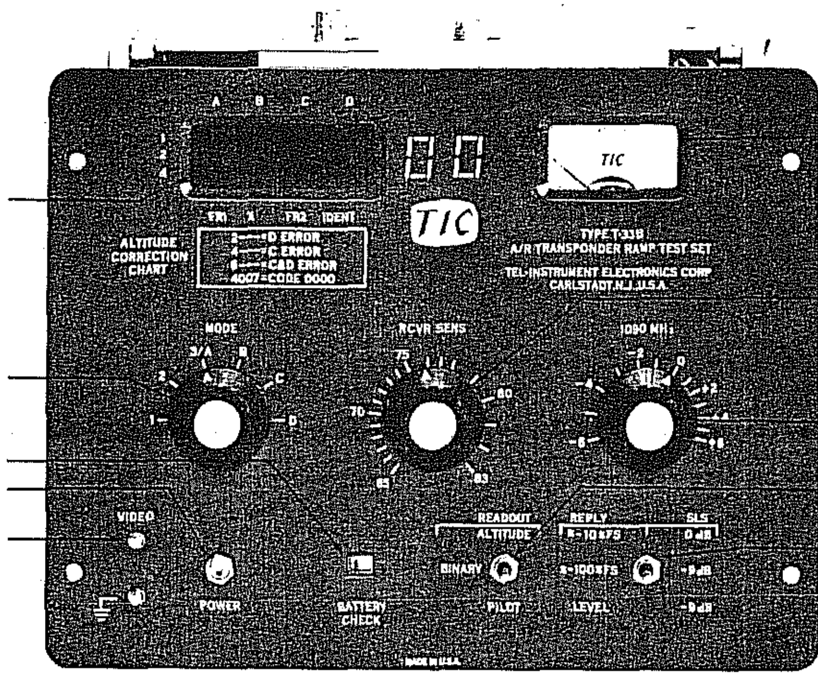
ALTITUDE	TRANSPONDER DIAL SETTING	PIN 9 IC38	PIN 6 IC38	PIN 2 IC38	PIN 15 IC38	PIN 6 IC37	PIN 2 IC37	PIN 15 IC37
0	0620	0	0	0	0	0	0	0
1K	0320	1	0	0	0	0	0	0
2K	0520	0	1	0	0	0	0	0
4K	4720	0	0	1	0	0	0	0
8K	6620	0	0	0	1	0	0	0
16K	3620	0	0	0	0	1	0	0
32K	1624	0	0	0	0	0	1	0
64K	0626	0	0	0	0	0	0	1

TABLE 4 - 3

5. Check 7 Bit Binary to BCD Converter by dialing an altitude code that results in an incorrect altitude display. The truth table (TABLE 4 - 4) for IC39, IC40 and IC41 is as follows:

INPUTS					OUTPUTS					
PIN 14 E	PIN 13 D	PIN 12 C	PIN 11 B	PIN 10 A	PIN 6 Y6	PIN 5 Y5	PIN 4 Y4	PIN 3 Y3	PIN 2 Y2	PIN 1 Y1
0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	1	0	0	0	0	0	1
0	0	0	1	0	0	0	0	0	1	0
0	0	0	1	1	0	0	0	0	1	1
0	0	1	0	0	0	0	0	1	0	0
0	0	1	0	1	0	0	1	0	0	0
0	0	1	1	0	0	0	1	0	0	1
0	0	1	1	1	0	0	1	0	1	0
0	1	0	0	0	0	0	1	0	1	1
0	1	0	0	1	0	0	1	1	0	0
0	1	0	1	0	0	1	0	0	0	0
0	1	0	1	1	0	1	0	0	0	1
0	1	1	0	0	0	1	0	0	1	0
0	1	1	0	1	0	1	0	0	1	1
0	1	1	1	0	0	1	0	1	0	0
0	1	1	1	1	0	1	1	0	0	0
1	0	0	0	0	0	1	1	0	0	1
1	0	0	0	1	0	1	1	0	1	0
1	0	0	1	0	0	1	1	0	1	1
1	0	0	1	1	0	1	1	1	0	0
1	0	1	0	0	1	0	0	0	0	0
1	0	1	0	1	1	0	0	0	0	1
1	0	1	1	0	1	0	0	0	1	0
1	0	1	1	1	1	0	0	0	1	1
1	1	0	0	0	1	0	0	1	0	0
1	1	0	0	1	1	0	1	0	0	0
1	1	0	1	0	1	0	1	0	0	1
1	1	0	1	1	1	0	1	0	1	0
1	1	1	0	0	1	0	1	0	1	1
1	1	1	0	1	1	0	1	1	0	0
1	1	1	1	0	1	1	0	0	0	0
1	1	1	1	1	1	1	0	0	0	1

TABLE 4 - 4



T - 33B FRONT PANEL CONTROL
FIG 4 - 3

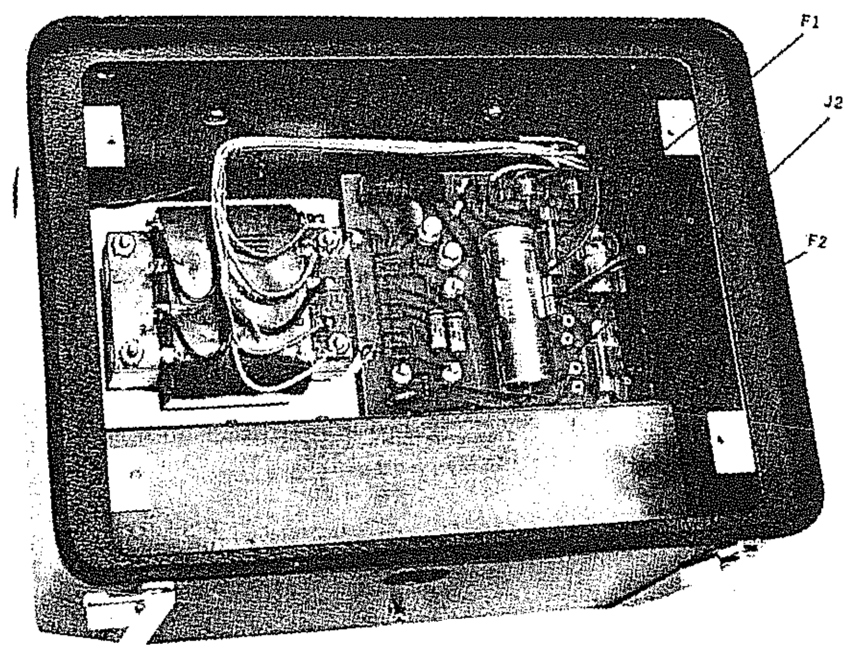


FIG 4 - 4

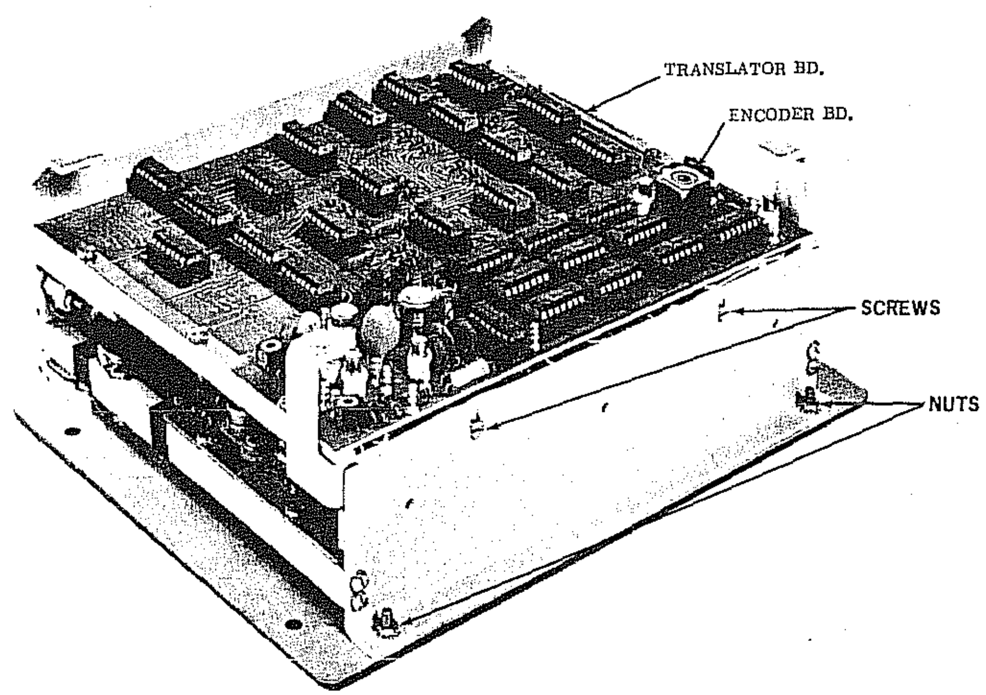


FIG 4 - 5

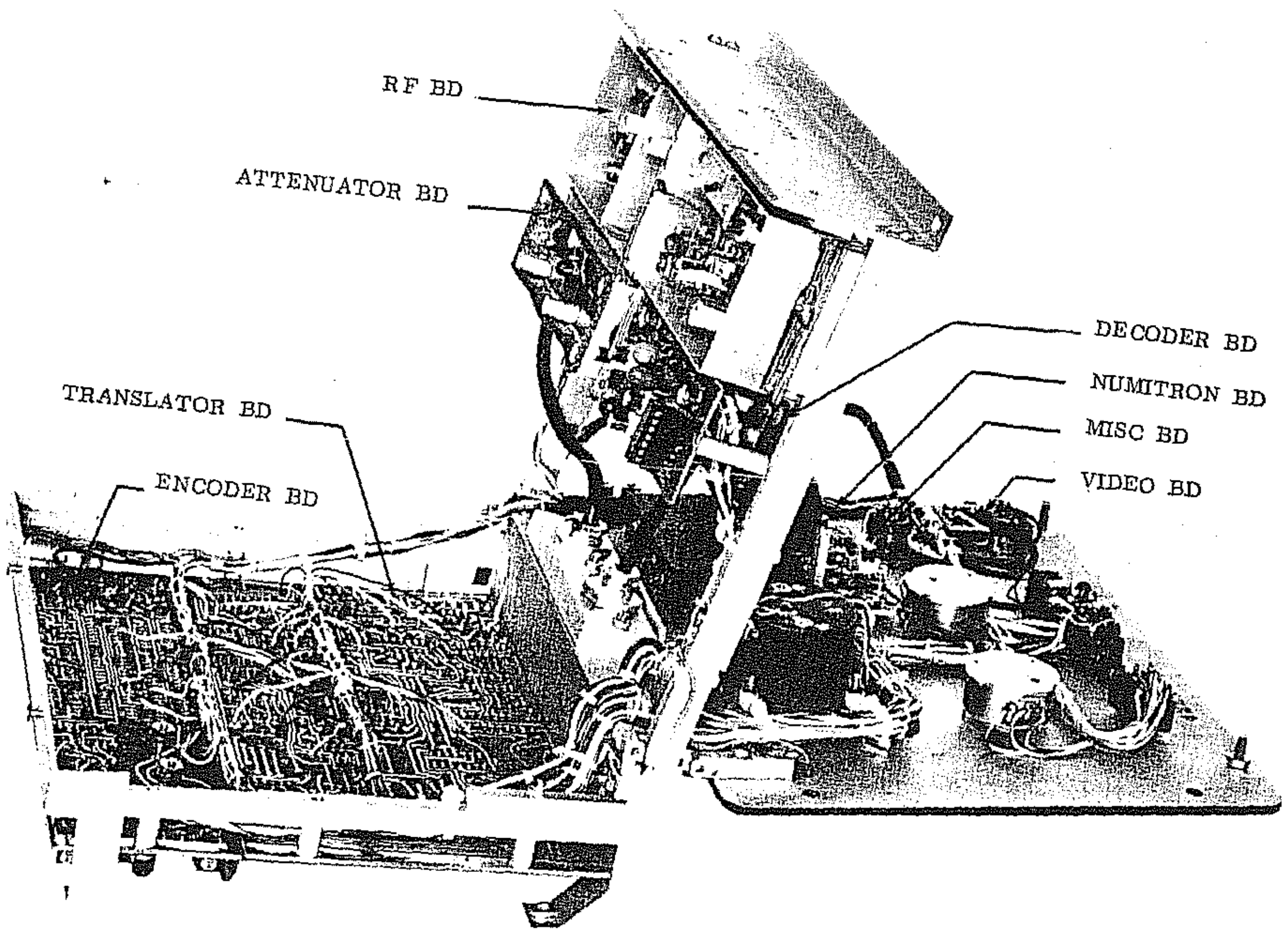
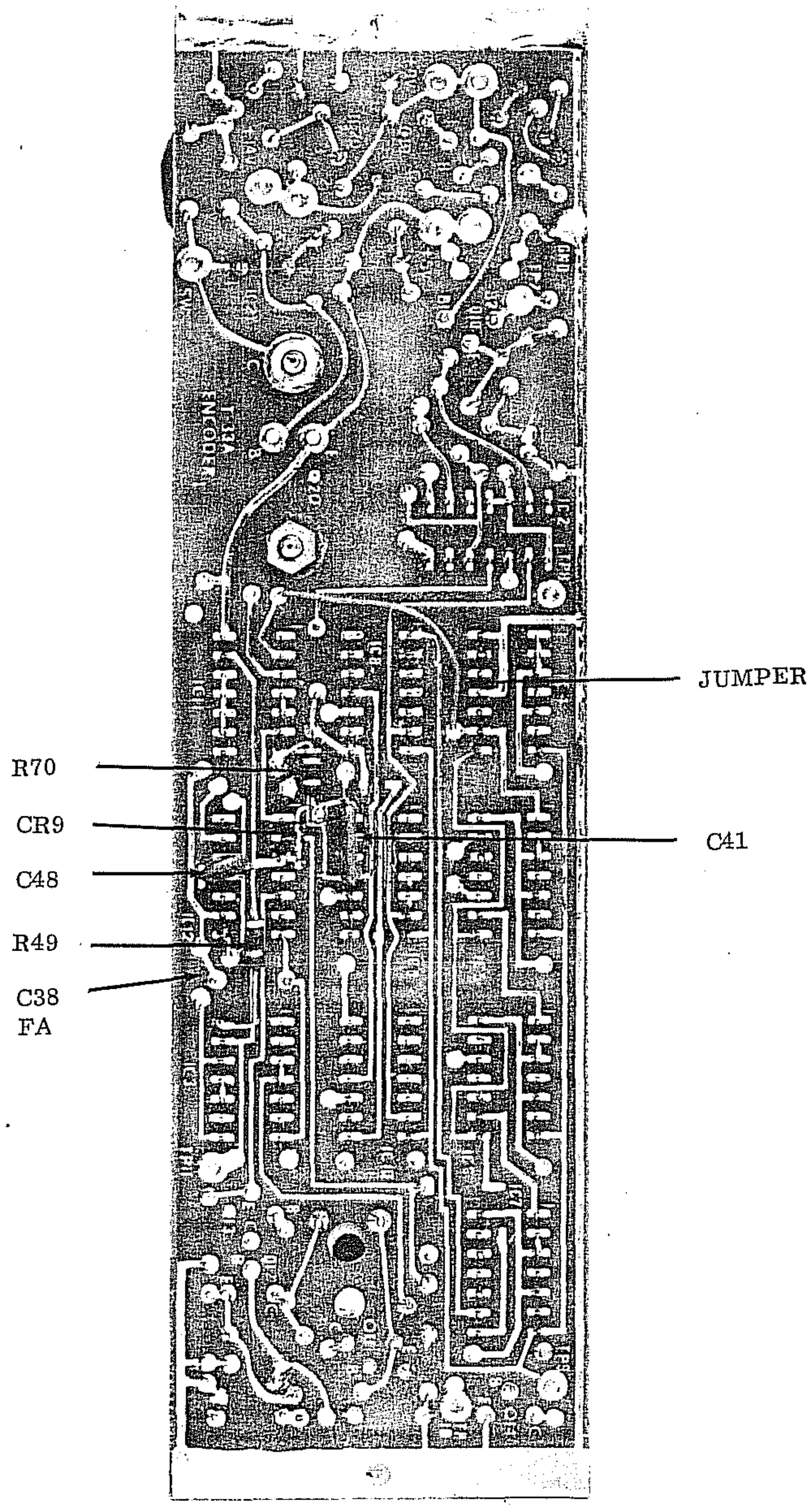

RF BD
ATTENUATOR BD
DECODER BD
NUMITRON BD
MISC BD
VIDEO BD
TRANSLATOR BD
ENCODER BD

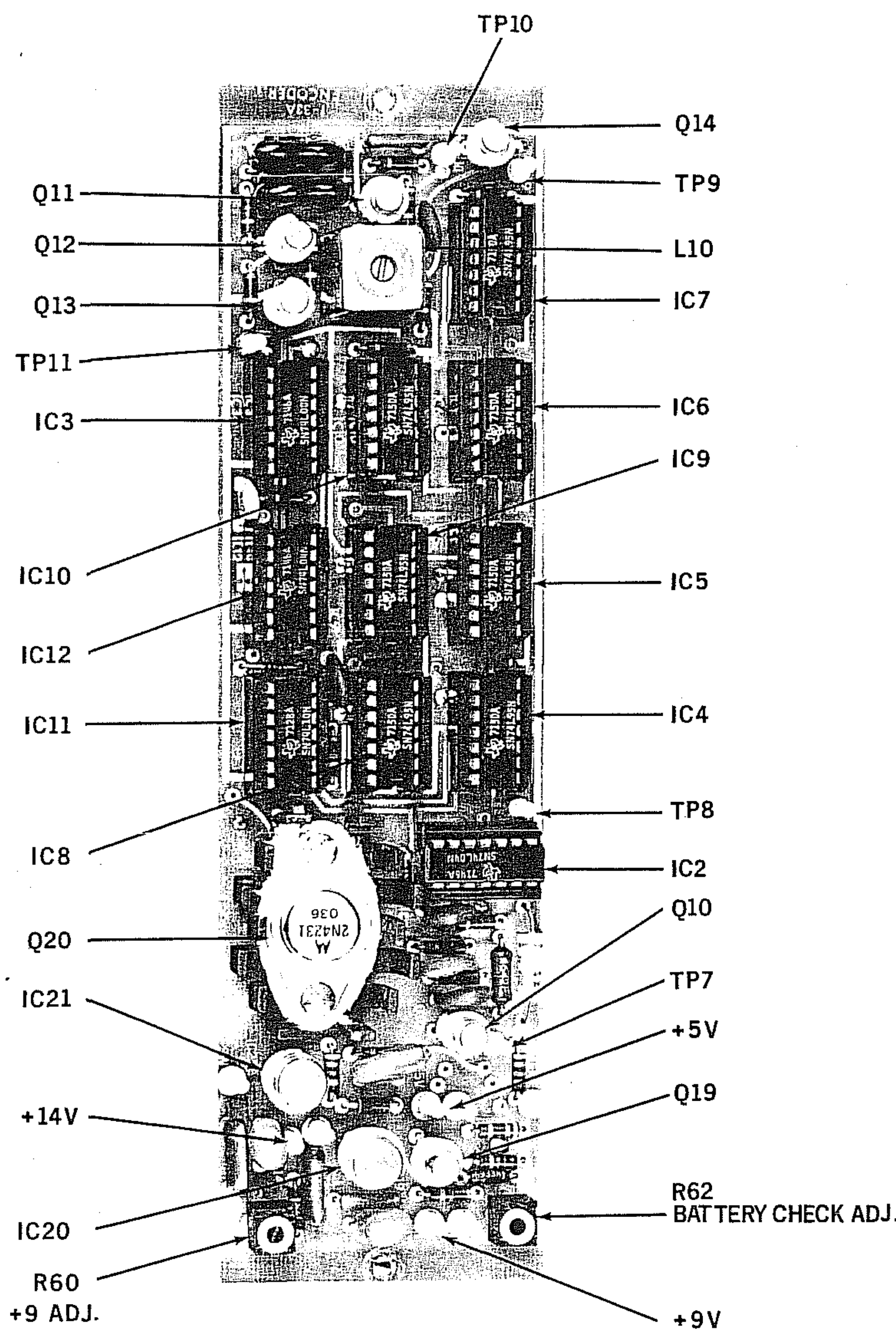
FIG 4 - 6



ENCODER

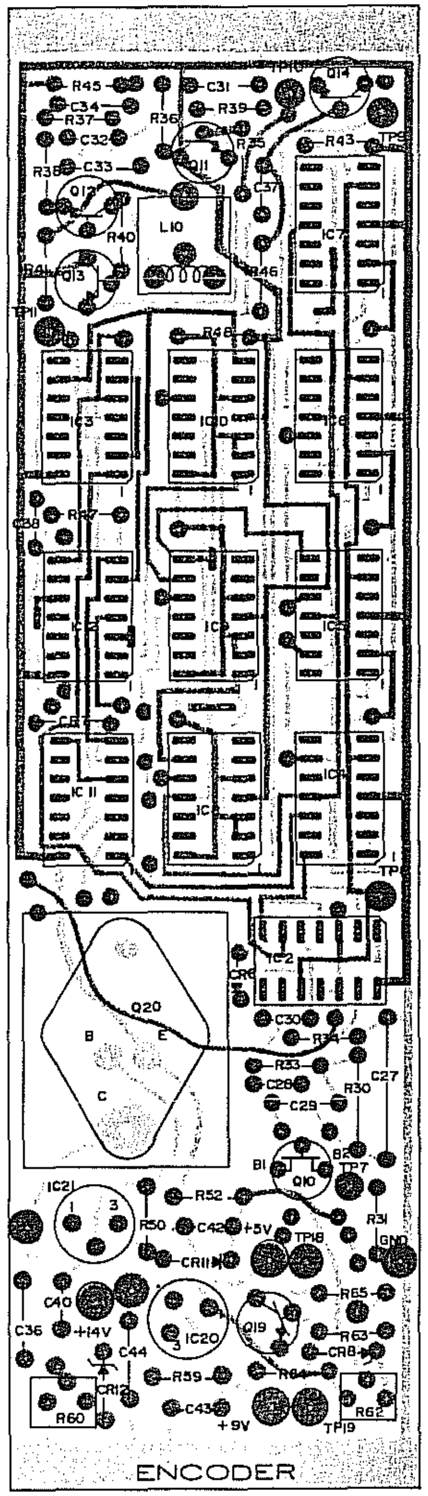
BOTTOM

FIG 4-7



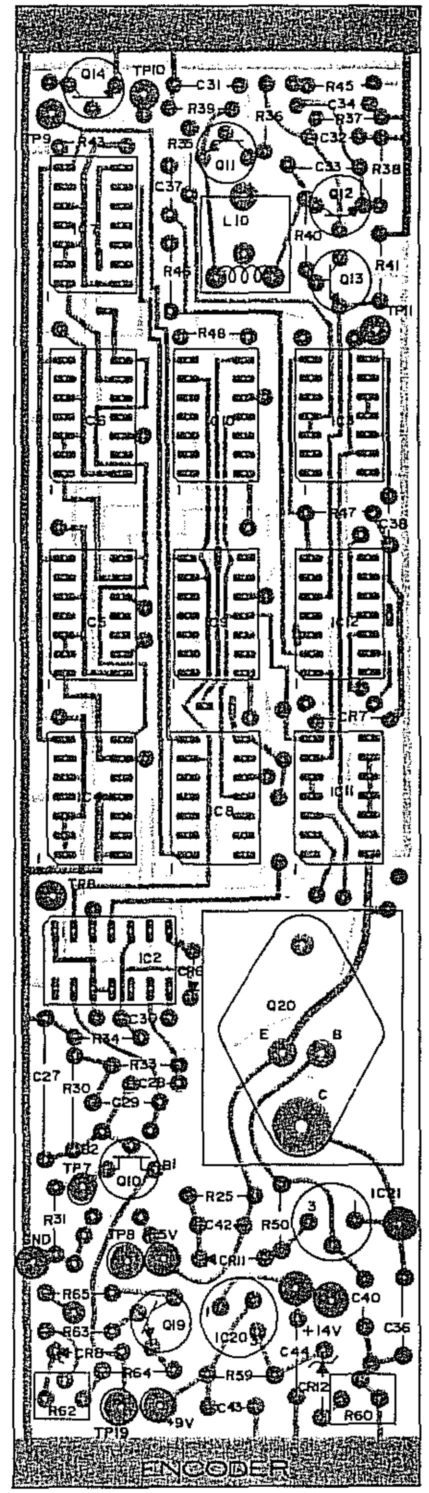
ENCODER
TOP

FIG 4-8



COMPONENT SIDE VIEW

fig 4-9

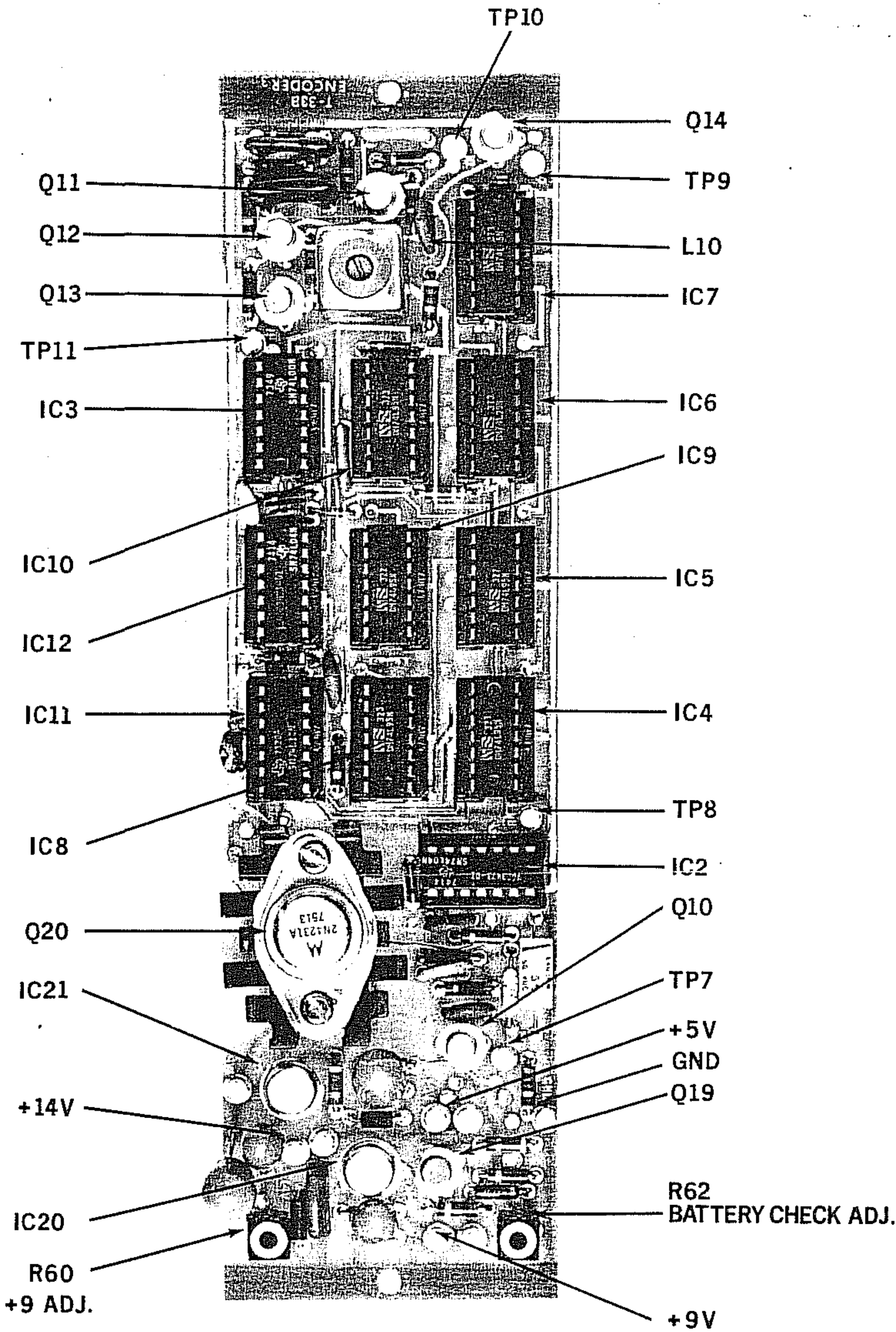


SOLDER SIDE VIEW

fig 4-10

ENCODER BOARD

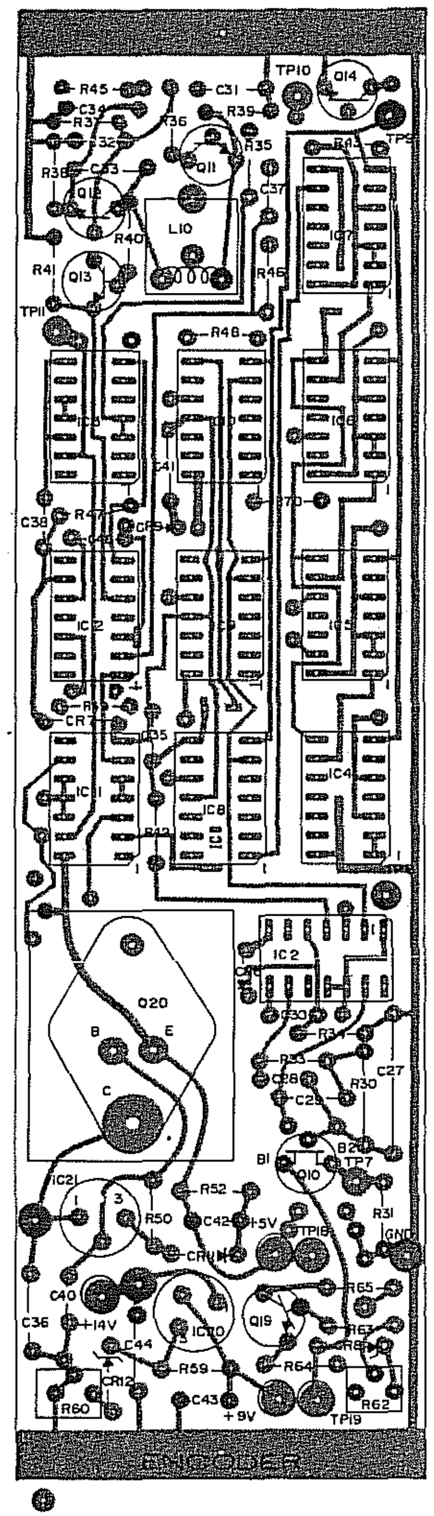
FOR USE WITH UNITS S/N 384 AND UP



ENCODER

FIG 4-11

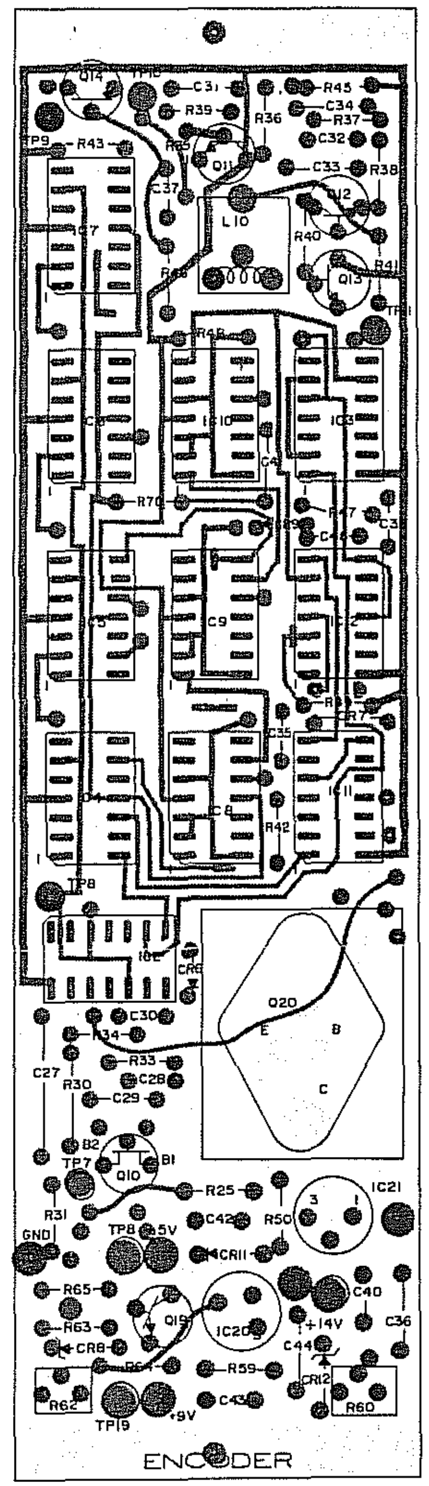
FOR USE WITH UNITS S/N 384 AND UP



COMPONENT SIDE VIEW

FIG 4-12

FOR USE WITH UNITS S/N 384 AND UP

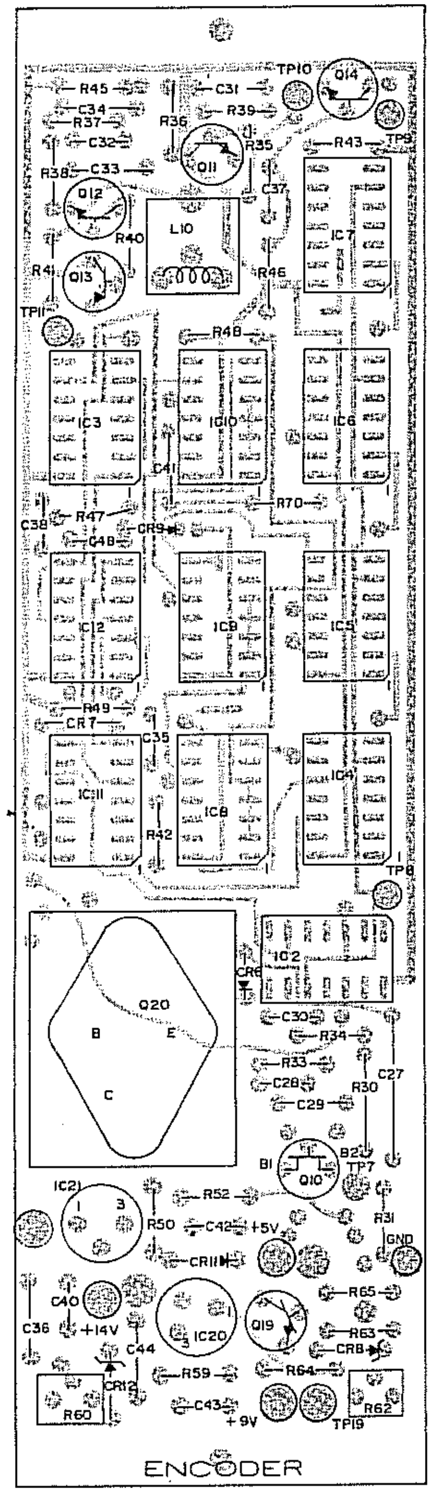


SOLDER SIDE VIEW

FIG 4-13

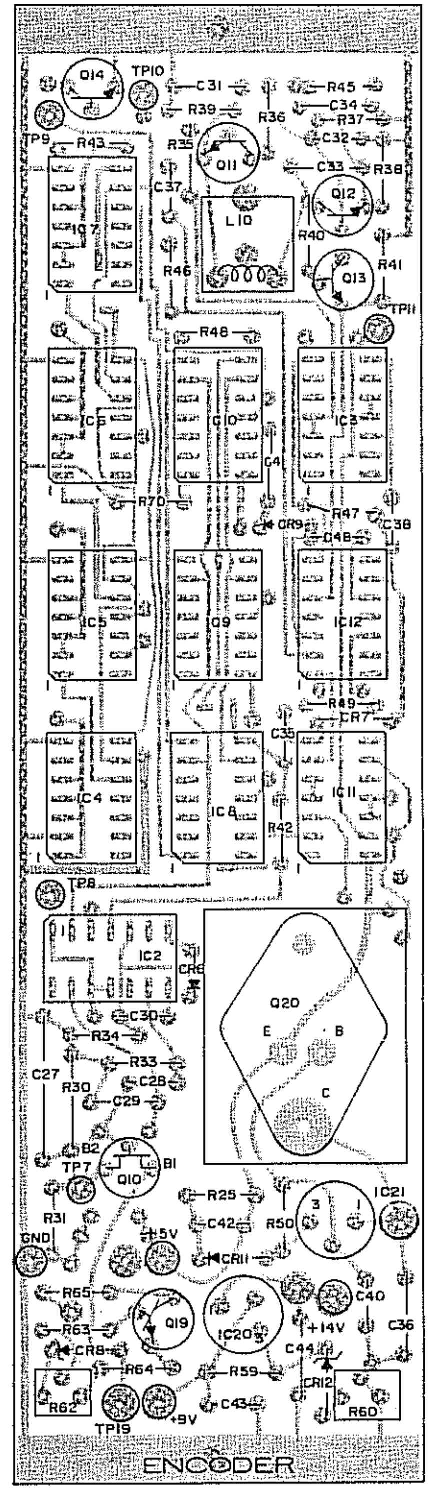
ENCODER BOARD

ITEM	DESCRIPTION: MFR/MFR PN	CIRCUIT DESIGNATION	QTY	TIC PART #
1	CAP - FXD DISC 220 pF 1KV 10% (TV) : CRL/DD-221	C38 F.A.	1	
2	CAP - FXD DISC 1K pF 500V 10% : ETP/801-000-X5F0102K	C29, 30, 35, 37	4	TC-94
3	CAP - FXD DISC .0015 μF 1KV 10% : CRL/DD-152	C28	1	TC-97
4	CAP - FXD DISC 0.1 μF 35V 20% : SPR/5C023104X8250B3	C31, 32, 41	3	TC-122
5	CAP - ELECT, TA 27 μF 35V 20% : SPR/196D276X00356B	C36	1	TC-160
6	CAP - ELECT, TA 100 μF 10V 20% : SPR/196D107X0010LA3	C40, 43	2	TC-168
7	CAP - ELECT, TA 300 μF 6V 20% : SPR/196D337X0006MA3	C42	1	TC-174
8	CAP - FXD DM 270 pF 500V 5% : SAN/DM195F271J	C33	1	TC-50-1
9	CAP - FXD DM 330 pF 500V 5% : SAN/DM195F331J	C34	1	TC-50-2
10	CAP - FXD MET, POLYS 0.1 μF 50V 5% : TRW/X463UW	C27	1	TC-122-A
11	CAP - FXD MNL 0.47 μF 50V 20% : SPR/7C02347X0500E	C44	1	TC-139
12	DIODE SI REC 1N2069 200V .75A	CR11	1	TD-16
13	DIODE SI SIG 1N4148 75V	CR6, 7, 9	3	TD-19-A
14	DIODE SI ZEN 1N4370A 2.4ZV 0.4W PD	CR8	1	TD-19-B
15	DIODE SI ZEN 1N5227A 3.6ZV 0.5W PD	CR12	1	TD-21-1
16	HEAT SINK TSTR : IER/LB66B1	XQ20	1	TH-3-A
17	IND - VAR 120-280 μH : MLR/9056	L10	1	TC-192-A
18	IC LM309H : N-S	IC20, 21	2	TLM309H
19	IC SN74L00N : T-I (For T-33B)	IC3	1	TSN74L00N
	SN74LS00N : T-I (For T-33C)	IC3	1	TSN74LS00N
20	IC SN74L04N : T-I (For T-33B)	IC2, 12	2	TSN74L04N
	SN74LS04N : T-I (For T-33C)	IC2, 12	2	TSN74LS04N
21	IC SN74L10N : T-I (For T-33B)	IC11	1	TSN74L10N
	SN74LS10N : T-I (For T-33C)	IC11	1	TSN74LS10N
22	IC SN74L95N : T-I (For T-33B)	IC4 - 10	7	TSN74L95N
	SN74LS95BN : T-I (For T-33C)	IC4 - 10	7	TSN74LS95BN
23	RES - FXD COMP 100Ω 1/4W 10% : A-B/CB1011	R42, 64	2	TR-145
24	RES - FXD COMP 470Ω 1/4W 10% : A-B/CB4711	R46, 50	2	TR-151
25	RES - FXD COMP 680Ω 1/4W 10% : A-B/CB6811	R31	1	TR-153
26	RES - FXD COMP 1KΩ 1/4W 10% : A-B/CB1021	R39, 43, 48, 52	4	TR-155
27	RES - FXD COMP 1.5KΩ 1/4W 10% : A-B/CB1521	R41	1	TR-157
28	RES - FXD COMP 2.2KΩ 1/4W 10% : A-B/CB2221	R32 - 34, 38, 63	5	TR-159
29	RES - FXD COMP 3.3KΩ 1/4W 10% : A-B/CB3321	R70	1	TR-161
30	RES - FXD COMP 4.7KΩ 1/4W 10% : A-B/CB4721	R35, 40, 49, 65	4	TR-163
31	RES - FXD COMP 10KΩ 1/4W 10% : A-B/CB1031	R36, 37	2	TR-167
32	RES - FXD MET FLM 2.21KΩ 1/4W 1% TYPE RN60C : MPE	R59	1	TR-93-C
33	RES - FXD MET FLM 49.4KΩ 1/4W 1% TYPE RN60C : MPE	R30	1	TR-75
34	RES - VAR CER 500Ω 10% : A-B/ZV5011	R60, 62	2	TP-38-A
35	SOCKET TSTR : IEH/MPT-4003-1	XQ10 - 13, 19	5	TS-34
36	SOCKET TSTR : IEH/MPT-6003-1	XIC20, 21	2	TS-36
37	SOCKET IC : AUG/314-AG5D-2R	XIC2 - 12	11	TS-42-A
38	TSTR N SI SH FT3904 : F-S	Q11 - 13	3	TT-32
39	TSTR P SI SH FT3906 : F-S	Q19	1	TT-33
40	TSTR UJT P SI D5K1 : GE	Q10	1	TT-16



COMPONENT SIDE VIEW

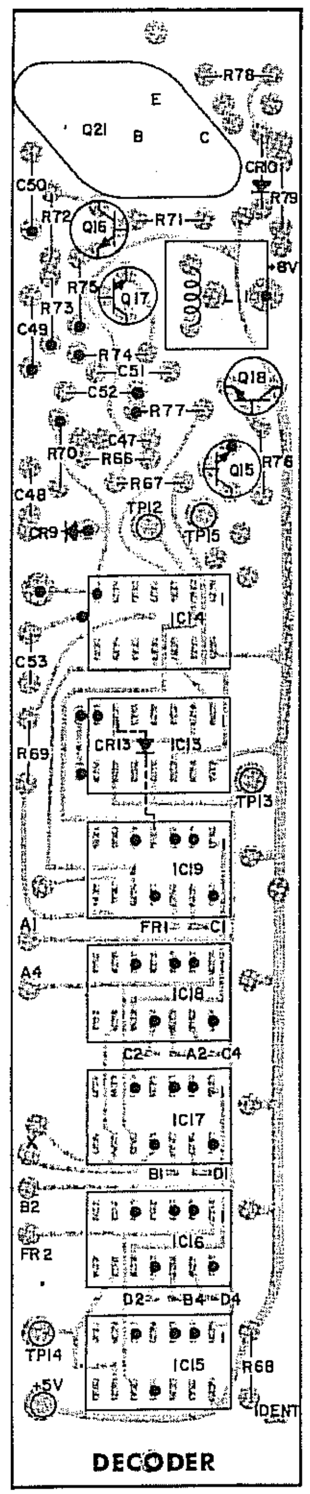
FIG 4-12



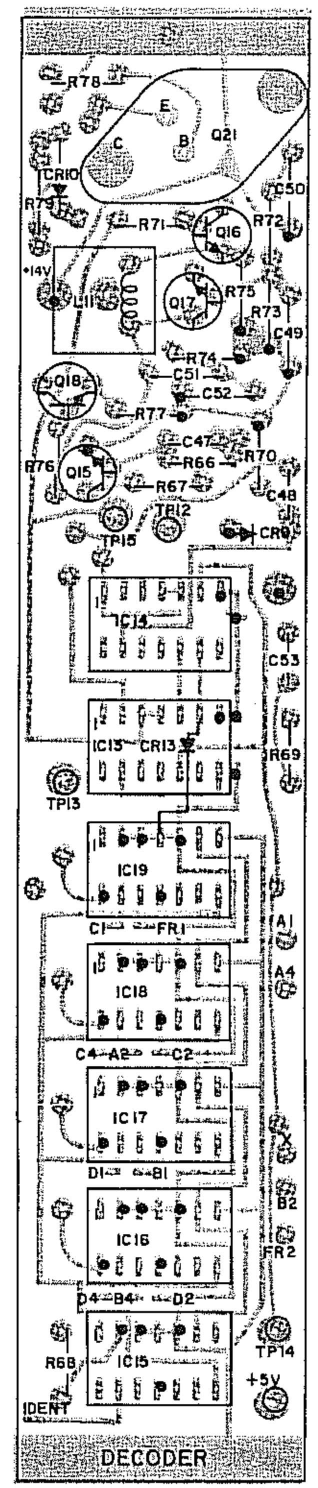
SOLDER SIDE VIEW

FIG 4-13

FOR T-33C/T-43C



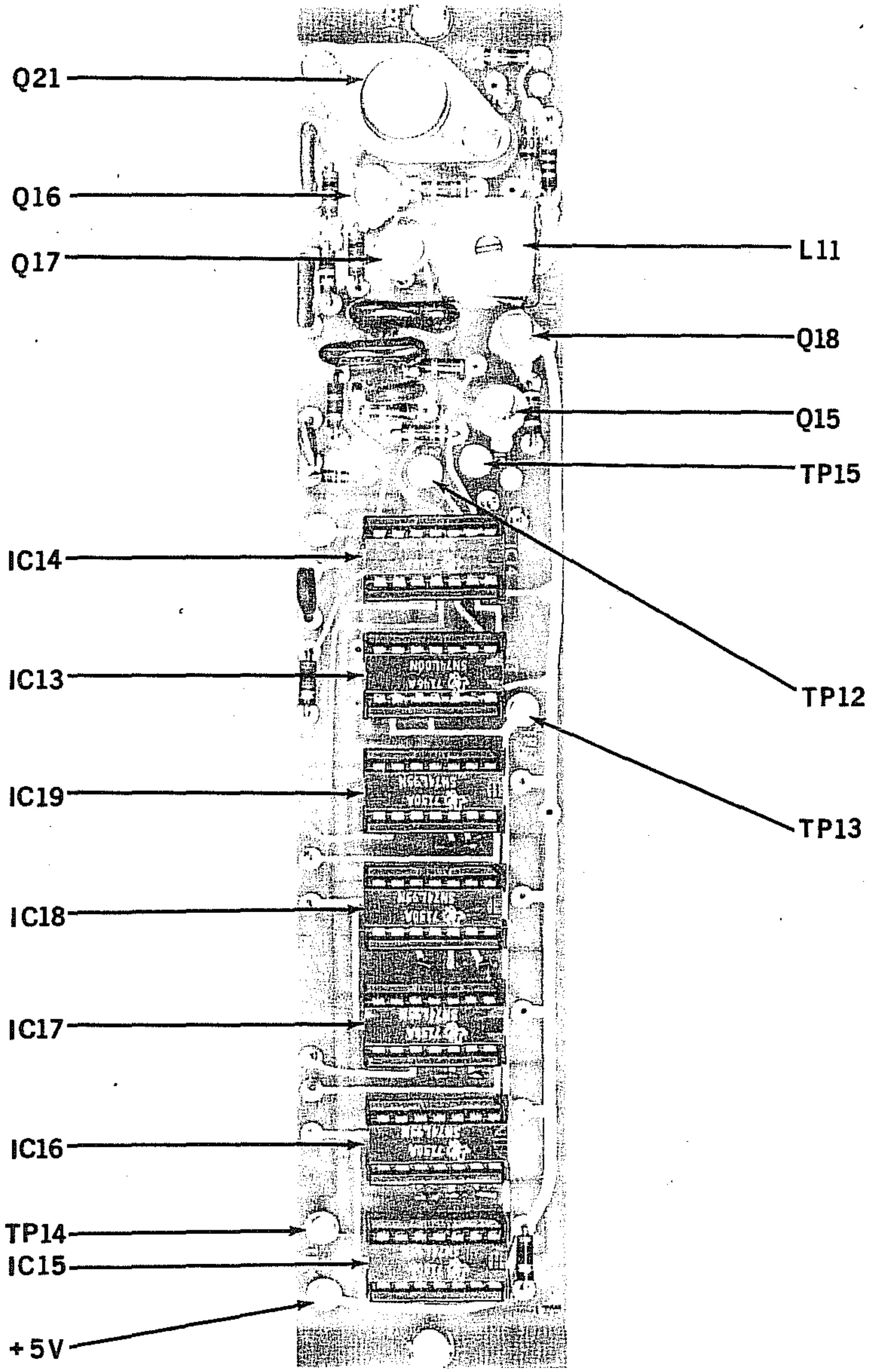
● CHASSIS GND.



● CHASSIS GND

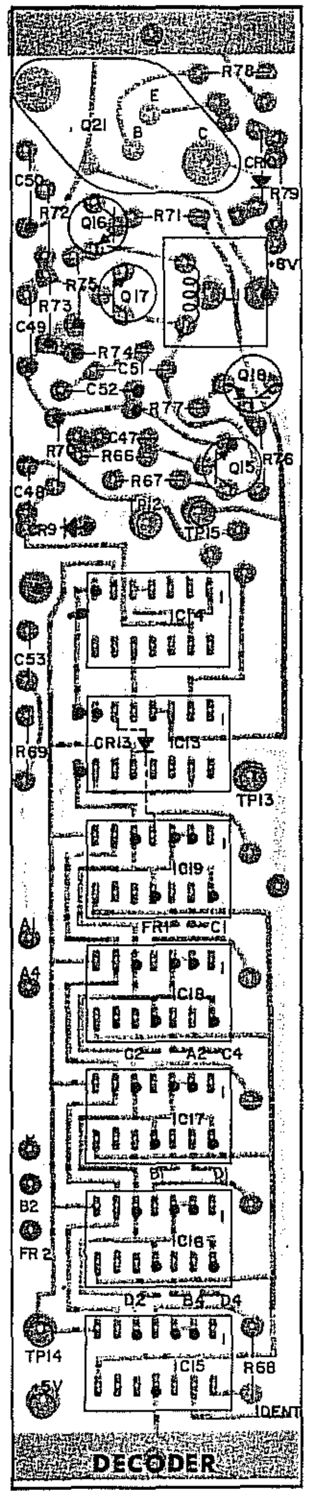
FOR T-33C/T-43C

DECODER BOARD



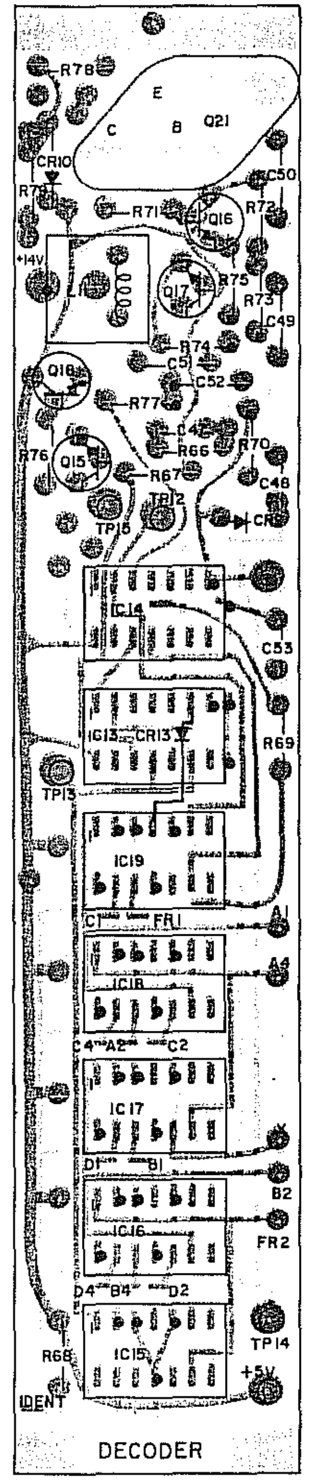
DECODER

fig 4-14



● CHASSIS GND.

COMPONENT SIDE VIEW
FIG 4 - 15



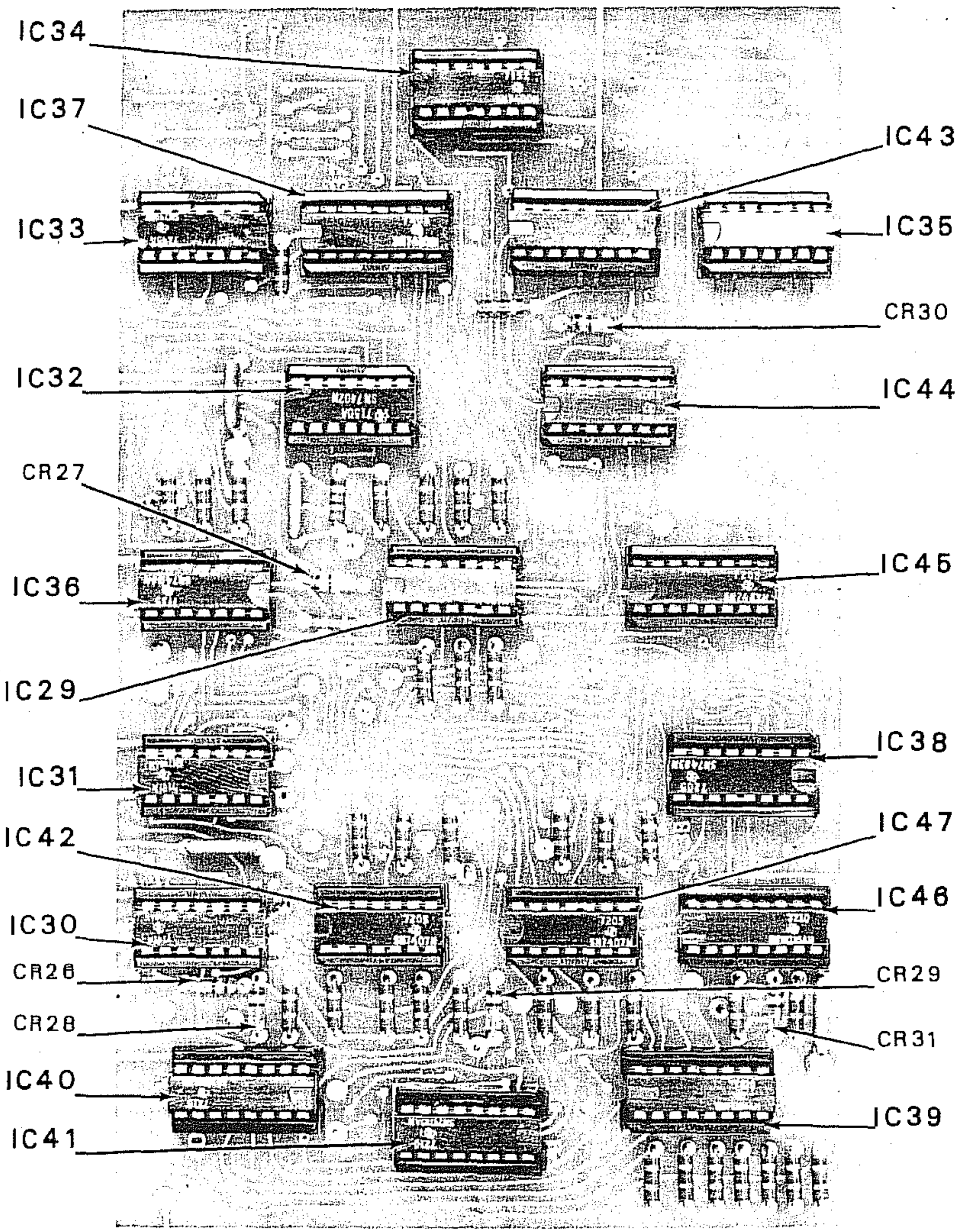
● CHASSIS GND

SOLDER SIDE VIEW
FIG 4 - 16

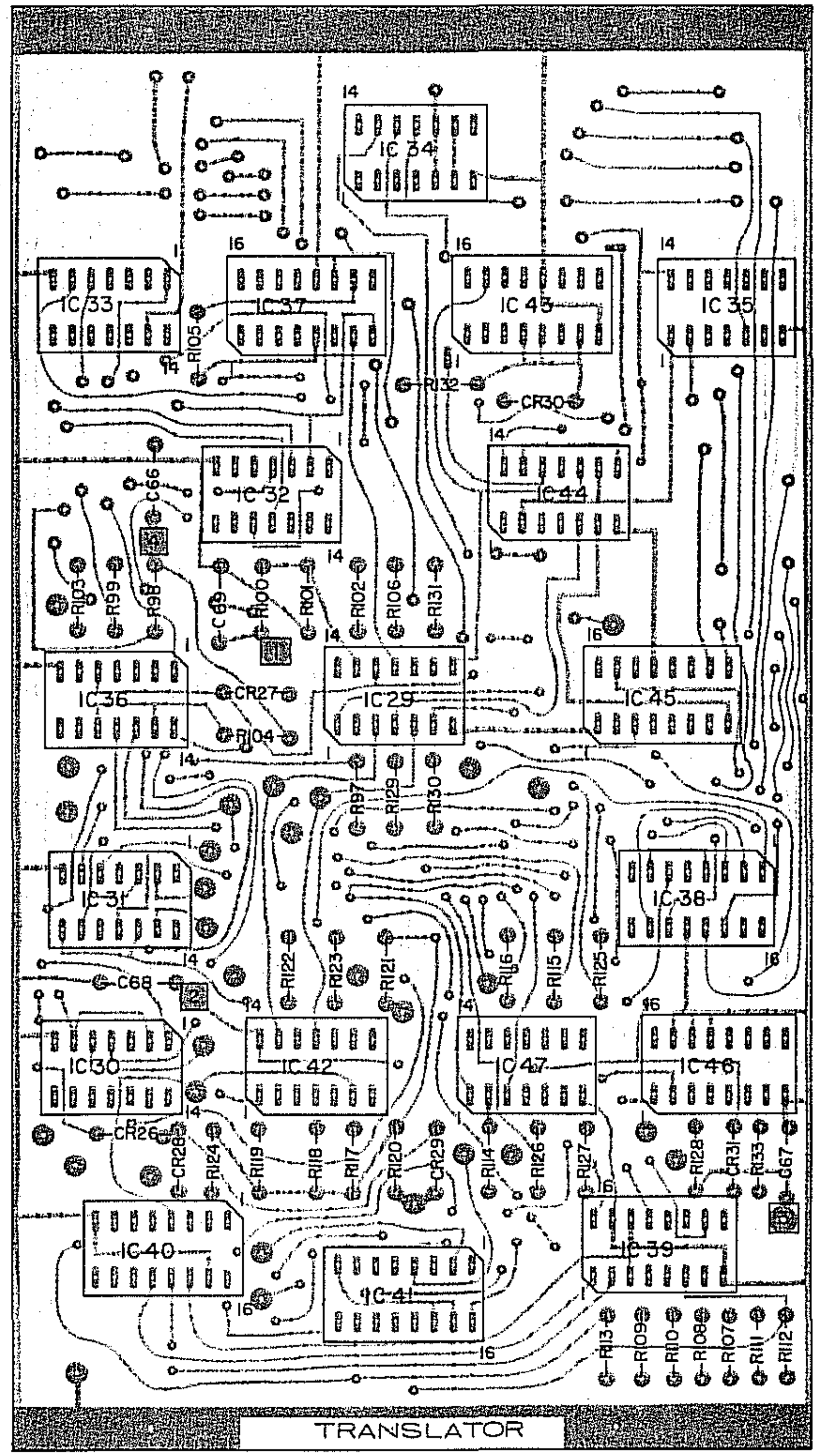
T-33B & T-33C A/R TRANSPONDER RAMP TEST SET

DECODER BOARD

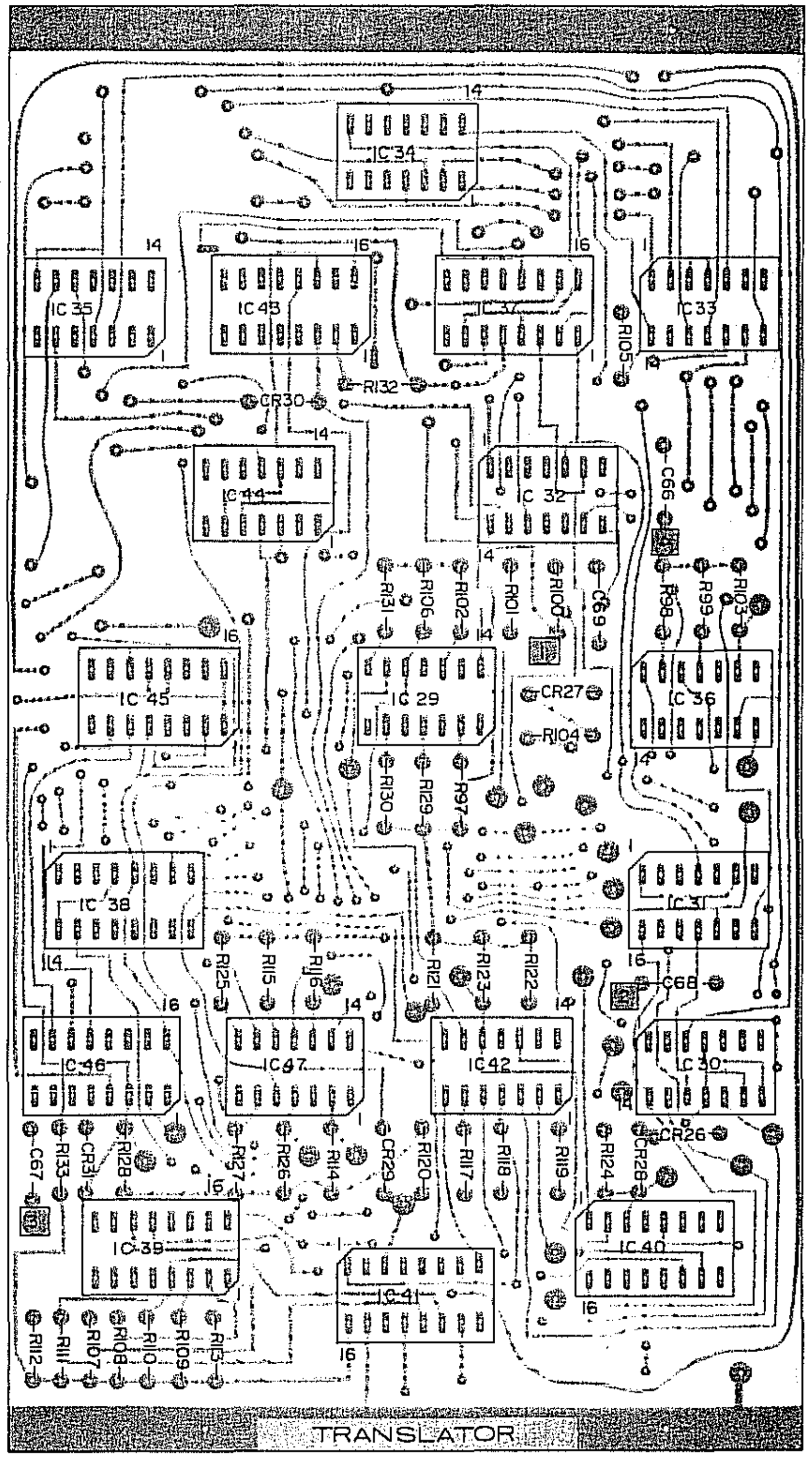
ITEM	DESCRIPTION : MFR/MFR PN	CIRCUIT DESIGNATION	QTY	TIC PART #
1	CAP - FXD DM 470 pF 500WVDC 15% : SAN/DM195F4715	C51	1	TC-50-A
2	CAP - FXD DM 620 pF 500WVDC 5% : SAN/DM195F621J	C52	1	TC-51
3	CAP - FXD CER DISC 1K pF 500WVDC 10% : ETP/801-000X5F0102K	C47	1	TC-94
4	CAP - FXD CER DISC 2K pF 500WVDC 20% : ETP/801-000Z5U202P	C53	1	TC-98
5	CAP - FXD CER DISC 0.1 μF 25WVDC 20% : SPR/5C023104X8250B3	C49, 50	2	TC-122
6	DIODE SI 1N2069 200V	CR10	1	TD-16
7	IND - VAR 120-280 μH : MLR 9056	L11	1	TC-192-A
8	IC SN7400N : T-I	IC13	1	TSN7400N
9	IC SN74L04N : T-I (For T-33B)	IC14	1	TSN74L04N
	IC SN74LS04N : T-I (For T-33C)	IC14	1	TSN74LS04N
10	IC SN74L95N : T-I (For T-33B)	IC15 - 19	5	TSN74L95N
	IC SN74LS95BN : T-I (For T-33C)	IC15 - 19	5	TSN74LS95BN
11	RES FXD COMP 100Ω 1/4W 10% : A-B CB1011	R69, 78	2	TR-145
12	RES FXD COMP 470Ω 1/4W 10% : A-B CB4711	R67	1	TR-151
13	RES FXD COMP 680Ω 1/4W 10% : A-B CB6811	R79	1	TR-153
14	RES FXD COMP 1K 1/4W 10% : A-B CB1021	R66, 68, 75	3	TR-155
15	RES FXD COMP 1.5K 1/4W 10% : A-B CB1521	R77	1	TR-157
16	RES FXD COMP 2.2K 1/4W 10% : A-B CB2221	R74	1	TR-159
17	RES FXD COMP 4.7K 1/4W 10% : A-B CB4721	R71, 76	2	TR-163
18	RES FXD COMP 10K 1/4W 10% : A-B CB1031	R72, 73	2	TR-167
19	SOCKET IC : AUG 314-AG5D-2R	XIC13 - 19	7	TS-42-A
20	SOCKET TSTR : IEH MPT -4003-1	XQ15 - 18	4	TS-34
21	TSTR FT 3904 : F-S	Q15 - 18	4	TT-32
22	TSTR 40318 : RCA	Q21	1	TT-43



TRANSLATOR BOARD



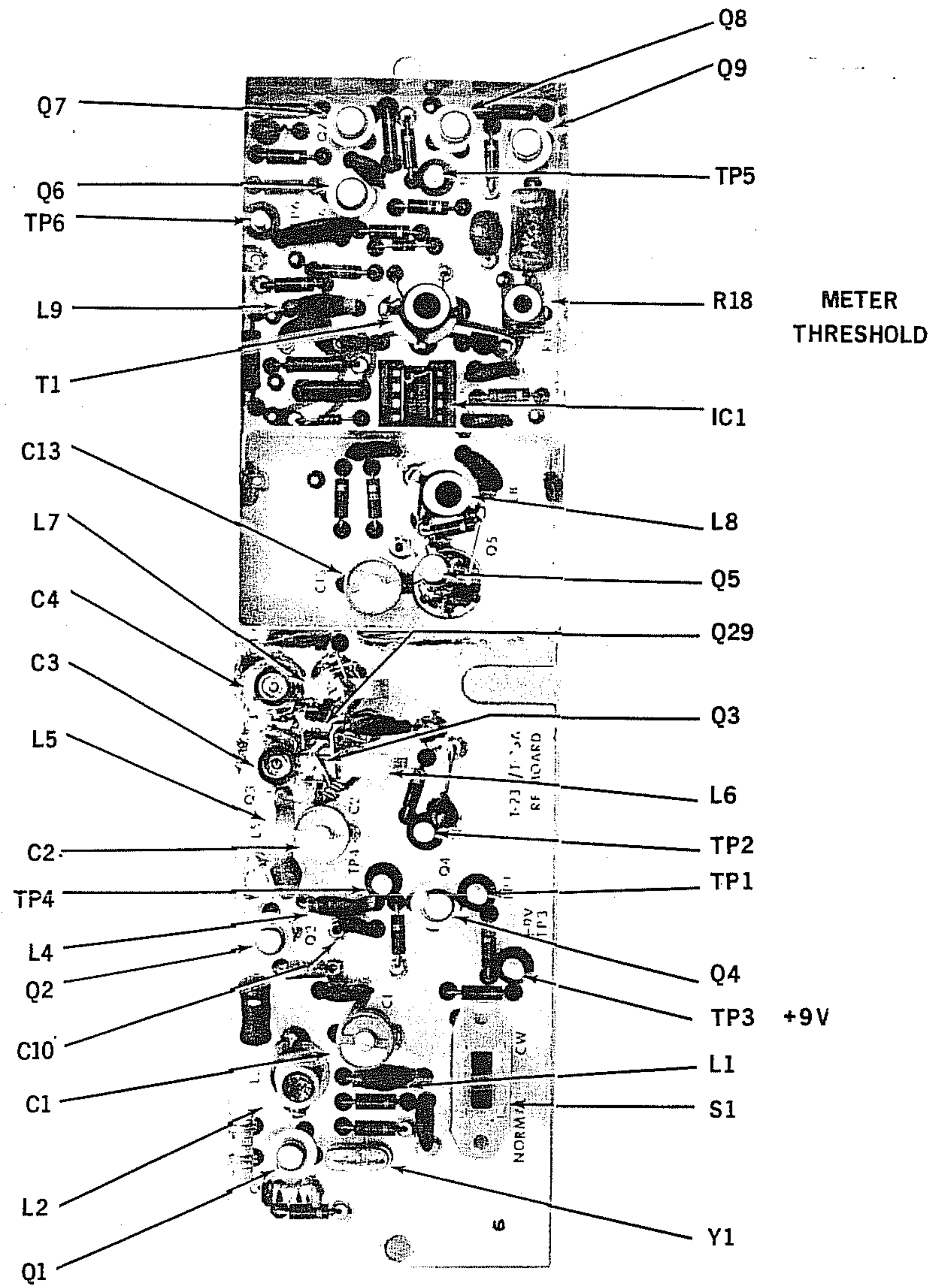
COMPONENT SIDE VIEW
FIG 4 - 18



SOLDER SIDE VIEW
FIG 4 - 19

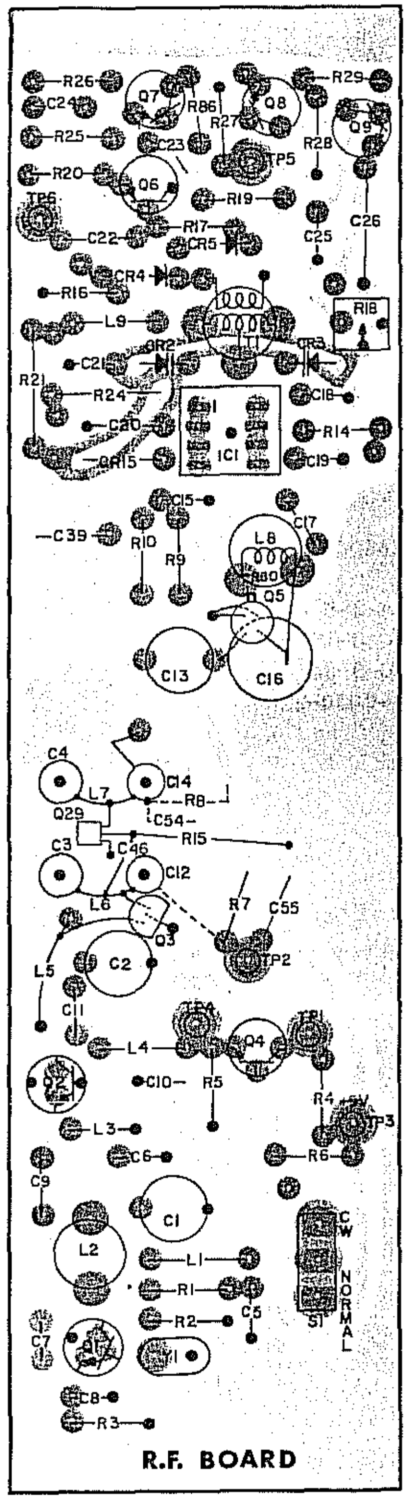
TRANSLATOR BOARD

ITEM	DESCRIPTION: MFR/MFR PN				CIRCUIT DESIGNATION	QTY	TIC PART #
1	CAP - FXD CER DISC 0.1 μF 25V 20%: SPR/5C023104X8250B3				C66 - 69	4	TC-122
2	DIODE GE SIG	1N90			CR26 - 31	6	TD-8
3	IC	SN7400N:	T-I	(For T-33B)	IC34	1	TSN7400N
		SN74LS00N:	T-I	(For T-33C)	IC34	1	TSN74LS00N
4	IC	SN7402N:	T-I	(For T-33B)	IC32, 35	2	TSN7402N
		SN74LS02N:	T-I	(For T-33C)	IC32, 35	2	TSN74LS02N
5	IC	SN7406N:	T-I		IC36	1	TSN7406N
6	IC	SN7407N:	T-I		IC29, 42, 57	3	TSN7407N
7	IC	SN7408N:	T-I	(For T-33B)	IC33	1	TSN7408N
		SN74LS08N:	T-I	(For T-33C)	IC33	1	TSN74LS08N
8	IC	SN7445N:	T-I		IC43	1	TSN7445N
9	IC	SN7483N:	T-I	(For T-33B)	IC37, 38, 45	3	TSN7483N
	IC	SN74LS83AN:	T-I	(For T-33C)	IC37, 38, 45	3	TSN74LS83AN
10	IC	SN74185N:	T-I		IC39, 40, 41, 46	4	TSN74185N
11	IC	SN7486N:	T-I	(For T-33B)	IC30, 31, 44	3	TSN7486N
	IC	SN74LS86N:	T-I	(For T-33C)	IC30, 31, 44	3	TSN74LS86N
12	RES - FXD COMP:		180Ω	1/4W 10% : A-B/CB1811	R100	1	TR-147
13	RES - FXD COMP:		220Ω	1/4W 10% : A-B/CB2211	R101, 121, 125	3	TR-148
14	RES - FXD COMP:		2.7KΩ	1/4W 10% : A-B/CB2721	R97 - 99, 102 - 120, 122 - 124, 126 - 133	33	TR-160
15	SOCKET IC:		AUG/314-AG5D-2R		XIC29 - 36, 42, 44, 47	11	TS-42-A
16	SOCKET IC:		AUG/316-AG5D-2R		XIC37 - 41, 43, 45, 46	8	TS-42-A



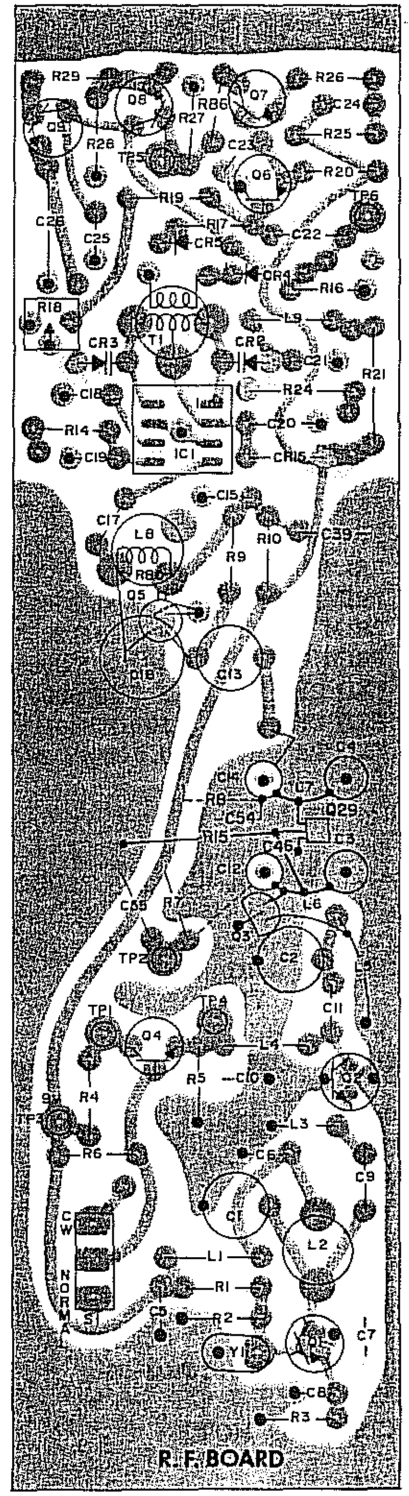
R.F. BOARD

FIG 4 - 20



● CHASSIS GND.

COMPONENT SIDE VIEW
FIG 4 - 21



● CHASSIS GND.

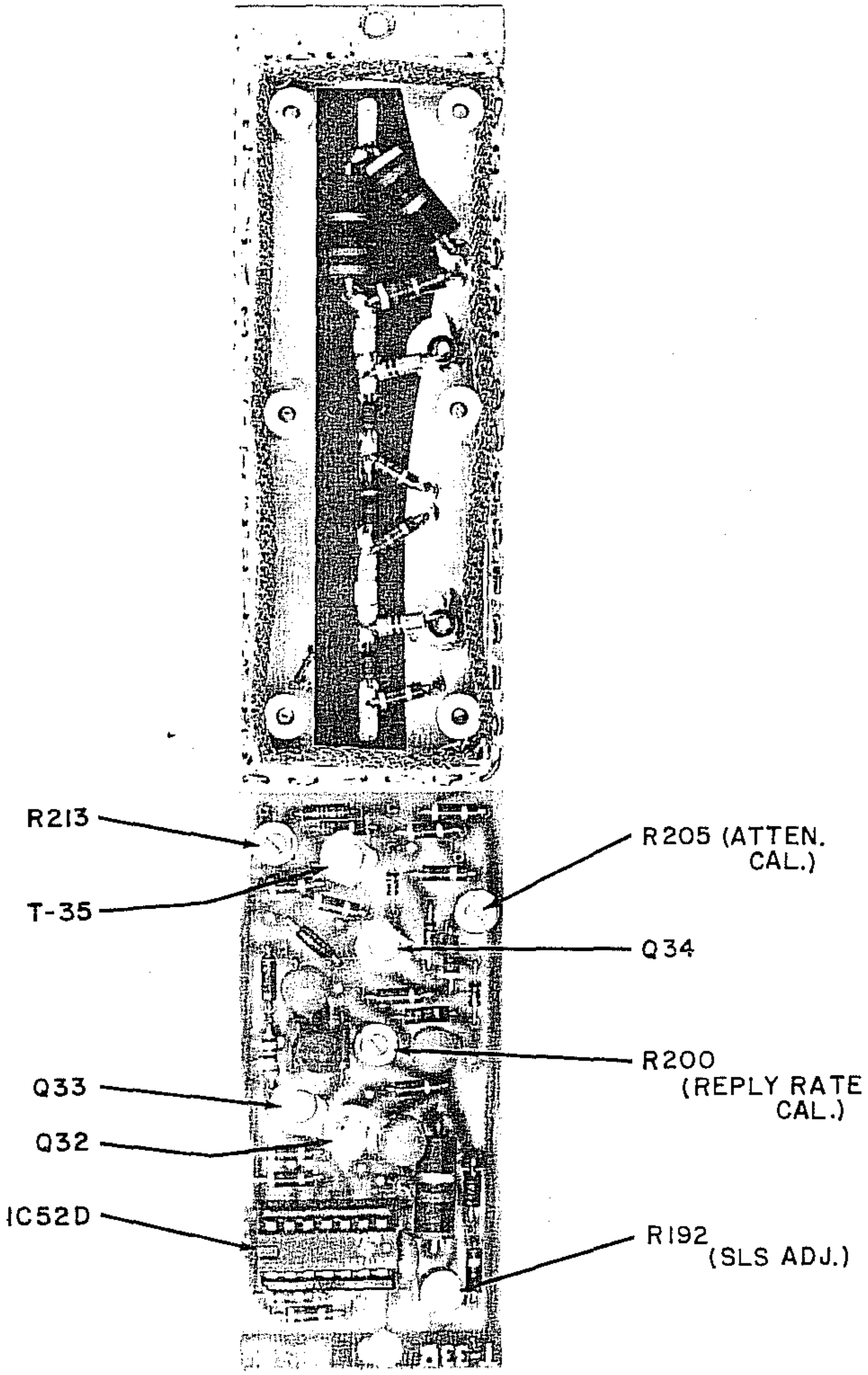
SOLDER SIDE VIEW
FIG 4 - 22

R. F. BOARD

ITEM	DESCRIPTION: MFR/MFR PN	CIRCUIT DESIGNATION	QTY	TIC PART #
1	CAP - FXD BT 47 pF 500V 10% : ETP/654-017-470K	C16	1	TC-77-A
2	CAP - FXD CER DISC 3.3 pF 1KV ± .5 pF : CRL/DD-3R3	C46	1	TC-70-A
3	CAP - FXD CER DISC 47 pF 500V 10% : ETP/831-000-X5F0-470K	C11, 92	2	TC-79
4	CAP - FXD CER DISC 100 pF 1KV 10% : CRL/DD-101	C19, 23	2	TC-82
5	CAP - FXD CER DISC 270 pF 3KV 10% : CRL/DD30-271	C10 F.A.	1	TV
6	CAP - FXD CER DISC 1K pF 500V 10% : ETP/801-000-X5F0102K	C5, 6, 15, 17 18, 21	6	TC-94
7	CAP - FXD CER DISC 0.01 μF 500V 10% : ETP/811-000-Z5U0-103M	C22	1	TC-105
8	CAP - FXD CHIP 100 pF 1KV 10% : ATC/100B101KMS	C90	1	TC-83-C
9	CAP - FXD ELECT, TA 15 μF 15V 10% : SPR/196D156X9015JA1	C24	1	TC-152
10	CAP - FXD ELECT, TA 100 μF 10V 20% : SPR/196D107X0010LA3	C25, 39	2	TC-168
11	CAP - FXD FT 50 pF 250V 10% : AER/EF-5	C89, 94	2	TC-80
12	CAP - FXD FT 500 pF 250V 10% : AER/EF-5	C12, 14	2	TC-92
13	CAP - FXD MNL 0.47 μF 50V 20% : SPR/7C02347X0500E	C20, 91	2	TC-139
14	CAP - TRIM GL 8-8.5 pF 1KV : ETP/563-013	C3, 4	2	TC-58
15	CAP - TRIM CER 2-8 pF 350V : ETP/538-011-A-2-8	C2	1	TC-60
16	CAP - TRIM CER 3-15 pF 200V : ETP/538-011-D-3-15	C1	1	TC-61
17	CAP - TRIM CER 9-35 pF 200V : ETP/538-011-D-9-35	C13	1	TC-65
18	CAP - FXD CER TB 2.2 pF 500V ±.25 pF : ETP/301-000-C0J0-2296	C9	1	TC-69
19	CAP - FXD CER TB 10 pF 600V ±.5 pF : CRL/TCZ-10	C8	1	TC-74-A
20	CAP - FXD TA TB 0.047 μF 200V : SPR/192P47392	C26	1	TC-117
21	COVER : TK		1	TSP-8
22	CRYSTAL 128.75 MHz : PZO/TIC-82	Y1	1	TC-315
23	DIODE SI SIG 1N87A	CR4 .	1	TD-7
24	DIODE SI SIG 1N4148	CR5, 15	2	TD-19-A
25	DIODE SI VRT M20109 : MOT	CR2, 3	2	TD-17-B
26	DIRECTIONAL COUPLER : TIC/TGC-8		1	OBD
27	IND - FXD 1.0 μH : CRA/190-1	L4	1	TC-196
28	IND - FXD 18 μH : DEL/1916	L1, 9	2	TC-199
29	IND - VAR : TIC	L2	1	TSP-3
30	IND - VAR : TIC	L5	1	TSP-6
31	IND - VAR : TIC	L6	1	TSP-7
32	IND - VAR : TIC	L7	1	TSP-8
33	IND - VAR : TIC	L8	1	TSP-4
34	INSERT : GPC/S13832-30	XL8, XT1	2	TI-5
35	IC MC1350P : MOT	IC1	1	TMC1350P

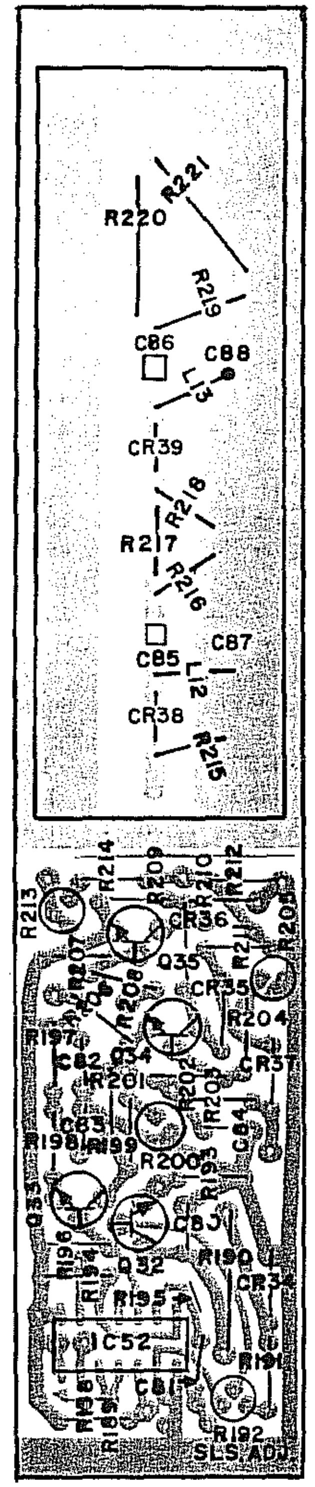
R. F. BOARD

ITEM	DESCRIPTION: MFR/MFR PN	CIRCUIT DESIGNATION	QTY	TIC PART #
36	RES - FXD COMP 22Ω 1/4W 10% : A-B/CB2201	R26	1	TR-140
37	RES - FXD COMP 51Ω 1/4W 10% : A-B/CB5105 (ON DIRECTIONAL COUPLER)	R227	1	TR-136-D
38	RES - FXD COMP 100Ω 1/4W 10% : A-B/CB1011	R10, 86	2	TR-145
39	RES - FXD COMP 220Ω 1/4W 10% : A-B/CB2211	R28	1	TR-148
40	RES - FXD COMP 270Ω 1/4W 10% : A-B/CB2711	R4	1	TR-148-A
41	RES - FXD COMP 330Ω 1/4W 10% : A-B/CB3311	R80	1	TR-149
42	RES - FXD COMP 470Ω 1/4W 10% : A-B/CB4711	R25	1	TR-151
43	RES - FXD COMP 1KΩ 1/4W 10% : A-B/CB1021	R3, 5, 6, 17 (F.A.) 20, 27, 29, 44	8	TR-155
44	RES - FXD COMP 4.7K 1/4W 10% : A-B/CB4721	R1, 2, 14	3	TR-163
45	RES - FXD COMP 10K 1/4W 10% : A-B/CB1031	R15, 83	2	TR-167
46	RES - FXD COMP 47K 1/4W 10% : A-B/CB4731	R17	1	TR-175
47	RES - FXD COMP 100K 1/4W 10% : A-B/CB1041	R19	1	TR-179
48	RES - FXD COMP 150K 1/4W 10% : A-B/CB1541	R9	1	TR-181
49	RES - FXD MET FLM 10K 1/4W 1% : TYPE RN60C	R21 (F.A.), 24 (F.A.)	2	TV
50	RES - VAR CER 500K 1/2W 10% : A-B/ZV5041	R18	1	TP-84-B
51	SOCKET IC : TIC	XIC1	1	TP-1186
52	SOCKET TSTR : IEH/MPT-4003-1	XQ4, 6, 7, 8, 9	5	TS-34
53	SOCKET TSTR : IEH/MPT-4004-1	XQ1, 2	2	TS-35
54	SWITCH TGL SPDT : C-K/7101MDC	S1	1	TS-90-A
55	TSTR SI N SH FT-3904 : F-S	Q4, 8, 9	3	TT-32
56	TSTR SI P SH FT-3906 : F-S	Q6, 7	2	TT-33
57	TSTR SI N AH 2N5179	Q5	1	TT-36
58	TSTR SI N LA 2N6305	Q1, 2, 3, 29	4	TT-36-B
59	TRANSFORMER : TIC	T1	1	TSP-5



ATTENUATOR
BOARD

FIG. 4-23



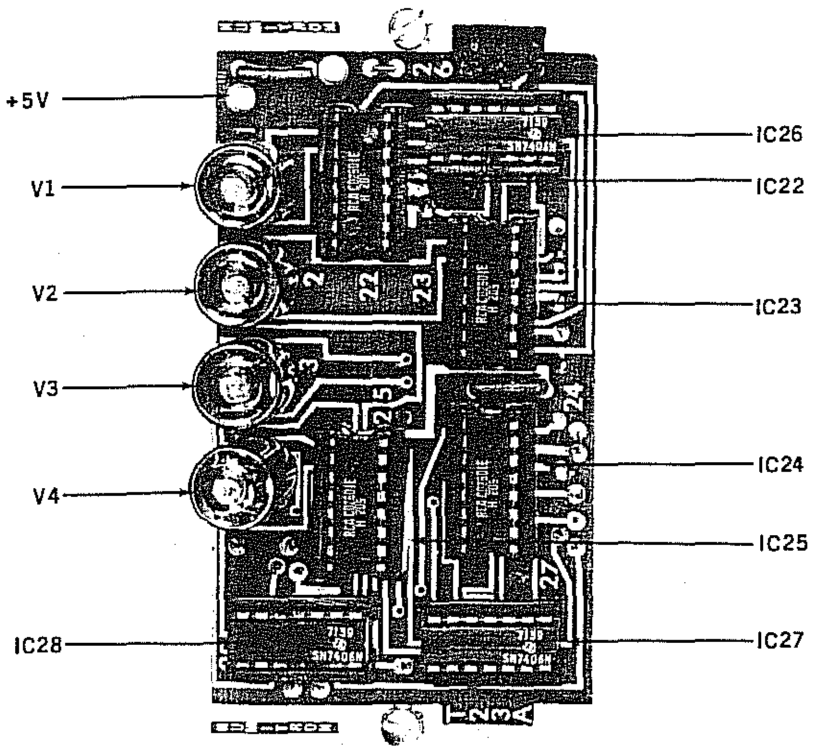
ATTENUATOR
BOARD

COMPONENT SIDE VIEW

FIG. 4-24

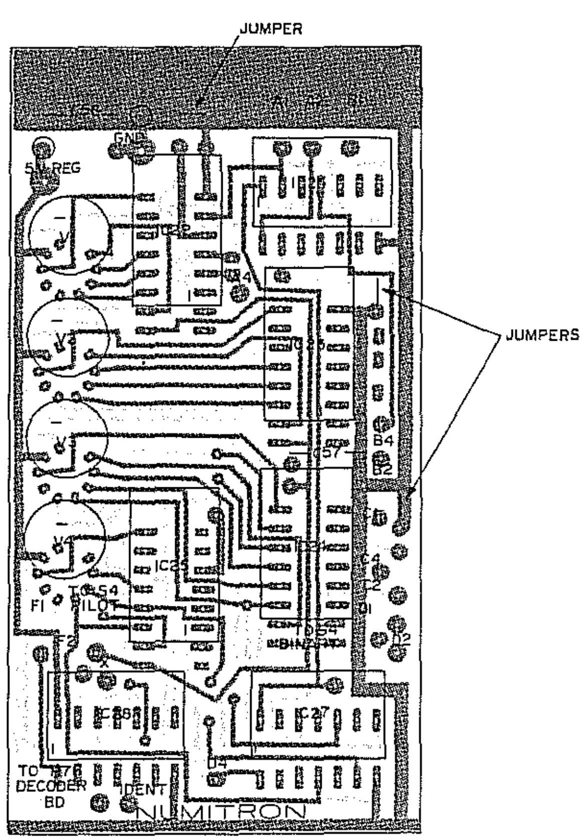
ATTENUATOR BOARD

ITEM	DESCRIPTION: MFR/MFR PN	CIRCUIT DESIGNATION	QTY	TIC PART #
1	CAP - FXD CHIP 100 pf 1KV 10% : ATC/100B101KMS	C85, 86	2	TC-83-C
2	CAP - FXD CER DISC 100 pf 1KV 10% : CRL/DD-101	C81	1	TC-82
3	CAP - FXD ELECT TA 22 μF 35V 10% : SPR/196D226X9034PE4	C80, 82, 84	3	TC-156
4	CAP - FXD ELECT TA 100 μF 10V 10% : SPR/196D107X0010LM3	C83	1	TC-168
5	CAP - FXD FT 470 pF 500V 20% : SPT/54-794-001	C87, 88	2	TC-88-A
6	DIODE SI SIG 1N4148 75V	CR35, 36, 37	3	TD-19-A
7	DIODE SI ZEN 1N4741 11V	CR34	1	TD-19-D
8	DIODE PIN 5082-3080 : H-P	CR38, 39	2	TD-23-B
9	IC SN74L03N : T-I (For T-33B)	IC52	1	TSN74L03N
	SN74LS03N : T-I (For T-33C)	IC52	1	TSN74LS03N
10	IND - FXD 0.1 μH : NYT/DD-0.10	L12, 13	2	TI-1
11	RES - FXD MET FLM 1KΩ 1/8W 1% TYPE RN55C : MPE	R206 F.A.	1	OBD
12	RES - FXD MET FLM 2.2KΩ 1/8W 1% TYPE RN55C : MPE	R214	1	OBD
13	RES - FXD MET FLM 3.32KΩ 1/8W 1% TYPE RN55C : MPE	R201	1	OBD
14	RES - FXD MET FLM 5.9KΩ 1/8W 1% TYPE RN55C : MPE	R198	1	OBD
15	RES - FXD MET FLM 10KΩ 1/8W 1% TYPE RN55C : MPE	R199	1	OBD
16	RES - FXD MET FLM 53.6KΩ 1/8W 1% TYPE RN55C : MPE	R197	1	OBD
17	RES - FXD COMP 27Ω 1/4W 10% : A-B/CB2701	R217	1	TR-141
18	RES - FXD COMP 47Ω 1/4W 10% : A-B/CB4701	R215	1	TR-142
19	RES - FXD COMP 91Ω 1/4W 10% : A-B/CB9101	R219	1	TR-219
20	RES - FXD COMP 180Ω 1/4W 10% : A-B/CB1811	R216, 218	2	TR-147
21	RES - FXD COMP 680Ω 1/4W 10% : A-B/CB6811	R203	1	TR-153
22	RES - FXD COMP 1KΩ 1/4W 10% : A-B/C1021	R191, 193, 211	3	TR-155
23	RES - FXD COMP 1.5KΩ 1/4W 10% : A-B/C1521	R195	1	TR-157
24	RES - FXD COMP 1.8KΩ 1/4W 10% : A-B/CB1821	R202	1	TR-158
25	RES - FXD COMP 2.7KΩ 1/4W 10% : A-B/CB2721	R222 F.A.	1	
26	RES - FXD COMP 4.7KΩ 1/4W 10% : A-B/CB4721	R188, 189, 194, 196, 204, 207, 208, 209, F.A., 212	9	TR-163
27	RES - FXD COMP 8.2KΩ 1/4W 10% : A-B/CB8221	R210 F.A.	1	
28	RES - FXD COMP 68Ω 1W 10% : A-B/CB6801	R220	1	TR-237-D
29	RES - FXD COMP 91Ω 1W 10% : A-B/GB9101	R221	1	TR-237-A-1
30	RES - FXD COMP 820Ω 1W 10% : A-B/GB8211	R190	1	TR-241-D
31	RES - VAR CER 5KΩ 1/2W : BEK/62PR5K	R192, 202	2	TP-58-A
32	RES - VAR WW 10KΩ 5W 10% : CRL/WW103 (FP)	R213	1	TP-69
33	RES - VAR CER 25KΩ 1/2W : BEK/62PR25K	R200	1	TP-75-B
34	RES - VAR CER 500KΩ 1/2W 10% : A-B/ZV5041	R13	1	TC-84-C
35	SOCKET IC : AUG/314-AG5D-2R	XIC52	1	TS-42-A
36	SOCKET TSTR : IEH/MPT-4003-1	XQ32 - 35	4	TS-34
37	TSTR SI N SH FT3904 : F-S	Q32	1	TT-32
38	TSTR SI P SH FT3906 : F-S	Q33 - 35	3	TT-33

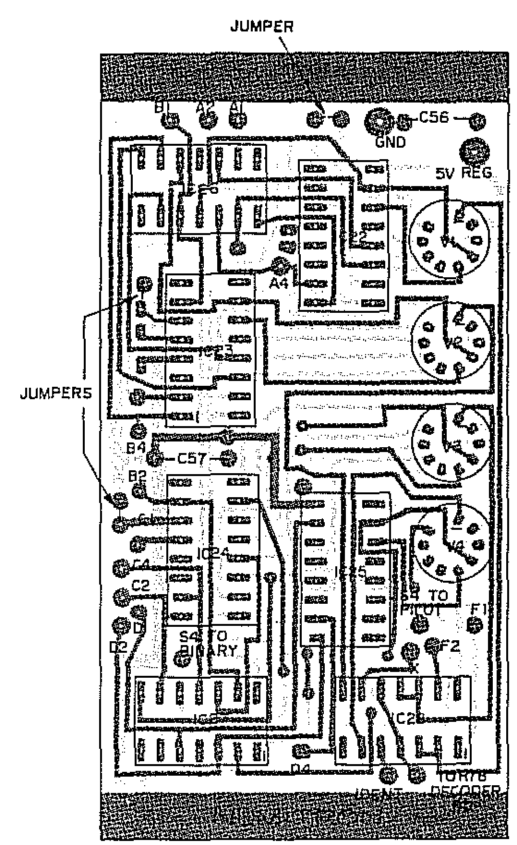


NUMITRON

FIG 4 - 25



COMPONENT SIDE VIEW
FIG 4 - 26



SOLDER SIDE VIEW
FIG 4 - 27

NUMITRON BOARD

ITEM	DESCRIPTION: MFR/MFR PN	CIRCUIT DESIGNATION	QTY	TIC PART #
1	CAP - FXD CER DISC 0.1 μF 25V 20% : SPR/5C023104X8250B3	C56, 57	2	TC-122
2	IC CD-2501E : RCA	IC22 - 25	4	TCD-2501E
3	IC SN7406N : T-I	IC26 - 28	3	TSN7406N
4	NUMITRON TUBE DR2110 : RCA	V1 - 4	4	TT-54
6	SOCKET IC : AUG/314-AG5D-2R	XIC26 - 28	3	TS-42-A
7	SOCKET IC : AUG/316-AG5D-2R	XIC22 - 25	4	TS-42-B
8	SOCKET TUBE : TIC	XV1 - 4	4	TS-30-A

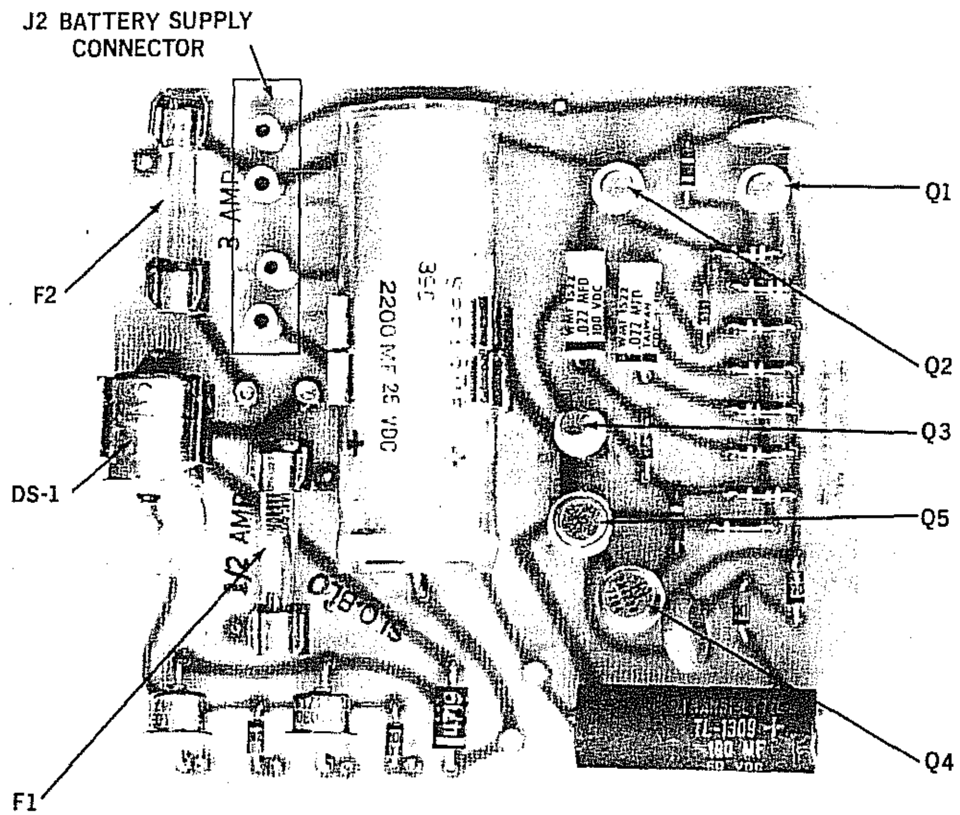
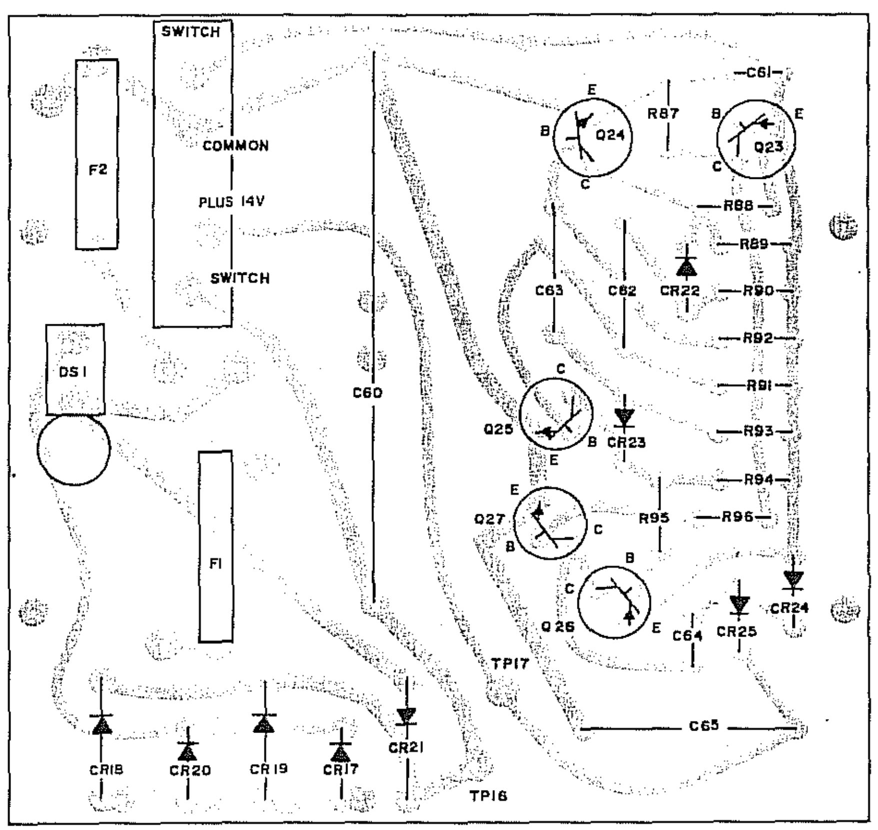


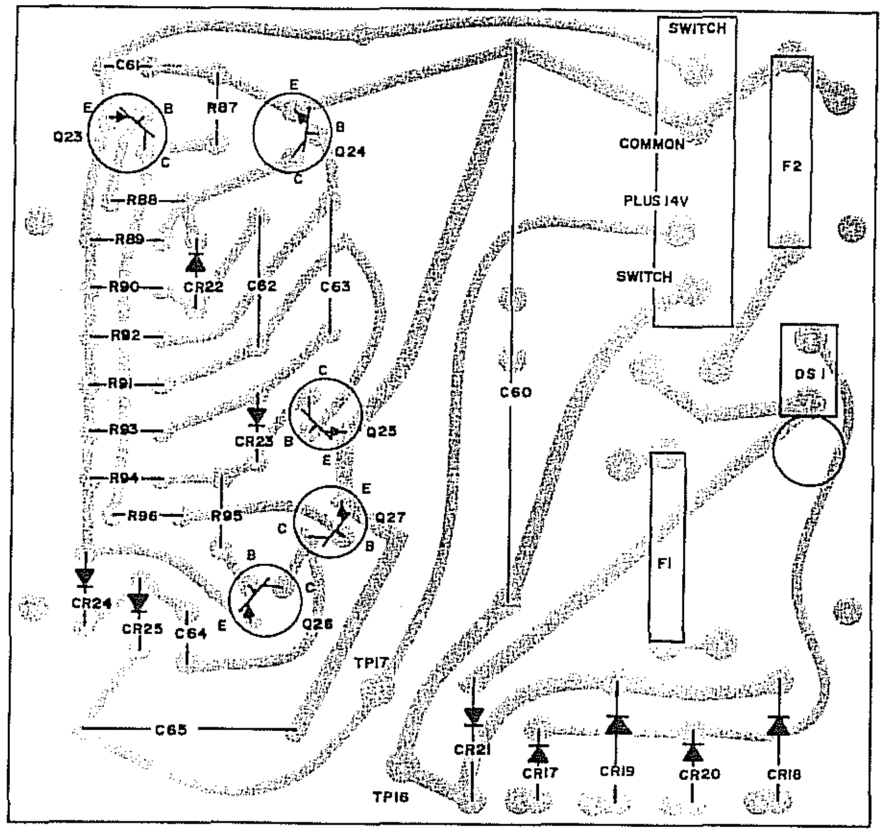
FIG 4 - 28



COMPONENT SIDE VIEW

FIG 4 - 29

BATTERY CHARGER



SOLDER SIDE VIEW

FIG 4 - 30

BATTERY CHARGER

T-33B A/R TRANSPONDER RAMP TEST SET

BATTERY CHARGER BOARD

ITEM	DESCRIPTION: MFR/MFR PN	CIRCUIT DESIGNATION	QTY	TIC PART #
1	CAP - FXD ELECT 100 µF 20V 20% : SPR/196D107X0020MA3	C61, 64	2	TC-169-A
2	CAP - FXD ELECT 100 µF 50V : SPR/TUA-1310	C65	1	TC-171
3	CAP - FXD ELECT 100 µ F 25V : SPR/39D228G025HP4	C60	1	TC-176-C
4	CAP - FXD MY 0.022 µ F 100V 10% : CDE/WMF1522	C62, 63	2	TC-108
5	DIODE SI REC 1N2069	CR17, 20, 24, 25	4	TD-16
6	DIODE SI REC 1N4719 : MOT ONLY	CR18, 19, 21	3	TD-19-1
7	DIODE SI SIG 1N4148	CR22, 23	2	TD-19-A
8	FUSE 1/2A : BUS/MDL SLO-BLO	F1	1	TF-18
9	FUSE 3A : BUS/AGC-3	F2	1	TF-22-B
10	JACK : EMC/5075-139-5	P2	1	TJ-5-B
11	LAMP : GE/67	DS-1	1	TL-1-A-1
12	CLIP - MTG FUSE : LIT/101002	XF1, XF2	2	TC-188-B
13	CLIP - MTG LAMP : AUG/6012-16CC	XDS-1	1	TC-179-1
14	RES - FXD COMP 220Ω 1/4W 10% : A-B/CB2211	R95 - 96	2	TR-148
15	RES - FXD COMP 4.7KΩ 1/4W 10% : A-B/CB4721	R87, 88, 89, 94	4	TR-163
16	RES - FXD COMP 10KΩ 1/4W 10% : A-B/CB1031	R90, 93	2	TR-167
17	RES - FXD COMP 22KΩ 1/4W 10% : A-B/CB2231	R91, 92	2	TR-171
18	SOCKET TSTR : IEH/MPT-4003-1	XQ23 - 25	3	TS-34
19	SOCKET TSTR : IEH/MPT-6003-1	XQ26, 27	2	TS-36
20	TSTR SI N SH FT3904 : F-S	Q24, 25	2	TT-32
21	TSTR SI P SH FT3906 : F-S	Q23	1	TT-33
22	TSTR SI P SP 2N4234	Q26	1	TT-34-A
23	TSTR SI P AP 2N4237	Q27	1	TT-34-B

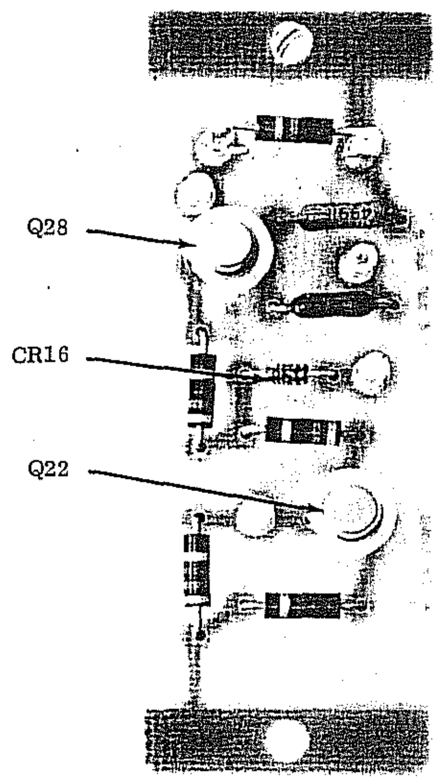
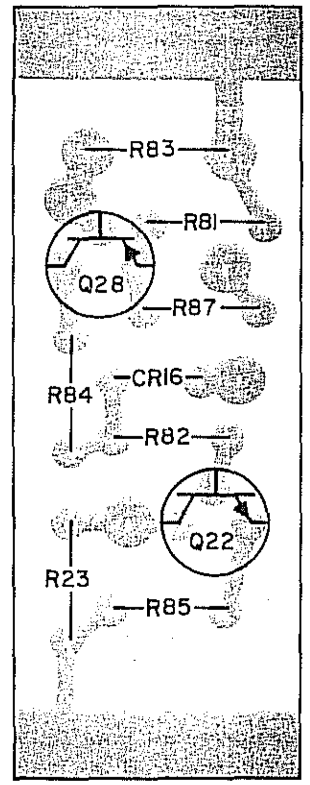


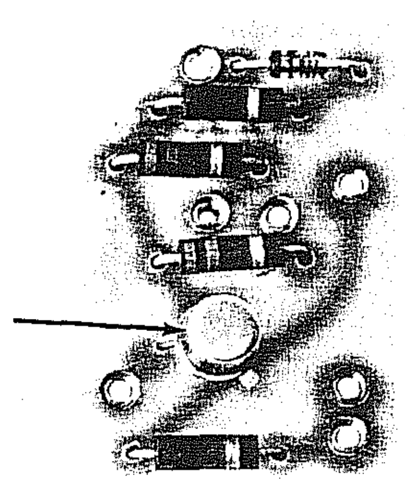
FIG 4 - 31

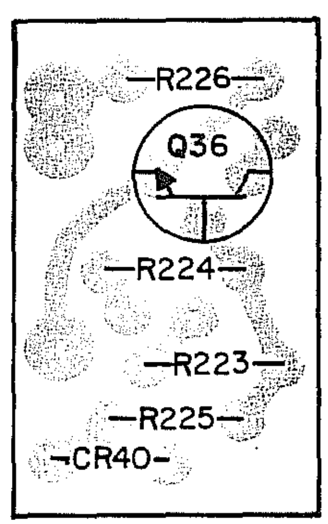


COMPONENT SIDE VIEW

FIG 4 - 32

MISC BOARD





COMPONENT SIDE VIEW

VIDEO BOARD

FIG 4 - 34

T-33B A/R TRANSPONDER RAMP TEST SET

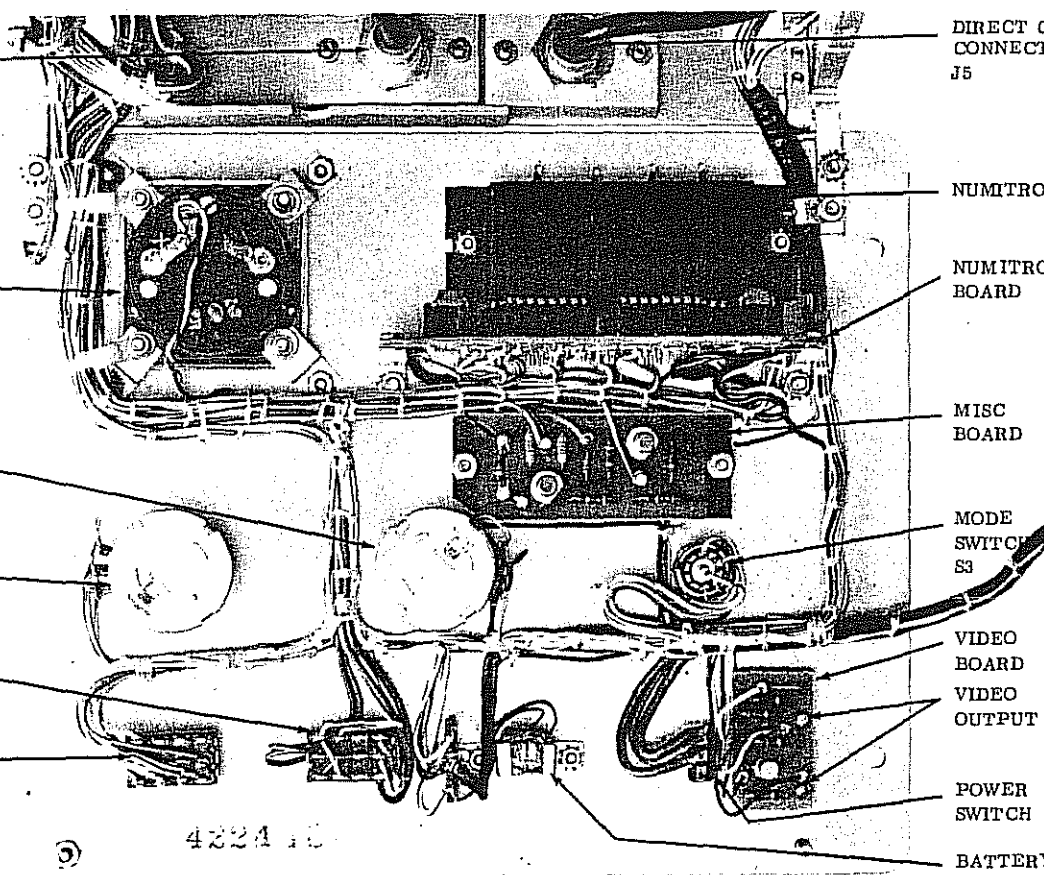
MISCELLANEOUS BOARD

ITEM	DESCRIPTION : MFR/MFR PN	CIRCUIT DESIGNATION	QTY	TIC PART #
1	DIODE SI SIG 1N4148 : MOT	CR16	1	TD-19-A
2	RES FXD COMP 270Ω 1/4W 10% : A-B/CB2717	R65	1	TR-148-A
3	RES. FXD COMP 680Ω 1/4W 10% : A-B/CB6811	R23	1	TR-153
4	RES FXD COMP 4.7KΩ 1/4W 10% : A-B/CB4721	R58, 82, 84	3	TR-163
5	RES FXD COMP 10KΩ 1/4W 10% : A-B/CB1031	R83	1	TR-167
6	RES FXD MET FLM 4.99K 1/4W 1% : TYPE RN606	R81	1	OBD
7	SOCKET TSTR : IEH/MPT-4004-1	XQ22, 28	2	TS-36
8	TSTR SI N SH FT3904 : F-S	Q22, 28	2	TT-32

T-33B A/R TRANSPONDER RAMP TEST SET

VIDEO BOARD

ITEM	DESCRIPTION : MFR/MFR PN	CIRCUIT DESIGNATION	QTY	TIC PART #
1	DIODE SI SIG 1N4148	CR40	1	TD-19-A
2	RES-FXD COMP 100Ω 1/4W 10%: A-B/CB1011	R226	1	TR-145
3	RES-FXD COMP 1K 1/4W 10%: A-B/CB1021	R225	1	TR-155
4	RES-FXD COMP 3.3K 1/4W 10%: A-B/CB3321	R224	1	TR-161
5	RES-FXD COMP 6.8K 1/4W 10%: A-B/CB6821	R223	1	TR-165
6	TSTR SI P SH FT3904: F-S	Q36	1	TT-32



MAIN CHASSIS
FIG 4 - 35

T-33B A/R TRANSPONDER RAMP TEST SET

MAIN CHASSIS

ITEM	DESCRIPTION: MFR/MFR PN	CIRCUIT DESIGNATION	QTY	TIC PART #
1	ANTENNA : TIC	P3	1	TSP-1
2	BATTERY, NI-CAD: G-E/41B004AA70 1.2V	BT-1 - 7	7	TB-7-C
3	CHART, CONVERSION CODE-to-ALTITUDE : TIC		1	TC-1-1A
4	CHART, CONVERSION ALTITUDE-to-CODE : TIC		1	TC-1-1B
5	CLIP, ANTENNA MOUNTING : AUG/6014-23A		2	TC-179-A
6	CABLE, COAX : ALF/RG58 C/U		1 ft	TC-9
7	CONN, COAX : APL/74868 UG-88 C/U	P5, XPDN	2	TC-250
8	CONN, COAX : APL/74868 UG-909 B/U (MOD BY TIC)	J5	1	TC-256
9	CONN, COAX : APL/77175 (PART OF ANTENNA ASSEMBLY)	P3	1	TC-265
10	CONN, PLUG : CTC/3299-2-03	J2	1	TP-22-B
11	DUST CAP, COAX TNC : APL/78750		1	TC-1-A
12	DUST CAP, COAX BNC : APL/31-006		1	TC-1-1
13	INDICATOR, CHARGER : TIC	DS1	1	TSP-10
14	KNOB ; NOB/1-505D (MODE SELECT)		1	TK-16-A1
15	KNOB : NOB/505D (1090 MHz ADJ, RCVR SENS)		2	TK-16-A
16	LINE CORD 8' FT : BEL/17258-S TYPE SUT # 18-3	P1	1	TL-7
17	METER : HOY/2015 0-50 μA DC	M2	1	TM-6-A
18	METER : EMC/802	M1	1	TM-7
19	RECEPTACLE : SCI/AG3G	J1	1	TR-1
20	RES - VAR WW 10K 5W 10% : CRL/WW103	R213	1	TP-69
21	RES - VAR WW 50K 5W 10% : CRL/WW503	R22	1	TP-80-A
22	RUBBER, GASKET : MRC/ZX-4264 50-60 DNP		42 in	TR-5-D
23	SWITCH, ROTARY SP10T : G-H/50CD36-01-1-ADJN	S3	1	TS-76
24	SWITCH, TOGGLE SPDT : AHH/TM-3-M	S5	1	TS-78
25	SWITCH, TOGGLE DPDT : C-K/7411-H	S4	1	TS-97
26	SWITCH, TOGGLE 4P3T : C-K/7413-H	S2	1	TS-98
27	TRANSFORMER : TIC/T357	T2	1	TT-15-F

TEL-INSTRUMENT ELECTRONICS CORP.

Feet	ABCD	Feet	ABCD	Feet	ABCD	Feet	ABCD
-1,000	0020	3,000	4120	7,000	6020	11,000	2120
-900	0030	3,100	4130	7,100	6030	11,100	2130
-800	0010	3,200	4110	7,200	6010	11,200	2110
-700	0410	3,300	4510	7,300	6410	11,300	2510
-600	0430	3,400	4530	7,400	6430	11,400	2530
-500	0420	3,500	4520	7,500	6420	11,500	2520
-400	0460	3,600	4560	7,600	6460	11,600	2560
-300	0440	3,700	4540	7,700	6440	11,700	2540
-200	0640	3,800	4740	7,800	6640	11,800	2740
-100	0660	3,900	4760	7,900	6660	11,900	2760
000	0620	4,000	4720	8,000	6620	12,000	2720
100	0630	4,100	4730	8,100	6630	12,100	2730
200	0610	4,200	4710	8,200	6610	12,200	2710
300	0210	4,300	4310	8,300	6210	12,300	2310
400	0230	4,400	4330	8,400	6230	12,400	2330
500	0220	4,500	4320	8,500	6220	12,500	2320
600	0260	4,600	4360	8,600	6260	12,600	2360
700	0240	4,700	4340	8,700	6240	12,700	2340
800	0340	4,800	4240	8,800	6340	12,800	2240
900	0360	4,900	4260	8,900	6360	12,900	2260
1,000	0320	5,000	4220	9,000	6320	13,000	2220
1,100	0330	5,100	4230	9,100	6330	13,100	2230
1,200	0310	5,200	4210	9,200	6310	13,200	2210
1,300	0710	5,300	4610	9,300	6710	13,300	2610
1,400	0730	5,400	4630	9,400	6730	13,400	2630
1,500	0720	5,500	4620	9,500	6720	13,500	2620
1,600	0760	5,600	4660	9,600	6760	13,600	2660
1,700	0740	5,700	4640	9,700	6740	13,700	2640
1,800	0540	5,800	4440	9,800	6540	13,800	2440
1,900	0560	5,900	4460	9,900	6560	13,900	2460
2,000	0520	6,000	4420	10,000	6520	14,000	2420
2,100	0530	6,100	4430	10,100	6530	14,100	2430
2,200	0510	6,200	4410	10,200	6510	14,200	2410
2,300	0110	6,300	4010	10,300	6110	14,300	2010
2,400	0130	6,400	4030	10,400	6130	14,400	2030
2,500	0120	6,500	4020	10,500	6120	14,500	2020
2,600	0160	6,600	4060	10,600	6160	14,600	2060
2,700	0140	6,700	4040	10,700	6140	14,700	2040
2,800	4140	6,800	6040	10,800	2140	14,800	3040
2,900	4160	6,900	6060	10,900	2160	14,900	3060

ALTITUDE-to-CODE CONVERSION CHART

Feet	ABCD	Feet	ABCD	Feet	ABCD	Feet	ABCD
15,000	3020	19,000	7120	23,000	5020	27,000	1120
15,100	3030	19,100	7130	23,100	5030	27,100	1130
15,200	3010	19,200	7110	23,200	5010	27,200	1110
15,300	3410	19,300	7510	23,300	5410	27,300	1510
15,400	3430	19,400	7530	23,400	5430	27,400	1530
15,500	3420	19,500	7520	23,500	5420	27,500	1520
15,600	3460	19,600	7560	23,600	5460	27,600	1560
15,700	3440	19,700	7540	23,700	5440	27,700	1540
15,800	3640	19,800	7740	23,800	5640	27,800	1740
15,900	3660	19,900	7760	23,900	5660	27,900	1760
16,000	3620	20,000	7720	24,000	5620	28,000	1720
16,100	3630	20,100	7730	24,100	5630	28,100	1730
16,200	3610	20,200	7710	24,200	5610	28,200	1710
16,300	3210	20,300	7310	24,300	5210	28,300	1310
16,400	3230	20,400	7330	24,400	5230	28,400	1330
16,500	3220	20,500	7320	24,500	5220	28,500	1320
16,600	3260	20,600	7360	24,600	5260	28,600	1360
16,700	3240	20,700	7340	24,700	5240	28,700	1340
16,800	3340	20,800	7240	24,800	5340	28,800	1240
16,900	3360	20,900	7260	24,900	5360	28,900	1260
17,000	3320	21,000	7220	25,000	5320	29,000	1220
17,100	3330	21,100	7230	25,100	5330	29,100	1230
17,200	3310	21,200	7210	25,200	5310	29,200	1210
17,300	3710	21,300	7610	25,300	5710	29,300	1610
17,400	3730	21,400	7630	25,400	5730	29,400	1630
17,500	3720	21,500	7620	25,500	5720	29,500	1620
17,600	3760	21,600	7660	25,600	5760	29,600	1660
17,700	3740	21,700	7640	25,700	5740	29,700	1640
17,800	3540	21,800	7440	25,800	5540	29,800	1440
17,900	3560	21,900	7460	25,900	5560	29,900	1460
18,000	3520	22,000	7420	26,000	5520	30,000	1420
18,100	3530	22,100	7430	26,100	5530	30,100	1430
18,200	3510	22,200	7410	26,200	5510	30,200	1410
18,300	3110	22,300	7010	26,300	5110	30,300	1010
18,400	3130	22,400	7030	26,400	5130	30,400	1030
18,500	3120	22,500	7020	26,500	5120	30,500	1020
18,600	3160	22,600	7060	26,600	5160	30,600	1060
18,700	3140	22,700	7040	26,700	5140	30,700	1040
18,800	7140	22,800	5040	26,800	1140	30,800	1044
18,900	7160	22,900	5060	26,900	1160	30,900	1064

Feet	ABCD	Feet	ABCD	Feet	ABCD	Feet	ABCD	Feet	ABCD	Feet	ABCD	Feet	ABCD	Feet	ABCD
31,000	1024	35,000	5124	39,000	7024	43,000	3124	47,000	2024	51,000	6124	55,000	4024	59,000	0124
31,100	1034	35,100	5134	39,100	7034	43,100	3134	47,100	2034	51,100	6134	55,100	4034	59,100	0134
31,200	1014	35,200	5114	39,200	7014	43,200	3114	47,200	2014	51,200	6114	55,200	4014	59,200	0114
31,300	1414	35,300	5514	39,300	7414	43,300	3514	47,300	2414	51,300	6514	55,300	4414	59,300	0514
31,400	1434	35,400	5534	39,400	7434	43,400	3534	47,400	2434	51,400	6534	55,400	4434	59,400	0534
31,500	1424	35,500	5524	39,500	7424	43,500	3524	47,500	2424	51,500	6524	55,500	4424	59,500	0524
31,600	1464	35,600	5564	39,600	7464	43,600	3564	47,600	2464	51,600	6564	55,600	4464	59,600	0564
31,700	1444	35,700	5544	39,700	7444	43,700	3544	47,700	2444	51,700	6544	55,700	4444	59,700	0544
31,800	1644	35,800	5744	39,800	7644	43,800	3744	47,800	2644	51,800	6744	55,800	4644	59,800	0744
31,900	1664	35,900	5764	39,900	7664	43,900	3764	47,900	2664	51,900	6764	55,900	4664	59,900	0764
32,000	1624	36,000	5724	40,000	7624	44,000	3724	48,000	2624	52,000	6724	56,000	4624	60,000	0724
32,100	1634	36,100	5734	40,100	7634	44,100	3734	48,100	2634	52,100	6734	56,100	4634	60,100	0734
32,200	1614	36,200	5714	40,200	7614	44,200	3714	48,200	2614	52,200	6714	56,200	4614	60,200	0714
32,300	1214	36,300	5314	40,300	7214	44,300	3314	48,300	2214	52,300	6314	56,300	4214	60,300	0314
32,400	1234	36,400	5334	40,400	7234	44,400	3334	48,400	2234	52,400	6334	56,400	4234	60,400	0334
32,500	1224	36,500	5324	40,500	7224	44,500	3324	48,500	2224	52,500	6324	56,500	4224	60,500	0324
32,600	1264	36,600	5364	40,600	7264	44,600	3364	48,600	2264	52,600	6364	56,600	4264	60,600	0364
32,700	1244	36,700	5344	40,700	7244	44,700	3344	48,700	2244	52,700	6344	56,700	4244	60,700	0344
32,800	1344	36,800	5244	40,800	7344	44,800	3244	48,800	2344	52,800	6244	56,800	4344	60,800	0244
32,900	1364	36,900	5264	40,900	7364	44,900	3264	48,900	2364	52,900	6264	56,900	4364	60,900	0264
33,000	1324	37,000	5224	41,000	7324	45,000	3224	49,000	2324	53,000	6224	57,000	4324	61,000	0224
33,100	1334	37,100	5234	41,100	7334	45,100	3234	49,100	2334	53,100	6234	57,100	4334	61,100	0234
33,200	1314	37,200	5214	41,200	7314	45,200	3214	49,200	2314	53,200	6214	57,200	4314	61,200	0214
33,300	1714	37,300	5614	41,300	7714	45,300	3614	49,300	2714	53,300	6614	57,300	4714	61,300	0614
33,400	1734	37,400	5634	41,400	7734	45,400	3634	49,400	2734	53,400	6634	57,400	4734	61,400	0634
33,500	1724	37,500	5624	41,500	7724	45,500	3624	49,500	2724	53,500	6624	57,500	4724	61,500	0624
33,600	1764	37,600	5664	41,600	7764	45,600	3664	49,600	2764	53,600	6664	57,600	4764	61,600	0664
33,700	1744	37,700	5644	41,700	7744	45,700	3644	49,700	2744	53,700	6644	57,700	4744	61,700	0644
33,800	1544	37,800	5444	41,800	7544	45,800	3444	49,800	2544	53,800	6444	57,800	4544	61,800	0444
33,900	1564	37,900	5464	41,900	7564	45,900	3464	49,900	2564	53,900	6464	57,900	4564	61,900	0464
34,000	1524	38,000	5424	42,000	7524	46,000	3424	50,000	2524	54,000	6424	58,000	4524	62,000	0424
34,100	1534	38,100	5434	42,100	7534	46,100	3434	50,100	2534	54,100	6434	58,100	4534	62,100	0434
34,200	1514	38,200	5414	42,200	7514	46,200	3414	50,200	2514	54,200	6414	58,200	4514	62,200	0414
34,300	1114	38,300	5014	42,300	7114	46,300	3014	50,300	2114	54,300	6014	58,300	4114	62,300	0014
34,400	1134	38,400	5034	42,400	7134	46,400	3034	50,400	2134	54,400	6034	58,400	4134	62,400	0034
34,500	1124	38,500	5024	42,500	7124	46,500	3024	50,500	2124	54,500	6024	58,500	4124	62,500	0024
34,600	1164	38,600	5064	42,600	7164	46,600	3064	50,600	2164	54,600	6064	58,600	4164	62,600	0064
34,700	1144	38,700	5044	42,700	7144	46,700	3044	50,700	2144	54,700	6044	58,700	4144	62,700	0044
34,800	5144	38,800	7044	42,800	3144	46,800	2044	50,800	6144	54,800	4044	58,800	0144		
34,900	5164	38,900	7064	42,900	3164	46,900	2064*	50,900	6164	54,900	4064	58,900	0164		

TEL-INSTRUMENT ELECTRONICS CORP.

CODE-to-ALTITUDE CONVERSION CHART

ABCD	Feet	ABCD	Feet	ABCD	Feet	ABCD	Feet	ABCD	Feet	ABCD	Feet	ABCD	Feet	ABCD	Feet
0010	-800	1010	30,300	2010	14,300	3010	15,200	4010	6,300	5010	23,200	6010	7,200	7010	22,300
0020	-1,000	1020	30,500	2020	14,500	3020	15,000	4020	6,500	5020	23,000	6020	7,000	7020	22,500
0030	-900	1030	30,400	2030	14,400	3030	15,100	4030	6,400	5030	23,100	6030	7,100	7030	22,400
0040		1040	30,700	2040	14,700	3040	14,800	4040	6,700	5040	22,800	6040	6,800	7040	22,700
0060		1060	30,600	2060	14,600	3060	14,900	4060	6,600	5060	22,900	6060	6,900	7060	22,600
0110	2,300	1110	27,200	2110	11,200	3110	18,300	4110	3,200	5110	26,300	6110	10,300	7110	19,200
0120	2,500	1120	27,000	2120	11,000	3120	18,500	4120	3,000	5120	26,500	6120	10,500	7120	19,000
0130	2,400	1130	27,100	2130	11,100	3130	18,400	4130	3,100	5130	26,400	6130	10,400	7130	19,100
0140	2,700	1140	26,800	2140	10,800	3140	18,700	4140	2,800	5140	26,700	6140	10,700	7140	18,800
0160	2,600	1160	26,900	2160	10,900	3160	18,600	4160	2,900	5160	26,600	6160	10,600	7160	18,900
0210	300	1210	29,200	2210	13,200	3210	16,300	4210	5,200	5210	24,300	6210	8,300	7210	21,200
0220	500	1220	29,000	2220	13,000	3220	16,500	4220	5,000	5220	24,500	6220	8,500	7220	21,000
0230	400	1230	29,100	2230	13,100	3230	16,400	4230	5,100	5230	24,400	6230	8,400	7230	21,100
0240	700	1240	28,800	2240	12,800	3240	16,700	4240	4,800	5240	24,700	6240	8,700	7240	20,800
0260	600	1260	28,900	2260	12,900	3260	16,600	4260	4,900	5260	24,600	6260	8,600	7260	20,900
0310	1,200	1310	28,300	2310	12,300	3310	17,200	4310	4,300	5310	25,200	6310	9,200	7310	20,300
0320	1,000	1320	28,500	2320	12,500	3320	17,000	4320	4,500	5320	25,000	6320	9,000	7320	20,500
0330	1,100	1330	28,400	2330	12,400	3330	17,100	4330	4,400	5330	25,100	6330	9,100	7330	20,400
0340	800	1340	28,700	2340	12,700	3340	16,800	4340	4,700	5340	24,800	6340	8,800	7340	20,700
0360	900	1360	28,600	2360	12,600	3360	16,900	4360	4,600	5360	24,900	6360	8,900	7360	20,600
0410	-700	1410	30,200	2410	14,200	3410	15,300	4410	6,200	5410	23,300	6410	7,300	7410	22,200
0420	-500	1420	30,000	2420	14,000	3420	15,500	4420	6,000	5420	23,500	6420	7,500	7420	22,000
0430	-600	1430	30,100	2430	14,100	3430	15,400	4430	6,100	5430	23,400	6430	7,400	7430	22,100
0440	-300	1440	29,800	2440	13,800	3440	15,700	4440	5,800	5440	23,700	6440	7,700	7440	21,800
0460	-400	1460	29,900	2460	13,900	3460	15,600	4460	5,900	5460	23,600	6460	7,600	7460	21,900
0510	2,200	1510	27,300	2510	11,300	3510	18,200	4510	3,300	5510	26,200	6510	10,200	7510	19,300
0520	2,000	1520	27,500	2520	11,500	3520	18,000	4520	3,500	5520	26,000	6520	10,000	7520	19,500
0530	2,100	1530	27,400	2530	11,400	3530	18,100	4530	3,400	5530	26,100	6530	10,100	7530	19,400
0540	1,800	1540	27,700	2540	11,700	3540	17,800	4540	3,700	5540	25,800	6540	9,800	7540	19,700
0560	1,900	1560	27,600	2560	11,600	3560	17,900	4560	3,600	5560	25,900	6560	9,900	7560	19,600
0610	200	1610	29,300	2610	13,300	3610	16,200	4610	5,300	5610	24,200	6610	8,200	7610	21,300
0620	000	1620	29,500	2620	13,500	3620	16,000	4620	5,500	5620	24,000	6620	8,000	7620	21,500
0630	100	1630	29,400	2630	13,400	3630	16,100	4630	5,400	5630	24,100	6630	8,100	7630	21,400
0640	-200	1640	29,700	2640	13,700	3640	15,800	4640	5,700	5640	23,800	6640	7,800	7640	21,700
0660	-100	1660	29,600	2660	13,600	3660	15,900	4660	5,600	5660	23,900	6660	7,900	7660	21,600
0710	1,300	1710	28,200	2710	12,200	3710	17,300	4710	4,200	5710	25,300	6710	9,300	7710	20,200
0720	1,500	1720	28,000	2720	12,000	3720	17,500	4720	4,000	5720	25,500	6720	9,500	7720	20,000
0730	1,400	1730	28,100	2730	12,100	3730	17,400	4730	4,100	5730	25,400	6730	9,400	7730	20,100
0740	1,700	1740	27,800	2740	11,800	3740	17,700	4740	3,800	5740	25,700	6740	9,700	7740	19,800
0760	1,600	1760	27,900	2760	11,900	3760	17,600	4760	3,900	5760	25,600	6760	9,600	7760	19,900

ABCD	Feet	ABCD	Feet	ABCD	Feet	ABCD	Feet	ABCD	Feet	ABCD	Feet	ABCD	Feet	ABCD	Feet
0014	62,300	1014	31,200	2014	47,200	3014	46,300	4014	55,200	5014	38,300	6014	54,300	7014	39,200
0024	62,500	1024	31,000	2024	47,000	3024	46,500	4024	55,000	5024	38,500	6024	54,500	7024	39,000
0034	62,400	1034	31,100	2034	47,100	3034	46,400	4034	55,100	5034	38,400	6034	54,400	7034	39,100
0044	62,700	1044	30,800	2044	46,800	3044	46,700	4044	54,800	5044	38,700	6044	54,700	7044	38,800
0064	62,600	1064	30,900	2064	46,900	3064	46,600	4064	54,900	5064	38,600	6064	54,600	7064	38,900
0114	59,200	1114	34,300	2114	50,300	3114	43,200	4114	58,300	5114	35,200	6114	51,200	7114	42,300
0124	59,000	1124	34,500	2124	50,500	3124	43,000	4124	58,500	5124	35,000	6124	51,000	7124	42,500
0134	59,100	1134	34,400	2134	50,400	3134	43,100	4134	58,400	5134	35,100	6134	51,100	7134	42,400
0144	58,800	1144	34,700	2144	50,700	3144	42,800	4144	58,700	5144	34,800	6144	50,800	7144	42,700
0164	58,900	1164	34,600	2164	50,600	3164	42,900	4164	58,600	5164	34,900	6164	50,900	7164	42,600
0214	61,200	1214	32,300	2214	48,300	3214	45,200	4214	56,300	5214	37,200	6214	53,200	7214	40,300
0224	61,000	1224	32,500	2224	48,500	3224	45,000	4224	56,500	5224	37,000	6224	53,000	7224	40,500
0234	61,100	1234	32,400	2234	48,400	3234	45,100	4234	56,400	5234	37,100	6234	53,100	7234	40,400
0244	60,800	1244	32,700	2244	48,700	3244	44,800	4244	56,700	5244	36,800	6244	52,800	7244	40,700
0264	60,900	1264	32,600	2264	48,600	3264	44,900	4264	56,600	5264	36,900	6264	52,900	7264	40,600
0314	60,300	1314	33,200	2314	49,200	3314	44,300	4314	57,200	5314	36,300	6314	52,300	7314	41,200
0324	60,500	1324	33,000	2324	49,000	3324	44,500	4324	57,000	5324	36,500	6324	52,500	7324	41,000
0334	60,400	1334	33,100	2334	49,100	3334	44,400	4334	57,100	5334	36,400	6334	52,400	7334	41,100
0344	60,700	1344	32,800	2344	48,800	3344	44,700	4344	56,800	5344	36,700	6344	52,700	7344	40,800
0364	60,600	1364	32,900	2364	48,900	3364	44,600	4364	56,900	5364	36,600	6364	52,600	7364	40,900
0414	62,200	1414	31,300	2414	47,300	3414	46,200	4414	55,300	5414	38,200	6414	54,200	7414	39,300
0424	62,000	1424	31,500	2424	47,500	3424	46,000	4424	55,500	5424	38,000	6424	54,000	7424	39,500
0434	62,100	1434	31,400	2434	47,400	3434	46,100	4434	55,400	5434	38,100	6434	54,100	7434	39,400
0444	61,800	1444	31,700	2444	47,700	3444	45,800	4444	55,700	5444	37,800	6444	53,800	7444	39,700
0464	61,900	1464	31,600	2464	47,600	3464	45,900	4464	55,600	5464	37,900	6464	53,900	7464	39,600
0514	59,300	1514	34,200	2514	50,200	3514	43,300	4514	58,200	5514	35,300	6514	51,300	7514	42,200
0524	59,500	1524	34,000	2524	50,000	3524	43,500	4524	58,000	5524	35,500	6524	51,500	7524	42,000
0534	59,400	1534	34,100	2534	50,100	2534	43,400	4534	58,100	5534	35,400	6534	51,400	7534	42,100
0544	59,700	1544	33,800	2544	49,800	3544	43,700	4544	57,800	5544	35,700	6544	51,700	7544	41,800
0564	59,600	1564	33,900	2564	49,900	3564	43,600	4564	57,900	5564	35,600	6564	51,600	7564	41,900
0614	61,300	1614	32,200	2614	48,200	3614	45,300	4614	56,200	5614	37,300	6614	53,300	7614	40,200
0624	61,500	1624	32,000	2624	48,000	3624	45,500	4624	56,000	5624	37,500	6624	53,500	7624	40,000
0634	61,400	1634	32,100	2634	48,100	3634	45,400	4634	56,100	5634	37,400	6634	53,400	7634	40,100
0644	61,700	1644	31,800	2644	47,800	3644	45,700	4644	55,800	5644	37,700	6644	53,700	7644	39,800
0664	61,600	1664	31,900	2664	47,900	3664	45,600	4664	55,900	5664	37,600	6664	53,600	7664	39,900
0714	60,200	1714	33,300	2714	49,300	3714	44,200	4714	57,300	5714	36,200	6714	52,200	7714	41,300
0724	60,000	1724	33,500	2724	49,500	3724	44,000	4724	57,500	5724	36,000	6724	52,000	7724	41,500
0734	60,100	1734	33,400	2734	49,400	3734	44,100	4734	57,400	5734	36,100	6734	52,100	7734	41,400
0744	59,800	1744	33,700	2744	49,700	3744	43,800	4744	57,700	5744	35,800	6744	51,800	7744	41,700
0764	59,900	1764	33,600	2764	49,600	3764	43,900	4764	57,600	5764	35,900	6764	51,900	7764	41,600

ABBREVIATIONS

A .... Ampere
A/D ...... Analog to digital
AC .... Alternating current
ADF ...... Automatic direction finder
ADJ ...... Adjustment
AF .... Audio frequency
AH .... Amplifier high frequencies
AL .... Aluminum
AMP ..... Amplifier
AM ...... Amplitude Modulation
AP .... Amplifier Power
A/R ...... Altitude recording
ARINC ... Aeronautical Radio
ATC ...... Air traffic control

BCD ...... Binary coded decimal
BT ...... Button

C .... Capacitor
CAP ..... Capacitor
CER ..... Ceramic (CAP)
Cermit (RES)
CM ...... Centimeter
COAX .... Coaxial
COMP .... Composition
CONN .... Connector
CP .... Cadmium Plate
CR .... Diode

D/A ...... Digital to analog
dB .... Decibel
dBm ...... Decibel referred to 1 MW
DC .... Direct current
DEPC .... Deposited carbon
DET ...... Detector
DM .... Dipped Mica
DME ..... Distance measuring equipment
DNP ...... Duro neoprene
DPDT .... Double-pole double throw

ELECT ... Electrolytic

F .... Farad
FA .... Factory adjust
FET ...... Field effect transistor
F/F ...... Flip Flop
FM .... Frequency modulation
FP .... Front panel
FREQ .... Frequency
FT .... Feedthru
FXD ..... Fixed

GE .... Germanium
GL .... Glass
GRD ..... Ground
GS .... Glide Slope

H .... Henry
HF .... High frequency
HG .... Mercury
HM .... Hot molded
HS .... High Speed
HV .... High Voltage
Hz .... Hertz

IC .... Integrated circuit
ID .... Inside diameter
IF .... Intermediate frequency
ILS ...... Instrument landing system
IN .... Inch
IND ...... Inductor
INS ...... Insulation
INT ...... Internal

Kg .... Kilogram
KΩ .... Kiloohm
KHz ...... Kilohertz
KV .... Kilovolt

L .... Inductor
LA .... Low noise amplifier
lb .... Pound
LOC ..... Localizer

M .... Meter
MA ...... Milliampere
MAX ..... Maximum
MB ...... Marker beacon
MΩ ...... Megohm
MEG ..... Meg $(10)^6$
MET ..... Metalized
MET FLM Metal Film
MET OX.. Metallic oxide
MF ...... Medium frequency
MFR ..... Manufacturer
Mg .... Milligram
MHz ..... Megahertz
MH ...... Millihenry
mho ...... mho
MIN ...... Minimum
mm ...... Millimeter
MNL ..... Monolythic
MOD ..... Modified
MOS ..... Metal-oxide semiconductor
MS ...... Microsecond
MTG ..... Mounting
MTR ..... Meter
MV .... Millivolt
MVAC .... Millivolt, AC
MVDC .... Millivolt, DC
MVP ..... Millivolt, peak
MVP-P ... Millivolt, peak-peak
MVrms ... Millivolts, rms
MW ...... Milliwatt
MY .... Mylar
μA ...... Microampere
μF .... Microfarad
μH .... Microhenry
μmho .... Micromho
μs .... Microsecond
μV .... Microvolt
μVAC .... Microvolt, AC

μVDC.... Microvolt, DC
μVPK.... Microvolt, peak
μVP-P... Microvolt, peak-to-peak
μVrms ... Microvolt, rms
μW ...... Microwatt

NA ...... Nanoampere
NC....... No connection
N/C...... Normally closed
NE....... Neon
NEG ..... Negative
NF....... Nanofarad
NI PL .... Nickel plate
N/O...... Normally open
NORM.... Normal
NRFR .... Not recommended for field replacement
NS .... Nanosecond
NW....... Nanowatt

OBD ..... Order by description
OD....... Outside diameter
OPAMP... Operational amplifier
OSC...... Oscillator
OX....... Oxide
oz .... Ounce
Ω .... Ohm

PC....... Printed circuit
PN....... Part number
POLYS ... Polystyrene
P-P...... Peak-to-peak
Pf .... Picofarad
Ps .... Picosecond

R .... Resistor
REC...... Rectifier
REG...... Regulator
RES...... Resistor
RF....... Radio frequency
rms...... Root-mean-square
Rom ..... Read-out memory
RWV ..... Reverse working voltage

S .... Second
S-B ...... Slow-blow
SCR...... Silicon controlled rectifier
SE .... Selenium
SEMICON. Semiconductor
SH .... Switch high speed
SI .... Silicon
SIC ...... Silver
SIG....... Signal
SL .... Slide
SNR...... Signal-to-noise ratio
SDTD..... Single-pole doubler-throw
SPST..... Single-pole single-throw
SSB ...... Single side band
SWR...... Standing wave ratio
SWT...... Switch

TA....... Tantalum
TB....... Tubular
TC....... Temperature compensating
TERM.... Terminal
TGL ..... Toggle
TI .... Titanium
TRIM .... Trimmer
TSTR .... Transistor
TTL ..... Transistor - Transistor Logic
TV....... Typical Value

UHF...... Ultrahigh frequency
UJT ...... Unijunction transistor

V .... Volt
VA....... Voltampere
VAR...... Variable
VCO...... Voltage - controlled oscillator
VDC...... Volt DC
VHF...... Very-high frequencies
VRMS .... Volts, rms
VRT ..... Varactor
VSWR .... Voltage standing wave ratio

W........ Watt
WVDC.... Working volts DC
WW ...... Wirewound

Z .... Characteristic impedance
ZEN ..... Zener
ZV .... Zener voltage

MULTIPLIERS

Abbreviation	Prefix	Multiple
T	tera	10^{12}
G	giga	10^{9}
M	mega	10^{6}
k	kilo	10^{3}
da	deka	10
d	deci	10^{-1}
c	centi	10^{-2}
m	milli	10^{-3}
u	micro	10^{-6}
n	nano	10^{-9}
p	pico	10^{-12}
f	femto	10^{-15}
a	atto	10^{-18}

CODE LIST OF MANUFACTURERS

A-B .... Allen-Bradley, Electronics Division, Milwaukee, Wisconsin 53204
AER .... Aerovox Corp., New Bedford, Massachusetts 02741
A-H .... Amp Hexseal Corp., 44 Honeck St., Englewood, New Jersey 07631
AHH .... Arrow Hart & Hegeman Inc., 103 Hawthorn St., Hartford, Connecticut 06106
ALF .... Alpha Wire Corp., 711 Lidgerwood Ave., Elizabeth, New Jersey 07207
ALN .... Allen Manufactor Co., Drawer 570, Hartford, Connecticut 06101
APL .... Amphenal Controls Division, 120 S. Main Street, Janesville, Wisconsin 53545
ATC .... American Technical Ceramics, 1 Norden Lane, Huntington Station, New York 11746
AUG .... Augat Inc., 34 Perry Ave., Attleboro, Massachusetts 02741

BAR .... Barnes Corp., Lansdowne, Pennsylvania 19050
BEK .... Beckman Instruments, 2500 Harbor Blvd., Fullerton, California 92634
BEL .... Belden Corp., Dept. G, P.O. Box 1100, Richmond, Indiana 47374
BIR .... Birtcher Corp., 4371 Valley Blvd., Los Angeles, California 90032
BOS .... Boston Gear, 14 Hayward St., Quincy, Massachusetts 02171
BOU .... Bourns Inc., 1200 Columbia Ave., Riverside, California 92507
BUK .... Buckeye Stamping Co., 555 Marion Rd., Columbus, Ohio 43207
BUR .... Burndy Corp., Richards Ave., Norwalk, Connecticut 06856
BUS .... Bussman Mfg., Jefferson St., St. Louis, Missouri 63107

C-K .... C & K Components Inc., 103 Morse St., Watertown, Massachusetts 02172
CAM .... Cam-Lok Div., Empire Products Inc., 10540 Chester Rd., Cincinnati, Ohio 45215
CAN .... ITT - Cannon Electric, 666 E. Dyer Rd., Santa Ana, California 92702
CDE .... Cornell Dubilier Electric, 150 Avenue L, Newark, New Jersey 07101
CEP .... Cherry Electrical Products Corp., 3600 Sunset, Waukegan, Illinois 60085
CIN .... TRW Cinch Div., 1500 Morse Ave., Elk Grove Village, Illinois 60007
CRA .... Cramer Coil Co., 1121 15th Ave., Grafton, Wisconsin 53024
CRL .... Centralab Electronics Div., Globe-Union Inc., 5757 N. Green Bay Ave., Milwaukee, Wisconsin 53201
CTC .... Cambridge Thermionic, 445 Concord Ave., Cambridge, Massachusetts 02138
CTS .... CTS Corp., 900 NW Blvd., Elkhart, Indiana 46514

DAL .... Dale Electronics, 1376 28th Ave., Columbus, Nebraska 68601
DAV .... McGraw - Edison Co. - Daven Div., Grenier Field, Manchester, New Hampshire 03103
DIG .... Digitran Co., 855 S. Arroyo Pkwy, Pasadena, California 91105

EMC .... Electronic Molding Corp., 96 Mill St., Woonsocket, Rhode Island 02895
EMI .... Electro Mechanical Instrument Corp., 8 & Chestnut St., Perkasie, Pennsylvania 18944
ESW .... Amerace Esna Corp - Elastic Stop Nut Div., 2330 Vauxhall Rd., Union, New Jersey 07083
ETP .... Erie Technological Products, 644 W. 12th St., Erie, Pennsylvania 16512
EVR .... Union Carbide - Battery Product Div., 270 Park Avenue, New York, New York 10017

F-S .... Fairchild Semiconductor, 464 Ellis Ct., Mountain View, California 94042
FER .... Ferroxcube Corp., Mt. Marion Rd., Saugerties, New York 12477

G-C .... General Cement Electronics, Rockford, Illinois 61101
G-E .... General Electric - Semiconductor Products, Electronics Park, Syracuse, New York 13201
G-H .... Grayhill, 565 Hillgrove Ave., La Grange, Illinois 60525
G-R .... General Radio, 300 Baker Ave., Concord, Massachusetts 01742
GLD .... Gould - Burgess Div., P.O. Box 3140, St. Paul, Minnesota 55165
GPC .... Grove-Pin Corp., 1125 Hendricks Causeway, Ridgefield, New Jersey 07657

H-P .... Hewlett-Packard, 1501 Page Mill Rd., Palo Alto, California 94304
HAN .... Hanson Mfrg. Co., Div. P R Mallory & Co., P.O. Box 23, Princeton, Indiana 47670
HIE .... Heinemann Electric Co., Rt 1, Trenton, New Jersey 08638
HOY .... Hoyt Electrical Instrument Work Inc., 556 Trapelo Rd., Belmont, Massachusetts 02179

I-S .... Instruments Specialties, 280 Bergen Blvd., Little Falls, New Jersey 07424
IEH .... Industrial Electronic Hardware Corp., 109 Prince St., New York, New York 10012
IER .... International Electronic Research Corp., 135 W. Magnolia, Burbank, California 91502
IRC .... TRW - IRC Resistors, 401 W. Broad, 11th Floor, Philadelphia, Pennsylvania 19108

JBT .... JBT Instruments Inc., 424 Chapel St., New Haven Connecticut 06508
JON .... Johason Mfg., 400 Rockaway Valley, Boonton, New Jersey 07005

KEY .... Keystone Electronics Corp., 423 Broome St., New York, New York 10013

LEE .... Leecraft Manufacturing Co., Inc. 21-16 44 Rd., Long Island City, New York 11101
LIT .... Littlefuse Inc., 800 E. Northwest Hwy., Des Plaines, Illinois 60016

MAL.... Mallory, P R & Co. Inc. - Mallory Battery, Broadway, Tarrytown, New York 10591
- Mallory Controls, P. O. Box 327, Frankort, Indiana 46041
- Mallory Capacitor Co., E. Washington St., Indianapolis, Indiana 46206
MEA.... Measurement - Systems, 523 West Ave., Norwalk, Connecticut 06850
MET.... Metex Corp., 970 New Durham Rd., Edison, New Jersey 08817
MLN.... James Millen Mfg. Co. Inc., 150 Exchange St., Malden, Massachusetts 02148
MLR.... J W Miller, 5917 S. Main St., Los Angeles, California 90014
MPC.... Mepo/Electra Inc., Columbia Rd., Morristown, New Jersey 07960
MRC.... Minor Rubber, 151 Ackerman St., Bloomfield, New Jersey 07003
MOT.... Motorola Semiconductor Product Inc., E. McDowell Rd., Phoenix, Arizona 85008

N-S .... National Semiconductor Corp., 2900 Semiconductor Dr., Santa Clara, California 95051
NOB .... Griffith Plastic Product - Nobex Div., 1027 California Dr., Burlingame, California 94010
NTT .... National Tel-Tronics, Meadville, Pennsylvania 16335

OAK .... Oak Industries Inc., Switch Div., Crystal Lake, Illinois 60014
OET .... Oetiker Inc., 71 Okner Parkway, Livingston, New Jersey 07039

PAL .... The Palnut Company, Glen Rd., Mountainside, New Jersey 07092
PAN .... Panob Corp., 18 Merritt, Port Chester, New York 10573
PEM.... Tech Ceramic Div. Penn Engineering Mfg. Corp., 1295 NW 163 St., Miami, Florida 33169
PEN .... Penn Resistor Corp., 526 N. Broad St. Lansdale, Pennsylvania 19446
PZO .... Piezo Crystal Co., 100 K St., Carlisle, Pennsylvania 17013

QCI .... Quality Components Inc., Bridge & Railraod Sts., St. Marys, Pennsylvania 15857

R-F .... Robert Shaw Control Co. - Fulton Sylphon Div., P.O. Box 400, Knoxville, Tennessee 37901
RCA .... RCA- Solid State Div., Box 3200, Somerville, New Jersey 08876
RCL .... RCL Electronics Inc., 700 S. 21st St., Irvington, New Jersey 07111
REP .... Republic Electronics, 176 E. 7th St., Paterson, New Jersey 07524
ROL .... Standard Press Steel - Rollpin Div., Benson East, Jenkintown, Pennsylvania 19046
ROT .... Rotron Inc., 7-9 Hasbrouck Ln., Woodstock, New York 12498

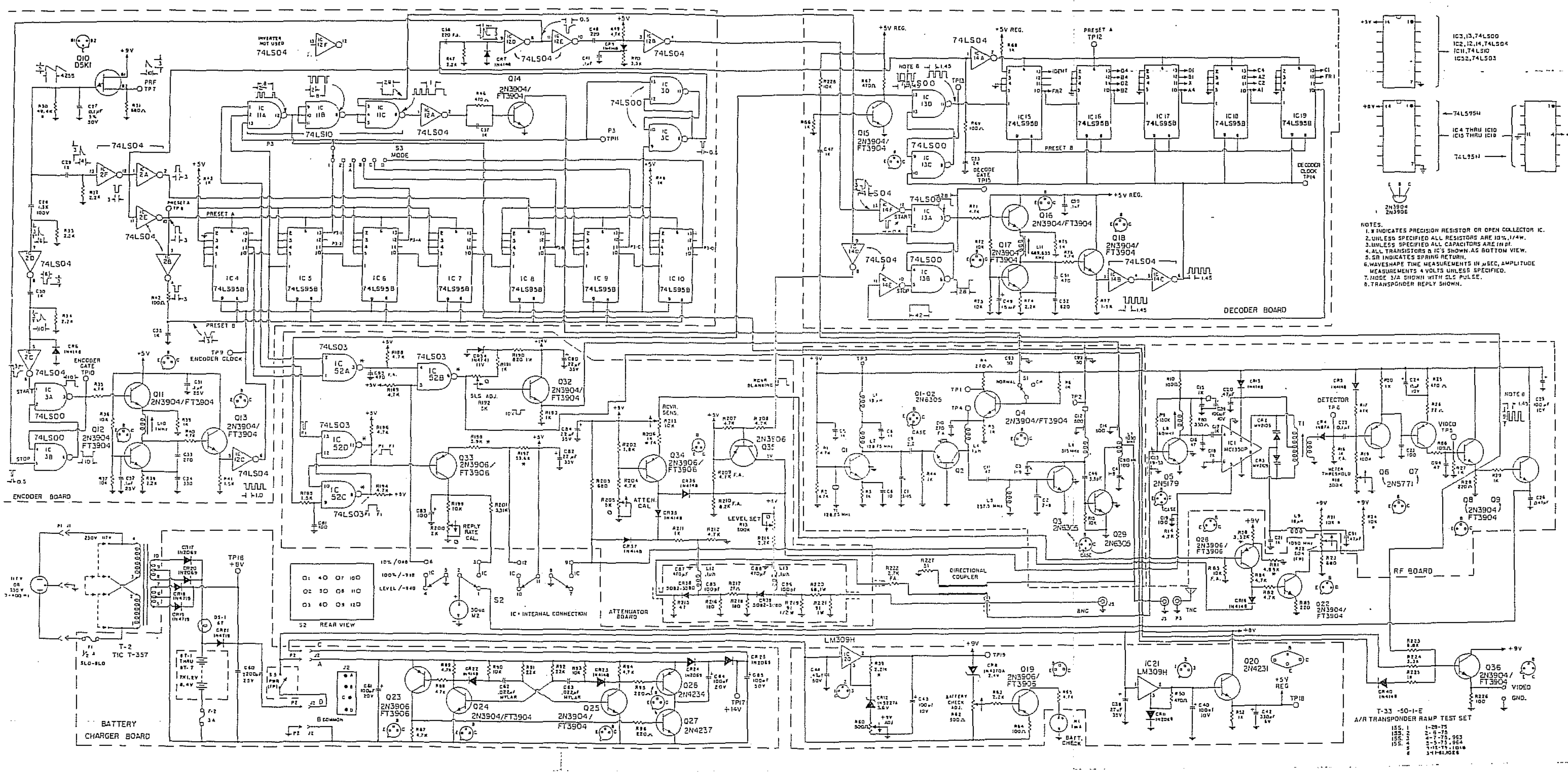
SAN .... Sangamo Electric Co., Capacitor Div., P. O. Box, 128 Pickens,South Carolina 29671
SCI .... Switchcraft Inc., 5555 N. Elston Ave., Chicago, Illinois 60630
SEL .... Selectro Corp. Mamaroneck, New York 10543
SHA .... Illinois Tool Works Inc., Shakeproof Div., St. Charles Rd., Elgin, Illinois 60120
SPR .... Sprague Electric Co., 645 Marshall St., N. Adams, Massachusetts 01247
SPT .... Spectrol Electronics Corp., 17070 E. Gale Avenue, City of Industry, California 91745
STA .... E. Stanwyck Coil Co. Inc., 75 Carson Ave., Newburgh, New York 12550
SUP .... Superior Electric Co., 3000 Middle St., Briston, Connecticut 06010

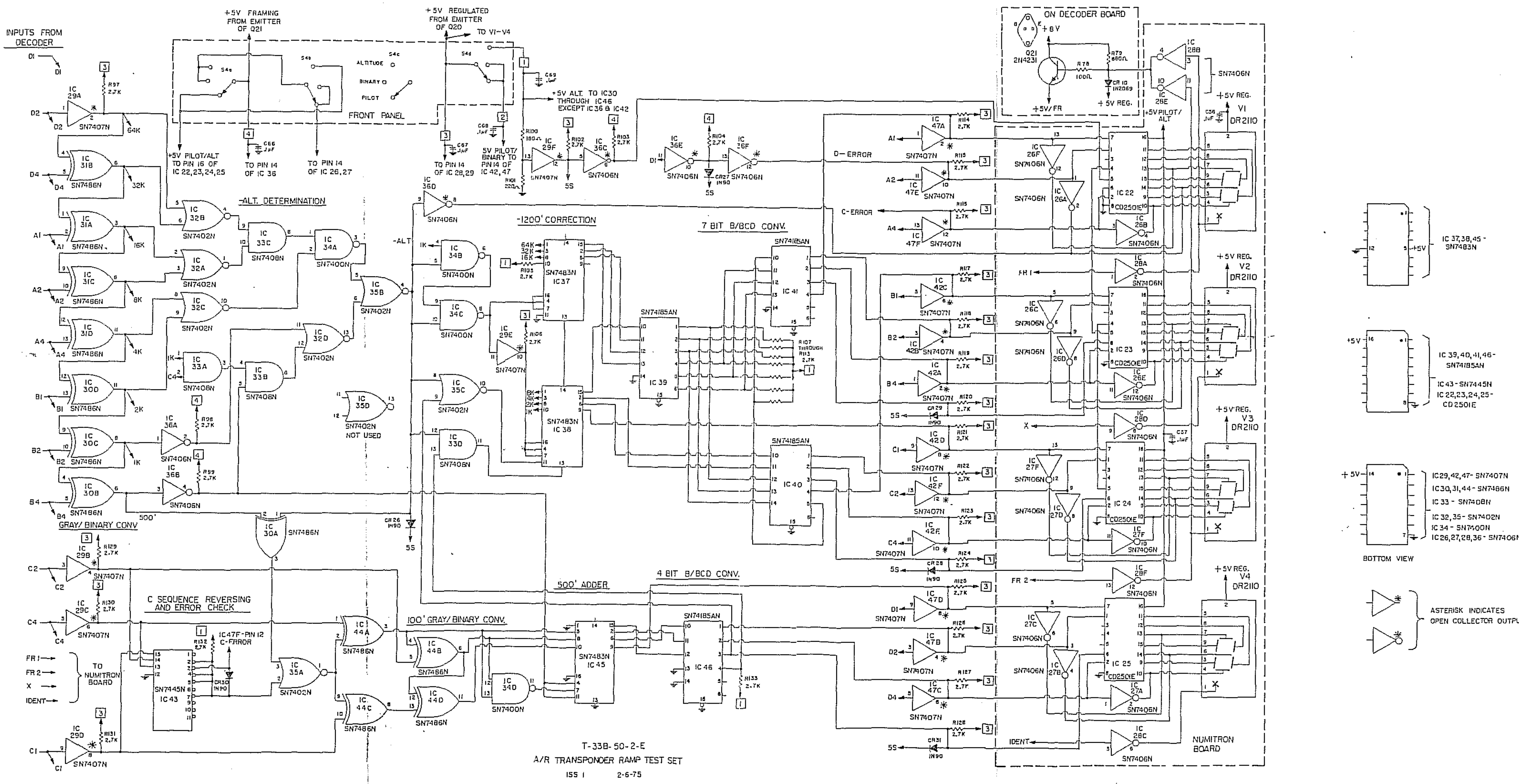
T-I .... Texas Instruments Inc., P. O. Box 5012, Mail Station 84, Dallas, Texas 75222
T-S .... Wagner Electrical Corp., Tung Sol Div., 630 Pleastent Ave., Livingston, New Jersey 07039
TEX .... Texscan Corp., 2446 N. Shadeland Ave., Indianapolis, Indiana 46219
TIC .... Tel-Instrument Electronics Corp., 728 Garden St., Carlstadt, New Jersey 07072
TNN .... Technical Nameplate Corp., 91 1st St., Passaic, New Jersey 07055
TRP .... Triplett Corp., 286 Harmon Rd., Bluffton, Ohio 45817
TRW.... TRW, 661 Glenn Ave., Wheeling, Illinois 60090

VAR .... Varo Semiconductor Inc., 2800 W. Kingsley Ave., Garland, Texas 75040
VEM .... Vemaline Products Co., 455 W. Main St., Wyckoff, New Jersey 07481

W-K .... Waldes Kohinoor Inc. (Truarc) 47 - 16 Austel Pl., Long Island City, New York 11101
W-L .... Ward Leonard Electric Co. Inc., 32 South St., Mt. Vernon, New York 10550
WAK .... Wakefield Engineering Inc., 777 Audubon Rd., Wakefield, Massachusetts 01880
WES .... Weston Instruments, 614 Frelinghuysen, Newark, New Jersey 07114
WOR .... Workman Electrical Products Inc., 75 Packinghouse Rd., Sarasota, Florida 33578

ZER .... Zero Manufacturing Co., 777 Front St., Burbank, California 91503


ENCODER BOARD
DECODER BOARD
RF BOARD
ATTENUATOR BOARD
BATTERY CHARGER BOARD
DIRECTIONAL COUPLER
S2 REAR VIEW
IC = INTERNAL CONNECTION
NOTES.
1. * INDICATES PRECISION RESISTOR OR OPEN COLLECTOR IC.
2. UNLESS SPECIFIED ALL RESISTORS ARE 10%, 1/4W.
3. UNLESS SPECIFIED ALL CAPACITORS ARE IN pf.
4. ALL TRANSISTORS & IC'S SHOWN AS BOTTOM VIEW.
5. SR INDICATES SPRING RETURN.
6. WAVESHAPE TIME MEASUREMENTS IN µSEC, AMPLITUDE MEASUREMENTS 4 VOLTS UNLESS SPECIFIED.
7. MODE 3/A SHOWN WITH SLS PULSE.
8. TRANSPONDER REPLY SHOWN.
T-33 -50-1-E
A/R TRANSPONDER RAMP TEST SET
ISS. 1 1-29-75
ISS. 2 2-6-75
ISS. 3 4-7-75, 953
ISS. 4 5-5-75, 964


INPUTS FROM DECODER
+5V FRAMING FROM EMITTER OF Q21
+5V REGULATED FROM EMITTER OF Q20
TO VI-V4
FRONT PANEL
ALTITUDE
BINARY
PILOT
+5V PILOT/ALT TO PIN 16 OF IC 22,23,24,25
TO PIN 14 OF IC 36
TO PIN 14 OF IC 26,27
+5V ALT. TO IC30 THROUGH IC46 EXCEPT IC36 & IC42
5V PILOT/BINARY TO PIN 14 OF IC 42,47
TO PIN 14 OF IC 28,29
ON DECODER BOARD
-ALT. DETERMINATION
-1200' CORRECTION
7 BIT B/BCD CONV.
D-ERROR
C-ERROR
GRAY/BINARY CONV
C SEQUENCE REVERSING AND ERROR CHECK
TO NUMITRON BOARD
IC47F-PIN 12 C-ERROR
500' ADDER
100' GRAY/BINARY CONV.
4 BIT B/BCD CONV.
NOT USED
NUMITRON BOARD
BOTTOM VIEW
IC 37,38,45 - SN7483N
IC 39,40,41,46 - SN74185AN
IC43 - SN7445N
IC 22,23,24,25 - CD2501E
IC29,42,47 - SN7407N
IC30,31,44 - SN7486N
IC 33 - SN7408N
IC 32,35 - SN7402N
IC 34 - SN7400N
IC26,27,28,36 - SN7406N
ASTERISK INDICATES OPEN COLLECTOR OUTPUT
T-33B-50-2-E
A/R TRANSPONDER RAMP TEST SET
ISS 1 2-6-75