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DEPARTMENT OF THE AIR FORCE TECHNICAL MANUAL TO 33A1-3-367-22

GENERAL SUPPORT AND DEPOT MAINTENANCE MANUAL

TEST SET, TRANSPONDER

AN/APM-123[V] 1

AN/APM-123[V] 2

AN/APM-123[V] 3

(NSN 6625-00-948-0071)

This copy IS a reprint which includes current pages from Changes 1 through 5.

DEPARTMENTS OF THE ARMY, THE NAVY, AND THE AIR FORCE
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CHANGE No. 5

DEPARTMENT OF THE ARMY,
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WASHINGTON, DC, *13 January 1982*

General Support and Depot Maintenance Manual

TRANSPONDER TEST SET AN/APM-123(V)1 (NSN 6625-00-948-0071), AN/APM-123(V)2, (NSN 6625-00-948-0077), AND AN/APM-123(V)3, (NSN 6625-00-948-0076)

TM 11-6625-667-45/NAVAIR 16-30APM123-2/T0 33A1-3-367-22, 26 June 1968, is changed as follows:

1. The title of the manual is changed as shown above.
2. New or changed material is indicated by a vertical barin the margin of the page.
3. Added or revised illustrations are indicated by a vertical bar adjacent to the illustration identification number.
4. Remove old pages and insert new pages as indicated below:

Remove pages	*Insert pages*
None	Warning pages a and b
i	i through iv
1-1	1-1 and 1-2
3-1 through 3-4	3-1 through 3-4
3-41	3-41 through 3-60
4-1 and 4-2	4-1 and 4-2
4-5 and 4-6	4-5 through 4-9
5-1 and 5-2	5-1 and 5-2
5-10-1	5-10.1/(5-10.2 blank)
5-25, 5-26 and 5-27	5-23, 5-24 and 5-25
5.1-5 and 5.1-6	5.1-5 and 5.1-6
None	5.10.5 through 5.1-10.16
5.1-19 through 5.1-22	5.1-19 through 5.1-22
None	5.1-31 through 5.1-47
None	5.2-1 through 5.2-18
7-1 and 7-2	7-1 and 7-2
None	7.1-1 through 7.1-6
8-103 (Figure 8-42)	8-103 (Figure 8-42)

5. File this change sheet in front of the manual for reference purposes.

By Order of the Secretaries of the Army, the Navy, and the Air Force:

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DISTRIBUTION:

To be distributed in accordance with DA Form 12-36A, Direct and General Support Maintenance requirements for AN/APM-123.

5 SAFETY STEPS TO FOLLOW IF SOMEONE IS THE VICTIM OF ELECTRICAL SHOCK

1 DO NOT TRY TO PULL OR GRAB THE INDIVIDUAL

2 IF POSSIBLE, TURN OFF THE ELECTRICAL POWER

3 IF YOU CANNOT TURN OFF THE ELECTRICAL POWER, PULL, PUSH, OR LIFT THE PERSON TO SAFETY USING A WOODEN POLE OR A ROPE OR SOME OTHER INSULATING MATERIAL

4 SEND FOR HELP AS SOON AS POSSIBLE

5 AFTER THE INJURED PERSON IS FREE OF CONTACT WITH THE SOURCE OF ELECTRICAL SHOCK, MOVE THE PERSON A SHORT DISTANCE AWAY AND IMMEDIATELY START ARTIFICIAL RESUSCITATION

WARNING

HIGH VOLTAGE

- Be careful when working around the 115 volt Ac power connections. Serious injury may result from contact with these terminals.
- Before switching on the instrument, the protective earth terminals of the instrument must be connected to the protective conductor of the (mains power cord. The mains plug shall only be inserted in a socket outlet provided with a protective earth contact. The protective action must not be negated by the use of an extension cord (power cable) without a protective conductor (Grounding.
- The service information found in this manual is often used with power supplied and protective covers removed from the instrument. Energy available at many points may, if contacted, result in personal injury.
- Test Set AN/APM-123(V)1, 2 and 3, weighs 50 pounds. A two man lift is required.

CAUTION

Before switching on the instrument

1. Make sure the instrument is set to the voltage of the power source.
2. Ensure that all devices connected to this instrument are connected to the protective (earth ground.
3. Ensure that the line power (mains plug is connected to a three conductor line power outlet that has a protective (earth ground. (Grounding one conductor of a two conductor outlet is not sufficient.)
4. Make sure that only fuses with the required rated current and of the specified type (normal blow, time delay, etc.) are used for replacement. The use of repaired fuses and the short circuiting of fuse holders must be avoided.

TECHNICAL MANUAL
No. 11-6625-667-45
TECHNICAL MANUAL
NAVAIR NO. 16-30APM123-2
TECHNICAL ORDER
T031A1-3-367-22

DEPARTMENTS OF THE ARMY,
THE NAVY, AND THE AIRFORCE

WASHINGTON, DC, *26 June 1968*

GENERAL SUPPORT AND DEPOT MAINTENANCE MANUAL

TRANSPONDER TEST SET **AN/APN-123(V)1**

(NSN 6625-00-948-0071) AN/AP/123(V)2,

(NSN 6625-00-948-0077) AND AN/APM-123(V)3

(NSN 6625-00-948-0076)

REPORTING ERRORS AND RECOMMENDING IMPROVEMENTS

You can help improve this manual. If you find any mistakes or if you know of away to improve the procedures, please let us know. Mail your letter or DA Form 2028 (Recommended Changes to Publications and Blank Forms) direct to: Commander, US Army Communications Electronics Command, ATTN: DRSEL ME-MQ, Fort Monmouth, NJ 07703.

For Air Force, submit AFTO Form 22 (Technical Order System Publication Improvement Report and Reply) in accordance with paragraph 6-5, Section VI, TO 00-5-1. Forward direct to prime ALC/MST.

For Navy, mail comment to the Commander, Naval Electronics Systems Command ATTN: ELEX 45053 (0. H.) Washington, D.C. 20360. In any case, a reply will be furnished direct to you.

• This manual supersedes TM 11-6625-667-35, 12 0ctober 1966.

LIST OF ILLUSTRATIONS

LIST OF ILLUSTRATIONS—Continued

LIST OF ILLUSTRATIONS—Continued

CHAPTER I

GENERAL

1-1. Scope

a. This manual contains general support and depot maintenance instructions for Test Set, Transponder AN/APM-123V. It includes instructions for troubleshooting, testing, aligning, and repairing the equipment. It also lists tools, materials, and test equipment required for general support and depot maintenance, Functional analysis of the equipment is covered in chapter 2. A schematic diagram of the cable required to perform mode 4 checks with the auxiliary computer is shown in figure 8-46.

NOTE

For equipment modified by MWO 11-6625-667-40-1, a visual indicator light (A15XDS4) to provide a code zeroize alarm and protection diode (A15CR6) to prevent overloading of the power supply have been added. In addition, MWO 11-6625-667-40-2 changed the prf from 400 pps to 230 pps and eliminated the SPI pulse.

b. The complete manual for this equipment includes one other publication, TM 11-6625-667-12.

1-2. Indexes of Publication

a. DA Pam 310-4. Refer to the latest issue of DA Pam 310-4 to determine whether there are new editions, changes, additional publications, or modification work orders pertaining to the equipment.

1-3. Maintenance Forms, Records, and Reports

a. Reports of Maintenance and Unsatisfactory Equipment. Department of the Army forms and procedures used for equipment maintenance will be those prescribed by TM 38-750, The Army Maintenance Management System (Army). Air Force personnel will use AFM 66-1 for maintenance reporting and TO-00-35D54 for unsatisfactory equipment reporting. Navy personnel will report maintenance performed utilizing the Maintenance Data Collection Subsystem (MDCS) IAW OPNAVINST 4790.2, Vol 3 and unsatisfactory material conditions (UR submissions) IAW OPNAVINST 4790.2, Vol 2, chapter 17.

b. Report of Packaging and Handling Deficiencies. Fill out and forward SF 364 (Report of Discrepancy (ROD)) as prescribed in AR 735-11-2/DLAR 4140.55/NAVMATINST 4355.73/AFR 400-54/MCO 4430.3E.

c. Discrepancy in Shipment Report (DISREP) (SF 361). Fill out and forward Discrepancy in Shipment Report (DISREP) (SF 361) as prescribed in AR 55-38 /NAVSUPINST 4610.33B/AFR 75-18 MCO 4610.19C/DLAR 45.0015.

1-4. Report Equipment Improvement Recommendation (EIR)

a. Army. If your equipment needs improvement, let us know. Send us an EIR. You, the user, are the only one who can tell us what you dont like about your equipment. Let us know why you dont like the design. Tell us why a procedure is hard to perform. Put it on an SF 368 (Quality Deficiency Report. Mail it to Commander, US Army Communications Electronics Command, ATTN: DRSEL ME-MQ, Fort Monmouth, NJ 07703. We 11 send you a reply.

b. Air Force. Air Force personnel are en couraged to submit EIRs in accordance with AFM 900-4.

c. *Navy.* Navy personnel are encouraged to submit EIRs through their local Beneficial Suggestion Program.

1-5. (Army Only) Destruction of Army Materiel to Prevent Enemy Use

Demolition of the test set will be accomplished only upon the order of the Commander. Refer to TM 750-244-2 for procedures to prevent the enemy from using or salvaging this equipment.

1-6. (Army Only) Administrative Storage

Administrative storage of equipment issued to and used by Army activities shall be maintained in a maximum Readiness Condition (REDCON). Equipment placed in administrative storage should be capable of being readied to perform its mission within a 24 hour period or as otherwise prescribed by the approving authority. Before equipment is placed in administrative storage, current maintenance service should be performed; shortcomings and deficiencies should be corrected: and all modification work orders (MWOs) as listed in DA Pam 310-4 should be applied. Particular attention is directed to security and calibration of installed electronic equipments in or out of aircraft or surface equipment prior and during administrative storage. Special procedures include protection from dust and humidity and the cleanliness and inspection of the electronic equipments. Upon removal from storage, the electronic equipments must be prepared for operation and tested in accordance with the PMCS charts and procedures in pertinent technical manuals.

CHAPTER 2

FUNCTIONING

2-1. Block Diagram

a. The test set evaluates the minimum performance of aircraft installed transponder sets on a go-no-go basis. It checks the receiving, decoding, coding, and transmitting functions and provides either an accept or reject indication. A coded interrogation signal is transmitted, and the transponder reply is analyzed. Incorrect or no replies result in a reject indication, and an accept indication will result when all transponder functions are performing within limits, With internally generated pulse-pairs, the test set can interrogate in modes 1, 2, 3/A, TEST, and C. In addition, a sidelobe-suppression test can be performed during interrogations. Mode 4 interrogation pulses are supplied by external mode 4 equipment for transmission. Radiation tests are performed with an adjustable antenna mounted on the front panel. Tests can also be performed by direct coupling, by using Cable Assembly, Radio Frequency CG-409H/U (radiofrequency (rf) cable) and Fixed Attenuator CN-1088A/U (attenuator), or using Test Hood, Antenna MX-4396/APM-123(V). Replies are analyzed for minimum power level, frequency, coding, and pulse position limits. A reply rate evaluator is included to provide an accept indication when 80 percent or more transponder replies are correct. The evaluator gives a reject indication when 50 percent or less transponder replies are correct. When the percentage of correct replies falls between 50 and 80 percent, the accept-reject indicators may give unsteady (flickering) indications. The reply evaluation is provided on a continuous basis and requires approximately 1/8 second (50 pulse repetition frequency (prf) periods) to change from an accept to a reject indication.

b. Figure 8-1 illustrates a general block diagram of the major functional sections and their major circuits. The power supply section provides direct current (dc) power to all other sections. The transmitter section produces the coded interrogations for transmission to the test set. The receiver section evaluates the test set reply frequency and power. The receiver video pulse train output is then evaluated in the decoder section for proper pulse positions. Paragraphs 2-2 through 2-5 cover the operation of these sections for system, identity, and emergency tests. Mode 4, self-test, and frequency-power operations are described in paragraphs 2-7 and 2-8, respectively. The power supply section is described in paragraph 2-9.

2-2. Encoder Circuit

(fig. 8-1)

The encoder is located in the transmitter section and generates the modes 1, 2, 3/A, TEST, and C pulse-pairs to modulate the transmitter rf output circuit. The interrogation sidelobe suppression (ISLS) pulse also can be selected for transmission, During mode 4, however, the encoder circuit is used only to shape interrogation pulses from external equipment. Certain circuits are shared with the decoder section and are described in the following paragraphs. Figure 2-1 illustrates the timing.

a. Prf Generator. The prf generator controls the repetition rate of the encoder circuit, and all test set operations. It produces 2.17-millisecond pulses at 230 + 5–10 pulses per second (pps). These pulses are applied to encoder line-drive generator ISSI and encode enable IFFI, and to readout DFF5 during self-test operations.

b. Pulse-Pair Generator.

(1) *Encoder enabling.* Encode enable IFFI enables the P1-P3 pulse gating circuits. The trailing edge of the 2.18 millisecond pulse from the prf generator sets this flip-flop, and a positive enable voltage is then applied to the gates.

(2) *Pulse-pair generation.* The pulse-pair generation operation is started simultaneously with the encoder enabling. Encoder line-drive generator ISSI is triggered by the trailing edge of 1, the 2.18-millisecond pulse from the prf generator. A negative 0.7-microsecond pulse is produced, and is gated and inverted by line drive gate 2 (OR). (This OR gate is also used during decoding operations.) The gated encoder line-drive pulse is coupled by an emitter follower (EF) to delay line A6DL1, which is also com-

mon to the decoder section. Six delay line taps are used for encoding. Five taps are used for the selectable P1 pulse, and a common tap is used for the P3 pulse. The P3 pulse tap is the last tap and is located 25 microseconds down the delay line.. The pulse-pair spacing is determined between the leading edges of P3 pulse and P1 pulse. The P1 pulse taps are located 3, 5, 6.5, 8, and 21 microseconds before the P3 tap. As the line-drive pulse flows down from the delay line, it first appears at each of the P1 taps. The P1 pulse are coupled by five respective emitter followers (EF) to P1-P3 pulse switching and gating circuits. The P1 delay line output, dependent on the mode, is selected at the delay line for the applicable test. The selected P1 pulse is gated and triggers P1-P3 shaper ISS4. The pulse output of ISS4 has a 0.8-microsecond duration and is negative. Then 3, 5, 6.5, 8, or 21 microseconds later, the P3 pulse is gated and also triggers ISS4. These delays represent modes 1, 2, TEST, 3/A, and C, respectively, The resulting negative pulse-pair is inverted and gated by the main modulator driver. The main modulator driver output is a positive pulse-pair applied to the transmitter main modulator circuit (para 2-3).

c. Interrogation Sidelobe-Suppression Pulse Generation. The ISLS pulse (P2) generation is initiated by the P1 pulse. The leading edge of the gated negative P1 pulse edge triggers delay generator ISS3. A 2-microsecond positive pulse is produced, and its trailing edge triggers P2 pulse shaper ISS2. This pulse shaper produces negative 0.8-microsecond pulses for all tests, except mode 4. During mode 4 tests, it is used to shape the external mode 4 interrogation trigger input by generating a 0.5-microsecond pulse for each trigger. Normally, the output of ISS2 is applied through ISLS switch A15S7 (OFF position) to the low P2 pulse modulator driver. The output of this modulator driver is a positive pulse, and is applied to the transmitter low P2 pulse modulator (para 2-3). In this case, the P2 pulse appears in the rf output at a minimum level of 10 decibels (dB) below the P1-P3 rf level. When switch A15S7 is at the ON position, it is routed the same way as the P1-P3 pulses to the main modulator in the transmitter. In this case, the P2 pulse amplitude at the rf output is the same as the other pulses. This pulse provides a transponder suppression circuit test. In each case, the P2 pulse is spaced 2 microseconds from the P1 pulse.

d. Encoder Disabling- and Decodcr Enabling Pulse. The P3 pulse from the delay line is used to reset encode enable IFF1 (b above), and as a decode enable (DE) pulse. After the P3 pulse is gated from the delay line, it is inverted and amplified by the DE amplifier. The trailing edge of the resultant positive pulse resets IFF1. Thus, enabling voltage is removed from the P1 and P3 gating circuits, The DE pulse is also routed to the decoder section to preset its various circuits for the transponder reply.

2-3. Transmitter Modulator and RF Circuits

(fig. 2-1)

The transmitter rf circuit is modulated by the encoder P1, P2, and P3 pulses and produces pulsed rf signals at 1,030 megacycles (mc). The rf level can be adjusted (internally) between – 15 and + 4 dbm, and normally is preadjusted to – 9 dBm ± 1, as measured at PROBE jack A15J24. The P2 pulse is transmitted at one of two levels. With ISLS switch A15S7 at OFF, the rf level is at least 10 dB below the preadjusted P1-P3 rf level. When this switch is on, its level is the same as the P1-P3 pulses. Two modulator circuits are

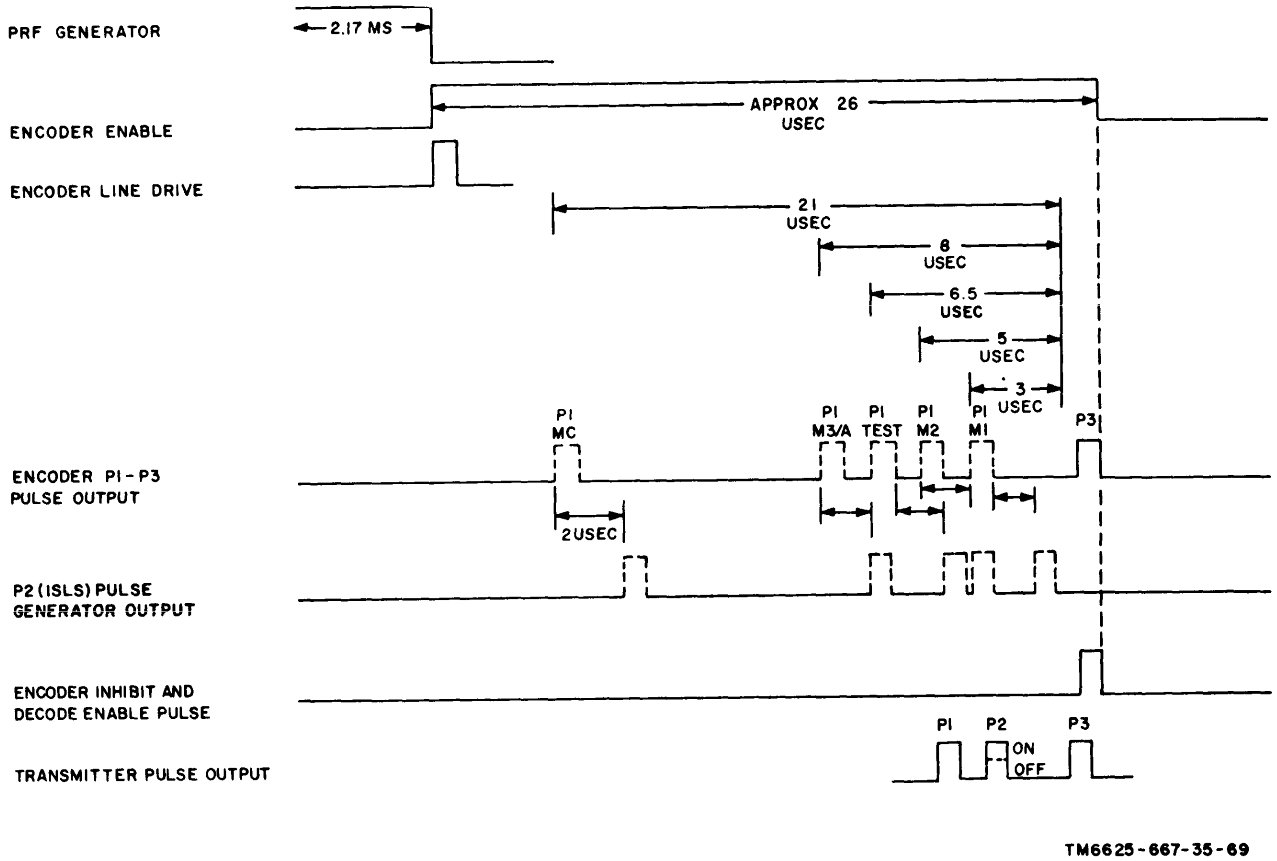


Figure 2-1. Encoder timing diaqram.

used to obtain these conditios. Encoder P2 pulses are directed to the adjustable low P2 pulse modulater driver when the ISLS switch is OFF. When the ISLS switch is ON, the P2 pulse is directed to the main modulator driver along with the P1 and P3 pulses The transmitted RF output level is attenuated approximately 57 db by the 50-foot radiation test distance, the RF cable and attenuator, or the RF cable, attenuator, and antenna test hood during umbilical tests. When preadjusted to the RF level of – 6 dbm, transponder sets with minimum sensitivity limits of – 66 dbm may be checked. Transponder sets that have minimum sensitivity limits between —53 and —72 dbm may be checked by preadjusting the transmitter power level between +4 and – 15 dbm as required. The antenna test hood and antenna perform as follows:

a. L-Band Antenna. The L-band antenna, a compact traveling-wave type, is used for transmission of the interrogation signal and reception of the signal during radiation tests. The highly directional horizontal field pattern of the antenna helps reduce interference to and from other RF systems. It is mounted in a horizontal plane on the control panel of the test set to radiate a vertically polarized signal. Adjustments can be made in this plane for line-of-sight antenna alignment. Also, it can be adjusted for horizontal polarization. Antenna bandwidth is sufficient for the transmission of 1,030-mc and reception of 1,090-mc signals Received signals travel from the antenna through the PROBE jack and the normally closed contacts of self-test relay A15K1 to the receiver section.

b. Antenna Test Hood. When the test hood is used with aircraft Antenna AT-884/APX-44, the test set L-band antenna is disconnected from the PROBE jack, then the test hood is connected to this jack through the attenuator and RF cable. The test hood insures that maximum RF energy is coupled between the test set and the aircraft antenna.

2-4. Receiver Section (fig. 8-1)

The receiver section evaluates the transponder set replies for proper frequency and power level. It consists of preselector A15Z1, detector A15Z2, a video amplifier, video switching and receiver gates, video shaper DSS1, mode 4 shaper DSS6, and an emitter follower. The receiver frequency is 1,090 mc ±0.5, and the bandwidth at the – 3-db points of the selectivity curve is 6.5 mc ±1. The receiver sensitivity is adjustable between – 15 and 0 dbm. It is normally preadjusted to – 9 dbm ±1 for testing transponder that have a minimum transmitter power level of +48 dbm. The receiver sensitivity can be preadjusted internally (– 15 to 0 dbm) to test minimum RF levels between +42 and +57 dbm. Transponder replies that have the proper frequency and RF levels *are* detected and will sufficiently drive the video amplifier. The video amplifier output is gated to trigger video shaper DSS1 during all test except mode 4. During mode 4 tests the video is gated to external equipment. The receiver video gates *are* enabled as described in paragraph 2-5a by the decoder section, and receiver gate periods are described in paragraph 2-5c.

2-5. Decoder Section

a. General. The decoder section (fig. 8-1) evalu*ates* the transponder reply video for all tests except mode 4. It detects the presence and position of each pulse in *a* reply train. Figure 2-2 illustrate the basic train, and the position of the identity pulse or a second F1 framing pulse. The various types of replies expected in system tests, identity tests and emergency tests are listed in the chart below. Since the test set, does not evaluate the mode 4 reply, its format is not illustrated. Framing and information pulses are evaluated for the following spacing variations; those within ±0.15-microsecond of the nominal are accepted; those deviating greater than ±0.35 microsecond from the nominal are rejected. Extra pulses or the absence of an expected pulse will also cause a reject condition. To perform this evaluation, the decoder section enables the receiver gate, generates a comparison pulse train, detects the quantity of correct replies within approximately 50 prf periods, and provides the accept or reject readout.

Test	Reply
System:	
Mode 1------	Any combination of A1, A2, A4, B1, and B2 plus framing pulses. Other information pulse not present.
Mode 2------	Any combination of all information pulses plus framing pulse.
Mode 3/A----	Any combination of all information pulses plus framing pulses.
Mode C------	Any combination of all information pulses, except for 500 feet increments (combinations of A1, A2, A4, B1, B2, B4, D2, D4, and I/P are used) and 100 feat increments (combinations of A1, A2, A4, B1, B2, B4, C1, C2, C4, and D2 are used) plus framing pulses.
Identity:	
Mode 2 and 3/A.	Any combination of all information pulses plus the I/P pulse and framing pulse.
Mode 1------	Two trains of any combination of all information pulses plus framing pulses.
Emergency:	
Mode 1 and 2-	Any combination of all information pulses plus three sets of framing pulses.
Mode 3/A----	A1, A2, A4, B1, B2, and B4 plus three sets of framing pulses.

b. Receiver Gating. Refer to figures 2-3 through 2-6 for the timing diagrams. The receiver gating operation is started by the decode enable pulse produced by the last (P3) interrogation pulse (para 2-2b). Video enable DFF6 is reset and video enable delay DSS4 is triggered by this pulse. In the reset state, DFF6 disables the receiver video gates. When triggered, DSS4 produces a 1.8-microsecond positive pulse. The trailing edge of the pulse sets DFF6, which in turn enables the receiver video gates and comparator pulse generator output. Thus, reply can be gated to video shaper DSS1 (para 2-4) 1.8 ±0.1 microsecond after the last interrogation pulse is produced. The gate period depends on the mode and function used in a test. Video enable DFF6 is reset by the video enable reset switching and gating circuits (d below). The output of video enable delay DSS4 also triggers read delay DSS5 (c below). Encircled numbers in the timing diagrams (figs. 2-3 through 2-6) indicate a new start.

c. Comparison Pulse Generation. A pulse train is generated in the decoder section for comparison with the expected reply train. Comparison of both signals is performed at the error detector. Basically, delay line A6DLI and the comparator generator and code switching circuits perform the pulse train generation. The pulse trains that can be produced are shown in figure 2-2. The first reply F1 pulse establishes the timing reference for the generation of the comparison pulses. One cycle of pulse generation is used for system tests and identification of position (I/P) tests (except mode 1). Two cycles are used for mode 1 I/P tests, and four are used for emergency tests.

(1) *System and identity (except mode 1) tests.* Timing is shown in figures 2-3 and 2-4. Pulse train generation circuits are enabled by the decode enable pulse, which also triggers the video enabling operation (b above). This pulse sets line-drive enable DFF1 and resets counter DFF3/DFF4. Line-drive gate 1 is then enabled by DFF1. The first F1 repIy pulse, from video shaper DSS1 in the receiver section, is gated by line-drive gates 1 and 2. Gated F1 pulses are coupled by emitter follower A1OQ7 (EF) to drive delay line A6DL1, to reset line-drive enable DFF1, and to trigger error blanking circuit DFF2. Resetting DFF1 disables line drive gate 1, thereby preventing the gating of other pulses. The action of the blanking circuit with respect to the first F1 pulse is described in e below. As the pulse flows down the delay line, it is tapped off at 14 delay points. Each pulse (12 information pulses, F2 pulse, and I/P pulse) is coupled by an emitter follower to the comparator pulse generator and code selection circuits. Here, the information pulses are selected with the aid of front pane] CODF. switches, and a comparison pulse train is generated. A positive and negative 0.5-micrsecond pulse is generated for each pulse in the train. These pulses are applied to the error detector (d below).

(2) *Mode 1 identity and emergency tests.* Timing is shown in figures 2-5 and 2-6. During mode 1 identity and emergency tests, additional pulse generation takes place. The first operation is similar to that described in (1) above. However, the additional F1 reply pulses are descoded and redrive the delay line to generate additional comparison pulse trains. Since the I/P pulse holds the same position as an F1 pulse, this delay line pulse is used for the additional F1 pulse comparison. The first operation ((1) above) produces the first F1 comparison pulse. For mode 1 identity tests, this pulse is compared against the F1 pulse of the second pulse train. For emergency tests, this comparison takes place with the F1 pulse of each set of framing pulses. After the first train, each additional F1 reply pulse is used to start comparison pulse generation. Twenty-two microseconds after the first F1 pulse enters the delay line, an Ml pulse is produced (fig. 8-1). This pulse sets line drive enable DFF1 and, in turn, enables another F1 pulse to pass to the delay line. The second F1 pulse produces the second train during mode 1 identity tests, and the first set of framing pulses (F1 and F2) during emergency tests. Using the M1 pulse, this operation is repeated two more times for emergency tests to produce the other two sets of framing pulses for comparison.

d. Receiver Gate Duration Control. The receiver gate in the receiver section is controlled by the state of video enable DFF6 *(a* above). In its set state, DFF6 enables the gate. The duration of this gating depends on the duration of the expected reply train, which is concluded within 5 microseconds after the last expected reply pulse. This operation is performed in conjunction with the video enable reset switching and gating circuits, and is effected during comparison pulse train generation (c above). During all tests, except self-test (para 2-7), the gate is closed by read delay DSS5 if replies were not received from the transponder. The state of the video enable reset switching and gating circuits is established by the positions of the front, panel MODE and FUNCTION switches, One of five different states is established to accommodate five possible signal conditions as follows: single pulse train, mode C pulse train, identity pulse train (except mode 1), mode 1 identity pulse train, and emergency pulse train. Refer to figures 2-3 through 2–6 for timing diagrams.

(1) *Signal pulse train and mode (C* pulse train. Either of these pulse trains is expected during system tests. A single pulse train is expected for all modes, except certain mode C tests.

During system tests in all modes except mode C, line-drive enable DFF1 is used to conclude the receiver gating period in the following manner. Twenty-two microseconds after the reply F1 pulse starts down the delay line to form comparison pulses, it is coupled by the MODE switch and M1/M3 amplifier to set DFF1. In this state, DFF1 applies a reset pulse to video enable DFF6 through the video enable reset gating and switching circuits. This action removes the enable voltage from the receiver gating circuits. When mode C tests are in progress, the 25-microsecond P3 encoder tap through the M1/M3 amplifier is used to obtain the video reset pulse. This delayed F1 reply pulse is coupled by the M1/M3 amplifier and video reset switching and gating circuits to reset DFF6; therefore in this case, the receiver is gated off 25 microseconds after the F1 reply pulse.

(2) *Indentity pulse train (except mode 1).* When the identity tests are in progress, line-drive enable DFF1 and counter DFF3/DFF4 develop the video reset pulse by a two-step operation. The first operation is started as in (1) above, by the 22-microsecond delayed F1 pulse from the M1/M3 amplifier. When the output of the M1/M3 amplifier sets DFF1, it also triggers DFF3/DFF4. An output "from each of these circuits gates on a video reset gate in the video reset switching and gating circuit. The second step in the operation is started by the reply I/P pulse. Since DFF1 is set, this pulse is gated by line-drive gates 1 and 2. It is then coupled by emitter follower A10Q7 (EF) to reset DFF1. The trailing edge of the pulse causes this reset. Upon being reset, DFF1 removes its gating voltage from the video reset gate. This action causes a negative-going signal, which resets video enable DFF6. Thus, the receiver gate is disabled after the I/P pulse.

(3) Mode *1 identity and emergency pulse trains.* Counter DFF3/DFF4 develops the video reset for these replies. The counter effectively counts F1 reply pulses flowing through the delay line. These are the trigger pulses coupled by the M1/M3 amplifier from the 22-microsecond delay line tap during these operations. With each trigger pulse, the counter changes state. Four sequential states and three outputs (one is common to the other two) provide the necessary reset conditions When mode 1 identity tests are in progress, the first F1 pulse count causes two of the outputs to gate on one of the video enable reset gates. The second F1 pulse count removes one output, and the resulting negative-going voltage resets video enable DFF6. Thus, the receiver gate is disabled after the F2 pulse of the second train. During emergency tests, the third F1 pulse count causes two of the outputs to gate on another video-enable reset gate. The fourth F1 pulse count meets DFF6, and disables the receiver gate after the F2 pulse of the fourth train.

e. Error Blanking and Detection.

(1) *Error blankinq.* Refer to figures 2-3 to 2-6 for timing diagrams. The error blanking circuit inhibits errors that normally would result from the first reply F1 pulse and comparison information pulses after the first train. As stated in c above, the first F1 pulse is not generated for comparison at the error detector. This F1 pulse, however, will appear at the error detector from video shaper DSS1. Without an internal] y generated pulse present, an error set output would normally result. To prevent this condition, the error blanking circuit is initially set by read delay DSS5, which was triggered by video enable delay DSS4 (b above). The leading edge of the DSS5 150-microsecond negative pulse performs the set operation 1.8 microsecond after the encoder P3 pulse is generated. In a set state. the blanking circuit provides an error inhibit voltage to the error detector; therefore, the first reply F1 pulse that arrives at the error detector does not cause an error set output. After the F1 pulse arrives at the input of delay line A6DLI to start comparison pulse train generation, it is also directed as a trigger to the error blanking circuit. The trigger resets the blanking circuit, thereby removing the error inhibit from the error detector. This blanking operation only applies to the first F1 pulse of any reply signal. When emergency tests are in progress, three sets of framing pulses follow the first train. In this case. three additional operations are used for setting and resetting the blanking circuit. When another F1 pulse appears after the first one at the input of delay line A6DLl, it

triggers the blanking circuit again. Since the blanking circuit was reset by the action of the first F1 pulse, the second F1 pulse will cause it to go in a set state. This state is maintained until an M2 reset pulse appears. The M2 pulse is the F1 pulse coupled from the encoder mode 2 P1 delay line pulse output. This tap is located 20 microseconds down the delay line; therefore, blanking periods will begin after the second, third, and fourth reply F1 pulse and terminate before their respective F2 reply pulse. This blanking period permits only F1 and F2 pulses to be detected at the error detector during the last three trains of an emergency reply.

(2) *Error detection.* The error detector senses the presence of pulses and determines whether they are properly positioned. Each reply pulse, after the F1 pulse, is compared against its corresponding pulse of the comparison pulse train. If a pulse is missing or not properly positioned, an error set pulse is applied to readout DFF5 (f below.

f. Readout Control and Reply Evaluator. The readout control is performed by readout DFF5. It is initially reset (reject state) by the decode enable pulse produced by the encoder P3 interrogation pulse. In this state, its output is low and is coupled to the reply evaluator. When an error is not sensed by the error detector (e above), the reset period is maintained for 150 microseconds. After this period, the error blanking circuit and read delay DSS5 gate on the readout gate. This action in turn triggers DFF5 and causes it to set (accept state). If an error is sensed by the error detector, it sets DFF5 before 150 microseconds. When it is triggered by the readout gate output, a reject condition is established. The state of DFF5 is sensed by the reply evaluator. When 80 percent or more correct replies cause a set state to occur after 150 microseconds, the reply evaluator provides an accept readout. When 50 percent or less of these replies cause this set state after 150 microseconds, a reject readout is provided.

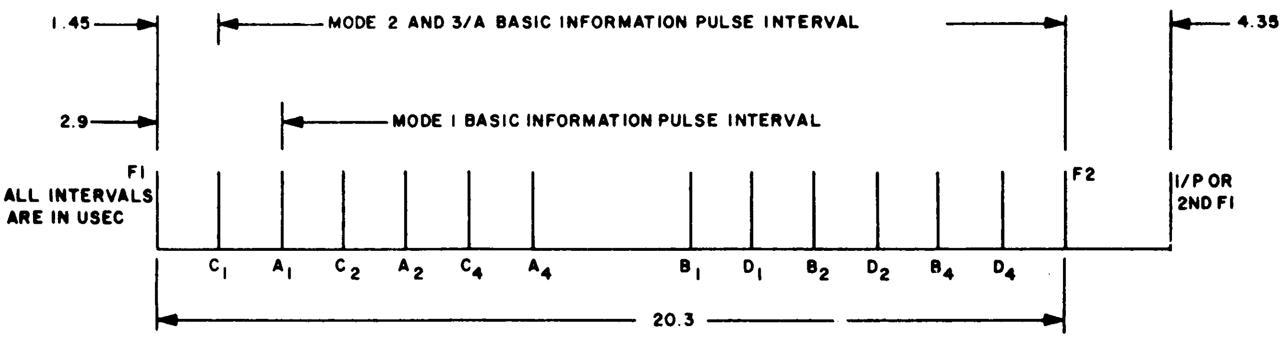


Figure 2-2. Typical SIF type reply trains.

2-6 Deleted.

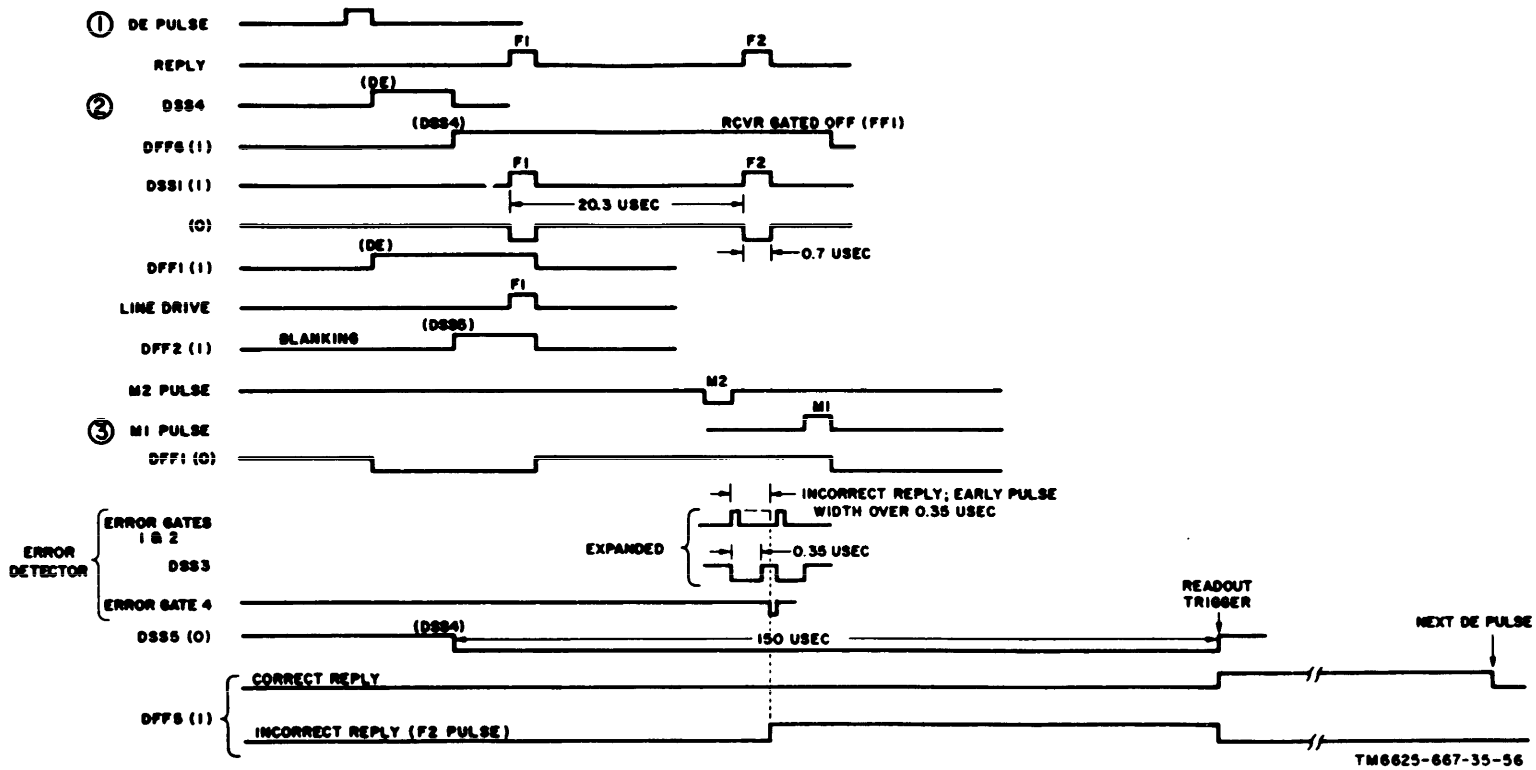


Figure 2-3. Single train timing diagram.

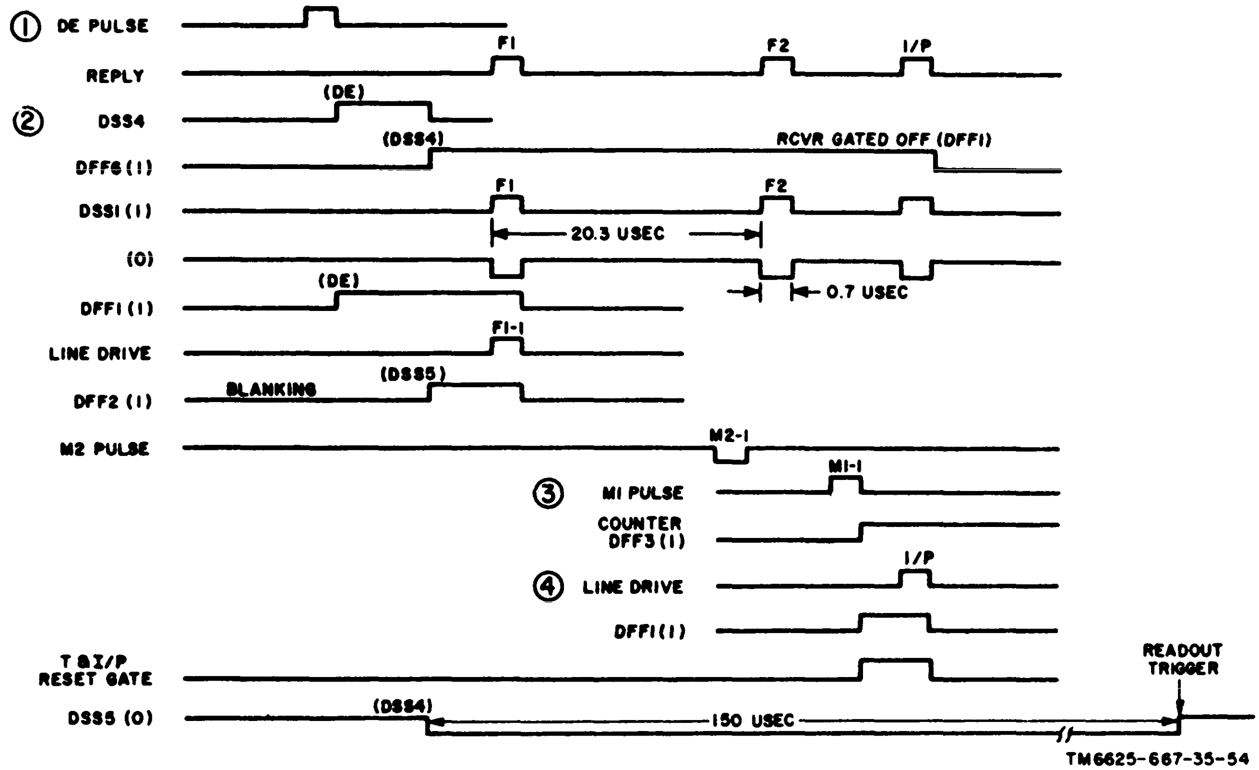


Figure 2-4. Train plus I/P pulse timing diagram.

2-7. Self-Test Operation (fig. 8-1)

During self-test, the encoder, modulator and transmitter, receiver section, and reply evaluator are tested. The receiver gate is enabled by encode enable IFF1 during self-test. The transmitter section RF pulses are routed by the self-test relay to the error detector, bypassing preselect or A15Z1. The detected video is amplified by the video amplifier as during normal tests. When the test set RF level is normal, the pulse are gated and shaped by video shaper DSS1. These pulses are compared at the error detector with those from the encoder. An accept indication is provided when all applicable circuits are performing correctly. Receiver gate *2* is disabled when encode enable IFF1 is reset by the DE *(P3)* pulse (para 2-2d).

2-8. Frequency-Power Test (fig. 8-1)

A frequency-power test can be performed to determine whether the transponder transmitter or its associated coder is causing a reject. When this test is performed, errors caused pulse information are inhibited at the error detector. At least one pulse must be received to determine the transponder transmitter frequency and power level. If a pulse is not received, a reject will occur, indicating that

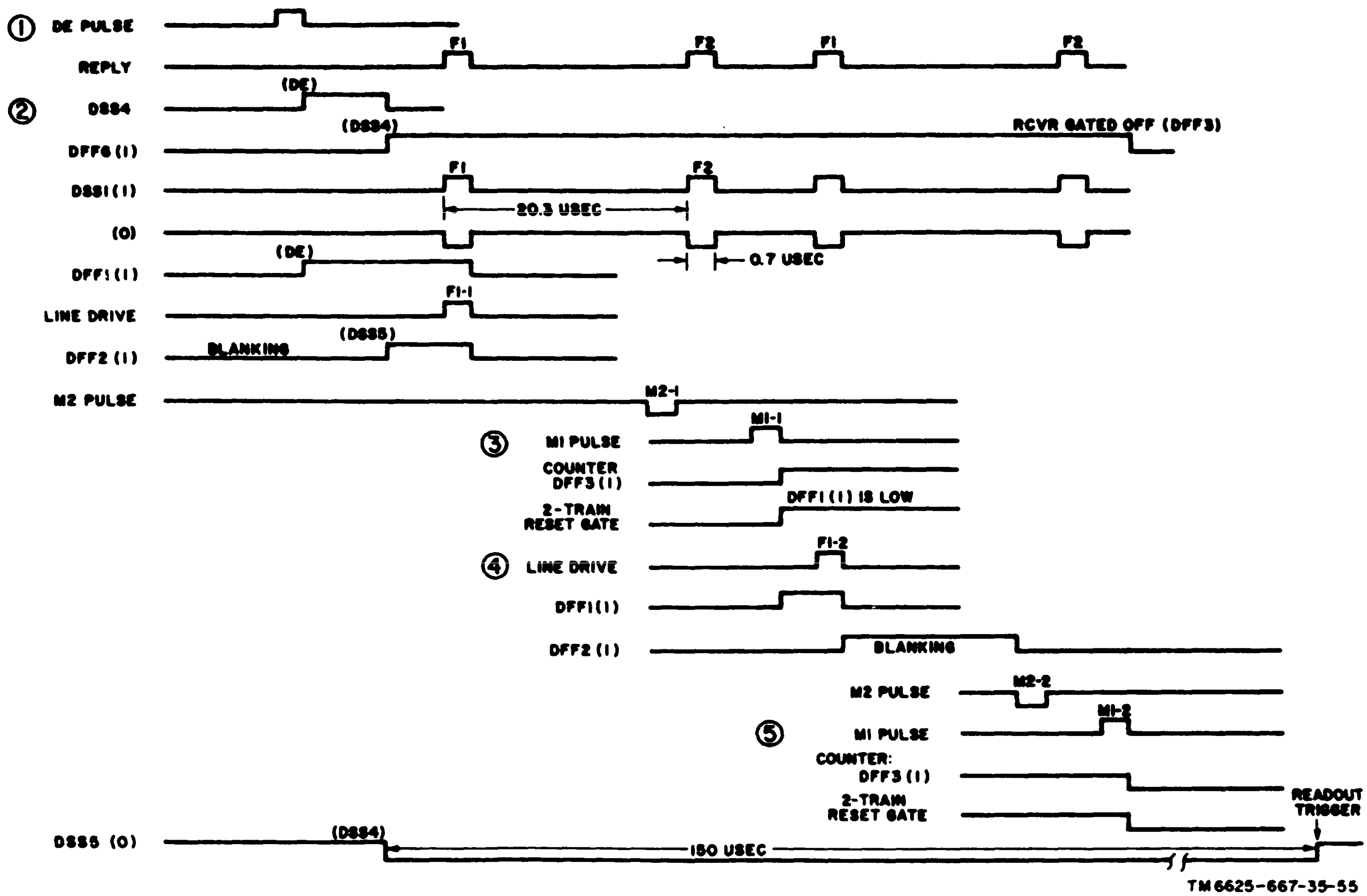


Figure 2-5. Two-train timing diagram.

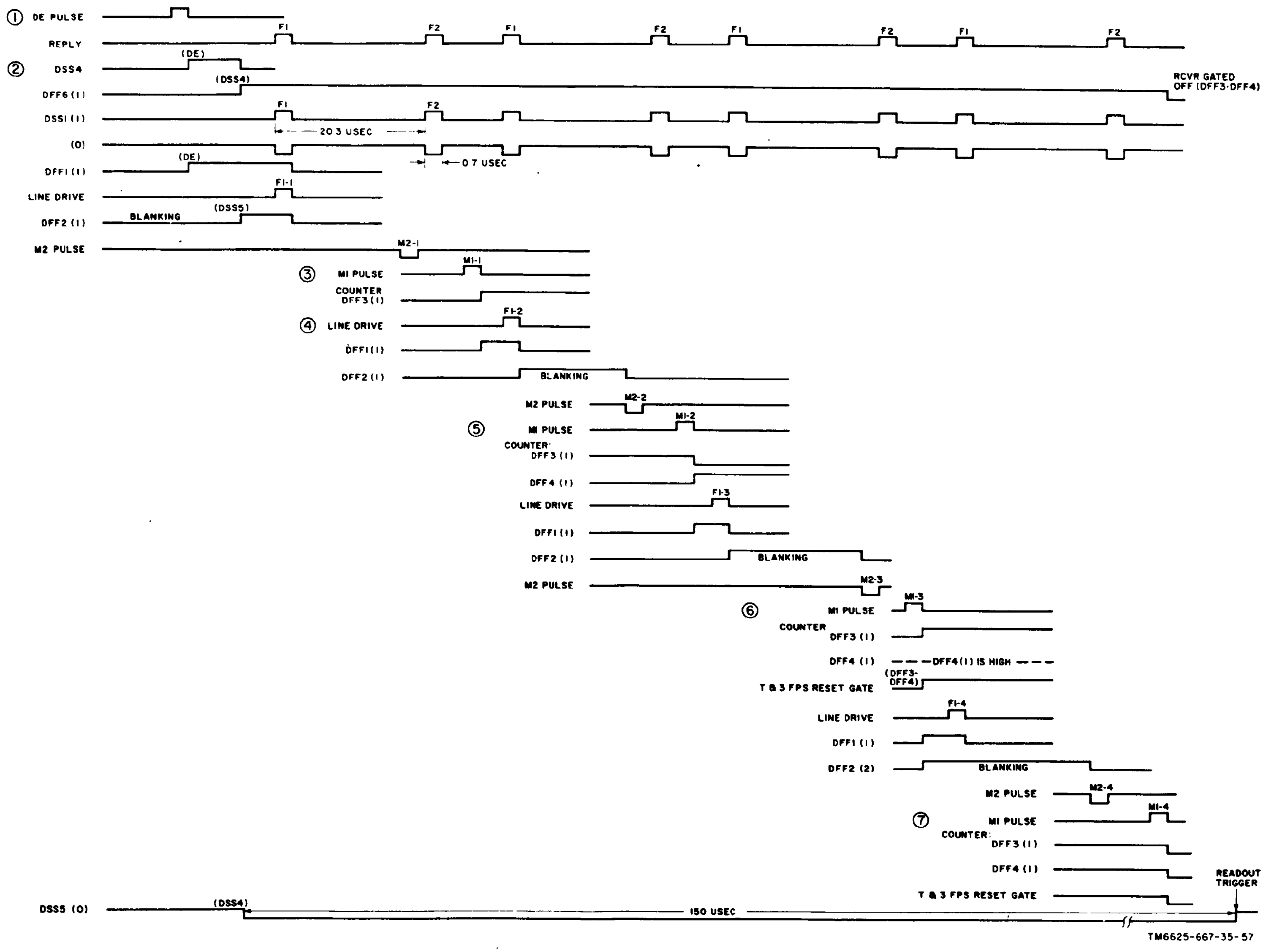


Figure 2-6. Train plus 3 Framing pulses timing diagram.

Figure 2-6.

at least one reply pulse was not received. A received pulse is processed by the receiver section as described in paragraph 2-4. During this test, if a pulse is not received, read delay DS5 inhibits the receiver gate after 150 microseconds. A received pulse triggers video shaper DSS1, then the error blanking circuit and read delay DSS5 will gate on the readout gate which, in turn, sets readout DFF5. The additional sequence of events is described in paragraph 2-5e.

2-9. Power Supply Section

The power supply section contains a 28-volt dc supply, + 12-volt dc supply, 12-volt dc supply, and + 150-volt dc supply. The 28-volt supply is part of the front panel assembly (A15). The +12-volt and - 12-volt sources are located on module A13, and the +150-volt supply is located on module A14. All supplies are fed by either the 28-volt supply or an external 28-volt input.. When the test set is operating with a 115 volts alternating current (ac) input, the 28-volt supply is switched into the circuit. by 28 VDC-115 VAC-OFF switch A15S1. Its output. is connected to + 12-volt regulator module A13, + 150-volt power supply module A14, and directly to the other test set sections. The –12-volt source is produced by a – 18-volt supply in module A14, which is regulated by the –12-volt regulator.

2-10. Basic Logic and Stage Analysis

The test set contains both digital and nondigital circuits. Opeations performed by digital circuits are described by means of basic logic circuit descriptions. Logic symbols and designations (MIL-STD-806B) are used in the supporting illusration, with associated switching also shown. Circuit elements normally are not shown unless they have special use. Logic circuits used in the test set are conventional and all flip-flops, one-shots, diode ASD gates, and transistor gates are similar in design. The main differences between flip-flops are the number of inputs or outputs that are used. The one-shots may prvide either one or two outputs. Nondigital circuits, such as conventional one or two-stage inverters ans emitter followers directly associated with logic circuits, are not described in detail. A two-stage inverter contains an emitter-follower stage and an amplifier stage and is used to couple and invert the logic information. To eliminate repetition during basic logic analysis, each type of logic circuit is described in a separate paragraph. Circuits that are essentially composed of nonlogic stages are described in later paragraphs in terms of stage analysis

a. Flip-Flop Multivibrators. All flip-flop multivibrators are bistable devices with one stage providing the 0-output and the other a 1 output. The assignment of 0 or 1 to a stage is arbitrary, but once established, it is carried through the text and illusrations. A conducting stage is considered to provide a low output and a nonconducting stage provides a high output. These conditions establish the state of the flip-flop. A flip-flop state can be selected by either a reset (c} or set input. In the test set, these inputs are usually negative-going voltages and may be either the lending edge or trailing edge of an input pulse. By definition, a reset input is applied to a 0 stage and a set input to a 1 stage, causing its respective output to go high because it stops the conduction of that stage. Therefore, when a flip-flop is in a set state, its 1 output is high and the 0 output is low. When it is in a reset state, its 0 output is high and 1 output is low. (Note that the term *reset* used in this manual is also known as clear.) Some flip-flops in the test set have more than one reset or set input and also a trigger (or toggle) input. A trigger input causes the flip-flop to assume the opposite state, regardless of its present state. Figure 2-7 illustrates a typical flip-flop. The circuit stages are dc cross-coupled by resistors R11 and R14. These resistor and capacitors C6 and C7 provide the resistance-capacitance (rc) constant for switching time. With the flip-flop in the reset state, transistor Q3 is biased off and not conducting. The collector (0 output) potential is high (approaching the +1% volt dc input). This potential also holds the base of Q4 high through resistor R11, thereby holding Q4 in n conducting state. Since Q4 is conducting, its collector (1 output) potential is low (approaching ground). This potential is coupled to the base of Q3 by resistor R14 and Q3 is held at. cutoff. A set input. (negative-going voltage) applied to C8 switches the state of the flip-flop. Transistor Q-1 is

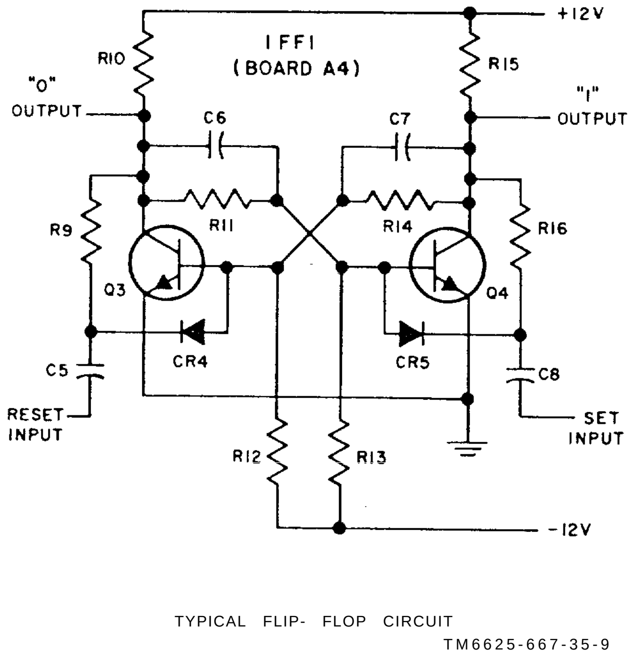


Figure 2-7. Typical flip-flop multivibrator circuit.

cut off by the input, and in turn drives Q3 into conduction. This is the set state, with Q3 providing the low 0 output and Q4 a high 1 output. Resistors R9 and R16 bold the respective inputs high when their stages are not, conducting, to prevent any additional pulses at the high input from switching a flip-flop state. Thus, an input to the conducting stage only will change the state. Flip-flops that have trigger inputs will assume the opposite state with an active signal at the input, of the concluding stage. The signal is coupled to both stages to force the change in state.

b. One-Shots. All one-shots in the test set are similarlv constructed. Some one-shots are triggered from the leading edge. of the input pulse and some are triggered from the trailing edge. The major difference, between one-shots is the rc time constant. that determines the duration of the output. Each one-shot has a control to adjust the width of its output pulse. Figure 2–8 illustrates a typical one-shot circuit. In this circuit, an output, is taken from each stage. In some circuits, only one of tile outputs shown is used. The time constant of the one-shot shown is determined by capacitor C2, resistor R5, and control R6. A trigger applied to C4 drives normally conducting Q2 to cutoff. Its rising collector potential is coupled by R4 to the base of Q1, driving Q1 into conduction. Capacitor C2 then starts discharging. and when discharged. the base of Q2 is driven positive. The one-shot then returns to its original state.

c. Gates. OR gates used in the test set are the simple diode types and are not described. Various types of AND gates exist and there are several ways of using them; those used in the test set are described in (1) and (2) below.

(1) Figure 2-9 illustrates a typical diode AND gate CR1 and CR2 with the inputs connnected to a typical signal source. This circuit is presented for analysis and does not represent any specific one in the test set. Two positive signals must be present at the input of the diodes fit the same time to cause an AND gate output. The negative signal at Q2 stops conducting and its collector potential goes positive. This aiction blocks the current flow through CR2 and provides an enabling voltage at gate diode CR2. When the negative pulse appears at the input of Q1, its conduction is stopped. The AND gate is thus enabled by Q2

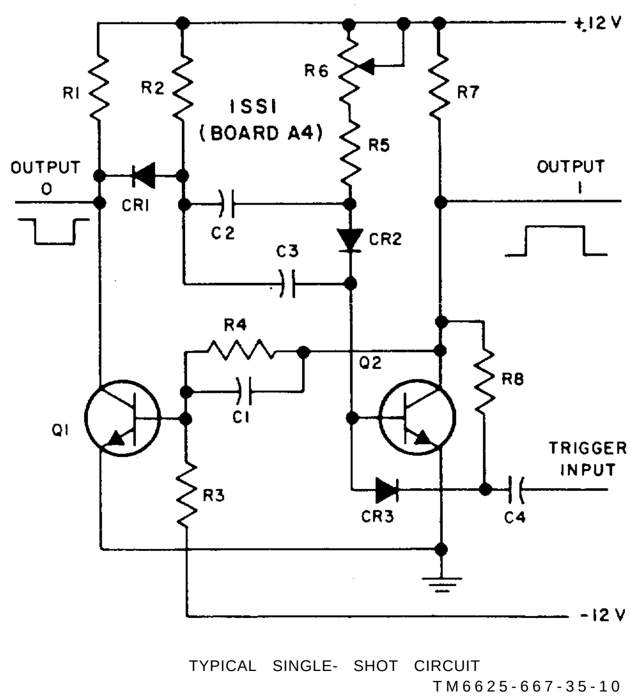


Figure 2–8. Typical one-shot circuit.

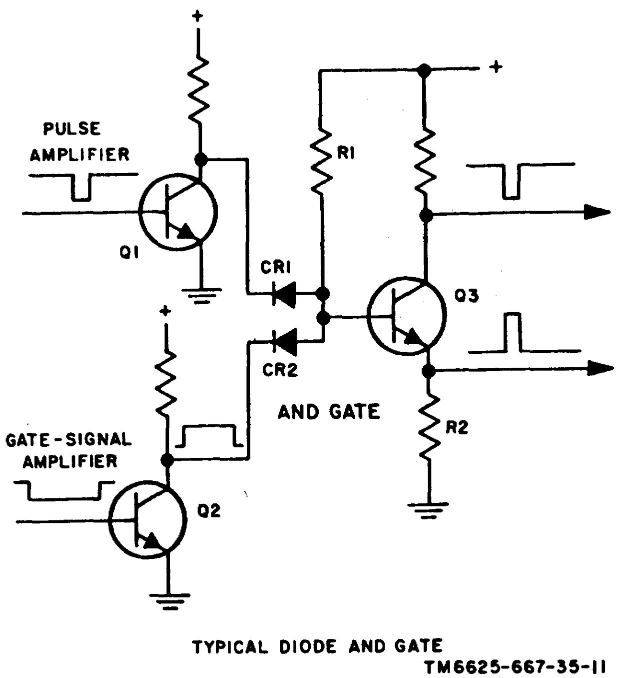


Figure 2-9. Typical diode AND gate circuit.

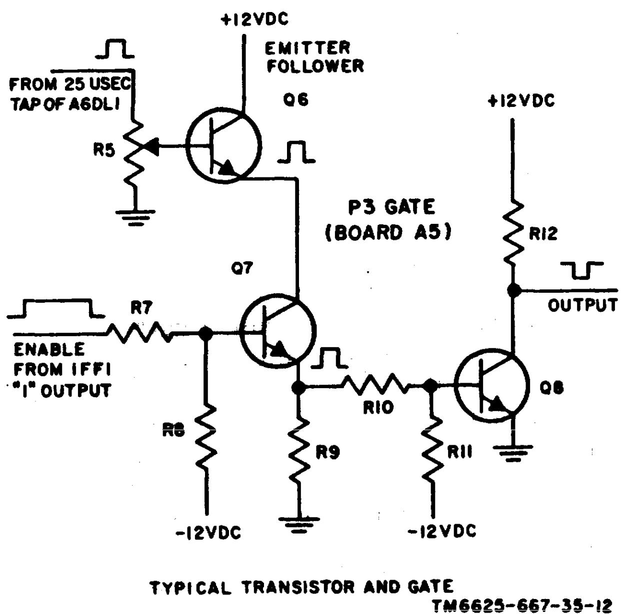


Figure 2-10. Typical transistor AND gate circuit.

when the positive output. of Q1 blocks gate diode CR1. The gate diodes control the conduction of transistor Q3 and when the pulses from Q1 and Q2 am gated, Q3 conducts. Two outputs are shown at Q3. If the gate is used as an inverter, the collector out put. is used and the output developed across emitter resistor R2 is not used. This type of gate is known as a NAND (negative AND) gate because it performs an inverting function. If the gate is not. used for inversion, the circuit used is an emitter follower and the output is taken across R2. This gate is known as an AND gate.

(2) Figure 2-10 illustrates a typical transistor AND gate. Gate inputs are applied to the collector and base of gate transistor Q7. In this circuit, emitter follower Q6, when conducting, -effectively connects the collector of Q7 to the +12-volt dc source. When an enable voltage is applied to the base of Q7, a positive pulse arriving from Q6 will cause conduction. The emitter output of Q7 causes gate transistor Q8 to conduct, and the gated pulse is taken from its collector.

2-11. Encoder Basic Logic Analysis (fig. 8-2)

a. Encoder Enabling and Line-Drive Generation. The prf generator starts the encoder operation. When PRESS-TO-TEST switch A15S4 pressed, the prf generator generates 2.17 millisecond pulses at a 230-pps rate. This pulse rate is adjusted by means of control A5R31. The trailing edge of each pulse is used to trigger line-drive generator ISS1 and to set encode enable IFF1.

(1) Line-drive generator ISS1 is a single-shot and contains transistors A4Q1 and A4Q2. Transistor A4Q1 is normally not conducting and provides the “0” output, and A4Q2 is normally conducting and provides the “1” output. When triggered by the prf generator, the “0” output goes low and the “1” output goes high. This produces 0.7-microsecond, negative-going pulses at the “0” output and positive-going pulses at the “1” output. The positive-going outlet is used for mode 4 pre-triggers during mode 4 tests. The negative-going (0) output is gated and inverted, then coupled by delay line driver A10Q7 to delay line A6DL1. The pulse width of ISS1 is adjusted by A4R6.

(2) Encode enable IFF1 provides enabling voltages to the delay line output AND gates (P1 and P3) and enables receiver video gate 2 (para 2-13c) during self-test opernation. Simultneous]y

with the triggering of ISS1, encode enable IFF1 is set. This flip-flop contains transistors A4Q3 and A4Q4. When set, the 1 output (A4Q4) goes high and establishes the gate enabling voltage at the P1 and P3 gates. This condition is maintained until IFF1 is reset approximately 25 microseconds later by the P3 pulse from inverter amplifier A5Q9/A5Q10. Thus, the 1 output goes low and disables the P1 and P3 gates after this period.

b. Interrogation. Pulse-Pair (P1 and P3) Generation.

(1) The interrogation pulse-pair (P1 and P3) is first formed in the delay line. This delay line is common to both the encoder circuit and decoder section of the test set. Six delay line taps are used for the encoder operation. Any one of the five selectable taps is used for obtaining a P1 pulse. A tap common to these selectable taps is used to obtain the P3 pulse. This common tap is 25 microseconds down the delay line. As shown in figure 8-2, the P1 pulse is .selected ahead of this tap: therefore, the nominal pulse-pair spacing is determined by subtracting the value of the selected P1 tap from the 25-microsecond common trip. *For* example. figure 8-2 shows MODE switch A15S5 positioned at mode 1. This connects the P1 gate to the 22-microsecond tap. Subtracting 22 microseconds from 25 microseconds results in 3 microseconds, the nominal mode 1 spacing. Each delay line output is coupled by an emitter follower to its respective AND gate.

(2) The P1 pulse delay time depends on the mode selected by MODE switch A15S5. The selected P1 pulse applied to the P1 gate is gated and inverted by the P1 gate. The resultant nega - tire pulse is applied to the P1-P3 gate and to P2 delay genealtor ISS3. A negative P3 pulse arrives later by any of the P3 gate. The negative P3 pulse is also applied to DE amplifier A5Q10. The nominal delays of the P3 pulse for modes 1, 2, TEST, 3/A, and C are 3, 5, 6, 5, 8, and 21 microseconds, respectively.

(3) The P1P3 pulses, gated and inverted by the P1-P3 gate, trigger P1-P3 shaper ISS4. This one-shot multivibrator (ISS4) contains transistors A4Q9 and A4Q10. Transistor A4Q9 provides the normally high 0 output and A4Q10 the normally low 1 output. The 1 output is used only during self-test operation. Upon being triggered by the P1 and P3 pulses, a negative pulse-pair is produced at the 0 output. The duration of each pulse is 0.8 microsecond. This duration is adjusted with control A4R41. The negative pulse-pair is gated and inverted by main modulator driver A4Q11 and A4Q12. The pulse are amplified and applied to the main modulator.

(4) The positive delay line P3 pulse is gated and inverted by the P3 gate and applied to DC amplifier A5Q9 and A5Q10 as a negative pulse. This pulse is again inverted, and the resultant positive pulse is used to reset IFF1. This action returns the 1 output to a low state. Thus, the enabling voltages are removed from the P1 and P3 gates approximately 25 microseconds after they were enabled The DE pulse is also applied to the decoder section as a decode-enable pulse.

c. Suppression Pulse (P2) Generation. Genera- t ion of the P2 pulse is delayed for 2 microseconds from the leading edge of the P1 pulse. The leading edge of the negative-going P1 gate output is developed from A5Q12 triggers P2 delay generator ISS3, a one-shot multivibrator containing transistors A4Q5 and A4Q6. When the one-shot multivibrator (ISS3) is triggered, it produces a 2-microsecond positive pulse the width of which is adjusted with control A4R32. The positive pulse is coupled by FUNCTION switch A15S6 and MODE switch A15S5 to P2 shaper ISS2 during all tests except mode 4 and self-test, P2 shaper ISS2 contains transistors A4Q7 and A4Q8 and functions as a one-shot multivibrator. The trailing edge of the 2-microsecond pulse triggers ISS2, which produces a negative-going, 0.8-microsecond P2 pulse. Thus, the P2 pulse is spaced 2 microseconds from P1-pulse. During mode 4 tests, the rc time constant of ISS2 is changed to produce 0.5-microsecond pulses. Resistor A4R30 is switched into the circuit by MODE switch A15S5. Contro] A4R29 provides a common pulse-width adjustment. The negative pulse output of ISS2 is coupled by ISLS switch A15S7 to either the low P2 modulator driver or to the main modulator driver. If the switch is set to OFF, the negative pulse will be amplified and inverted by the low P2 modulator driver and applied as a positive pulse to the low P2 pulse modulator in the transmitter. The effective result is an RF P2 pulse that has a minimum amplitude 10 db below the PI1 and P3 pulses. With the ISLS switch at ON, the P2 pulse is directed to the main modulator driver and its RF amplitude is approximately the same as the other pulses. The P2 pulse will appear at the transmitter output 2 microseconds after the P1 pulse.

2-12 Transmitter Section, Stage Analysis

a. Modulator.

(1) General. The modulator (fig. 2-11) amplifies the P1 and P3 pulses and either amplifies or attenuates the encoder P2 pulse. It then drives the transmitter RF output stage with these three pulses. Main modulator A16Q1 and low P2 pulse modulutor A16Q2 perform these operations. Encoder pulses are applied to A16Q1 and A16Q2 when IS1S switch A16S7 is set to OFF, and A16Q1 is used only when this switch is set to ON. The circuits of the two modulator stages are similar except that A16Q2 has an output level control (A16R6).

(2) *Main modulator A16Q1.* This stage amplifies the positive encoder P1 and P3 pulses. It also amplifies the positive encoder P2 pulse when sidelobe-suppression test is in progress (switch *A15S7* is ON). The pulses that appears at the base input are amplified and the resultant negative pulses are coupled to the transmitter output stage (A16A1V1) cathode. Capacitor . A16C2 at the input neutralizes the storage-time delay to improve the risetime of the output pulse, Resistors A16R3 and A16R4 provide base bias. Resistor A16R2 is a collector load, common to both modulators.

(3) Low P2 *pulse modulator A16Q2.* This stage is used when the sidelobe-suppression test is not in progress (switch A15S7 is at OFF). It is a pulse-level-control circuit t that reduces the amplitude of the encoder P2 pulse. Control A16R6 is used to adjust the P2 pulse RF amplitude at the transmitter out put to at least – 10) dbm below that of the P1 and P3 pulses, The P2 pulses at the base input causes A16Q2 to conduct. This conduction is controlled by control A16R6 in the collector lead which is in series with load resistor A16R2. The pulse amplitude at the junction of these resistors is determined by the setting of A16R6. The capacitor and resistors in the base circuit serve the same purpose as described in (2) above for A16Q1.

b. Transmitter Oscillator A16Q8. The transmitter oscillator (fig. 8-7) is crystal controlled, and produces a 38.14815-mc, continuous wave (cw) signal. The collector tank circuit, consisting of transformer A16Tl and capacitors A16C6 and A16C7, is tuned by trimmer capacitor A16C6. The RF output from A16T1 is coupled by capacitor A16C8 to the control grid of first tripler amplifier A16V1.

c. First Tripler A16VI and Seccond Tripler A16V2 The first and second triplers (fig. 8-7) have their plate circuits tuned to three times their input frequency. The RF output of oscillator A16Q3 is coupled to the control grid of A16V1. The plate tank circuit (T2, C12, and C13) is tuned to 114.44445 mc (three times the input frequency). Trimmer capacitor A16C12 is used to tune the tank circuit.. The RF output of A16T2 is coupled by capacitor A16C14 to the control grid of tripler A16V2. Its plate tank circuit (T3, C17, and C18) is tuned to 343.33335 me (three times the input frequency) : trimmers A16C17 and A16C18 are used to tune the primary and secondary of transformer A16T3. The secondary of A16T3 couples the RF energy to the cathode of cavity tripler A16A1V1.

d. Cavity Tripler A16A1V1. The cavity tripler (fig. 8-7) produces the pulsed RF interrogation signal to be transmitted to the transponder set under test. It is a tuned-cavity stage. with electron tube A16A1V1 housed in the cavity. The cathode of A16A1V1 is biased with a positive voltage to hold it at cutoff when pulses are not present. The P1. P2, and P3 negative pulses from the modulator are applied to the cathode and each pulse causes A16A1V1 to conduct for 0.8 microsecond. The cavity is tuned to three times the RF input frequency from second tripler A16V2 to produce a pulsed RF output of 1.030 mc. The frequency is tuned with the FREQ control on the cavity. A power-level PWR control is also located on the cavity and is used to adjust the output power level by changing the Q of the cavity. Power level is preadjusted between – 15 and +4 dbm, depending on the equipment to be tested. Capacitor A16A1

C2 is used to adjust the RF coupling to PROBE jack A15J24.

e. 22-Volt Regulator. The regulator (fig. 8-7) maintains a constant dc voltage at the cathode of A16A1V1 and electron tube filaments. The regulator output is preadjusted with control A16A2R1 to + 18.5± 0.5 volts at test point A16TP4. This. voltage is critical since transmitter power level and electron tube life are affected by departures from this level. Transistor A16A2Q1 senses regulator output changes through Capacitor A16A2C1. An output voltage increase causes increased conduction, and a voltage decrease causes decreased conduction. The transistor collector output goes low or high, respectively, and controls the conduction of emitter followers A16A2Q2 and A16A2Q3; therefore, these transistor produce corresponding voltage changes at the regulator output (A16A 2Q3). This action nullifies input voltage changes. Regulator diodes A16A2VR1, A16A2VR2, and A16A2VR3 maintain a constant bias at the emitter and base of A16A2QL

2-13. Receiver Section, Preselector A15Z1 and Detector A15Z2 (fig. 2-12)

a. Preselector A16ZI. Preselector A15Z1 is a passive resonant cavity. It is adjusted to 1,090 mc ±0.5 and provides receiver selectivity of 6.5 mc ±1 at the 3-db points of the selectivity curve. The RF reply received at PROBE jack A15J24 is passed through preselector A15Z1 and coupled to detector A15Z2. Crystal diode CR1 of A15Z2 demodulates the RF and applies the demodulated signal to the video amplifier input stage (b below).

b. Video *Amplifiers Q1 and A3* Video amplifiers Q1 and Q3 (fig. 2-12) provide receiver sensitivity-control and amplifies the reply video. The gain of video amplifier (Q1 is adjusted by sensitivity control A8R5 and determines receiver sensitivity. Reply video from detector A15Z2 coupled by capacitor A8C3, causes A8Q1 to conduct. The negative output voltage from the collector of A8Q1 decreases the conduction of A8Q2 proportionately. The output video level to video

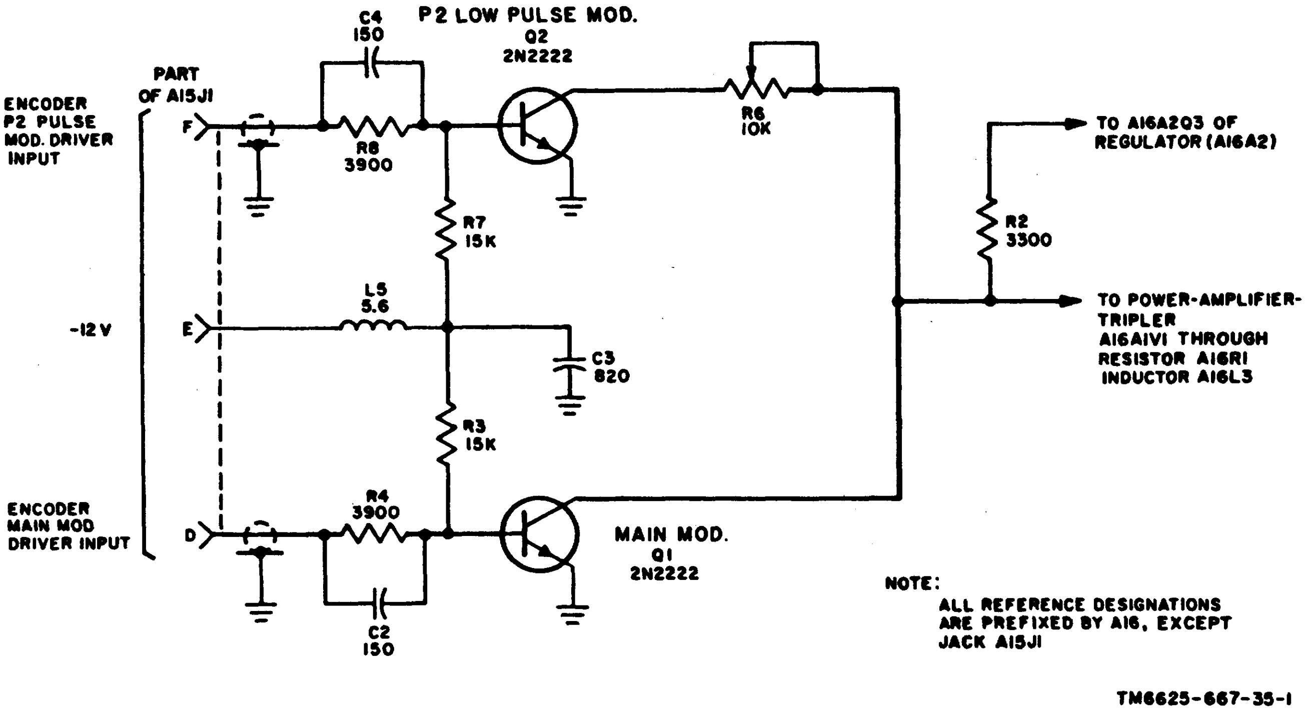


Figure 2-11. Low P2 pulse and main modulator, simplified diagram.

ampifier Q3 is controlled by receiver sensitivity control A8R5. Adjustments are made with the equivalent minimum transponder set RF level (0 to – 15 dbm) present at PROBE jack A15J24. Sensitivity control A8R5 is then adjusted until video amplifier Q3 output is sufficient is just drive video shaper DSS1 through video gate 2 (c below). This action results in a just-accept condition. A voltage divider consisting of resistors A8R6, A8R7, and A8R8 connects the emitter of A8Q2 to the base of A8Q1 to provide current feedback for temperature compensation. Capacitor A8C6, connected across A8R8, provides high frequency compensat ion. When A8Q1 conducts, the resultant negative-going signal at the emitter of A8Q2 is coupled through capacitor A8C5 and resistor A8R9 to video amplifier A8Q3. Video amplifier A8Q3 and emitter follower A8Q4 are temperature compensated by a voltage divider network similar to the one in video amplifier Q1. Video amplifier A8Q3 is normally conducting and the negative input video pulse at its base decreases this conduction. The increasing collector voltage of A8Q3, in turn, increases the emitter voltage of A8Q4. To obtain a fast pulse risetime, capacitor A8C8 is forced to discharge through resistor A8R11 by the emitter action of A8Q4. This effective feedback to the base of A8Q4 forces it to conduct at a faster rate. In discharging, capacitor A8C8 blocks conduction through diode A8CR3 until its charge potential approaches +12 volts. This condition isolates the capacitor surge from the + 12-volt source. The resultant video at the emitter of A8Q4 is coupled by capacitor A8C16 to either video gate 1 or video gate 2 (c below).

c. Receiver *Gating.* Video gate 2 (fig. 8-3) performs as the receiver gate during all test set operations, except mode 4 tests. Mode 4 video is controlled by video gate 1 and gates this video signal to external equipment. Video gate 2 is enabled during self -test. operation by encode enable IFF1 (para 2-11) when FUNCTION switch A15S6 is at SELF TEST. During all other functions, switch A15S66 connects gate diode A8CR11 to video enable DFF6 (para 2-14a). Video enable DFF6 provides an enabling voltage to video gate 2, 1.8 microseconds after transmission of the last interrogation (P3) pulse. Duration of the gate period depends on the type of test in progress. After video gate 2 is enabled, the reply video processed by the video amplifier is gated to video shaper DSS1. Each video pulse triggers video shaper DSS1, which produces 0.7-microsecond pulses. The video shaper is a one-shot multivibrator containing transistors A11Q1 and A11Q2 and provides 0 and 1 outputs. Transistor A11Q2 produces the postive-going 1 output, while A11Q2 simultaneously produces the negative-going 0 output. Both groups of pulses are fed to the error detector (para 2-14d). The positive pulses are also fed to line-drive gate 1 in the decoder section, where only the F1 or I/P pulses of a pulse train are gated (para 2-14C(3)).

2-14. Decoder Section, Basic Logic Analysis

a. Video-Enabling Functioning. Video-enable DFF6 (fig. 8-3) provides the video-enabling voltage to video gate 2 (para 2-13c). This flip-flop multivibrator is initially reset by a decode-enable pulse produced by the last (P3) interrogation pulse. The decode-enable pulse also triggers video-enable delay DSS4, which generates a video-delay pulse. Video-enable delay DSS4 is a one-shot multivibrator containing transistors A10Q1 and A10Q2, and produces a 1.8-microsecond positive pulse (fig. 8-13). The output is taken from the collector of transistor A10Q2, normally conducting. When DSS4 is triggered, A10Q2 ceases conduction for 1.8 microsecond. The trailing edge of the resultant 1.8-microsecond positive pulse sets video-enable DFF6 and also triggers read delay DSS5 (e below). Video-enable DFF6 is a flip-flop multivibrator containing transistors A9Q1 and A9Q2 (fig. 8-12). In a set state, the 1 output of A9Q2 is high and enables video gate 2 (fig. 8-3). Thus, the receiver gate is enabled 1.8-microsecond after the trailing edge of the P3 interrogation pulse.

b. Receiver Gate Period and Video-Enabe Reset Functining. Line-drive enable DFF1, counter DFF3/DFF4, or the M1/M3 timing pulses ((1) below) conclude the receiver gate period by resetting video-enable DFF6 (fig. 8-3). This action removes the enabling voltage from video gate 2 in the receiver section. A delayed 22-microsecond M1 pulse controls the operation of DFF1 and

NOTES:
UNLESS OTHERWISE INDICATED
ALL DESIGNATIONS ARE PREFIXED
BY A8, EXCEPT THOSE PREFIXED
BY A15; EXAMPLE A8R1, A8C2, ETC.

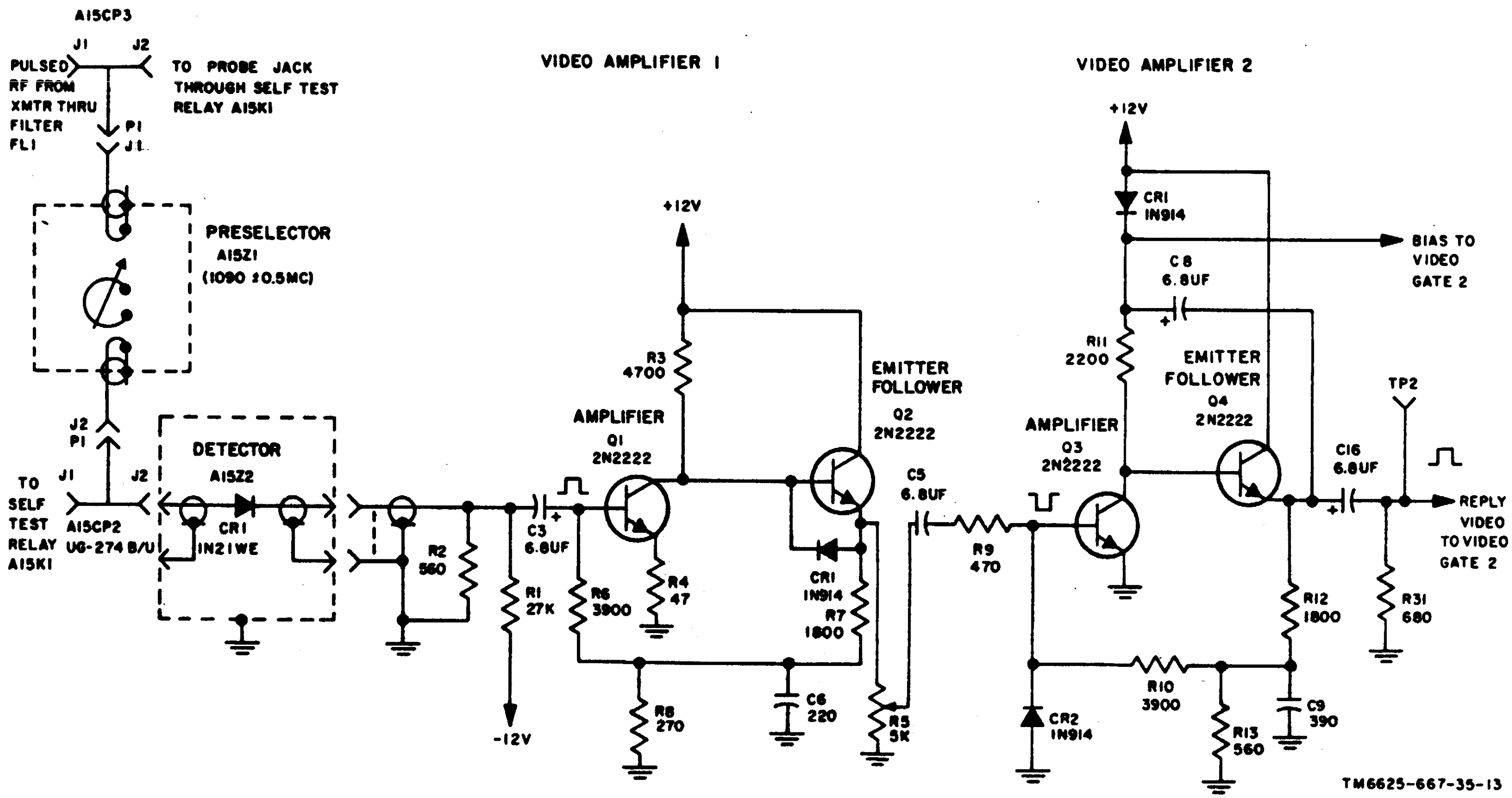


Figure 2-12. Receiver section, input and video amplifier, simplified schematic diagram.

DFF3/DFF4 during all modes except mode C. The reset operation for mode C is initiated by a 25-microsecond delayed M3 timing pulse from delay line A6DL1. Functioning of the video reset operation and the means of obtaining the M1 and M3 timing pulses are described in (1) through (4) below. Functioning of the. comparator-pulse generator is provided in c below.

(1) *M1/M3 timing pulses.* Line-drive enable DFF1, initially set by the decode-enable pulse, provides the positive enabling voltage to line-drive gate 1 (fig. 8-4). An F1 positive pulse from video shaper DSS1 (para 2-13c) is then gated by line-drive gate 1 and inverted. The resultant negative pulse is gated and inverted by line-drive gate 2 to provide a positive output pulse coupled by delay-line driver A10Q7 to drive delay line A6DL1. The positive pulse is also routed to reset line-drive enable DFF1. This action causes the 1 output of DFF1 to go low, thereby, removing the enabling voltages from line-drive gate 1. For all modes, except mode C, 22 microseconds after the pulse is applied to A6DL1, the pulse is coupled by MODE switch A15S5-H to M1/M3 amplifier A10Q8/A10Q9. The 22-microsecond delayed positive output of this circuit is called the M1 pulse. The trailing edge of the positive M1 pulse again sets line-drive enable DFF1, and triggers DFF3 of the counter. During mode C, the 25-microsecond tap is coupled by MODE switch A15S5-H to the M1/M3 amplifier. This timing pulse is identified as M3 and is used to reset video enable DFF6 during mode C tests.

(2) Systems tests. During all system tests, exrept mode C, the action of line-drive enable DFF1 only is used to conclude the receiver gate period. When DFF1 is set by the trailing edge of the positive M1 pulse. its 1output (A9Q7) goes high and its 0 output (A9Q6) goes low. The negative-going 0 output is coupled by MODE switch A15S5 and FUNCTION switch A15S6 to reset video enable DFF6 (fig. 8-3). In this state, the DFF6 1 (A9Q2) output is low and disables video gate 2, concluding the receiver gate period. During mode *C* tests the M3 timing pulse (delayed *25* microseconds) resets DFF6 and thereby disables video gate 2.

(3) Identity *(except mode 1).* During the identity tests, line-drive enable DFF1 and counter DFF3/DFF4 control video enable DFF6. The 1 outputs of DFF1 and DFF3 are connected to the input of the train+ I/P reset gate. The output of this reset gate is connected through the MODE and FUNCTION switches to the reset (C1) input of video enable DFF6. The 22-microsecond delayed M1 pulse simultaneously triggers the counter and sets DFF1. Since both circuits were in a reset state, their 1 outputs go high. The *train* + I/P reset gate is gated on and its output goes high. This action does not affect DFF6 since its reset (C1) input requires a negative-going signal. The high 1 output of DFF1 also enables line-drive gate 1. Approximately 24 microseconds after the F1 pulse, an I/P pulse arrives and is gated by line-drive gates 1 and 2. The positive output of gate 2 is coupled by delay-line driver A10Q7 to reset DFF1. Thus, the enabling voltage to the reset gate goes low and causes the train + I/P reset gate output to go low. This action, in turn, resets video enable DFF6 and ends the receiver gate period by removing the enabling voltage from video gate 2.

(4) *Mode 1 identity and emergency tests (fig. 8-3).* During mode 1 identity and emergency tests, counter DFF3/DFF4 *is* used to reset video enable DFF6. The 1 output of DFF3 and 0 output of DFF4 are connected to the mode 1 I/P reset gate for mode 1 identity tests. The 1 outputs of both counter sections are connected to the emergency gate. The gate output is connected to the reset (C1) input of DFF6 through the FUNCTION switch. Since *a* mode 1 identity reply consists of two pulse training two line-drive pulses are counted in this operation. In emergency operation, four line-drive pulses are counted. The first 22-microsecond delayed M1 pulse triggers the counter and sets DFF1 as in the other tests described above. In this state, the counter section DFF3 1 output. is high and the DFF4 0 output is high, For mode 1 identity operations, this establishes a high output through the mode 1 identity reset gate, at the reset (C1) input of video enable DFF6. Then, 22 microseconds later the second Ml pulse causes the DFF3 1 output to go low. This act ion triggers counter section DFF4 and causes its 0 outputs to go low. The gating voltage is removed from the mode 1 identity reset gate and

the output goes low and resets video enable DFF6. In emergency operation the first two M1 pulses have no effect on the emergency gate. When the third M1 pulse triggers counter section DFF3, its 1 output again goes high. A positive-going voltage does not trigger counter section DFF4; therefore, the 1 outputs of both sections are high and gate on the emergency reset gate. A fourth M1 pulse again triggers the counter, causing both sections to go to a reset state. Thus, the gating voltages are removed from the emergency reset gate, and video enable DFF6 is reset.

c. Comparison Pulse Generation (fig. 8-4).

(1) *Line-drive enable DFF2 and delay line A6DL1.* The line-drive enable DFF1 controls the decoder line-drive pulses. It permits only the F1 reply pulses from video shaper DSS1 (receiver sect ion) to pass. Initially set by the decode enable pulse, the 0 output (A9Q6) of linedrive enable DFF1 is low and the 1 output (A9Q7) is high. In this state, the 1 output enables line-drive gate 1, and the positive F1 reply pulse from DSS1 is then gated. The gated pulse is coupled by line-drive gate 2 and delay-line driver A10Q7 to delay line A6DL1, and fed back to reset DFF1 for the purpose of disabling line-drive gate 1. As the pulse flows down A6DL1, 12 information pulses, an F2 pulse and an identity pulse are developed. Each information pulse is coupled by an emitter follower to the respective CODE selection switch (A, B, C, or D). Figure 8-4 shows these switches set for code 7777, and all 14 pulses of A6DLl are available. During mode 1 identity test the delay-line I/P pulse output is used as an F1 pulse for comparison with the second F1 pulse of the second pulse train. Two pulse trains are produced in the delay line during this test since the delayed M1 pulse again sets DFF1. Thereby, the second F1 only pulse is gated to the delay line, producing the second group of information pulses and the F2 pulse. During emergency tests this operation is extended, because four F1 replay pulses are used to obtain the necessary train plus three sets of F1 and P2 pulses The M1 pulse sets DFF1 each time to permit gating of each subsequent F1 reply pulse. In this test three I/P pulse outputs of the delay line are used as the last three F1 comparison pulses. All pulses are applied to delay-line ouput amplifier A10Q10 and Q11, then gated by the delay-line output gate to comparison pulse shaper DSS2.

(2) *Comparison pulse shaper DSS2.* Comparison pulse shaper DSS2 shapes the delay-line pulse output. Each delay-line pulse triggers DSS2, which simultaneously produces both a positive- and negative-going 0.5-microsecond pulse (fig. 8-4). Comparison pulse shaper DSS2 is a one-shot multi vibrator containing transistors A11Q3 and A11Q4, with A11Q3 the normally conducting stage. The negative-going pulse is taken from A11Q3, and the positive-going pulse is taken from A11Q4. The outputs are applied to error gates 1 and 2 of the error detector (d below).

d. Error Detection Circuit.

(1) Error gates 1 and 2 form a coincidence circuit (fig. 8-5). They detect the coincidence of reply-video pulses with those generated by comparison pulse shaper DSS2. Error gate 1 is connected to the normally low 1 output of video shaper DSS1 and comparison pulse shaper DSS2. Error gate 2 is connected to the normally high (0) outputs of these shapers Error gate 1 will normally be in an on state, while gate 2 will be in an off state. Also because both gate outputs are connected together, an effective zero-reference output is established. With this arrangement, a change in state of only one gate causes the common output to go high. One gate must be off while the other gate is on to obtain the common zero-reference output. During error detect ion, the gates perform as shown in the chart below. Reference time A represents the condition before any pulses are present. Reference time B indicates the condition caused by the arrival of the DSS1 pulse. Reference time C indicates the coincidence of the pulses from DSS1 and DSS2. Reference time D is the result of the trailing edge of the DSS2 pulse. Reference time E is the result. of the trailing edge of the DSS1 pulse. Two positive pulses are produced during reference times A through E.

Reference time	Error gate 1 input		Error gate 2 input		Common output level
	DSS1	*DSS2*	*DSS1*	*DSS2*	
A-----	High	High	Low	Low	Zero reference.
	Low	High	High	Low	High.
B------	Low	Low	High	High	Zero referance.
D----	Low	High	High	LOW	High.
E-----	Low	Low	High	High	Zero reference.

(2) A typical reply pulse and its acceptable spacing test limits are illustrated in figure 2-13 under the Accept, condition column. Assume the C1 reply pulse arrives early. Under these conditions, error gate 2 is disabled by the Cl reply pulse. Its output then causes the zero-reference level to go high. The duration of this condition depends on the actual position of the reply pulse. If this pulse is missing, the period will be 0.5 microsecond. If the pulse is present, the period equals the deviation in pulse spacing from the nominal value. When the pulses at error gate 1 coincide, its output goes low. Thus, the common output returns to the zero reference since the gate 2 output is high. The duration of each resultant positive error pulse for an accept condition is within 0.15 microsecond, and that for a reject condition is greater than 0.35 microsecond. These conditions are sensed for a readout ((3) below).

(3) The leading edge of each positive error pulse, developed by error gates 1 and 2, triggers pulse generator DSS3 (fig. 8-5). Pulse generator DSS3 produces a negative-going 0.35-microsecond pulse for each trigger. The error pulses are also gated by error gate 3 and coupled by inverter A11Q9 and Q10 to error gate 4. Note that error gate 3 is inhibted during the first F1 pulse time of each type of reply (para 2-5d). Error pulses will arrive at error gate 4 in coincidence with the negative 0.35-microsecond pulse from DSS3. If the duration of each positive error is less than the negative 0.35-microsecond pulse from DSS3, error gate 4 remains off. When either positive error pulse duration is greater than 0.35 microsecond, error gate 4 is gated on (fig. 2-13). The negative pulse output of error gate 4 sets readout memory DFF5.

e. Readout Circuit.

(1) The readout circuit effectively provides the results of each interrogation receiver cycle to the reply evaluator (f below). The state of readout memory DFF5 is the result of each test cycle and protides a readout of the reply evaluator. Readout memory DFF5 is a flip-flop multivibrator consisting of transistors A12Q2 and A12Q3. When DFF5 is in a reset state, the 1 output is low and A12Q3 is conducting. The flip-flop multivibrator is initially reset by the decode-enable pulse produced by the encoder P3 (last) interrogation pulse. Either a trigger from read delay DSS5 (fig. 8-5) or a pulse from the error detection circuit causes a change in state.

(2) Read delay DSS5 is triggered by video enable delay DSS4 and produces a negative, 150-microsecond pulse at its 0 output. The trailing edge of this pulse is gated by the readout gate when error blanking DFF2 is reset. When a reply is correct, this trigger sets DFF5, since it is initially in a reset state. The 1 output then goes high until the next decode-enable pulse resets DFF5. This set period is relatively long. If a reply is incorrect, the error detection circuit sets DFF5 before the read-delay trigger arrives. Since DFF5 is now set, the arrival of the read-delay trigger causes it to go in a reset state; therefore, a relatively long reset state is established. The 1 output of DSS5 is coupled to the reply evaluator (f below) through MODE switch A15S5-B. The reply evaluator senses the state of DFF5 by this output and provides a test indication after a predetermined period. Read delay DSS5 also inhibits receiver video gate 2 after 150 microseconds (para 2-14b).

f. Reply Evaluator. The reply evaluator (fig. 8-5) senses the number of correct replies within approximately 50 prf periods (approximately .1 second). It then provides either a rejector an accept output, depending on the information received from the readout circuit. A voltage integrator consisting of resistor A12R18 and capacitor A12C8 is used to sense the output from readout memory DFF5. Schmitt trigger A12Q51Q6 is controlled by the voltage integrator. This trigger circuit has 0 (A12Q5) and 1 (A12Q6) outputs. Control A12R19 is preadjusted for a trigger level corresponding to a specific charge level of A12C8. The state of readout memory DFF5 during 50 prf periods determines the charge-discharge cycle of the voltage integrator. When a reply is correct, the high (1) output of DFF5 causes the input inverter (A12Q4) to conduct for a comparatively long period. The junction of resistors A12R17 and A12R18 will go low and capacitor A12C8 discharges through A12R18. When 80 percent or more replies are correct during 50 prf periods, A12C8 discharges to a level that causes the 1 output of the Schmitt trigger to go low. Thus, the accept gate is gated on and causes the accept emitter follower to conduct through ACCEPT indicator A15DS1. If a reply is incorrect, the low 1 output of DFF5 has no effect and the emitter-follower output is high; thus, capacitor A12C8 is charged through A12R18 for this period. When 50 or fewer replies are correct., the capacitor is charged to a high level and causes the 0 output of the Schmitt trigger to go low. The reject gate is gated on and causes the reject emitter follower to conduct through REJECT indicator A15DS2. Note that 50 to 80 percent correct replies can cause alternate triggering of the Schmitt trigger. This in turn will result in alternate accept and reject indications.

2-15. Plus 28-Volt Dc Supply, Stage Analysis (fig. 8-6)

The +28-volt dc power supply provides the main B+ power to the test set. It is a conventional bridge rectifier, with diodes A15CR1 through A15CR4 providing the rectification. The 115-volt ac, primary power source is applied from the POWER jack through POWER switch A15S3 to stepdown transformer T1. The rectified +28 volts dc is coupled by inductor 1.1 to the test set modules. Regulator diode A 15VR1 provides regulation.

2-16. Twelve-Volt Regulator Module A13, Stage Analysis (fig. 8-6)

This module contains two separate regulates a + 12-volt and a – 12-volt circuit. The circuit perform as follows:

a. + 12-Volt Regulator. This regulator consists of transistors Q1, Q2. and Q8. Transistor Q1 is the series power regulator stage. Assuming a constant 28-volt input is present, Q1 provides and effective 16-volt drop in the line since it is in series, This results in a 12-volt emitter output, and its conduct ions is regulated by stage Q3. This stage (Q3) is normally conducting and the collector output is coupled to the base of Q1 by emitter follower Q2. The bias of Q3 is held constant by the emitter-base bias arrangement. The emitter voltage of Q8 is held at 4.7 volts by regulator diode VR2. Base bias is held at 5.3 volts by regulator diode VR3 and resistor R5. Diodes CR1 through CR5 in the base circuit serve as a series clamp. An increase in the +28-volt input voltage increases the conduction of Q3 through load resistors R2 and R3. This action decreases the collector voltage of Q3 and the cor-

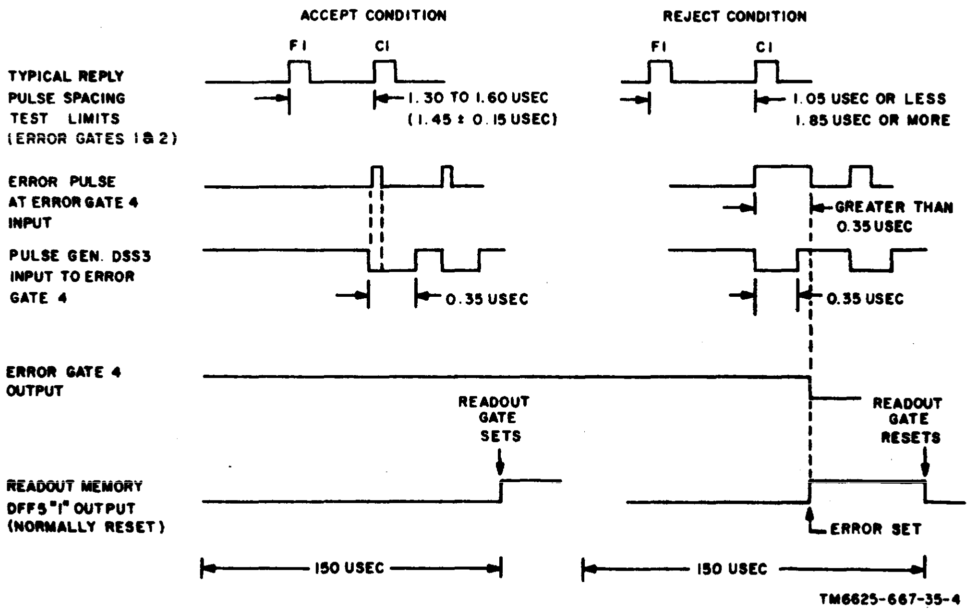


Figure 2-13. Error dectection timing diagram.

responding voltage change is coupled by Q2 to the base of Q1, decreasing the conduction of Q1, and effectively increasing the voltage drop across it. A decrease in the input voltage will cause an opposite effect. Stage Q3 will conduct less and cause Q1 to conduct more, and the voltage drop of Q1 will then decrease. These voltage changes are proportional to the input voltage change. Thus, the emitter voltage of Q1 is maintained at 12 volts. Regulator diode VR1 serves as overload protection for Q1. If the regulator output lend increases abnormally, VR1 provides a current path to the input voltage source. Its conduction through resistor R2 decreases the conduction of Q3 and of Q1 in turn.

b. – 12-Volt *Rcgulator.* This regulator uses a – 18-volt input from the 150-volt. dc power supply (module A14). A sing]e transistor stage (Q4) is used. which is always conducting through R8. Its base bias is regulated by the action of diode CR6 and regulator diodes VR4 and VR5. This arrangement maintains constant emitter conduction through R8, which provides a 6-volt drop. Thus, a regulated – 12-volt. out put is taken from the emitter of Q-1.

2-17. Dc Power Supply Module A14, 150-Volt, Stage Analysis (fig. 8-6)

a. General. The 150-volt dc power supply module is a dc-to-dc converter type find provides 150 volts dc and – 18 volts dc. Input power for this unit is provided by the +28 volts dc from either the 28-volt. power supply or an external 28-volt source. Two oscillator circuits, containing transistors Q1 through Q4 and common transformer T1, generate a square wave voltage. This square wave voltage is transformer-coupki to two full-wave bridge rectifiers. Diodes CR1 through CR4 form a full-wave bridge rectifier circuit. to provide – 18 volts dc. Diodes CR5 through CR8 form the 150-volt dc bridge rectifier. Ripple components on the 150-volt dc line are reduced by a resistive-capacitive filter circuit composed of resistors R.5 and R6 and capacitors C8 and C9. A regulator circuit is used to control the 150-volt dc output by controlling the voltage to the square wave oscillators.

b. Square Wave Oscillator Functioning. Two saturable-core type square wave oscillator circuits produce the square wave voltage. Transistors Q1 and Q2 form one oscillator and transistors Q3 and Q4 the other. The operating voltage of the oscillator circuits is supplied by the +28-volt input. One transistor in each oscillator conducts and forms the first one-half cycle of the square wave. The second transistor in each oscillator conducts and forms the second one-half cycle. Oscillation depends primarily on the characteristics of transformer T1 and the value of the dc voltage input to the transistors. Changes in transistor collector-emitter currents, and currents flowing in the primary windings of the transformer, cause changes in transformer flux. This changing flux generates voltages in the feedback and output. windings of the transformer. Voltages from the feedback windings provide the regenerative action required to maintain oscillation. The output voltage from the oscillators is a square wave and is coupled by separate windings to the bridge rectifiers.

c. 18-Volt and 150-Volt Dc Bridge Rectifier Functioning. The rectified output of the – 18-volt bridge rectifier is applied to the – 12-volt regulator in module A13. The rectified output of the 150-volt dc bridge rectifier is applied to the transmitter (A16) also used to control the input voltage regulator.

d. Input Voltage Regulator Functioning. This regulator consists of transistors Q5, Q6, and Q7. It regulates the operating voltage of the saturable-core, square wave oscillators. The 150-volt bridge rectifier output is sensed at the base of Q7 through resistors R7 and R8. The regulator output is adjusted with R8. A change in the 28-volt dc input will cause a corresponding voltage change at the bridge rectifier. A voltage increase causes Q7 to conduct through R11 and decreases the conduction of Q5 nnd Q6. Thus, the emitter of Q5 goes low and effectively maintains the 28-volt input to oscillator Q3/Q4. A decrease in the X1-volt input will cause the opposite condition. Conduct ion of transistor Q7 will decrease, hereby increasing the conduct ion through Q5 and Q6. The emitter output of Q5 goes high and maintains the 28-volt input to the oscillator.

CHAPTER 3
TROUBLESHOOTING

Section I. GENERAL TROUBLESHOOTING TECHNIQUES

NOTE

See Section III When Using AN/TPM-25A.

3-1. General Instructions

Troubleshooting at general support and depot maintenance categories includes all techniques outlined for organizational maintenance and any special or additional techniques required to isolate a defective part. Section II of this chapter provides intra-unit (within the unit localizing and isolating techniques to be used at the general support maintenance category.

3-2. Organization of Troubleshooting Procedures

a. General. The first step in servicing a defective test set is to sectionalize the fault. Sectionalization means tracing the fault to a particular module or subassembly (for example, encoder module A4 or transmitter A16). The second step is to localize the fault. Localization means tracing the fault to a defective stage or circuit responsible for the abnormal condition. The third step is isolation. Isolation means locating the defective part or parts.

b. Sectionalization The daily maintenance checks and services (TM 11-6625-667-12). provides a satisfactory means of determining whether the transponder test set may be operating. Because of the nature of the self test operation, the exact cause of an internal fault cannot be determined with this chart. The test set provides only an accept or reject indication; therefore, one or more internal circuits can cause an improper indication. To simplify the location of a fault, consider that there are four main functional sections in Test Set TS-1890/APM-123(V). These functional sections include the power supply, transmitter, receiver, and decoder. The first step in tracing trouble is to determine the module or subassembly of the section that contains the fault.

(1) *Visual inspection.* The purpose of visual inspection is to locate faults that may be evident without testing or measuring. This includes broken wires, bent or corroded connector pins, damage circuit boards, or loose rf jacks and plugs. All possible visible inspections should be performed before attempting operational tests.

(2) *Sectionalization tests.* The sectionalization tests are operational type tests and frequently indicate the general location of trouble. In some instances, the tests will help in determining the exact nature of the fault. Tests are given in paragraph 3-4.

c. *Localization.* Localization procedures should be performed after the trouble has been sectionalized *(b* above. Localization procedures applicable to this equipment are described in paragraphs 3-5 and 3-6, and should be used in localizing the trouble to a stage in the suspected module or subassembly.

d. Isolation Procedures for isolating troubles are given in paragraph 3-7.

e. Techniques. When performing the sectionalization para 3-4), localization, and isolation procedures, one or more of the techniques described below may be applied. Apply these techniques only as indicated, and observe all cautions.

(1) *Voltage measurements.* This equipment is transistorized. When measuring voltages, use tape or sleeving (spaghetti) to insulate the entire test probe, except for the extreme tip. A momentary short circuit can ruin a transistor. Use the same or equivalent electronic multimeter specified on the voltage and resistance diagrams.

NOTE

Modules A4, A5, and A7 through A12 contain digital circuits. Do not attempt to analyze their operation with voltage indications. Analyze their operation with the waveforms shown in figures 8-17 through 8-23.

(2) *Resistance measurements.* Make resistance

measurements in this equipment only as directed on the voltage and resistance diagrams. For transistorized circuits, use only the ohmmeter ranges specified on figures 3-8 through 3-18; otherwise, indications will be inaccurate.

CAUTION

Before using any ohmmeter to test transistors or transistor circuits, check the open circuit voltage across the ohmmeter test leads. Do not use the ohmmeter if the open circuit voltage exceeds 1.5 volts. Also, since the RX1 range normally connects the ohmmeter internal battery directly across the test leads, the comparatively high current (50 ma or more) may damage the transistor under test. As a general rule, the RX1 range of any ohmmeter should not be used when testing low-power transistors.

(3) *Waveforms. Signals* associated with digital circuits are illustrated with waveforms, Unless otherwise specified, pulse duration is a secondary consideration, Important pulse durations are specified as nominal values when applicable. Test point pulse amplitudes are not shown, since they all range between 7 and 12 volts. Waveforms shown for the transmitter output specify all characteristics of the pulses except the levels, which are determined by power measurements of the transmitter output.

NOTE

When pulse duration is specified, it is measured between the 50-percent points of the waveform. Pulse spacing is measured between the 50-percent points of the leading edges of the specified pulses.

(4) Test points. All electrical subassemblies of the test set are equipped with test jacks to facilitate connection of test equipment (para 3-4 b). These test jacks should be used whenever possible to avoid needless disassembly of the equipment. The test points are shown on the schematic diagrams. Figure 8-36 illustrates the waveforms for certain test points. Physical location of the test points is shown in figure 3-6. Test point (TP) numbers are color coded and can be identified by the standard RETMA color code as indicated in the charge below:

Test point color	Test point number
Brown	1
Red	2
Orange	3
Yellow	4
Green	5
Blue	6
Violet	7
Gray	8
White	9

(5) *Extender board.* Measurements to be made at points other than at the test jacks require the use of an extender board (fig. 3-6). The extender board is designed so that 11 connections are symmetrically placed on each side of center. Because of the symmetrical design, insertion of the extender board right side up or wrong side up will not mechanically or electrically affect the circuit. However, *plug-in boards* inserted in the extender board must be inserted exactly the same as originally positioned in the equipment.

(6) *Resistor, capacitor, and diode color code diagrams.* Color-code diagrams for resistors, capacitors, and diodes (figs. 8-0.1 and 8-0.2) provide pertinent resistance, voltage rating, and tolerance information.

CAUTIONS

Make sure that no metal objects (screwdriver, pliers, etc.) come in contact with the printed circuit board while power is applied. A short circuit of the wiring could damage the solid-state circuit elements mounted on the board.

Be certain both the extender board and plug-in board are properly installed in their respective sockets.

3-3. Test Equipment and Tools Required

The following chart lists the test equipment (a below) for general support maintenance of Test Set. Transponder AN/APM-123(V). The associated technical manuals are also listed. Tools are listed in *b* below.

CAUTIONS

Make test equipment connections carefully to avoid short circuits that can be caused by exposed test equipment connections. Tape or sleeve test probes or clips, as necessary; leave only sufficient metal exposed to make contact to the circuit under test.

The power must be turned off when a circuit card is to be removed or inserted in the extender card. The card must be inserted in the extender receptacle before power is reapplied to the test set.

Do not use test cables with exposed (braided shields. Use jacketed cables to avoid short circuits where the cables must pass over the circuit cards and other subassemblies.

a. Test Equipment Required

Test equipment	Technical manual
Oscilloscope, AN/USM-281A	TM 11-6625-1709-15
Frequency Meter AN/USM-207	TM 11-6625-700-10
Modulator (MD-796) (pin diode type modulator preserves pulse risetime and falltime to at least 25 nanoseconds.	
Attenuator, Fixed (FSN 5905-781-0312).	
Generator, Signal AN/URM-64A	TM 11-6625-299-15
Multimeter ME 26B/U	TM 11-6625-200-15
Multimeter TS 352B/U	TM 11-6625-366-15
Test Set, Crystal Rectifier TS 268/U	TM 11-1242
Test Set, Electron Tube TV 7/U	TM 11-6625-274-12
Test Set, Radar **AN/UPM-98**[ab]	TM 11-6625-403-14
Test Set, Radar AN/UPM-137A[a]	NAVELEX 0969-158-1010 NAVAIR 16-30 UPM-1337-6-1 AIR FORCE T.O. 33A1-3-426-21-1 NAVELEX 0969-158-1020 NAVAIR 16-30UPM-137-6-2 AIR FORCE T.O. 83A1-3-426-21-2
Test Set Transistor TS 1836/U	TM 11-6625-539-15
Wattmeter **AN/URM-98**[c]	TM 11-6625-433-15
Comparator, Frequency CM-77A/USM	TM 11-6625-493-15

[a]Either the AN/UPM-98A or AN/UPM-98B may be used for all procedures.

[b]If the Test Set, Radar AN/UPM-137A is used, the Oscilloscope AN/USM-182 and Test Set, Radar AN/UPM-98 are not required.

[c]Includes summation Bridge TS 779A/U and Waveguide Probe MX-2144A/U.

b. Tools.

(1) Repair Kit, Printed Wiring Board MK-722/U.

(2) Tool Kit, Electronic Equipment TK-100/G.

3-4. Sectionalization Tests

WARNING

Be extremely careful when working around the 115 volt AC power connections. Serious injury or death may result from contact with these terminals.

a. General. Sectionalization tests are performed to sectionalize a fault to a module or subassembly. These tests are an extension of the operational tests in the daily maintenance checks and services chart (TM 11-6625-667-12). Two sectionalization tests are provided, the first used Radar Test Set AN/UPM-98A or AN/UPM-98B and the second uses Radar Test Set AN/UPM137A.

b. Test Setups. A test setup is provided for each type of test (fig. 3-5 for sectionalization tests using AN/UPM-98A or AN/UPM-98B and fig. 3-5.1 for sectionalization tests using AN/UPM-137A). Instructions for making primary power connections are in TM 11-6625-667-12. During the sectionalization tests, the required setup is referred to and test conditions noted. Refer to figure 3-6 for physical location of the test points. Test steps must be performed in the order given to ensure proper equipment connections and test conditions.

Instructions are provided in the charts for using the test equipment. These instructions, however, should be supplemented with the instruction manual applicable to the test equipment. Before preceding with a test setup, remove the trans ponder test set from its case and remove the card cage cover to expose the test points and controls. Proceed as follows:

(1) Unlatch and remove the test set cover.

(2) Remove four hexagonal screws form the front panel with a hexagonal driver. One screw is located above and one below each front panel handle.

(3) Lift the TS-1089/APM-123(V) from the case. A gentle rocking motion maybe necessary.

(4) Set the TS-1089/APM-123(V) carefully on a clean area of the workbench. Position the TS-1089/APM-123(V) for convenient access to both the rear section (test point location, fig. 3-6) and the front panel.

(5) Remove the card cage cover by unfastening the four screws which secure it to the preselector (A15A1Z1) and remove the two screws which secure it to the card cage.

c. Use of Chart. The sectionalization test charts (d and e below) are step by step test procedures with reference to an applicable paragraph which contains a troubleshooting chart covering the probable trouble and required corrective measure to obtain normal indication. Each step should be followed in the order given for effective fault isolation. The Procedure column refers to the applicable test setup and provides instructions for adjusting the equipment for a specific measurement. The Normal indication column specifies the results that should be observed. Waveforms at applicable test points are illustrated in figure 8-36.

d. Sectionalization Tests Using AN/UPM-98.

Step	*Control settings* *Test equipment*	*Control settings* *Equipment under test*	*Procedure*	*Normal indication*	*Paragraph reference*
1	ME-26B/U FUNCTION: (+) RANGE 30V	MODE 1 FUNCTION SYSTEM ISLS: OFF 28 VDC-115 VAC OFF OFF	*a.* Connect the equipment as illustrated in figure 3-1, except for dc probe. *b.* Set the ME-26B/U FUNCTION switch at (+) and turn on the test set. Allow 2 minutes-warmup time. Connect the dc test probe to test point A13TP4. *c.* Deleted. *d.* Connect the ME-26B/U dc test probe to test point A13TP3. Observe the meter indication.	*a.* None. *b.* +28 vdc ± 3. *c. Deleted.* *d. +12* vdc ± 1.	3-6c
2	*ME-26R/U* FUNCTION: (-)	....	Connect the dc test probe to teat point A13TP1 and observe the meter indication.	-12 vdc ±1.	3-6c.
3	*ME-26B/U* FUNCTION: (+) RANGE 300V	....	Connect the dc teat probe to teat point A14TP3 and observe the meter indication.	+150 vdc + 5.	3-6c.
4	*AN/USM-2O7* DIRECT/HETRODYNE Switch: HETRODYNE VOLTAGE switch: 10V FREQ TUNING-MC: 150 FUNCTION: FREQ SENSITIVITY: PLUG IN CM-77A/USM POWER: ON	Same as step 1	a. Turn off the transponder test set and connect the equipment as shown in figure 3-2. *b.* Turn on the AN/USM-207 and CM-77A/USM. Permit a 1-hour warmup period. c. Turn on the transponder test set and permit a 2-minute Warm-up period. Connect A4TP5 to ground. *d.* Press and turn the transponder test set PRESS-TO-TEST switch at LOCK.	*a.* None. *b.* None. *c.* None. *d.* None.	
5	....		*a.* Position the CM-77A/USM FREQUENCY MEGACYCLES control near 206 and adjust the control until the scope on the CM-77A indicates a zero beat. *b.* Note the frequency readout on AN/USM-207. Add 150 to this readout and multiply the re-Sults by 5.	*a.* None. *b.* 1,030 mc ± 206 kc.	3-6d.
6	TS-779A/U BOLO BIAS CURRENT OFF BOLO RES: 200 BOLO TEMP COEF: NEG	Same as step 1	CAUTION The Bolo Bias Current switch must be in the OFF position before connecting the MX-2144A to the TS-779A/U. *a.* Connect the MX-2144/U to the TS-779A/U input. ***b.*** Adjust the TS-799A/U as follows:	*a.* None. *b.* None.	

Step	Control settings: Test equipment	Control settings: Equipment under test	Procedure	Normal indication	Panagraph reference
			(1) RANGE switch at -0 DBM. (2) BOLO BIAS CURRENT switch at 10-16 MA. (3) LINE-POWER switch at ON and permit a 15-minute warmup period. (4) Adjust ZERO SET COARSE and FINE controls to zero meter.		
			c. Connect the equipment as shown in figure 3-3. Be certain test point A4TP5 is grounded.	*c.* None.	
			d. Connect the MX-2144A/U to the transponder test set PROBE jack. Observe the power indication.	*d.* -9 dbm ±1.	
			e. Disconnect the ground from test point A4TP5 and connect A4TP4 to ground. Turn RANGE switch to – 10 DBM.	*e.* None.	
			f. Observe the power meter indication. When finished with this step remove the ground from A4TP4.	*f.* Meter deflects slightly to right (approximately -21 dBm).	3-6d.
7	*AN/USM-281A* POWER: ON Sweep Display Switch: Delayed Delayed Time/Div: 5µsec Main Time/Div: 10µsec Sweep Mode AUTO MAIN SLOPE: - DELAYED SLOPE – DIV DELAY 02 Main Trigger source Switch: EXT DISPLAY A A VOLTS/DIV: 5 A POLARITY:+ Up A Input Coupling Switch: AC	Same as step 1	*a.* Connect the equipment as shown in A, figure 3-4. Turn on the oscilloscope and test set. Permit a few minutes warmup time. *b.* Adjust the oscilloscope HORIZONTAL Position Main Trigger Level INTENSITY, FOCUS, and ASTIGMATISM controls until a clear and stable waveform is observed. . *c.* Set the transpondr test set MODE switch to 1, 2, 3A and C and observewhether a pulse-pair (P1-P3) and low level P2 pulse are present for each mode.	*a.* None. *b.* None. *c.* Pulse-pair (P1-P3) and pulase present for modes 1, 2, 3/A, TEST and C.	3-6d.
8	AN/USM-281A Main Trigger Source: Int. Main Time/Div: 5 µSEC volts/Div: Magnifier X5	Same as step 1	*a.* Connect the equipment as shown in B, figure 3-4. Adjust Main Trigger Level to obtain stable trace. *b.* Measure the pulse widths of the P1, P2, and P3 pulses.	*a.* None .... *b.* P1, P2, and P3 pulse widths 0.8 µ sec ±0.l.	3-6f.

Step	Control Settings: Test equipment	Control Settings: test	Procedure	Normal	Paragraph reference
			c. Adjust the oscilloscope controls in order to measure the spacing between the P1, P2, and P3 pulses.	*c.* Delay between P1 and P2 should be 2 µsec ± 0.2. Delay between P1 and P2 should be µsec ± 0.2.	
			d. Set the test set MODE switch at each of the following positions and measure delays.	*d.* P1-P2 pulse spacing.	
			Mode (1) 2	(1) 5 µsec ± 0.2	
			(2) 3/A	(2) 8 µsec µ 0.2.	
			(3) C	(3) 21 µsec ± 0.2.	
			(4) TEST	(4) 6.5 µsec ± 0.2.	
9	*AN/UPM-98* CODE (A, B, C, D): 7777 FUNCTION: N AMPLITUDE: 2 SUB PULSE SELECT OFF LEVEL: LO PULSE WIDTH: 0.45 WXTAL MARK & SYNC UNIT: SYNC SELECT? -EXT. SUP: Completely CCW POWER ON Trigger Delay 5-50	MODE: 2 CODE (A, B, C, D): 7777 PRESS TO TEST: POWER: 115V	*a.* Connect the equipment as shown in figure 3-5. Connect oscilloscope CHANNEL A to A8TP2. CAUTION Be sure that the TS-656/U Power Supply voltage adjustment se at 0 output or damage to the diodes in the MD-796 will result.	*a.* None.	
	AN/URM-64 POWER ON Signal Frequency: 1065 MC Attenuator: Fully Clockwise		*b. Connect* the output of the AN/URM-64 to the rf input *of* the *MD-796* and the output of the MD-796 to the probe input to the transponder test set.	*b.* None.	
	AN/USM-281A Same as step 7		*c.* Be sure the voltage adjustment on the TS-656 is fully counterclockwise. Turn the POWER switch to ON and adjust the voltage to *0.8 Be sure the* negative lead is connected to the center conductor of cable.	*c.* None.	
	TS-656 POWER OFF Voltage: OFF Function: DC Volts		*d.* Press and turn the PRESS TO TEST knob to the position. The accept light should be on. If it is not, adjust the AN/URM-64 Frequency knob until the transponder test set indcates steady accept. Then adjust the	*d.* None.	

Step	Control settings: Test equipment	Control settings: Equipment under test	Procedure	Normal indication	Paragraph reference
			frequency for maximum signal deflection on the oscilloscope.		
	AN/USM-207 Same as step 4 except the Freq Tuning - MC Switch to: 200		e. Remove the AN/URM-64 output cable from the MD-796 and connect it to the CM-77A as indicated in figure 3-5. Tune the FREQUENCY MEGACYCLES dial for a zero beat indication. Observe the reading on the AN/USM-207. Add 200 to the number and multiply the results by 5.	e. The frequency must be 1090 MC ± 1.	
	TS-779A RANGE: 5 DBM BOLO BIAS Current: 10-16 MA BOLO Temp CDEF: Neg. BOLO Res: 200 r		f. Reconnect the output of the AN/URM-64 to the rf input of the MD-796. Turn the ATTENUATOR control of the AN/URM-64 counter clockwise until the REJECT light just comes on the transponder test set.	f. None.	
			g. Disconnect the output of the MD-796 from the transponder test set at the probe jack. Connect the output from the MD-796 to the MX-2144. Turn OFF the TS-656 and reduce the AN/UPM-98 output to zero. Read the output on the wattmeter.	g. Sensitivity −9 ± 1 dbm.	
			h. Adjust the ATTENUATOR output on the AN/URM-64 until the TS-779A/U indicates −6 dbm. Reconnect the output of MD-796 to the transponder test set. Return the TS-656 POWER switch to ON and adjust the AN/UPM-98 output to the original amplitude setting of 2.	h. None.	
10	....		a. Connect the oscilloscope probe (CHAIN A) to each of the following test points in the order given. Observe whether the pulses are normal.	a. Refer to figure 8-36	
			(1) A10TP5 (video-enable delay)	....	(1) 3-6j.
			(2) A9TP4 (video-enable output)	....	(2) 3-6i.
			(3) A11TP1 (video-shaper output)	....	(3) 3-6k.
			(4) A9TP3 (line-drive enable output)	....	(4) 3-6i.
			(5) A10TP4 (line-drive pulse)	....	(5) 3-6j.
			(6) A10TP2 (delay-line pulses)	....	(6) 3-6j.
			(7) A10TP1 (delay-line main gate input)	....	(7) 3-6j.
			(8) A11TP2 (comparison pulse-shaper output).		(8) 3-6k.

Step	Control settings: Test equipment	Control settings: Equipment under test	Procedure	Normal indication	Paragraph reference
			(9) A10TP6 (read delay)		(9) 3-6j.
			(10) A12TP4 (error blanking)		(10 3-6k.
			b. Check the following dc levels with oscilloscope:	Indications are—	
			(1) A11TP6 (error detector output). Set AN/UPM-98 CODE switches to 7776 to observe low dc level. Return switches to 7777 to observe normal indication.	(1) 7-12 volts dc.	
			(2) A12TP3 (readout)	(2) 7 to 12 volts dc.	
			(3) A12TP1 (reply evaluator accept output).	(3) 7 to 12 volts dc.	
			c. Repeat *a* (2) through (10) above with transponder test set MODE switch at C, 3/A, TEST, and 1, respectively. NOTE If all conditions were normal in *a* above, and an abnormal condition in *c* above is noted, check the MODE switch for continuity.	*c*. Indications should be the same as in *a* above.	
			d. Set the AN/UPM-98 and test set CODE switches to 7700.	*d*. None.	3-6i.
			e. Set the AN/UPM-98 FUNCTION switch to ID and the test set FUNCTION switch to I/P. Connect the oscilloscope probe to test point A9TP4. Observe whether the pulse is normal.	*e*. Waveform in figure 8-36 (A9TP4, I/P).	3-6i.
			f. Set the AN/UPM-98 and test set FUNCTION switch to EMER. Observe whether the pulse is normal.	*f*. Waveform in figure 8-36 (A9TP4, MODE 2-I/P).	3-6i.
			g. Set the test set FUNCTION switch to I/P and MODE switch to 2. Observe whether the pulse is normal.	*g*. Waveform in figure 8-36 (A9TP4, MODE 2-I/P).	3-6i.

e. Sectionalization Tests Using AN/UPM-137A.

Step	Control settings: Test equipment	Control settings: Equipment under test	Procedure	Normal indication	Paragraph reference
1	*ME-26/V* SELECTOR SWITCH: + RANGE 30		**CAUTION** If any indication during steps 1 through 3 appears abnormal due to a short circuit, shut off the equipment and refer to paragraph 3-5. A short circuit may cause further equipment damage.		
		MODE: 1 FUNCTION: SYSTEM ISLS: OFF	*a.* Connect equipment as shown in figure 3-1.l.	*a.* None.	3-6d.
			b. Turn on equipment Allow 5 minutes warmup time. Connect dc test probe to A13TP4.	*b.* +28 ± 3 vdc.	
			c. Connect dc test probe to test A13TP3. Observe meter indication Change ME-26A/U SELECTOR SWITCH to-	*c.* +12 ± 1 vdc.	
			d. Connect the dc test probe A13TPl and observe the meter indication.	*d.* - 12 ± 1 vdc.	3-6d.
2	*AN/USM-207* DIRECT/HETRODYNE switch: HETRODYNE VOLTAGE Switch: 10V FREQ TUNING-MC: 150 POWER: TRACK FUNCTION: FREQ SENSITIVITY: PLUG IN CM-77A/USM POWER: ON	Same as step l	*a.* Turn off the test set and connect the equipment as shown in figure 3-2.	*a.* None.	
			b. Turn on the AN/USM-270A and CM-77A/USM. Permit a l-hour warmup period.	*b.* None.	
			c. Turn on the teat set and permit a 2-minute warmup period,	*c.* None.	
			d. Press and turn the teat set PUSH TO TEST switch to LOCK. On the test set ground TPA4TP5.	*d.* None.	
3	....	....	*a.* position the CM-77A/USM FREQUENCY MEGACYCLES control near 206 and adjust the control until the units display indicates a zero beat.	*a.* None.	
			b. Multiply the AN/USM-207 indication by 5 to obtain the transmitter frequency.	*b.* 1,030 mHz ±206 kHz.	3-6e.
4	TS-779A/U BOLO BIAS CURRENT OFF BOLO RES: 200 BOLO TEMP COEF: NEG	Same as step 1.	CAUTION TS-779A/U BOLO BIAS CURRENT control must be set to OFF before the MX-2144A/U is connected to the TS-779A/U to avoid equipment damage.		
			a. Connect the MX-2144A/U to the TS-779A/U input.	*a.* None.	
			b. Adjust the TS-779A/U as follows:	*b.* None.	

Step	Test equipment	Equipment under test	Procedure	Normal indication	Paragraph reference
			(1) RANGE switch at − 5 DBM.		
			(2) BOLO BIAS CURRENT switch at 10-16 MA.		
			(3) LINE-POWER switch at ON and permit a 15-minute warmup period.		
			(4) Adjust ZERO SET COARSE and FINE controls to zero meter.		
			c. Connect the equipment as shown in figure 3-3. Ground A4TP5 by connecting to A13TP2.		
			d. Connect the MX-2144A/U to the test set PROBE jack. Observe the power indication.	*d.* −9 dbm ± 1.	
			e. Disconnect the ground from A4TP5 and connect A4TP4 to ground.	*e.* None.	
			f. Observe the power meter indication.	*f.* −21 dbm ± 1.	3-6e.
5	*AN/UPM-137* VERTICAL-CHAN A-VOLTS DIV: .5 VERTICAL-CHAN A-AC/DC: AC VERTICAL-CHAN A-75Ω IN/OUT: OUT SYNC: EXT AC	Same as step 1	*a.* Connect the equipment as shown in A, figure 3-4. Turn on the oscilloscope and test set. Permit a few minutes warmup time. Connect oscilloscope to test set A4TP6.	*a.* None.	
			b. Adjust the oscilloscope HORIZONTAL, VERTICAL, INTENSITY, SWEEP DELAY, FOCUS, and ASTIGMATISM controls until a clear waveform is observed.	*b.* None.	
			c. Set the transponder test MODE switch to 1, 2, 3A, and C and observe whether a pulse-pair (P1-P3) and low level P2 pulse are present for each mode.	*c.* Pulse-pair (P1-P3) and P2 pulses present for modes 1, 2, 3/A, TEST and C.	
6	Same as step 5	Same as step 1	*a.* Connect the equipment as shown in B, figure 3-4. Adjust the AM-3174/USM oscilloscope plug-in for X10 GAIN AC, 0.005 volts/CM, operation.	*a.* None.	3-6f.
			b. Measure the pulse widths of the P1, P2, and P3 pulses.	*b.* P1, P2, and P3 pulse widths: 0.8 μsec ± 0.1.	
			c. Adjust the oscilloscope as follows:	*c.* Normal indication are-	
			(1) Adjust the HORIZONTAL control until the 50-percent point of the first pulse leading edge is positioned at the center graticule line.	(1) None.	
			(2) Adjust the DELAY TIME MULTIPLIER control to measure the delay between the 50-percent points of pulses P1 and P2. Multiply dial reading by 2 and note.	(2) Delay between P1 and P2 should be 2 μsec ± 0.15.	

Step	Control settings: Test equipment	Control settings: Equipment under test	Procedure	Normal indication	Paragraph reference
			(3) Adjust the DELAY MULTIPLIER control to measure the delay between pulses P1 and P3 at the 50-percent points of the leading edges. Multiply dial reading by 2 and note.	(3) Delay between P1 and P3 should be 3 μsec ± 0.2.	
			d. Set oscilloscope TIME BASE B TIME/CM to 5.	*d.* None.	
			e. Set the test set MODE switch at each of the following positions and repeat c(3) above to measure delays, except to multiply dial reading by 5.	*e.* P1-P3 pulse spacing.	
			(1) 2	(1) 5 μsec ±0.2.	
			(2) 3/A	(2) 8 μsec ±0.2.	
			(3) C	(3) 21 μsec ±0.2.	
			(4) TEST.	(4) 6.5 μsec ± 0.2.	
	AN/UPM-137A (rf signal generator) OUTPUT ATTEN 0-100 dBm: TRANSMITTER-XMTR FREQ: XTAL TRANSMITTER-CW SOURCE EXT 1090 *(interrogator signa1 simulator)* TRANSMITTER-XMTR FREQ: XTAL (SIS generator) SIF 1 CODER-Code switches (A, B, C, D): 7777 SIF 1 CODER-FUNCTION SEL: N SIF 1 CODER-WIDTH ADJ: approx. center SIF 1 CODER-SUBST PULSE SEL: OFF MIXED VIDEO-MIXED VIII SEL: SIF 1 PRF-RANGE MULT: EXT- TRIGGERS-DELAY TRIG (μSEC) DLY RANGE MULT: X4 TRIGGERS-DELAY TRIG (μSEC) MULT 1-11:6.0 (oscilloscope)	MODE: 2 CODE (A, B, C, D) 7777	*a.* Connect equipment as shown in figure 3-5.1 and turn on AN/UPM-137A and test set. Permit a few minutes to warmup.	*a.* None.	
			b. Press test set PUSH TO TEST switch and turn to LOCK position.	*b.* None.	
			c. If necessary adjust AN/UPM-137A SIS generator TRIGGERS-DELAY (μSEC)-MULT 1-11 control until test set indicates ACCEPT and will indicate REJECT when test . set CODE switches are changed to 7776.	c. None.	
			d. Adjust AN/UPM-137A oscilloscope controls as necessary for a clear display and to perform required measurements.	*d.* None.	

Step	Control settings: Test equipment	Control settings: Equipment under test	Procedure	Normal indication	Paragraph reference
	VERTICAL-CHAN A-VOLT/ DIV: 5 VERTICAL-CHAN B-AC/DC: DC VERTICAL-CHAN-B-75W/ OUT: OUT VERTIAL-CHAN B-VOLT/ DIV: 5 CALIBRATORS-XTAL MARK (µSEC): OFF CALIBRATORS-LEVEL: Midposition				
8	Same as step7	Same as step 7.	*a.* Connect AN/UPM-137A oscilloscope VERTICAL-CHAN A-VIDEO IN jack to following test points in order given. Observe whether pulses are normal.	*a.* Refer to figure 8-36.	
			(1) A10TP5 (video-enable delay).		(1) 3-6j
			(2) A9TP4 (video-enable output).		(2) 3-6i
			(3) A1lTP1 (video-shaper output).		(3) 3-6k
			(4) A9TP3 (line-drive enable output).		(4)3-6i
			(5) A10TP4 (line-drive pulse).		(5) 3-6j
			(6) A10TP2 (delay-line pulses).		(6) 3-6j
			(7) A10TP1 (delay-line main gate input).		(7) 3-6j
			(8) A11TP2 (comparison pulse-shaper output).		(8) 3-6k
			(9) A10TP6 (read relay).		(9) 3-6j
			(10) A12TP4 (error blanking).		(10) 3-6i
			b. Connect AN/UPM-137A oscilloscope VERTICAL-CHAN A-VIDEO IN jack to following teat points in order given. Verify that correct dc levels are present.	*b.* Indications are-	*a.* None.
			(1) A11TP6 (error detector output).	(1) 7 to 12 volts dc.	
			(2) A12TP3(readout)	(2) 7 to 12 volts dc. When REJECT indicator is lighted.	*b.* None.
			c. Repeat a(2) through (10) above with test set MODE switch at C, 3/A, TEST, and 1 respectively.	*c.* Indications should be the same as in a above.	
			d. Set test set CODE switches to 7700 and MODE switch to 2. Set AN/UPM-137A SIS generator SIF 1 CODER-Code switches to 7700.	*d.* None.	
			e. Set AN/UPM-137A SIS generator SIF 1 CODER-FUNCTIONAL SEL switch to I/P and	*e.* Waveform in figure 8-36 (A9TP4).	3-6i

Step	Control settings: Test equipment	Control settings: Equipment under test	Procedure	Normal indication	Paragraph reference
			test set FUNCTION switch to I/P. Connect AN/UPM-137A oscilloscope VERTICAL CHAN A-VIDEO IN jack to test set A9TP4.		
			f. Set AN/UPM-137A SIS generator SIF 1 CODER-FUNCTION SEL switch to EMER and set teat set FUNCTION switch to EMER. Observe whether puke is normal.	*f.* Waveform in figure 8-36 (A9TP4).	3-6i
			g. Set test set FUNCTION switch to I/P. Observe whether pulse is normal.	*g.* Waveform in figure 8-36 (A9TP4).	3-6i

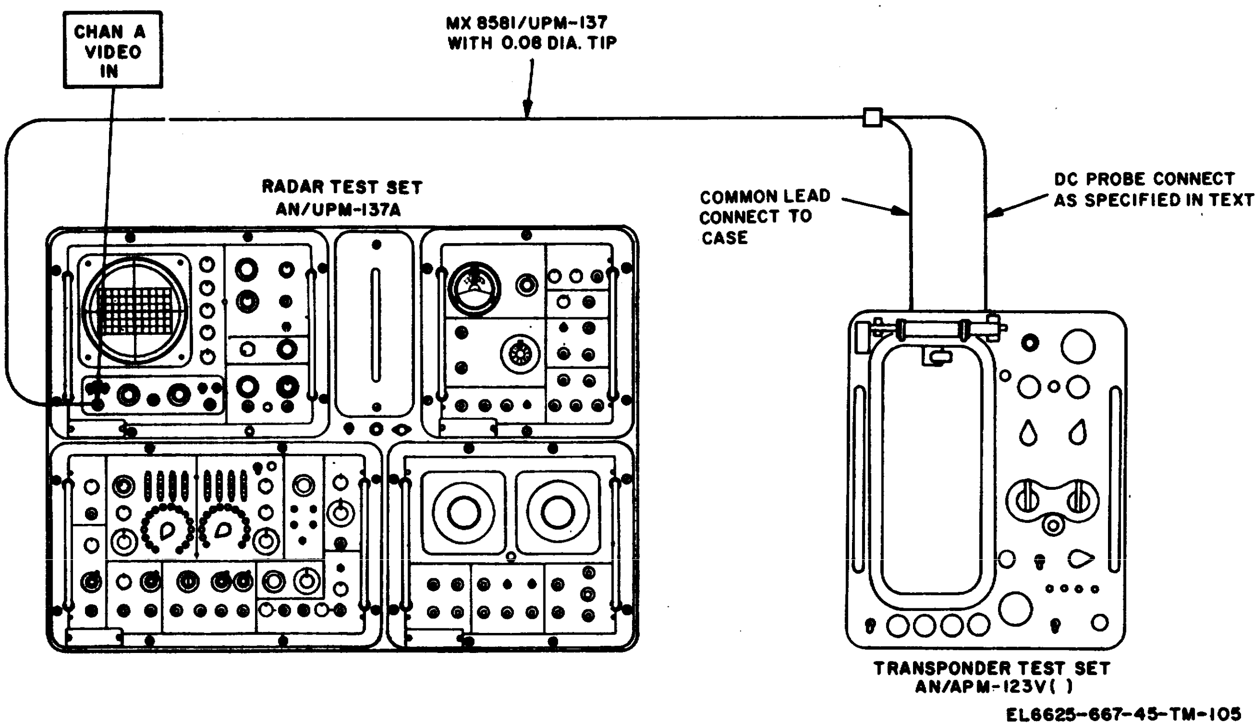


Figure 3-1.1. Power supply test setup using AN/UPM-137A

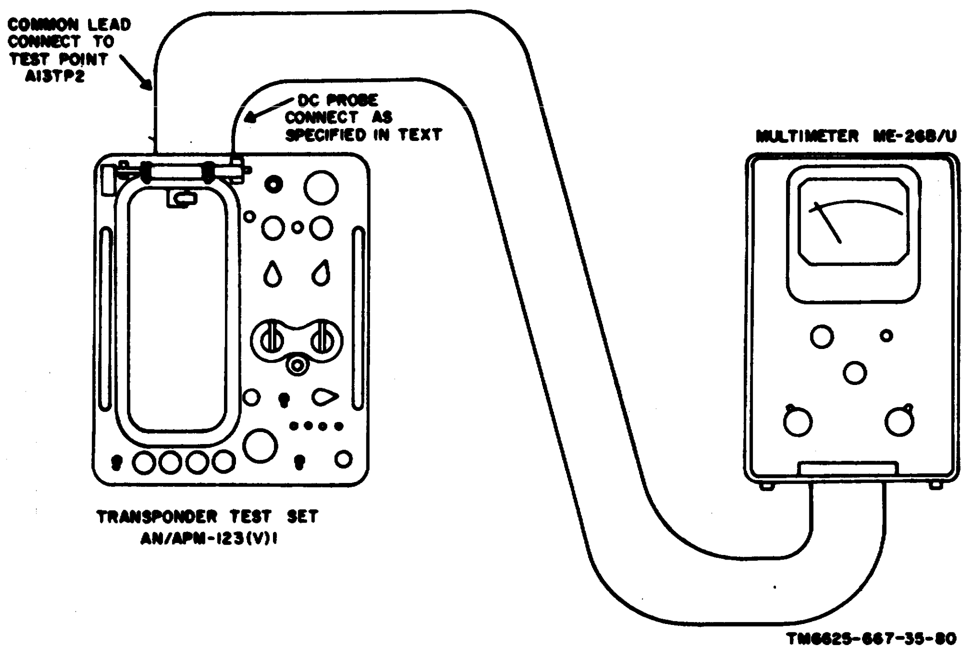


Figure 3-1. Power supply test setup.

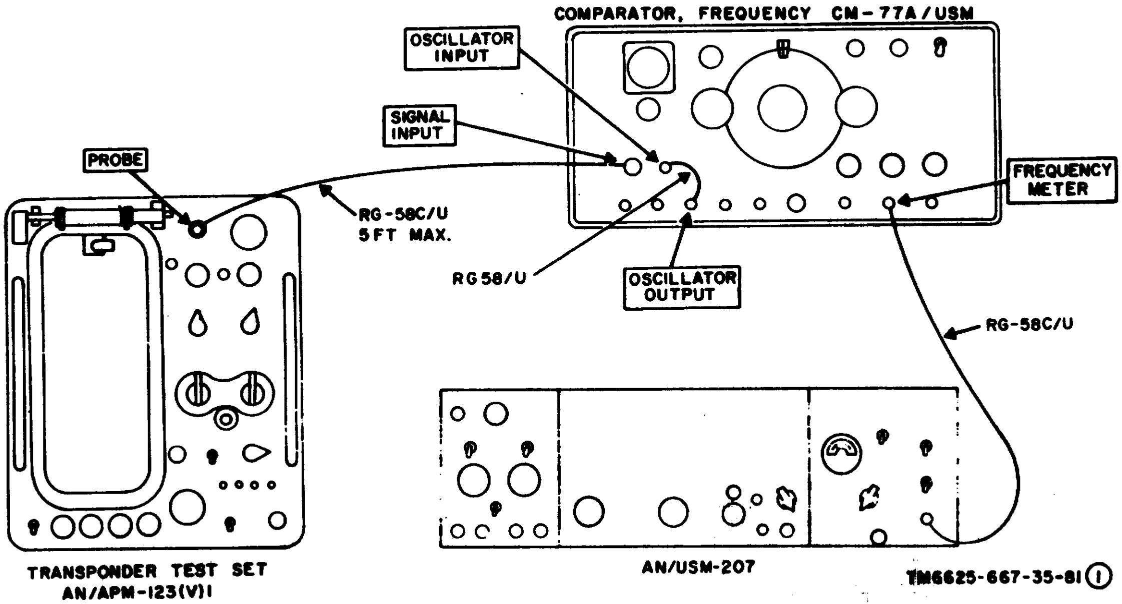


Figure 3-2. Transmitter frequency test setup.

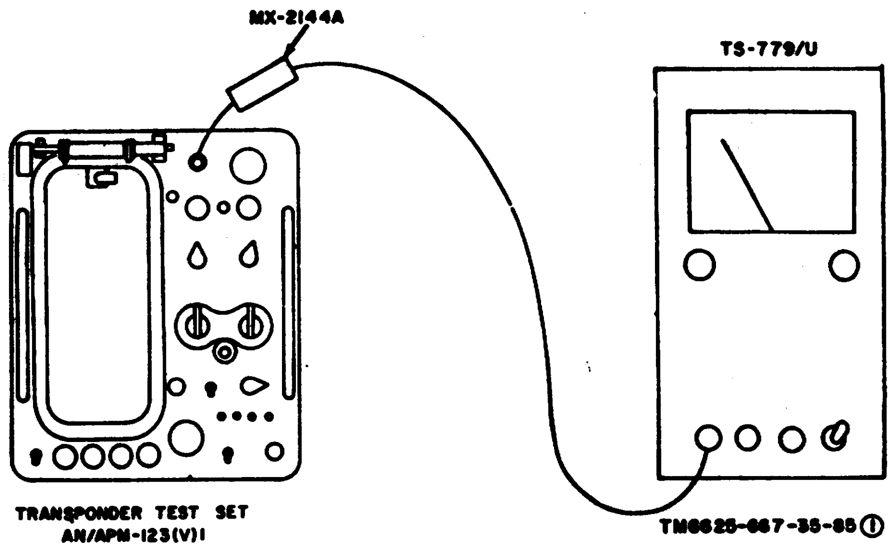


Figure 3-3. Transmitter power test setup.

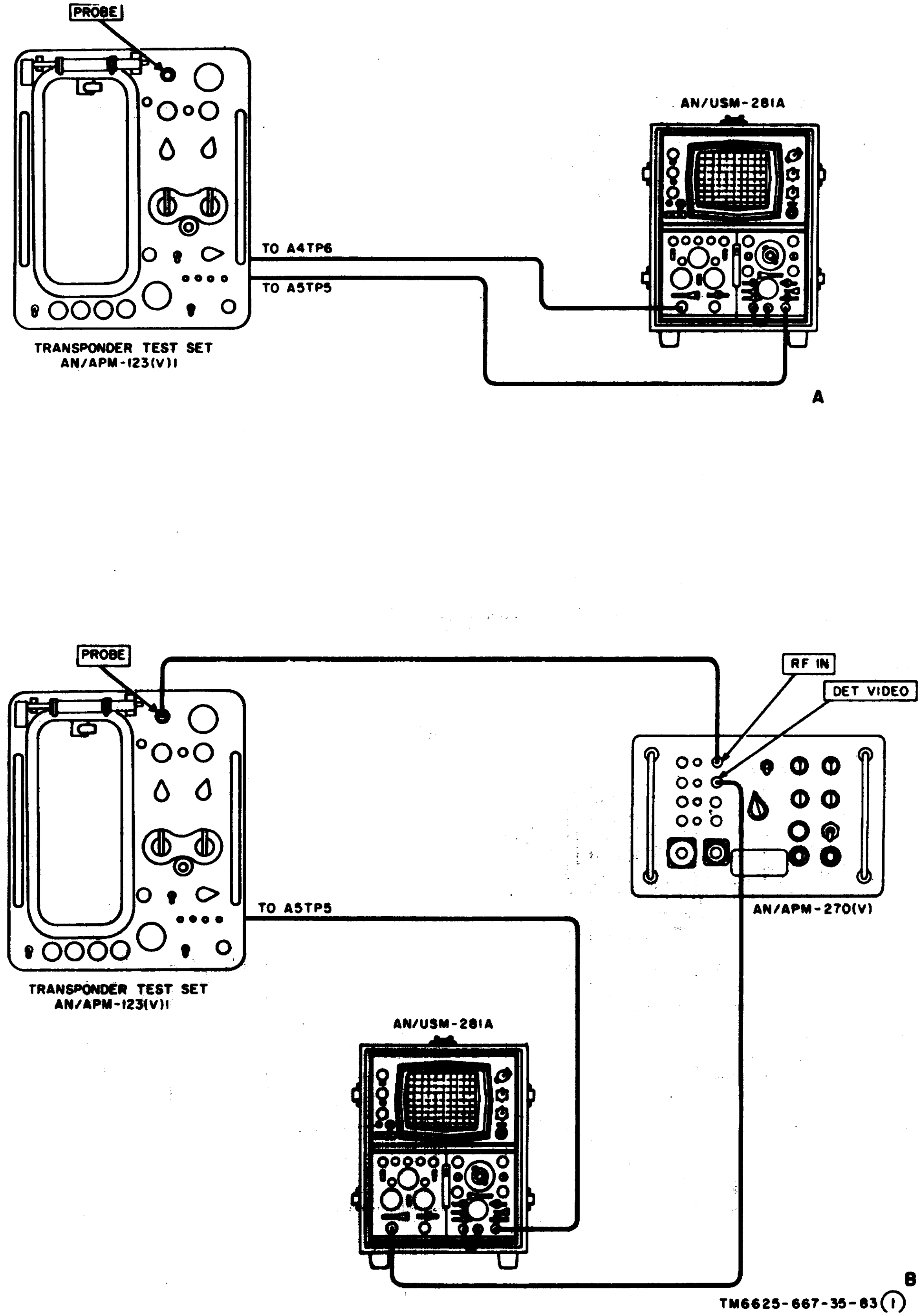


Figure 3-4. Transmitter pulse characteristics test setup.

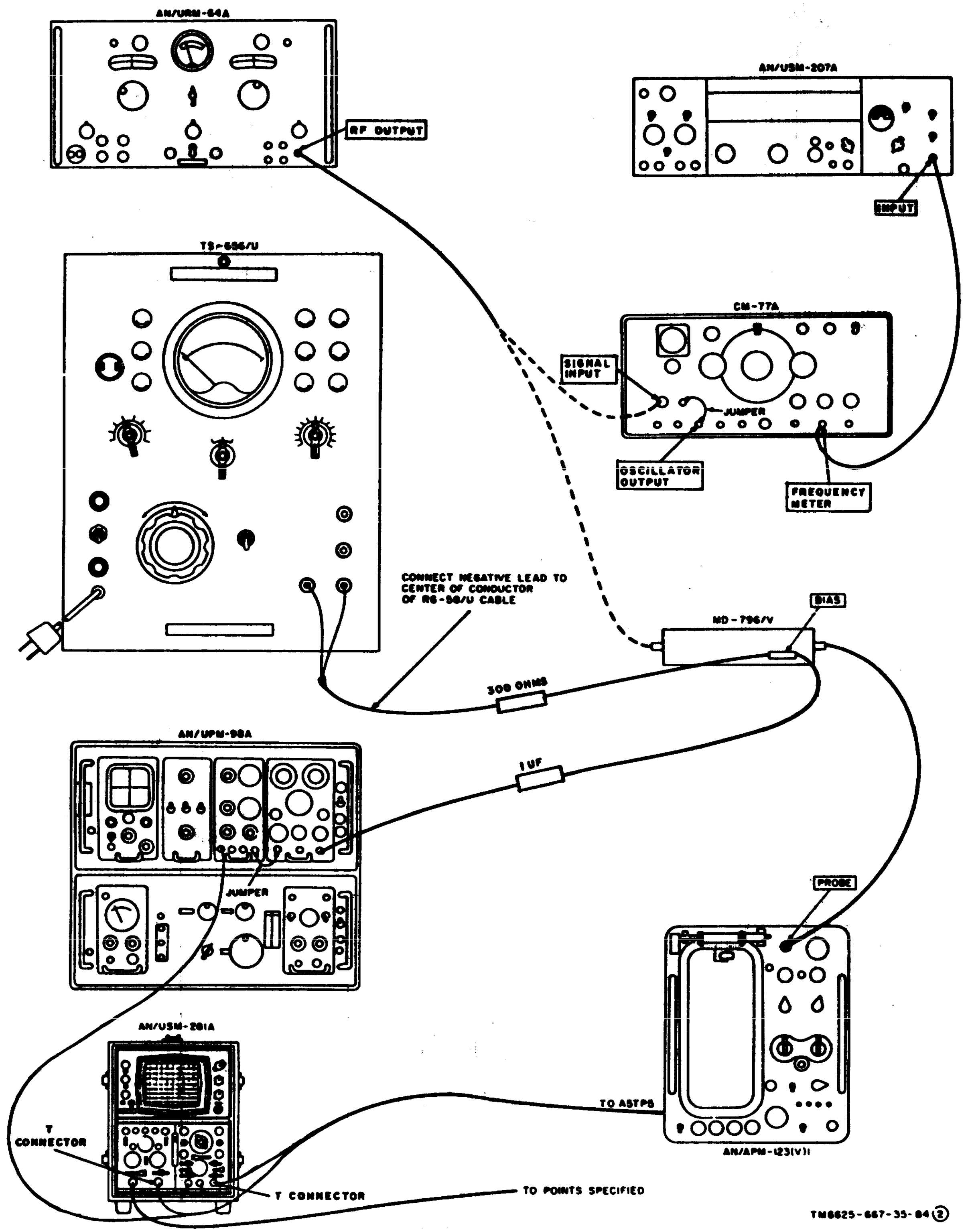


Figure 3-5. Receiver and decoder test setup.

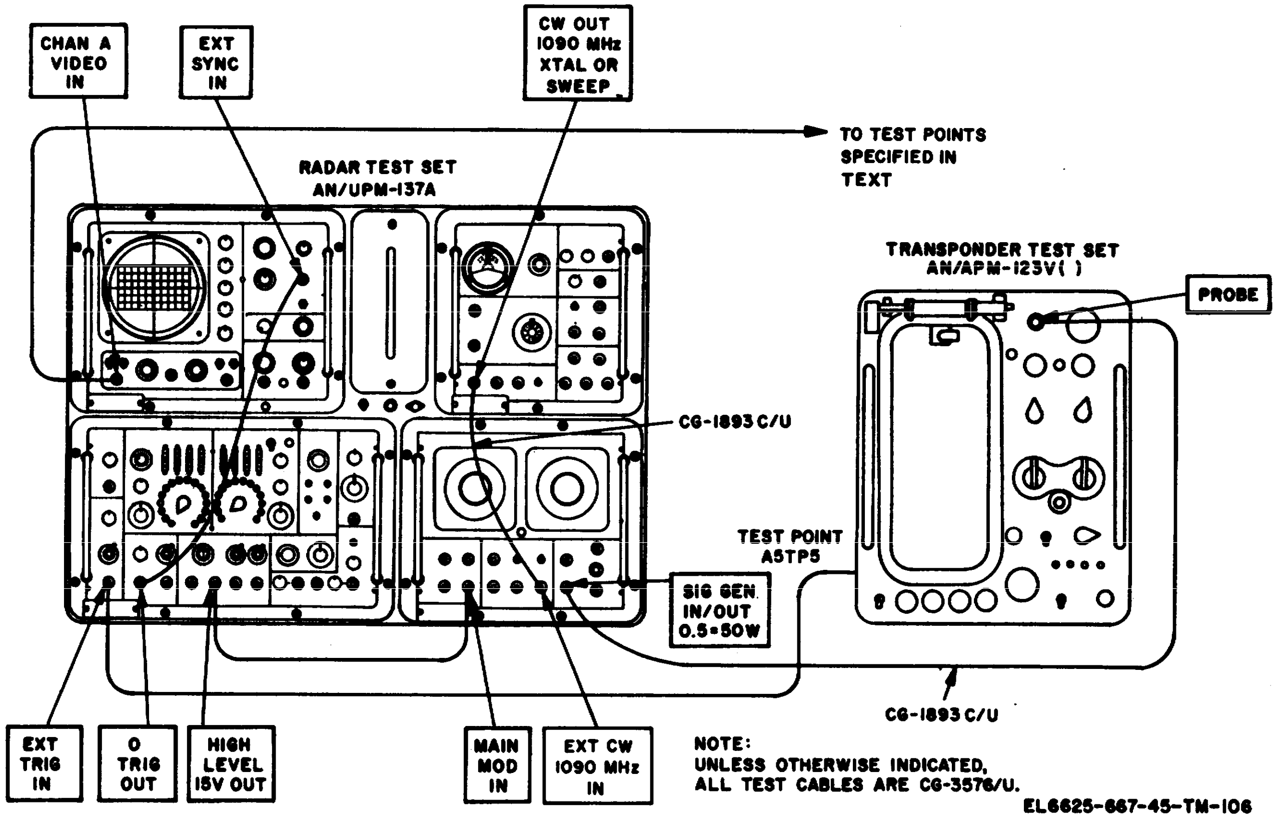


Figure 3-5.1. Receiver and Decodcr test setup using AN/UPM-137A

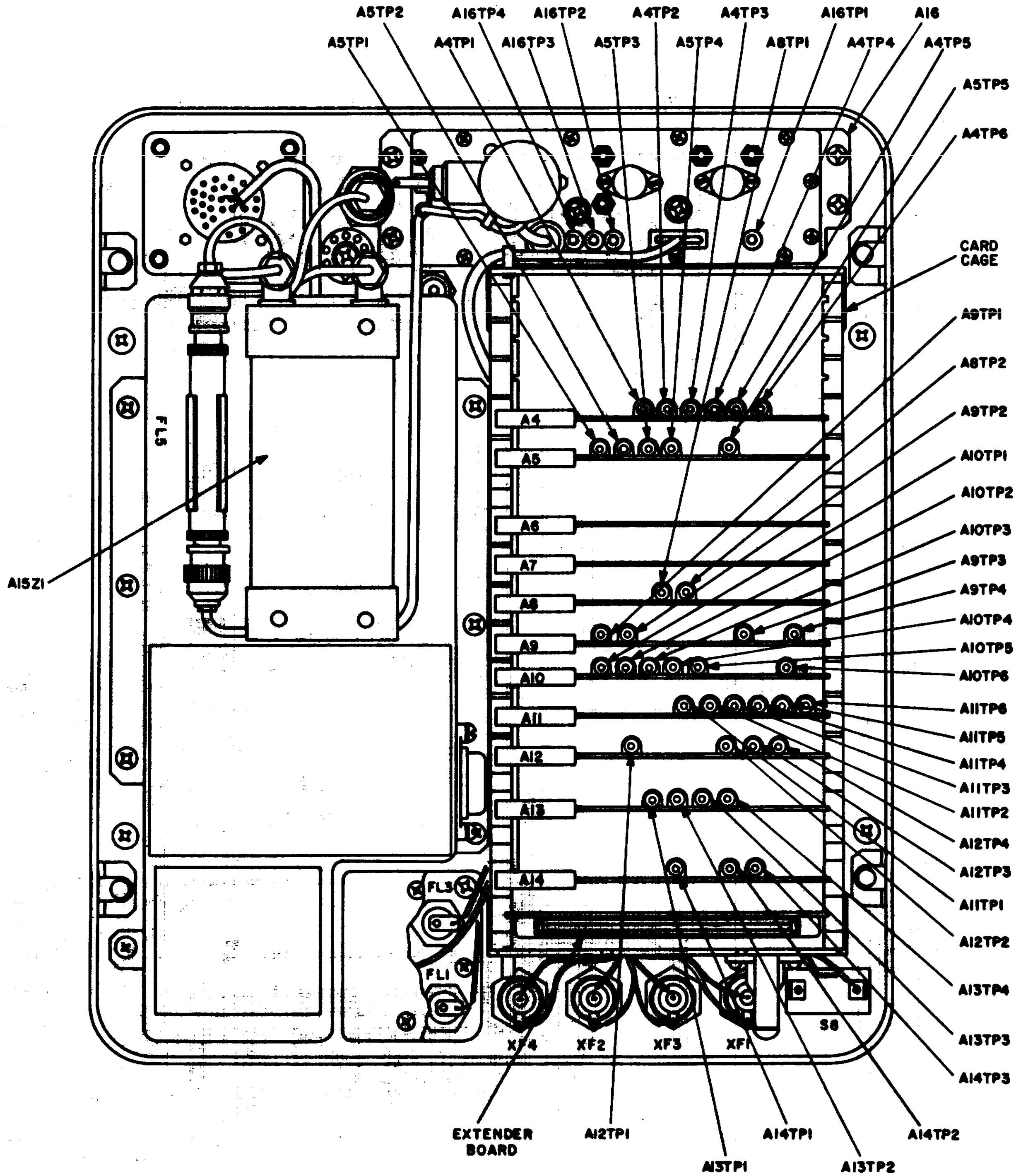


Figure 3-6. Test point location.

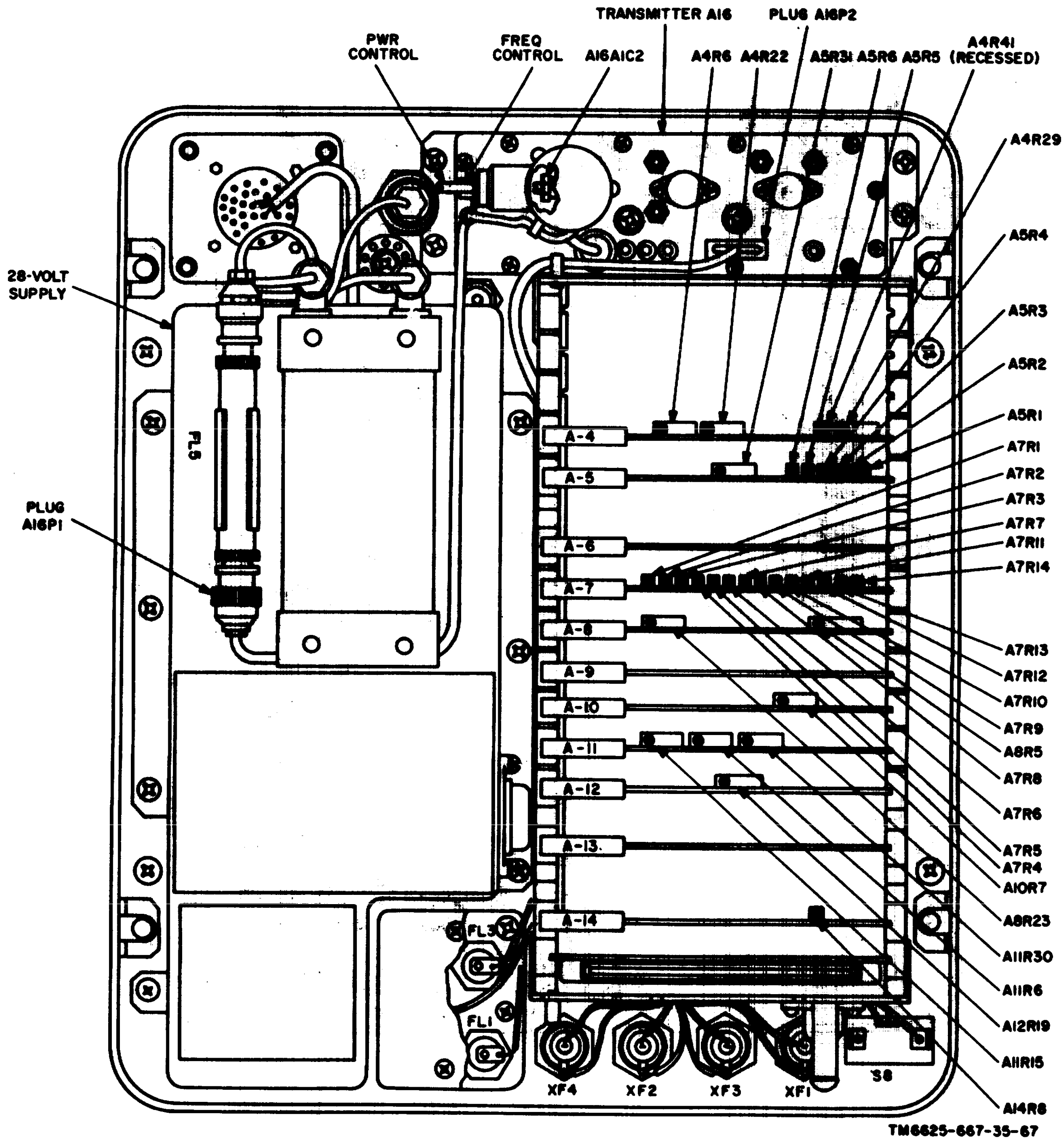


Figure 3-7. Adjustmcnt control location.

Section II. TROUBLESHOOTING TEST SET, TRANSPONDER AN/APM-123(V)1

Caution: Do not attempt removal or replacement of parts before reading the instructions in paragraph 4-1.

3-5. Checking Power Supply Section and B+ output Circuits for Shorts

a. When *to Check.* When any of the following conditions exist, check for short circuits and, unless otherwise specified, remedy trouble before applying power:

(1) When fuses continually blow.

(2) When abnormal symptoms during sectionalization tests indicate possible B + trouble.

b. Conditions for Tests. Prepare the equipment for short circuit tests as follows:

(1) Set PANEL LIGHT switch to OFF.

(2) Remove modules A13 and A14 (fig. 3-6).

(3) Remove extender board and insert in module A13 receptacle.

(4) Disconnect plug A16P2 (fig. 3-7) at the transmitter by removing the two screws securing the plug to chassis, then carefully pull it out.

c. Measurements.

Caution: This equipment is transistorized, refer to paragraph 3-7 for instructions Do not use the RX1 scale or multimeter.

Step	*Point of measurement*	*Normal indication*	*Isolating procedure*
1	Pins 10 and 22 of extender board.	40 ohms ± 20% (multimeter scale RX 100).	If normal, proceed with step 2. Zero resistance indicates trouble in the 28-volt supply.
2	Pins land l0 of extender board.	*a.* Infinity (∞) ohms (multimeter scale RX10K),	*a.* Reconnect plug A 16P2 to jack A 16J2. If the resistance is zero, remove transmitter (para 3-10) and check socket resistances of subassembly A16A2 (fig. 3-10) with plug A16P2 disconnected. If the resistance is normal, proceed with b below.
		b. 40 ohms ± 20% (multimeter scale RX100).	*b.* Insert module A 16 into its receptacle and observe meter indication. Zero resistance indicates trouble in module A14. If resistance is normal, proceed with c below.
		c. ∞ ohms (multimeter scale RX1OK).	*c.* Remove module A 14 and extender board. Insert the card extender board into the module A 14 receptacle, and module A13 into its receptacle. An abnormally low resistance (200K or less) indicates trouble in module A 13. If the resistance is normal, proceed with step 3.
3	Test points A13TP1 (positive lead) and A13TP2 (ground).	1,100 ohms ± 20% (multimeter scale RX1OO).	Remove modules A4, A5, and A7 through A12. Check the resistance between these points A13TP1 and A13TP2. If normal, proceed with step 4. If the resistance is abnormally low, proceed as follows: *a.* Insert module A14 and observe resistance. If resistance decreases, the trouble is in the – l8-volt power supply of module A14. If resistance does not decrease, check wiring (fig. 8-16); if the wiring is not shorted, proceed with b below. *b.* Insert modules A4, A5, and A7 through A12 one at a time and observe resistance. If the resistance decreases to less than 500 ohms with the insertion of a module, the trouble exists in the B– input of that module.
4	A13TP3 (positive lead) and A13TP2.	120 ohms ± 20% (multimeter scale RX1).	Remove modules A4, A5, and A7 through A12 and repeat step 2b. If resistance is zero with the insertion of a board, the trouble exists in the B+ circuits of the board.

3-6. Localizing Troubles

a. General. The troubleshooting charts (d through *e* below) outline procedures for localizing troubles to a stage within the respective module or subassembly. Figures 8-6 through 8-16 are schematic diagram Figures 8-25 through 8-37 are parts location diagrams. To check stages or parts in either transmitter A16 or the 28-volt power supply, refer to paragraph 3-10 for instructions to remove the subassembly.

b. Use of Troubleshooting Charts. A troubleshooting chart is provided for each module or subassembly. Selection of the applicable chart is based on the sectionalization test step (para 3-4) that the failure was noted.

Note. Test setup and condition should be as specified at the step in the sectionalization test where the trouble was noted.

c. Power Supply Section Troubleshooting. Refer to figure 8-6 for schematic diagram and to figures 3-8 and 3-9 for socket voltage and resistance

Caution: If replaced fuses blow, turn off power and refer to paragraph 3-5 to locate short circuit

Symptom	*Probable trouble*	*Corrective measures*
+28 volts abnormal-----------	*a.* Bridge rectifier-------- ---------	*a.* Check A15CR1 through A15CR4 (fig. 8-37).
	b. Regulator diode --------------	*b.* Check diode A15VR1.
	c. Power transformer---------------------	*c.* Check continuity and resistance across primry and secondary of A15T1.
	d. Series inductor -------------------	*d.* Check continuity of A15L1.
+12volts abnormal-----------	Transistor A13Q1, A13Q2, or A13QJ3---	Check socket voltages and resistances (fig. 3-8).
–12volts abnormal, +156 volts normal.	*a. Transistor* A3Q4-----------------	*a.* Check voltages and resistances (fig. 3-8).
	b. Resistor A13R8-----------------	*b.* Check resistance against rated value.
	c. -l8-volt bridge rectifier-----------	*c.* Check diodes A14CR1 through A14CR4. If normal, check capacitor A14C7.
– 12 volts abnormal and +156 volts abnormal.	Transistor A14Q1, A14Q2, A14Q3, or A14Q4.	Check socket voltages and resistance (fig. 3-9).
+150 volts abnormal, -12 volts normal.	*a.* Voltage adjustment-------------.	*a.* Adjust control A14R8 to obtain normal voltage.
	b. Transistor A14Q5, A14Q6, or A14Q7.	*b.* Check socket voltages and resistances (fig. 3-9).
	c. + 150-volt bridge rectifier-------- --	*c.* Check A14CR6, through A14CR9 and capacitors A14C8 and A14C9. Replace defective part.

d. Transmitter A16 Troubleshooting. Socket voltages and resistances are shown in figure 3-10, and the schematic diagram is figure 8-7.

Symptom	*Probable trouble*	*Corrective measures*
Incorrect frequency----------	A16Y1-----------------------------	Replace crystal A16Y1.
No RF power output with test point A4TP5 or A4TP4 grounded.	*a.* Cable connections to PROBE jack.	*a.* Tighten loose cable connection. Replace broken cable or connector.
	b. Transistors and tubes: (1) A16Q1; A16Q2 (2) A16Q3; A16V1, or A16A1V1. (3) A16A2Q1, A16A2Q2 or A16A2Q3.	*b.* Check transistors and tubes listed in Probable trouble column in the order given; use voltage and resistance diagram.
No RF power with test point A4TP5 grounded, but normal With A4TP4 grounded.	Transistor Al6Ql--------------------	Check A16Q1; use socket voltage and resistance diagram.

Symptom	Probable trouble	Corrective measures
No RF power with A4TP4 grounded, but normal with A4TP5 grounded.	Transistor A16Q2---------------------------	Check A16Q2; use voltage and resistance diagram.
Low RF power output With test point A4TP5 or A4TP4 grounded.	*a.* Electron tube filament voltage abnormal, or transmitter adjustment required.	a Adjust transmitter (para 4-4).
	b. Transistors and tubes: (1) A16Q3, A16V1, A16V2, or A16A1V1. (2) A16Q1; A16Q2; A16A2Ql-A16A2Q3.	*b.* Check stages in order given; use socket voltage and resistance diagram.
Low power output, below -8 dbm, with test point A4TP5 grounded, but normal (-21 ±1 dbm) with A4TP4 grounded.	A16Q----------------------------	Check A16Q1; use socket voltage and resistance diagram.
Low power output below – 20 dbm with test point A4TP4 grounded, but normal (-9 ± 1 dbm) with A4TP5 grounded.	*a.* P2 pulse level adjustment ----------	*a.* Adjust P2 pulse level control A16R6 to obtain normal power.
	b. Transistor Al6Q2----------------	*b.* Check A16Q2; use socket voltage and resistance diagram.
Pulses not present at test point A16TP1.	Module A4 or A5--------------------	Refer to encoder modules A4 and A5 troubleshooting chart in *f* below.
P1 and P3 RF pubes not within 0.8 µsec ± 0.2.	Pulse width adjustment, module A4- --	Adjust control A4R41 (fig. 3-7) to obtain specified RF pulse width for P1 and P3 pulses.
P2 RF pulse width not within 0.8 µsec ± 0.2.	Pulse width adjustment, module A4- --	Adjust control A4R41 (fig. 3-7) to obtain specified RF pulse width for P2 pulse.
P1 and P3 spacing abnormal in any mode.	Adjustment-------------------------	Refer to paragraph 4-4.
P1 and P2 spacing not within 2 µsec ± 0.2.	Adjustment of A4R22------------	Adjust A4 R22 for normal spacing.
Transmitter operating during receiver cycle.	Encoder module A4------------------	Refer to troubleshooting chart in *f* below. Look for symptom described as encoder enable locked in set state.

e. Encoder Module A4 and A5 Troubleshooting. Refer to figures 8-17 (module A4), 8-18 (module *A5)*, and 8-36 (test points) for waveforms. Voltages and resistances are given in figures 3-11 (module A4) and 3-12 (module AS). Schematic diagrams are figures 8-8 (A4) and 8-9 (A5).

Symptom	Probable trouble	Corrective measures
No pulse present at test point A4TP6, but a pulse is present at test point A16TP1 (ISLS switch OFF).	P1-P3 shaper 1SS4 or modulator driver A16Q1.	*a.* Check waveform at A4TP5. If abnormal, check resistances at A4Q9 and A4Q1O. If normal, proceed with b below. *b.* Set ISLS switch ON and observe whether pulse is present at A4TP6. If present, check diode A4CR16 and replace if defective. If pulse is not present, check transistor A4Q11 and diode A4CR17.

Symptom	*Probable trouble*	*Corrective measures*
No pulse are present at test point A16TP1 (ISLS switch ON or OFF) for all MODE switch positions.	P1 and P3 pulses are not forming or encode enable IFF1 inoperative.	*a.* Check waveform at A10TP4. If normal, proceed with e below. If abnormal, proceed with b below. *b.* Check waveform at A4TP5. If normal, proceed with c below. If abnormal, check resistances at A5Q14 and A5Q15. *c.* Check waveform at A4TP1. If normal, proceed with d below. If abnormal, check socket resistances at transistors A4Q1 and A4Q2. *d.* Check waveform at A4TP2. If normal, proceed with *e* below. If abnormal, oheck resistances at A4Q3 and A4Q4. *e.* Replace delay-line module A6DL1.
P1 pulse rnissing, but P2 and P3 pulses are present at test point A16TP1.	Gate diode A5CR3----------------	Check diode A5CR3.
During all modes, P1 and P2 pulses are not present at test point A16TP1, but P3 pulse is present.	*a.* P1 gate------------------------- *b.* MODE switch --------------------	*a.* Check waveform at test point A5TP2. If normal, check resistances at transistor A5Q12. If abnormal, proceed with b below. *b.* Check resistance at transistor A5Q11. If normal, check continuity of MODE switch A15S5, section F.
During one mode,Pl and P2 pulses are not present at test point A16TP1 but P3 pulse is present.	*a.* P1 emitter follower----- *b.* MODE switch contacts.	Check resistances of P1 emitter follower associated with inoperative mode (mode 1: A5Ql; mode 2: A5Q2; mode 3: A5Q3; mode C: A5Q4; or test: A5Q5).
P3 pulse not present at test point A16TP1.	*a.* P3 gate------------------------- *b.* Gate diode A5CR2---------------- *c.* P3 emitter follower----------	*a.* Check waveform at test point A5TP4. If abnormal proceed with *b* below. If normal, proceed with *c* below. *b.* Check resistances at transistors A5Q6 and A5Q7. *c.* Check resistance at transistor A5Q8. If normal, replace gate diode A5CR2.
only P2 pulse is missing with ISLS switch at ON and OFF at test point Al6TP1.	Encode line driver ISS1 or SLS delay generator 1SS3.	check waveform at A4TP3. If normal, check resistances at transistors A4Q7 and A4QS. If abnormal, check resistances at A5Q4 and A5Q5.
P2 pulse missing at test point A16TP1 With ISLS switch at at OFF, but is present when it is at ON.	P2 modulator driver or diode ACR57- -	Check resistances at transistors A5Q17 and A5Q18; if resistances are normal, check A5CR7.
P2 pulse missing at test point A16TP1 with ISLS switch at ON, but is present when it is at OFF.	Diode A4CRl5----------------------	Check diode.
Encoder enable IFF1 locked in set state, P3 pulse present at test point A16TP1.	DE pulse missing-----	Check waveform at A5TP3. If abnormal, check resistances at A5Q9 and A5QI0. If normal, check resistances at transistors A4Q3 and A4Q5.

f. Decoder Module A7 Troubleshooting. Transistor socket voltages (if applicable) and resistances are shown in figure 3-13. Socket waveforms are shown in figure 8-19. Schematic diagram is figure 8-10.

Symptom	*Probable trouble*	*Corrective measures*
All information pulses missing, as observed at test point A10TP2; F2 and I/P pulses are present.	Information inhibit gate	Check socket resistances at transistor A7Q16; check gate diodes A7CR1 and A7CR2.
One or more information pulses, but not all, are missing at test point A10TP2. Pulses are identified as follows :	Transistor associated with pulse. Listing is correlated with pulse identification given in the Symptom column.	Check socket waveforms, voltages, and resistances at the applicable transistor. Check CODE switch (A15S2 and A15S3) operation, **if** transistors are normal.
a. Cl	*a. A7Q1*	Substitute anew module A6 (delay line).
b. C2	*b.* A7Q2	
c. C4	*c.* A7Q3	
d. D1	*d.* A7Q4	
e. D2	*e.* A7Q5	
f. D4	*f.* A7Q6	
g. Al	*g.* A7Q7	
h. A2	*h.* A7Q8	
i. A4	*i. A7Q9*	
j. B1	*j. A7Q10*	
k. B2	*k. A7Q11*	
l. B4	*1. A7Q12*	
F2 pulse missing	Transistor A7Q13	Check socket voltage and resistances.
I/P pulse missing	Transistor A7Q15	Check socket voltages and resistances.
Ml pulse abnormal as observed at test point A10TP3.	Transistor A7Q14	Check socket voltages and resistances.
All pulses missing as observed at A10TP3, but line-drive pulse is normal at A10TP4.	Delay line	Replace delay-line module A6.

g. Receiver Section, Video Module A8 Troubleshooting. Transistor socket voltage and resistances are shown in figure 3-14; schematic diagram is figure 8-11.

Symptom	*Probable trouble*	*Corrective measures*
Less than +7 volts at test point A8TP2 with normal RF signal at PROBE jack,	*a.* Sensitivity adjustment	*a.* Adjust receiver sensitivity control A8R5 until ACCEPT indicator just lights with a – *9* dbm RF input at the PROBE jack.
	b. Transistor A8Q1, A8Q2, A8Q3, or A8Q4.	*b.* Check socket voltages and resistances.
	c. Detector diode	*c.* Check diode A15Z2CR1.
Video shaper output at test point Al1TP1 abnormal; waveforms are normal at test point A8TP2 and video-enable output (test point A9TP5).	Video gate 2	*a.* Check socket resistance at transistor A8Q9. *b.* If transistor appears normal, refer to chart, first item, in subparagraph j below.

h. Decoder Module A9 Troubleshooting.

Note 1. Transistor socket resistance and waveforms are shown in figures 3-15 and 8-20, respectively.

Note 2. Test point waveforms are shown in figure 8-36.

Note 3. The schematic diagram is figure 8-12.

Note 4. It is assumed that waveforms at test points A10TP4 and A10TP6 were normal during the sectionalization tests. Also that mode 2 interrogation signals (transmitter section) were normal.

Symptom	*Probable trouble*	*Corrective measures*
Video-enable DFF6 output at test point A9TP4 abnormal during all modes.	*a.* Video enable DFF6 *b.* Diode A9CR7, A9CR8, or A9CR9.	*a.* Check transistors A9Q1 and A9Q2 socket *resistances.* *b.* Check diodes.
Video-enable output at test point A9TP4 abnormal only during one of the tests listed in a, *b,* and c below (the line-drive enable output (A9TP3) and M1 timing pulse at test point A10TP3 were normal during sectionalization tests).		
a. I/P (except mode 1)	a. Counter section DFF3 or train plus I/P reset gate.	*a.* Check socket resistances at transistors A9Q8 and A9Q9. If normal, check gate diodes A9C R5 and A9CR6.
b. I/P mode l	*b.* Counter sections DFF3 and DFF4, or 2-train reset gate.	*b.* Check socket waveforms at transistors A9Q8 through Q9Q11 to isolate faulty stage. If normal, check gate diodes A9CR3 and A9CR4.
c. Emergency (I/P mode 1 normal)	*c.* Train plus 3 FPS reset gate	*c.* Check gate diodes A9CR1 and A9CR2.
Line-drive enable DFF1 output at test point A9TP3 is abnormal as indicated by a, 6, and C below.		
a. Locked in low state (does not set).	*a.* Delay-enable pulse input transistor A9Q6 or A9Q7.	*a.* Perform the following: (1) Check waveform at test point A5TP3 (encoder module A5, fig. 8-36). If normal, proceed with (2) below; if abnormal, refer to encoder modules A4 and AS troubleshooting chart *(f.* above). (2) Check socket resistances of transistors A9Q6 and A9Q7 (fig. 3-15).
b. Looked in a high state (does not reset).	*b.* Line-drive pulse reset input; transistor A9Q6 *or* A9Q7.	*b.* Perform the following: (1) Check waveform at test point A1OTP4 (fig. 8-36). If normal, proceed with (2) below. If abnormal, refer to decoder module A10 troubleshooting chart (j below). (2) Check socket resistances of transistors A9Q6 and A9Q7.
c. During I/P and emergency tests, after line-drive enable DFF1 is reset by first line-drive pulse, it does not set (go high) again.	*c.* Check the following: (1) Ml timing pulses	*c.* Perform the following: (1) Check M1 pulse waveform at test point A10TP3 (fig. 8-36). If abnormal, refer to troubleshooting procedures in chart j below. If normal, proceed with (2) below.
	(2) Diode A9CR16 or A9R35 (3) FUNCTION switch A15S6 section C.	(2) Check diode A9CR16 and resistor A9R35. If normal, check wiring and continuity of MODE switch A15S5, section C (fig. 8-16).

Symptom	*Probable trouble*	*Corrective measures*
Error blanking pulse at test point A12TP4 abnormal, but error blanking gate (module A12) is normal.	M2 inverter, error blanking DFF2, or FUNCTION switch A15S6, section G.	Check socket waveforms at transistors A9Q3, A9Q4, and A9Q5 (fig. 8-20). Check socket resistances of suspected stage. If alI three transistors appear normal, check FUNCTION switch.

i. Decoder Module A10 Troubleshooting. Transistor socket resistances and waveforms are shown in figures 3-16 and 8-21, respectively. Test point waveforms are shown in figure 8-36. The schematic diagram is figure 8-13.

Symptom	*Probable trouble*	*Corrective measures*
Video-enable delay waveshape abnormal at test point A10TP5.	*a.* Adjustment	a. Adjust control A10R7 (fig. 3-7) for pulse width of 1.8 µsec ± 0.05.
	b. Video-enable delay DSS4	*b.* Check socket resistances of transistors A10Q1 and A10Q2 (fig. 3-16).
	c. Capacitor A10C3, resistor A10R6, or variable resistor A10R7.	*c.* Check leakage of capacitor A 10C3. Check value of resistor A1OR6 and control A10R7.
Line-drive pulse abnormal at test point A10TP4; line-drive enable output high DFF1 is set as indicated at test A9TP3.	Line-drive gate 1 or 2; A10Q7	Check socket waveforms at A10Q5, A10Q6, and A10Q7 to locate faulty stage. Check socket resistances of the stage and gate diodes as applicable.
M1 timing pulse abnormal at test point A1OTP3 (fig. 8-36).	Module A7	Refer to decoder module A7 troubleshooting procedures in *g* above for M1 timing pulse symptom.
Delay-line pulse input at test point A10TP2 abnormal.	Module A7	Refer to decoder module A7 troubleshooting procedures in *g* above for applicable delay-line pulse output symptom.
Delay-1ine output amplifier A10Q10/ Al0Ql1 output at test point A10TP1 is abnormal; input at test point A10TP2 is normal.	Delay-line output amplifier-	Check socket resistances of transistors A10Q10 and A10Q11.
Read delay DSS5 output at test point A1OTP6 abnormal; video-enable delay at test point A10TP5 normal.	Readout delay DSS5	Check socket resistances of transistors A10Q3 and A10Q4.

j. Decoder Module All Troubleshooting. Transistor socket resistances are provided in figure 3-7 and waveforms are provided in figure 8-14. Test point waveforms are in figure 8-36. The schematic diagram is figure 8-14.

Symptom	*Probable trouble*	*Corrective measures*
Video shaper DSSl output at test point Al1TP1 abnormal.	*a.* Video gate 2 input	*a.* Refer to subparagraph h above. Symptom is similarly described.
	b. A11Ql or A1lQ2	*b.* Check transistor socket resistances.
	c. Pulse width adjustment	*c.* Adjust control Al1R6 for pulse width of 0.7(+0.0, -0.05) µsec.
Comparison pulse shaper output at test point Al1TP2 abnormal.	*a.* Video shaper DSS1, gate diode A11CR5, or gate diode A11CR6.	*a.* Check socket resistances of transistom Al1Q3 and A11Q4; if normal, check diodes Al1CR5 and A11CR6.
	b. Pulse width adjustment	*b.* Adjust control Al1R15 for pulse width of 0.5 µsec ±0.01.

Symptom	Probable trouble	Corrective measures
Error detector output at teat point A11TP6 abnormal; waveforms were normal at test points A10TP6, A12TP4, A11TP1, and A11TP2 during sectionalization teats.	*a.* Error gate 1 or *2.*-----------------	*a.* Check waveform at test point A11TP4. If abnormal, check socket resistance at A11Q5 and A11Q6; check gate diodes A11CR10 through A11CR13.
	b. Error gate 8 or inverter Transistors A11Q9 and A11Q10.	*b.* Cheek socket waveforms to insolate faulty stage. Check socket resistances at faulty stage.
	c. Accept/reject generator DSS3 or pulse width adjustment.	c. Cheek waveform at test point A11TP3. If pulse width in abnormal, adjust control A11R30 to obtain 0.35 +0.01 µsec. Check socket waveforms and resistance at A11Q7 and A11Q8.

k. Decoder Module A12 Troubleshooting. Transistor socket waveforms are shown in figure *8-23* and socket resistances are shown in figure 3-18. Test point waveforms are shown in figure 8-36. The schematic diagram is figure 8-15.

Symptom	Probable trouble	Corrective measures
Error blanking pulse at test point A12TP4 abnormal.	Error blanking gate or module A9-----	Check socket resistance at A12Q11; if normal, refer to decoder module A9 troubleshooting chart in i above.
Read memory inoperative; error detector output was normal during sectionalization tests (para 3-4).	Readout memory DFF5--------------	Check socket waveforms and resistances at transistors A12Q2 and A12Q3.
Reply evaluator output at test point A12TP1 abnormal (7 to 12 vdc).	Transistor A12Q4, A12Q5, or A12Q6, capacitor A12C8, or adjustment *of* the reply evaluator.	Check socket resistance of transistor and cheek capacitor A12C8. If norreal, perform adjustment in paragraph 4-5e.
No accept or reject indication, but reply evaluator is normal.	Transistor A12Q7, A12Q8, A12Q9, or A12Q1O.	Check socket resistances of transistors.

3-7. Isolating Trouble Within Stage

a. General. When trouble has been localized to a stage during troubleshooting (para 3-6), isolate the defective part by voltage measurements or resistance measurements; use the figure referenced in the corrective *measures* column.

Caution: Before attempting to perform voltage and resistance measurements, refer to paragraph 3-2e and 3-8. *Carefully follow instructions and observe notes on voltage and resistance diagrams.*

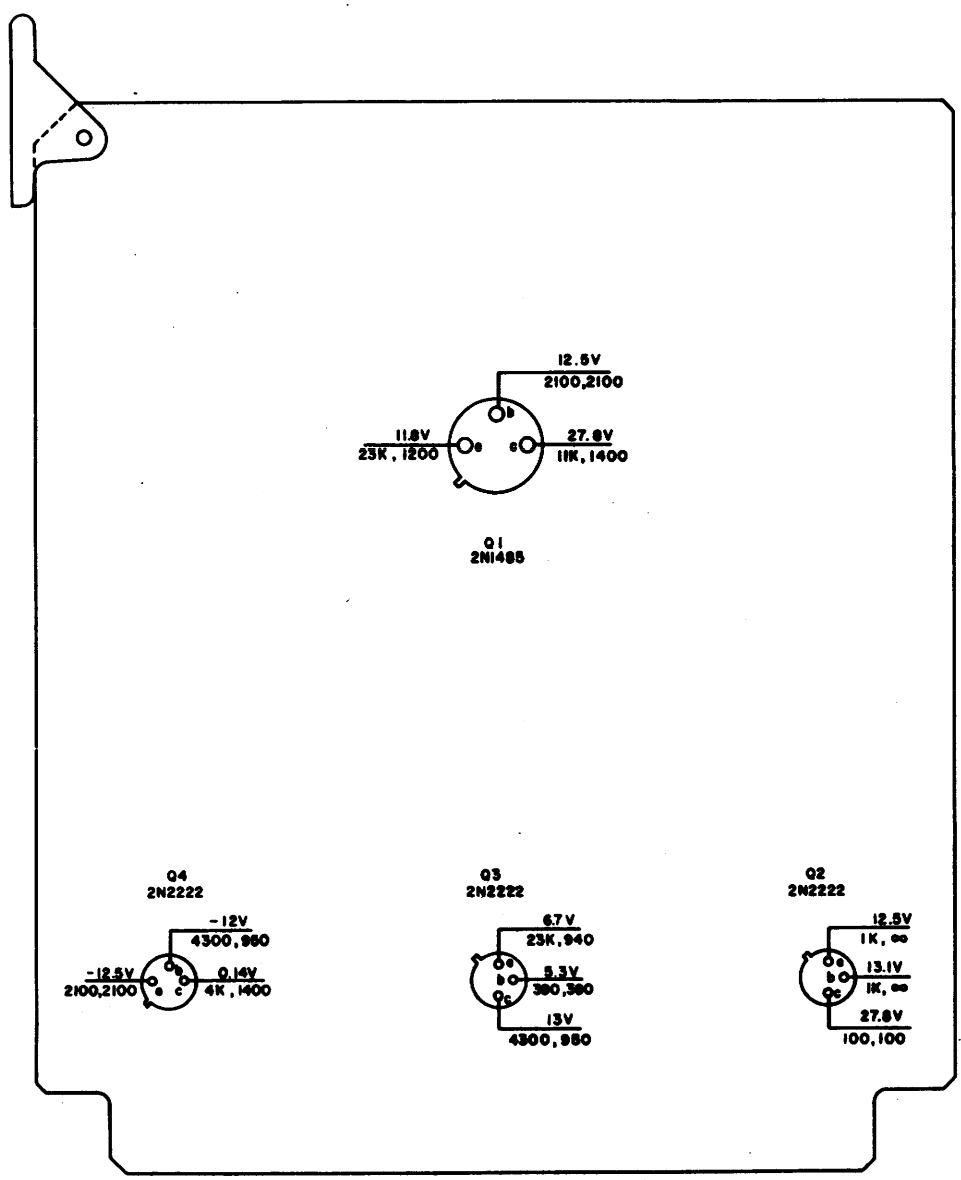
Carelessness may cause more troubles in the equipment and make the troubleshooting job more difficult. Do not remove or insert a transistor with voltage applied to the circuit..

b. Transistor Testing. The transistors are wired in the circuit; therefore. every effort should be made to troubleshoot the equipment without physically unsoldering and removing the transistors. Paragraph 3-8e contains information that maybe helpful in isolating trouble with the transistors wired in the circuit.

c. Wiring Diagrams. Use the wiring diagrams (figs. 8-24 through 8-35s) to circuit trace and isolate the faulty part.

3-8. Analysis of Measurements

a. In-Circuit Transistor Resistance Measurements. When measuring resistance of circuit elements connected across the junctions of any transistor (base-emitter or base-collector), consider polarity of the ohmmeter and try measurements with the ohmmeter connectd one way, and then reverse the leads. Also consider that different values of resistance will be obtained with the ohmmeter on different ranges. As *an example,* if the transistor junction or a resistor plus the transistor junction is measured in the forward direction of the RX10 range, the actual reading will be less



NOTES:
UNLESS OTHERWISE INDICATED

1. ALL MEASUREMENTS ARE FROM DESIGANTED TERMINAL CHASSIS. VOLTAGES SHOWN ABOVE LEAD LINES, RESISTANCES BELOW. VOLTAGES SHOWN FOR NON-DIGITAL CIRCUITS ONLY
2. VOLTAGES MEASURED WITH MULTIMETER ME-26/U, NO SIGNAL CONDITIONS
3. REMOVE MODULE FROM EQUIPMENT TO MAKE RESISTANCE MEASUREMENTS. MAKE MEASUREMENTS WITH MULTIMETER TS-352/U, R x100 RANGE FOR INDICATED RESISTANCES 10K OR BELOW, AND R X10K RANGE FOR THOSE ABOVE 10K. FIRST READING WITH NEGATIVE LEAD TO CHASSIS, SECOND WITH LEADS REVERSED
4. PREFIX REFERENCE 0ESIGNATIONS WITH A13

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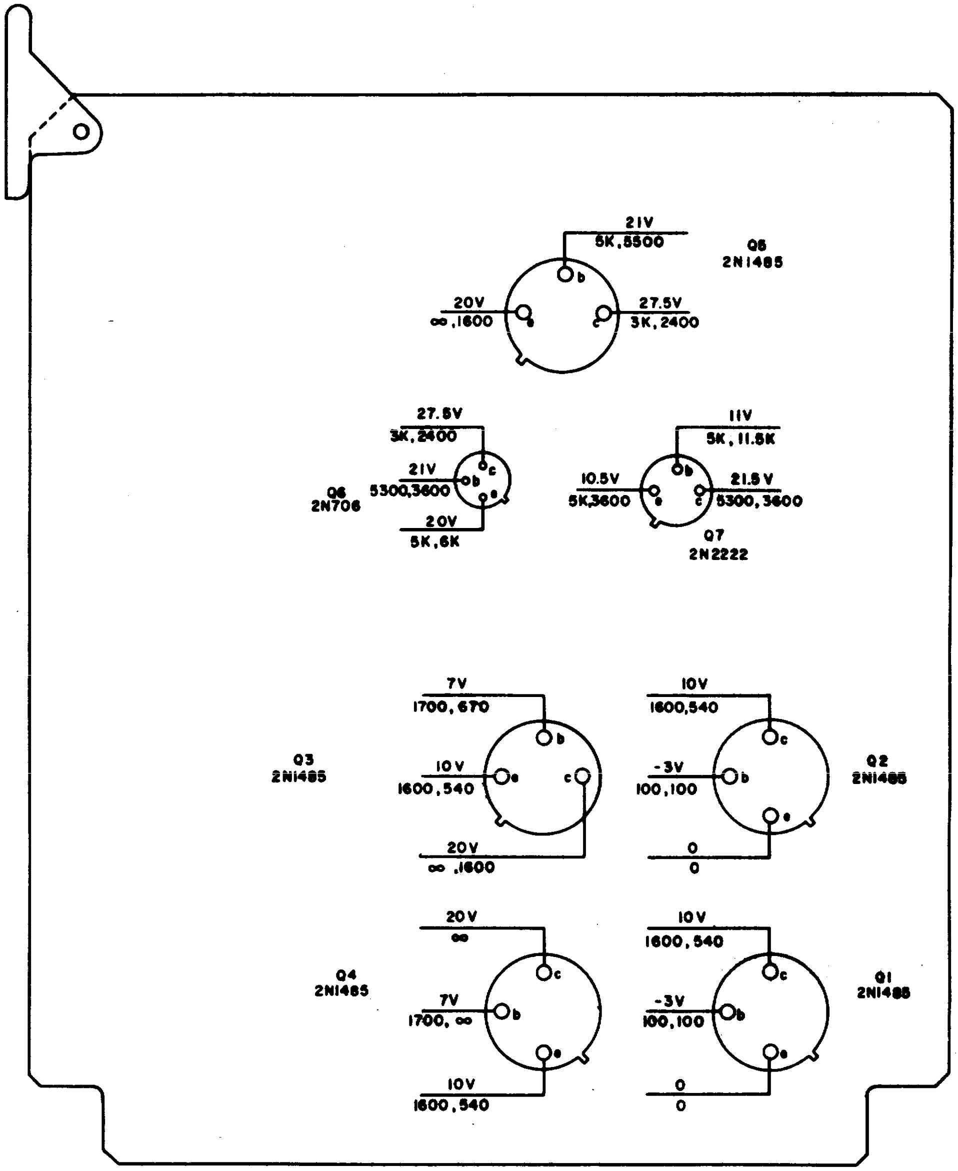
Figure 3-8. 12-volt regulator and resistance diagram.



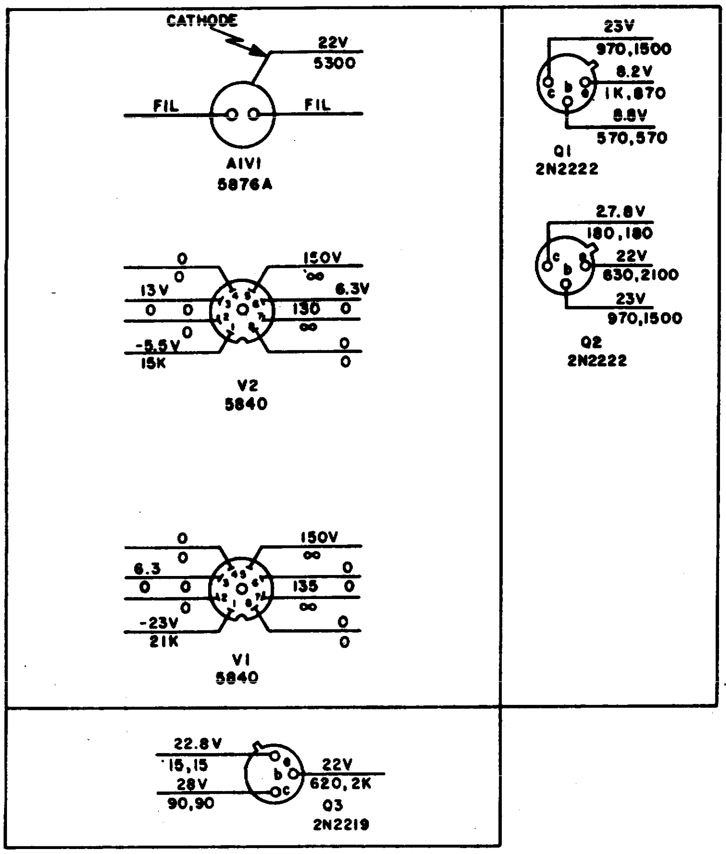
NOTES

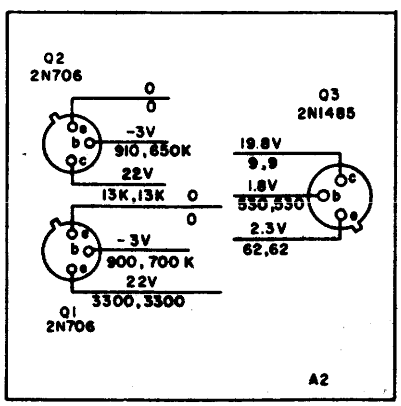
UNLESS OTHERWISE INDICATED

1. ALL MEASUREMENTS ARE FROM DESIGNATED TERMINAL TO CHASSIS. VOLTAGE SHOWN ABOVE LEAD ABOVE LEAD LINES, RESISTANCES BELOW. VOLTAGES SHOWN FOR NON-DIGITAL CIRCUITS ONLY
2. VOLTAGES MEASURED WITH MULTIMETER NO SIGNAL CONDITIONS
3. REMOVE MODULE FORM EQUIPMENT TO MAKE RESISTANCE MEASUREMENTS. MAKE MEASUREMENTS WITH MULTIMETER TS-352/U, R x100 RANGE FOR INDICATED RESISTANCES 10K OR BELOW, AND Rx 10K RANGE FOR THOSE ABOVE 10K. FIRST READING WITH NEGATIVE LEAD TO CHASSIS, SECOND WITH LEADS REVERSED
4. PREFIX REFERENCE DESIGNATIONS WITH A14

TM6625-667-35-58

Figure 3-9. 150-volt power supply voltage and resistance diagram.





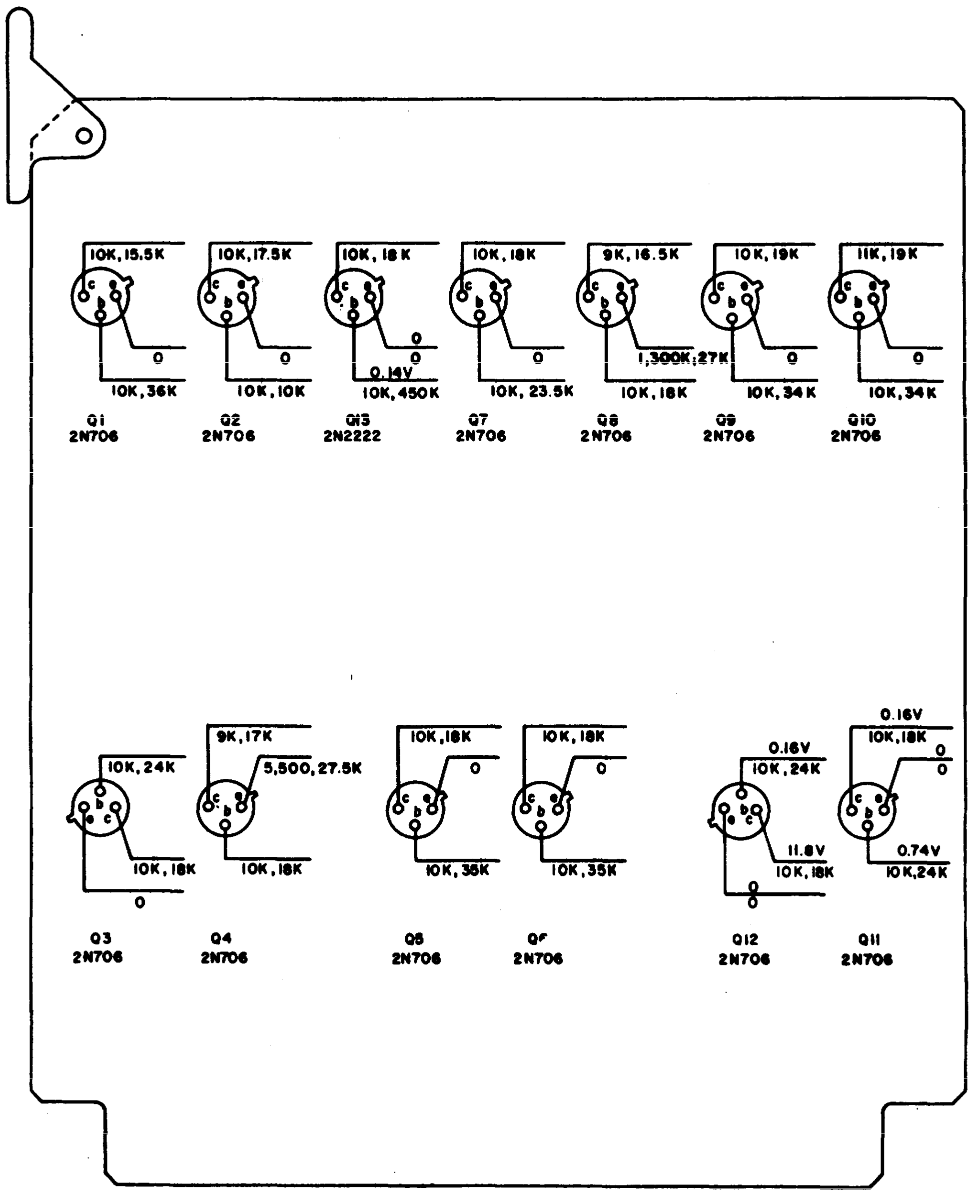
NOTES:

UNLESS OTHERWISE INDICATED

1. ALL MEASUREMENTS ARE FROM DESIGNATED TERMINAL TO CHASSIS. VOLTAGES SHOWN ABOVE LEAD LINES, RESISTANCES BELOW. VOLTAGES SHOWN FOR NON-DIGITAL CIRCUITS ONLY
2. VOLTAGES MEASURED WITH MULTIMETER ME-26/U NO SIGNAL CONDITIONS
3. REMOVE MODULE FROM EOUIPMENT TO MAKE RESISTANCE MEASUREMENTS. MAKE MEASUREMENTS WITH MULTIMETER TS-352/U, Rx 100 RANGE FOR INDICATED RESISTANCES 10 K OR BELOW, AND Rx 10K RANGE FOR THOSE AB0VE 10K FIRST READING WITH NEGATIVE LEAD TO CHASSIS, SECOND WITH LEADS REVERSED
4. NOTES 1, 2 AND 3 D0 NOT APPLY TO ELECTRON TUBES
5. PREFIX REFERENCE DESIGNATIONS WITH A16

TM6625-667-35-29

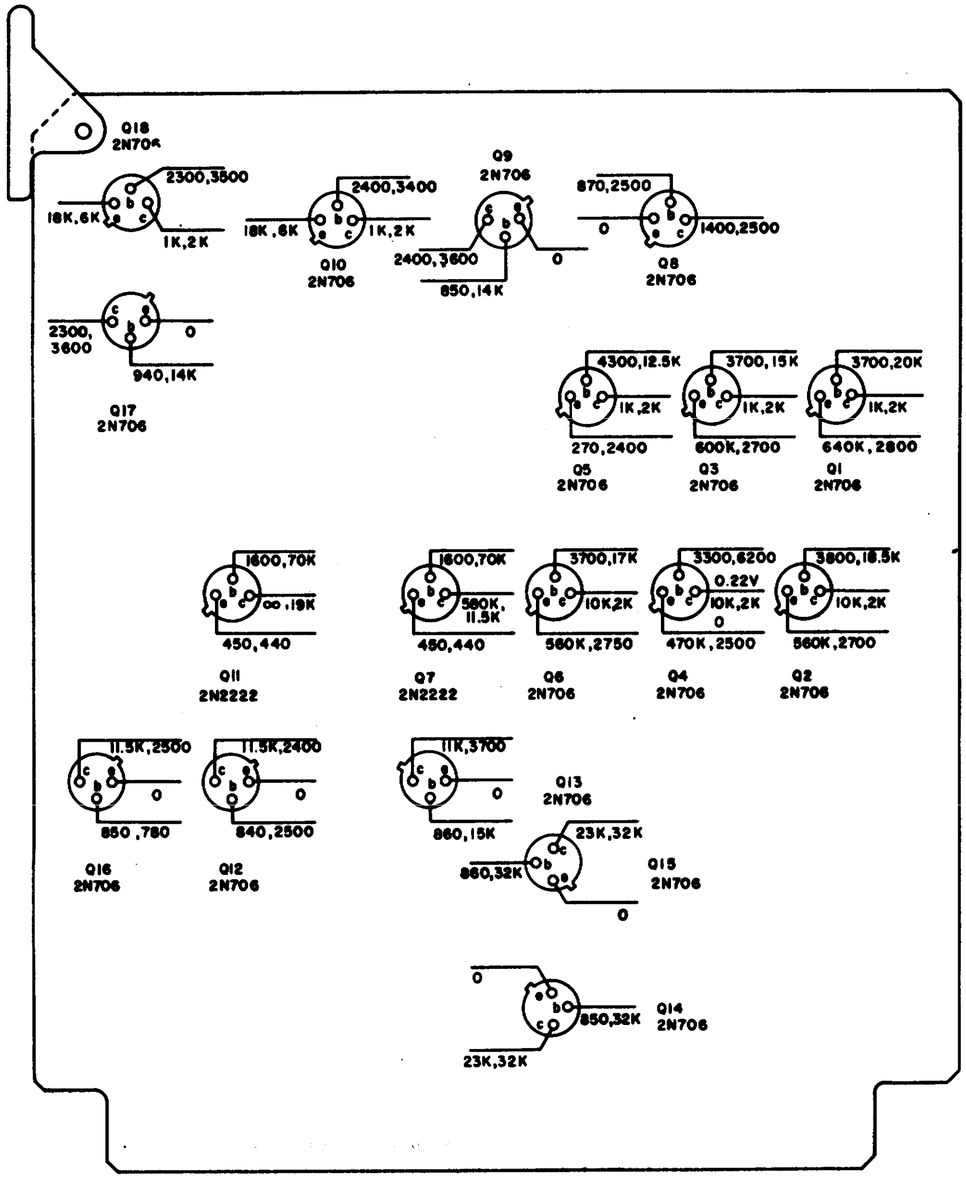
Figure 3-10. Transmitter A16 voltage and resistance diagram.



NOTES:
UNLESS OTHERWISE INDICATED
1. ALL MEASUREMENTS ARE FROM DESIGNATED TERMINAL TO CHASSIS. VOLTAGES SHOWN ABOVE LEAD LINES, RESISTANCES BELOW. VOLTAGES SHOWN FOR NON-DIGITAL CIRCUITS ONLY
2. VOLTAGES MEASURED WITH MULTIMETER ME-26/U, NO SIGNAL CONDITIONS
3. REMOVE MODULE FROM EQUIPMENT TO MAKE RESISTANCE MEASUREMENTS. MAKE MEASUREMENTS WITH MULTIMETE R TS-352/U, Rx 100 RANGE FOR INDICATED RESISTANCES 10K OR BELOW, AND Rx 10K RANGE FOR THOSE ABOVE 10K. FIRST READING WITH NEGATIVE LEAD TO CHASSIS, SECOND WITH LEADS REVERSED
4. PREFIX REFERENCE DESIGNATIONS WITH A4

TM6625-667-35-22

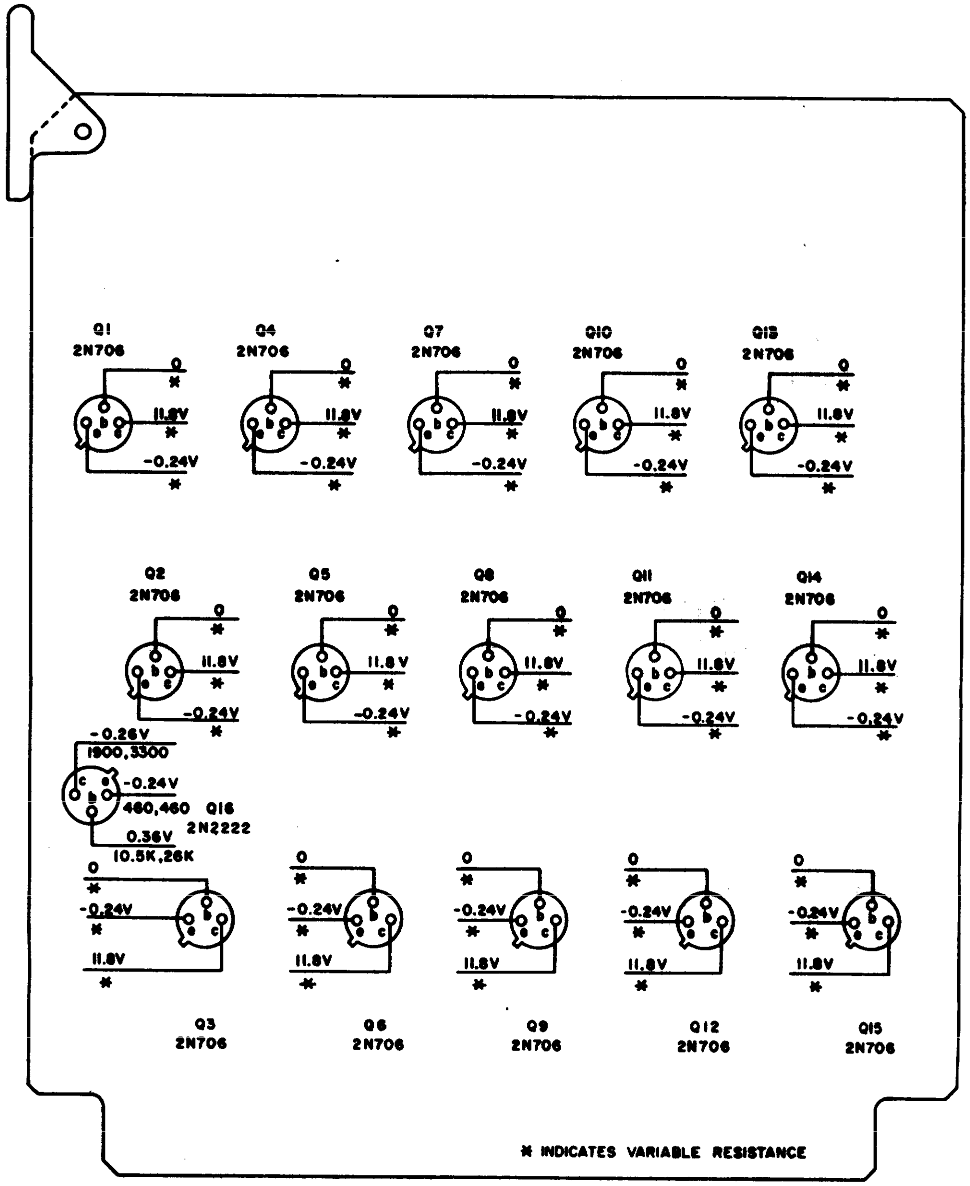
Figure 3-11. Encoder module A4 voltage and resistance diagram.



NOTES:
UNLESS OTHERWISE INDICATED
1. ALL MEASUREMENTS ARE FROM DESIGNATED TERMINAL TO CHASSIS. VOLTAGES SHOWN ABOVE LEAD LINES, RESISTANCES BELOW. VOLTAGES SHOWN FOR NON-DIGITAL CIRCUTS ONLY
2. VOLTAGES MEASURED WITH MULTIMETER ME-26/U, NO SIGNAL CONDITIONS
3. REMOVE MODULE FROM EQUPMENT TO MAKE RESISTANCE MEASUREMENTS. MAKE MEASUREMENTS WITH MULTIMETER TS-352/U, Rx 100 RANGE FOR INDICATED RESISTANCES 10K OR BELOW. AND Rx 10K RANGE FOR THOSE ABOVE 10K. FIRST READING WITH NEGATIVE LEAD TO CHASSIS, SECOND WITH LEADS REVERSED
4. PREFIX REFERENCE DESIGNATIONS WITH A5

TM6625-667-35-24

Figure 3-12. Encoder module A5 voltage and resistance diagram



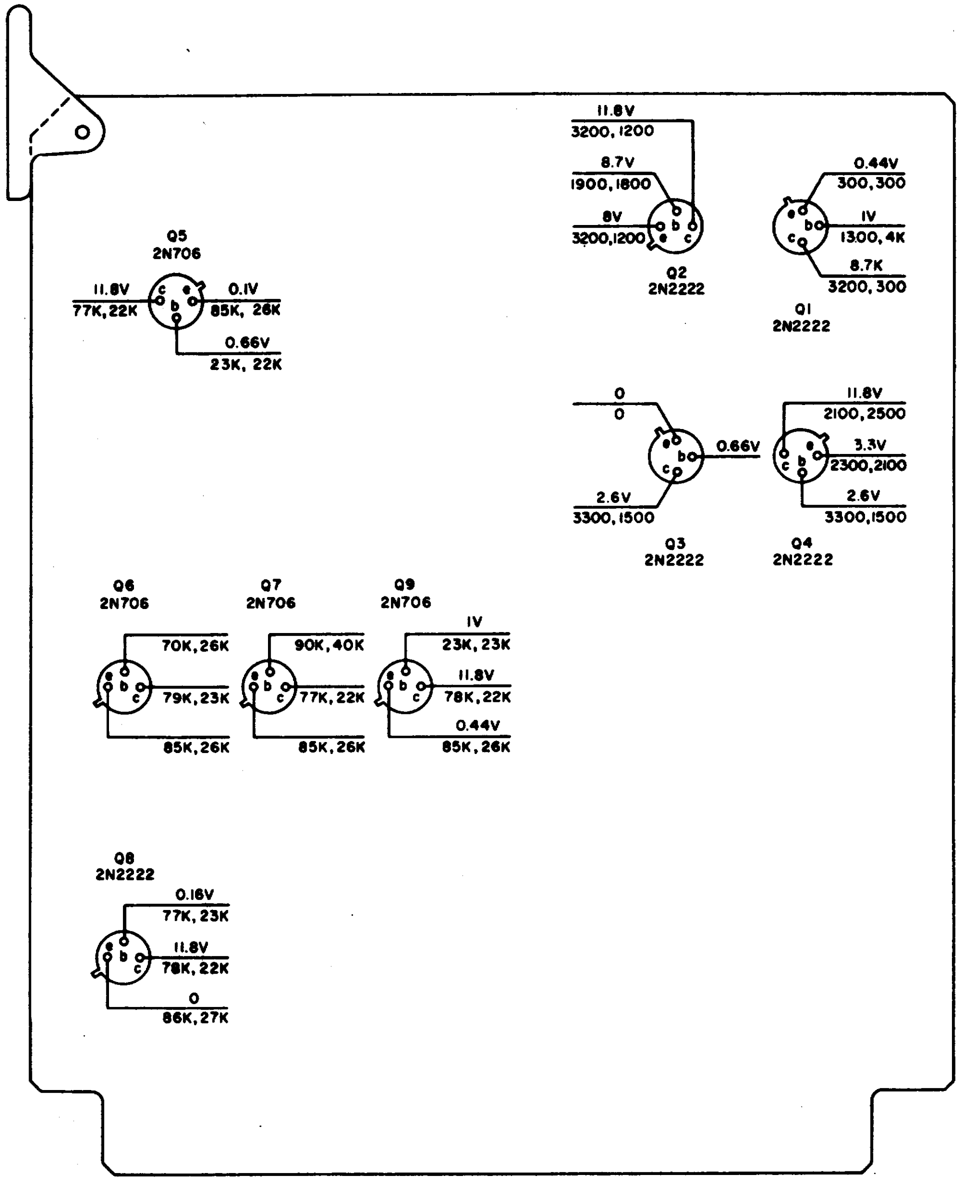
NOTES:

UNLESS OTHERWISE INDICATED

1. ALL MEASUREMENTS ARE FROM DESIGNATED TERMINAL TO CHASSIS. VOLTAGES SHOWN ABOVE LEAD LINES, RESISTANCES BELOW. VOLTAGES SHOWN FOR NON-DIGITAL CIRCUITS ONLY
2. VOLTAGES MEASURED WITH MULTIMETER ME-26/U, NO SIGNAL CONDITIONS
3. REMOVE MODULE FROM EQUIPMENT TO MAKE RESISTANCE MEASUREMENTS. MAKE MEASUREMENTS WITH MULTIMETER TS-352/U, R×100 RANGE FOR INDICATED RESISTANCES 10K OR BELOW, AND R×10K RANGE FOR THOSE ABOVE 10K. FIRST READING WITH NEGATIVE LEAD TO CHASSIS, SECOND WITH LEADS REVERSED
4. PREFIX REFERENCE DESIGNATIONS WITH A7

TM6625-667-35-40

Figure 3-13. Decoder module A7 voltage and resistance diagram.



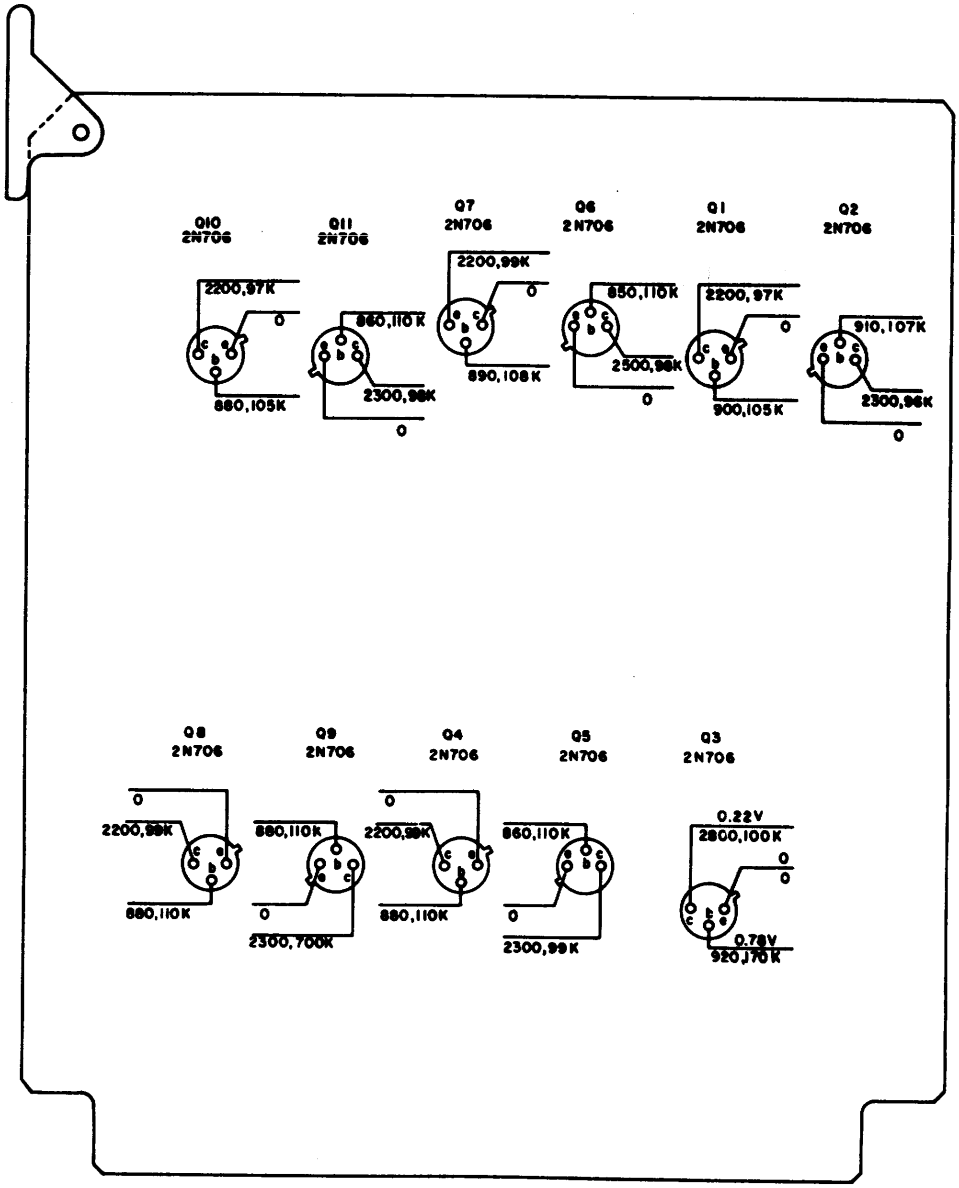
NOTES:

UNLESS OTHERWISE INDICATED

1. ALL MEASUREMENTS ARE FROM DISIGNATED TERMINAL TO CHASSIS. VOLTAGES SHOWN ABOVE LEAD LINES, RESISTANCE BELOW VOLTAGES SHOWN FOR NON-DIGITAL CIRCUITS ONLY
2. VOLTAGES MEASURED WITH MULTIMETER ME-26/U, NO SIGNAL CONDITIONS
3. REMOVE MODULE FROM EQUIPMENT, TO MAKE RESISTANCE MEASUREMENTS. MAKE MEASUREMENTS WITH MULTIMETER TS-352/U, Rx 100 RANGE FOR INDICATEO RESISTANCES 10K OR BELOW, AND RX10K RANGE FOR THOSE ABOVE 10K. FIRST READING WITH NEGATIVE LEAD TO CHASSIS SECOND WITH LEADS REVERSED
4. PREFIX REFERENCE DESIGNATIONS WITH A8

TM6625-667-35-21

Figure 3-14. Decoder module A8 voltage and resistance diagram.



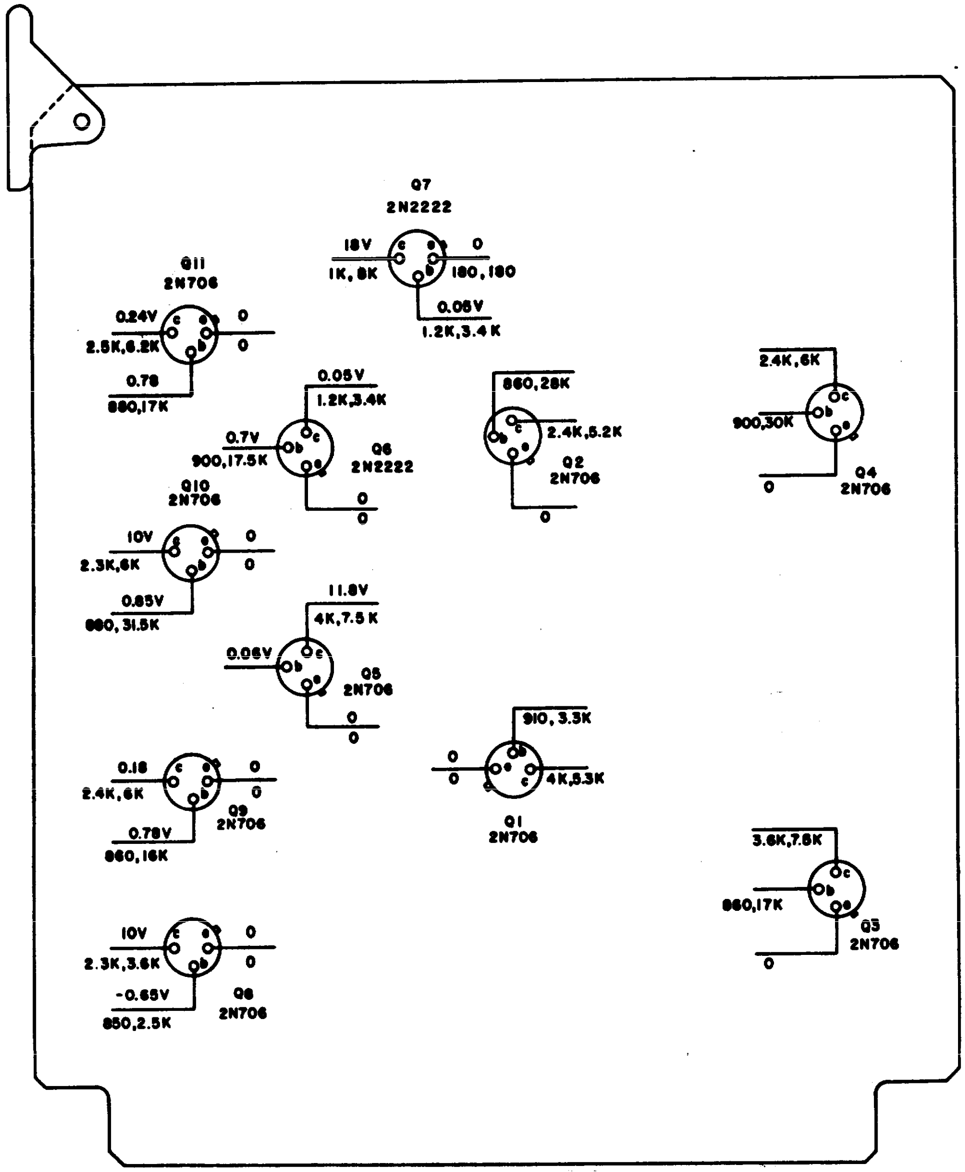
NOTES:

UNLESS OTHERWISE INDICATED

1. ALL MEASUREMENTS ARE FROM DESIGNATED TERMINAL TO CHASSIS. VOLTAGES SHOWN ABOVE LEAD LINES, RESISTANCES BELOW. VOLTAGES SHOWN FOR NON-DIGITAL CIRCUITS ONLY
2. VOLTAGES MEASURED WITH MULTIMETRER ME-26/U, NO SIGNAL CONDITIONS
3. REMOVE MODULE FORM EQUIPMENT TO MAKE RESISTANCE MEASUREMENTS. MAKE MEASUREMENTS WITH MULTIMETER TS-352/U, Rx 100 RANGE FOR INDICATED RESISTANCES 10K OR BELOW, AND Rx 10K RANGE FOR THOSE ABOVE 1OK. FIRST READING WITH NEGATIVE LEAD TO CHASSIS, SECOND WITH LEADS REVERSED
4. PREFIX REFERENCE DESIGNATIONS WITH A9

TM6624-667-35-30

Figure 3-15. Decoder module A9 voltage and resistance diagram.



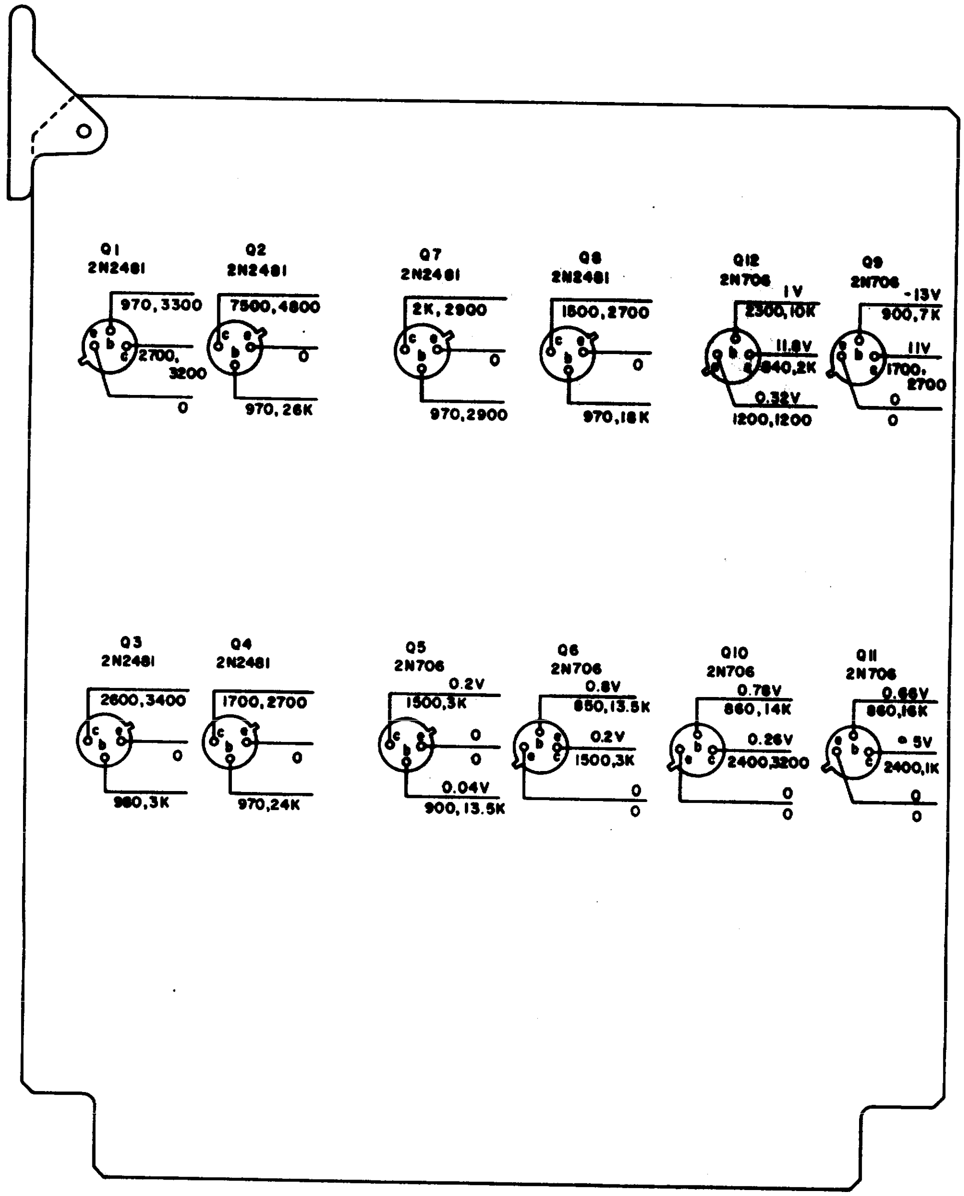
NOTES:

UNLESS OTHERWISE INDICATED

1. ALL MEASUREMENTS ARE FROM DESIGNATED TERMINAL TO CHASSIS. VOLTAGE SHOWN ABOVE LEAD LINES, RESISTANCES BELOW. **VOLTAGES SHOWN FOR NON-DIGITAL CIRCUITS ONLY**
2. **VOLTAGES** MEASURED WITH MULTIMETER ME-26/U, NO SIGNAL CONDITIONS
3. REMOVE MODULE FROM EQUIPMENT TO MAKE RESISTANCE MEASUREMENTS. MAKE MEASUREMENTS WITH MULTIMETER TS-352/U, Rx 100 RANGE FOR INDICATED RESISTANCES 10K OR BELOW AND **Rx** 100K RANGE FOR THOSE ABOVE 10K. FIRST READING **WITH NEGATIVE LEAD TO CHASSIS, SECOND WITH LEADS REVERSED**
4. **PREFIX REFERENCE DESIGNATIONS WITH A10**

TM6625-667-35-19

Figures 3-16. Decoder module A10 voltage and resistance digram.



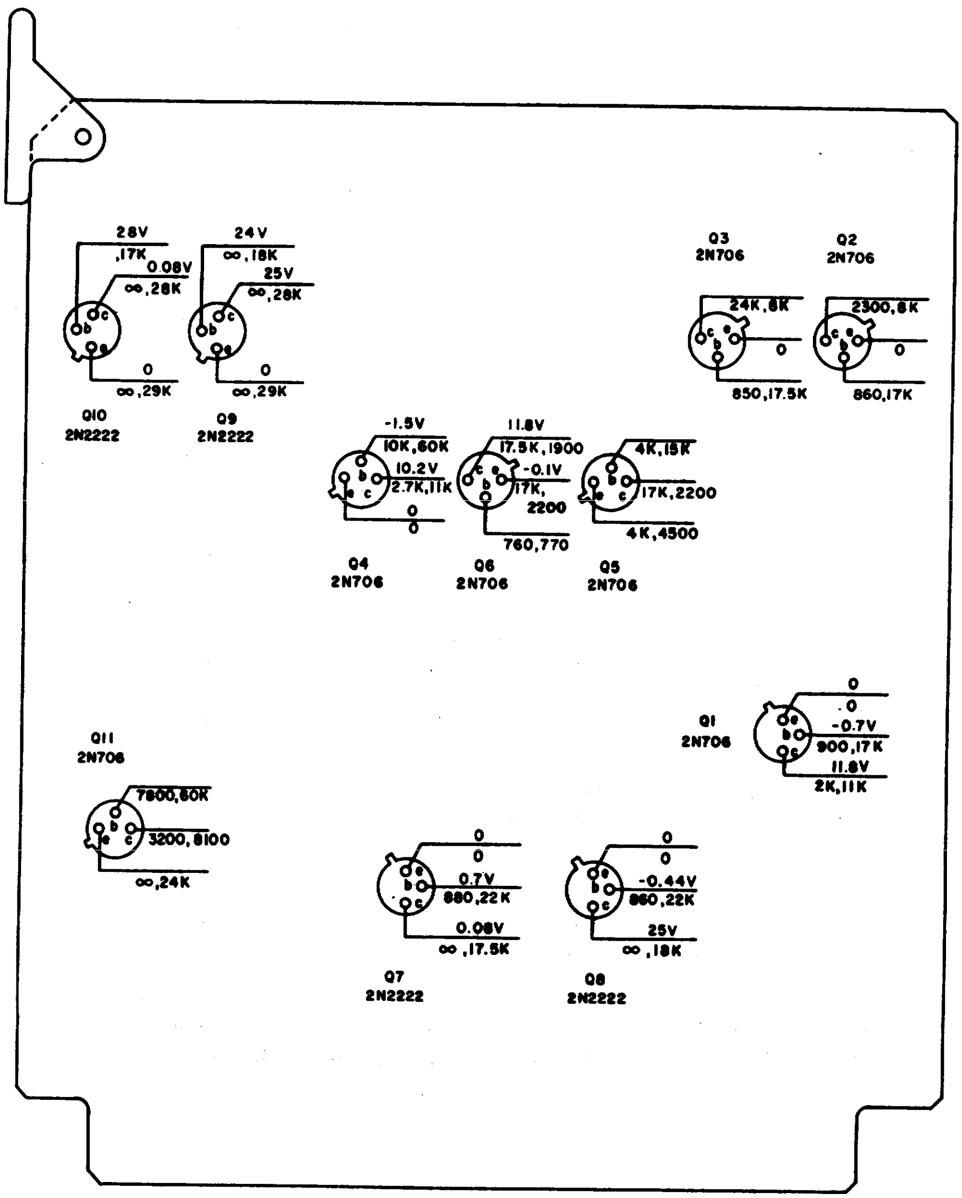
NOTES:

UNLESS OTHERWISE INDICATED

1. ALL MEASUREMENTS ARE FROM DESIGNATED TERMINAL CHASSIS. VOLTAGES SHOWN ABOVE LEAD LINES, RESISTANCES BELOW. VOLTAGES SHOWN FOR NON-DIGITAL CIRCUITS ONLY
2. VOLTAGES MEASURED WITH MULTIMETER ME-26/U NO SIGNAL CONDITIONS
3. REMOVE MODULE FROM EQUIPMENT TO MAKE RESISTANCE MEASUREMENTS. MAKE MEASUREMENTS WITH MULTIMETER TS-352/U, Rx 100 RANGE FOR INDICATED RESISTANCES 10 K OR BELOW, AND RX 10K RANGE FOR THOSE ABOVE 10K. FIR$T READING WITH NEGATIVE LEAD TO CHASSIS, SECOND WITH LEADS REVERSED
4. PREFIX REFERENCE DESIGNATIONS WITH A11

TM6625-667-35-27

Figure 3-17. Decoder module A11 voltage and resistance diagram.



NOTES:

UNLESS OTHERWISE INDICATED

1. ALL MEASUREMENTS ARE FROM DESIG6NATE0 TERMINAL TO CHASSIS. VOLTAGES SHOWN ABOVE LEAD LINES, RESISTANCES BELOW. VOLTAGES SHOWN FOR NON-DIGITAL CIRCUITS ONLY
2. VOLTAGES MEASURED WITH MULTIMETER ME-26/U, NO SIGNAL CONDITI0NS
3. REMOVE MODULE FROM EQUIPMENT TO MAKE RESISTANCE MEASUREMENTS. MAKE MEASUREMENTS WITH MULTIMETER TS-352/U, Rx100 RAN6E FOR INDICATED RESISTANCES 10K OR BELOW, AND Rx10K RANGE FOR THOSE ABOVE 10K. FIRST READING WITH NEGATIVE LEAD TO CHASSIS, SECOND WITH LEADS REVERSED
4. PREFIX REFERENCE DESIGNATIONS WITH A12

TM6625-667-35-26

Figure 3-18. Decoder module A12 voltage and resistance diagram.

than if taken with the ohmmeter on the RX100 range. When in doubt about the result of resistance measurements, check a known good equipment for correct readings The readings in b below were taken with each module removed from the equipment. First measure between the base and the emitter and between the base and the collector with the positive ohmmeter lead connected to the base, and then measure between the base and the emitter and between the base and the collector with the negative ohmmeter lead connected to the base.

b. In-Circuit Resisance Charts. Listed in the charts in (1) through (11) below are resistance measurements taken of the emitter and collector with the transistors connected in the circuit. The measurements are made with Multimeter TS-352B/U. These readings will be valid only if the same type ohmmeter is used and polarity and range scales are strictly adhered to. Refer to figure 3-19 for the test setup.

(1) *In-circuit resistance measurements of module A4.* All transistors except G13 (2N2222), are type 2N706. All measurements should be within ±50 percent of values shown.

Stage	Measurements with positive ohmmeter lead connected to base				Measurments with negative ohmmeter lead connected to base			
	Emitter to base		Collector to base		Emitter to base		Collector to base	
	Resistance (ohms)	Range	**Resistance (ohms)**	**Range**	Resistance (ohms)	**Range**	**Resistance (ohms)**	Range
Q1------------	24K	R X 10K	9K	R X 100	880	R X 100	710	R X 100
Q2------------	33K	R X 10K	14K	R X 10K	870	R X 100	730	R X 100
Q3------------	23K	R X 10K	8K	R X 100	860	R X 100	630	R X 100
Q4------------	23X	R X 10K	8K	R X 100	850	R X 100	670	R X 10
Q5------------	33K	R X 10K	8K	R X 100	880	R X 100	710	R X 100
Q6------------	35K	R X 10K	17K	R X 10K	870	R X 100	710	R X 100
Q7------------	24K	R X 10K	8500	R X 100	880	R X 100	720	R X 100
Q8------------	470K	R X 10K	750K	R X 10K	840	R X 100	700	R X 100
Q9------------	10K	R X 10K	7K	R X 100	850	R X 100	710	R X 100
Q10-----------	35K	R X 10K	17K	R X 10K	870	R X 100	730	R X 100
Q11-----------	34K	R X 10K	8500	R X 100	850	R X 100	650	R X 100
Q12-----------	780	R X 100	1100	R X 100	840	R X 100	630	R X 100
Q13 (2N2222)..	678K	R X 10K	1200	R X 100	830	R X 100	820	R X 100

(2) In-circuit resistance measurements of module A5. All transistor, except Q7 and Q11, are type 2N706. All measurements should be within ±50 percent of values shown.

	Measurements with *positive* ohmmeter lead connected to base				Measurements with *negative* ohmmeter lead connected to base			
			Collector to base		Emitter to base		Collector to base	
	Resistance (ohms)	Range	Resistance (ohms)	Range	Resistance (ohms)	Range	Resistance (ohms)	Range
Q1------------	530K	R X 10K	30K-----	R X 10X	800	R X 100	720	R X 100
Q2------------	480K	R X 10K	30K-----	R X 10K	880	R X 100	720	R X 100
Q3------------	540K	R X 10K	26K-----	R X 10K	880	R X 100	710	R X 100
Q4------------	450K	R X 10K	17K-----	R X 10K	900	R X 100	720	R X 100
Q5------------	410K	R X 10K	24K-----	R X 10K	910	R X 100	830	R X 100
Q6------------	480K	R X 10K	28K-----	R X 10K	900	R X 100	720	R X 100
Q7 (2N2222) ---	71K	R X 10K	1 mego---	R X 10K	920	R X 100	920	R X 100
Q8------------	2500	R X 100	12K-----	R X 10K	900	R X 1 0 0	770	R X 100
Q9------------	14X	R X 10K	8K------	R X 100	860	R X 100	700	R X 100
Q10-----------	830	R X 100	675K----	R X 100	870	R X 100	1100	R X 100
Q11 (2N2222)--	71K	R X 10K	750K----	R X 10K	920	R X 100	920	R X 100
Q12-----------	2600	R X 100	14K-----	R X 10K	860	R X 100	770	R X 100
Q13-----------	15K	R X 10K	8K------	R X 100	880	R X 100	720	R X 100
Q14-----------	32K	R X 10K	23K-----	R X 10K	860	R X 100	730	R X 100
Q15----------	32K	R X 10K	23K-----	R X 10K	880	R X 100	720	R X 100
Q16-----------	7K	R X 10K	20K-----	R X 10K	870	R X 100	730	R X 100
Q17----------	14K	R X 10K	8K------	R X 100	950	R X 100	880	R X 100
Q18-----------	830	R X 100	1K------	R X 100	870	R X 100	650	R X 100

(3) In-circuit resistance measurements of module A7. All transistors, except Q16 (2N2222), are type 2N706. All measurements should be within ±50 percent of values shown.

	Measurements with *positive* ohmmeter lead connected to base				Measurements witb negative ohmeter lead connected to base			
	Emitter to base		Collector to base		Emitter to base		Collector to base	
	Resistance (ohms)	Range	Resistance (ohms)	Range	Resistance (ohms)	Range	Resistance (ohms)	Range
Q1------------	510K----	R X 10K	55K	R X 10K	860	R X 1 0 0	700	R X 100
Q2------------	510K----	R X 10K	56K	R X 10K	870	R X 1 0 0	680	R X 100
Q3-----------	430K----	R X 10K	53K	R X 10K	900	R X 1 0 0	720	R X 100
Q4------------	510K----	R X 10K	56K	R X 10K	880	R X 1 0 0	750	R X 100
Q5------------	470K----	R X 10K	56K	R X 10K	880	R X 1 0 0	730	R X 100
Q6------------	480K----	R X 10K	56K	R X 10K	880	R X 1 0 0	710	R X 100
Q7------------	560K----	R X 10K	56K	R X 10K	850	R X 1 0 0	730	R X 100
Q8------------	520K----	R X 10K	56K	R X 10K	880	R X 1 0 0	720	R X 100
Q9------------	540K----	R X 10K	54K	R X 10K	870	R X 1 0 0	730	R X 100
Q10-----------	510K----	R X 10K	53K	R X 10K	880	R X 1 0 0	720	R X 100
Q11-----------	570K----	R X 10K	56K	R X 10K	880	R X 1 0 0	720	R X 100
Q12-----------	500K----	R X 10K	55K	R X 10K	880	R X 1 0 0	720	R X 100
Q13----------	Variable-.	------------	56K	R X 10K	870	R X 1 0 0	700	R X 100
Q14-----------	430K----	R X 10K	∞	R X 10K	800	R X 1 0 0	720	R X 100
Q15----------	490K----	R X 10K	56K	R X 10K	860	R X 1 0 0	730	R X 100
Q16 (2N2222)--	Variable-.	------------	29K	R X 10K	910	R X 1 0 0	900	R X 100

(4) ***In-circuit resistance measurements of module A8.*** **Unless specified otherwise, all transistors are type 2N706. All measurements should be within ±50 percent of values shown.**

Stage	Measurements with *positive* ohmmeter lead connected to base				Measurements with *negative* ohmmeter lead connected to base			
	Emitter to base		Collector to base		Emitter to base		Collector to base	
	Resistance (ohms)	Range	Resistance (ohms)	Range	Resistance (ohms)	Range	Resistance (ohms)	Range
Q1 (2N2222)	4300	R X 100	9K	R X 100	860	R X 100	8800	R X 100
Q2 (2N2222)	880	R X 100	880	R X 100	730	R X 100	880	R X 100
Q3 (2N2222)	780	R X 100	7K	R X 100	880	R X 100	7K	R X 100
Q4 (2N2222)	4K	R X 100	2800	R X 100	910	R X 100	2800	R X 100
Q5	112K	R X 10K	110K	R X 10K	880	R X 100	100K	R X 10K
Q6	10K	R X 10K	7600	R X 100	860	R X 100	7600	R X 100
Q7	110K	R X 10K	110K	R X 100	860	R X 100	100K	R X 100
Q8 (2N2222)	17K	R X 10K	830	R X 100	780	R X 100	820	R X 100
Q9	112K	R X 10K	110K	R X 10K	860	R X 100	100K	R X 10K

(5) *In-circuit resistance measurements of module A9.* All transistors are type 2N706. All measurements should be within ±50 percent of values shown.

Stage	Measurements with *positive* ohmmeter lead connected to base				Measurements with *negative* ohmmeter lead connected to base			
	Emitter to base		Collector to base		Emitter to base		Collector to base	
	Resistance (ohms)	Range	Resistance (ohms)	Range	Resistance (ohms)	Range	Resistance (ohms)	Range
Q1	100K	R X 10K	8K	R X 100	10K	R X 10K	740	R X 100
Q2	100K	R X 10K	8K	R X 100	10K	R X 10K	680	R X 100
Q3	175K	R X 10K	50K	R X 10K	10K	R X 10K	800	R X 100
Q4	100K	R X 10K	8K	R X 100	10K	R X 10K	720	R X 100
Q5	100K	R X 10K	8K	R X 100	10K	R X 10K	680	R X 100
Q6	100K	R X 10K	8K	R X 100	10K	R X 10K	680	R X 100
Q7	100K	R X 10K	8K	R X 100	10K	R X 10K	680	R X 100
Q8	100K	R X 10K	8K	R X 100	10K	R X 10K	680	R X 100
Q9	100K	R X 10K	8K	R X 100	10K	R X 10K	640	R X 100
Q10	100K	R X 10K	8K	R X 100	10K	R X 10K	700	R X 100
Q11	10K	R X 10K	8K	R X 100	10K	R X 10K	720	R X 100

(6) *In-circuit resistance measurements of module A10.* Unless specified otherwise, all transistors are type 2N706. All measurements should be within ±50 percent of values shown.

Stage	Measurements with *positive* ohmmeter lead connected to base				Measurements with *negative* ohmmeter lead connected to base			
	Emitter to base		Collector to base		Emitter to base		Collector to base	
	Resistance (ohms)	Range	Resistance (ohms)	Range	Resistance (ohms)	Range	Resistance (ohms)	Range
Q1	3300	R X 100	8500	R X 100	870	R X 100	710	R X 100
Q2	28K	R X 10K	17K	R X 10K	880	R X 100	720	R X 100
Q3	17K	R X 10K	9200	R X 10K	880	R X 100	770	R X 100
Q4	30K	R X 10K	19K	R X 10K	860	R X 100	710	R X 100
Q5	18K	R X 10K	10K	R X 10K	900	R X 100	740	R X 100
Q6 (2N2222)	18K	R X 10K	900	R X 100	910	R X 100	900	R X 100
Q7 (2N2222)	13K	R X 10K	1800	R X 100	860	R X 100	860	R X 100
Q8	2600	R X 100	5800	R X 100	880	R X 100	740	R X 100
Q9	16K	R X 10K	8200	R X 100	910	R X 100	770	R X 100
Q10	42K	R X 10K	36K	R X 10K	850	R X 100	700	R X 100
Q11	17K	R X 10K	8500	R X 10K	880	R X 100	710	R X 100

(7) *In-circuit resistance measurements of module A11*. Unless specified otherwise, all transistors are type 2N706. All measurements should be within ±50 percent of values shown.

Stage	Measurements with *positive* ohmmeter lead connected to base				Measurements with *negative* ohmmeter lead connected to base			
	Emitter to base		Collector to base		Emitter to base		Collector to base	
	Resistance (ohms)	Range	Resistance (ohms)	Range	Resistance (ohms)	Range	Resistance (ohms)	Range
Q1 (2N2481)	3300	R X 100	12K	R X 10K	980	R X 100	800	R X 100
Q2 (2N2481)	26K	R X 10K	31K	R X 10K	960	R X 100	800	R X 100
Q3 (2N2481)	1K	R X 100	800	R X 100	3K	R X 100	5K	R X 100
Q4 (2N2481)	25K	R X 10K	15K	R X 10K	970	R X 100	800	R X 100
Q5	13K	R X 10K	5300	R X 100	890	R X 100	720	R X 100
Q6	13K	R X 10K	5300	R X 100	860	R X 100	700	R X 100
Q7 (2N2481)	3K	R X 100	4300	R X 100	1K	R X 100	820	R X 100
Q8 (2N2481)	17K	R X 10K	9K	R X 100	960	R X 100	800	R X 100
Q9	7K	R X 100	15K	R X 10K	900	R X 100	730	R X 100
Q10	14K	R X 10K	7200	R X 100	870	R X 100	780	R X 100
Q11	15K	R X 10K	8200	R X 100	900	R X 100	740	R X 100
Q12	11K	R X 10K	1300	R X 100	900	R X 100	670	R X 100

(8) *In-circuit resistance measurements of module A12.* Unless specified otherwise, all transistors are type 2N706. All measurements should be within ±50 percent of values shown.

Stage	Measurements with *positive* ohmmeter lead connected to base				Measurements with *negative* ohmmeter lead connected to base			
	Emitter to base		Collector to base		Emitter to base		Collector to base	
	Resistance (ohms)	Range	Resistance (ohms)	Range	Resistance (ohms)	Range	Resistance (ohms)	Range
Q1	16K	R X 10K	8500	R X 100	720	R X 100	720	R X 100
Q2	16K	R X 10K	8200	R X 100	870	R X 100	720	R X 100
Q3	16K	R X 10K	8200	R X 100	900	R X 100	740	R X 100
Q4	60K	R X 10K	54K	R X 10K	910	R X 100	700	R X 100
Q5	14K	R X 10K	12K	R X 10K	880	R X 100	720	R X 100
Q6	17K	R X 10K	18K	R X 10K	880	R X 100	720	R X 100
Q7 (2N2222)	21K	R X 10K	∞	R X 10K	870	R X 100	760	R X 100
Q8 (2N2222)	21K	R X 10K	∞	R X 10K	880	R X 100	860	R X 100
Q9 (2N2222)	∞	R X 10K	∞	R X 10K	890	R X 100	860	R X 100
Q10 (2N2222)	∞	R X 10K	∞	R X 10K	880	R X 100	870	R X 100
Q11	440K	R X 10K	54K	R X 10K	890	R X 100	740	R X 100

(9) *In-circuit resistance measurements of module A13.* All measurements should be within ±50 percent of values shown.

Stage	Measurements with *positive* ohmmeter lead connected to base				Measurements with *negative* ohmmeter lead connected to base			
	Emitter to base		Collector to base		Emitter to base		Collector to base	
	Resistance (ohms)	Range	Resistance (ohms)	Range	Resistance (ohms)	Range	Resistance (ohms)	Range
Q1 (2N1485)	4K	R X 100	770	R X 100	580	R X 100	580	R X 100
Q2 (2N2222)	1200	R X 100	4K	R X 100	910	R X 100	900	R X 100
Q3 (2N2222)	24K	R X 10K	5K	R X 100	890	R X 100	880	R X 100
Q4 (2N2222)	1200	R X 100	400K	R X 10K	820	R X 100	820	R X 100

(10) *In-circuit resistance measurements of module A14.* Unless specified otherwise, all transistors are type 2N1485. All measurements should be within ±50 percent of values shown.

Stage	Measurements with *positive* ohmmeter lead connected to base				Measurements with *negative* ohmmeter lead connected to base			
	Emitter to base		Collector to base		Emitter to base		Collector to base	
	Resistance (ohms)	Range	Resistance (ohms)	Range	Resistance (ohms)	Range	Resistance (ohms)	Range
Q1	100	R X 100	1500	R X 100	100	R X 100	480	R X 100
Q2	100	R X 100	1500	R X 100	100	R X 100	480	R X 100
Q3	100	R X 100	∞	R X 10K	200	R X 100	600	R X 100
Q4	100	R X 100	∞	R X 10K	100	R X 100	480	R X 100
Q5	∞	R X 10K	1K	R X 100	630	R X 100	620	R X 100
Q6 (2N706)	4700	R X 100	2K	R X 100	850	R X 100	700	R X 100
Q7 (2N2222)	19K	R X 10K	20K	R X 10K	930	R X 100	930	R X 100

(11) *In-circuit resistance measurements of module A16.* Unless specified otherwise, all transistors are type 2N706. All measurements should be within ±50 percent of values shown. Transistor Q3 is not listed because it is not accessible.

Stage	Measurements with positive ohmmeter lead connected to base				Measurements with negative ohmmeter lead connected to base			
	Emitter to base		Collector to base		Emitter to base		Collector to base	
	Resistance (ohms)	Range	Resistance (ohms)	Range	Resistance (ohms)	Range	Resistance (ohms)	Range
Q1 (2N2222) ---	750K	R X 10K	780K	R X 10K	10K	R X 10K	10K	R X 10K
Q2 (2N2222) ---	680K	R X 10K	700K	R X 10K	10K	R X 10K	11K	R X 10K
A2Q1---------	58K	R X 10K	58K	R X 10K	10K	R X 10K	740	R X 100
A2Q2----------	22K	R X 10K	22K	R X 10K	10K	R X 10K	720	R X 100
A2Q3 (2N1485)-	11K	R X 10K	11K	R X 10K	620	R X 100	620	R X 100

3-9. Out-of-Circuit Transistor Tests

Perform as many in-circuit tests (para 3-8) as practical before removing wired-in transistors When a transistor tester is not available an ohmmeter may be used to test the emitter and collector diode condition (a below), maximum leakage **(I_{co})** (b below), and grounded emitter and current gain (dc beta) (c below).

***Caution:* Use only the ohmmeter range specified to avoid transistor damage. Set ohmeter range before making any connections.**

a. Emitter and Collector Diode Test. Use the chart (d below) in conjunction with figure 3-19, to determine the condition of the emitter and collector diodes of the transistor under test. Ohmmeter connections, to measure forward and reverse resistance of either emitter or collector diodes of NPN transistors, are shown in the illustration. Only NPN-type transistors are used in this equipment. If the needle of the ohmmeter creeps slowly toward a lower value while forward or reverse resistance measurements are being performed, the transistor is defective.

***Caution:* If either of the transistor junctions (diodes) is shorted, as indicated by low dc resistance of both directions do not perform the leakage test (b below) as the ohmmeter may be damaged.**

b. Leakage Test. Connect the transistor and the TS-352B/U as shown in figure 3-20. The resultant value should be equal to, or less than, the maximum allowable leakage current (I_{co}) for that particular transistor as shown in the *Maximum leakage* **(I_{co})** column (d below).

Note. Although Multimeter TS-352B/U cannot be utilized for measuring current as low as 1 microampere **(µa)**, any readable deflection in this range can be assumed to be in excess of the permissible maximum leakage current. Since the **10-µa** reading is also on the low end of the meter scale and similarly difficult to read, any indication significantly higher (above 20 µa) can be assumed to be too great.

c. Gain Test. Connect the transistor and ohmmeter as shown in figure 3-21. Note the ohmmeter indication. The grounded emitter current gain (dc beta) can then be computed from the appropriate formula below and compared with the values listed in the *Minimum gain dc beta* column (d below).

Low-power transitions: $\text{Dc beta} = \dfrac{12{,}000}{\text{Ohmmeter reading}}$

High-power transistors: $\text{Dc beta} = \dfrac{1{,}200}{\text{Ohmmeter reading}}$

Note. A transistor that indicates normal during gain tests may still have excessive leakage.

d. Readings. The following chart lists readings taken with the TS-352B/U connected as shown in figure 3-19 (resistance), figure 3-20 (leakage, I_{co}), and figure 3-21 (gain, dc beta).

NPN transistor (A, B, fig. 3-19)		Emitter-base				Collector-base				Maximum leakage (I_{co}) (fig. 3-20)	Minimum gain dc beta (fig. 3-21)
		Forward		Reverse		Forward		Reverse			
Type	Power	Range	Reading ±30%	Range	Reading ±30%	Range	Reading ±30%	Range	Reading ±30%		
2N706	Low	RX10K	500K	RX100	830	RX10K	720	RX100	∞	0.005μa	20
2N2222	Low	RX10K	∞	RX100	820	RX10K	830	RX100	∞	0.01μa	75
2N1485	High	RX10K	∞	RX100	600	RX10K	560	RX100	∞	15μa	35
2N2219	Low	RX10K	1.5 mego	RX100	900	RX10K	890	RX100	∞	0.01μa	75
2N2481	Low	RX10K	∞	RX100	1600	RX10K	850	RX100	∞	0.05μa	40

3-10. Removal of Transmitter A16 for Trouble-shooting (fig. 3-7)

To reach transistor and tube sockets for trouble-shooting, remove the transmitter from its case. Do this by removing the 10 screws around its outer perimeter, then withdrawing the transmitter from its case This action also exposes regulator sub-assembly A16A2 and transistors A16Q1 and A16Q2, all located within the transmitter (fig. 8-25).

3-11. Dc Resistance of Transformers

a. The dc resistance data (b below) is provided as an aid to trouldeshooting. When using the data, observe the following:

(1) Before making resistance measurements of the windings, determine that faulty operation is likely due to a faulty transformer or coil. To do this, follow the troubleshooting procedures (paras 3-5 and 3-6d).

(2) Do not use the resistance measurements as the sole basis for discarding a transformer as

during manufacture, resistances may vary from one transformer to another; the chart values are typical average values.

(3) The normal resistance of replacement transformers may differ greatly from the values given in the chart.

(4) Special attention should be given to the resistance balance between windings of trans-former A14T1. Refer to figure 8-6 and determine whether transformer windings associated with each square wave multi vibrator are within ±5 per-cent of each other.

b. The following chart contains dc resistance of transformer A15T1 and A14T1.

Transformer	Winding	Resistance (ohms)
A14T1	1-2	2 6
	3-4	1.2
	4-5	1.2
	6-7	2 5
	8-9	2.6
	10-11	1.2
	11-12	1.2
	13-14	2 6
	15-16	800
	17-18	12.5
A15T1	1-2	7
	2-3	1.8
	4-5	0.5
	6-7	0.5

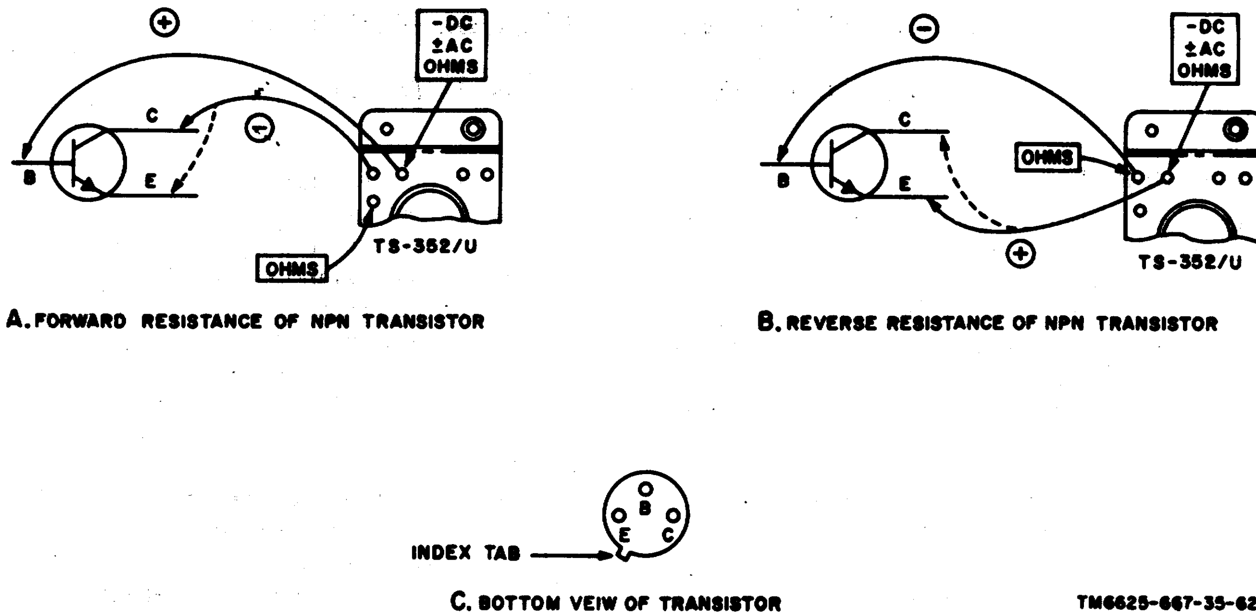


Figure 3-19. Transistor forward and reverse resistance measurements.

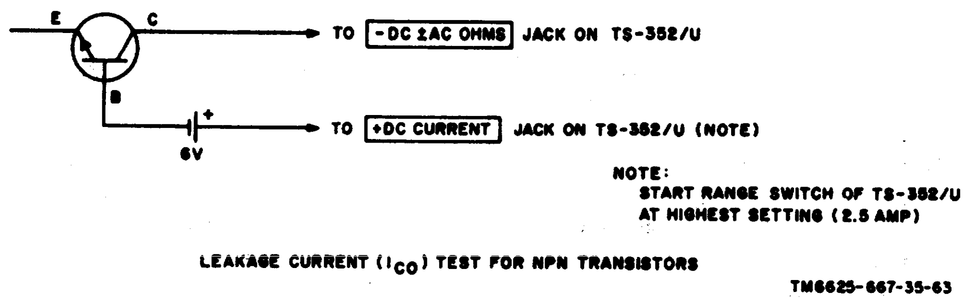


Figure 3-20. *Transistor leakage current (I_{co}) tests.*

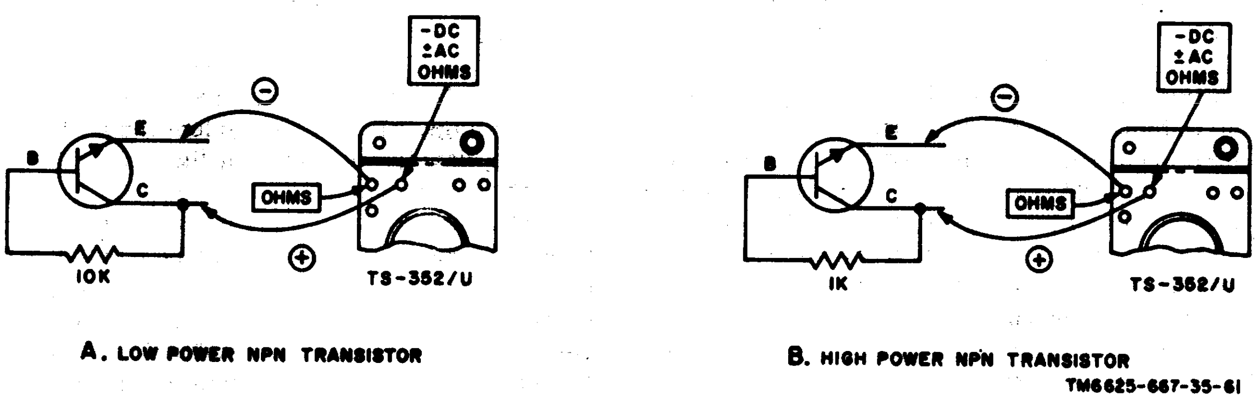


Figure 3-21. Grounded emitter dc gain tests.

SECTION III. GENERAL TROUBLESHOOTING TECHNIQUES USING AN/TPM-25A

3-12. General Instructions

Troubleshooting at general support and depot maintenance categories encludes all techniques outlined for organizational maintenance and any special or additional techniques required to isolate a defective part. Section II of this chapter provides intra unit within the unit) localizing and isolating techniques to be used at the general support maintenance category.

3-13. Organizational of Troubleshooting Procedures

a. General. The first step in servicing a defective test set is to sectionalize the fault. Sectionalization means tracing the fault to a particular module or subassembly (for example; encoder module A4 or transmitter A16). The second step is to localize the fault. Localization means tracing the fault to a defective stage or circuit responsible for the abnormal condition. The third step is isolation. Isolation means locating the defective part or parts.

b. Sectionalization. The daily maintenance checks and services (TM 11-6625-667-12) provides a satisfactory means of determining whether the transponder test set may be operating. Because of the nature of the self test operation, the exact cause of an internal fault cannot be determined with this chart. The test set provides only an accept or reject indication; therefore, one or more internal circuits can cause an improper indication. To simplify the location of a fault, consider that there are four main functional sections in Test Set, Transponder TS-1809/APM-23V. These functional sections include the power supply, transmitter, receiver, and decoder. The first step in tracing trouble is to determine the module or subassembly of the section that contains the fault.

(1) *Visual inspection.* The purpose of visual inspection is to locate faults that maybe evident without testing or measuring. This includes broken wires, bent or corroded connector pins, damage circuit boards, or loose RF jacks and plugs. All possible visible inspections should be performed before attempting operational tests.

(2) *Sectionalization tests.* The sectionalization tests are operational type tests and frequently indicate the general location o trouble. In some instances, the tests will help in determining the exact nature of the fault. Tests are given in paragraph 3-15.

c. Localization. Localization procedures should be performed after the trouble has been sectionalized (b above. Localization procedures applicable to this equipment are described in paragraphs 3-5 and 3-6, and should be used in localizing the trouble to a stage in the suspects module or subassembly,

d. Isolation. Procedures for isolating troubles are given in paragraph 3-7.

e. Techniques. When performing the sectionalization para 3-4), localization, and isolation procedures, one or more of the technique described below may be applied. Apply these techniques only as indicated, and observe al cautions.

(1) *Voltage measurements. This equipmen* is transistorized. When measuring voltages, use tape or sleeving (spaghetti) to insulate the entire test probe, except for the extreme tip. A momentary short circuit can ruin a transistor Use the same or equivalent electronic multimeter specified on the voltage and resistance diagrams.

NOTE

Modules A4, A5, and A7 through A12 contain digital circuits. Do not attempt to analyze their operation with voltage readings. Analyze their operation with the waveforms shown in figures 8-17 through 8-23.

(2) *Resistance measurements.* Make resistance measurements in this equipment only as directed on the voltage and resistance diagrams. For transistorized circuits, use only the ohmmeter ranges specified on figures 3-8 through 3-18; otherwise, indications will be inaccurate.

CAUTION

Before using an ohmmeter to test transistors or transistor circuits, check the open circuit voltage across the ohmmeter test leads. Do not use the ohmmeter if the open circuit voltage exceeds 1.5 volt. Also, since the RX1 range normally connect the ohmmeter internal battery directly across the test leads, the comparatively high current (50 ma or more may damage the transistor under test. As a general rule, the RX1 range of any ohmmeter should not be used when testing low powered transistors.

(3) *Waveforms*. Signals associated with digitial circuits are illustrated with waveforms. Unless otherwise specified, pulse duration is a secondary consideration. Important pulse durations are specified as nominal values when applicable. Test Point pulse amplitudes are not shown, since they all range between 7 and 12 volts. Waveforms shown for the transmitter output specify all characteristics of the pulses excepts the levels, which are determined by power measurements of the transmitter output.

NOTE

When pulse duration is specified, it is measured between the 50 percent points of the waveform. Pulse spacing is measured between the 50 percent points of the leading edges of the specified pulses.

(4) Test *points.* All electrical subassemblies of the test set are equipped with test jacks to facilitate connection of test equipment (para 3-1b). These test jacks should be used whenever possible to avoid needless dissembly of the equipment. The test points are shown On the schematic diagrams. Figure 8-36 illustrates the waveforms for certain test points. Physical location of the test points is shown in figure 3-6. Test point (TP) numbers are color coded and can be identified by the standard RETMA color code as indicated in the chart below:

Test point color	*Test point number*
Brown	1
Rd	2
Oragne	3
Yellow	4
Green	5
Blue	6
Violet	7
Gray	8
White	9

(5) *Extender board.* Measurements to be made at points other than at the test jacks require the use of an extender board (fig. 3-6). The extender board is designed so that 11 connections are symmetrically placed on each side of center. Because of the symmetrical design, insertion of the extender board right side up or wrong side up will not mechanically or electrically affect the circuit. However, plug in boards in serted in the extender board must be inserted exactly the same as originally positioned in the equipment.

(6) *Resistor, capacitor, and diode color code diagrams.* Color code diagrams for resistors, capacitors, and diodes (fig. 8-0.1 and 8-0.2) provide pertinent resistance, voltage rating, and tolerance information.

CAUTION 1

Make sure that no metal objects (screwdriver, pliers, etc.) come in contact with the printed circuit board while power is applied. A short circuit of the wiring could damage the solid state circuit elements mounted on the board.

CAUTION 2

Be certain both the extender board and plug in board are properly installed in their respective sockets.

3-14. Test Equipment and Tools Required

The following chart lists the test equipment (a below) for general support maintenance of Test Set, Transponder AN/APM-123V(V)1,2,3. The associated technical manuals are also listed. Tools are listed in *b* below.

CAUTION 1

Make test equipment connections carefully to avoid short circuits that can be caused by exposed test equipment connections. Tape or sleeve test probes or clips, as necessary; leave only sufficient metal exposed to make contact to the circuit under test.

CAUTION 2

The power must be turned off when a circuit card is to be removed or inserted in the extender card. The card must be inserted in the extender receptacle before power is reapplied to the test set.

CAUTION 3

Do not use test cables with exposed braided) shields. Use jacketed cables to avoid short circuits where the cables must pass over the circuit cards and other subassemblies.

a. Test Equipment Required

Test Equipment	*Technical Manual*
Oscilloscpe, AN/USM-281A	TM 11-6625-l703-l6
Attenuator, Fixed (NSN 5905-00-781-0312).	
Multimeter ME 26B/U	TM 11-6625-200-15
Multimeter TS 352/U	TM 11-6625-366-15
AN/UPM-15A	TM 11-6825-368-10
Test Set, Electron Tube TV 7/U	TM 11-6625-274-12
Test Set, Radar AN/TPM-A	TM 11-6625-2610-12
Test Set, Radar **AN/UPM-137A**[a]	NAVELEX 0960-158-1010 NAVAIR 16-30UPM-137-6-1 AIR FORCE T.O. 33A1-3-426-21-1
Test Set, Radar **AN/UPM-137A**[a] (cont	NAVELEX 0969-158-1020 NAVAIR 16-30UPM-137-6-2 AIR FORCE T.O. 83A1-3-426-21-2
Test Set Transistor TS 1836/U	TM 11-6625-539-15
Wattmeter AN/URM-98[b]	TM 11-6625-433-15

[a]If the Test Set, Radar AN/UPM-137A is used, oscillscope AN/USM-281A and Test Set, Radar AN/TPM-25A are not required.
[b]Includes Summation Bridge TS 779A/U and Waveguide Probe MX-2144/U.

b. Tools.

(1) Repair Kit, Printed Wiring Board MK-772/U.

(2) Tool Kit, Electronic Equipment TK-100/G.

3-15. Sectionalization Tests

a. General. Sectionalization tests are performed to sectionalize a fault to a module or subassmembly. These tests are an extension of the operational tests in the daily maintenance checks and services chart (TM 11-6625-667-12). Two sectionalization tests are provided, the first uses Radar Test Set AN/TPM-25A and the second uses Radar Test Set AN/UPM-137A.

b. Test Setups. A test setup is provided for each type of test (fig. 3-22 through 3-25 for sectionalization tests using AN/TPM-25A and figure 3-5.1 for sectionalization tests using AN/UPM-137A). Instructions for making primary power connections are in TM 11-6625-667-12. During the sectionalization tests, the required setup is referred to and test conditions noted. Refer to figure 3-6 for physical location of the test points. Test steps must be performed in the order given to ensure proper equipment connecting and test conditions. Instructions are provided in the charts for using the test equipment. These, instructions, however, should be supplamented with the instruction manual applicable to the test equipment. Before proceeding with a test setup, remove the transponder test set from its case remove the card cage cover to expose the test points and controls. Proceed as follows:

(1) Unlatch and remove the test set cover.

(2) Remove four hexagonal screws from the front panel with a hexagonal driver. One screw is located above and one below each front panel handle.

(3) Lift the TS-1089/APM-123V from the case. A gentle rocking motion may be necessary.

(4) Set the TS-1089/APM-123V carefully on a clean area of the workbench. Position the TS-1089/APM-123V for convenient access to both the rear section (test point location, fig. 3-6), and the front panel.

(5) Remove the card cage cover by unfastening the four screws which secure it to the preselector (A15A1Z1) and remove the two screws which secure it to the card cage.

c. Use of Chart. The sectionalization test charts (d and e below) are step by step test procedures with reference to an applicable paragraph which contains a troubleshooting chart covering the probable trouble and required corrective measure to obtain a normal indication. Each step should be followed in the order given for effective fault isolation. The procedure column refers to the applicable test setup and provides instrucitons for adjusting the equip ment for a specific measurement. The normal indication column specifies the results that should be observed. Waveforms at applicable test points are illustrated in figure 8-36.

d. Sectionalization Test Using AN/TPM-25A.

Step	Control settings		Procedure	Normal Indication	Paragraph reference
	Test equipment	Equipment under test			
1	ME-26B/U FUNCTION (+) RANGE: 30V	MODE: 1 FUNCTION: SYSTEM ISLS: OFF 28 VDC 115-VAC OFF: OFF	*a.* Connect the equipment as illustrated in figure 3-1, except for dc probe. *b.* Set the transponder test set 28 vdc 115 VAC switch to 115 VAC *c.* Set the ME 26B/U FUNCTION switch (+) and turn on the test set Allow 2 minutes warmup time Connect the dc test probe to test point A13TP4. *d.* Connect the ME 26B/U dc test probe to test point A13TP3. Observe the meter indication.	*a.* None *b.* None *c.* +28 vdc ±3. *d.* +12 vdc ±l.	3-6c.
2	*ME 26B/U* FUNCTION: (-)		*c.* Connect the dc test probe to test point A13TP1 and observe the meter in dication.	–12 vdc ±l.	3-6c.
3	*ME 26B/U* FUNCTION: (+) RANGE: 300V		Connect the dc test probe to test point A14TP3 and observe the meter in dication.	+150 vdc ±5.	3-6c.
4	*AN/TPM-25A* *POWER ON* MEASUREMENT FUNCTION SEL: PWR REPLIES MODULATION SEL: SIF RANGE DELAY SEL: 0100 PRT SEL (USEC): Immaterial TRIG SEL INT DCD/ EXT EXT SIG GEN FUNCTION: FIXED FREQ AN/USM-281A POWER: ON Sweep dis play switch: MAIN DELAYED TIME/DIV: OFF MAIN TIME/DIV: 1 MSEC INT/AUTO/EXT/EXT÷ 10: AUTO MAIN - SLOPE + : + DIV DELAY: Immaterial	MODE 1 FUNCTION: SYSTEM PUSH TO TEST LOCK 28 VDC 115 VAC OFF: 115VAC	*a.* Connect equipment as shown in figure 3-22, to perform system timing test. *b.* On AN/USM-281A, observe positive going prf pulse from A5TP5 on A INPUT, and the delayed prf pulse from the AN/UPM-15A on B IN-PUT. *c.* Adjust AN/UPM-15A PULSE DELAY to position the delayed prf pulse approximately .5 ms before the trailing edge of the prf pulse. *d.* Continue adjustment of PULSE DELAY as required until the trans-sponder test set ACCEPT lamp is on solidly.	a. None. *b.* None *c.* None. *d.* CL ACCEPT lamp is on.	

Step	Control settings: Test equipment	Control settings: Equipment under test	Procedure	Normal Indication	Paragraph reference
(Cont)	DISPLAY: ALT A and B VOLTS/DIV: 5 A and-B-POLARITY: + UP A and B AC/GND/DC: DC				
5	*AN/TPM-25A* POWER ON MEASUREMENT FUNCTION SEL: FREQ REPLIES MODULATION SEL:OFF REPLIES SUB PULSE SEL: OFF RANGE DELAY SEL: 0100 PRT SEL (USEC): Immaterial TRIP SEL INT DCD/ EXT: EXT SIG GEN FUNCTION: SWP ±5 MHz AN/USM-281A POWER: ON Sweep display switch: MAIN MAIN TIME/DIV: .1 MSEC INT/AUTO/EXT/EXT÷ 10: AUTO EXT÷10/EXT INT LINE: EXT MAIN - SLOPE +:+ DISPLAY: ALT B VOLTS/DIV: 2 A VOLTS/DIV: 5 A and B POLARITY: + UP A and B AC/GND/DC: DC	Same as step 4.	*a.* Perform system timing setup step 4 above. *b.* To perform transmitter frequency test, turn off transponder test set and connect equipment as shown in figure 3-23. *c.* Turn off transponder test set and allow two minutes warmup. *d.* On AN/USM-281A, adjust DIV DELAY to position the center (1030 MHz marker on the center vertical graticule. *e.* On AN/TPM-25A, adjust MEASUREMENT FREQ MEA! control for maximum amplitude o either of the pulses displayed on the scope. *f.* Determine the frequency at which the pulse reaches its maximum amplitude by comparison of its position with respect to 1030, 1030 ±1, and the 1030 ± 5 MHz markers.	a. None. *b.* None. *c.* None. *d.* None. *e.* None. *f.* 1030 MHz* 206 kHz.	3-6d.
6	TS 779A/U BOLO BIAS CURRENT: OFF BOLO RES: 200 BOLO TEMP COEF: NEG	Same as step 4	**CAUTION** The bolo bias current switch must be in the OFF position before connecting the MX-2144A/U to the TS 779A/U.		

Step	Control settings: Test equipment.	Control settings: Equipment under test	Procedure	Normal Indication	Paragraph reference
6 (Cont)			*a.* Connect the MX-2144A/U to the TS 779A/U input. . *b.* Adjust the TS-779A/U as follows: (1) RANGE switch at –O DBM. (2) BOLO BIAS CURRENT switch at 10-16 MA. (3) LINE POWER switch at ON and permit a 15-minute warm-up period (4) Adjust ZERO SET COARSE and FINE controls to zero meter. *c.* Connect the equipment as shown in figure 3-3. Be certain test point A4TP5 is grounded *d.* Connect the MX-2144A/U to the transponder test PROBE jack. Observe the power indication. *e.* Disconnect the ground from test point A4TP5 and connect A4TP4 to ground. Turn RANGE switch to -10 DBM. *f.* Observe the power meter indication. When finished with this step, remove the ground from A4TP4.	*a* None *b.* None. *c.* None. *d.* -6 dBm ±1 e. None. *f.* Meter deflects slightly to right approximately -21 dBm).	3-6d.
7	*AN/USM-281A* POWER ON Sweep Display DELAYED TIME/DIV: *5 USEC* *MAIN TIME/DIV:* .1 MSEC INT/AUTO/EXT/EXT ÷ 10 AUTO MAIN-SLOPE+:+ DELAYED–SLOPE +:+ DIV DELAY: 35	Same as step 4.	*a.* Perform system timing setup, step 4 above. *b.* Connect the equipment as shown in figure 3-24. To perform transmitter pulse characteristics test, turn on the oscilloscope and test equipment a few minutes warmup time. *c.* Connect oscilloscope A INPUT to A4TP6 and adjust tbe oscilloscope HORIZONTAL POSITION, MAIN TRIGGER LEVEL, INTENSITY, FOCUS, and ASTIGMATISM controls until a clear and stable waveform is observed.	*a.* None *b.* None. *c.* None.	

Step	Control settings: Test equipment	Control settings: Equipment under test	Procedure	Normal Indication	Paragraph reference
(Cont)	MAIN TRIGGER SOURCE SWITCH: EXT Display: A A VOLTS/DIV: 5 A POLARITY:+ UP A Input Coupling Switch AC AN/TPM-25A MEASUREMENT FUNCTION SEL PWR SIG GEN FUNCTION FIXED FREQ		*d.* Set the transponder test set MODE switch to 1, 2, 3A, and C and observe whether *a pulse pair* (P1 P3) is present for each mode.	*d.* Pulse pair (P1-P3) and P2 pulses present for modes 1, 2, 3/A, TEST and C.	3-6d.
8	*AN/USM-281A* *Main Time* Div:.1 MSEC DIV DELAY: 830 EXT÷ 10/ EXT INT LINE: INT DISPLAY: ALT	ISLS: ON	*a.* Perform system timing setup, step 4 above. *b.* Connect the equipment as shown in figure 3-24, to perform transmitter pulse characteristics test. Adjust MAIN TRIGGER LEVEL to obtain stable trace. c. Set DELAYED TIME DIV to lµSEC. *d.* Measure the pulse widths of the P1, P2, and P3 pulses using the .1 µs frequency markers. *e.* Measure the spacing between the P1, P2, and P3 pulses using .lµs markers. Measurements are made from leading edge to leading edge. *f.* Set the test set MODE switch at each of the following positions (adjust DELAY DIV and DELAYED TIME/DIV as required and measure delays Mode (1) 2 . . . . (2) 3/A. Mode (3) C . . . . (4) TEST 0	*a.* None. *b.* P1, P2, and P3 pulse widths: 0.8 µ s ±0.1 . *c.* Delay between P1 and P2 should be 2 µS ±0.2. Delay between P1 and P3 should be 3µS ±0.2. *d.* P1, P2 and P3 pulse widths should be 0.8 µ s ±0.1. *e.* P1-P3 pulse spacing. (1) 5 µ s ±*0.2.* (2) 8 µ s ±0.2. (3) 21 µ s ±*0.2.* (4) *6.5* µ s ±*0.2.*	3-6f.
9	*AN/TPM-25A* REPLIES panel MODULATION SEL: SIF	Set test set CODE switches to 7777. PUSH TO TEST	*a.* Perform the system timing setup, step 4 above. *b.* Rotate AN/TPM-25A SUM ATTEN dial to increase attenuation until test set REJECT light just comes on.	*a.* None. *b.* None.	

Step	Control settings: Test equipment	Control settings: Equipment under test	Procedure	Normal Indication	Paragraph reference
9 (Cont)	REPLY WIDTH: 0.45 SIF REPLY CODE: 7777 SUB PULSE SEL: OFF RANGE DELAY SEL: 0100 GATING PASS 00 GATING INHIBIT 00 SIF CHAL VID SIF MODE SEL OFF TRIG SEL INT DCD/ EXT INT SIG GEN FUNCTION: FIXED FREQ SUM ATTEN: 0 DB. All other switch settings immaterial.	LOCK FUNCTION: SYSTEM	*c*. Calculate the test set sensitivity by adding SUM ATTEN dial reading and the 1000 MHz insertion loss of cable 45413-139526. *d*. Adjust SUM ATTEN dial for a reading of 3 dB less than that in step *b*.	*c*. sensitivity -9± dBm. *d*. None.	
10	AN/USM-281A DISPLAY: A MAIN TIME/DIV DELAYED TIME/ DIV as required for wave-form		*a*. Connect the oscilloscope A INPUT probe (Figure 3-25) to each of the following test points in the order given to perform receiver and decoder tests. Observe whether the pulses are normal. (1) A10TP5(video enable delay) . . . . (2) A9TP4 (video enable output) . . . . (3) A11TP1 (video shaper output) . . . (4) A9TP3(line drive enable output . . . . (5) A10TP4 (line drive pulse) . . . . (6) A10TP2 (delay line pulse) . . . . . . (7) A10TP1 (delay line main gate input) . . . . (8) A11TP2 (comparison pulse shaper output). . . . . (9) A10TP6 (read delay) . . . . (10) A12TP4 (error blanking) . . . . *b*. Check the following dc levels with oscilloscope (1) A11TP6 (error detector output. Set AN/TPM-25A SIF REPLY CODE switches to 7776 to observe low & level. Return switches to 7777 to observe normal indication.	*a*. Refer to figure 8-36. *b*. Indications are (1) 7-12 volts dc.	(1) 3-6j. *(2) 3-6i.* *(3)* 3-6k. *(4)* 3-6i. *(5) 3-6j.* *(6) 3-6j.* *(7) 3-6j.* *(8)* 3-6k. *(9) 3-6j.* (10) 3-6k.

Step	Control settings: Test equipment	Control settings: Equipment under test	Procedure	Normal Indication	Paragraph reference
10 (Cont)			(2) A12TP3 (readout)	(2) 7 to 12 volts dc.	
			(3) A12TP1 (reply evaluator accept output 1	(3) 7 to 12 volts dc.	
			c. Repeat a (2) through (10) above with transponder test set MODE switch at C, 3/A, TEST, and 1, respectively.	*c*. Indications should be the same as in *a* above.	
			NOTE If all conditions were normal in a above, and an abnormal condition in c above is noted, check the MODE switch for continuity.		
			d. Set the AN/TPM-25A and test set SIF REPLY CODE switches to 7700.	*d*. None.	3-6i.
			e. Set the AN/TPM-25A REPLIES MODULATION SEL switch to IP M2/3 and the test set FUNCTION switch to IP. Connect to oscilloscope probe to test point A9TP4. Observe whether the pulse is normal.	*e*. Waveform in figure 8-36 (A9TP4, I P.	3-6i.
			f. Set the AN/TPM-25A REPLIES MODULATION SEL switch and test set FUNCTION switch to EMER. Observe whether the pulse is normal.	*f*. Waveform in figure 8-36. (A9TP4, MODE 2-IP).	2-6i
			g. Set the test set FUNCTION switch to UP and MODE switch to 2. Observe whether the pulse is normal.	*g*. Waveform in figure 8-36 (A9TP4, MODE 2-I/P).	3-6i.

e. Sectionalization Test Using AN/UPM-137A.

Step	Control settings: Test equipment	Control settings: Equipment under test	Procedure	Normal indication	Paragraph reference
1	*ME 26/U* SELECTOR SWITCH: + RANGE: 30	MODE: 1 FUNCTION: SYSTEM ISLS: OFF	**CAUTION** If any indication during steps 1 through 3 appears abnormal due to a short circuit, shut off the equipment and refer to paragraph 3-5. A short circuit may cause further equipment damage. *a.* Connect equipment as shown in figure 3-1.1. *b.* Turn on equipment. Allow *S* minutes warmup time. Connect &test probe to A13TP4. *c.* Connect dc test probe to test A13TP3. Observe meter indication. Change ME 26A/U SELECT SWITCH to *d.* Connect the dc test probe A13TP1 and observe the meter indication.	*a.* None. *b.* +28±3 vdc. *c.* +12 ±1 vdc. *d.* -12 ±1 vdc.	3-6d. 3-6d.
2	AN/USM-207 DIRECT HETRODYNE switch Hetrodyne VOLTAGE Switch 10V FREQ TUNING–MC: 150 POWER TRACK FUNCTION FREQ SENSITIVITY: PLUG IN CM-77A/USM POWER ON	same as step 1	*a.* Turn off the test set and connect the equipment as shown in figure 3-2. *b.* Turn on the AN/USM-270A and CM-77A/USM. Permit a 1-hour warmup period. *c.* Turn on the test set and permit a 2-minute warmup period. *d.* Press and turn the test set PUSH TO TEST switch to LOCK. On the test set ground TPA4TP5.	*a.* None. *b.* None. *c.* None. *d.* None.	
8	. . . .	. . . .	*a.* Position the CM-77A/USM FREQUENCY MEGACYCLES control near 206 and adjust the control until the units display indicates a zero heat. *b.* Multiply the AN/UMS 207 indication by 6 to obtain the transmitter frequency.	*a.* None. *b.* 1,030 mHz ±206 kHz.	3-6e.

Step	Control settings: Test equipment	Control settings: Equipment under test	Procedure	Normal Indication	Paragraph reference
4	TS 779A/U BOLO BIAS CURRENT OFF BOLO RES 200 BOLO TEMP COEF: NEG	Same as step 1.	**CAUTION** TS 779A/U BOLO BIAS CURRENT control must be set to OFF before the MX-2144A/U is connected to the TS-779A/U to avoid equipment damage *a.* Connect the MX-2144A/U to the TS 779A/U input. *b.* Adjust the TS 779A/U as follows: (1) RANGE switch at –5 DBM. (2) BOLO BIAS CURRENT switch at 10-16 . (3) LINE POWER switch at ON and permit a 15-minute warmup period. (4) Adjust ZERO SET COARSE and FINE controls to zero meter. *c.* Connect the equipment as shown in figure 3-3. Ground A4TP5 by connecting to A13TP2. *d.* Connect the MX-2144A/U to the test set PROBE jack. Observe the power indication. *e.* Disconnect the ground from A4TP5 and connect A4TP4 to ground. *f.* Observe the power meter indication.	*a.* None. *b.* None. *d.* –9 dbm ±1. *e.* None. *f.* -21 dbm ±1.	3-6e.
5	*AN/UPM-137* VERTICAL CHAIN A-VOLTS DIV: .5 VERTICAL CHAN A-ACIDC:AC VERTICAL CHAN A-**75 Ω IN/OUT:** OUT SYNC:EXT AC	Same as step	*a.* Connect the equipment as shown in A, figure 3-4. Turn on the oscilloscope and test set. Permit a few minutes warmup time. connect oscilloscope to test set A4TP6. *b.* Adjust the oscilloscope HORIZONTAL VERTICAL, INTENSITY, SWEEP DELAY, FOCUS, and ASTIGMATISM controls until a clear waveform is observed. *c.* Set the transponder test MODE switch to 1, 2, 3A, and C and observe whether a pulse pair (P1 P3) and low level P2 pulse are present for each mode.	*a.* None. *b.* None. *c.* Pulse pair (P1-P3) and P2 pulses present for mode 1, 2, 3,/A. TEST and C.	

Step	Control settings: Test equipment	Control settings: Equipment under test	Procedure	Normal Indication	Paragraph reference
6	Same as step 5	Same as step 1.	*a.* Connect the equipment as shown in B, figure 3-4. Adjust the AM-3174/USM oscilloscope plug in for X10 GAIN AC, 0.005 volts CM, operation. *b.* Measure the pulse widths of the P1, P2, and P3 pulses. c. Adjust the oscilloscope as follows: (1) Adjust the HORIZONTAL control until the 50-percent point of the first pulse leading edge is positioned at the center graticule line. (2) Adjust the DELAY TIME MULTIPLIER control to measure the delay between the 50-percent points of pulses P1 and P2. Multiply dial reading by 2 and note. (3) Adjust the DELAY MULTIPLIER control to measure the delay between P1 and P3 at the 50-percent of the leading edges, multiply dial reading by 2 and note. *d.* Set oscilloscope TIME BASE B TIME/CM to 5. *e.* Set the test set MODE switch at each of the following positions and repeat c 3) above to measure delays, except to multiply dial reading by 5. (1) 2. . . . . (2) 3/A. . . . . (3) C . . . . (4) TEST	*a* None. *b.* Pl, P2, and P3 pulse widths: 0.8 µ sec ±0.1. *c.* Normal indication are. (1) None. (2) Delay between Pl and P2 should be 2 µ sec ±0.15. (3) Delay between Pl and P3 shown be 3 µ sec ± 0.2. *d.* None. *e.* P1-P3 pulse spacing (1) 5 µ sec ±0.2. (2) 8 µ sec ±0.2. (3) 21 µ sec ±0.2. (4) 6.5 µ sec ±0.2.	3-6f.
7	AN/UPM-137A (rf signal generator OUTPUT ATTEN 0-100 dBm: –5 TRANSMITTER XMTR FREQ XTAL TRANSMITTER CW	MODE: 2 CODE (A, B, C, D): 7777	*a.* Connect equipment as shown in figure 3-5.1 and turn on AN/UPM-137A and test set. Permit a few minutes to warmup. *b.* Press test set PUSH TO TEST switch and turn to LOCK position. *c.* If necessary adjust AN/UPM-137A SIS gen erator TRIGGERS–DELAY (µ SEC)–MULT 1-11 control until test set	*a.* None. *b.* None. c. None.	

Step	Control settings: Test equipment	Control settings: Equipment under test	Procedure	Normal Indication	Paragraph reference
7 (Cont)	SOURCE EXT: 1090 *(interrogator signal simulator* TRANSMITTER XMRT FREQ: XTAL (SIS generator SIF 1 CODER Code switches (A, B, C, D): 7777 SIF 1 CODER FUNCTION SEL: N SIF 1 CODER WIDTH ADJ approx. center SIF 1 CODER SUBST PULSE SEL: OFF MIXED VIDEO MIXED VID SEL SIF 1 PRF RANGE MULT. EXT TRIGGERS DELAY TRIG (μ SEC) DLY RANGE MULT X4 TRIGGERS DELAY TRIG (μ SEC) MULT 1-11:6.0 *(oscilloscope* VERTICAL CHAN A-VOLT DIV: 5 VERTICAL CHAN B-AC/DC: DC VERTICAL CHAN B-75 IN/OUT: OUT VERTICAL CHAN B-VOLT DIV: 5 CALIBRATORS-XTAL MARK (μ SEC): OFF CALIBRATORS LEVEL Midposition		indicates ACCEPT and will indicate REJECT when test set CODE switches are changed to 7776. *d.* Adjust AN/UPM-137A oscilloscope controls as necessary for a clear display and to perform required measurements.	*d.* None.	
8	Same as step 7	Same as step 7	a. Connect AN/UPM-137A oscilloscope VERTICAL CHAN A-VIDEO IN jack to following test points in order given. Observe whether pulses are normal.	*a.* Refer to figure	

Step	Control settings		Procedure	Normal Indication	Paragraph reference
	Test equipment	Equipment under test			
8 (Cont.)			(1) A10TPS (video enable delay).		(1) 3-6j
			(2) A9TP4 (video enable output).		(2) 3-6i
			(3) Al1TP1 (video shaper output).		(3) 3-6k
			(4) A9TP3 (line drive enable output).		(4) 3-6i
			(5) A10TP4 (line drive pulse).		(5) 3-6j
			(6) A10TP2 (delay line pulses).		(6) 3-6j
			(7) A10TP1 (delay line main gate input)		(7) 3-6j
			(8) A11TP2 (comparison pulse shaper output).		(8) 3-6k
			(9) A10TP6 (read relay).		(9) 3-6j
			(10) A12TP4(error blanking).		(10) 3-6i
			b. Connect AN/UPM - 137A oscilloscope VERTICAL-CHAN A-VIDEO IN jack to following test points in order given. Verify that correct dc levels are present.	*b.* Indications are	
			(1) A11TP6 (error detector output).	(1) 7 to 12 volts dc.	*a* None.
			(2) A12TP3 (readout)	(2) 7 to 12 volts dc. When REJECT indicator is lighted.	*b.* None.
			c. Repeat a(2) through (10) above with test set MODE switch at C, 3/A, TEST, and 1 respectively.	*c.* Indications should be the same as in *a* above.	
			d. Set test set CODE switches to 7700 and MODE switch to 2. Set AN/UPM-137A SIS generator SIF 1 CODER Code switches to 7700.	*d.* None.	
			e. Set AN/UPM-137A SIS generator SIF 1 CODER-FUNCTIONAL SEL switch to I/P and test set FUNCTION switch to I/P. Connect AN/UPM-137A oscilloscope VERTICAL-CHAN A-VIDEO IN jack to test set A9TP4.	*e.* Waveform in figure 8-36 (A9TP4).	3-6i
			f. Set AN/UPM-137A SIS generator SIF 1 CODER-FUNCTION SEL switch to EMER and set test set FUNCTION switch to EMER. Observe Whether pulse is nor	*f.* Waveform in figure 8-13 (A9TP4).	3-6i
			g. Set test set FUNCTION switch to I P. Observe whether pulse is normal.	*g.* Waveforl in figure 8-36 (A9TP4).	3-6i

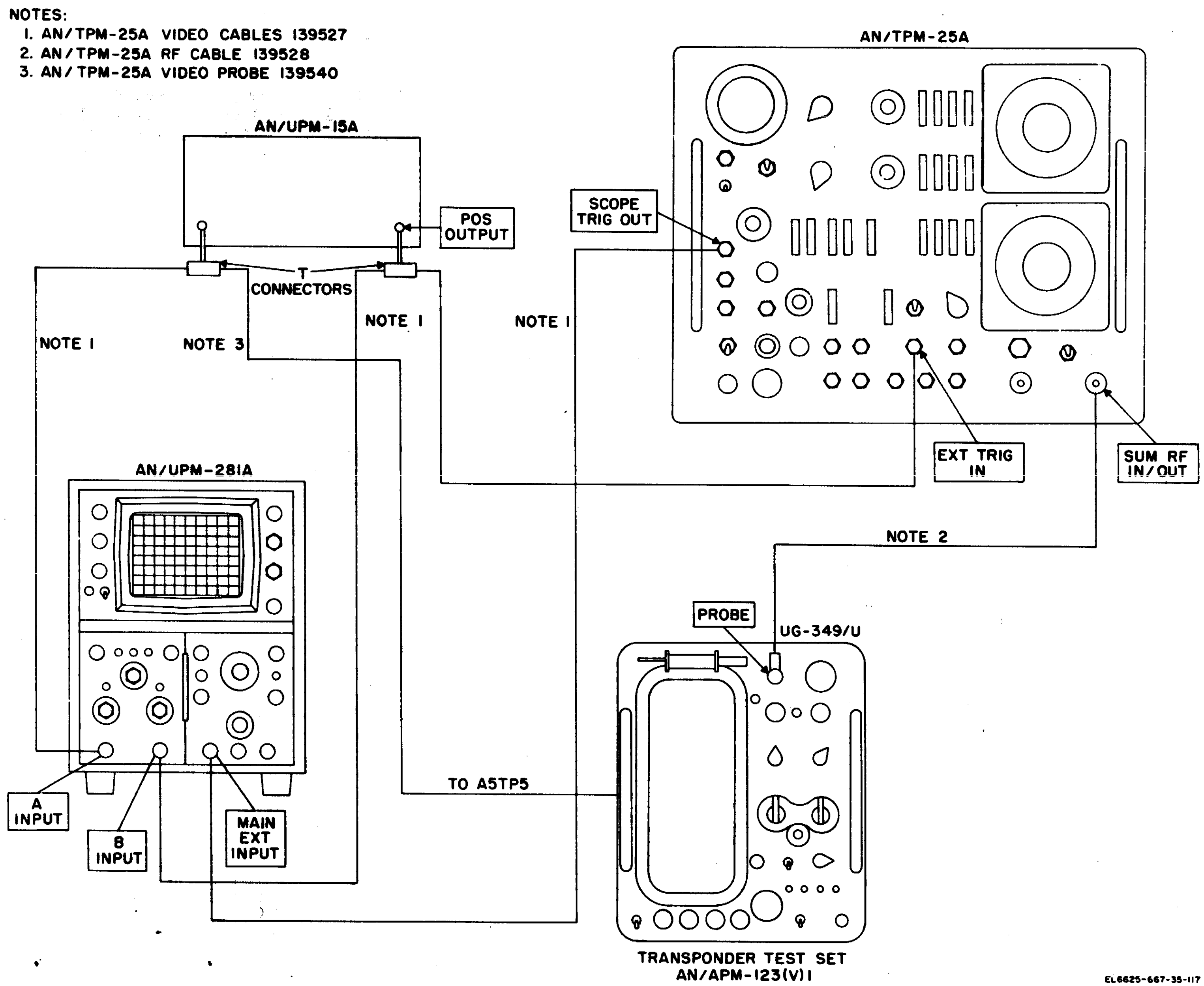


Figure 3-22. System timing setup using AN/PM-25A.

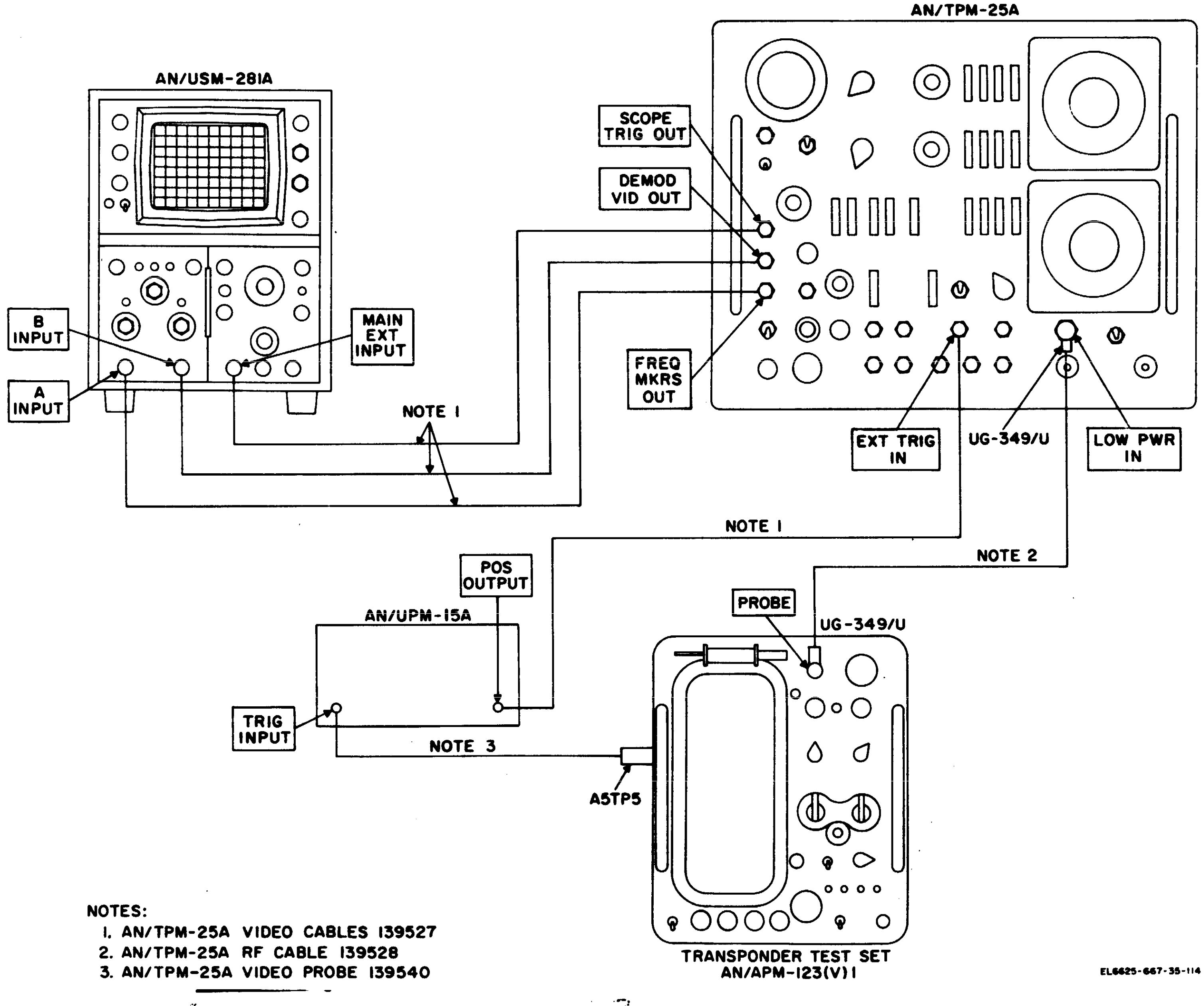


Figure 3-23. Transmitter frequency test setup using AN/TPM-25A.

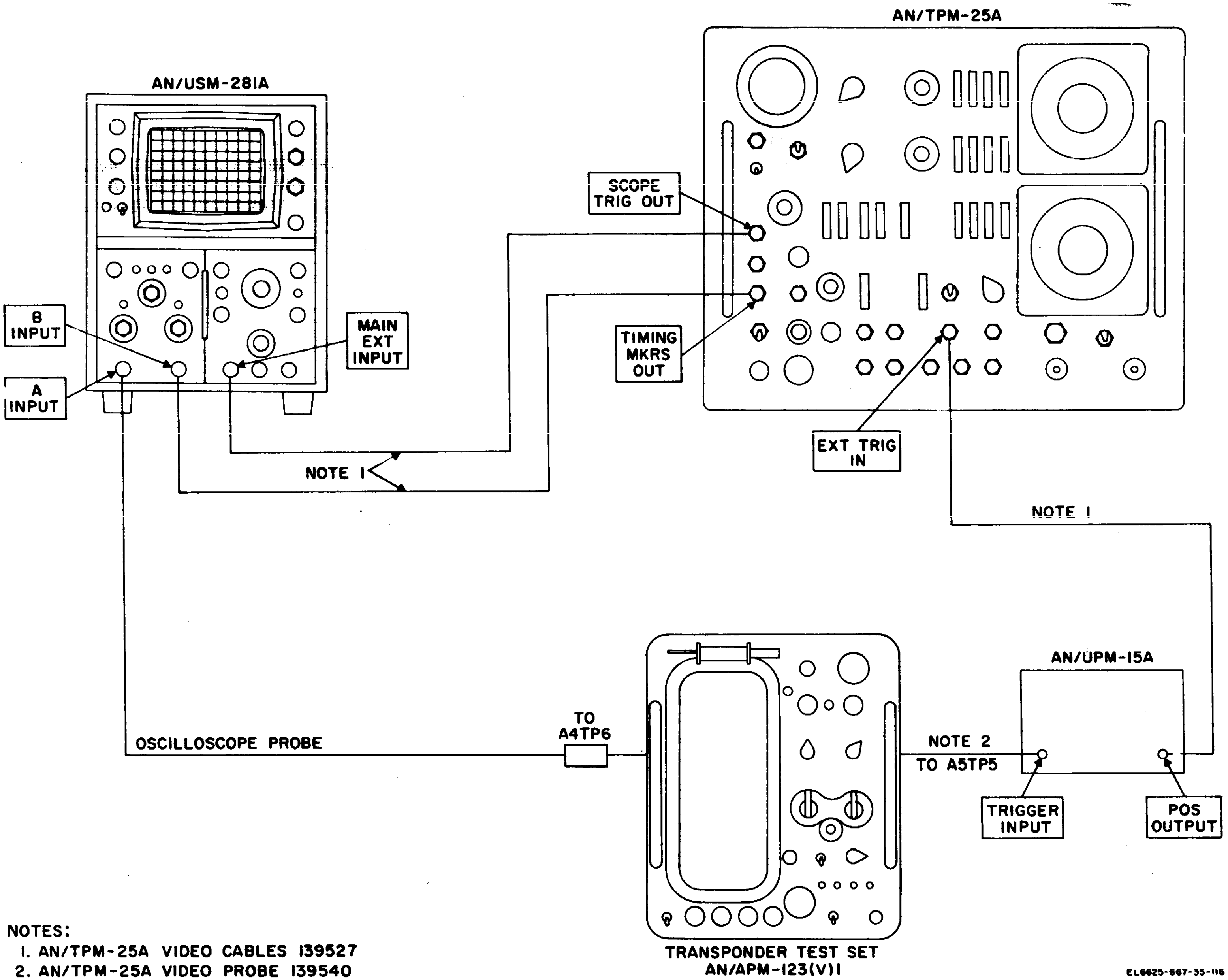


Figure 3-24. Transmitter pulse characteristics test setup using AN/TPM-25A.

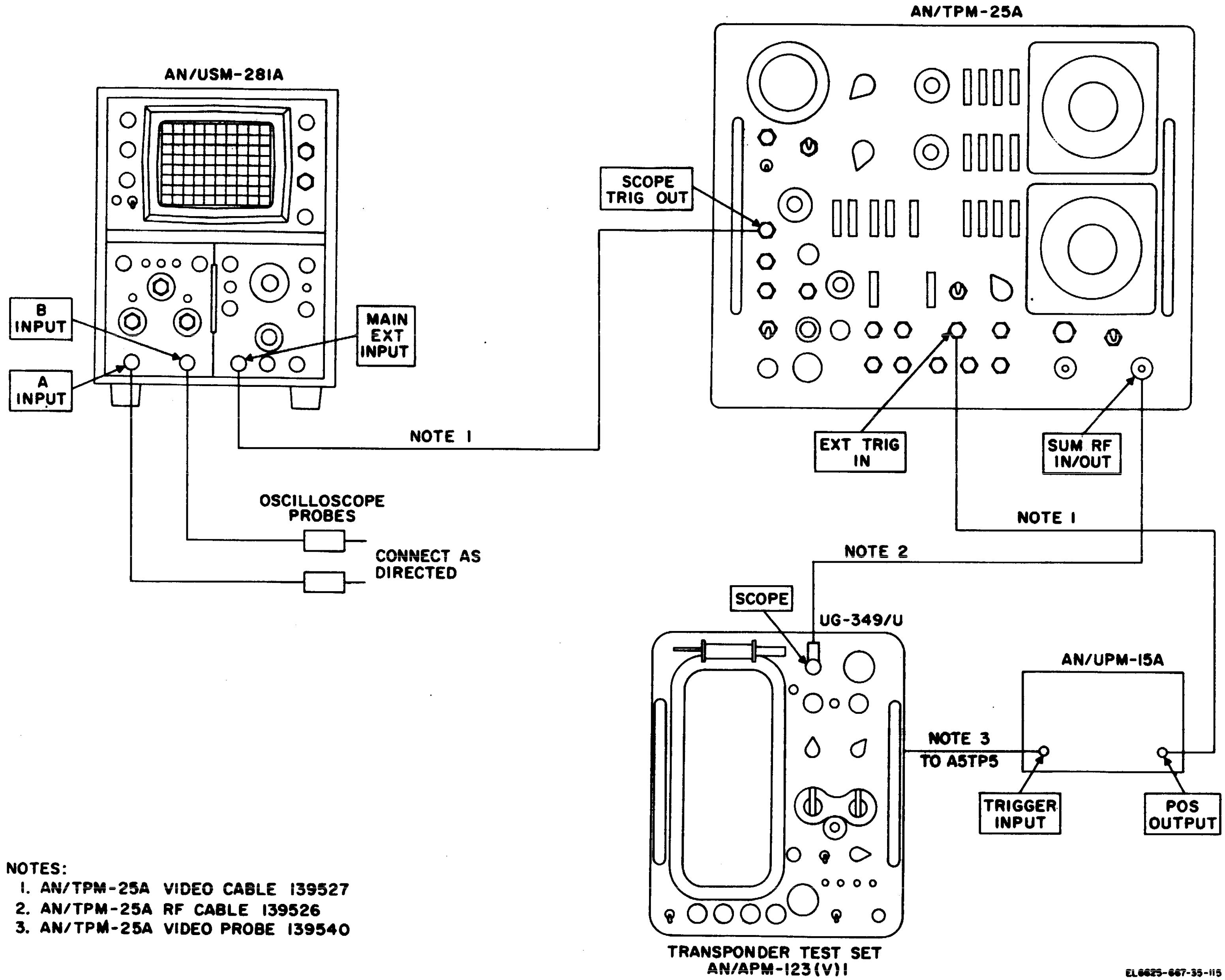


Figure 3-25. Receiver and decoder test setup or video delay and period test using AN/TPM-25A.

CHAPTER 4

REPAIRS AND ALIGNMENT

4-1. General Parts Replacement Techniques

Most of the parts of Test Set, Transponder AN/APM-123V are readily accessible since they are located on pullout circuit boards. Access to parts in the transmitter and 28-volt power supply, however, requires removal of its respective chassis from the test set for removal and replacement. All front panel switches require removal of one or more subassemblies for access to repair or replace them. After repairing the equipment, the adjustments in paragraph 4-2 should be performed. The precautions in a through e below apply specifically to this test set.

a. Do not disturb the adjustment of preselector A15Z1 (fig. 3-6). It was adjusted at the factory. This adjustment is extremely critital, and special test equipment is required to test it or to perform an adjustment. Adjustment of this preselector will void the entire calibration of the unit. If this part appears faulty, it should be replaced with a new one.

b. Do not disturb the settings of controls A5R1 through A5R6 and A7R1 through A7R14 (fig. 3-7). These adjustments were performed at the factory and are extremely critical. Any movement of one or more controls will void the entire calibration of the unit.

CAUTION

If control A16A2R1 of the transmitter voltage regulator is adjusted to a voltage greater than specified it will degrade and shorten the transmitter electron tube performance and life.

c. Do not adjust control A16A2R1 (fig, 8-25) of the transmitter voltage regulator without first referring to the instructions outlined in paragraph 4-4c. This adjustment can void the calibration of this equipment.

d. Use a pencil type soldering iron with a 25-watt maximum capacity. This test set is transistorized. If the soldering iron must be used with alternating current (ac, use an isolating transformer between it and the line. Do *not* use a soldering gun; damaging voltages can be induced in components.

e. When soldering transistor leads, solder quickly wherever wiring permits, use a heat sink (such as a pair of long nosed pliers between the soldered joint and the transistor. Use approximately the same length and dress of transistor leads as used originally.

4-2. Adjustment

NOTE

See para 4-6 when using AN/TPM-25A.

After a circuit in a fictional section is repaired, the functional section should be adjusted to insure proper equipment operation. Two adjustment procedures are provided for the transmitter, receiver and decoder functional sections to use either conventional test equipment and the Radar Test Set AN/UPM-98 or the Radar Test Set AN/UPM-137A. The functional sections are listed below together with the reference to the paragraph containing the adjustment procedures.

a. Power supply section (para 4-3).

b. Transmitter section (para 4-4 and para 4-4.1).

c. Receiver and decoder section (para 4-5 and 4-5.1)

4-3. Power Supply Adjustments

a. Test Equipment Required. Multimeter ME-26B/U is required.

b. Test Setup. The test setup is shown in figure 3-1. The ME-26B/U is connected as specified in *c* below. Refer to figure 3-6 for test point location and figure 3-7 for adjustment control location.

c. Procedure

(1) Set the ME-26B/U SELECTOR control to(+) and RANGE control to 300V.

(2) Connect the ME-26B/U common lead to test point A13TP2 (ground and the dc probe to test point A14TP3.

(3) Apply power to the test set.

(4) Adjust A14R8 until the meter indicates + 150± 2 volts.

4-4. Transmitter Power and Pulse Adjustments

NOTE

See paragraph 4-7 when using AN/TPM-25A.

a *Standard Test Equipment.* The following chart lists the Army test equipment required for the tests.

Test equipment	Technical manual
Multimeter ME 26B/U..	TM 11-6625-200-15
Wattmeter AN/URM-98	TM 11-6625-433-15
Oscilloscope AN/USM-281	TM 11-6625-1703-15
Test Facilities Set Transponder Test Set AN/APM-270(V)	TM 11-6625-1644-12/NAV-AIR 16-30APM270-1 To 38D9-62-5-1

b. Test Setup. Instructions for the applicable test setup are provided in *c* and *d* below. Test point location is shown in figure 3-6 and adjustment control location in figure 3-7.

c. *Preliminary Procedure.* The preliminary procedure is given in (1) through (12) below. The final adjustment is in *d* below.

NOTE

Wattometer AN/URM-98 should be warmed up for 15 minutes before final adjustments are made.

(1) Remove the transmitter from its case (para 3-10).

(2) Use the test setup in figure 3-1.

(3) Set the ME-26B/U SELECTOR switch at(+) and RANGE switch at 300V.

(4) Apply power to the test set, and set the test set PRESS TO TEST switch at LOCK and MODE switch at 1.

(5) Perform the procedure in paragraph 4-3c.

(6) Disconnect the dc probe from test point A14TP3, and set the ME-26B/U RANGE switch at 30V.

(7) Connect the dc probe to test point A16TP4. Adjust control A16A2R1 for +18±.05 volts.

(8) Disconnect the dc probe from A16TP4 and set the ME-26B/U SELECTOR switch to (–).

(9) Connect the de probe to test point A16TP1. Adjust variable capacitor A16C6 for a maximum peak meter indication. The voltage should be – 16 volts dc minimum.

(10) Connect the dc probe to test point A16TP2. Adjust variable capacitor A16C12 for a maximum peaked meter indication. The voltage should be -16 volts dc minimum.

(11) Disconnect the dc probe from A16TP2, and set the ME-26B/U SELECTOR switch to (+).

(12) Connect the dc probe to test point A16TP3. Adjust variable capacitors A16C17 and A16C18 for a maximum peaked meter indication. The voltage should be 6 volts dc, minimum.

d. Find Power Level Adjustments.

(1) Turn on the equipment, and permit a 15 minute warmup. Connect test point A13TP2 (ground to A4TP5 (fig. 3-6).

(2) Set the test set FUNCTION control SYSTEM, MODE switch at 1, and ISLS switch to OFF.

(3) Set the Summation Bridge TS-779A/U RANGE switch at –O DBM.

(4) Disconnect Waveguide Probe MX-2144A/U from the AN/APM-123(V)l PROBE connection. Adjust the TS-779A/U meter to zero with the ZERO control.

(5) Reconnect the MX-2144A/U to the AN/APM-123(V)l PROBE connection. Observe the meter indication. The power should be –6±dbm.

NOTE

If necessary: adjust the test set A16A1C2 and power controls A16R6 (fig. 3-7) to obtain performance standards.

(6) Disconnect test point A13TP2 (ground from A4TP5, and connect it to test point A4TP4.

NOTE

If necessary, adjust control A16R6.

e. Transmitter Pulse Adjustments. Use the AN/APM-270 and the AN/USM-281A. Make the connections shown in B, figure 3-4. Set and adjust the controls as follows:

(1) Apply power to the equipment and permit it to warm up for 5 minutes.

(2) Set and adjust the oscilloscope controls as given in the chart below:

Control	*Position*
Horizontal Magnifier	XI
Horizontal Display	INT
Main Vernier	Fully Clockwise
Main Time/Div	50 μsec
Sweep Display Switch	Mixed
Sweep MODE Switch	AUTO
Delayed Trigger Source	EXT
Delayed SLOPE	—
Delayed Trigger Coupling Switch	AC
Main Trigger Source	EXT
Main SLOPE	—
Main Trigger Coupling	AC
Display	A
A Volts/Div	10

(3) Set the test set FUNCTION switch at SYSTEM and ISLS switch at OFF.

(4) Set the test set to each mode in the following chart. Use the oscilloscope to observe the spacing between the first and last pulse. Performance standards are listed with the controls to be used if an adjustment is necessary.

Mode	*Limits*	*Adjustment control*
1	3±0.2	A5R1
2	5±0.2	A5R2
3/A	8±0.2	A5R3
TEST	6.5±0.2	A5R5
C	21±0.2	A5R4

NOTE

Control A5R6 should be adjusted for a symetrical P3 pulse shape.

(5) Set the test set ISLS switch to ON. Measure the spacing between the first and second pulse. It should be 2±0.1 microseconds.

NOTE

If necessary, adjust control A4R22 to obtain performance standards.

(6) Measure the width of each pulse. The width should be 0.8±0.l microsecond.

NOTE

If necessary, adjust control A4R41 to obtain performance standards for the first and last pulse. Adjust control A4R29 to obtain performance standards for the second pulse.

(7) Adjust the oscilloscope TIME BASE A and B TIME/CM controls to observe two groups of interrogation pulses. Measure the spacing between the first pulse of each group. It should be between 4,255 and 4,545 microseconds (equal to prf of 230±5, -10pps).

NOTE

If necessary, adjust control A5R31 to obtain performance standards.

4-4.1. Transmitter Power and Pulse Adjustments Using AN/UPM-137A

a. Test Equipment Required. The following chart lists the test equipment required.

Test equipment	*Technical manual*
Attenuator, Fixed (FSN 5905-781-0312).	
Detector: Microlab XA-0640 detector mount with diode IN21WE.	
Wattmeter AN/URM-98.	TM 11-6625-433-15
Test Set, Radar AN/UPM-137A.	NAVELEX 0969-158-1010 NAVAIR 16-30UPM137-6-1 AIR FORCE TO 33A1-3-426-21-1 AND NAVELEX 0968-158-1020 NAVAIR 16-30UPM137-6-2 AIR FORCE T.O. 33A1-3-426-21-2

b. Test Setup. Instructions for the applicable test setup are provided in *c* and *e* below. Test point location is shown in figure 3-6 and adjustment control location in figure 3-7.

c. Preliminary Procedure. The preliminary procedure is given in (1) through (6) below. The final power level adjustment procedure is given in *d* and the transmitter pulse adjustment procedure is given in *e*.

(1) Remove test set from its case (para 3-10).

(2) Perform procedure given in paragraph 3-4 *d*, step 1, 2, and 3.

(3) Connect dc test probe to test set AJ6TP4. Adjust control A16A2R1 for +18±0.5 vdc.

(4) Connect dc test probe to test set

A16TPl. Adjust variable capacitor A 16C6 for maximum negative voltage.. Voltage should be —20 vdc minimum.

(5) Connect dc test probe to test set A16TP2. Adjust variable capacitor A16C12 for a maximum negative voltage. Voltage should be -20 vdc minimum.

(6) Connect dc test probe to test set A16TP3. Adjust variable capacitors A16C17 and A16C18 for maximum voltage. Voltage should be +6 vdc minimum.

d. Final Power Level Adjustments.

(1) Connect test set A13TP2 (ground) to A4TP5.

(2) Set test set ISLS switch to OFF.

(3) Connect equipment as shown in figure 3-3.

(4) Set Summation Bridge TS-779A/U (part of wattmeter AN/URM-98) RANGE switch to — 5 DBM.

(5) Disconnect cable from test set PROBE jack and adjust Summation Bridge TS-779A/U ZERO control to zero meter.

(6) Reconnect cable to test set PROBE jack. Observe meter indication. Power should be-9 ±1 dbm.

NOTE

If necessary, adjust test set control A16A1C2 and power controls A16A1C2 and power controls (fig. 3-7) to obtain performance standard.

(7) Disconnect test set A13TP2 (ground) from A4TP5 and connect to A4TP4.

(8) Set Summation Bridge TS-779A/U RANGE switch to – 10 DBM.

(9) Repeat step (5).

(10) Reconnect cable to test set PROBE jack. Observe meter indication. Power should be -21 ±1 dbm.

NOTE

If necessary, adjust test set control A16R6 to obtain performance standard.

e. Transmitter Pulse Adjustments. Connect the equipment as shown in figure 3-4B. Set and adjust the controls as follows:

(1) Apply power to equipment and permit 5-minute warmup.

(2) Set and adjust the oscilloscope controls as given in the chart below.

Control	Position
HORIZONTAL DISPLAY	"A" DEL'D BY "B"
TIME BASE B TRIGGER SLOPE.	EXT (—)
DELAY TIME MULTIPLIER	00
TIME BASE B TIME/CM	5 μsec
TIME BASE A STABILITY	Completely cw
TIME BASE A TIME/CM	0.5 μsec
TIME BASE A TRIGGERING	AC

(3) Set the test set FUNCTION switch at SYSTEM and ISLS switch at OFF.

(4) Set the test set to each mode in the following chart. Use the oscilloscope DELAY TIME MULTIPLIER control, and measure the spacing between the first and last pulse. Performance standards are listed with the controls to be used if an adjustment is necessary.

Mode	Limits	Adjustment control
1	3±0.2	A5R1
2	5±0.2	A5R2
3/A	8±0.2	A5R3
TEST	6.5±0.2	A5R5
C	21±0.2	A5R4

NOTE

Control A5R6 should be adjusted for symmetrical P3 pulse shape.

(5) Set the test set ISLS switch to ON. Measure the spacing between the first and second pulse. It should be 2 ±0.1 μ sec.

NOTE

If necessary, adjust control A4R22 to obtain performance standards.

(6) Measure the width of each. pulse. The width should be 0.8 ± 0.1 microsecond.

NOTE

If necessary, adjust control A4R41 to obtain performances standards for the first and last pulse. Adjust control A4 R29 to obtain performance standards for the second pulse.

(7) Adjust the oscilloscope TIME BASE A and B TIME/CM controls to observe two groups of interrogation pulses. Measure the spacing between 4,255 and 4,545 microseconds (equal to prf of 230 ± 5 --10 pps).

NOTE

If necessary, adjust control A5R31 to obtain performance standards.

(7) Disconnect the MX-2144A/U from the AN/APM-123(V)l PROBE connecting. Set the TS-779A/U RANGE switch to –10 DBM and again zero its meter with the ZERO control.

(8) Reconnect the MX-2144A/U to the AN/APM-123(V)1 PROBE connection. Observe the TS-779A/U power meter indication. It should just barely move upscale (approximately -21 dB).

4-5. Receiver Section and Decoder Section Adjustments

NOTE

See para 4-8 when using AN/TPM-25A.

The test equipment listed in the chart below is required for these adjustments. Additional test equipments required are described in *a* below.

Test equipment	Technical manual
Frequency Meter AN/USM-207	TM 11-6625-700-25
Comparator. Frequency CM-77A/USM	TM 11-6625-493-15
Generator, Signal AN/URM-64A	TM 11-6625-299-15
Test Set, Radar AN/USM-98	TM 11-6625-403-14
Multimeter ME 26B/U	TM 11-6625-200-15
Oscilloscope AN/SM-281A	TM 11-6625-1703-15

a. Additional Test Equipment Required.

(1) *Modulator*. A pin diode type modulator with a minimum operating frequency range of from 1,000 to 1,100 megacycles and a power of 9 dBm MD-796 is required. Pulse risetime and falltime must be preserved to within 25 nanoseconds.

b. Test Setup.

(1) Connect the equipment as shown in figure 3-5.

(2) Adjust the equipment as specified in 9a through *h* of the chart in paragraph 3-4d. This establishes the test conditions for all receiver and decoder adjustments.

NOTE

Disregard the specified measurements and the normal indication columns in the chart.

(3) The ME-26B/U is shown in figure 3-5; however, it is used in e below. Instructions are provided in e below for its connections and use.

c. Receiver Sensitivity Adjustment. Adjust control A8R5 (fig. 3-7) completely countterclockwise. Then, turn the control until the ACCEPT indicator just lights.

d. Decoder Adjustments. The chart below lists the decoder adjustments. The oscilloscope probe should be connected to the test point indicated. The *Control* column indicates the control to be adjusted, and the Limits μ sec column indicates the requirements. The decoder reply evaluator adjustment procedure is given in e below.

Adjustment	Control	Test point	Limits m sec
Video enable delay (DSS4)	A10R7	A10TP5	1.8±0.2
Video pulse width (DSS1)	AllR6	A1lTP1	0.7±0.0 ±0.05
Line drive generator (ISS1)	A4R6	A4TP1	0.6±0.01
Accept reject pulse width (DSS3)	A11R30	A11TP3	0.35±0.01

e. Reply Evaluator Adjustment.

(1) Set the ME-26B/U SELECTOR switch at (+) and Range switch at 10V. Connect the common lead to test point A13TP2 (ground and the dc probe to test point A12TP2.

(2) Set the AN/UPM-98 CODE swithes to 7767.

(3) Adjust the ME-26B/U ZERO ADJ for a zero meter indication.

(4) Set the AN/UPM-98 switches to 7777. Note the ME-26BKJ indication.

NOTE

The setting of the SUB PULSE POS control is extremely critical. Vary the control very slowly in the following steps.

(5) Set the AN/UPM-98 SUB PULSE

SELECT control to the Cl pulse position. Adjust the SUB PROBE POS control until the ME-26B/U indication is 65 percent of that noted in (4) above.

(6) Adjust control A12R19 until the ACCEPT and REJECT Indicators are continually alternating indications (intermittent.

(7) Repeat the procedures (2) through (6) above.

(8) Adjust the AN/UPM-98 SUB PULSE POS control until the ME-26B/U indication is 50 percent of that noted in (4) above. The REJECT indicator should be on. Repeat the adjustment until the indication is 80 percent of the noted voltage. The ACCEPT indicator should be on.

4-5.1. Receiver Section and Decoder Section Adjustments Using AN/UPM-137A

a. Test Equipment Required. Radar Test Set AN/UPM-137A is required.

b. Test Setup.

(1) Connect the equipment as shown in figure 3-5.1.

(2) Adjust the equipment as specified in steps 9a through *d* of the chart in paragraph 3-4e. This establishes the test conditions for all receiver and decoder adjustments.

NOTE

Disregard the specified measurements and the normal indication columns in the chart.

c. Receiver Sensitivity Adjustment. Set AN/UPM-137A signal generator OUTPUT ATTEN 0-100 dBm to -8.1 dBm plus attenuation marked on cable connected to test set PROBE jack. (Example: -8.1 plus -0.9 equals –9). Adjust control A8R5 (fig. 3-7) completely CCW. Then, turn the control until the ACCEPT and REJECT indicators are alternately lighting.

d. Decoder Adjustments. The chart below lists the decoder adjustments. The AN/UPM-137A oscilloscope VERTICAL-CHAN A—VIDEO IN jack should be connected to the test point indicated. The *Control* column indicates the control to be adjusted, and the *Limits* column indicates the requirements. The decoder reply evaluator adjustment procedure is given in e below.

Adjustment	Control	Teat point	Limits μ sec
Video enable delay (DSS4)	A10R7	Al0TP5	1.8±0.2
Video pulse width (DSS1)	A11R6	A1lTP1	0.7+0.0 -0.05
Line drive generator (ISS1)	A4R6	A4TP1	0.6±0.01
Accept reject pulse width (DSS3)	A11R30	A11TP3	0.35±0.01

e. Reply Evaluator Adjustment.

(1) Set ME-26B/U SELECTOR switch to (+) and RANGE switch to 10V. Connect common lead to A13TP2 (ground and dc probe to A12TP2.

(2) Set AN/UPM-137 SIS generator SIF 1 CODER-Code (A, B, C, D) switches to *7767.*

(3) Adjust ME-26B/U ZERO ADJ control for a zero meter indication.

(4) Set AN/UPM-317A SIS generator SIF 1 CODER-Code (A, B, C, D) switches to 7777. Note ME-26B/U indication.

(5) Set AN/UPM-137A SIS generator SIF 1 CODER-SUBST PULSE SEL stitch to Cl. Adjust SIF 1 CODER-SUBST PULSE POSN control until ME-26B/U indication is 65 percent of that noted in (4) above.

(6) Adjust control A12R19 until ACCEPT and REJECT indicators are continually alternating indications (intermittent.

(7) Repeat procedures (2) through (6) above.

(8) Adjust AN/UPM-137A SIS generator SIF 1 CODER-SUBST PULSE POSN control until ME-26B/U indication is 50 percent of that noted in (4) above. The REJECT indicator should be on. Adjust AN/UPM-137A SIS GENERATOR SIF 1 CODER SUBST PULSE POSN control untlI ME-26B/U indication is 80 percent of the noted voltage. ACCEPT indicator should be on.

4-6. Adjustments

After a circuit in a functional section is required, the functional section should be adjusted to insure proper equipment operation. Two adjustment procedures are provided for the transmitter, receiver, and decoder functional sections to use either convention test equipment and Radar Test Set ANI/PM-25A or Radar Test Set AN/UPM-137A. The functional sections are listed below together with the reference to the paragraph containing the adjustment procedures.

a. Power supply section (para 4-3).

b. Transmitter section (para 4-4.1 and 4-7).

c. Receiver and decoder section (para 4-5.1 and 4-8).

4-7. Transmitter Power and Pulse Adjustments

a. *Standard Test Equipment.* The following chart lists the Army test equipment required for the tests.

Test equipment	*Technical manual*
Multimeter ME 26B/U	TM 11-6625-200-15
Wattmeter AN/URM-98	TM 11-6625-433-15
Oscilloscope AN/USM-281	TM 11-6625-1703-15
Radar Test Set AN/TPM-25A......	TM 11-6625-2610-12
Pulse Generator AN/UPM-15A	TM 11-6625-368-10

b. Test Setup. Instructions for the applicable test setup are provided in *c* and *d* below. Test point location is shown in figure 3-6 and adjustment control location in figure 3-7.

c. Premliminary Procedure. The preliminary procedure is given in (1) through (13) below. The final adjustment is in *d* below.

NOTE

Wattmeter AN/URM-98 should be warmed up for 15 minutes before final adjustments are made.

(1) Remove the transmitter from its case (para 3-10).

(2) Use the test setup in figure 3-1.

(3) Set the ME-26/U SELECTOR switch at (+) and RANGE switch at 800V.

(4) Apply power to the test set, and set the test set PRESS TO TEST switch at LOCK and MODE switch at 1.

(5) Connect dc probe to A14TP3.

(6) Adjust A14R8 until meter indicates +150 ±2 volts.

(7) Disconnet the dc probe from test point A14TP3, and set the ME-26B/U RANGE switch at 30V.

(8) Connect the dc probe to test point A16TP4. Adjust control A16A2R1 for +18±0.5 volts.

(9) Disconnect the dc probe from A16TP4 and set the ME-26B/U SELECTOR switch to (–).

(10) Connect the dc probe to test point A16TP1. Adjust variable capacitor A16C6 for a maximum peak meter indication. The voltage should be —16 volts dc minimum.

(11) Connect the dc probe to test point A16TP2. Adjust variable capacitor A16C12 for a maximum peaked meter indication. The voltage should be —16 volts dc minimum.

(12) Disconnect the dc probe from A16TP2, and set the ME-26B/U SELECTOR switch to (+).

(13) Connect the dc probe to test point A16TP3. Adjust variable capacitors A16C17 and A16C18 for a maximum peaked meter indication. The voltage should be less than 16 volts dc.

d. Final Power Level Adjustments.

(1) Turn on the equipment, and permit a 15-minute warmup. Connect test point A13TP2 (ground to A4TP5 (fig. 3-6).

(2) Set the test set FUNCTION control at SYSTEM, MODE switch at 1, and ISLS switch at OFF:

(3) Set the summation Bridge TS-779A/U RANGE switch at –0 DBM.

(4) Disconnect Waveguide Probe MX-2144A/U from the AN/APM-123(V)l PROBE connection. Adjust the TS-779A/U meter to zero with the ZERO control.

(5) Reconnect the MX-2144A/U to the AN/APM-123(V)l PROBE connection. Observe the meter indication. The power should be –6 ±1 dBm.

NOTE

If necessary, adjust the test set A16A1C2 and power controls (fig. 3-7) to obtain performance standards.

(6) Disconnect test point A13TP2 (ground from A4TP5, and connect it to test point A4TP4.

(7) Disconnect the MX-2144A/U from the AN/APM-123(V)l PROBE connection. Set the TS-779A/U RANGE switch to -10 DBM and again zero its meter with the ZERO control.

(8) Reconnect the MX-2144A/U to the AN/APM-123(V)l PROBE connection. Observe the TS-779A/U power meter indication. It should just barely move upscale (approximately –21 dB).

NOTE

If necessary, adjust control A16R6.

e. Transmitter Pulse Adjustments. Use the AN/TPM-25A and the AN/USM-281A. Make the connections shown in figure 3-24. Set and adjust the controls as follows:

(1) Apply power to the equipment and permit it to warm up for 5 minutes.

(2) Set and adjust the oscilloscope controls as given in the chart below:

Control	*Position*
HORIZONTAL MAGNIFIER	XI
HORIZONTAL DISPLAY	INT
MAIN VERNIER	Fully Clockwise
MAIN TIME/DIV	50 µ SEC
SWEEP MODE Switch	AUTO
INT AUTO/EXT/EXT 10	EXT
- SLOPE +	
DELAYED ACS/ACF/AC/DC	AC
MAIN EXT÷+10/EXT/INT/LINE	EXT
MAIN - SLOPE +	
MAIN ACS/AFC/AC/DC	AC
DISPLAY	ALT
A VOLTS/DIV	10

(3) Set the test set FUNCTION switch at SYSTEM and ISLS switch at OFF.

(4) Set the test set to each mode in the following chart. Use the oscilloscope to observe the spacing between the first and last pulse. Measure spacing from leading edge to leading edge. Performance standards are listed with the controls to be used if an adjustment is necessary.

Mode	Limits	*Adjustment control*
1	3±0.2 µs	A5R1
2	5±0.2 µs	A5R2
3/A	8±0.2 µs	A5R3
TEST	6.5±0.2 µs	A5R5
C	21±0.2 µs	A5R4

NOTE

Control A5R6 should be adjusted for a symmetrical P3 pulse shape.

(5) Set the test set ISLS switch to ON. Measure the spacing between the first and second pulse. It should be 3 ±0.1 µ s.

NOTE

If necessary adjust control A4R22 to obtain performance standards.

(6) Measure the width of each pulse. The width should be 0.8 ±0. 1 µ s.

NOTE

If necessary, adjust control A4R1 to obtain performance standards for the first and last pubs. Adjust control A4R29 to obtain performance standards for the second pulse.

(7) Adjust the oscilloscope MAIN AND DELAYED TIME/DIV controls to observe two groups of interrogation pulses. Measure the spacing between the first pulse of each group. It should be between 4,255 and 4,545 microsecond (equal to prf of 230 ±5, -10) pps.

NOTE

If necessary, adjust control A5R31 to obtain performance standards.

4-8. Receiver Section and Decoder Section Adjustments Using AN/TPM-26A

a. Test Equipment. The test equipment lists in the chart below is required for these ad justments.

Test equipment	*Technical manual*
Test Set, Radar AN/TPM-25A	TM 11-6625-2610-1
Multimeter ME 26B/U	TM 11-6625-200-15
Oscilloscope AN/USM-281A.	TM 11-6625-1703-15
Generator, Pulse AN/USM-15A.. . . .	TM 11-6626-368-10

b. System Timing Setup. Perform the procedures in paragraph 3-15d step 4 *a* through *d.* Once set, do not change AN/UPM-15A DELAY setting.

c. Test Setup.

(1) Perform the system timing setup specified in step 4 of the chart in paragraph 3-15d

(2) On the AN/TPM-25A adjust SUM ATTEN for a reading of -9 dB less the 1090 MHz loss of cable 139526. This establishes the test conditions for all receiver and decoder ad justments.

NOTE

Disregard the specified measurements and the normal indication columns in the chart.

(3) The ME-26B/U is not shown in figure 3-22; however, it is used in *f* below. Instruction are provided in *f* below for its connections and use.

d. Receiver Sensitivity Adjustment. Adjust control A8R5 (fig. 3-7) completely counterclockwise. Then, turn the control until the

ACCEPT indicator just lights. Set AN/TPM-25A SUM ATTEN dial for a reading of 6 dB less the 1090 MHz loss of cable 139526.

e. Decoder Adjustments. The chart below lists the decoder adjustments. The oscilloscope probe should be connected to the test point indicated. The *Control* column indicates the control to be adjusted, and the *Limits* μ s column indicates the requirements. The decoder reply evaluator adjustment procedure is given in *f* below.

Adjustment	*Control*	*Test Point*	*Limit us*
Video enable delay (DSS4).	A10R7	A10TP5	1.8 ±0.2
Video pulse width (DSS1).	A11R6	A1lTP1	0.7 +0.0 -0.05
Line drive generator (ISS1).	A4R6	A4TP1	0.6 ±0.01
Accept reject pulse width (DSS3).	A11R30	A11TP3	0.35±0.01

f. Reply Evaluator Adjustment.

(1) Set the ME-26B/U SELECTOR switch at (+) and RANGE switch at 10V. Connect the common lead to test point A13TP2 (ground and the dc probe to test point A12TP2.

(2) Set the AN/TP25A REPLIES SIF REPLY CODE switches to 7767.

(3) Adjust the ME-26B/U ZERO ADJ. for a zero meter indication.

(4) Set the AN/TPM-25A REPLIES SIF REPLY CODE switches to 7777. Note the ME-26B/U indication.

(5) Set the AN/TPM-25A REPLIES SUB PULSE SEL control to the Cl pulse position and REPLIES SUB PULSE POS to VARY. Adjust the REPLIES SUB PULSE POS VARY control until the ME-26B/U indication is 65% of that noted in (4) above.

(6) Adjust control A12R19 until the ACCEPT and REJECT indicators are continually alternating indications (intermittent).

(7) Repeat the procedures in (2) through (5) above.

(8) Adjust the AN/TPM-25A REPLIES SUB PULSE POS VARY control until the ME-26B/U indication is 50% of that noted in (4) above. The REJECT indicator should be on. Repeat the adjustment until the indication is 80% of the noted voltage. The ACCEPT indicator should be on.

CHAPTER 5

GENERAL SUPPORT TESTING

PROCEDURES

NOTE

See Chapter 5.2 When Using AN/TPM-25A.

5-1. General

a. Testing procedures are prepared for use by Electronics field maintenance shops and Electronics service organizations responsible for general support maintenance of electronics equipment to determine the acceptability of repaired equipment. These procedures set forth specific requirements that repaired equipment *must* meet before it is returned to the using organization. These procedures may also be used as a guide for testing equipment that has been repaired direct support if the proper tools and test equipments are available. Two test procedures are provided for those test procedures that use test equipment that can be replaced with the Radar Test Set AN/UPM-137A.

b. Comply with the instructions preceding each chart before proceeding to the chart. Perform each step in sequence. Do not vary the sequence. For each step, perform all the actions required in the *Test equipment control settings* and Equipment under test control settings columns; then perform each specific test procedure and verify it against its performance standard.

5-2. Test Equipment Required

The test equipment listed below, or approved equivalent, is required to perform the test procedures. The Radar Test Set AN/UPM-137A replaces the Radar Test Set AN/UPM-98 or AN/UPM-98B.

Test equipment	*Technical manual*
0scillscope,AN/USM-281A	TM 11-6625-1703-15
Frequency Meter AN/USM -207	TM 11-6625-700-10
Modulator MD-796	
Generator, Signal AN/URM-64A	TM 11-6625-299-15
Wattmeter AN/URM-98 (including TS 779A/U and MX-2144A/U).	TM 11-6625-433-15
Comparator, Frequency CM-77A/USM	TM 11-6625-493-15
Multimeter ME 26B/U	TM 11-6625-200-15
Test Set, Radar AN/UPM-98	TM 11-6625-403-14
Test Set, Radar AN/UPM-137A	NAVSHIPS 0969-126-1000 NAVAIR 16-30UPM137-1-1 AIR FORCE T.O. 33Al-3-426-1-1

NOTE

Either the AN/UPM-98A or AN/UPM-98B maybe used to perform the test procedures.

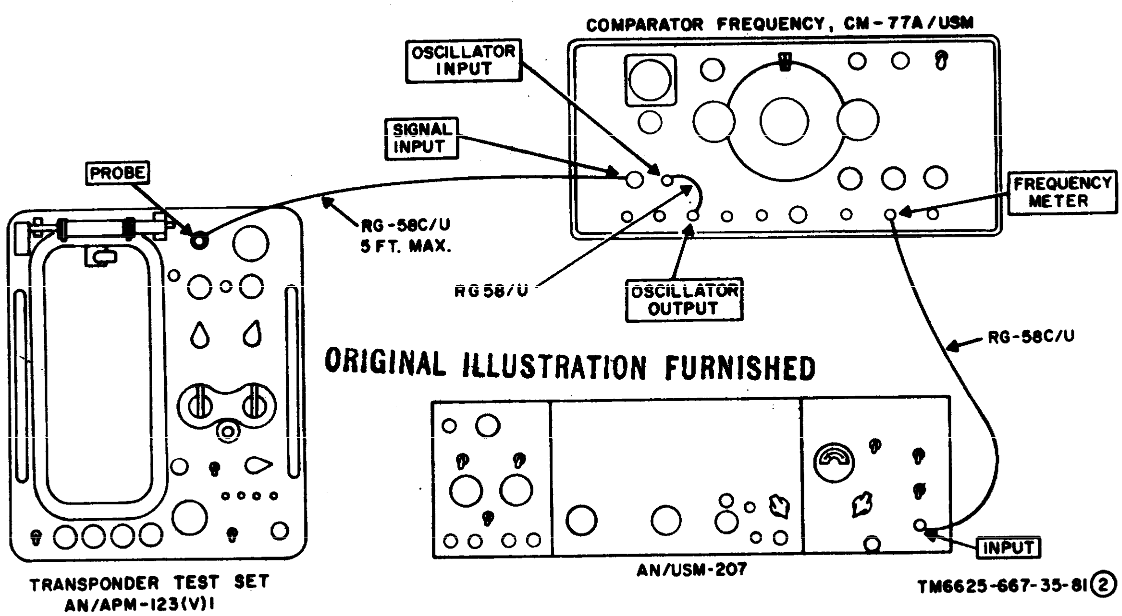


Figure 5-1. Transmitter frequency test setup.

5-3. Transmitter Frequency Test

a. Test Equipment Required

(1) Frequency Meter AN/USM-207.

(2) Comparator, Frequency CM-77A/USM.

b. Test Connections and Conditions. Connect the equipment as shown in figure 5-1. Connect A4TP5 to ground.

c. Procedure.

	Control settings			
Step	*Test equipment*	*Equipment under test*	*Test procedure*	*Performance standard*
1	*AN/USM-207* DIRECT/HETRODYNE Switch: HETRODYNE VOLTAGE Switch: 10V FREQ TUNING-MC: 150 POWER TRACK FUNCTION: FREQ SENSITIVITY: Plug in	MODE: 1 FUNCTION: SYSTEM. CODE: Any. POWER 115 vac or 28 vdc, as applicable.	*a.* Turn on the AN/USM-207 and CM-77A/USM. Permit a l-hour warmup. *b.* Turn on the test set, and permit a 2-minute warmup. *c.* Press the PRESS-TO-TEST switch and turn to LOCK.	*a.* None. *b.* None. *c.* None.
2	*CM-77A/USM* FREQUENCY MEGACYCLES: 206. VIDEO RESEONSE-GAIN: CW. VIDEO RESPONSE-HIGH FREQUENCY: CCW.		*a.* Adjust the CM-77A/USM FREQUENCY MEGACYCLES and VIDEO RESPONSE controls until the oscilloscope display indicates zero beating (setting should be near 206). *b.* Note the frequency on the AN/USM-207 add 150 to it and multiply the results by 5.	*a.* None. *b.* 1,030 mc ± 206 kc.

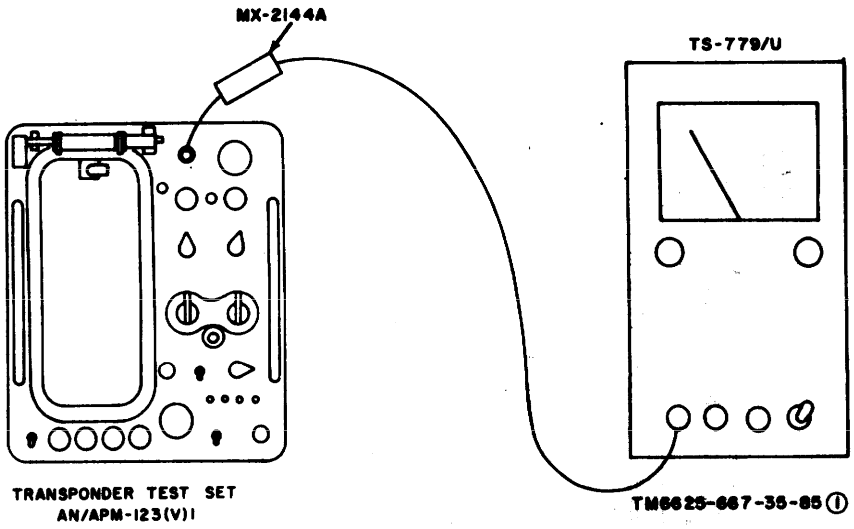


Figure 5-2. Transmitter power test setup.

5-4. Transmitting Power Test

a. Test Equipment Required

b. Test Connections and Conditions.

(1) Connect the equipment as indicated in *c* below.

(2) Connect test point A4TP5 to ground (module A4 at the rear of test set).

c. Procedure.

	Control settings			
Step	*Test equipment*	*Equipment under test*	*Test procedure*	*Performance standard*
1	N. A.	MODE: 1. CODE: Any. FUNCTION: SYSTEM. POWER: ON. ISLS: OFF.	None	None.
2	TS-779A/U BOLO BIAS CURRENT: OFF. BOLO RES: 200. BOLO TEMP COEF: NEG. RANGE: –0 DBM.	Controls remain as in step 1.	CAUTION The teat equipment settings must be performed before the MX-2144A/U, is connected to avoid equipment damage. *a.* Connect the MX-2144A/U to the TS-779A/U. *b.* Adjust the TS-779A/U as follows: (1) Set the BOLO BIAS CURRENT Switch to 10-16 MA. (2) Set the LINE-POWER switch to ON, and permit a 15-minute warmup. (3) Adjust the ZERO SET COARSE AND FINE controls to zero meter. *c.* Connect the equipment as shown in figure 5-2. Make sure that test point A4TP5 is grounded. *d.* Connect the MX-2144A/U to the test set PROBE jack. Observe the power indication. *e.* Disconnect the ground from test point A4TP5, and connect test point A4TP4 to ground. Disconnect the MX-2144A/U.	*a.* None. *b.* None. *c.* None. *d.* –6 ± 1dbm. e. None.

Step	Control settings: Test equipment	Control settings: Equipment under test	Test procedure	Performance standard
			f. Set the RANGE switch to-10 DBM and readjust zero set course and fine controls to zero meter. Reconnect the MX-2144A/U to the AN/APM-123 PROBE connector. Observe the power meter reading. *g.* Remove the jumper from A4TP4 to ground.	*f.* Meter deflects slightly to right (approximately -21 dbm).

5-5. Transmitter Output Pulse Test

a. Test Equipment Required

(1) Oscilloscope, AN/USM-281A.

(2) Test Facilities Set, Transponder Set AN/APM-270.

b. Test Connections and Conditions. Connect the equipment as shown in B, figure 5-3.

c. Procedure.

Step	Control settings: Test equipment	Control settings: Equipment under test	Test procedure	Performance standard
1	*AN/USM-281A* POWER: ON Sweep delay switch Delayed. Delayed TIME/DIV: 5 μ sec Main TIME/DIV: .5 μ sec Sweep Mode: AUTO Main SLOPE: - Delayed SLOPE: - DIV DELAY: 02 Main Trigger Source switch: EXT DISPLAY: A A VOLTS?DIV 5 A POLARITY: UP A Input coupling switch: AC	FUNCTION: SYSTEM. ISLS: ON. POWER ON. PRESS-TO-TEST: LOCK. MODE: 1.	*a.* Turn on the oscilloscope and test set. Pemit a few minutes warmup. *b.* Press the test set PRESS-TO-TEST switch and turn to LOCK. *c.* Adjust the oscilloscope as follows: (1) Adjust the HORIZONTAL position control until the .50% point of the first pulse leading edge is positioned at the center graticule line. Measure the pulse width. (2) Adjust the oscilloscope controls to measure the delay between the 50% points of pulses Pl and P2. (3) Adjust the oscilloscope control to measure the delay between pulses Pl and P3 at the 50% points of the leading edge. *d.* Set the test set MODE switch at each of the positions, in (1) through (4) below and repeat the procedure in c (3) above to measure delays between P1 and P3.	*a.* None. *b.* None. *c.* See (1) through (9) below. (1) Pulse widths: 0.8 ± 0.1 μ sec. (2) Delay between P1 and P2 shall be 2 ± 0.2 μ sec. (3) Mode spacing: 3 ± 0.2 μ sec. *d.* None.

Step	Control settings: Test equipment	Control settings: Equipment under test	Test procedure	Performance standard
			(1)2	(1) Mode 2 spacing: 5 ± 0.2 sec.
			(2) 3/A	(2) Mode 3/A spacing: 8 ± 0.2
			(3) C.	(3)Mode C spacing 21 ± 0.2 sec.
			(4) TEST	(4) Mode TEST spacing: 6.5 ± 0.2 sec.

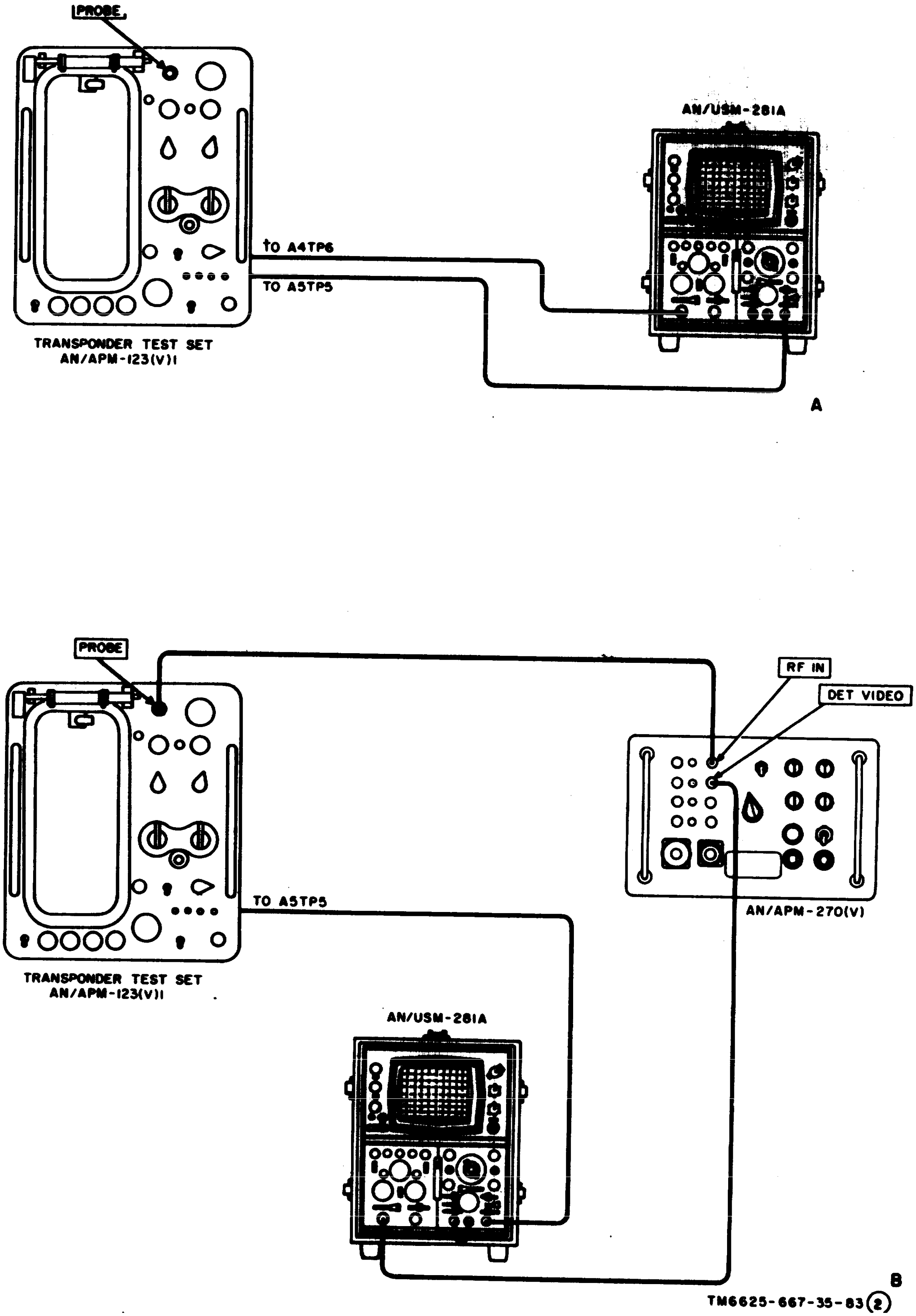


Figure 5-3. Transmitter output pulse test.

5-6. Receiver Frequency, Sensitivity, and Bandwidth Test

a. Test Equipment Required.

(1) Modulator MD-796
(2) Generator, Signal AN/URM-64A.
(3) Frequency Meter AN/USM-207.
(4) Test Set, Radar AN/UPM-98.
(5) Comparator, Frequency CM-77A/USM.
(6) Oscilloscope, AN/USM-281A.

b. Test Connection and Conditions. Connect the equipment as shown in figure 5-4. The modulator and the AN/URM-64A shall be connected as specified in *c* below.

c. Procedure.

Step	Control settings: Test equipment	Control settings: Equipment under test	Test procedure	Performance standard
1	*AN/UPM-98* *(SIF CODER)* CODE (A, B, C, D): 0000 AMPLITUDE: 2 FUNCTION: N SUB PULSE SELECT: OFF LEVEL: III PULSE WIDTH: .45 *AN/USM-207* DIRECT HETRODYNE switch: HETRODYNE VOLTAGE switch: 10V FREQ TUNING-MC: 200 POWER: TRACK FUNCTION: FREQ SENSITIVITY: PLUG IN *TS-799A/U* BOLO TEMP COEF: NEG BOLO RES: 200 r RANGE: −5 DBM BOLO BIAS CURRENT: 10-16 MA LINE POWER: ON *CM-77A/USM* POWER: ON *AN/URM-64A* POWER: ON FUNCTION: ZERO SET SIGNAL FREQUENCY: 1090 MC ATTENUATOR: −3 DRM	MODE: 1 CODE (A, B, C, D): 0000 FUNCTION: SYSTEM POWER: ON PRESS-TO-TEST: Press and turn to LOCK.	*a.* Turn on the AN/URM-64A CM-77A/USM, AN/USM-207, and modulator. Permit this equipment to warm up 1 hour. *b.* Adjust and connect the AN/URM-64A as follows: (1) Adjust the ZERO set control to zero the meter. (2) Set the function switch to CW, and adjust the POWER SET control for a 0-dBm meter indication. (3) Connect the RF OUTPUT to the modulator RF IN. (4) Connect the RF output of the MD-796 to the MX-2144/U and the output of the MX-2144/U to the TS-799/U. (5) Measure the output of the MD-796 with no bias applied to the MD-796 and the modulation not applied. If it is not −6 dBm, adjust the output of the AN/URM-64 until it is. Reconnect the output of MD-796 to the PROBE input of the transponder test set.	*a.* None. *b.* None.
2	*AN/UPM-98* XTAL MARK & SYNC TRIGGER DELAY RANGE: 0 TRIGGER DELAY COARSE AND FINE: completely ccw. SYNC SELECT: -EXT SUP: completely CCW. POWER: ON CODE: (A, B, C, D): 0000		*a.* Turn on the test set, oscilloscope, and AN/UPM-98; and the TS-656, permit a few minutes warmup. *b.* Adjust the oscilloscope FOCUS, INTENSITY, AND ASTIGMATISM controls for clear signal displays. *c.* Adjust the AN/UPM-98 TRIGGER DELAY COARSE and FINE controls until a solid test set ACCEPT indication is just obtained.	*a.* None. *b.* None. *c.* None.
3	N/A	Same as step 1	Adjust the AN/URM-64A as follows: *a.* Increase the frequency with the	*a.* None.

Step	Control settings: Test equipment	Control settings: Equipment under test	Test procedure	Performance standard
			SIGNAL FREQUENCY control until the test set barely indicates accept condition (ACCEPT indicator barely lights).	
			b. Disconnect the AN/URM-64A from the modulator, and connect the AN/URM-64A to the CM-77A/USM (fig. 5-4). Adjust the CM-77A/USM FREQUENCY MEGACYCLES control for a zero beat signal on its display.	*b.* None.
			c. Observe the frequency counter indication. Add 200 to the frequency counter indication, multiply by 5, and note this as F1.	*c.* None.
			d. Reconnect the AN/URM-64 to the modulator. Decrease the AN/URM-64A SIGNAL FREQUENCY control setting until the teat set REJECT indicator barely lights. Then increase setting until the ACCEPT indicator barely lights.	*d.* None.
			e. Repeat *b* and *c* above except note as	*e.* None.
			f. Determine the receiver bandwidth and center frequency as follows (1) Subtract the frequency F2 noted in e above from F1 in c above.	(1) Bandwidth: 6.5 ± 1 mc.

Step	Control settings: Test equipment	Control settings: Equipment under test	Test procedure	Performance standard
			(2) Add the frequency noted in *c* and l above, l and divide by 2. This is the receiver center frequency.	(2) center frequency: 1,090 ± 0.5 mc.
4	N/A	Same as step l	a. Adjust the AN/URM-64A frequency to the receiver center frequency noted in step 3f (2). Use steps 2b and c to properly obtain this adjustment, except do not note the result.	*a.* None.
			b. Remove the connection between the AN/URM-64A RF OUTPUT and CM-77A/USM SIGNAL INPUT. Connect the AN/URM-64A to the modulator.	*b.* None.
			c. Adjust the AN/URM-64A ATTENUATOR control to decrease its output until the test set barely indicate an accept condition. Measure this output from the modulator on the wattmeter.	*c.* Sensitivity —9±1.

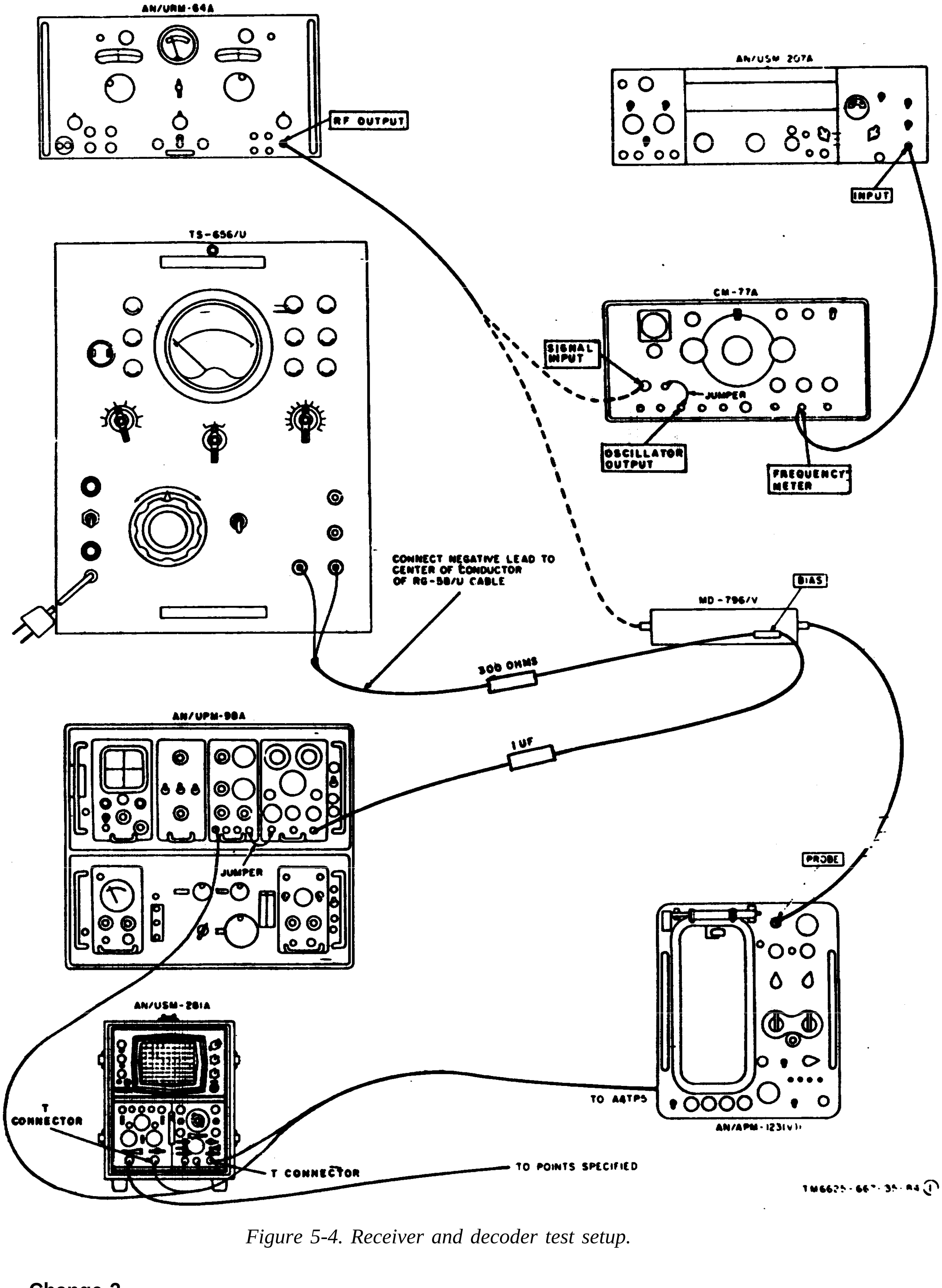


Figure 5-4. Receiver and decoder test setup.

5-7. Video Enable Delay and Test

a. Test equipment required.

(1) Modulator: MD-796/U.
(2) Generator, Signal AN/URM-64A.
(3) Oscilloscope, AN/USM-281A.
(4) Test Set, Radar AN/UPM-98.

b. Test Connections and Conditions. Connect the equipment as shown in figure 5-5. Connect the oscilloscope CHANNEL A to test point A10TPS.

c. *Procedure.*

Step	*Control settings* Test equipment	*Control settings* Equipment under test	Test procedure	Performance standard
1	*AN/UPM-98* *(SIF CODER)* CODE (A, B, C, D): 0000 AMPLITUDE: 2 FUNCTION: N SUB PULSE SELECT: OFF LEVEL: HI PULSE WIDTH: .45 (XTAL MARK & SYNC) TRIGGER DELAY RANGE: 0. TRIGGER DELAY COARSE AND FINE: completely ccw. SYNC SELECT: −EXT SUP: completely ccw *AN/URM-64A* POWER: ON FUNCTION: ZERO SET SIGNAL FREQUENCY: 1090 MC.	MODE: 2 CODE (A, B, C, D): 0000 FUNCTION: SYSTEM POWER: ON PRESS-TO-TEST: Press and turn to LOCK.	*a.* Turn on the AN/URM-64A. Permit this equipment to warm up 1 hour. *b.* Adjust and connect the AN/URM-64A as follows: (1) Adjust the ZERO set control to zero the meter. (2) Set the FUNCTION switch to CW, and adjust the POWER SET control for a 0-dbm meter indication.	*a.* None. *b.* None.
2	*AN/USM-281A* HORIZONTAL MAGNIFIER: XI HORIZONTAL DISPLAY: INT Main VERNIER: Fully Clockwise Main TIME/DIV: 50 μsec Sweep Display Switch: Mixed Sweep MODE Switch: AUTO Delayed Trigger Source: EXT Delayed SLOPE: − Delayed Trigger Coupling Switch: AC Main Trigger Source: EXT Main SLOPE: − Main Trigger Coupling: AC Display: ALT 1		*a.* Turn on the test set, oscilloscope, and AN/UPM-98, and permit a few minutes warmup. *b.* Adjust the oscilloscope FOCUS, INTENSITY, and ASTIGMATISM controls for clear signal display. *c.* Adjust the AN/UPM-98 TRIGGER DELAY COARSE and FINE controls until the test set indicates a solid accept.	*a.* None. *b.* None. *c.* None.

Step	Control settings: Test equipment	Control settings: Equipment under test	Test procedure	Performance standard
	A VOLTS/DIV 10 B VOLTS/DIV 10			
3	3 as step 2	Same as step 2	*a.* Connect the oscilloscope CHANNEL A to A10TP5. Measure and record the width of the pulse at CHANNEL A. This is the video enable delay.	*a.* The video enable delay 1.8 ± 0.05 microseconds.
			b. *Disconnect* CHANNEL B from A5TP5, and connect it to A9TP4.	*b.* None.
			c. Adjust the oscilloscope controls until a complete pulse is observed at CHANNEL A. Measure the delay between trailing edges of the last pulse at CHANNEL A. This determines the video enable period limits.	*c.* The video enable period win conclude within 6 microseconds of the trailing edge of the last expected reply pulse.
			d. Set the test set FUNCTION switch to IDENTITY and the AN/UPM-98 FUNCTION switch to ID. Repeat above.	*d.* Same as c above.
			e. Set the test set MODE switch to land the AN/UPM-98 FUNCTION switch to EMER. Repeat the procedure in c above.	*e.* Same as *c* above, after two trails.
			f. Set the test set FUNCTION switch to EMER. Repeat the procedure in *c* above.	*f.* Same as *c* above.

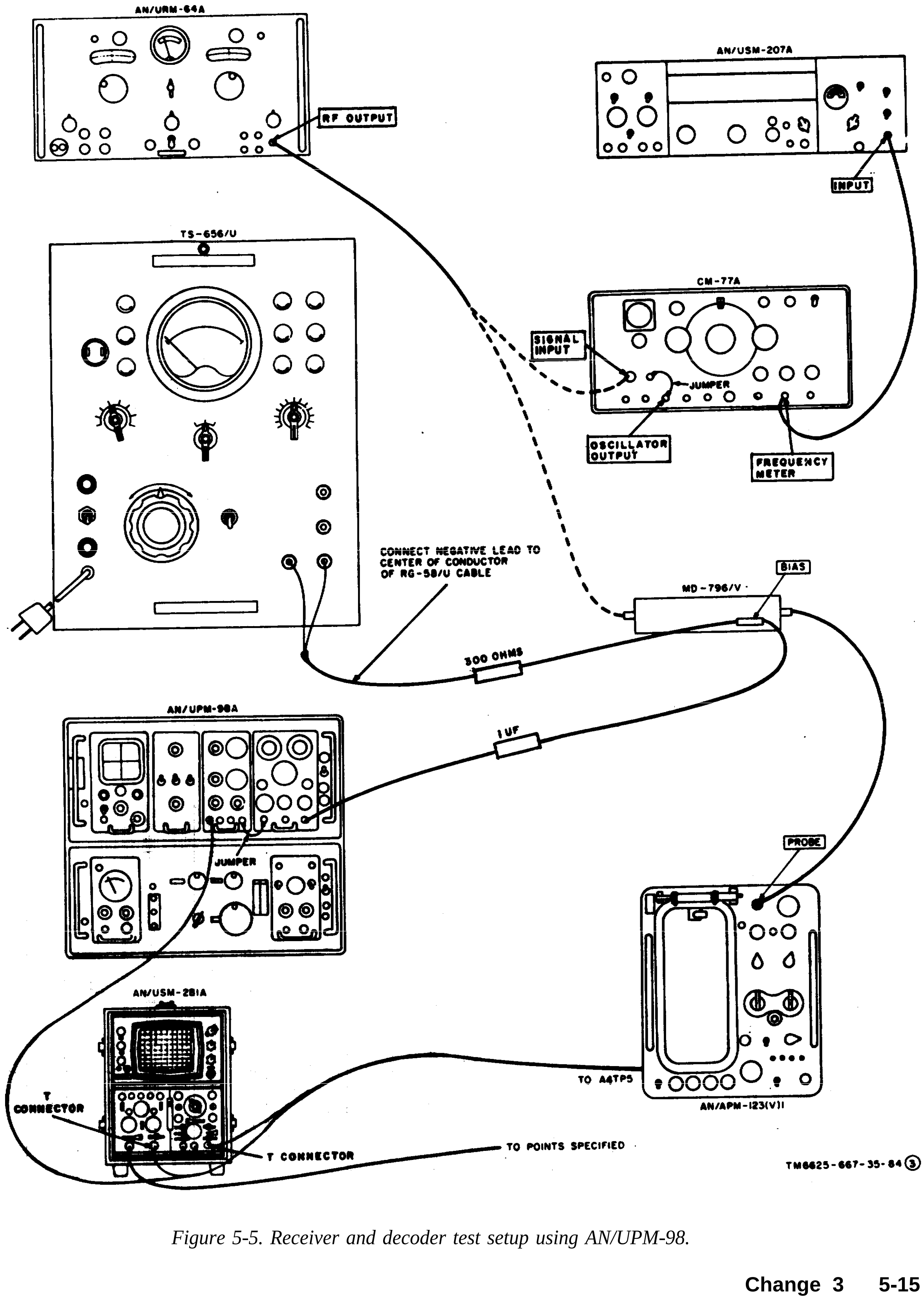


Figure 5-5. Receiver and decoder test setup using AN/UPM-98.

5-8. Decoder Tests

a. Test Equipment Required

(1) Test Set, Radar AN/UPM-98.

(2) Oscilloscope, AN/USM-281A.

(3) Generator, Signal AN/URM-64A.

(4) Modulator: MD-796

b. Test Connections and Conditions. Connect the equipment as shown in figure 5-6. Connect the oscilloscope CHANNEL A to test point A1lTP1.

c. Procedure.

Step	Control settings: Test equipment	Control settings: Equipment under test	Test procedure	Performance standard
1	*AN/UPM-98* CODE (A, B, C, D): 0000 AMPLITUDE: 2 FUNCTION: N SUB PULSE SELECT: OFF. LEVEL: HI PULSE WIDTH: .45 (XTAL MARK & SYNC) TRIGGER DELAY, RANGE: 0. TRIGGER DELAY COARSE AND FINE: Completely ccw. SYNC SELECT: —EXT SUP: Completely ccw POWER: ON *AN/URM-64A* POWER: ON FUNCTION: ZERO SET SIGNAL FREQUENCY: 1090 MC. ATTENUATOR: —6dbm	None.	*a.* Turn on the AN/URM-64A and modulator. Permit this equipment to warm up 1 hour. *b.* Turn on the AN/UPM-98, and permit a few minutes warmup. *c.* Adjust and connect the AN/URM-64A as follows: (1) Adjust the ZERO set control to zero the meter.	*a.* None. *b.* None. *c.* None.
2	*AN/USM-281A* HORIZONTAL MAGNIFICATION: XI HORIZONTAL DISPLAY: INT Main VERNIER: Fully clockwise Main TIME/DIV: Sweep Display Switch: MIXED Delayed Trigger Source: EXT Delayed SLOPE: — Delayed Trigger Coupling Switch: AC Main Trigger Source: EXT Main SLOPE: — Main Trigger Coupling: AC	FUNCTION: SYSTEM POWER: ON CODE: 0000 PRESS-TO-TEST: LOCK MODE: 1	*a.* Turn on the oscilloscope and test set. Permit a few minutes warmup. *b.* Press the test set PRESS-TO-TEST switch, and turn to LOCK.	*a.* None. *b.* None.

Step	Control settings Test equipment	 Equipment under test	Test procedure	Performance standard
	Display: A A VOLTS/DIV 10			
3	N/A	Same as step 1	*a.* Adjust both the test set and AN/UPM-98 SIF CODER CODE controls to each code as follows, and note the test set readout. *CODE* *A* *B* *C* *D* 0 0 0 0 1 1 1 1 2 2 2 2 3 3 3 3 4 4 4 4 5 5 5 5 6 6 6 6 7 7 7 7	*a.* The test set must indicate ACCEPT.
			b. Repeat the procedure in *a* above with the test set MODE switch set at 2, 3/A, and TEST, respectively. This is to determine whether operation is normal in these modes.	*b.* The test set indicate ACCEPT.
			c. Set the AN/UPM-98 SIF CODER switches to 7774, and the FUNCTION switch to ID.	*c.* None.
			d. Set the test set FUNCTION switch to I/P, and the MODE switch to 2. This action checks the I/P test function for modes 2, 3/A, and TEST.	*d.* The test set must indicate ACCEPT.
			e. Set the AN/UPM-98 SIF CODER CODE switches to 7700, and the FUNCTION switch to EMER.	*e.* None.
			f. Set the test set CODE switches to 7700, and the FUNCTION switch to EMER.	*f.* The test set must indicate ACCEPT.
	AN/UPM-98 CODE: 0000 FUNCTION: N SUB PULSE SELECT: SP.	CODE: 0000 MODE: 2 FUNCTION: SYSTEM	*a.* Adjust the AN/UPM-98 SIF CODER SUB PULSE POS control from 0 clockwise and then from counterclockwise until the test set barely accepts. Measure the spacing between the pulses, observed on oscilloscope CHANNEL A, for each accept condition.	*a.* The test set will accept framing pulses spaced within ± 0.15 μsec of nominal spacing.
			b. Repeat the procedure in *a* above, except adjust the SUB PULSE POS control for	*b.* The test set will reject framing pulses

Step	Control settings: Test equipment	Control settings: Equipment under test	Test procedure	Performance standard
			a just-reject condition. Measure spacing for each reject condition.	spaced greater than ± 0.35 μsec of nominal spacing.
5	*AN/UPM-98* SUB PULSE SELECT: C1. CODE: 7777	CODE: 7777	*a.* Adjust the AN/UPM-98 SUB PULSE POS control from 0 clockwise and then counterclockwise until the test set barely accepts. Measure the spacing between the F1 pulse and C1 subpulse as observed on oscilloscope CHANNEL A, for each accept condition.	*a.* The test set will accept information pulses spaced within 0.15 μsec of the nominal position of the C1 pulse.
			b. Adjust the AN/UPM-98 SUB PULSE POS control from 0 clockwise and then counterclockwise until the test set barely rejects. Measure the spacing between the C1 pulse and F1 pulse as observed on oscilloscope.	*b.* The test set will reject information pulses spaced more than ± 0.35 microsecond from the nominal position of the pulse.

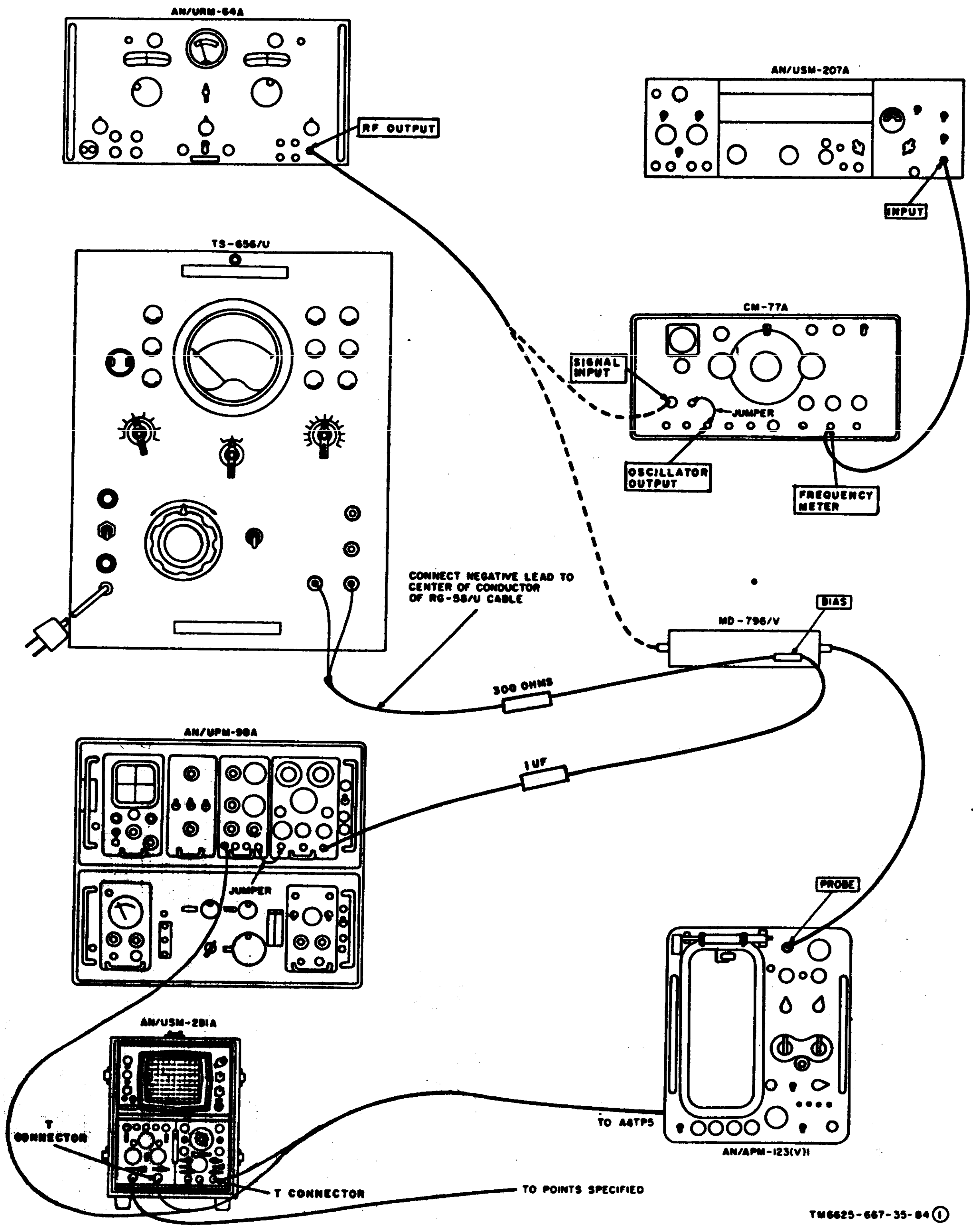


Figure 5-6. Receiver and decoder test setup.

5-9. Reply Evaluation Percentage Tests

a. Test Equipment Required

(1) Test Set, Radar AN/UPM-98.
(2) Generator, Signal AN/URM-64A.
(3) Modulator MD-796.
(4) Multimeter ME-26B/U.
(5) Oscilloscope,

b. Test Connections and Conditions. Connect the equipment as shown in figure 5-7.

c. Procedure.

Step	Control settings: Test equipment	Control settings: Equipment under test	Test procedure	Performance Standard
1	***AN/UPM-98*** ***(SIF CODER)*** **CODE (A, B, C, D): 0000** **AMPLITUDE: 2** **FUNCTION: N** **SUB PULSE SELECT: OFF.** **LEVEL: HI** **PULSE WIDTH: .45** ***AN/UPM-98*** ***(XTAL MARK & SYNC)*** **TRIGGER DELAY, RANGE: 0.** **TRIGGER DELAY, COARSE AND FINE: Completely ccw.** **SYNC SELECT: —EXT** **SUP: Completely ccw** **POWER: ON** ***AN/URM-64A*** **POWER: ON** **FUNCTION: ZERO SET** **SIGNAL FREQUENCY: 1090 MC.** **ATTENUATOR: —6 dbm.**	**None**	*a.* Turn on the AN/URM/64A. Permit this equipment to warm up 1 hours. b. Turn on the AN/UPM-96 and permit a few minutes warmup. c. Adjust and connect the AN/URM-64A as follows: (1) Adjust the ZERO SET control to zero the meter. (2) Set the FUNCTION switch to CW, and adjust the POWER SET control for 0-dbm meter indication. (3) Adjust the SIGNAL FREQUENCY control to 1,090 mc.	*a.* None. *b.* None. *c.* None.
2	***AN/USM-281A*** **HORIZONTAL MAGNIFICATION: X1** **HORIZONTAL DISPLAY: INT** **MAIN VERNIER: Fully Clockwise** **Main TIME/DIV:** **Sweep Display Switch: MIXED** **Delayed Trigger Source: EXT** **Delayed SLOPE: —** **Delayed Trigger Coupling Switch: AC** **Main Trigger Source: EXT** **Main SLOPE: —**	**FUNCTION: SYSTEM** **POWER: ON** **CODE: 0000** **PRESS-TO-TEST: LOCK** **MODE: 1** **FUNCTION: SYSTEM**	*a.* Turn on the oscilloscope and test set. Permit a few minutes warmup. *b.* Press the test set PRESS-TO-TEST switch, and turn to LOCK. *c.* Adjust the TRIGGER DELAY COARSE AND FINE controls until a solid test set ACCEPT indication is just obtained.	*a.* None *b.* None. *c.* None.

Step	Control settings: Test equipment	Control settings: Equipment under test	Test procedure	Performance standard
	Main Trigger Coupling: AC Display: A A VOLTS/DIV 10			
3	*ME-26B/U* RANGE: 30V SELECTOR: (+)		*a.* Set the AN/UPM-98 SUB PULSE SELECT switch to Cl information pulse position.	*a.* None.
			b. Adjust the SUB PULSE POS control until the test set barely indicates REJECT. Adjust the ME-26B/U ZERO SET to zero meter.	*b.* None.
			c. Adjust the AN/UPM-96 SUB PULSE POS control until test set set indicates ACCEPT. Note ME-26B/U indication.	*c.* None.
			d. Adjust the SUB PULSE POS control, in either direction, until the test set barely indicates REJECT. Note the ME-26B/U indication. This voltage should be 80% of that noted in *c* above.	*d.* The test set will provide an ACCEPT indication when 80% or more replies are correct.

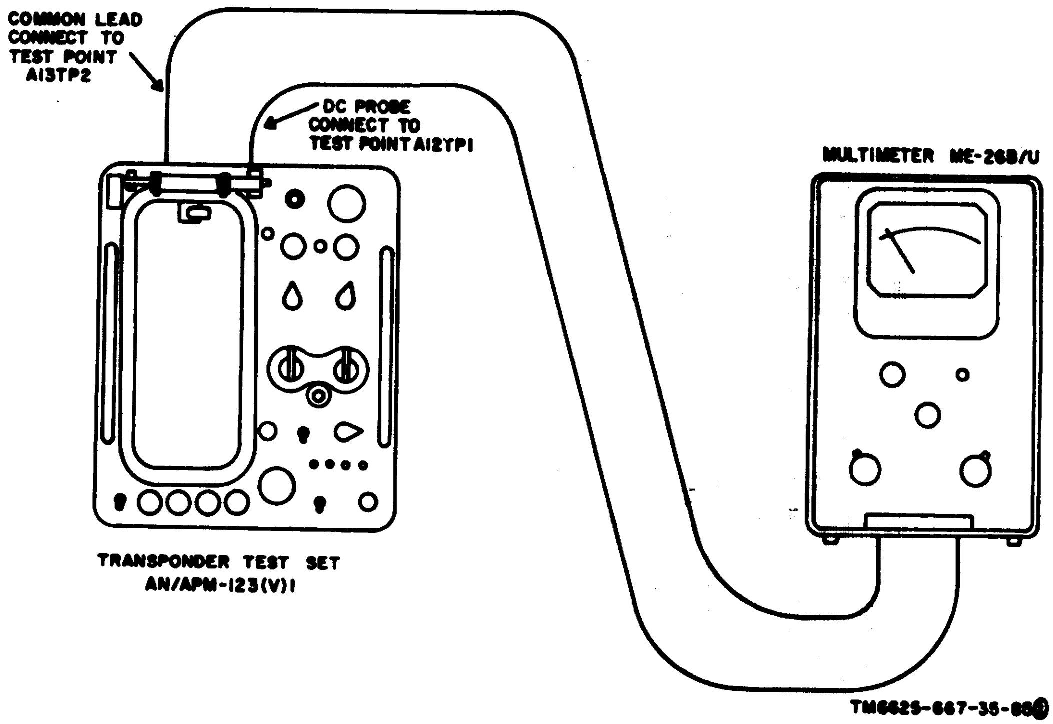


Figure 5-7. Reply evaluation percentage test setup using AN/UPM-98.

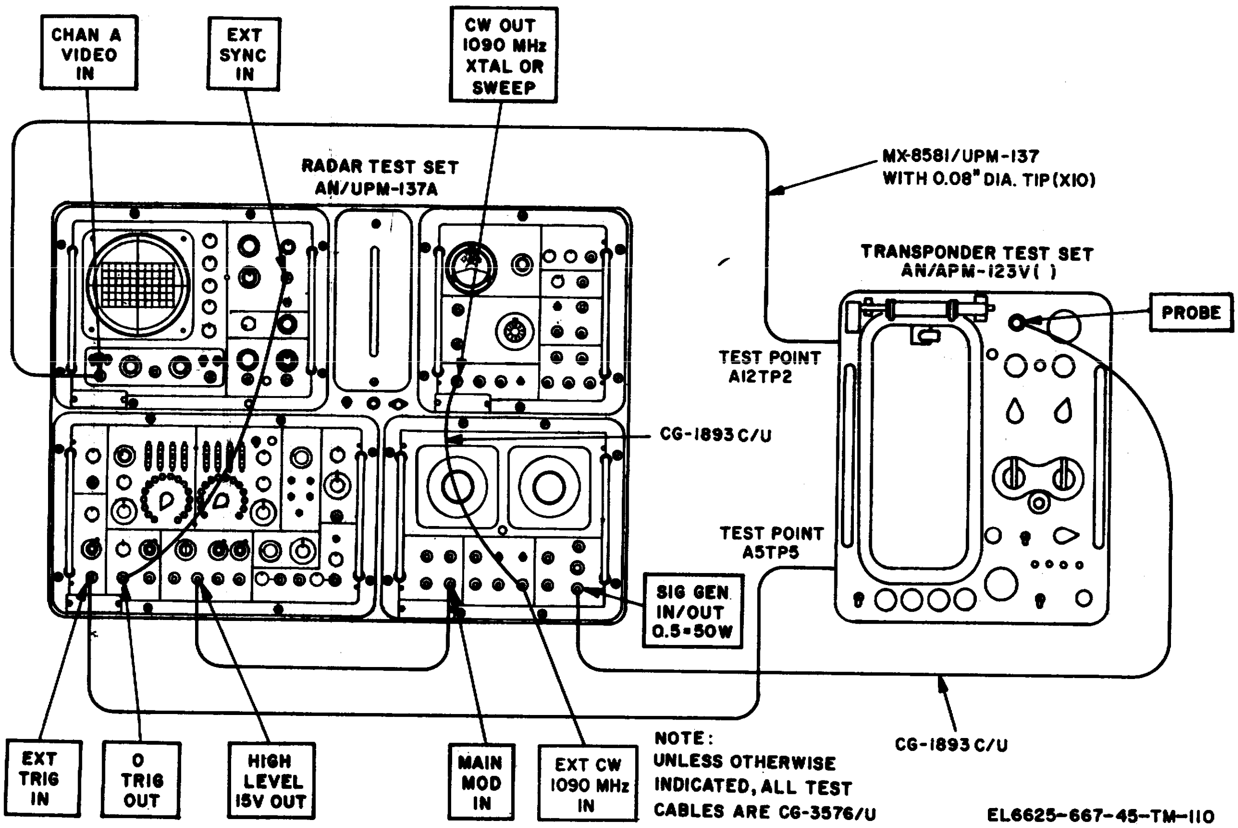


Figure 5-7.1 Reply evaluation percentage test setup using AN/UPM-137A.

5-9.1. Evaluation Percentage Tests Using AN/UPM-137A

a. Test Equipment Requested.

(1) Test Set, Radar AN/UPM-137A.

b. Test Connections and Conditions. Connect the equipment as shown in figure 5-7.1.

c. Procedure.

Step No.	Control Settings Test Equipment	Equipment Under Test	Test Procedure	Performance Standard
1	*AN/UPM-137A* (rf signal generator) OUTPUT ATTEN 0-100 dbm: −6 TRANSMITTER-XMTR FREQ: XTAL TRANSMITTER-CW SOURCE: EXT 1090 MHz (interrogator signal simulator) TRANSMITTER-XMTR FREQ: XTAL (SIS generator) SIF 1 CODER-Code switches (A, B, C, D): 7777 SIF 1 CODER-FUNCTION SEL: N SIF 1 CODER-WIDTH ADJ: approx. center SIF 1 CODER-SUBST PULSE SEL: OFF MIXED VIDEO-MIXED VID SEL: SIF 1 PRF-RANGE MULT: EXT TRIGGERS-DELAY TRIG (μSEC)-MULT 1 — 11:6.0 *ME-26B/U* SELECTOR: + RANGE: 10V	FUNCTION: SYSTEM ISLS: OFF MODE: 1 CODE (A, B, C, D): 7777	*a.* Turn on AN/UPM-137A and test set. Permit 5 minute warm-up. *b.* Press test set PUSH TO TEST switch and turn to LOCK position. *c.* Adjust AN/UPM-137A SIS generator TRIGGERS-DELAY TRIG (μSEC)- MULT 1 — 11 control until test set indicates ACCEPT and will indicate REJECT when test set CODE switches are changed to 7776. *d.* Connect ME-26B/U common lead to A13TP2 (ground) and dc probe to A12TP2.	*a.* None *b.* None *c.* None *d.* None
2	*AN/UPM-137A* (SIS generator) SIF 1 CODER-SUBST PULSE SEL: C1	Same as step 1	*a.* Adjust AN/UPM-137A SIS generator SIF 1 CODER-SUBST PULSE POSN control completely cw. *b.* Adjust ME-26B/U ZERO ADJ control for ZERO meter indication. *c.* Adjust AN/UPM-137A SIS generator SIF 1 CODER-SUBST PULSE POSN control to 0. Note ME-26B/U indication.	*a.* Test set should indicate REJECT. *b.* None *c.* Test set should indicate ACCEPT.

d. Adjust AN/UPM-187A SIS generator SIF 1 CODER-SUBST PULSE POSN control, in either direction, until dc voltage level indicated on ME-26B/U is 80% of that noted in *c* above.	*d.* Test set should indicate ACCEPT.
e. Adjust AN/UPM-187A SIS generator SIF 1 CODER-SUBST PULSE POSN control, in either direction, until dc voltage level indicated on ME-26 B/U is 50% of that noted in *c* above.	*e.* Teat set should indicate REJECT.

CHAPTER 5.1

MODE 4 FUNCTIONING AND MAINTENANCE FOR MODE 4

Section I. FUNCTIONING

5.1-1. General

a. The test set performs mode 4 tests when connected to mode 4 interrogator equipment. A transponder set under test is connected to mode 4 transponder equipment. Test results indicate whether the transponder set and mode 4 equipments are performing correctly. Radiation and direct RF coupling type tests are performed in a manner similar to SIF tests (modes 1, 2, 3, and C). The test set front panel MODE 4 switch, RAD-DIR, is set to RAD for radiation and DIR for direct connection tests. Each switch position establishes the condition necessary for an accept indication. During SIF tests, 80 percent or more correct replies provide an accept indication. When mode 4 radiation checks are in progress, 56 or more correct replies within a 64 pulse recurrence frequency (prf) evaluation period are required for an accept condition. For mode 4 direct RF coupling tests, 16 consecutive correct replies within the 64 prf evaluation period are required. When the PUSH TO TEST switch is depressed, the test begins after approximately 50 prf periods. Testing is not performed on a continuous basis as with SIF tests. A mode 4 indication (ACCEPT or REJECT indicator) will appear as long as the PUSH TO TEST switch is depressed.

b. When the PUSH TO TEST switch is depressed, mode 4 pretrigger pulses will be produced by the encoder in the transmitter section. These pulses are applied through the MODE 4 jack to the mode 4 interrogation equipment. After a delay of time, this equipment returns mode 4 challenge video modulation pulses to the test set. The signal consists of a group of pulses (36 maximum) in response to each pretrigger pulse, and there are four such groups during a test period. The challenge video modulated RF is transmitted to the transponder set by the test set transmitter section.

c. Mode 4 ISLS pulses are produced in the mode 4 encoder. When selected, the first mode 4 challenge video pulse causes an ISLS trigger forming circuit to produce an ISLS trigger pulse after 8 microseconds. The resultant pulse will appear as the fifth pulse of the mode 4 challenge video. Responses from the transponder to mode 4 challenges are detected and processed by the test set receiver section. The resultant three-pulse reply video is decoded. When the pulse positions are within established limits, a decoded reply video pulse is routed through the MODE 4 jack to the mode 4 interrogation equipment. The mode 4 interrogation equipment returns a time-decoded video pulse (TVD) to the test set for counting in response to the decoded reply video pulse and a test ACCEPT or REJECT indication is produced under the conditions described above.

5.1-2. Detailed Functional Analysis

a. Mode 4 Decoder Section Challenge Video Shaping, ISLS Generation, and Reply Evaluation Enabling fig. 8-38. When the PUSH TO TEST switch is pressed, the mode 4 pretrigger and prf generator A5Q14/A5Q15 circuits are activated. The prf signal is coupled by PRF-AMPL A1Q7 to set M4 decode enable A1FF2, thereby enabling ISLS line drive gate A1M8B and enable gate A1M8A. The mode 4 pretrigger is directed through the MODE 4 jack and causes the mode 4 interrogation equipment to respond, through MODE 4 jack after a delay of 168 µ sec, with mode 4 challenge video. These pulses are coupled by inverter A5Q16 to M4 challenge shaper A1SS6 which produces 0.5-microsecond (nominal) pulses at its 1 and 0 outputs. The duration is adjusted by control A1R32, for 0.5-microsecond pulses at the transmitter output. Differences in duration are because of inherent pulse stretching at the transmitter. The positive-going 1 output is coupled by inverter A1Q4 to drive the main modulator driver in encoder module A4. The negative-going 0 output is coupled by inverter A1M8D to enable gate A1M8A and ISLS line drive gate AlM8B. The first pulse gated by A1M8A triggers video enable delay A1SS5 and time-decoded video gate de lay A2SS1, and sets video sensor enable A2FF15. A gated pulse is also coupled by inverter A1M8D to reset M4 decode enable A1FF2 and set M4 ISLS enable A1FF3. This action disables enable gate A1M8A and ISLS line drive gate A1M8B and enables ISLS trigger gate A1M9A. The single pulse output of line drive gate A1M8B is coupled by MODE switch A15S5-C to module A10. The pulse is gated by line drive gate 2 and coupled by delay line driver, A10Q7 to delay line A6DL1. These circuits are time-shared with the SIF test functions. The pulse is delayed for 8 microseconds and coupled by M4 amplifier A1Q3 to ISLS trigger gate A1M9A. The gated delayed pulse is coupled by MODE switch A1SS5-E to trigger P2 shaper ISS2 (module A4), and by inverter A1M9B to reset M4 ISLS enable A1FF3. The M4 ISLS pulse output of ISS2 is 0.5 microsecond and is applied to P2 modulator driver A5Q17/A5Q18 on main modulator driver A4Q11/A4Q12 (modules A5 and A4, respectively). The resultant challenge video that appears at the transmitter will include the ISLS pulse spaced 8 microseconds from the first mode 4 challenge video pulse.

b. Mode 4 *Reply Decoding.* Mode 4 video decode enabling is performed by reply video enable A1FFL The first challenge video pulse, gated by enable gate A1M8A triggers video enable delay AlSS5 to produce a positive 150-microsecond pulse. The trailing edge of this puke sets reply video enable A1FF1, and its positive going 1 output enables decode gates A1M1A, A1M1B, A1M1C, and A1M5A. Mode 4 replies are detected and processed by the receiver section, and coupled from video amplifier module A8 to amplifier A1Q6. This amplifier effectively controls receiver sensitivity for mode 4 operations. An adjustment is performed after the initial test set receiver sensitivity is established while in an SIF mode. Then, the test set is set for mode 4 operation and control A1R43 is adjusted while the PUSH TO TEST switch is continually pressed and released with a pause between each action. Such action is necessary since a mode 4 test indication is locked until the PUSH TO TEST switch is released. The output of A1Q6 is gated by decode gates A1M1A and A1M5A to frost decode shaper A1SS3 and M4 line drive shaper A1SS4, respectively. Each of the three reply pulses trigger these one-shots. The 0.3-microsecond pulse output of A1SS3 is applied to reply coincidence gate A1M6B. The 0.7-microsecond pulse output of AlSS4 is coupled by MODE switch A155-C to line drive gate 2 (module A10). Gated pulses are amplified by delay line driver A10Q7 and applied to delay linee A6DL1. Pulses that appear at a 1.8microsecond tap are coupled by amplifier A1Q2 to decode gate A1M1B. Each gated puke triggers second decode shaper ASS2. Pulse that appear at a 3.6 microsecond tap are coupled by amplifier A1Q1 to decode gate A1M1C. These gated pulses trigger third decode shaper A1SS1. The outputs of A1SS2 and A1SS3 are, therefore delayed, and then applied to the reply coincidence gate. When the third pulse from oneshot A1SS3 is in coincidence with the second pulse from one-shot A1SS2 and the first pulse from one-shot A1SS1, the reply coincidence gate is gated on. If a reply pulse is miming or positioned incorrectly, one of the shaper outputs will not appear in coincidence with the others; therefore, a coincidence puke will not be gated by the reply coincidence gate and a video count is then inhibited. A gated coincidence pulse is coupled by inverter AlQ5 and video gate 1 (module A8) to trigger M4 shaper A8DSS6. The 0.5-microsecond pulse output from A8DSS6 is coupled by amplifier A8Q7, through the MODE 4 jack, to the mode 4 interrogation equipment. The pulse is also applied to the decoded video sensing gate A2M14A. This equipment returns a time-decoded video pulsee to the mode 4 reply evaluation section.

5.1-3. Mode 4 Reply Evaluation Section

a. General. This section determines whether a sufficient number of correct replies within 64 prf periods were processed. It contains two counters and time-decoded video enable circuits for this purpose. The counters are enabled after the PUSH TO TEST switch is activated, and a delay equivalent to 50 prf periods elapses. When the switch is activated the 28-volt supply charges capacitor A2C9 through resistor A2R22 (fig. 8-41 (2)). After the effective 50 prf delay constant, the voltage level will be sufficient to cause count delay amplifier A2M18C (fig. 8-38 (2)) to conduct. Regulator diode A2VR4 holds the voltage at this level. The negative-going output of the count delay amplifier inhibits gate A2Q6/A2Q7, therefore, the reset level is removed from both counters.

b. Time-Decoded Video Counting. Test indications are dependent on the number of time-decoded video pulses received within 64 prf periods. Each time-decoded video pulse from the mode 4 interrogation equipment is counted by the time-decoded video counter. The operation is initially started with the triggering of time-decoded video delay A2SS1 (fig. 8-38 (2)) by the output of enable gate A1M18A which produces a 267-microsecond pulse; its trailing edge triggers time-decoded video gate enable A2SS2. The time-decoded video pulse from the mode 4 interrogation equipment can then be gated to the time decoded video counter. This pulse is in response to the decoded video from the test set mode 4 decoder section; A counter output gate circuit is controlled by the RAD-DIR switch, which selects a count of 16 or 56. The count of 56 is selected when radiation tests are to be performed. A count of 16 is selected for direct rf coupling tests.

(1) *Radiation test count.* The RAD position of switch A15S9 inhibits gate A2M19A and enables gate A2M19B. In this state, gate A2M19B is gated on at the count of 56 by the counter. The 1 outputs of A2FF4, A2FF5, and A2FF6 are high when at least 56 time-decoded video pulses are received. The gating of A2M19B sets readot it control A2FF7 and its 0 output goes low. Inverter A2Q4 then stops conducting and its positive-going output causes the reply rate evaluator to provide an ACCEPT indication. If less than 56 time-decoded pulses are received, readout control A2FF7 remains in a reset state. Inverter A2Q4 is, therefore, conducting for a full prf period and causes the reply rate evaluator to produce a REJECT indication. In either case, the count and test indication is held until the PUSH TO TEST switch is released. Additional counting, however, is inhibited by a prf counter after 64 prf periods.

(2) *Direct rf connection test count.* This operation requires 16 consecutive correct replies (within 64 prf periods) for an accept condition. In addition to the counter, a counter error reset circuit is enabled, When the RAD-DIR switch ,is set at DIR, counter output gate A2M19B is inhibited, Gate A2M19A and counter reset gates A2M15A and A2M15B are enabled through A2FF7. The latter two gates are part of the counter error reset circuit. This circuit senses whether mode 4 decode video was present and only a single reply was received during a prf period. The counter trigger from enable gate A1M8A sets video sensor enable A2FF15 and its positive-going 1 output enables decoded, video sensing gate A2M14A and counter reset gate A2M15A. Decoded video, gated by gate A2M14A, is coupled by inverter A2M14B to reset A2FF15. If the decoded reply is missing, the high 1 output of this flip-flop will be present when one-shot A2SS2 is triggered by a subsequent counter trigger; therefore, counter reset gate A2M15B is gated on and a counter reset signal is applied to the counter through gates A2M18B and A2Q5. If two replies occur during a prf period the 0 of flipflop A2FF15 goes high upon the arrival of the first decoded pulse and enables counter reset gate A2M15A; therefore, the second reply will

be gated by counter reset gate A2M15A. This action also gates a counter reset signal through gates A2M18A and A2Q5/A2Q6 to the counter. Both counter reset gates are inhibited when readout control A2FF7 is set by an acceptable count. A constant readout (ACCEPT or REJECT) is maintained by the reply rate evaluator until the PUSH ON TEST switch is released.

c. Prf Counting. The prf counter controls the operation of time-decoded video enable A2SS2. It enables this one-shot for the initial 64 prf periods. After this time, it disables A2SS2 until the counter is reset by the release of the PUSH TO TEST switch. When the PUSH ON TEST switch is activated, each prf pulse is gated by prf count gate 1 (A2M16A) and coupled by inverter A2M16C to trigger flip-flop A2FF8. On the count of 64, flip-flop A2FF14 goes high and gates on prf count gate 2. This action disables prf count gate 1 and one-shot A2SS2 until the prf counter is reset by the release and activation of PUSH TO TEST switch; therefore, additional time-decoded video counts are inhibited.

5.1-4. 5-Volt Regulator Module A3

(fig. 8-39)

This voltage regulator provides the power source to the micrologic circuits in mode 4 modules Al and A2. Regulation is performed by series power regulator A3Q1, and its conducting is controlled by the operation of square wave oscillator A3Q10A/A3Qll through amplifiers A3Q3 and A3Q9. The operation of the oscillator is controlled by a constant current circuit. Transistors A3Q5 and A3Q6 form a + 12-volt bias protection circuit. If the +12-volt bias is not present, this circuit stops the conduction of A3Q1, thus preventing regulator circuit damage because of loss of bias voltage.

a. Series Power Regulator A8Q1. This stage operates in series with the 28-volt source and mode 4 modules (Al and A2). Its conduction determines the source output voltage and is controlled by square wave oscillator A3Q10/A3Q11 (fig. 8-39). Diode A3CR1 (fig. 8-42) performs an isolating function in the collector circuit. The emitter output is fed into a filter consisting of inductor A3L1 and capacitors A3C2 and A3C6. Diode VR1 provides regulation at the output of the filter if the voltage increases above 6.3 volts. At this point, the voltage is normally 5.6 volts (approximately). Additional filtering is performed by the action of capacitors C7, C8, and C9.

b. Square Wave Oscillator A8Q10/A3Q11 (fig. 8-39). This square wave oscillator controls the operation of series power regulator A3Q1. Its operating frequency is dependent on the load, and is controlled by the action of constant current amplifier A3Q7/A3Q8. The square wave output, applied through amplifier A3Q9 to emitter follower A3Q3, is held off one-fifth more than on; therefore, this action maintains approximately 5.6 volts at the emitter of series power regulator A3Q1 by effectively dividing the 28-volt dc input.

c. Constant Current Circuit. The constant current circuit consists of constant current amplifier A3Q7/A3Q8, limiting amplifier A3Q2/A3Q4, and differential amplifier A3Q12/A3Q13. This circuit provides a constant current source for the square wave oscillator. The constant current amplifier operation is controlled by the limiting and differential amplifiers. Output current limiting is adjusted with, control A3R3 (fig. 8-42). The setting of this control establishes the base bias of stage A3Q2 and, in turn, its conduction. The collector output of stage A3Q4 is coupled by diode A3CR3 to the common emitter circuit of constant current amplifier A3Q7/A3Q8. Adjusting control A3R3 will establish a regulated emitter bias at A3Q7/A3Q8. Differential amplifier A2Q12/A3Q13 establishes the base bias at stages A3Q7/A3Q8. Control A3R24 is used to adjust the differential amplifier (A3Q7/A43Q8) operation and, in turn, the regulator output voltage. If a short circuit occurs at the regulator output, the current limiting stages serve as a load, thereby preventing power supply damage. If the regulator input voltage changes, it is sensed by the differential amplifier. This amplifier causes the square wave oscillator to change frequency through the constant current amplifier. Such action will effectively change the on-off period of series power regulator A3Q1 to increase or decrease its output as applicable.

Section II. TROUBLESHOOTING

5.1-5. Organization of Troubleshooting Procedures

a. General. The first step in servicing a test set with improper mode 4 operation is to sectionalize the fault. Sectionalizing means tracing the fault to either module Al, A2, or A3. The second step is to localize the fault. Localization means tracing the fault to a defective stage or circuit causing the abnormal condition. The third step is isolation. Isolation means locating the defective part or parts that are responsible for the malfunction.

NOTE

The equipment must provide a satisfactory self test before proceeding with mode 4 tests. A mode 4 self test cannot be performed. In the event of a self test REJECT indication, refer to troubleshooting instructions for other test set operations.

b. Sectionalization. To simplify the location of a fault, it is convenient to consider that there are six main functional mode 4 circuits: power supply, challenge video circuit, reply decoder, counter circuits, double-reply detection circuit, and reply evaluator; therefore, the first step in tracing troubles is to determine the circuit where the fault is location.

(1) *Visual inspection.* The purpose of visual inspection is to locate faults that may be evident without testing or measuring. This includes such things as broken wires, bent or corroded connector pins, damaged circuit boards, or loose RF jacks and plugs. All possible visible inspections should be performed before attempting operational tests.

(2) *Sectionalization tests.* The sectionlization tests are operational type tests and frequently indicate the general location of trouble. In some instances, the tests will help in determining the exact nature of the fault. Tests are given in paragraph 5.1-6.

c. Localizatiotion. Localization procedures should be performed after the trouble has been sectionalized (*b* above). Localization procedures applicable to this equipment are described in paragraph 5.1-7, and should be used to localize the trouble to a stage in the suspected module or subassembly.

d. Isolation. Procedures for isolating trouble to a detail part are given in paragraph 5.1-8.

e. Techniques. The techniques for sectionalization are described in paragraph 5.1–6, and those for isolation in paragraph 5.1-3. In performing localization and isolation procedures, one or more of the techniques described below may be applied. Apply these techniques only as indicated and *observe* all cautions.

(1) *Voltage measurements.* This equipment containes transistor circuits. When measuring voltages, use tape or sleeving to insulate the entire test probe, except for the extreme tip. A momentary short circuit can damage a transistor. Use the same or equivalent electronic multimeter specified on the voltaged and resistance charts.

NOTE

Modules A1 and A2 contain digital circuits. Do not attempt to analyze. their operation with voltage readings. Analyze their operation with the waveforms in figures 5.1-8 and 5.1-9.

(2) *Resistance measurements.* Make transistor resistance measurements in this equipment only as directed on the voltage and resistance diagrams. Use only the ohmmeter ranges indicated on figures 5.1-3, 5.1-4, and 5.1-5; otherwise, the indications will not be accurate.

CAUTION

Before using any ohmmeter to test transistors or transistor circuits, check the open-circuit voltage across the ohmmeter test leads. Do not use the ohmmeter if the open-circuit voltage exceeds 1.5 volts. Also, since the RX1 range usually connects the ohmmeter internal battery directly across the test leads, the comparatively high current (50 ma or more may damage the transistor under test. As a general rule, the RX1 range of any ohmmeter should not be used when testing low-power transistors. Do not use an ohmmeter to check in tegrated circuits.

(3) *Use of test points*. Each module is provided with test jacks to facilitate connection of test equipment. These test jacks should be used as directed during troubleshooting to avoid needless disassembly of the equipment. The test points are indicated on schematic diagrams and physical locations of test points are shown in figure 5.1-1. Test point designator numerals for each module are identified by standard RETMA color code as shown in the chart below. Black is always aground test point.

Color	*Test point designator numberal*
Brown	1
	2
Orange	3
Yellow	4
Green	5
Blue	6
Violet	7
Gray	8
White	

(4) Use of extender card. Measurements to be made at points other than at the test jacks provided require the use of the extender board (fig. 5.1-1). To use the extender card, the equipment power must first be turned off. Then, remove the circuit card that is to be tested from its receptacle. Remove the extender card and insert it in the receptacle. The module is then inserted in the receptacle of the extender card. The power should then be turned on to resume testing.

CAUTION

Be sure that no metal objects (screwdrivers, pliers, etc) come in contact with the printed circuit board while power is applied. A short circuit of the wiring could damage the solid state circuit elements mounted on the board.

CAUTION

Be sure that the module is properly installed. The reversal of the module could result in damage to the circuit elements.

5.1-6. Sectionalization Tests

NOTE

See para 5.1-6.1 when using AN/TPM-25A.

a. General. Sectionalization tests are per formed to sectionalize a fault to a module or subassembly. Two sectionalization test charts are provided. The fit uses Radar Test Set AN/UPM-98A or AN/UPM-98B and the second uses Radar Test Set AN/UPM-137A. Uses of the sectionalization test charts is described in c below.

b. Test Setup. A test setup is provided for each type of test (fig. 5.1-2 and 5.1-7). Instructions for making primary power connections are in TM 11-6625-667-12. During the sectionalization tests, the required test setup is referred to and test conditions noted. Reference should be made to figure 5.1-1 for location of specified internal test points. Test steps must be performed in the order given for proper equip ment connections and conditions. General instructions are provided in the charts for using the test equipment. These instructions should be supplemented with the instruction manual applicable to the specific test equipment used. Before proceeding with a test setup, remove the unit from its case to expose test points and adjustment controls as follows:

(1) Unlatch and remove the test set cover.

(2) Release two screws on each side, top, and bottom of front panel with a screwdriver.

(3) Lift the test set from the case.

(4) Place the unit carefully on a clean area *of* the workbench. Position it for convenient access to both the rear section and the front panel. Remove module retainer by removing the securing screws.

c. Use of charts. The sectionalization test charts (*d* and *e* below) are step by step test procedures. Each step should be followed in the order given for effective fault isolation. The Procedure column refers to the applicable test setup and provides instructions for adjusting the equipment for a measurement. The *Normol indication* column specifies the results that should be observed. If in any step the result is not normal, refer to paragraph 5.1-7 for the troubleshooting procedure necessary to localize the trouble.

d. Sectionalization Tests Using AN/UPM-98.

Step	*Control settings* — *Test equipment*	*Control settings* — *Equipment under test*	*Procedure*	*Normal indication*
1	Multimeter Range: 10V Polarity:(+)	FUNCTION: SYSTEM MOD 4 DIR-RAD: RAD ISLS: OFF	*a.* Apply power to multimeter and transponder test set equipment and permit 5-minute warmup period.	*a.* None.
			b. Connect equipment with multimeter dc probe connected to test point A3TP1 (fig. 5.1-1).	*b.* +5± 0.1 volt.
2	AN/APM-270(V) CONSECUTIVE REPLIES: 64. SPACING PULSE:2:0 SPACING PULSE 3:0 SYNC GAIN: Midposition REPLY MODULATION 1X-2X 1X AN/URM-64A FUNCTION: CW OUTPUT ATTENUATOR Fully clockwise		*a. Connect* equipment as shown in figure 5.1-7. Apply power to RF power teat set and signal generator. Permit 5-minute warmup period.	*a.* None.
			b. Apply power to oscilloscope, AN/APM-270(V), and modulator. Permit 5-minute warmup period.	*b.* None.
			c. Continuously press transponder teat set PUSH-TO-TEST switch so that it is alternately on, then off, then on etc.	*c.* None.
			d. Adjust signal generator frequency until transponder test set indicates a solid ACCEPT (frequency approximately 1,090 mc). **NOTE** If ACCEPT light does not come On, go directly to step 3.	*d.* None.
			e. Adjust signal generator OUTPUT ATTENUATOR control counterclockwise until test set indicates REJECT. Then, adjust control clockwise until test set just indicates ACCEPT. Measure rf level at modulator RF OUT jack with rf power test set. **NOTE** Check the power at end of cable.	*e.* -9± 0.1 dBm.
			f. Increase signal generator output level 3 dB above value noted in e above.	*f.* None.
3	AN/USM-281A HORIZONTAL MAGNIFIER: XI HORIZONTAL DISPLAY INT Main VERNIER: Fully clockwise Main TIME/DIV: 50 µsec		*a.* Disconnect cable at modulator RF OUT jack and connect cable to RF IN jack of AN/APM-270(V).	*a.* None.
			b. Conmect oscilloscope CHANNEL A to DET VIDEO jack of AN/APM-270(V).	*b.* None.

Step	Control settings: Test equipment	Control settings: Equipment under test	Procedure	Normal indication
	Sweep Display Switch Mixed Sweep MODE Switch AUTO Delayed Trigger Source: EXT Main SLOPE - Main Trigger Coupling: AC Display A A VOLTS/DIV: 5		*c.* Adjust oscilloscope *TIME/DIV* control Until one complete group to challenge video pulses is observed. Count number of pulses.	*c. 36* pulses present: 4 pulses, a vacant position, and 32 pulases.
			d. Measure amplitude of first and last pulse and detamine percentage of difference.	*d.* 10% maximum difference in amplitude between two pubes.
			e. Measure spacing between first and second pulse.	e. 2 ±0.07 µsec
			f. Measure pulse width of first pulse.	*f.* 0.5 ±0.1 µsec.
4	. . . .	. . . .	*a.* Set transponder test set ISLS switch to ON. Note whether a pulse, having similar amplitude as others, occupies fifth pulse position.	*a.* Fifth pulse position occupied.
			b. Measure pulse spacing with respect to first pulse.	*b. 8* ± 0.7 µsec.
			c. Measure ISLS pulse width.	*c.* 0.5 ±0.1 wed.
			d. Transponder test set ILSL switch to OFF. Note whether amplitude of fifth pulse decreases.	*d.* pulse amplitude decreases.
			e. Disconnect cable at RF IN of AN/APM-270(V) and connect cable to modulator RF OUT.	*e.* None.
5	. . . .	PUSH TO TEST: Continually press and release to observe specific conditions.	*a.* Adjust AN/APM-27(V) SPACING PULSE 2 control towards -0.5 until transponder test set REJECT indicator just glows.	*a.* None.
			b. Adjust AN/APM-27(V) SPACING PULSE 2 control clockwise until a just accept condition is obtained. Note spacing between leading edges of first and second reply modulation pulses. Continue to turn control clockwise until a REJECT indication is observed. and then clockwise until a just accept condition is again obtained Note spacing between first and second pulses.	*b.* 1.7 µsec minimum, 1.9 µsec maximum.
			c. Reset AN/APM-207(V) SPACING 2 control to 0.	*c.* None.
			d. Perform *a* and b above using SPAC-*ING* PULSE 3 control and observe spacing between first and last pulses. Return control to 0.	*d.* 3.5 µsec minimum, 3.7 µsec maximum.

Step	Control settings: Test equipment	Control settings: Equipment under test	Procedure	Normal indication
6		PUSH TO TEST: Continually press and release to observe specified conditions.	*a.* set AN/APM-270(V) CONSECUTIVE REPLIES switch at 56 and note transponder test set indication. *b.* Repeat a above, but set to 55 and then 54. Note whether normal indication is provided for both settings of switch.	*a.* ACCEPT indicator glows. *b.* REJECT indicator glows.
7	AN/AMPM-270(V) CONSECUTIVE REPLIES: 16	*a.* DIR-RAD: DIR *b.* PUSH TO TEST: Contiually press and release to observe specific conditions.	*a.* Note transponder test set indication *b.* Set AN/UPM-270(V) CONSECUTIVE REPLIES switch to 15 and then 14. Note whether normal indication is provided in each position. *c.* Reset AN/APM-270(V) CONSECUTIVE REPLIES switch to 16. *d.* Set AN/APM-270(V) REPLY MODULATION 1X-2X switch at 2X. Note transponder test set indication.	a, ACCEPT indicator glows. *b.* REJECT indicator glows. *c.* None. *d.* REJECT indicator glows.

e. Sectionalization Tests Using AN/UPM-137A.

Step	Control Settings: Test equipment	Control Settings: Equipment under test	Procedure	Normal indicatwn
1	*AN/UPM-137A* (Oscilloscope) HORIZONTAL-SYNC: EXT DC HORIZONTAL-TIME/DIV: 10 µsec DISPLAY-CHAN A/ALT/CHAN B: CHAN A VERTICAL-CHAN A-75Ω IN/OUT: OUT VERTICAL-CHAN A-AC/DC DC VERTICAL-CHAN A-VOLT/DIV: 1	FUNCTION SYSTEM MODE 4 DIR-RAD: RAD ISLS: OFF	*a.* Apply power to equipment and permit 5 minutes warmup. *b.* Connect multimeter dc probe to A3TP1 (fig. 5.1-1). Observe voltage indication.	*a.* None. *b.* +5 ± 0.1 volt.
2	AN/APM-270(V) CONSECUTIVE REPLIES: 64 REPLY MODULATION-SPACING-PULSE 2:0 REPLY MODULATION-SPACING-PULSE 3:0 SYNC-GAIN: Midposition SYNC-DELAY Midposition	Same as step 1	*a.* Connect equipment as shown in figure 5.1-7.1. Apply power to test set, AN/APM-270(V), and AN/UPM-137A and permit 15-minute warmup. *b. Press* test set PUSH TO TEST switch and turn to LOCK position.	*a.* None. *b.* Test set should indicate ACCEPT.

Step	Control settings: Test equipment	Control settings: Equipment under test	Procedure	Normal indication
	REPLY MODULATION-1X-2X 1X AN/UPM-137A (interrogator signal simulator) OUTPUT ATTEN 0-100 dBm - 6 TRANSMITTER FREQ XTAL TRANSMITTER-CW SOURCE EXT 1090 MHz *(oscilloscope)* HORIZONTAL-SYNC: EXT DC- HORIZONTAL-TIME/DIV: 10 µSEC CALIBRATORS-XTAL MARK (µSEC): .1 & 1 CALIBRATORS-LEVEL *Midposition* *VERTICAL-CHAN A-AC/DC DC* VERTICAL-CHAN A-75Ω IN/OUT: IN VERTICAL-CHAN A-VOLT/DIV: 5 DISPLAY-CHAN A/ALT/CHAN B: ALT			
3	Same as step 2.	PUSH TO TEST: Continually press and release to observe specified conditions.	*a.* Adjust AN/UPM-137A rf signal generator OUTPUT ATTEN 0-100 dBm control ccw until test set indicates REJECT. Then adjust control cw until test set just indicates ACCEPT *b.* Add AN/UPM-137A rf signal generator OUTPUT ATTEN 0-100 dBm control setting to cable attenuation marked on cable connected to test set PROBE jack to determine rf output level EXAMPLE Control setting -8.5 dBm cable atten. -0.9 dBm 9.4 dBm	*a.* None. *b.* -9 ±1.0 dBm

Step	Control settings: Test equipment	Control settings: Euipment under test	Procedure	Normul indication
			c. *Increase AN/UPM-137A rf signal gemerator OUTPUT ATTEN* 0-100 dBm control to -6 dBm.	*c.* None.
4	Same as step 2	PUSH TO TEST: LOCK	*a.* Disconnect cable at AN/UPM-137A rf signal generator SIG GEN IN/OUT 0.5-50W jack and connect to AN/APM-270(V) RF IN jack.	*a.* None.
			b. Connect AN/UPM-137A oscilloscope VERTICAL CHAIN A-VIDEO IN jack to DET VIDEO jack of AN/APM-270(V).	*b.* None.
			c. Adjust AN/UPM-137A oscilloscope controls for clear display on CHAN A.	*c.* None.
			d. Adjust AN/UPM-137A oscilloscope controls as necessary until one complete group of challenge video pulses is observed. Count number of pulses.	*d.* 36 pulses present: 1 pulses, a vacant position. andld *32* pulses.
			e. Measure amplitude of first and last pulse and determine percentage of difference.	*e.* 10% maximum difference in amplitude between two pulses.
			NOTE Adjust AN/UPM-137A oscilloscope controls.	
			f. Measure Spacing between *leading* edges first and second pulses.	*f.* 2 ± 0.07 µsec.
			g. Measure pulse width of first pulse at 50% point of amplitude.	*g.* 0.5 ± 0.2 µsec.
			h. Set test ISLS switch to ON. Note whether a pulse, having similar amplitude as other, occupies, fifth pulse position.	*h.* Fifth pulse position occupied.
			i. Measure pulse spacing with respect to first pulse.	*i.* 8 ± 0.15 µsec.
			j. Measure ISIS pulse width at 50% point.	j. 0.5 ± 0.1 µsec.
			k. Set Teat ISLS switch to OFF. Note whether amplitude of fifth pulse decreases.	*h.* Pulse amplitude decreases to low amplitude.
5	Same as step 2	PUSH TO TEST Continually press and release to observe specific conditions.	*a.* Disconnect cable at RF IN jack of AN/APM-270(V) and connect to AN/UPM-137A rf signal generator RF SIG GEN IN/OUT 0.05-50W jack.	*a.* None,

Test equipment	Control settings: Euipment under test	Procedure	Normal indication
		b. Adjust AN/APM-270(V) REPLY MODULATION-SPACING-PULSE 2 control ccw until test set just indicates REJECT.	*b.* None.
		c. Connect AN/UPM-137A oscilloscope VERTICAL-CHAN A-VIDEO IN jack to AN/UPM-137A rf generator VIDEO OUT jack.	*c. None.*
		d. Adjust AN/APM-270V REPLY MODULATION-SPACING-PULSE 2 control ccw until delay between leading edges of first and second pulses displayed on AN/UPM-137A oscilloscope CHAN A is l.45 µsec.	*d.* REJECT indicator lights.
		e. Adjust AN/APM-270V REPLY MODULATION SPACING PULSE 2 control cw until delay between leading edges of first and second pulses displayed on AN/UPM-137A oscilloscope CHAN A is 1.65 µsec.	*e.* ACCEPTindicator lights.
		f. Adjust AN/APM-270V REPLY MODULATION-SPACING-PULSE 2 control cw until delay between leading edges of first second pulses displayed on AN/UPM-137A oscilloscopeCHANA is 1.95 µsec.	*f.* ACCEPT indicator lights
		g. Adjust AN/APM-270V REPLY MODULATION-SPACING-PULSE 2 control cw until delay between leading edges of first and second pulses displayed on AN/UPM-137A oscilloscope CHAN A is 2.15 µsec.	*g.* REJECT indicator lights.
		h. Set AN/APM-270(V) REPLY MODULATION-SPACING-PULSE 2 control to 0.	*h.* None
		i. Adjust AN/APM-270V REPLY MODULATION-SPACING-PULSE 3 control ccw until delay between leading edges of first and third pulses displayed on AN/UPM-137A oscilloscope CHAN A is 3.25 µsec.	*i.* REJECT indicator lights.

Step	Control settings: Test equipment	Control settings: Equipment under test	Procedure	Normal indication
			j. Adjust AN/APM-270V REPLY MODULATION-SPACING-PULSE 3 control cw until delay between leading edges of first and third pulses displayed on AN/UPM-137A oscilloscope CHAN A is 3.45 μsec.	*j*. ACCEPT indicator lights.
			k. Adjust AN/APM-270V REPLY MODULATION-SPACINGPULSE 3 control cw until delay between leading edges of first and third pulses displayed on AN/UPM-137A oscilloscope CHAN A is 3.75 μsec.	*k*. ACCEPT indicator lights.
			l. Adjust AN/APM-270V REPLY MODULATION-SPACING-PULSE 3 control cw until delay between leading edges of first and third pulse displayed on AN/UPM-137A oscilloscope CHAN A is 3.95 μsec. At end of test, set REPLY MODULATIONS-PACING-PULSE 3 control to zero.	*1*. REJECT indicator lights.
6		PUSH TO TEST Continually press and release to observe specified conditions.	*a*. Set AN/APM-270(V) CONSECUTIVE REPLIES switch at 56 and note transponder test set indication.	*a*. ACCEPT indicator lights.
			b. Repeat a above, but set switch to 55 and then to 54. Note whether normal indication is provided for both settings of switch.	*b*. REJECT indicator lights.
7	*AN/APM-270(V)* CONSECUTIVE REPLIES: 16	*a*. DIR-RAD DIR	*a*. Note test set indication.	*a*. ACCEPT indicator lights.
		b. PUSH TO TESTS: Continually press and release to observe specified conditions.	*b*. Set AN/APM-270(V) CONSECUTIVE REPLIES switch to 15 and then 14. Note whether normal indication is provided in each position.	*b*. REJECT indicator lights.
			c. Reset AN/APM-270(V) CONSECUTIVE REPLIES switch to 16.	*c*. None.
			d. Set AN/APM-270(V) REPLY MODULATION 1X-2X switch at 2X. Note transponder test set indication.	*d*. REJECT indicator lights.

5.1-6.1 Sectionalization Tests Using AN/TPM-25A

a. General. Sectionalization tests are performed to sectionalize a fault to a module or subassembly. Two sectionalization test charts are provided. The first uses Radar Test Set AN/TPM-25A and the second uses Radar Test Set AN/UPM-137A. Use of the sectionalization test charts is described in c below.

b. Test Setup. Test setups are provided for each type of test (fig. 5.1-7, 5.1-11, and 5.1-12). Instructions for making primary power connections are in TM 11-6625-667-12. During the sectionalization tests, the required test setup is referred to and test conditions noted. Reference should be made to figure 5.1-1 for location of specified internal test points. Test steps must be performed in the order given for proper equipment connections and conditions. General instructions are provided in the charts for using the test equipment. These instructions should be supplement with the instruction manual applicable to the specific test equipment used. before proceeding with a test setup, remove the unit from its case to expose test points and adjustment controls as follows:

(1) Unlatch and remove the test set cover.

(2) two screws on each side tip and bottom of front panel.

(3) Lift the test set from the case.

(4) Place the unit carefully on a clean area of the workbench. Position it for convenient access to both the rear section and the front panel Remove module retainer by removing the securing screws.

c. Use of charts. The sectionalization test charts (d and e. below) are step by step test procedures. Each step should be followed in the order given for effective fault isolation. The Procedure column refers to the applicable test setup and provides instructions for adjusting the equipment for a measurement. The Normal Indication column specifies the results that should be observed. If the result is not normal in any step, refer to paragraph 5.1-7 for the troubleshooting procedure necessary to localize the trouble.

d. Sectionalization Tests using AN/TPM-25A

Step No.	Control Settings: Test equipment	Control Settings: Equipment under test	Procedure	Normal indication
1	Multimeter Range 10V Polarity: (+)	FUNCTION: SYSTEM MODE: 4 DIRRAD: RAD ISLS: OFF	*a.* Apply power to multimeter and transponder test set equipment and permit 5 minute warmup period. *b.* Connect equipment with multimeter dc probe connected to test point A3TP1 (fig. 5.1-1).	*a.* None *b.* +5 ±0.1 volt.
2	*AN/TPM-25A* REPLIES panel MODULATION SET M4-3P REPLY WIDTH 0.45 SUB PULSE SEL: OFF RANGE DELAY SEL (USEC): 0001. MEASUREMENT PANEL: PRF RANGE: X100 FUNCTION SEL PRF CHAL DEMOD VID LEVEL: Mid position SIF CHAL VID panel SIF MODE SEL OFF 20V/5V: 5V TRIG SEL panel: DCE MODE SEL: SEL: lNTDC/EXT: EXT SIG GEN FUNCTION: FIXED FREQ SIG GEN NORM/INTER LEAVE: NORM SUM ATTEN: -6 DB GATING PASS: 00 GATING INHIB: 00 AN/USM-281A Sweep display switch DELATED MAIN TIME/DIV: .1 MSEC DELAYED TIME/DIV: 1 µsec EXT ÷10/EXT/INT/LINE: EXT INT/AUTO/EXT/EXT÷ AUTO MAIN–SLOPE +: + DELAYED – SLOPE +: + MAIN ACS/ACF/AC/DC: DC DIV DELAY: 475 A VOLTS DIV: 5 B VOLTS DIV: 2	PRESS TO TEST: LOCK	*a.* Connect equipment as shown in figure 5.1-11. *b.* On AN/USM-281A, adjust DIV DELAY as required to observe reply pulse on B INPUT. c. On AN/U PM-15A, adjust POSITIVE AMPLITUDE for a 5 volt delayed pulse on A INPUT. *d.* On AN/UPM-15A. adjust PULSE WIDTH fine control for a .5 µs pluse on oscilloscope A input. *e.* While observing the reply pulse on oscilloscope B INPUT and the delayed pulse on B INPUT. adjust AN/UPM-15A PULSE DELAY to position the leading edge of the delayed pulse 3.5 µs from leading edge of the reply pulse.	*a.* None. *b.* None. *c.* None. *d.* None. *e.* None.

. ! -

Step No	Control Settings: Test equipment	Control Settings: Equipment under test	Procedure	Normal indication
2 (Cont.)	*AN/UPM-15A* TRIGGER SELECT: EXT PULSE DELAY coarse 10 μ s PULSE WIDTH coarse: 10 μ s POSITIVE AMPLITUDE: Fully ccw.			
3			*a.* Continuously press transponder test set PUSH-TO-TEST switch so that it alternates on and off.	*a.* ACCEPT indicator glows.
			b. Rotate AN/TPM-25A SUM ATTEN dial slowly counterclockwise until REJECT indicator glows.	*b.* None.
			c. Rotate SUM ATTEN dial slowly clockwise until ACCEPT indicator just goes on.	*c.* None.
			d. Calculate power at PROBE input by adding the SUM ATTEN dial reading, and the 1090 MHz loss of cable 139526.	*d.* 9 ± 0.1 dBm
4	*AN/USM-281A* MAIN TIME/DIV: .1 MSEC DELAYED TIME/DIV: 10 μ SEC	PRESS TO TEST: LOCK	*a* Connect equipment as shown in figure 5.1-12.	*a.* None.
			b. Observe and count pulses of mode *4* challenge on oscilloscope A INPUT.	*b.* 36 pulses: *4* pluses, a vacant spot and 32 pulses.
			c. Measure amplitude of first and last pulses and determine percentage of difference.	*c.* 10% maximum difference in amplitude between the two pulses.
			d. On AN/USM-281A, set DELAYED TIME/DIV to 1 μ SEC and adjust DIV DELAY So that the first two pulses of the challenge train may be observed.	*d.* None
			e. Using the 1 μ s markers displayed on B INPUT, measure the pulse spacing between the first two pulses. (Measure from leading edge to leading edge.)	*e.* 2 ±0.07 μ s
			f. Measure pulse width of first pulse.	*f.* 0.5 ±0.1 μ s

Step No.	Control Settings: Test equipment	Control Settings: Equipment under test	Procedure	Normal indication
5			*a.* Set transponder test set ISLS switch to ON. check for isls pulse in fifth pulse position. *b.* Measure pulse spacing, leading edge to leading edge, between the first pulse and isls pulse. *c.* Measure isls pulse width. *d.* set transponder test set ISLS switch to OFF. Check that isls pulse decreases in amplitude.	*a.* Fifth pulse position is occupied. *b.* 8 ±0.7µ s *c.* 0.5 ±0.1 µ s *d.* Pulse amplitude decreases.
6	*AN/TPM-25A* REPLIES SUB PULSE SEL: M4-P2 REPLIES SUB PULSE POS: VARY	Continually press and release PRESS TEST switch to observe specified conditions.	*a.* Connect equipment as shown in figure 5.1-11, except connect AN/TPM-25A REPLY VID OUT to AN/USM-281A A INPUT. *b.* On AN/TPM-25A, adjust REPLIES SUB PULSE POS VARY control counterclockwise until REJECT lamp glows, and then clockwise until ACCEPT lamp just goes on. Measure pulse spacing from leading edge of first pulse to leading edge of second pulse *c.* On AN/TPM-25A, set replies SUB PULSE SEL to M4-P3. *d.* Repeat step b above and measure pulse spacing from leading edge of fiat pulse to leading edge of third pulse.	*a.* None. *b.* 1.7 µ s min, 1.9 µ s max. *c.* None. *d.* 3.5 µ s min,, 3.7 µ s max.
7	*AN/TPM-25A* REPLIES SUB PULSE SEL OFF REPLIES SUB PULSE POS: 0 REPLIES GATING PASS:56 REPLIES GATING INHIB: 08	Same as step 6.	*a.* Same as step 6a above. *b.* On AN/TPM-25A, sat REPLIES GATING PASS to 55 and then to 54, and REPLIES GATING INHIB to 09 and then to 10, respectively.	a ACCEPT lamp glows. *b.* REJECT lamp gbws.
8	AN/TPM-25A REPLIES GATING PASS: 16 REPLIES GATING INHIB: 48	Same as step 6, except set DIR/ RAD switch to DIR.	*a.* Same as step 6a, above. *b.* On AN/TPM-25A, set REPLIES GATING PASS to 15 and then 14, and REPLIES GATING INHIB to 49 and 50, respectively.	*a.* ACCEPT lamp glows (See note *b.* REJECT lamp glows.

NOTE

If the ACCEPT lamp does not go on, it is possible that the mode 4 reply from the AN/TPM-25A is arriving too late for the timing of the transponder test set. To check this, continue as above, while slowly turning 269 μs gate adjust A2R2 slowly clockwise until the ACCEPT lamp glows. If the ACCEPT lamp glows, the performance standard in step 8 has been met. Perform the adjustment procedure for the 269 μs gate as described in paragraph 5.1-22.

e. Sectionalization Tests Using AN/UPM-137A.

Step	Control settings: Test equipment	Control settings: Equipment under test	Procedure	Normal indication
1	*AN/UPM-137A* (oscilloscope HORIZONTAL SYNC: EXT DC HORIZONTAL TIME/DIV: 10 μ SEC DISPLAY-CHAN A/ALT CHAN B: CHAN A VERTICAL CHAN A-75 Ω IN/OUT: OUT VERTICAL CHAN A-AC/DC: DC VERTICAL CHAN A-VOLT DIV: 1	FUNCTION: SYSTEM MODE: 4 DIR RAD: RAD ISLS: OFF	*a.* Apply power to equipment and permit 5 minutes warmup. *b.* Connect multimeter dc probe to A3TP1 (fig. 5.1-1). Observe voltage indication.	*a.* None. *b.* +5 ±0.1 volt.
2	AN/APM-27(W) CONSECUTIVE REPLIES: 64 REPLY MODULATION SPACING PULSE 2:0 REPLY MODULATION SPACING PULSE 3:0 SYNC GAIN: Midposition SYNC DELAY: MidPosition REPLY MODULATION 1X-2X: 1X *AN/UPM-137A* *(interrogator* signal *simulator* OUTPUT ATTEN 0-100 dBm: –6 TRANSMITTER XMTR FREQ: XTAL TRANSMITTER CW SOURCE: EXT 1090 MHz	Same as step 1	*a.* Connect equipment as shown in figure 5.1-7.1. Apply power to test set, AN/APM-270(V), and AN/UPM-137A and permit 15-minute warmup. *b.* Press test set PUSH TO TEST switch and turn to LOCK position.	*a.* None. *b.* Test set should indicate ACCEPT.

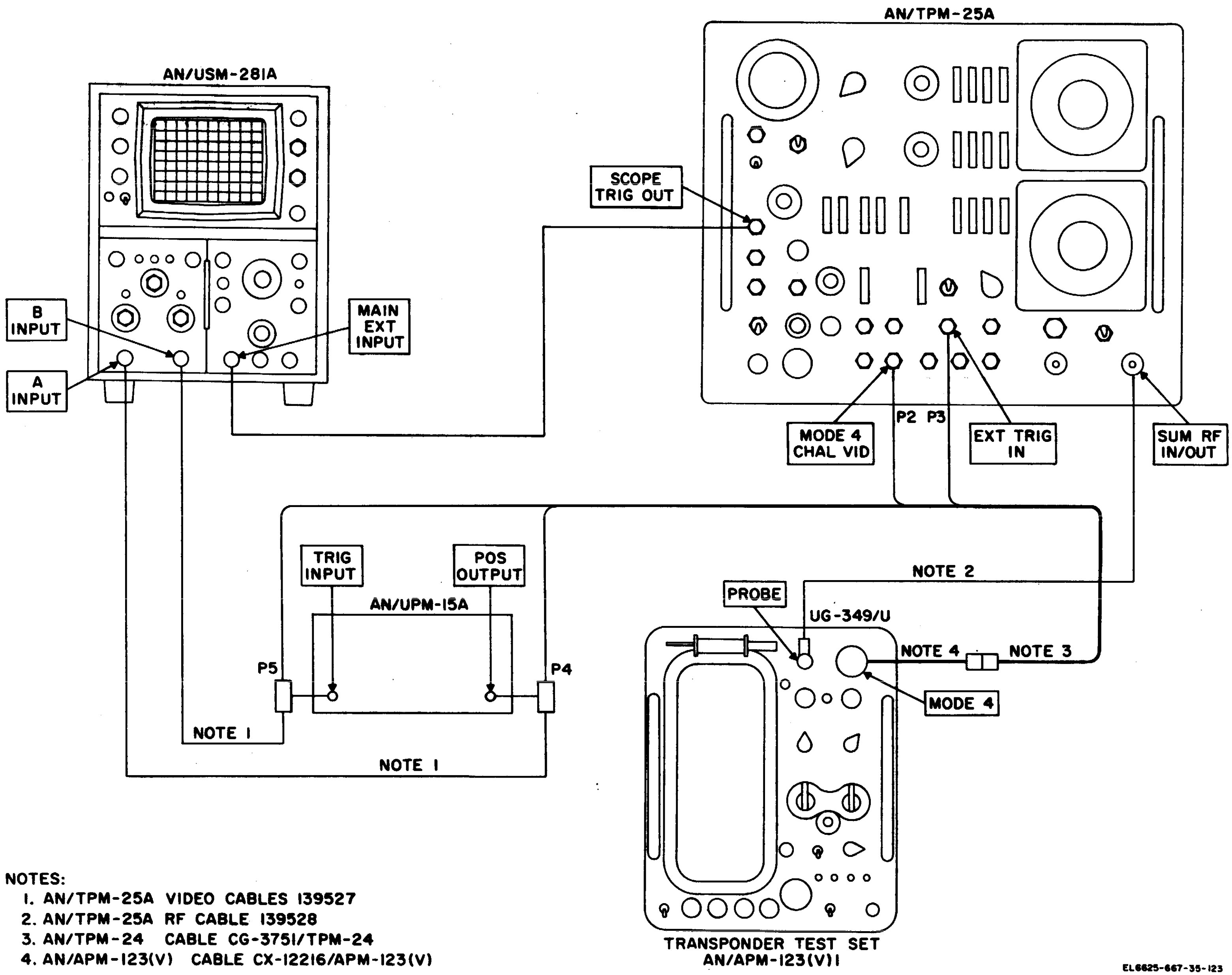
Step	Test equipment	Equipment under test	Procedure	Normal indication
2 (Cont)	(oscilloscope HORIZONTAL SYNC: EXT DC- HORIZONTAL TIME/DIV: 10 µSEC CALIBRATORS XTAL MARK (µ SEC): 1 & 1 CALIBRATORS LEVEL: Mid psoittion VERTICAL CHAN A-AC/DC: DC VERTICAL CHAN A-75 IN/OUT: IN VERTICAL CHAN A-VOLT DIV: 5 DISPLAY-CHAN A/ALT CHAN B ALT			
3	Same as step 2.	PUSH TO TEST: Continually press and release to observe specified conditions.	*a.* Adjust AN/UPM-137 rf signal generator OUTPUT ATTEN 0-100 dBm control ccw until test set indicates REJECT. Then, adjust control cw until test set just indicates ACCEPT.	*a.* None.
			b. Add AN/UPM-137A rf signal generator OUTPUT ATTEN 0-100 dBm control setting to cable attenuation marked on cable connected to teat set PROBE jack to determine rf output level. EXAMPLE Control setting -8.5 dBm Cable atten. -0.9 dBm 9.4 dBm	*b.* -9±1.0 dBm
			c. Increase AN/UPM-137A rf signal generator OUTPUT ATTEN 0 100 dBm control to –6 dBm.	*c.* None.
4	Same as step 2	PUSH TO TEST: LOCK	*a.* Disconnect cable at AN/UPM-137A rf signal generator SIG GEN IN/OUT 0.5-50W jack and connect to AN/APM-270(V) RF IN jack.	*a.* None.

Step	Control Settings		Procedure	Normal Indication
	Test equipment	*Equipment under test*		
4 (Cont)			*b.* Connect AN/UMP-137A oscilloscope VERTICAL CHAIN A VIDEO IN jack to DET VIDEO jack of AN/APM-270(V).	*b.* None.
			c. Adjust AN/UPM-137A oscilloscope controls for clear display on CHAN A.	*c.* None.
			d. Adjust AN/UPM-137A oscilloscope controls as necessary until one complete group of challenge video pulses is observed. Count number of pulses.	d. 36 pulses present 4 pulses, vacant position, and 32 pulses.
			e. Measure amplitude of first and last pulse and determine per centage of difference. **NOTE** Adjust AN/UPM-187A oscilloscope controls.	*e.* 10% maximum difference in amplitude between two pulses.
			f. Measure spacing between lead ing edges first and second pulses.	*f.* 2 ± 0.07 sec.
			g. Measure pulse width of first pulse at 50% point of amplitude.	*g. 0.5 ± 0.24* μsec.
			h. Set test ISLS switch to ON. Note whether a pulse, having similar amplitude as other, occupies fifth pulse position.	*h.* Fifth pulse position occupied.
			i. Measure pulse spacing with respect to first pulse.	i. 8 ± 0.15 μsec.
			j. Measure ILSL pulse width at 50% point.	j. 0.5 ±0.1 μsec.
			k. Set Test ISLS switch to OFF. Note whether amplitude of fifth pulse decreases.	k. Pulse amplitude decreases to low amplitude.
5t	Same as step 2	PUSH TO TEST Continually press and release to observe specified conditions.	*a.* Disconnect cable at RF IN jack of AN/APM-270(V) and connect to AN/UPM-137A rf signal generator RF SIG GEN IN/OUT 0.05-50W jack.	a. None.

Step	Control settings		Procedure	Normal Indication
	Test equipment	Equipment under test		
5 (Cont)			b. Adjust AN/APM-270(V) REPLY MODULATION–SPACING–PULSE 2 control ccw until test set just indicates REJECT.	b. None.
			c. Connect AN/UPM-187A oscilloscope VERTICAL–CHAN A–VIDEO IN jack to AN/UPM-137A rf generator VIDEO OUT jack.	c. None.
			d. Adjust AN/APM-270V REPLY MODULATION SPACING PULSE 2 control ccw until delay between leading edges of first and second pulses displayed on AN/UPM-137A oscilloscope CHAN A is 1.45 µ sec.	d. REJECT indicator lights.
			e. Adjust AN/APM-270V REPLY MODULATION SPACING PULSE 2 control cw until delay between leading edges of first and second pulses displayed on AN/UPM-137A oscilloscope CHAN A is 1.65 µ sec.	e. ACCEPT indicator lights.
			f. Adjust AN/APM-270V REPLY MODULATION–SPACING–PULSE 2 control cw until delay between leading edges of first and second pulses displayed on AN/UPM-137A oscilloscope CHAN, A is 1.95 µ sec.	f. ACCEPT indicator lights.
			g. Adjust AN/APM-270V REPLY MODULATION-SPACING-PULSE 2 control cw until delay between leading edges of first and second pulses displayed on AN/UPM-137A oscilloscope CHAN A is 2.16 µ sec.	g. REJECT indcator lights.
			h. Set AN/APM-270(V) REPLY MODULATION–SPACING–PULSE 2 control to 0.	h. None.

Step	Control settings: Test equipment	Control settings: Equipment under test	Procedure	Normal Indication
5 (Cont)			*i.* Adjust AN/APM-270V REPLY MODULATION–SPACING–PULSE 3 control ccw until delay between leading edges of first and third pulses displayed on AN/UPM-137A oscilloscope CHAN A is 3.25 µ sec.	*i.* REJECT indicator lights.
			j. Adjust AN/APM-270V REPLY MODULATIONS–SPACING–PULSE 3 control cw until delay between leading edges of first and third pulses displayed on AN/U PM- 137A oscilloscope CHAN A is 3.45 µ sec.	*j.* ACCEPT indicator lights.
			k. Adjust AN/APM-270V REPLY MODULATION–SPACING–PULSE 3 control cw until delay between leading edges of first and third pulses displayed on AN/UPM-137A oscilloscope CHAN A is *3.75* µ sec.	*h.* ACCEPT indicator lights.
			l. Adjust AN/APM-270V REPLY MODULATION–SPACING–PULSE 3 control cw until delay between leading edges of first and third pulse displayed on AN/UPM-137A oscilloscope CHAN A is 3.95 µ sec. At end of test, set REPLY MODULATION-SPACING–PULSE 3 control to zero.	*l.* REJECT indicator lights.
6		PUSH TO TEST: Continually press and release to observe specified conditions.	*a.* Set AN/APM-270(V) CONSECUTIVE REPLIES switch at 56 and note transponder test set indication.	*a.* ACCEPT indicator lights.
			b. Repeat a above, but set switch to 55 and then to 54. Note whether normal indication if provided for both settings of switch.	*b.* REJECT indicator lights.

Step	Control settings		Procedure	Normal Indication
	Test equipment	Equipment under test		
7	AN/APM-270(V) CONSECUTIVE REPLIES: 16	*a.* DIR RAD: DIR *b.* PUSH TO TEST: Contindully press and release to observe speccified conditions.	*a.* Note test set indication. *b.* Set AN/APM-270(V) CONSECUTIVE REPLIES switch to 15 and then 14. *Note* whether normal indication is provided in each position. *c.* Reset *AN/APM-27(V)* CONSECUTIVE REPLIES switch to 16. *d.* Set AN/APM-270(V) REPLY MODULATION 1X-2X switch at *2X*. *Note transponder* test set indication.	*a.* ACCEPT indicator lights. *b.* REJECT indicator lights. *c.* None. *d.* REJECT indicator lights.



NOTES:
1. AN/TPM-25A VIDEO CABLES 139527
2. AN/TPM-25A RF CABLE 139528
3. AN/TPM-24 CABLE CG-3751/TPM-24
4. AN/APM-123(V) CABLE CX-12216/APM-123(V)

Figure 5.1-11. Note 4 timing test setup, using AN/TPM-25A.

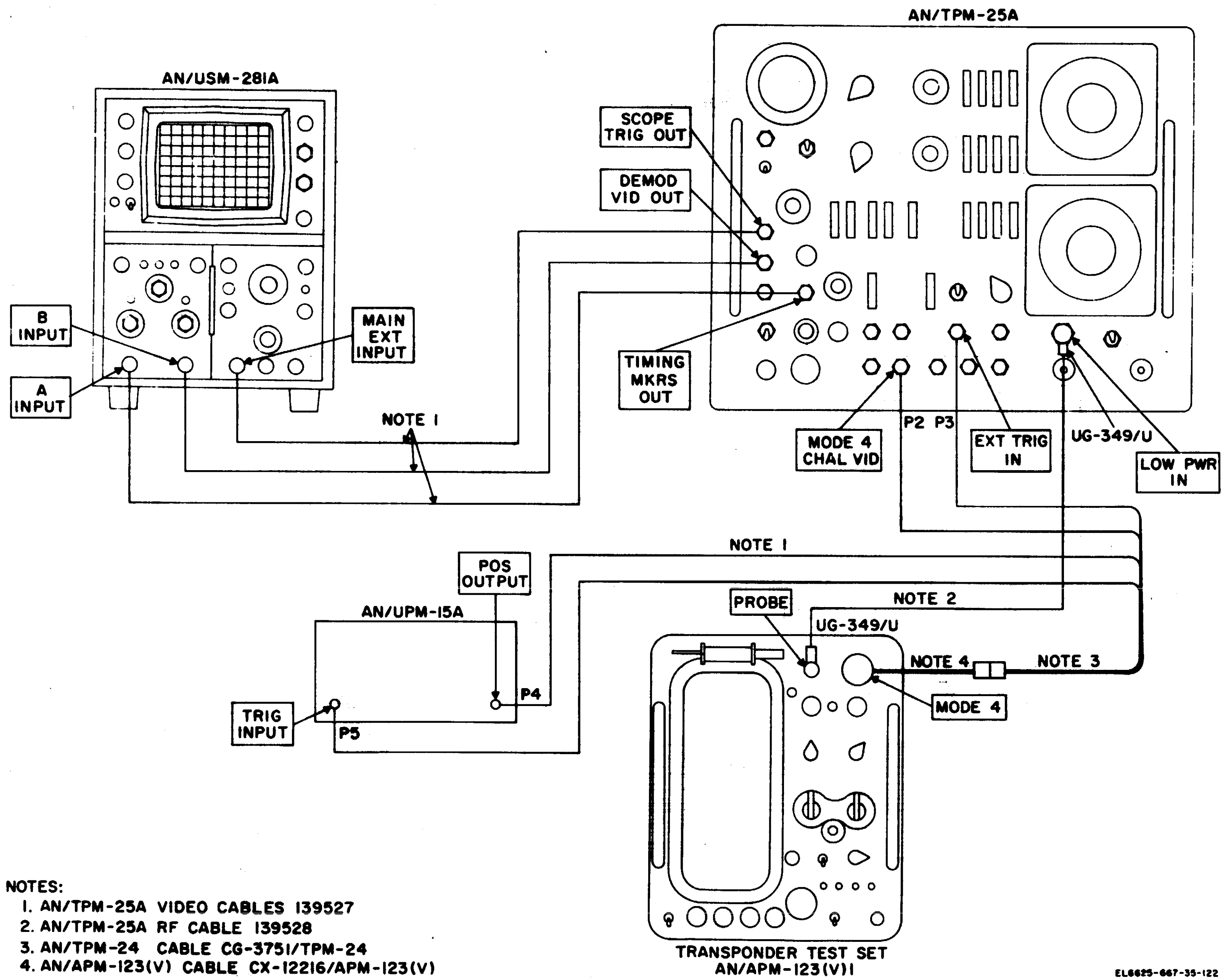


Figure 5.1-12. Mode 4 test connections using AN/TPM-25A.

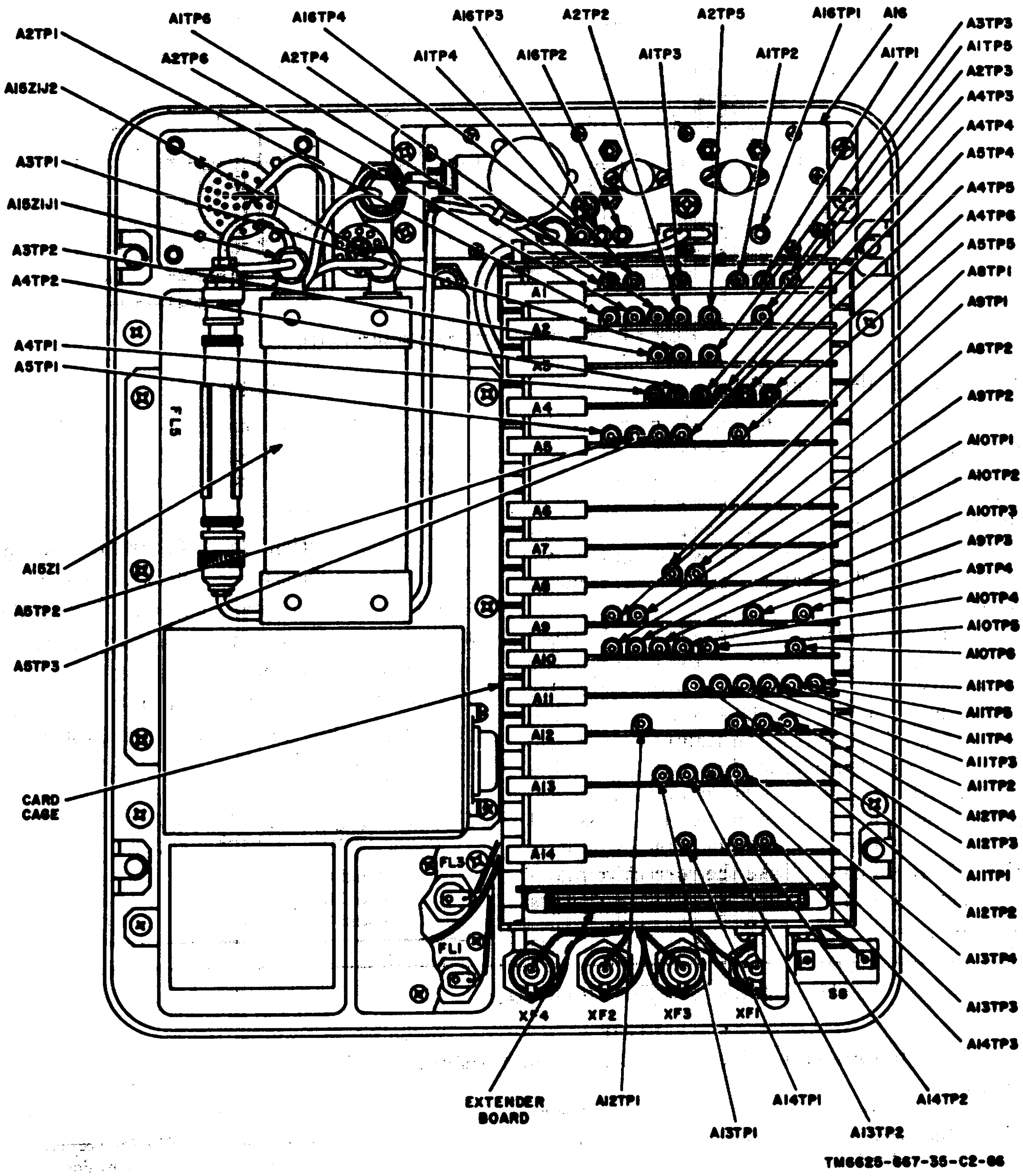


Figure 5.1-1. Test point location

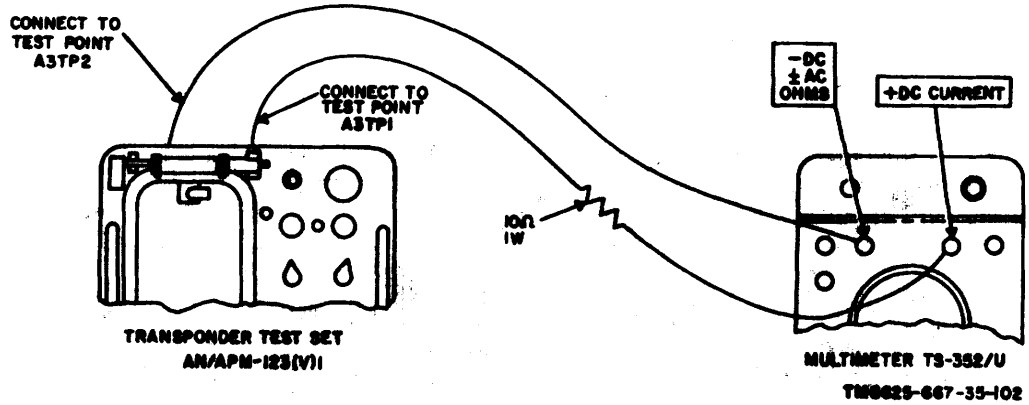


Figure 5.1-2. Current limiting measurements.

5.1-7. Localizing Troubles

a. General. The troubleshooting charts *(d, e,* and *f* below) outline procedures for localizing troubles to a stage within the respective module. Schematic diagrams are in figures 8-40, 8-41, and 8-42. Parts location diagram are located in figures 8-43, 8-44, and 8-45. Refer to b below before using the troubleshooting charts.

b. Use. of Troubleshooting Charts. A troubleshooting chart is provided for each module or subassembly. Selection of the applicable one is based on the sectionalization test step (para 5.1-6d) in which the failure was noted. To locate the troubleshooting chart covering the probable faulty module, refer to c below. Then find the description of the observed symptom in the *Trouble symptom* column of the referenced chart. Take the corrective measures recommended in the *Corrective measures* column.

NOTE

Test setup and conditions should be as specified during the step in the sectionalization test where the trouble was noted.

c. Troubleshooting Chart Location. The applicable troubleshooting chart is located by referring to the following chart and finding the sectionalization test step (para 5.1-6d where the trouble was observed. The second column of the chart refers to the applicable paragraph containing the applicable troubleshooting chart.

Sectionalization test step	Reference paragraph
1	5.1d
2 and *3*	5.1-6e
4 and 5	5.1-6e
6 and 7	5.1-6f

d. 6-Volt Regulator Module As Troubleshooting.

NOTE

Refer to figure 5.1-5 for socket voltages and resistances.

Item No.	Trouble symptom	Probable trouble	Corrective measurment
1	Improper voltage at test point A3TP1.	Adjustment	Adjust control A3R24 for normal indication. If adjustment does not correct trouble, refer to *2* below.
2	Adjustment does not correct improper voltage condition	Note. Due to interaction of stages systematic check of each stage should be made.	Isolate improper operating stage using voltage and resistance diagram.
3	No voltage at test point A3TP1.	*a.* Fuse A3F1. *b.* Transistor stage	*a.* Replace defective fuse. *b.* Same as 2 above.

e. Mode 4 Module A1 Troubleshooting.

NOTE

Refer to figure 5.1-3 for socket voltages and resistances and figure 5.1-8 for waveforms.

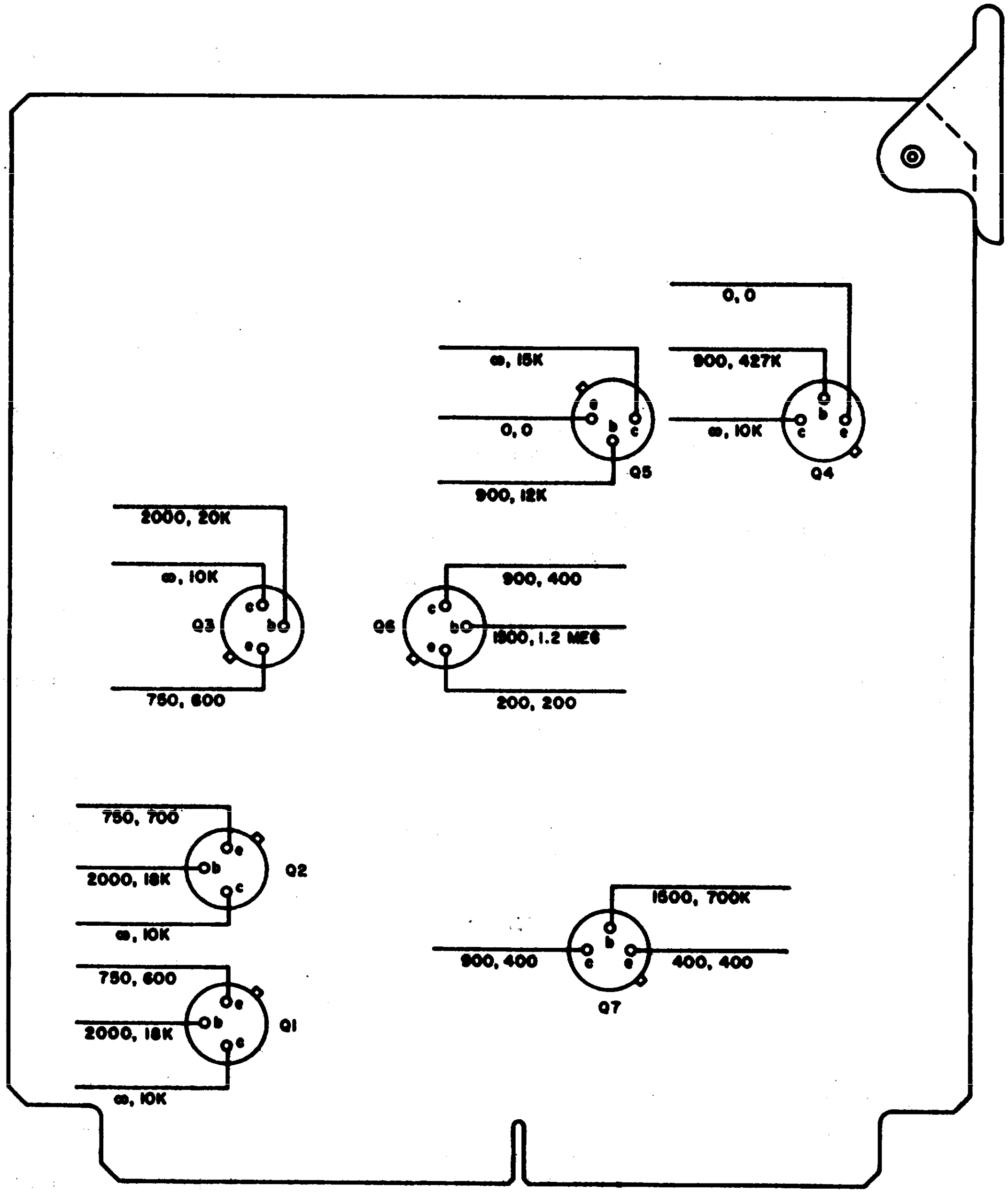
	Trouble symptom	Probable trouble	Corrective measures
1	Receiver sensitivity abnormal; not within -9 ±0.5 dbm.	*a.* Adjustment. *b.* Transistor A1Q6.	*a.* Refer to procedure in paragraph 5.1-13. *b.* Check socket resistances.
2	Challenge video pulses (36) not present.	M14 challenge shaper A1SS6 (AlM11) or transistor A1Q4.	Check waveform at test point A1TP6. If normal, check socket resistances of A1Q4. If abnormal, check socket waveforms of A1M11.
3	Challenge video pulse width abnormal.	*a.* Adjustment. *b.* M4 challenge shaper A1SS6 (A1M1l).	*a.* Refer to procedure in paragraph 5.1-14. *b.* Check integrated socket waveforms at A1M1l.
4	Challenge video pulse spacing abnormal.	Transistor, A1Q6 or M4 challenge shaper A1SS6.	Check socket wavafonns.
5	ISLS pulse missing; pulse train nomnal.	Integrated circuit A1M8B or A1M9, or transistor A1Q3.	Check socket waveforms.
6	ISLS pulse spacing abnormal.	*a.* Adjustment. *b.* Transistor A1Q3.	*a.* Adjust control A1R28. *b.* Check socket waveforms.
7	Second reply pulse decode spacing abnormal.	*a.* Adjustment. *b.* Second decode pulse shaper A1SS2 (A1M3).	*c.* Refer to procedure in paragraph 5.1-14. *b.* Check socket waveforms.
8	Third reply pulse decode spacing abnormal.	*a.* Adjustment *b.* Third decode pulse shaper AlSS1 (A1M2).	*a.* Refer to pmxedum in pamgraph 5.1-14. *b.* Check socket waveforms.

f. Mode 4 Module A2 Troubleshooting.

NOTE

Refer to figure 5.1-4 for socket voltages and resistances and figure 5.1-9 for waveforms.

Item No.	Trouble symptom	Probable trouble	Corrective measures
1	Reply reject count is improper for direct and radiation operation.	*a.* Counter A2FF1 to A2FF7 (A1M1 to A1M6). *b.* Time-decoded video delay A2SS1 (A2Q1/Q2) or time-decoded video delay A2SS2 (A2M17).	*a.* Check socket waveforms. *b.* Check wavefomns at test points at A2TP1 and A2TP2 respectively. If abnormal, perform adjustment in paragraph 5.1-13. If still abnormal, check socket waveforms.
2	Reply reject count is improper for direct operation only.	Decode video sensing gate A2M14A, video sensor enablle A2FF15 (M14C), 16-count reset gate A2M15A or A2M15B, or gate A2M18B.	Check socket waveforms.
3	Double-reply reject inoperative; 16-count operation normal.	Same as 2 above.	Same as 2 above
4	Counter reset abnormal.	PRF counter A2FF8 to A2FF14 (A2M17 to A2M8) or gates A2M16A and B.	Check socket waveforms



NOTES:
UNLESS OTHERWISE INDICATED
1. ALL TRANSISTORS ARE 2N2222.
2. ALL RESISTANCE MEASUREMENTS ARE FROM DESIGNATED TERMINAL TO CHASSIS.
3. MAKE RESISTANCE MEASUREMENTS WITH MULTIMETER TS-352/U, R X 100 RANGE. FIRST READING WITH NEGATIVE LEAD TO CHASSIS. SECOND WITH LEADS REVERSED.
4. PREFIX ALL REFERENCE DESIGNATIONS WITH A1.

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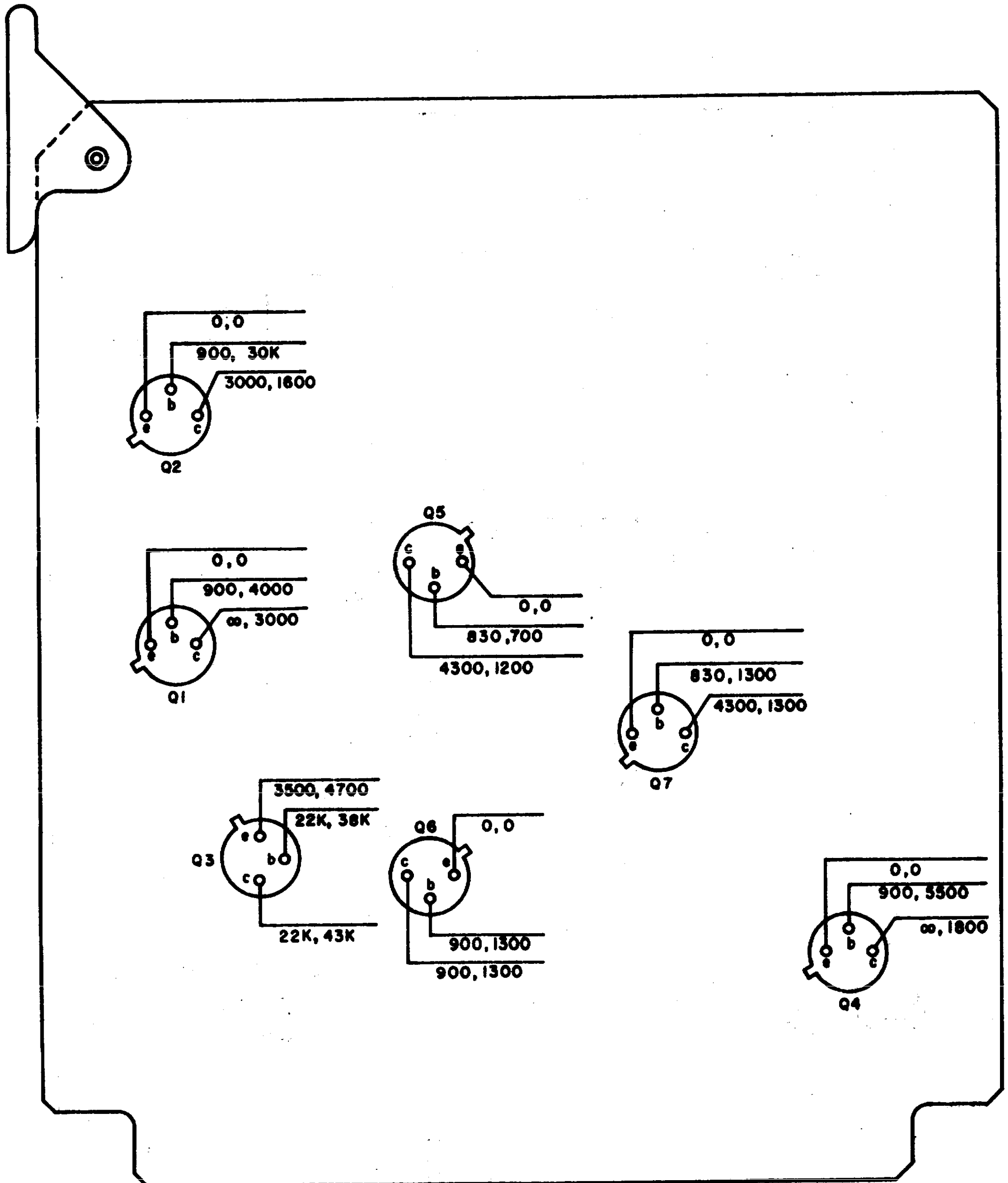
Figure 5.1-3. Module A1 resistance diagram.



NOTES:
UNLESS OTHERWISE INDICATED
1. ALL TRANSISTORS ARE 2N2222
2. ALL RESISTANCE MEASUREMENTS ARE FROM DESIGNATED TERMINAL TO CHASSIS.
3. MAKE RESISTANCE MEASUREMENTS WITH MULTIMETER TS-352/U, R X 100 RANGE. FIRST READING WITH NEGATIVE LEAD TO CHASSIS. SECOND WITH LEADS REVERSED.
4. PREFIX ALL REFERENCE DESIGNATIONS WITH A2.

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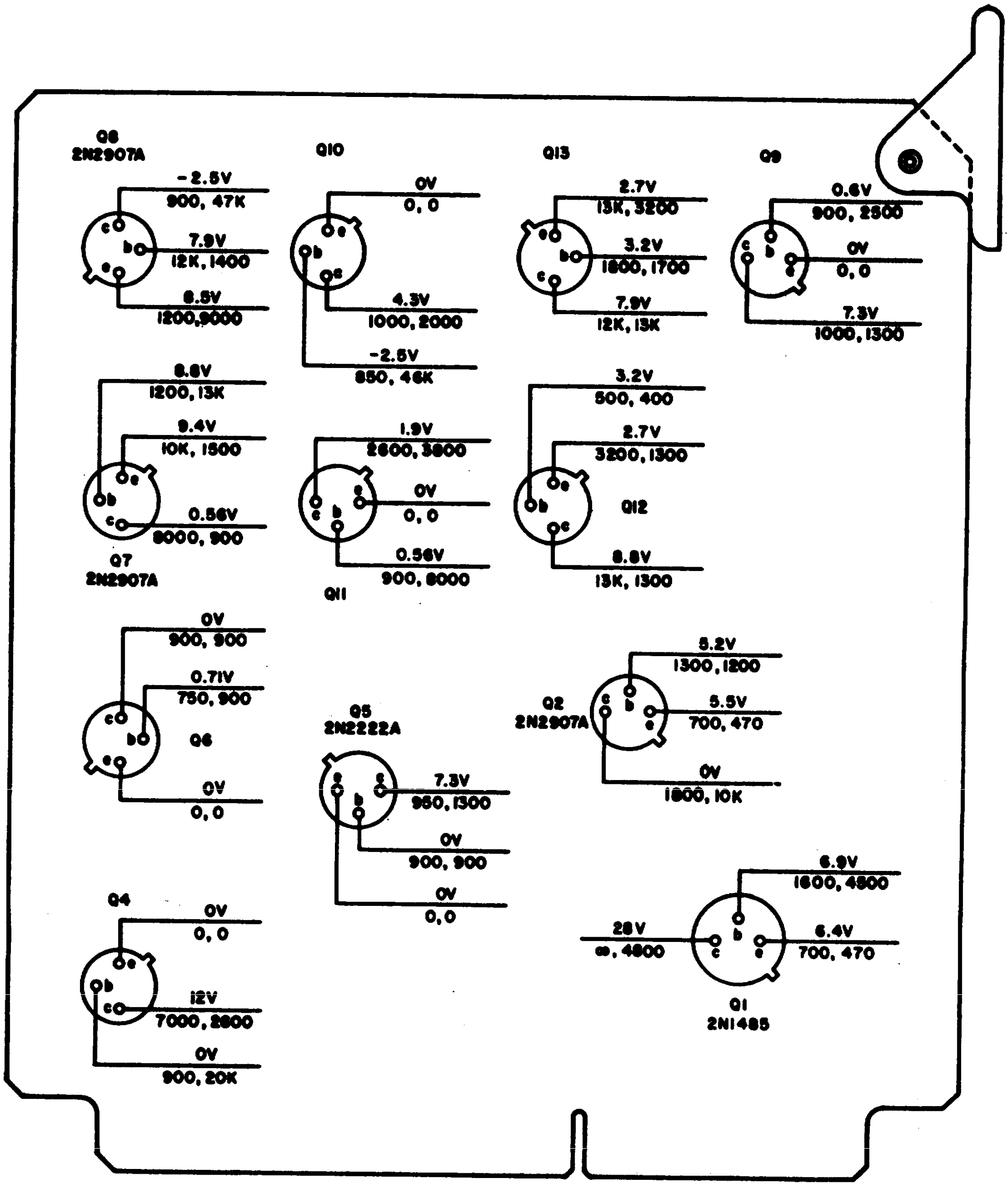
Figure 5.1-4. Module A2 resistance diagram.



NOTES:
UNLESS OTHERWISE INDICATED
1. ALL TRANSISTORS ARE 2N2222
2. ALL RESISTANCE MEASUREMENTS ARE FROM DESIGNATED TERMINAL TO CHASSIS.
3. VOLTAGES MEASURED WITH MULTIMETER ME-26/U, NO SIGNAL CONDITIONS.
4. MAKE RESISTANCE MEASUREMENTS WITH MULTIMETER TS-352/U, R X 100 RANGE. FIRST READING WITH NEGATIVE LEAD TO CHASSIS. SECOND WITH LEADS REVERSED.
5. PREFIX ALL REFERENCE DESIGNATIONS WITH A3

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Figure 5.1-5. Module A3 voltage and resistance diagram.

5.1-8. Isolating Trouble Within Stage

a. General. When trouble has been localized to a transistor stage during troubleshooting (para 5.1-7), isolate the defective part by voltage measurements or resistance measurements using the figure referenced in the note or the Corrective measures column of the chart. For integrated circuit trouble isolation, refer to c below.

CAUTION

Carefully follow instructions and observe notes on voltage and resistance diagrams. Carelessness may cause more troubles in the equipment and make the troubleshooting job more difficult. Do not remove or insert a transistor or integrated circuit element with voltage applied, to the circuit. Do not perform resistance measurements of integrated circuit.

b. Transistor Testing. Since the transistors are wired in the circuit, every effort should be made to troubleshoot the equipment without physically unsoldering and removing the transistors.

c. Integrated Circuit Testing. Faulty integrated circuits may be isolated by oscilloscope signal tracing; figures 5.1-3 and 5.1-9 illustrate the signal conditions at each applicable pin.

d. Wiring Diagrams. Use the wiring diagrams (fig. 8-43, 8-44, and 8-45) to circuit trace and isolate the fault part.

5.1-9. Analysis of Measurements

For an interpretation of readings when taking the voltage and resistance measurements, refer to TB SIG 357.

a. In-Circuit Transistor Resistance Measure*ments.* When measuring resistance of circuit elements connected across the junction of any transistor (base-emitter or base-collector), consider polarity of the ohmmeter and try measurements with the ohmmeter connected one way; then reverse the leads. Also, consider that different values of resistance will be obtained with the ohmmeter on different ranges; for example, if the transistor junction, or a resistor plus the transistor junction, is measured in the forward direction of the R X 10 range the actual reading will be less than if taken with the ohmmeter on the R *x* 100 range. When in doubt about the result of resistance measurements, check a known good equipment of correct readings. The readings in *b* below were taken with each module removed from the equipment. First measure between the base and the emitter and between the base and the collector with the positive ohmmeter lead connected to the base; then measure between the base and the emitter and between the base and the collector with the negative ohmmeter lead connected to the base.

b. In-Circuit Transistor Resistance Charts. Listed in the charts ((1) and (2) below) are resistance measurements taken of the emitter and collector with the transistors connected in the circuit. The measurements are made with Multimeter TS-352B/U. These readings will be valid only if the same type of ohmmeter is used and polarity and range scales are strictly adhered to. Refer to figure 5.1-6 for the test setup.

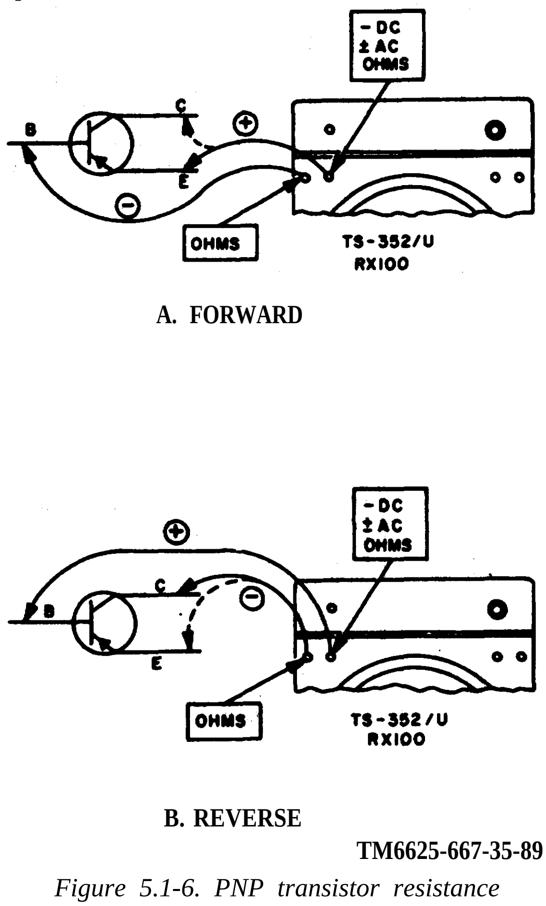


Figure 5.1-6. PNP transistor resistance measurements

(1) In-circuit resistance measures of modules A1 and A2.

NOTE

Unless specified otherwise, all transistors are typed 2N2222. All measurements should be within ±50 per-

Module stage		Measurements with positive ohmmeter lead connected to base							
		Emitter to base		Collector to base		Emitter to base		Collector to base	
		Resistance (ohms)*	Range	Resistance (ohms)	Range	Resistance (ohms)	Range	Resistance (ohms)	Range
A1	Q1	20K	R X 10K	∞	R X 10K	820	R X 100	820	R X 100
	Q2	20K	R X 10K	∞	R X 10K	860	R X 100	840	R X 100
	Q3	20K	R X 10K	∞	R X 10K	860	R X 100	840	R X 100
	Q4	10K	R X 10K	∞	R X 10K	860	R X 100	840	R X 100
	Q5	14K	R X 10K	∞	R X 10K	860	R X 100	860	R X 100
	Q6	1.2 Mego	R X 10K	2 Mego	R X 10K	860	R X 100	840	R X 100
	Q7	1.2 Mego	R X 10K	25 Mego	R X 10K	860	R X 100	860	R X l00
A2	Q1	10K	R X 10K	∞	R X 10K	860	F X 100	860	R X 100
	Q9	30K	R X 10K	**20K**	R X 10K	860	R X 100	840	R X 100
	Q10	55K	R X 10K	**4K**	R X 10K	840	R X l00	840	R X 100
	Q11	7K	R X 10K	∞	R X 10K	840	R X 100	810	R X 100
	Ql2	3K	R X 10K	**6K**	R X 10K	840	R X 100	840	R X 100
	Q13	3K	--------	**3K**	R X 10K	840	R X 100	840	R X 100
	Q14	3K	R X 10K	**3K**	R X 10K	830	R X 100	820	R X 100

(2) In-circuit resistance measurements of module *A 3*

NOTE

Unless specified otherwise, all transistors are type 2N2222. All measurement should be within ±50 per-cent of values shown.

Module stage	Measurements with positive ohmmeter lead connected to base				lead connected to base Measurements with negative ohmmeter			
	Emitter to base		Collector to base		Emitter to base		Collector to base	
	Resistance (ohms)	Range	Resistance (ohms)	Range	Resistance (ohms)	Range	Resistance (ohms)	Range
Q1 (2N1434)	20K	R X 10K	5 Meg	R X 10K	660	R X 100	580	R X 100
Q2 (2N3251)	650	R X 100	760	R X 100	640	R X 100 R X 100	500K 880	R X 10K R X 100
Q4	20K	R X 10K	28K	R X 10K	860			

Module stage	Measurements with positive ohmmeter lead connected to base				Measurements with negative ohmmeter lead connected to base			
	Emitter to base		Collector to base		Emitter to base		Collector to base	
	Resistance (ohms)	Range	Resistance (ohms)	Range	Resistance (ohms)	Range	Resistance (ohms)	Range
Q5	9K	R X 10K	9K	R X 10K	860	R X 100	860	
Q6	850	R X 100	9K	R X 10K	860	R X 100	860	R X 100
Q7 (2N3251)	880	R X 100	860	R X 100	15K	R X 10K	15K	R X 10K
Q8 (2N3251)	880	R X 100	880	R X 100	18K	R X 100	58K	R X 10K
Q9	4 K	R X 10K	12K	R X 10K	850	R X 100	850	R X 100
Q10	10K	R X 10K	10K	R X 10K	860	R X 100	860	R X 100
Q11	9 K	R X 10K	9K	R X 10K	860	R X 100	860	R X 100
Q12	4K	R X 10K	11K	R X 10K	860	R X 100	860	R X 100
Q13	6K	---------	11K	R X 10K	840	R X 100	840	R X 100

Section III. MODE 4 ALIGNMENT

NOTE

See Section V when using AN/TPM-25A.

5.1-10. General

The test equipment listed in paragraph 5.1-11, or approved equivalent, is required to perform alignment procedures. Two procedures are provided for each alignment procedure. The first procedure uses conventional test equipment in conjunction with the Radar Test Set AN/UPM-98A and AN/UPM-98B. The second procedure uses the Radar Test Set AN/UPM-137A. Refer to figure 5.1-10 for adjustment control location.

5.1-11. Test Equipment Required for Alignment

Test equipment	*Technical manual*
Oscilloscope AN/USM-281A.	TM 11-6625-1703-14
Wattmeter AN/URM-98 (including Test Set, Radio Frequency Power TS-779A/U and Bolo Meter, Radio Frequency MX-2144A/U)	TM 11-6625-433-13
Test Facilities Set, Transponder Test Set AN/APM-270(V).	TM 11-6625-1644-12
Generator, Signal AN/URM-64A	TM 11-6625-299-15
Modulator MD-796	
Multimeter TS 352 B/U	TM 11-6625-366-15
Multimeter ME 26B/U	TM 11-6625-200-15
Test Set, Radar AN/UPM-137A	NAVELEX 0969-158-1010 NAVAIR 16-30UPM137-6-1 AIR FORCE T.O. 33AI-8-426-21-1 AND NAVELEX 0969-158-1020 NAVAIR 16-30UPM 137-6-2 AIR FORCE T.O. 33AI-3-426-21-2

5.1-12. Power Supply Adjustment

a. Connect equipment as shown in figure 3-1.

b. Set the ME-26B/U RANGE control to 10V.

c. Connect the ME-26B/U dc probe to test point A3TP1.

d. Adjust control A3R24 until the ME-26B/U indicates 5 ± 0.1 volts.

e. Disconnect the ME-26B/U from the test set.

f. Connect the equipment as shown in figure 5.1-2.

g. Set the TS-352B/U FUNCTION switch to DC+ CURRENT and range switch to 500MA.

h. Adjust control A3R3 for a multimeter indication of 400 ± 20 milliamperes.

5.1-13. Mode 4 Receive Sensitivity and Reply Video Adjustments

a. Set and adjust the AN/APM-270(V) controls as follows:

(1) CONSECUTIVE REPLIES to 64.

(2) SPACING PULSE 2 to 0.

(3) SPACING PULSE 3 to 0.

(4) SYNC GAIN to midposition.

(5) REPLY MODULATION 1X-2X to 1X.

b. Set the transponder test set controls as follows:

(1) FUNCTION to SYSTEM.

(2) MODE to 4.

(3) DIR-RAD to RAD.

(4) ISLS to OFF.

c. Apply POWER TO THE EQUIPMENT AND PERMIT A 14-minute warmup period.

d. Connect the equipment as shown in figure 5.1-7, except connect the RF power test set to the modulator RF OUT jack.

e. Adjust the signal generator for cw operation at 1,090 mc and RF level of – 9 ± dbm as indicated by the RF power test set.

f. Disconnect the cable at the modulator RF OUT jack and connect the transponder test set to the RF OUT jack.

g. Continually press the transponder test set PUSH-TO-TEST switch and adjust control AlR43 (fig. 8-43) for a just accept indication. Increase the signal generator output level 3 dbm.

h. Set and ADJUST the oscilloscope as follows:

(1) Sweep Display Switch: Mixed.

(2) MAIN and DELAYED SLOPE Switches: –.

i. Connect the oscilloscope CHANNEL A to test points listed in the chart below. Adjust the control indicated until performance requirement is obtained.

NOTE

In order to observe the pulse at A2TP2, it is necessary to continuously operate the PUSH-TO-TEST Switch.

Adjust the oscilloscope sweep and delay controls as necessary to observe signal.

Test point	Adjust *control*	*Pulse* width (μ sec)
A1TP1	A1R8	0.3 ± 0.01
A1TP2	A1R11	0.3 ± 0.01
A1TP3	A1R14	0.3 ± 0.01
A1TP4	A1R17	0.7 ± 0.01
A2TP1	A2R2	269 ± 2
A2TP2	A2R7	12 ± 0.1
A1TP5	A1R22	150 ± 7.5

5.1-13.1 Mode 4 Receiver Sensitivity and Reply Video Adjustments Using AN/UPM-137A

a. Set and adjust AN/APM-270(V) controls as follows:

(1) CONSECUTIVE REPLIES to 64.

(2) REPLY MODULATION-SPACING –PULSE 2 to 0.

(3) REPLY MODULATION-SPACING–PULSE 3 to 0.

(4) SYNC GAIN to mid position.

(5) SYNC DELAY to mid position.

(6) REPLY MODULATION–1X/2X to 1X.

b. Set test set controls as follows:

(1) FUNCTION to SYSTEM.

(2) MODE to 4.

(3) DIR. RAD to RAD.

(4) ISLS to OFF.

c. Set AN/UPM-137A interrogator signal simulator TRANSMITTER-XMTR FREQ switch to XTAL.

d. Set and adjust AN/UPM-137A rf signal generator controls as follows:

(1) OUTPUT ATTEN 0-100 dbm to –6.

(2) TRANSMITTER–XMTR FREQ to XTAL.

(3) TRANSMITTTER-CW SOURCE to EXT 1090 MHz.

e. Set and adjust AN/UPM-137A oscilloscope controls as follows:

(1) VERTICAL-CHAN A-AC/DC to DC.

(2) VERTICAL-CHAN A-75 Ω IN/OUT to OUT.

(3) VERTICAL-CHAN A-VOLT/DIV to 2.

(4) DISPLAY-CHAN A/ALT/CHAN B to ALT.

(5) HORIZONTAL-SYNC to EXT DC–.

(6) CALIBRATORS-XTAL MARK (μ SEC) to .1 & 1.

(7) CALIBRATORS LEVEL to mid. position.

f. Connect equipment as shown in figure 5.1-7.1.

g. Apply power to equipment and permit 15-minute warmup.

h. Adjust AN/UPM-137A rf signal generator OUTPUT ATTEN control –9 dbm minus cable attenuation marked on cable connected to test set PROBE jack.

Example: –9 dbm minus –0.9 dbm is –8.1 dbm.

i. Continually press and release test set PUSH TO TEST switch and adjust control AlR43 for just ACCEPT indication. Adjust AN/U PM-137A rf signal generator OUTPUT ATTEN 0-100 dbm to –6 dbm.

j. Connect AN/UPM-137A oscilloscope VERTICAL-CHAN A-VIDEO IN jack to test set test points listed in chart below. Set test set PUSH TO TEST switch to LOCK and adjust test set control indicated until performance requirement is obtained.

NOTE

Adjust the AN/UPM-137A oscilloscope controls as necessary to observe signal.

Test point	*Adjust* control	*Pulse width (μ sec)*
A1TP1	A1R8	0.3 ± 0.01
A1TP2	A1R11	0.3 ± 0.01
A1TP3	A1R14	0.3 ± 0.01
A1TP4	A1R17	0.7 ± 0.01
A2TP1	A2R2	269 ± 2
A2TP2	A2R7	12 ±0.1
A1TP5	A1R22	150 ± 7.5

5.1-14. Mode 4 Challenge Video Adjustment

a. Perform the procedures given in paragaphs 5.1-13 a through g.

b. Disconnect the transponder test set PROBE jack cable from the modulator RF OUT connector and connect the cable to the AN/APM-270(V) RF IN jack.

c. Connect the oscilloscope CHANNEL A cable to the AN/APM-270(V) DET VIDEO jack.

d. Adjust the oscilloscope sweep and delay controls until the first pulse of the pulse train is observed.

e. Adjust control A1R32 until the pulse width is 0.5 ± 0.1 microsecond.

f. Set the AN/APM-270(V) ISLS switch to ON and adjust the oscilloscope to observe the first five pulses. Adjust Control A1R29 until the spacing between the first and fifth pulses is 8 ± 0..5 microseconds.

5.1-14.1 Mode 4 Challenge Video Adjustment Using AN/UPM-137A

a. Perform procedures given in paragraphs 5.1-13.1 a through g.

b. Connect cable from test set PROBE jack to AN/APM-270(V) RF IN jack.

c. Connect AN/UPM-137A oscilloscope VERTICAL-CHAN A-VIDEO IN jack to AN/APM-270(V) DET VIDEO jack.

d. Adjust AN/UPM-137A oscilloscope controls as necessary until first pulse of pulse train is observed.

e. Adjust control A1R32 until pulse width is 0.5 ± 0.2 5sec.

f. Set test set ISLS switch to ON and adjust AN/UPM-137A oscilloscope to observe first five pulses. Adjust control A1R9 until spacing between first and fifth.pulses is 8 ±0.15 μsec.

Section IV. GENERAL SUPPORT TESTING PROCEDURES

NOTE

See Section VI When Using AN/TPM-25A

5.1-15. General

These procedures describe tests for the transponder test set mode 4 operation. They should be performed after repair of module A1, A2, or A3. Two test procedure are provided for both the Mode 4 Reply Decoder Tests and the Mode 4 Challenge Video Tests. The first procedure uses conventional test equipment and the Radar Test Set AN/UPM-98A or AN/UPM-98B. In the second test procedure and Radar Test Set AN/UPM-137A is the only piece of test equipment used.

CAUTION

When using the test set in Mode 4, if the REJECT light does not come on momentarily before the ACCEPT light, there is a problem in the 5-volt power supply (Module A3).

5.1-16. Mode 4 Reply Decoder Tests

a. *Test Equipment Required.*

(1) Oscilloscope AN/USM-281A.

(2) Modulator MD-796.

(3) Test Facilities Set, Transponder Test Set AN/APM-270(V).

(4) Generator, Signal AN/URM-64A.

(5) Wattmeter AN/URM-98.

b. *Test Connections and Conditions.*

(1) Apply power to the test equipment and permit a 15-minute warmup period.

(2) Connect the equipment as shown in figure 5.1-7, except connect the rf power test set. cable (through rf bolometer) to the modulator RF OUT connector.

c. Procedure.

Step	*Control settings: Test equipment*	*Control settings: Equipment under test*	*Test procedure*	*Performance standard*
1	*AN/APM-270(V)* *CONSECUTIVE REPLIES: 64* SPACING PULSE 2: 0 SPACING PULSE 3:0 SYNC GAIN: midposition REPLY MODULATION 1X-2X: 1X	FUNCTION: SYSTEM. MODE 4 DIR-RAD: RAD ISLS: ON	*a.* Adjust signal generator output level until rf power test set indicates -9 ±0.5 dBm.	*a.* None.
			b. Disconnect modulator rf output from rf power test set and connect to transponder test set PROBE jack.	*b.* None.
			c. Press transponder test set PUSH TO TEST switch. ACCEPT indicator should glow.	*c.* ACCEPT indicator glows.
			d. Increase signal generator output to -6 dBm.	*d.* None.
			a. Set *AN/APM-270(V)* CONSECUTIVE REPLIES switch to 56. Press the PUSH TO TEST switch. First the *REJECT* light comes on then the ACCEPT. Repeat 5 times.	*a.* ACCEPT indicator glows. Each 1 ma.
			b. Set AN/APM-270(V) CONSECUTIVE REPLIES switch to 55. REJECT indicator should glow when transponder test set PUSH TO TEST switch is pressed.	*b.* REJECT indicator glows.
			c. Set transponder test set DIR-RAD switch to DIR.	*c.* None.
			d. Set AN/APM-270(V) CONSECUTIVE REPLIES switch to 16. Press the PUSH TO TEST switch. First the REJECT light comes on then the ACCEPT indicator should glow when transponder set PUSH TO TEST switch is pressed.	*d.* ACCEPT indicator glows.
			e. Set AN/APM-270(V) CONSECUTIVE REPLIES switch to 15. REJECT indicator should glow when transponder test set PUSH TO TEST switch is pressed.	*e.* REJECT indicator glows.
			f. Set AN/APM-270(V) CONSECUTIVE REPLIES switch to 16.	*f.* None.
	....	....	Set AN/APM-270(V) REPLY MODULATION 1X-2X switch at 2X. REJECT indicator should glow when transponder test set PUSH TO TEST switch is pressed. Return switch to 1X.	REJECT indicator should glow.

Step	Control settings: Test equipment	Control settings: Equipment under test	Test procedure	Performance Standard
4	. . . .	. . . .	*a. Continually press, with* slight pauses, transponder test set PUSH-TO TEST switch, while rotating AN/APM-270(V) SPACING PULSE 2 control clockwise until a just reject condition is obtained then counterclockwise for an accept condition. Note spacing between first and second pulses.	*a.* 1.65 μsec maximum.
			b. Repeat a above, except turn SPACING PULSE 2 control counter-clcokwise for REJECT and then clocwise for ACCEPT.	*b.* 1.35 μsec maximum.
			c. Repeat a and *b* above, except operate AN/APM-270(V) SPACING PULSE 3 control.	*c. 3.45 μse minimum, 3.75 μsec maximum.*

5.1-16.1. Mode 4 Reply Decoder Tests Using AN/UPM-137A

a. Test Equipment Required.

(1) Test Facilities Set, Transponder Test Set AN/APM-270(V).

(2) Test Set, Radar AN/UPM-137A.

b. Test Connections and Conditions.

(1) Apply power to test equipment and permit 15-minute warmup period.

(2) Connect the equipment as shown in figure 5.1-7.1.

Step No.	Control Settings: Test Equipment	Control Settings: Equipment Under Test	Test Procedure	Performance Standard
1	*AN/APM-270(V)* *a.* CONSECUTIVE REPLIES: 64	*a.* FUNCTION: SYSTEM *b.* MODE: 4 *c.* DIR-RAD: RAD *d.* ISLS: OFF	*a.* Connect equipment as shown in figure 5.1-7.1. Apply power to test set AN/APM-270(V) and AN/UPM-137A and permit 15 minute warmup.	*a.* None.
	b. REPLY MODULATION-SPACING PULSE 2: 0		*b.* Press test set PUSH TO TEST switch and turn to LOCK position.	*b.* Test set should indicate ACCEPT.
	c. REPLY MODULATION-SPACING-PULSE 3: 0 *d.* SYNC-GAIN: Mid position *e.* SYNC-DELAY: Mid position *f.* REPLY MODULATION-1X/2X: 1X *AN/UPM-137A* (interrogator signal simulator) *a.* TRANSMITTER-XMTR-FREQ: XTAL (rf signal generator) *a.* OUTPUT ATTEN 0-100 dbm: −6 *b.* TRANSMITTER-XMTR FREQ: XTAL *c.* TRANSMITTER-CW SOURCE: EXT 1090 MHz (oscilloscope) *a.* HORIZONTAL-SYNC: EXT DC— *b.* HORIZONTAL-TIME/DIV: 20 μSEC *c.* CALIBRATORS-XTAL MARK (μSEC): .1 & 1 *d.* CALIBRATORS-LEVEL: Mid position *e.* VERTICAL-CHAN A-AC/DC: DC *f.* VERTICAL-CHAN A-75Ω IN/OUT: OUT *g.* VERTICAL-CHAN A-VOLT/DIV: 5 *h.* DISPLAY-CHAN A/ALT/CHAN B: ALT			

Control Section

Step	Test Equipment	Equipment Under Test	Test Procedure	Performance Standard
2	*Same as step 1* - - - - - - - - - - - - - - - - -	*Same as step 1* - - - - - - - - - - - - - - - - -	*a.* Set AN/APM-270(V) CONSECUTIVE REPLIES switch to 56. ACCEPT indicator should light when test set PUSH TO TEST switch is depressed.	*a.* ACCEPT indicator lights.
			b. Set AN/APM-270(V) CONSECUTIVE REPLIES switch to 65. REJECT indicator should light when test set PUSH TO TEST switch is depressed.	*b.* REJECT indicator lighs.
			c. Set test set DIR-RAD switch to DIR	*c.* None.
			d. Set AN/APM-270(V) CONSECUTIVE REPLIES switch to 16. ACCEPT indicator should light when test set PUSH TO TEST switch is depressed.	*d.* ACCEPT indicator lights.
			e. Set AN/APM-270(V) CONSECUTIVE REPLIES switch to 16. REJECT indicator should light when test set PUSH TO TEST switch is depressed.	*e.* REJECT indicator lights.
			f. Set AN/APM-270(V) CONSECUTIVE REPLIES switch to 16.	*f.* None.
			g. Set AN/APM-270(V) REPLY MODULATION 1X/2X switch at 2X. REJECT indicator should light when teat set PUSH TO TEST switch is depressed Return switch to 1x	*g.* REJECT indicator should lights.
3	3 Same as step 1 ----------------	Same as step 1 --------------------	*a.* connect AN/UPM-137A oscilloscope VERTICAL-CHAN A-VIDEO IN jack to AN/UPM-137A rf sigml generator *VIDEO* OUT jack	*a.* None.
			b. Adjust AN/APm-270(v) MODUJLATION-SPACING PULSE 2 control ccw until delay between leading edges of first and second pulses displayed on AN/UPM-137A oscilloscope CHAN A is 1.45 µSEC.	*b.* REJECT indicator lights.

c. Adjust AN/APM-270(V) MODULATION-SPACING PULSE 2 control cw until delay between leading edges of first and second pulses displayed on AN/UPM-137A oscilloscope CHAN A is 1.65 μsec.	*c.* ACCEPT indicator lights.
d. Adjust AN/APM-270(V) REPLY MODULATION SPACING-PULSE 2 control cw until delay between leading edges of first and second pulse displayed on AN/UPM-137A oscilloscope CHAN A is 1.95 μsec.	*d.* ACCEPT indicator lights.
e. Adjust AN/APM-270(V) REPLY MODULATION SPACING-PULSE 2 control cw until delay between leading edges of first and second pulse displayed on AN/UPM-137A oscilloscope CHAN A is 2.15 μsec.	*e.* REJECT indicator lights.
f. Adjust AN/APM-270(V) REPLY MODULATION SPACING-PULSE 3 control ccw until delay between leading edges of first and second pulses displayed on AN/UPM-137A oscilloscope CHAN A is 3.25 μsec.	*f.* REJECT indicator lights.
g. Adjust AN/APM-270(V) REPLY MODULATION SPACING-PULSE 3 control cw until delay between leading edges of first and second pulses displayed on AN/UPM-137A oscilloscope CHAN A is 3.45 μsec.	*g.* ACCEPT indicator lights.
h. Adjust AN/APM-270(V) REPLY MODULATION SPACING-PULSE 3 control cw until delay between leading edges of first and second pulses displayed on AN/UPM-137A oscilloscope CHAN A is 3.75 μsec.	*h.* ACCEPT indicator lights.
i. Adjust AN/APM-270(V) REPLY MODULATION SPAC-	*i.* REJECT indicator lights.

Step No.	Control Settings: Test Equipment	Control Settings: Equipment Under Test	Test Procedure	Performance Standard
			ING-PULSE 3 control cw until delay between leading edges of first and second pulse displayed on AN/UPM-137A oscilloscope CHAN A is 3.95 μsec.	

5.1-17. Mode 4 Challenge Video Tests Using AN/UPM-98

a. Test Equipment Required.

(1) Modulator MD-798.

(2) Oscilloscope AN/USM-281A.

(3) Test Facilities Set, Transponder Test Set AN/APM-270(V).

b. Test Connection and Conditions.

(1) Connect the equipment as shown in figure 5.1-7, except connect the transponder test set PROBE jack cable to AN/APM-270(V) RF IN jack, and the oscilloscope CHANNEL A cable to the AN/APM-270(V) DET VIDEO jack.

(2) Apply power to the equipment and permit a 5-minute warmup period.

c. Procedure

Step	*Control settings* — *Test equipment*	*Control settings* — *Equipment under test*	*Test procedure*	*Performance standard*
		FUNCTION: SYSTEM MODE 4 ISLS: ON PUSH TO TEST: LOCK	*a.* Adjust oscilloscope sweep and delay to observe first five pulses of pulse train. Measure spacing between first and second pulses. *b.* Measure spacing between fourth and fifth pulse. *c.* Adjust oscilloscope sweep and delay to observe one complete pulse train. Determine whether amplitudes of first and 37th pulses are within 10 percent.	*a. 2 ± 0.07 µsec.* *b. 2 ± 0.07 µsec.* c. Amplitude difference between first and 37th pulses is 10 percent maxium.

5.1-17.1. Mode 4 Challenge Video Tests Using AN/UPM-137

a. Test Equipment Required.

(1) Test Facilities Set, Transponder Test Set AN/APM-270(V).

(2) Test Set, Radar AN/UPM-137A.

b. Test Connection and Conditions.

(1) Connect the equipment as shown in figure 5.1-7.1, except connect the AN/UPM-137A oscilloscope VERTICAL-CHAN A-VIDEO IN connector to AN/APM-270(V) DET VIDEO connector. Connect the test set PROBE output to the AN/APM-270(V) RF IN connector.

(2) Apply power to the equipment and permit 15-minute warmup.

c. *Procedure.*

Step	Control settings: Test equipment	Control settings: Equipment under test	Test procedure	Performance standard
1	*AN/APM-270(V)* CONSECUTIVE REPLIES: 64 REPLY MODULATION-SPACING-PULSE 2: 0 REPLY MODULATION-SPACING-PULSE 3: 0 SYNC-GAIN: Midposition SYNC-DELAY: Midposition REPLY MODULATION-1X/2X: 1X *AN/UPM-137A (interrogator signal simulator)* TRANSMITTER—XMTR FREQ: XTAL *(rf signal generator)* OUTPUT ATTEN 0-100 dBm: −5 TRANSMITTER—XMTR FREQ: XTAL TRANSMITTER-CW SOURCE: EXT 1090 MHz *(oscilloscope)* HORIZONTAL-SYNC: EXT DC HORIZONTAL-TIME/DIV: 20 μSEC CALIBRATORS-XTAL MARK (μSEC): .1 & 1 CALIBRATORS-LEVEL: Midposition VERTICAL-CHAN A-AC/DC: DC VERTICAL-CHAN A-75Ω IN/OUT: OUT VERTICAL-CHAN A-VOLT/DIV: 1 DISPLAY-CHAN A/ALT/CHAN B: ALT	FUNCTION: SYSTEM MODE: 4 DIR-RAD: RAD ISLS: OFF	*a.* Press test set PUSH TO TEST switch and turn to LOCK position.	*a.* Test set should indicate ACCEPT.
2	Same as step 1.	Same as step 1.	*a.* Adjust AN/UPM-137A oscilloscope sweep and delay controls to observe first five pulses of pulse train. Measure spacing between first and second pulses.	*a.* 2.± 0.07 μsec.

b. Measures spacing between fourth and fifth pulse.	*b.* *2* ±0.07 μsec.
c. Adjust oscilloscope sweep and delay controls to observe one complete pulse train. Determine whether amplitudes of first and thirty-seventh pulses are within ten percent.	*c.* Amplitudes differ. First and thirty-seventh pulses are ten percent of maximum.

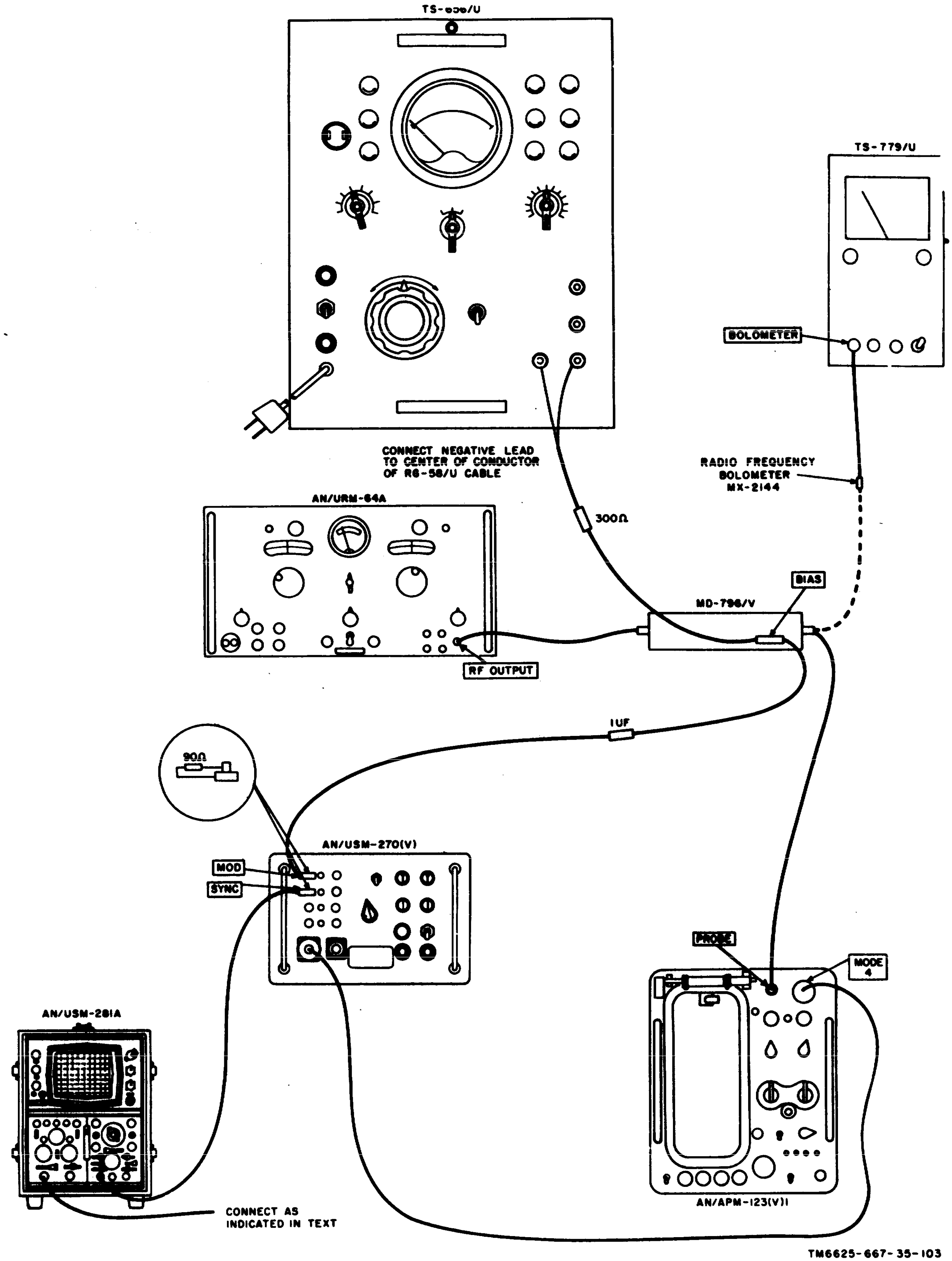


Figure 5.1-7. Mode 4 test connections.

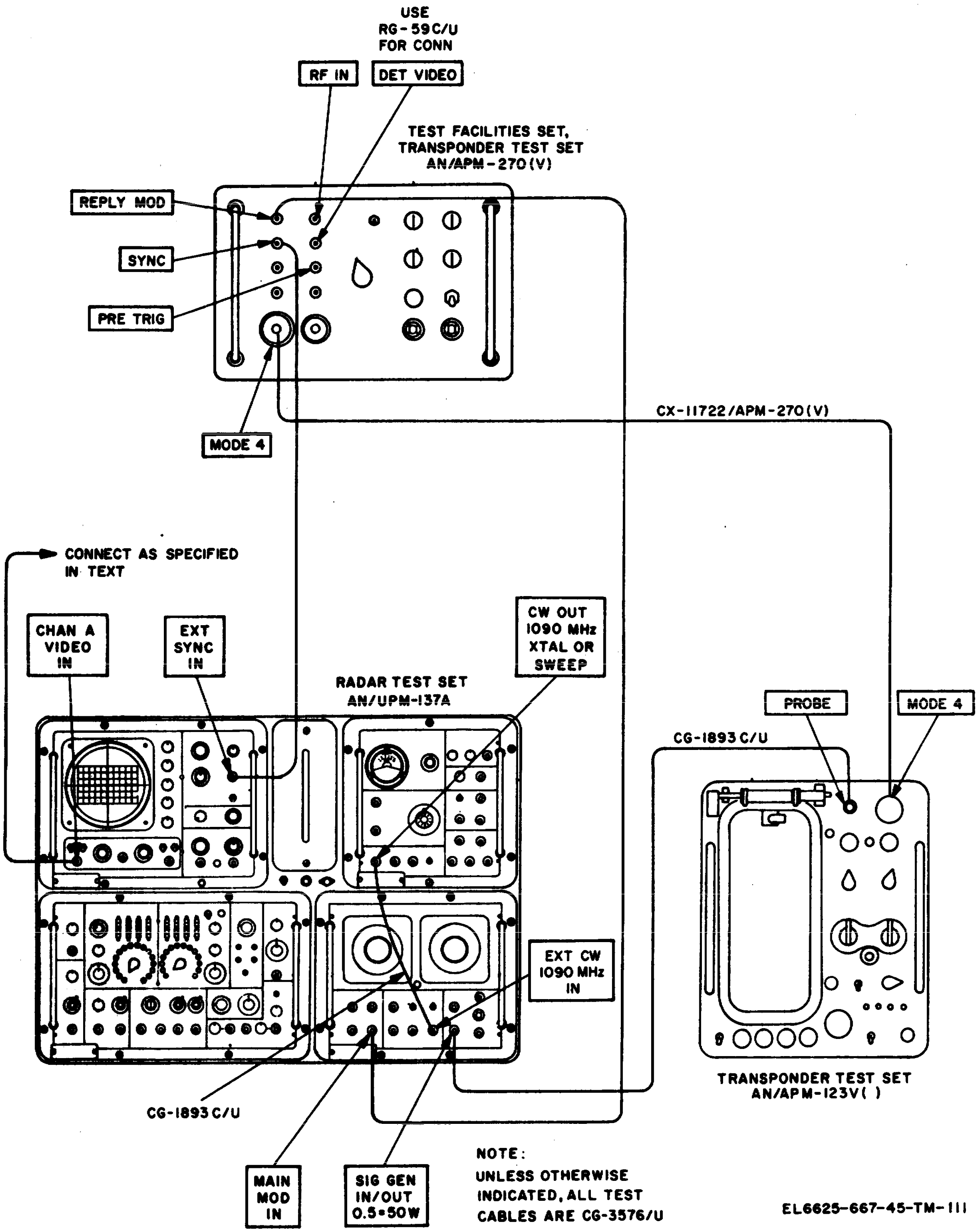
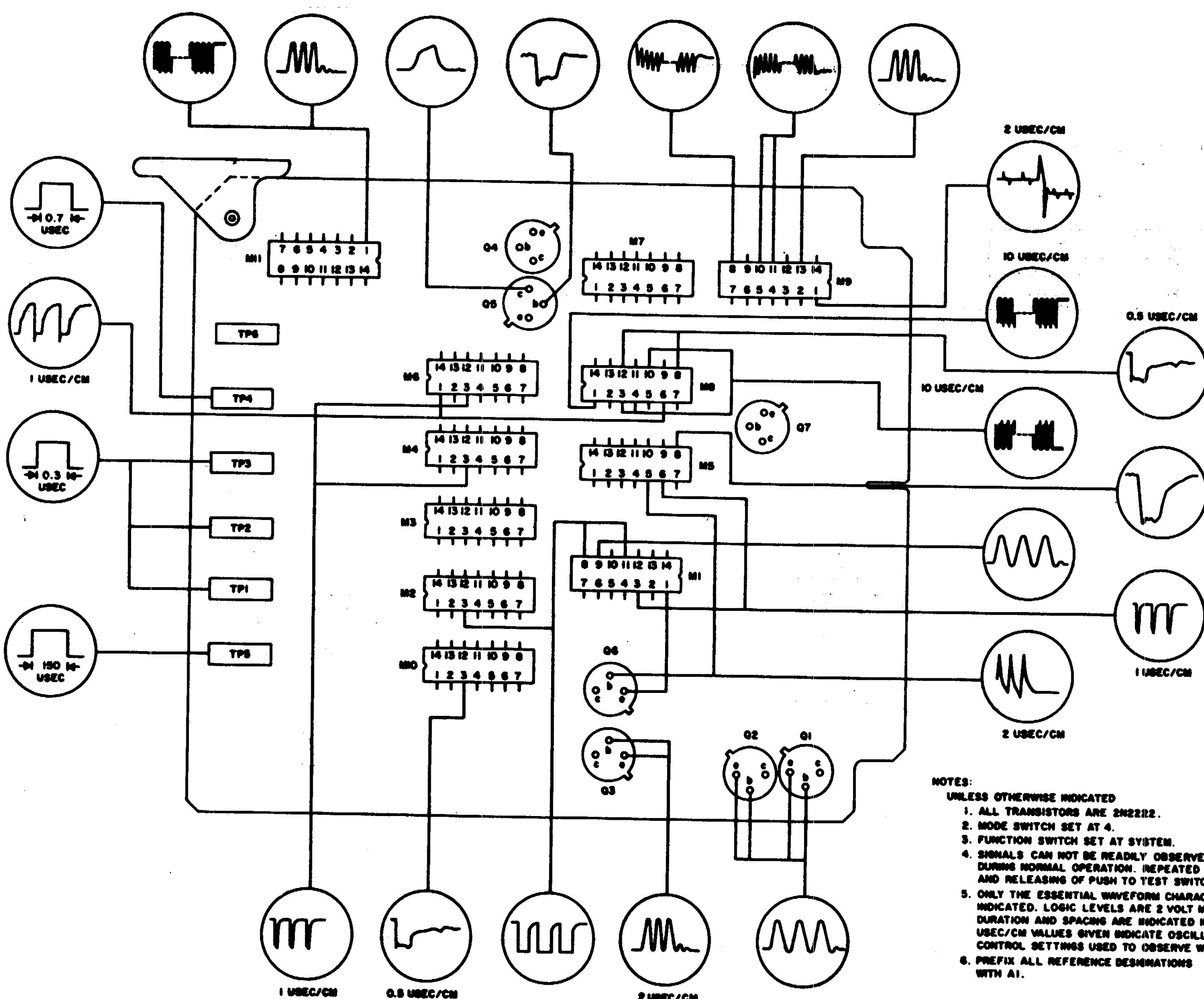


Figure 5.1-7.1. Mode 4 Test connections using AN/UPM-137A.



NOTES:

UNLESS OTHERWISE INDICATED

1. ALL TRANSISTORS ARE 2N2222.
2. MODE SWITCH SET AT 4.
3. FUNCTION SWITCH SET AT SYSTEM.
4. SIGNALS CAN NOT BE READILY OBSERVED DURING NORMAL OPERATION. REPEATED PRESSING AND RELEASING OF PUSH TO TEST SWITCH IS REQUIRED.
5. ONLY THE ESSENTIAL WAVEFORM CHARACTERISTICS ARE INDICATED. LOGIC LEVELS ARE 2 VOLT MINIMUM. DURATION AND SPACING ARE INDICATED IF ESSENTIAL. USEC/CM VALUES GIVEN INDICATE OSCILLOSCOPE CONTROL SETTINGS USED TO OBSERVE WAVEFORM.
6. PREFIX ALL REFERENCE DESIGNATIONS WITH A1.

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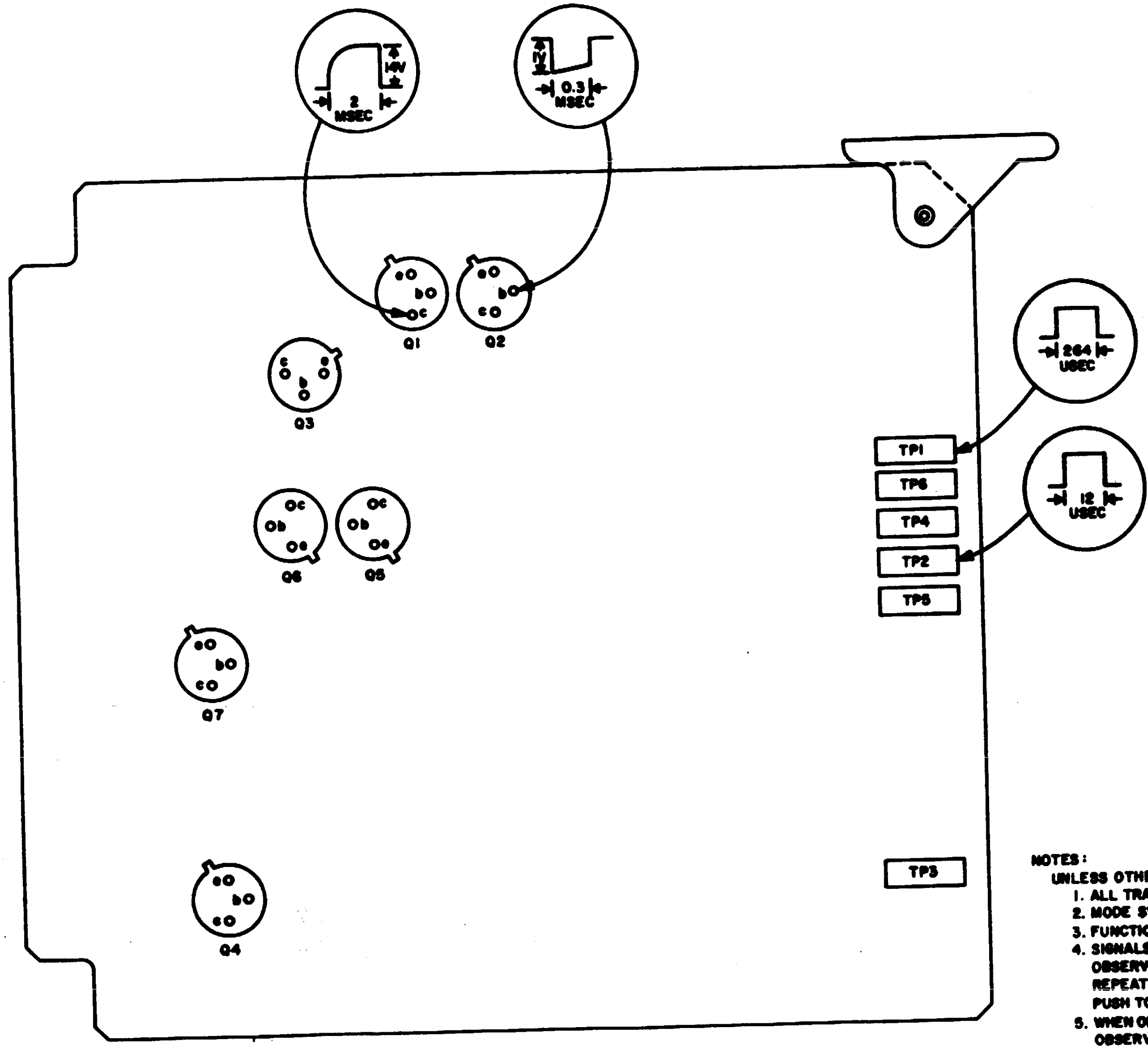
Figure 5.1–8. Module A1 socket waveforms.



NOTES:
UNLESS OTHERWISE INDICATED
1. ALL TRANSISTORS ARE 2N2222
2. MODE SWITCH SET AT 4
3. FUNCTION SWITCH SET AT SYSTEM
4. SIGNALS CAN NOT BE READILY OBSERVED DURING NORMAL OPERATION. REPEATED PRESSING AND RELEASING OF PUSH TO TEST SWITCH IS REQUIRED.
5. WHEN ONLY DC LEVEL CHANGES CAN BE OBSERVED, WAVEFORMS ARE NOT SHOWN.
6. PREFIX ALL REFERENCE DESIGNATIONS WITH A2

TM6625-667-35-97

Figure 5.1-9. Module A2 socket waveforms.

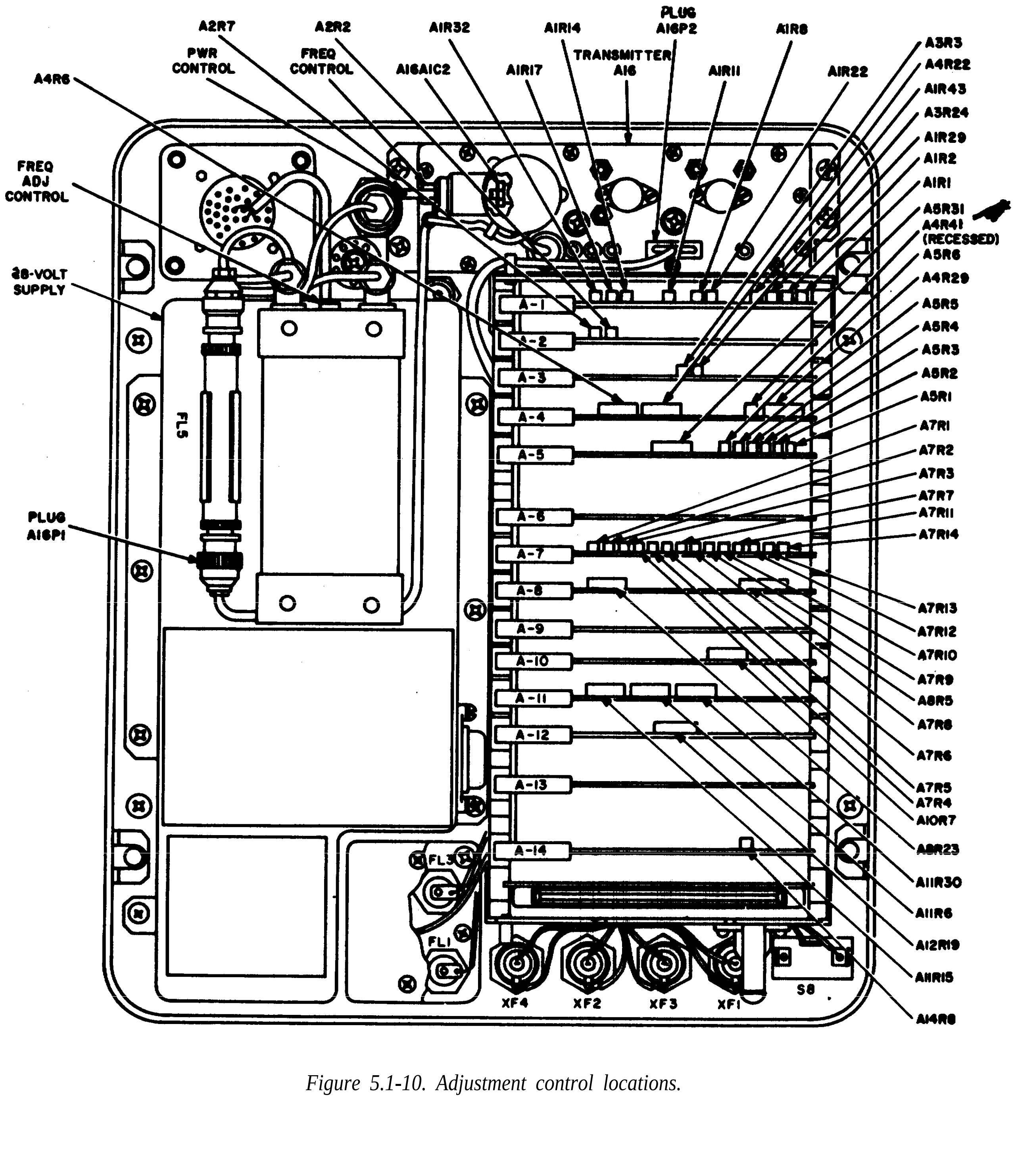


Figure 5.1-10. Adjustment control locations.

Section V. MODE 4 ALIGNMENT USING AN/TPM-25A

5.1-18. General

The test equipment listed in paragraph 5.1-19, or approved equivalent, is required to perform alignment procedures. Two procedures are provided for each alignment procedure. The first procedure used conventional test equipment in conjunction with the Radar Test Set AN/TPM-25A. The second procedure used the Radar Test Set AN/UPM-137A. Refer to figure 5.1-10 for adjustment control location.

5.1-19. Test Equipment Required for Alignment

Test Equipment	Technical Manual
Oscilloscope AN/USM-281A	TM 11-6625-1703-14
Radar Test Set AN/TPM-25A	TM 11-6625-2610-12
Mulitmeter TS 352B/U	TM 11-6625-366-15
Mulitmeter ME 26B/U	TM 11-6625-200-15
Test Set, Radar AN/UPM-137A	NAVELEX 0969-158-1010 NAVAIR 16-30UPM137-6-1 AIR FORCE T.O. 33A1-3-426-21-1 AND NAVELEX 096-158-1020 NAVAIR 16-30UPM137-6-2 AIR FORCE T.O. 33A1-3-426-21-2

5.1-20. Power Supply Adjustment

a.Connect equipment as shown in figure 3-1.

b. Set the ME-26B/U RANGE control to 10V.

c. Connect the ME-26B/U dc probe to test point A3TP1.

d. Adjust control A3R24 until the ME-26B/U indicates 5 ±0. 1 volts.

e. Disconnect the ME-26B/U from the test set.

f. Connect the equipment as shown in figure 5.1-2.

g. Set the TS-352B/U FUNCTION switch to DC + CURRENT and range switch to 500MA.

h. Adjust control A3R3 for a multimeter in dication of 400 ±20 milliamperes.

5.l-21. Power Supply Adjustment Using AN/UPM-137A

a. Connect equipment as shown in figure 3-1.1.

b. Set and adjust AN/UPM-137A oscilloscope controls as follows:

Control	*Position*
Horizontal SYNC	EXT DC
HORIZONTAL TIME/DIV	1O µ SEC
DISPLAY-CHAN A/ALT CHAN B	CHAN A
VERTICAL CHAN A-75 Ω IN/OUT	OUT
VERTICAL CHAN A-AC/DC	DC
VERTICAL CHAN A-VOLT/DIV	1

c. Connect dc test probe to test point A3TP1.

d. Apply power to equipment and permit 5-minute warmup.

e. Adjust test set control A3R24 unti AN/UPM-137A oscilloscope display indicates 5 ±0.l vdc.

f. Connect equipment as shown in figure 5.1-2.

g. Set TS-352B/U FUNCTION switch to DC + CURRENT and RANGE switch to 500MMA.

h. Adjust control A3R3 for meter indication o 400 ±20 ma.

5.1-22. Mode 4 Receiver Sensitivity and Reply Video Adjustments Using AN/TPM-25A

a. Set and adjust the AN/TPM-25A control: as follows:

REPLIES panel
- MODULATION SEL: M4-3P
- REPLY WIDTH: 0.45
- SUB PULSE SEL: OFF
- RANGE DELAY SEL (USEC) :0001

MEASUREMENT PANEL:
- PRF RANGE: X100
- FUNCTION SEL: PRF CHAL
- DEMOD VID LEVEL: Mid position

SIF CHAL VID panel
- SIF MODE SEL: OFF
- 20V/5BV: 5V

TRIG SEL panel
DCD MODE SEL: OFF
INT/DCD/EXT EXT
SIG GEN FUNCTION FIXED FREQ
SIG GEN NORM/INTERLEAVE: NORM
SUM ATTEN: -6 DB
GATING panel
PASS: 00
INHIB: 00

b. Set and adjust the AN/USM-281A controls as follows:

MAIN TIME/DIV .1 MSEC
DELAYED TIME/DIV: As required to observed indicated waveform
EXT ÷ 10/EXT/INT/LINE: EXT
INT/AUTO/EXT/EXT ÷ 10: AUTO
MAIN – SLOPE +:+
DELAYED – SLOPE +: +
DIV DELAY: As required to observe indicated waveform
DISPLAY: ALT
A VOLTS/DIV 5
B VOLTS/DIV 2

c. Set and adjust the AN/UPM-15A controls as follows:

TRIGGER SELECT:EXT
PULSE DELAY coarse control 10 μs
PULSE WIDTH coarse control 10 #s
POSITIVE AMPLITUDE: Fully ccw.

d. Connect the equipment as shown in figure 5.1-11 and apply power to all equipment.

e. On the AN/USM-281A, adjust DIV DELAY as required to observe reply pulse on B INPUT.

f. On the AN/UPM-15A, adjust POSITIVE AMPLITUDE for a *5* volt pulse on A INPUT, adjust PULSE WIDTH fine control for a pulse width of. 5 μs, and PULSE DELAY fine control for a delayed pulse leading edge 3.5 μs from leading edge of reply pulse.

g. Adjust AN/TPM-25A SUM ATTEN dial for a reading of –9 dBm minus the 1090 MHz loss of cable 139526.

h. Continually press the transponder test set PUSH TO-TEST switch and adjust control A1R43 (fig. 8-43) for a just accept indication. Increase the signal generator output level 3 dBm.

i. Set and adjust the AN/USM-281 as follows:

(1) Sweep Display Swtich: ALT

(2) MAIN and DELAYED – SLOPE + Switches: +.

j. Connect the AN/USM-281A A INPUT to test points listed in the chart below. Adjust the control indicated until performance requirement is obtained.

NOTE

In order to observe the pulse at A2TP2, it is necessary to continuously operate the PUSH-TO-TEST switch.

Adjust the oscilloscope sweep and delay controls as necessary to observe signal.

Test Point	*Adjust Control*	*Pulse Width (μs)*
A1TP1	A1R6	0.3±0.01
A1TP2	A1R1l	0.3±0.01
A1TP3	A1R14	0.3±0.01
A1TP4	A1R17	0.7 ±0.01
A2TP1	A2R2	269±2
A2TP2	A2R7	12±0.1
A1TP5	A1R22	150±7.5

5.1-23 Mode 4 Receiver Sensitivity and Reply Video Adjustments Using AN/UPM-137A

a. Set and adjust AN/APM-27(V) controls as follows:

(1) CONSECUTIVE REPLIES to 64.
(2) REPLY MODULATION-SPACING-PULSE 2 to 0.
(3) REPLY MODULATION-SPACING-PULSE 3 to 0.
(4) SYNC GAIN to mid position.
(5) SYNC DELAY to mid position.
(6) REPLY MODULATION–1X/2X to

b. Set test set controls as follows:

(1) FUNCTION TO SYSTEM.
(2) MODE to 4.
(3) DIR. RAD to RAD.
(4) ISLS to OFF.

c. set AN/UPM-137A interrogator signal simulator TRANSMITTER-XMTR FREQ switch to XTAL.

d. Set and adjust AN/UPM-137A rf signal generator controls as follows:

(1) OUTPUT ATTEN 0-100 dbm to. -6.
(2) TRANSITTER–XMTR FREQ to XTAL.
(3) TRANSMITTER-CW SOURCE to EXT 1090 MHz.

e. Set and adjust AN/UPM-137A oscilloscope controls as follows:

(1) VERTICAL-CHAN A-AC/DC to DC.

(2) VERTICAL-CHAN A-75 Ω IN OUT to OUT.

(3) VERTICAL-CHAN A-VOLT/DIV to 2.

(4) DISPLAY/CHAN A/ALT/CHAN B to ALT.

(5) HORIZONTAL-SYNC to EXT DC -

(6) CALBIRATORS–XTAL MARK (μ SEC) to.1 & 1.

(7) CALIBRATORS LEVEL to mid-position.

f. Connect equipment as shown in figure 5.1-7.1.

g. Apply power to equipment and permit 15-minute warmup.

h. Adjust AN/UPM-137A rf signal generator OUTPUT ATTEN control to -9 dBm minus cable attenuation marked on cable connected to test set PROBE jack.

Example -9 dBm minus –0.9 dB is –8.1 dBm

i. Continually press and release test set PUSH TO TEST switch and adjust control A1R43 to just ACCEPT Indication. Adjust AN/UPM-137A rf signal generator OUTPUT ATTEN 0-100 dbm to 3 dB less than that in step h.

j. Connect AN/UPM-137A oscilloscope VERTICAL-CHAN A-VIDEO IN jack to test set test points listed in chart below. Set test set PUSH TO TEST switch to LOCK and adjust test set control indicated until performance requirement is obtained.

NOTE

Adjust the AN/UPM-137A oscilloscope controls as necessary to observe signal.

Test Point	*Adjust Control*	*Pulse Width (μs*
A1TP1	A101	0.3±0.01
A1TP2	A1R11	0.3±0.01
A1TP3	A1R14	0.3±0.01
A1TP4	A1R17	0.7±0.01
A2TP1	A2R2	269±2
A2TP2	A2R7	12 ±0.l
A1TP5	A1R22	150±7.5

5.1-24. Mode 4 Challenge Video Adjustment Using AN/TPM-25A

a. Perform the procedures given in paragraph 5-22a and *b.*

b. Connect the equipment as shown in figure 5.1-12.

c. Set AN/USM-281 DELAYED TIME/DIV to 1 μSEC, and adjust DELAY DIV to observe the first pulse of the challenge video on oscilloscope A INPUT and the 1 μs markers on B INPUT.

d. Adjust control A1R32 until the pulse width is 0.5 ±0.1 μs.

e. On the transponder test set, set ISLS to ON Adjust control A1R29 until the spacing between the first challenge video pulse and the fifth, isls, pulse is 8 ±0.05 μs.

5.1-25 Mode 4 Challenge Video Adjustment Using AN/UPM-137A

a. Perform procedures given in paragraph 5.1-23 *a* through *g.*

b. Connect cable from test set PROBE jack to AN/APM-270(V) RF IN jack.

c. Connect AN/UPM-137A oscilloscope VERTICAL-CHAN A-VIDEO IN jack to AN/APM-270(V) DET VIDEO jack.

d. Adjust AN/UPM-137A oscilloscope con trols as necessary until first pulse of pulse train is observed.

e. Adjust control A1R32 until pulse width is 0.5 ±0.2 μs.

f. Set test set ISLS switch to ON and adjust AN/UPM-137A oscilloscope to observe first five pulses. Adjust control A1R29 until spacing between first and fifth pulses is 8 ±0.15 μs.

Section VI. GENERAL SUPPORT TESTING PROCEDURES DURING MODE 4 OPERATION USING AN/TPM-25A AND AN/U PM-137A

5.1-26 General

These procedures describe tests for the transponder test set mode 4 operation. They should be performed after repair of module Al, A2, or A3. Two test procedures are provided for both the Mode 4 Reply Decoder Tests and the Mode 4 Challenge Video Tests. The first procedure uses conventional test equipment and the Radar Test Set AN/TPM-25A, In the second test procedure, Radar Test Set AN/UPM-137A is the only piece of test equipment used.

CAUTION

When using the test set in Mode 4, if the REJECT light does not come on momentarily before the ACCEPT light, there is a problem in the 5 volt power supply (Module A3).

5.1-27 Mode 4 Reply Decoder Tests

a *Test Equipment Required*

(1) Oscilloscope AN/USM-281A.

(2) Radar Test Set AN/TPM-25A

b. Test Conditions and Conditions.

(1) Apply power to the test equipment and permit a 15-minute warmup period.

(2) Connect the equipment as shown in figure 5.1-11.

c. Procedure

Step No.	Control Settings: Test Equipment	Control Settings: Equipment under test	Test Procedure	Performance Standard
1	*AN/TPM-25A* REPLIES panel: MODULATION SEL: M4-3P REPLY WIDTH:-0.45 SUB PULSE SEL: OFF RANGE DELAY SEL (µSEC): 0001 MEASUREMENT panel: PRF RANGE: X100 FUNCTION SEL: PRF CHAL DEMOD VID LEVEL Mid position SIF CHAL VID panel SIF MODE SEL: OFF 20V/5V:5V TRIG SEL panel: DCD MODE SEL: OFF INT DCD/EXT: EXT SIG GEN FUNCTION: FIXED FREQ SIG GEN NORM INTER-LEAVE: NORM SUM ATTEN: -6 dB GATING panel PASS: 00 INHIB: 00 *AN/USM-281A* Sweep Display Switch DELAYED MAIN TIME/DIV: .1 MSEC DELAYED TIME/DIV: 1 µSEC EXT ÷ 10/EXT/INT/LINE: EXT INT AUTO/EXT/EXT ÷ 10: AUTO MAIN – SLOPE +:+ DELAYED – SLOPE +:+ MAIN ASC/ACF/AC/DC: DC DIV DELAY: 475 DISPLAY ALT A VOLT/DIV: 5 B VOLTS/DIV: 2	FUNCTION: SYSTEM MODE: 4 DIR/RAD: RAD ISLS: OFF PRESS TO TEST LOCK	*a.* Connect equipment as shown in figure 5.1-11. *b.* On AN/USM-281A, adjust DIV DELAY as required to observe reply pulse on B INPUT. *c.* On AN/UPM-15A, adjust POSITIVE AMPLITUDE for a 5 volt delayed puke on oscilloscope A INPUT. *d.* Adjust PULSE WIDTH fine control for a delayed pulse width of .5 µ 9. *e.* Adjust PULSE DELAY fine control for a delayed pulse leading edge 3.5 s from leading edge of reply pulse.	*a.* None *b.* None *c.* None *d.* None *e.* None

Step No.	Control Settings: Test Equipment	Control Settings: Equipment under test	Test Procedure	Performance Standard
1 (Cont)	AN/UPM-15A TRIGGER SELECT: EXT PULSE DELAY coarse 10 μs PULSE WIDTH coarse 10 μs POSITIVE AMPLITUDE: Fully ccw.			
2		FUNCTION: SYSTEM MODE: 4 DIR/RAD: RAD ISLS: OFF.	Depress transponder test set PUSH TO TEST switch. ACCEPT indicator should glow.	ACCEPT indicator glows.
3			*a.* Set AN/TPM-25A GATING PASS to 56 and GATING INHIB to 8. Depress transponder test set PUSH TO TEST switch. ACCEPT indicator should glow. *b.* Set AN/TPM-25A GATING PASS to 55 and GATING INHIB to 9. Depress transponder test set PUSH TO TEST switch. REJECT indicator should glow. *c.* Set transponder test set DIR/RAD switch to DIR. *d.* Set AN/TPM-25A GATING PASS to 16 and GATING INHIB to 48. Depress transponder test set PUSH TO TEST switch. ACCEPT indicator should glow.	*a.* ACCEPT indicator glows. *b.* REJECT indicator glows. *c.* None *d.* ACCEPT indicator glows. (See note

NOTE

If the ACCEPT lamp does not go on, it is possible that the mode 4 reply from the AN/TPM-25A is arriving too late for-the timing-of the transponder test set. To check this, continue as above while slowly turning 269 μs gate adjust A2R2 clockwise until the ACCCEPT lamp glows. If the ACCEPT lamp glows, the performance standard, in 3d above, has been met. Perform the 269 μs gate ad justment procedure given in paragraph 5.1-22.

Step No.	Test Equipment	Equipment under test	Test Procedure	Performance Standard
			e. Set AN/'PM-25A GATING PASS to 15 and GATING INHIB to 49. Depress transponder test set PRESS TO TEST switch. REJECT indicator should glow. *f.* Set AN/TPM-25A GATING PASS to 16 and GATING INHIB to 48.	*e.* REJECT indicator glows. *f.* None

Step No.	Control Settings		Test Procedure	Performance Standard
	Test Equipment	Equipment under test		
4			Set AN/TPM-25A M4 JAMMING to 1. Depress transponder test set PRESS , TO TEST switch. REJECT indicator should glow.	REJECT indicator glows.
5	*AN/TPM-25A* REPLIES panel GATING INHIB: 00 GATING PASS: 00 M4 JAMMING: 0 SUB PULSE SEL: M4-P2 SUB PULSE POS: VARY *AN/USM 281A4* Sweep display switch DELAYED MAIN TIME/DIV: .1 MSEC DELAYED TIME/DIV: 1 µSEC EXT ÷ 10/EXT/INT/LINE: EXT INT AUTO/'EXT/EXT ÷ 10 AUTO MAIN - SLOPE +: + DELAYED – SLOPE +: + MAIN ACS/ACF/AC/DC: DC DIV DELAY: 0.82 DISPLAY:ALT A VOLTS/DIV: .5 B VOLT/DIV: 5		*a.* Continually depress and release PRESS TO TEST switch, and, on AN TPM-25A, turn REPLIES SUB PULSE POS VARY control counter clockwise until REJECT' indicator glows, and then clockwise until ACCEPT indicator just goes on. *b.* Observe the frequency markers on AN/USM-281A B INPUT and the reply video pulses on A INPUT. Measure spacings from leading edge of first pulse of leading edge of second pulse. *c.* Repeat steps *a* and *b* above, except turn REPLIES SUB PULSE SEL control clockwise first. *d.* On AN/TPM-25A, set REPLIES SUB PULSE SEL to M4-P3, repeat steps *a, b,* and c above, and measure spacing between leading edge of first pulse and leading edge of third pub.	*a.* None *b.* 1.65 µs max *c.* 1.85 µs max *d.* 3.45 µs max 3.75 µs max

5.1-28 Mode 4 Reply Decoder Tests Using AN/ UPM-137A

a Test Equipment Required.

(1) Test Facilities Set. Transponder Test Set AN/APM-270(V).

(2) Test Set. Radar AN/UPM-137A.

b. Test Connections and Conditions.

(12) Apply power to test equipment and permit 15-minute warmup period.

(2) Connect the equipment as shown in figure 5.1-7.1.

c. Procedure

Step No.	Control Settings: Test Equipment	Control Settings: Equipment Under Test	Test Procedure	Performance Standard
1	***AN/APM-270(V)*** *a.* CONSECUTIVE REPLIES 64 *b.* REPLY MODULATION–SPACING PULSE 2:0 *c.* REPLY MODULATION–SPACING-PULSE 3:0 *d.* SYNC-GAIN: Mid position *e.* SYNC-DELAY: Mid position *f.* REPLY MODULATION-1X/2X. 1X AN/UPM-137A (interrogator signal simulator *a.* TRANSMITTER-XMTR-FREQ XTAL (rf signal simulator *a.* OUTPUT ATTEN 0-1000 dbm: –6 *b.* TRANSMITTER-XMTR FREQ: XTAL *c.* TRANSMITTER-CW SOURCE: EXT 1090 MHz (oscilloscope) *a.* HORIZONTAL-SYNC: EXT DC– *b.* HORIZONTAL-TIME/DIV: 20 µSEC *c.* CALIBRATORS-XTAL MARK (µSEC): 1 & 1 *d.* CALIBRATORS-LEVEL Mid position *e.* VERTICAL-CHAN A-AC/DC: DC *f.* VERTICAL-CHAN A-75 Ω IN/OUT: OUT *g.* VERTICAL-CHAN A-VOLT DIV: 5 *h.* DISPLAY-CHAN/ALT CHAN B: ALT	*a.* FUNCTION: SYSTEM *b.* MODE: 4 *c.* DIR RAD: RAD *d.* ISLS: OFF	*a.* Connect equipment as shown in figure 5.1-7.1. Apply power to test set AN/APM-270(V:) and AN/UPM-137A and permit 15 minute warmup. *b.* Press test set PUSH TO TEST switch and turn to LOCK position.	*a.* None. *b.* Test set should indicate. ACCEPT.

Step No.	Control Settings		Test Procedure	Performance Standard
	Test Equipment	Equipment under test		
2	*Same as step 1*	*Same as step 1*	*a.* Set AN/APM-270(V) CONSECUTIVE REPLIES switch to 56. ACCEPT indicator should light when test set PUSH TO TEST switch is depressed.	*a.* ACCEPT indicator lights.
			b. Set AN/APM-270(V) CONSECUTIVE REPLIES switch to 55. REJECT indicator should light when test set PUSH TO TEST switch is depressed.	*b.* REJECT indicator lights.
			c. Set test set DIR RAD switch to DIR.	*c.* None.
			d. Set AN/APM-270(V) CONSECUTIVE REPLIES switch to 16. ACCEPT indicator should light when test set PUSH TO TEST switch is depressed.	*d.* ACCEPT indicator lights.
			e. Set AN/APM-270(V) CONSECUTIVE REPLIES switch to 15. REJECT indicator should light when test set PUSH TO TEST switch is depressed.	*e.* REJECT indicator lights.
			f. Set AN/APM-270(V) CONSECUTIVE REPLIES switch to 16.	*f.* None.
			g. Set AN/APM-270(V) REPLY MODULATION lX/2X switch at 2X. REJECT indicator should light when test set PUSH TO TEST switch is depressed. Return switch to lX.	*g.* REJECT indicator should light.
3	*Same as step 1*	*Same as step 1*	*a.* Connect AN/UPM-137A oscilloscope VERTICAL-CHAN A-VIDEO IN jack to AN/UPM-137A rf signal generator VIDEO OUT jack.	*a.* None.
			b. Adjust AN/APM-270(V) MODULATION–SPACING PULSE 2 control ccw until delay between leading edges of first and second pulses displayed on AN/UPM-137A oscilloscope CHAN A is 1.45 μs	*b.* REJECT indicator lights.

Step No.	Control settings: Test equipment	Control settings: Equipment under test	Test Procedure	Performance Standard
3 (Cont)			*c*. Adjust AN/APM-270(V) MODULATION–SPACING PULSE 2 control cw until delay between leading edges of first and second pulses displayed on AN/UPM-137A oscilloscope CHAN A is 1.65 μs	*c.* ACCEPT indicator lights.
			d. Adjust AN/APM-270(V)REPLY MODULATION SPACING–PULSE 2 control cw until delay between leading edges of first and second pulse displayed on AN/UPM-137A oscilloscope CHAN A is 1.95 μs	*d.* ACCEPT indicator lights.
			e. Adjust AN/APM-270(V) REPLY MODULATION SPACING–PULSE 2 control cw until delay between leading edges of first and second pulse displayed on AN/UPM-137A oscilloscope CHAN A is 2.15 μs	*e.* REJECT indicator lights.
			f. Adjust AN/APM-270(:V) REPLY MODULATION SPACING–PULSE 3 control ccw until delay between leading edges of first and second pulses displayed on AN/UPM-137A oscilloscope CHAN A is 3.25 μs	*f.* REJECT indicator lights.
			g. Adjust AN/APM-270(V) REPLY MODULATION SPACING–PULSE 3 control cw until delay between leading edges of first and second pulses displayed on AN/UPM-137A oscilloscope CHAN A is 3.45 μs	*g.* ACCEPT indicator lights.
			h. Adjust AN/APM-270(V) REPLY MODULATION SPACING–PULSE 3 control cw until delay between leading edges of first and second pulses displayed on AN/UPM-137A oscilloscope CHAN A is 3.75 μs	*h.* ACCEPT indicator lights.

Step No.	Control settings		Test Procedure	Performance Standard
	Test equipment	Equipment under test		
3 (Cont)			*i.* Adjust AN/APM-270(V) REPLY MODULATION SPACING–PULSE 3 control cw until delay between leading edges of first and second pulse displayed on AN/U PM-137A oscilloscope CHAN A is 3.95 µ SEC.	*i.* REJECT indicator lights.

5.1-29. Mode 4 Challenge Video Tests

a Test Equipment Required.

(1) Radar Test Set AN/TPM-25A.

(2) Oscilloscope AN/USM-281A

b. Test Connection and Conditions.

(1) Connect the equipment as shown in figure 5.1-12.

(2) Apply power to the equipment and permit a 5-minute warmup period.

c. Procedure.

Step No.	Control Settings: Test equipment	Control Settings: Equipment under test	Test Procedure	Performance Standard
1	*AN/TPM-25A* REPLIES panel: MODULATION SEL: M4-3P REPLY WIDTH: 0.45 SUB PULSE SEL: OFF RANGE DELAY SEL (μSEC): 0001 MEASUREMENT panel: PRF RANGE: X100 FUNCTION SEL: PRF CHALZ DEMOD VID LEVEL: Mid position SIF CHAL VID panel SIF MODE SEL: OFF *AN/USM-281A* Sweep Delay Switch *DELAYED* MAIN TIME/DIV: .1 MSEC DELAYED TIME/DIV: 10 μSEC EXT ÷ 10/EXT/INT/LINE: EXT INT AUTO/EXT/EXT ÷ l0: AUTO MAIN–SLOPE +:+ DEALYED–SLOPE +: + MAIN ACS/ACF/AC/DC: DC DIV DELAY: 0.82 DISPLAY: ALT A VOLT/DIV: 5 B VOLTS/DIV: 2	FUNCTION: SYSTEM MODE: 4 ISLS: ON PUSH TO TEST: LOCK	*a.* Adjust AN/USM-281 DELAYED sweep and DIV DELAY controls to observe the first five pulses of the challenge train on A INPUT and the timing markers on B INPUT. Measure pulse spacing from leading edge of the first pulse to leading edge of second pulse. 6. Using procedures in *a* above, measure pulse spacing from fourth to fifth pulse. c. Adjust AN/USM-281A DELAYED TIME & DIV and DIV DELAY to observe all 37 pulses of the pulse train. Observe amplitudes of first and last pulses.	*a.* 2 ±0.07 μs *b.* 2 *0.07 μs *c.* Amplitude difference does not exceed 10%

5.1-30 Mode 4 Challenge Video Tests

a. Test *Equipment Required.*

(1) Test Facilities Set, Transponder Test Set AN/APM-270(V).

(2) Test Set, Radar AN/UPM-137A.

b. Test Connection and Conditions.

(1) Connect the equipment as shown in figure 5.1-7.1, except connect the AN/UPM-137A oscilloscope VERTICAL-CHAN A-VIDEO IN connector to AN/APM-270(V) DET VIDEO connector.

(2) Apply power to the equipment and permit 15-minute warmup.

Step	Control settings: Test equipment	Control settings: Equipment under test	Procedure	Normal Indication
1	AN/APM-27UV) CONSECUTIVE REPLIES: 64 REPLY MODULATION-SPACING PULSE 2:0 REPLY MODULATION-SPACING PULSE 3:0 SYNC-GAIN: Midposition SYNC-DELAY Midpostion REPLY MODULATION-1X/2X 1X AN/UPM-197A *(interrogator signal simulator)* TRANSMITTER-XMTR FREQ XTAL (rf signal generator) OUTPUT ATTEN 0-100 dBm; –5 TRANSMITTER-XMTR FREQ: XTAL TRANSMITTER-CW SOURCE: EXT 1000 MHz (oscilloscope HORIZONTAL-SYNC: EXT DC HORIZONTAL-TIME/DIV: 20 µSEC CALIBRATORS–XTAL MARK (µSEC) 1 & 1 CALIBRATORS–LEVEL: Mid position VERTICAL–CHAN A-AC/DC: DC VERTICAL–CHAN A75 Ω IN/OUT: OUT VERTICAL–CHAN A-VOLT DIV: 1 DISPLAY–CHAN A/ALT CHAN B: ALT	FUNCTION: SYSTEM MODE: 4 DIR-RAD: RAD ISLS: OFF	Press test set PUSH TO TEST switch	Test set should indicate ACCEPT.
2	Same as step 1	Same as step 1	*a.* Adjust AN/UPM-137A oscilloscope sweep and delay controls to observe first five pulses of pulse train. Measure spacing between first and second pulses.	a. 2. ±0.07 µ sec.

Step	Control settings		Procedure	Normal Indication
	Test equipment	Equipment under test		
2 (Cont)			*b*. Measures spacing between fourth and fifth pulse. *c*. Adjust oscilloscope sweep and delay controls to observe one complete pulse train. Determine whether amplitudes of first and thirty-seventh pulses are within ten percent.	b. 2±0.07 μs c. Amplitudes differ. First and thirty seventh pulses are ten percent of maximum.

CHAPTER 5.2

GENERAL SUPPORT TESTING PROCEDURES USING AN/TPM-25A

5.2-l. General

a. Testing procedures are prepared for use by electronics field maintenance shops and electronics service organizations responsible for general support maintenance of electronics equipment to determine the acceptability of repaired equipment. These procedures set forth specific requirements that repaired equipment must meet before it is returned to the using organization. These procedures may also be used as a guide for testing equipment that has been repaired at direct support if the proper tools and test equipments are available. Test procedures are provided for those tests that use test equipment that can be replaced with Radar Test Set AN/TPM-25A.

b. Comply with the instructions preceding each chart before proceeding to the chart. Perform each step in sequence. Do not vary the sequence For each step, perform all the actions required in the *test equipment control settings* and *equipment under test control settings* columns; then perform each specific test procedure and verify it against its performance standard.

5.2-2. Test Equipment Required

The test equipment listed below, or approved equivalent, is required to perform the test procedures. Radar Test Set AN/TPM-25A replaces Radar Test Set AN/UPM-98 or AN/UPM-98B.

Test equipment	*Technical manual*
Oscilloscope, AN/USM-281A	TM 11-6625-1703-15
Wattmeter AN/URM-98 (including TS 779A/U and MX-2144A/U)	TM 11-6625-433-15
Multimeter ME 26B/U	TM 11-6625-200-15
Test Set, Radar AN/TPM-25A	TM 11-6625-2610-12
Generator Pulse AN/UPM-15A	TM 11-6625-368-10

5.2-3. Transmitter Frequency Test

a. Test Equipment Required

(1) Radar Test Set AN/TPM-25A.

(2) Oscilloscope AN/USM-281A.

(3) Generator, Pulse AN/UPM-15A.

b. Test Connections and Conditions. Connect the equipment as described in *c,* steps 1 and 2 below. Connect A4TP5 to ground.

c. Procedure.

step	Control settings: Test equipment	Control settings: Equipment under test	Procedure	Normal Indication
1	*AN/TPM-25A* POWER: ON MEASUREMENT FUNCTION SEL: PWR REPLIES MODULATION SEL: SIF REPLIES SUB PULSE SEL: OFF RANGE DELAY SEL:0100 PRT SEL (USEC) IMMATERIAL TRIG SEL INT DCD/EXT EXT SIG GEN FUNCTION: FIXED FREQ *AN/USM-281A* POWER ON Sweep display switch *MAIN* DELAYED TIME/DIV: OFF MAIN TIME/DIV: 1 MSEC INT AUTO/EXT/EXT ÷ 10: AUTO EXT ÷ 10/EXT/INTL: EXT MAIN - SLOPE + : + DIV DELAY: Immaterial DISPLAY: ALT A AND B VOLTS/DIV: 5 A AND B POLARITY: + UP A AND B AC/GND/DC: DC INT AU'TO/EXT/EXT ÷ 10: AUTO EXT ÷ 10/EXT/INT/ILINE: EXT MAIN – SLOPE +:+ DIV DELAY 280 DISPLAY. ALTERNATE A AND B VOLTS/DIV: 2 A AND B POLARITY: + UP A AND B AC/GND/DC: DC	MODE: 1 FUNCTION: SYSTEM ISLS: OFF PUSH TO TEST: lock 28 VDC-115 VAC OFF: 115 VAC MODE: 1 FUNCTION: SYSTEM CODE: ANY POWER: 115 VAC PRESS TO TEST LOCK	*a.* Connect system timing setup as shown in figure 5.2-1. *b.* On AN/USM-281A, observe positive going prf pulse from A5TP5 on A INPUT, and the delayed prf pulse from the AN/UPM-15A on B INPUT. c. Adjust AN/UPM-15A PULSE DELAY to position the delayed prf pulse approximately .5 ma before the trailing edge of the prf pulse. *d.* Continue adjustment of PULSE DELAY as required until the transponder test set ACCEPT lamp is on solidly.	*a.* None. *b.* None. *c.* None. *d.* ACCEPT LAMP IS ON.
2	*AN/TPM-25A* POWER: ON MEASUREMENT FUNCTION SEL: FREQ		*a.* Turn off transponder test set and connect equipment as shown in figure 5.2-2, transmitter frequency test setup.	*a.* None.

Step	Control settings		Procedure	Normal Indication
	Test equipment	Equipment under test		
2 (Cont.)	SIG GEN FUNCTION: SWP ±5 MHz AN/USM-281A POWER: ON Sweep Display Switch DELAYED DELAYED TIME/DIV: 5 µsec MAIN TIME/DIV: 1 MSEC		*b*. Turn on transponder test set and allow two minutes warmup. *c*. On AN/USM-281A, adjust DIV DELAY to position the center (1030 MHz) marker on the center vertical graticule. *d*. On AN/TPM-25A, adjust MEASUREMENT FREQ MEAS control for maximum amplitude of either of the pulses displayed on the scope. *e*. Determine the frequency at which the pulse reaches its maximum amplitude by comparison of its position with respect to 1090, 1090 ±1, and the 1090 ±5 MHz markers.	*b*. None. c. None. *d. None.* *e*. 1030 MHz ±206 kHz.

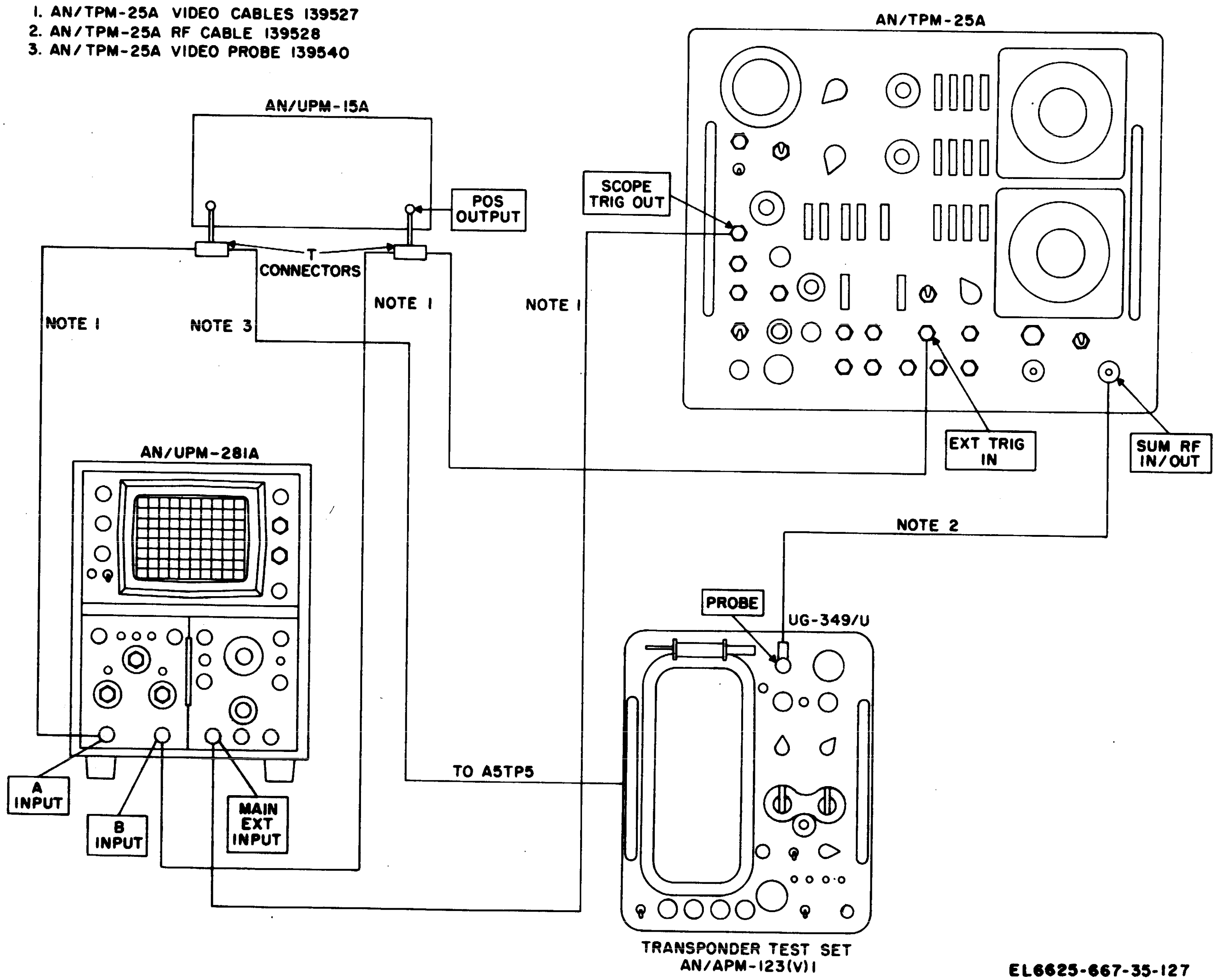


Figure 5.2-1. System timing setup using AN/TPM-25A.

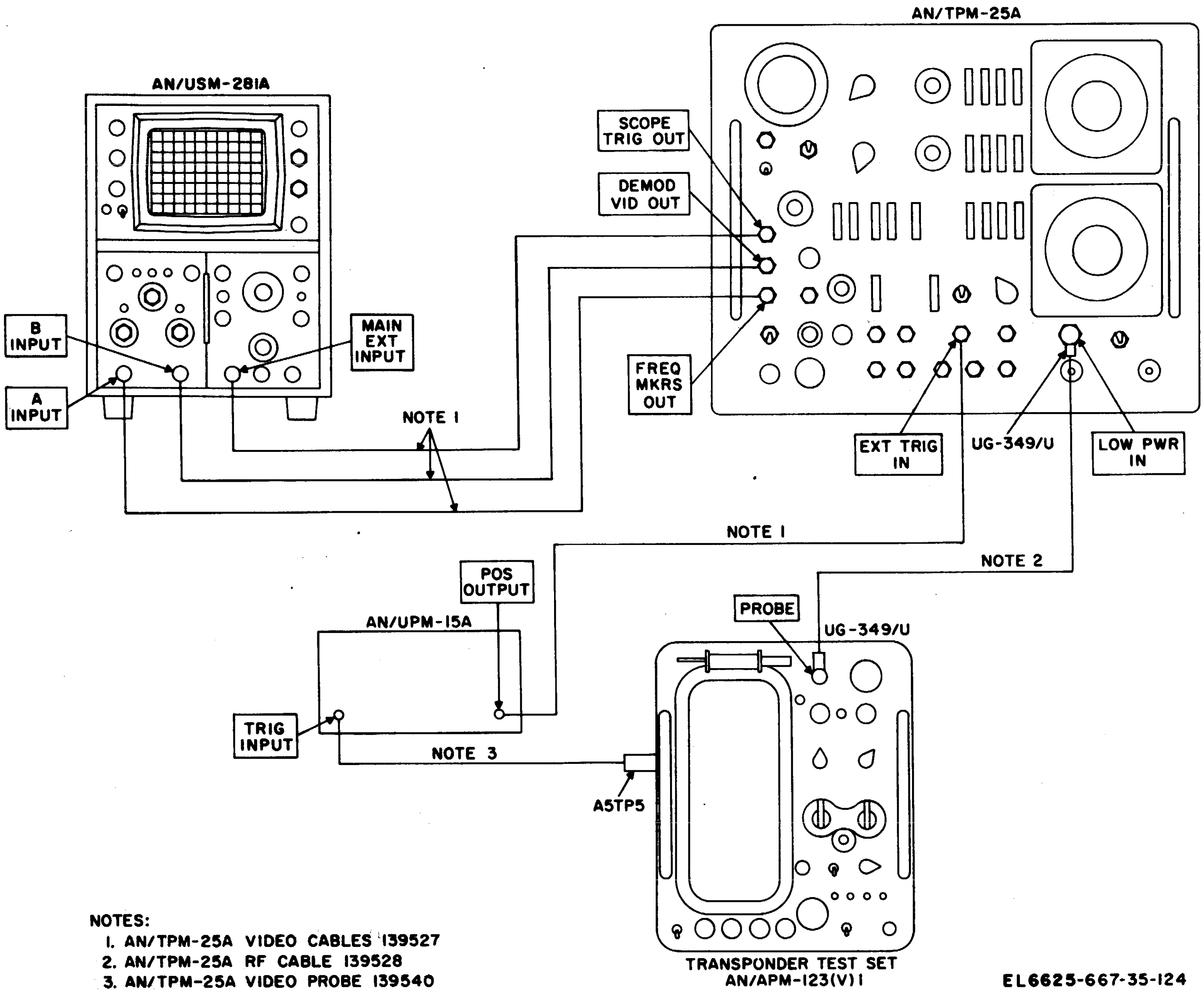


Figure 5.2-2. Tmnsmitter frequency test setup using AN/TPM-25A.

5.2-4. Transmitter Power Test

a. Test Equipment Required

b. Test Connections and Conditions.

(1) Connect the equipment as indicated in c below.

(2) Connect test point A4TP5 to ground (module A4 at the rear of test set.

c. Procedure.

Step	Control settings: Test equipment	Control settings: Equipment under test	Test procedure	Performance standard
1	N/A	MODE: 1. Code Any. FUNCTION: SYSTEM POWER ON. ISLS: OFF	None	None.
2	*TS 779A/U* BOLO BIAS CURRENT OFF. BOLO RES:200. BOLO TEMP COEF: NEG. RANGE: –0 DBM.	Controls remain as in step 1.	**CAUTION** The test equipment settings must be performed before the MX-2144A/U, is connected to avoid equipment damage. a Connect the MX-2144A/U to the TS 779A/U. *b.* Adjust the TS 779A/U as follows: (1) Set the BOLO BIAS CURRENT switch to 10-16 MA. (2) Set the LINE POWER switch to ON, and permit a 15-minute warmup. (3) Adjust the ZER0 SET COARSE AND FINE controls to zero meter. c. Connect the equipment as shown in figure 5-2. Make sure that test point A4TP5 is grounded. d. Connect the MX-2144A/U to the test set PROBE jack. Observe the power indication. e. Disconnect the ground from test point A4TP5, and connect test point A4TP4 to ground. Disconnect the MX-2144A/U.	 *a.* None. *b.* None. *c.* None. *d.* -6±1 dbm. *e.* None.

Step	Control settings: Test equipment	Control settings: Equipment under test	Test Procedure	Performance Standard
2 (Cont)			*f.* Set the RANGE switch to – 10 DBM and readjust zero set coarse and fine controls to zero meter. Reconnect the MX-2144A/U to the AN/APM-123 PROBE connector. Observe the power meter reading. g. Remove the jumper from A4TP4 to ground.	*f.* Meter deflects slightly to right (approximately – 21 dbm).

5.2-5. Transmitter Output Pulse Test

a. Test Equipment Required.

(1) Oscilloscope, AN/USM-28A.

(2) Radar Test Set, AN/TPM-25A.

(3) Generator, Pulse AN/UPM-15A.

b. Test connections and conditions. Perform the system timing setup as described in the chart in paragraph *5.2-4 c* step (l). Then connect the equipment as shown in figure 5.2-3, transmitter pulse characteristics test setup.

c. *Procedure*

Step	Control settings: Test equipment	Control settings: Equipment under test	Test Procedure	Performance Standard
1	*AN/TPM-25A* *POWER ON* MEASUREMENT FUNCTION SEL PWR REPLIES MODULATION SEL SIF REPLIES SUB PULSE SEL: OFF PRT SEL (µSEC) 4000 TRIG SEL INT DCD/EXT INT SIG GEN FUNCTION: FIXED FREQ	FUNCTION: SYSTEM ISLS: ON. POWER: ON. PRESS TO TEST: LOCK MODE: 1.	*a.* Turn on the oscilloscope and test set. Permit a few minutes warmup. *b.* Adjust the oscilloscope MAIN TRIGGER LEVEL, INTENSITY, and FOCUS for a clear view of the pulses and the. 1 µs markers displayed on oscilloscope. (1) Measure pulse widths at 50% points.	*a.* None. *b.* (See(1) through (3) below. (1) Pulse widths 0.8 ±0.1 µs.

Step	Control settings: Test equipment	Control settings: Equipment under test	Procedure	Normal Indication
	AN/USM-2181A POWER ON Sweep display switch DELAYED DELAYED TIME/DIV: 1 µ SEC MAIN TIME/DIV: .1 MSEC INT AUTO/EXT/EXT÷l0: AUTO EXT÷l0/EXT/INT/LINE: EXT MAIN +SLOPE +:+ DIV DELAY: 02 DISPLAY: A A and B VOLT/DIV: 5 A and B POLARITY: + UP A and B AC/GND/DC: DC		(2) Measure delay between P1 and P2 at 50% points.	(2) Delay between P1 and P2 shall be 2 ±0.2 µs.
			(3) Measure spacing between P1 and P9 at 50% points.	(3) Mode spacing 3 ±0.2 µs.
			c. Set the test MODE switch at each of the positions, in (1) through (4) below and repeat the procedure in *b* above to measure delays between P1 and P3.	*c.* See(1) through (4) below.
			(1) 2	(1) Mode 2 spacing 5 ±0.2
			(2) 3/A	(2); Mode 31A spacing: 8±0.2 µs.
			(3) C	Mode C spacing 21 ±0.2 µs.
			(4) TEST	(4) Mode TEST spacing 6.5 ±0.2 µs.

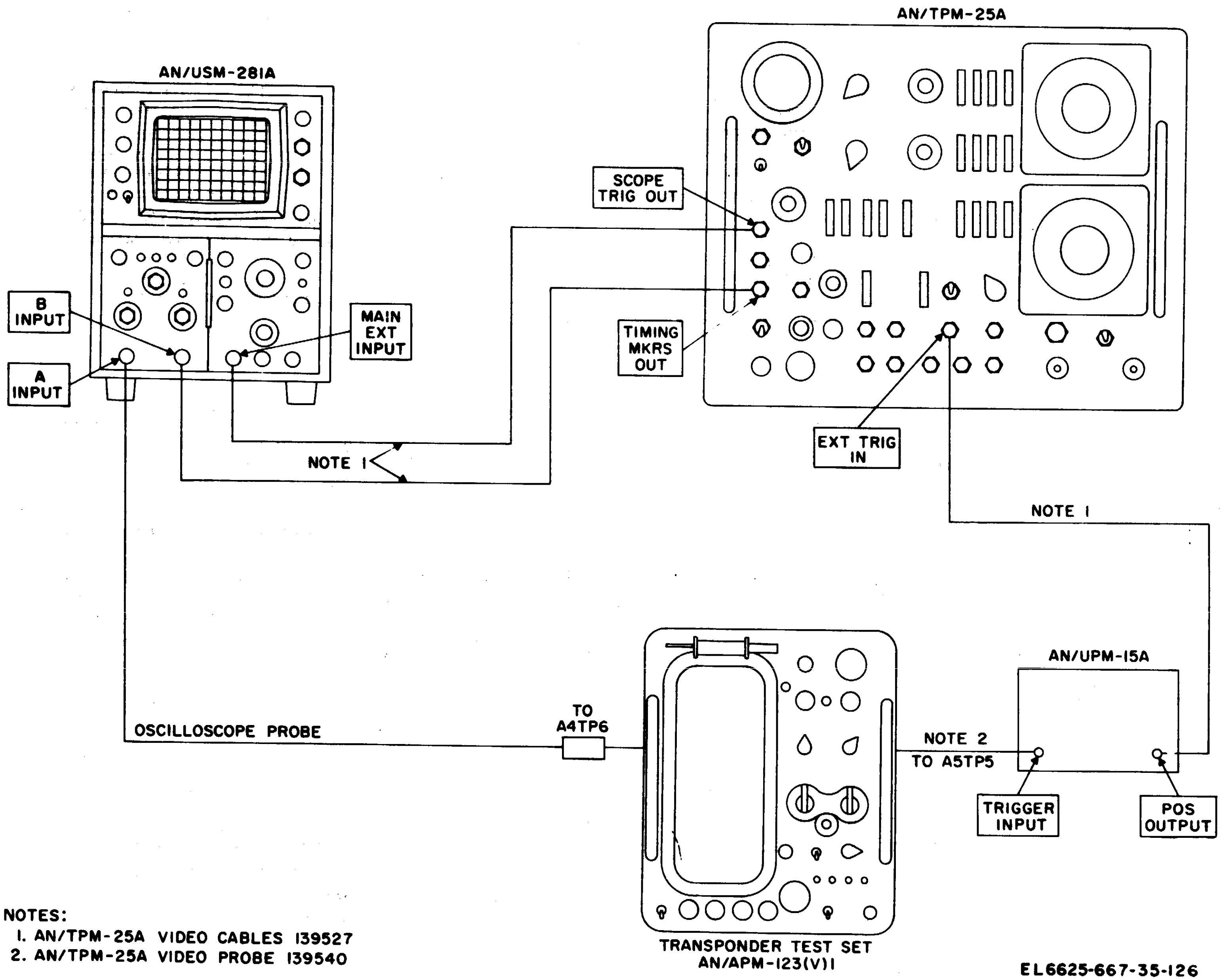


Figure 5.2-3. Transmitter pulse characteristics test setup using AN/TPM-25A.

5.2-6. Receiver Frequency, Sensitivity, and Bandwidth Test

a. Test Equipment Required

(1) Test Set, Radar AN/TPM-25A.

(2) oscilloscope, AN/USM-281A.

(3) Generator, Pulse AN/UPM-15A.

b. Test connections and conditions. Perform the system timing setup as described in the chart in paragraph 5.2-4c step (l). Then connect the equipment as shown in figure 5.2-4 receiver frequency and bandwidth test setup.

c. *Procedure.*

Step	Test equipment	Equipment under test	Test procedure	Performance standard
1	*AN/TPM-25A* REPLIES panel: MODULATION SEL: SIF PULSE WIDTH: 0.45 SIF REPLY CODE: 0000 SUB PULSE SEL OFF RANGE DELAY SEL: (μSEC) 0100 GATING PASS: 00 M4 JAMMING: 0 PRT SEL (μSEC) Immaterial SIG GEN FUNCTION: SWP ±5 MHZ SUM ATTEN: -3 DB *AN/USM-281A* Sweep display switch DELAYED DELAYED TIME/DIV: 20 μs MAIN TIME/DIV: .5 MS INT AUTO/EXT/EXT÷10 AUTO EXT÷10/EXT/lNT/LINE: EXT MAIN - SLOPE +:+ DIV DELAY 0.9 DISPLAY: ALT A VOLTS/DIV: 1 B VOLT/DIV: 5 A and B, AC/G RND/DC: DC	MODE: 1 CODE (A,B,C,D) 0000 FUNCTION: SYSTEM POWER: ON PRESS-TO-TEST: LOCK	*a.* Use AN/USM-281A DIV DELAY dial to position the center (1090 MHz) frequency marker on the center vertical graticule of the oscilloscope. Note that the ±1 MHz markers appear on vertical lines two divisions from the center. Each division on the oscilloscope .5 MHz. *b.* While observing the frequency markers on B input and the reply video on A input, adjust AN/TPM-25A MEASUREMENT FREQ MEAS dial to position the reply video near the center (1090 MHZ) frequency marker. *c.* Observe the oscilloscope as in *b* above, and adjust AN/TPM-25A MEASUREMENT FREQ MEAS dial counterclockwiee until test REJECT lamp lights and then clockwise until ACCEPT lamp lights. Note position of the outside reply pulse with respect to the 1090 MHz frequency marker. The frequency is 0.5 MHz less than 1090 for each oscilloscope division. Note this frequency as F1.	*a.* None. *b.* Test set ACCEPT lamp is lit. *c.* None.

Step	Control settings		Test procedure	Performance standard
	Test equipment	Equipment under test		
1 [Cont)			*d.* Using the procedures in c above, adjust AN/TPM-25A MEASUREMENT FREQ MEAS clockwise and then counerclockwise to determine the upper frequency. Note this frequency as F2.	*d.* None.
			e. Determine the receiver bandwidth and center frequency as follows	e. None.
			(1) Subtract frequency F1 *(c* above from frequency F2 *(d* above .	(1) Bandwidth: 6.5 ± 1 MHz.
			(2) Add frequencies F1 and F2 and divide the result by 2.	(2) Center frequency: 1090 **±0.5** MHz
			f. Set AN/TPM-25A SIG GEN FUNCTION switch to FIXED FREQ.	*f.* None.
			g. On the AN/TPM-25A, adjust SUM ATTEN dial counterclockwise until the test set REJECT lamp lights, and then clockwise until ACCEPT lamp just lights. Note SUM ATTEN dial reading, then add at-. tenuation of cable connected to PROBE input of the test set.	g. Sensitivity –0 ± 1 dB.

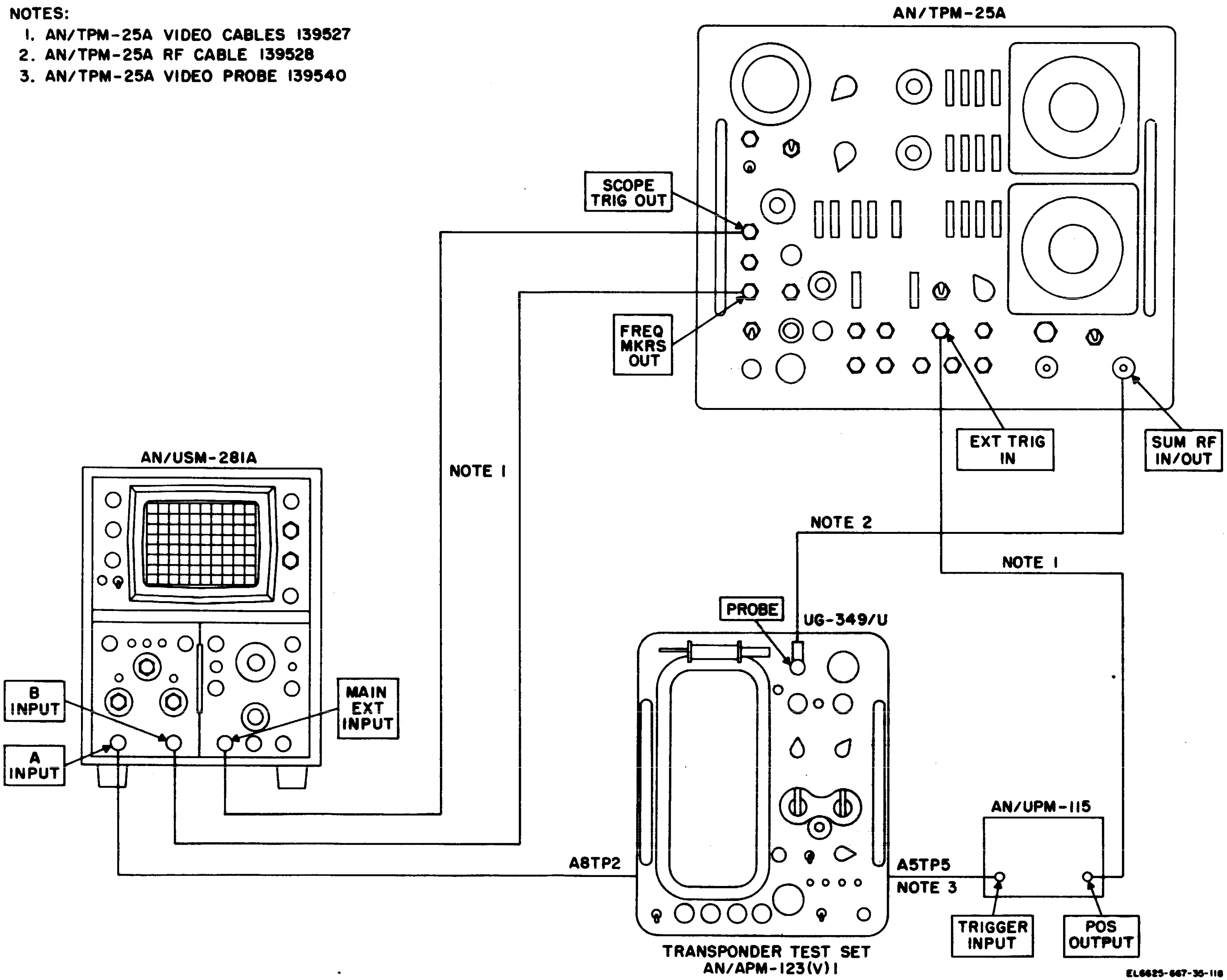


Figure 5.2-4. Receiver frequency and bandwidth test setup using AN/TPM-25A.

5.2-7. Video Enable Delay and Period Test

a. Test equipment required

(1) Generator, Pulse AN/UPM-15A

(2) Oscilloscope, AN/USM-281A.

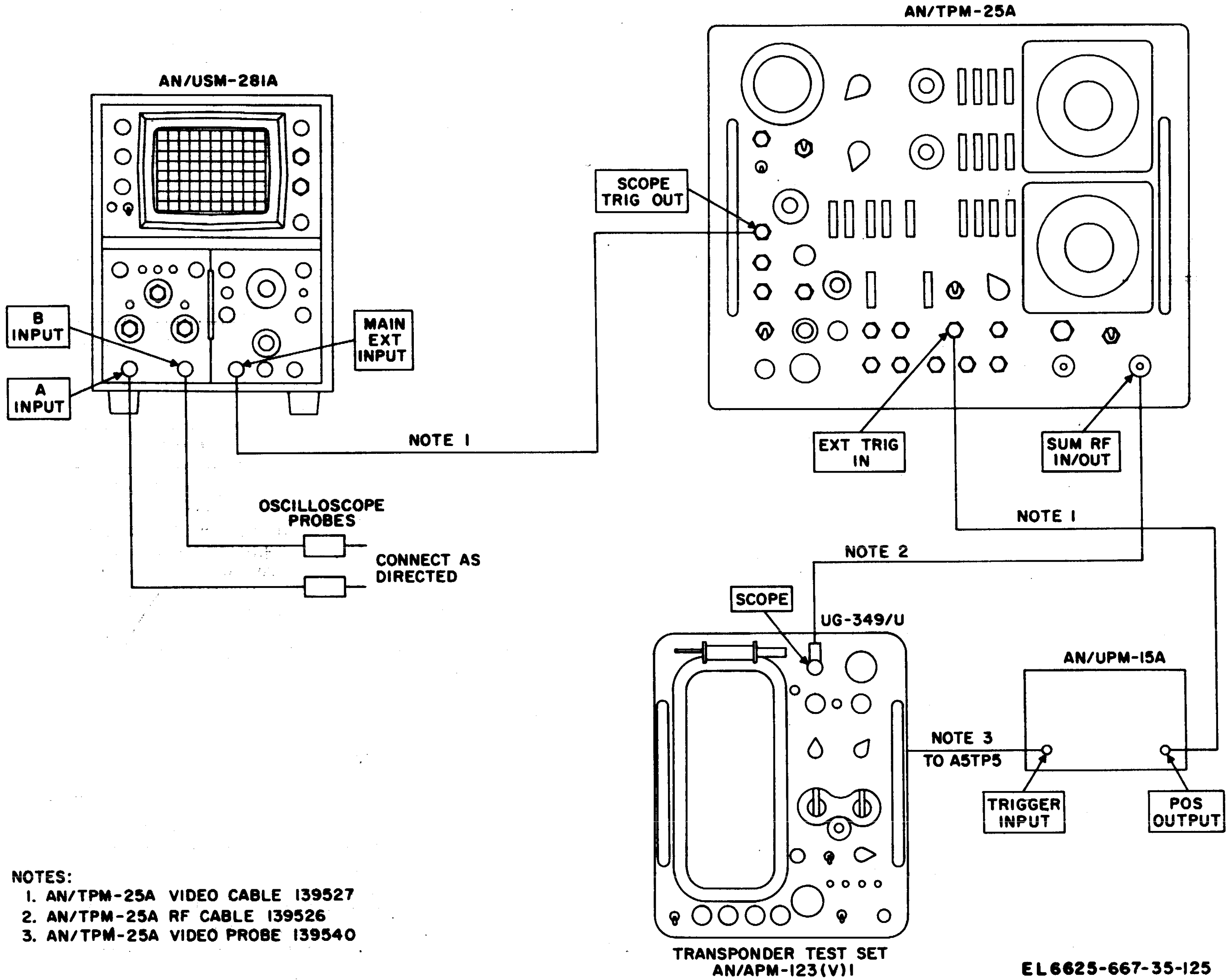
(3) Test Set, Radar AN/TPM-25A.

b. Test Connections and Conditions. Performs the system timing setup as described in the chart in paragraph 5.2-4 c step (1). Then connect the equipment as shown in figure 5.2-5, video enable delay and period test.

c. *Procedure*

Step	Control settings		Test procedure	Performance standard
	Test equipment	Equipment under test		
1	*AN/TPM-25A* REPLIES panel: MODULATION SEL: SIF PULSE WIDTH: 0.45 SIF REPLY CODE: 0000 SUB PULSE SEL: OFF RANGE DELAY SEL (µ SEC): 0001 GATING PASS: 00 GATING INHIBIT: 00 M4 JAMMING: 0 TRIG SEL INT/DCD/EXT EXT SIG GEN FUNCTION: FIXED FREQ SUM ATTEN: 0 DB POWER: ON *AN/USM-281A* POWER. ON Sweep display switch MAIN MAIN TIME/DIV: 2 µSEC INT/AUTO/EXT/EXT÷10 EXT MAIN – SLOPE + : + DIV DELAY: 852 DISPLAY: A A and B VOLTS/DIV: 5 A and B POLARITY: + UP A and B AC/GND/DC: DC	MODE: 2 CODE (A, B, C, D): 0000 FUNCTION: SYSTEM POWER: ON PRESS-TO-TEST LOCK	*a.* Connect oscilloscope A INPUT to A10TP5. *b.* Observe video enable delay pulse on A INPUT. Measure pulse width.	*a* None. *b.* The video enable delay 1.8 ±0.05 µ s.
2	*AN/USM-281A* DISPLAY: ALT		*a* Connect oscilloscope B INPUT to A9TP4.	a None.

Step	Control settings: Test equipment	Control settings: Equipment under test	Test procedure	Performance standard
2 (Cont)			*b.* Note that start of video enable period pulse on B INPUT is coincident with the trailing edge of the video enable delay pulse on A INPUT. c. Set oscilloscope MAIN TIME/DIV to 10 µSEC. Observe the complete video enable period pulse. *d.* Disconnect A INPUT from A10TP6 and connect to AN/TPM-25A REPLY VID OUT. *e.* Observe position of trailing edge of last reply pulse on A INPUT with respect to trailing edge of video enable period pulse on B INPUT. *f.* Set test set FUNCTION switch IP and MODE switch to 1. g. Set AN/TPM-25A REPLIES FUNCTION SEL switch to I/P Ml. Repeat procedure in e above. *h.* Set test set MODE switch to 2. *i.* Set AN/TPM-25A REPLIES MODULATION SEL switch to I/P M2/3. Repeat procedures in *e* above. *j.* Set test set FUNCTION switch to EMER. *k.* Set AN/TPM-25A REPLIES MODULATION SEL switch to EMERG. *l.* Set oscilloscope MAIN TIME/DIV to 10 µSEC and repeat procedure in e. above.	*b.* None. *c.* None. *d.None*. *e.* The video enable period will conclude within 6 µs after the trail-edge of the last reply pulse. *f.* None. *g.* Same as e above. *h.* None. *i.* Same as e above. *j.* None. *k.* None. *l.* Same as e above.



NOTES:
1. AN/TPM-25A VIDEO CABLE 139527
2. AN/TPM-25A RF CABLE 139526
3. AN/TPM-25A VIDEO PROBE 139540

Figure 5.2-5. Video enable delay and period test setup using AN/TPM-25a.

5.2-8 Decoder Tests

a. Test Equipment Required

(1) Test Set, Radar AN/TPM-25A.

(2) Oscilloscope, AN/USM-281A.

(3) Generator, Pulse AN/UPM-15A.

b. Test Connections and Conditions. Perform the system timing setup as described in the chart in paragraph 5. 2-4c step (1) Then connect the equipment as shown in figure 5.2-3, transmitter pulse characteristics test setup.

c. *Procedure.*

Step	Control settings		Test procedure	Performance standard
	Test equipment	Equipment under test		
1	*AN/TPM-25A* REPLIES panel: MODULATION SEL: SIF REPLY WIDTH:0.45 SIF REPLY CODE: 0000 SUB PULSE SEL: OFF RANGE DELAY SEL 0100 GATING PASS 00 GATING INHIBIT 00 SIF CHAL VID SIF MODE SEL OFF TRIG SEL INT DCD/ EXT: EXT SIG GEN FUNCTION: FIXED FREQ SUM ATTEN: 0 DB All other switch settings immaterial.	FUNCTION: SYSTEM POWER: ON CODE: 0000 PRESS-TO-TEST: LOCK MODE: 1	*a.* Turn on the oscilloscope and teat set. Permit a few minutes warmup. *b.* Press the test set PRESS–TO-TEST switch, and turn to LOCK.	*a.* None. *b.* None.
2	N/A N/A	N/A	*a.* Adjust both the test set and AN/TPM-25A REPLIES SIF REPLY CODE controls to each code as follows, and note the test set readout. CODE A B c D 1 1 1 1 2 2 2 2 3 3 3 3 4 4 4 4 5 5 5 5	*a.* The test set must indicate ACCEPT.

Step	Control settings		Procedure	Normal Indication
	Test equipment	Equipment under test		
2 (Cont.)			6 6 6 6 7 7 7 7 *b.* Repeat the procedure in *a* above with the test set MODE switch set at 2, 3/A, and TEST respectively. This is to determine whether operation is normal in these modes. c. Set the AN/TPM-25A REPLIES MODULATION SEL switch to IP M213 *d.* Set the test set FUNCTION switch to I P, and the MODE switch to 2. This action checks the I P test function for modes 2, 3/A, and TEST. *e.* Set the AN/TPM-25A REPLIES SIF REPLY CODE switches to 7700, and the FUNCTION switch to EMER G. *f.* Set the test set CODE switches to 7700, and the FUNCTION switch to EMER,	*b.* The test set indicates ACCEPT. *c.* None *d.* The test set must indicate ACCEPT. *e.* None. *f.* The test set must indicate ACCEPT.
3	AN/TPM-25A REPLIES SUB PULSE SEL: BRKT 2		*a.* Adjust the AN/TPM-25A SUB PULSE POS to + or- .15 *b.* Repeat procedure in *a* above, except adjust the SUB PULSE SEL control to + or – .35.	*a.* The test set must indicate ACCEPT *b.* The test set must indicate REJECT.
4	*AN/TPM-25A* REPLIES REPLY CODE 7777 REPLIES SUB PULSE SEL: c l	CODE 7777	*a.* Adjust the AN/TPM-25A SUB PULSE SEL control to 0.15. *b.* Adjust the AN/TPM-25A SUB PULSE control to 0.35.	*a.* The test set must indicate ACCEPT. *b.* The test set must indicate REJECT.

5.2-9 Reply Evaluation Percentage Tests

a. Test Equipment Required

(1) Test Set, Radar AN/TPM-25A.

(2) Multimeter ME-26B/U.

b. Test Connections and Conditions. Perform the system timing setup as described in the chart in paragraph 5.2-4c step (1). Connect the equipment as shown in figure 5.2-6, reply evaluation percentage tests.

c. Procedure

Step	Control settings: Test equipment	Control settings: Equipment under test	*Procedure*	Normal Indication
1	*AN/TPM-25A* REPLIES panel MODULATION SEL: SIF REPLY WIDTH: 0.45 SIF REPLY CODE: 7777 SUB PULSE SEL: Cl SUB PULSE POS Select 0 GATING PASS: 00 GATING INHIBIT:00 M4 JAMMING: 0 PRT SEL (USEC): 0001 SIF CHAL VID SIF CODE SEL: OFF TRIG SEL INT DCD/EXTY: INT SIG GEN FUNCTION: FIXED FREQ ME 26B/U RANGE: 30V SELECTOR (+)	FUNCTION: SYSTEM POWER: ON CODE: 7777 PRESS-TO-TEST LOCK MODE: 2	*a.* Turn on the AN/TPM-25A and allow a few mrnutes warmup. *b.* Turn on the test set and allow a few minutes warmup. *c.* Set AN/TPM-25A SUB PULSE POS SELECT to VARY. *d.* Adjust the SUB PULSE POS VARY control until the test set barely indicates REJECT. Adjust the ME 26B/U ZERO SET to zero meter. *e.* Adjust the SUB PULSE POS VARY control until the test set indicates ACCEPT. Note ME 26B/U indication. *f.* Adjust the SUB PULSE POS VARY control in either direction, until the test set barely indicates REJECT. Note the ME-26 B/U indication. The voltage should be 80% of that noted in *c* above.	*a.* None. *b.* None. *c.* None. *d.* None. *e.* None. *f.* The test set will provide an ACCEPT indication when 80% or more replies are correct.

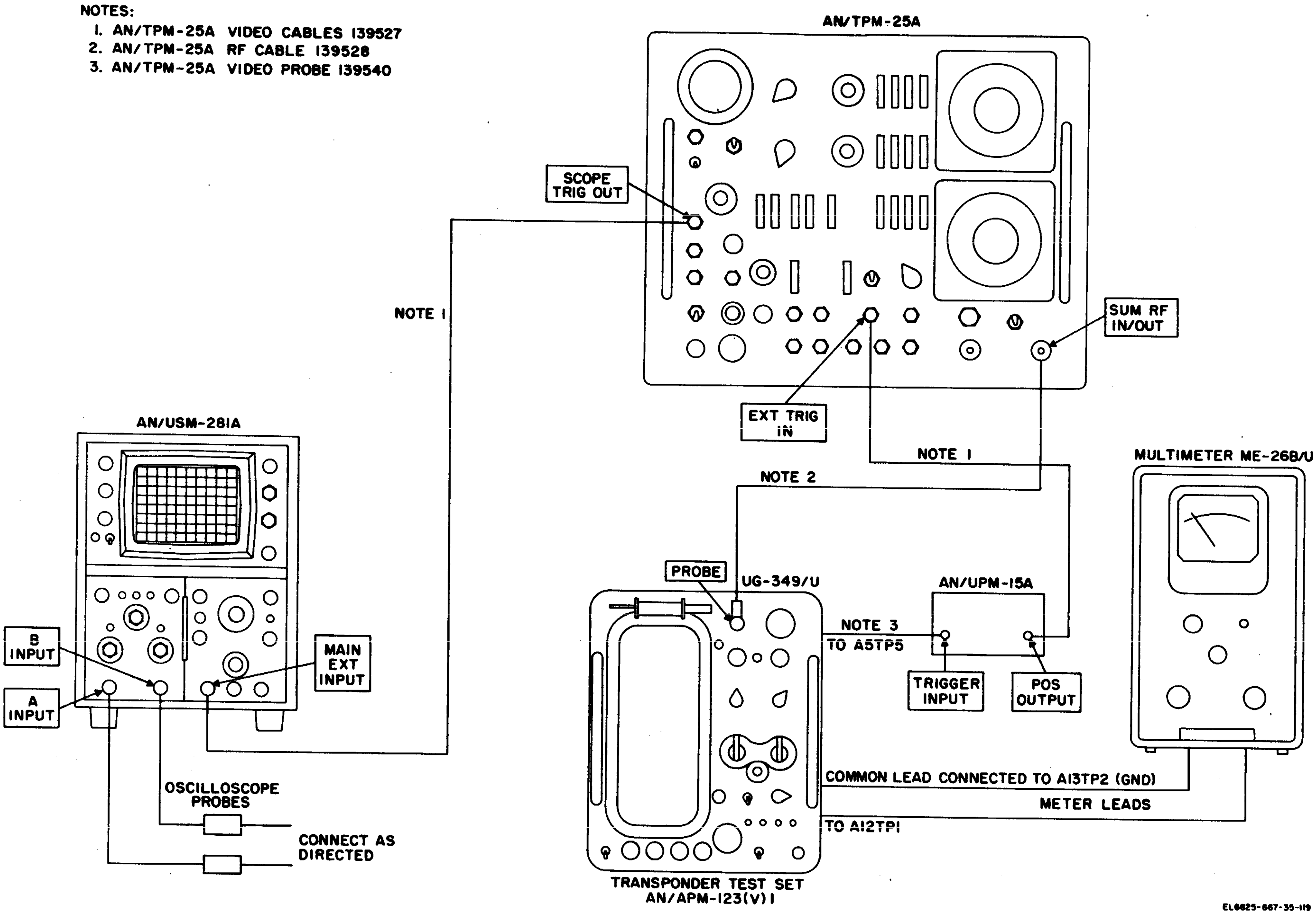


Figure 5.2-6. Reply evaluation percentage tests.

CHAPTER 6

DEPOT MAINTENANCE

6-1. Depot Rebuild Operations

Complete rebuild of Test Set, Transponder AN/APM-123V( ) and/or its individual components may be accomplished by depot maintenance facilities when authorized. Rebuild action will include all repairs, rebuild, and replacement operations necessary to make the equipment suitable for return to DA supply system storks for reissue to using organizations as equipment equivalent to new material. Detailed procedures for accomplishing the repairs and adjustments established in the preceding portions of this manual and such additional repair and rebuild operations as deemed necessary will be established by the facility performing the work. Paragraphs 7-1 through 7-13 establish the requirements that *must be met* by rebuilt *or repaired* equipment before it is returned to DA supply system stocks.

6-2. General Parts Replacement Techniques

a. Read the instructions in paragraph 4-1. These instructions contain important information pertaining to parts replacement.

b. If any control setting is disturbed during rebuild operations, except those indicated in *c* below, refer to paragraph 4-2 for adjustment instruction

c. The pulse spacing output of delay line A6DL1 is critical for equipment calibration Replacement of parts in circuits associated with this output may require recalibrating the circuit. If the settings of controls A5R1 through A5R5 or A7R1 through A7R14 are disturbed, recalibration will be necessary. Calibration instructions are provided during the applicable tests (paras 7-5 through 7-13) if such action is required.

d. Instructions are provided in paragraph 6-3 for the repair and rebuild of cavity A16A1Z1. After repair, the complete transmitter should be adjusted (para 4-4).

Caution: **Exercise extreme care when handling the internal cavity parts. Damage to these parts or internal cavity structure will require replacement of the complete unit.**

6-3. Repair of Cavity A16A1Z1 (fig. 6-1)

a. General. **Normally, cavity A16A1Z1 should not be completely disassembled for repair. Three capacitors (9, 10, and 12) and an RF choke (11) are the only electrical parts. Access to these parts requires unfastening three screws (1) (two each) and (4) to permit removal of the RF shield (8). If it is necessary to completely disassemble the cavity, proceed with *b* below. Reassembly procedures are outlined in *c* below.**

b. Disassembly Procedures.

Note. In the following procedure, it is assumed that the RF shield (8) was removed (*a* above).

(1) Remove the five screws (23) and the sixth screw (19), securing the tuning core holding assembly (33) to the cavity housing (32). Remove the tuning core holding assembly.

(2) Remove the screw (26) and nut (27) that secure the tuning sleeve (31), angle bracket (16). and terminal lug (28) to the cavity housing (32). This action also releases capacitor insulator disks (29 and 30).

c. Reassemby Procedure.

(1) Replace the screw (26) in the tuning sleeve (31). Set the capacitor insulator disk (30)

in place on top of the tuning sleeve (31). Insert these items into the cavity housing (32), until the screw (26) protrudes through the hole.

(2) Replace, in sequence, the capacitor insulator disk [29), angle bracket (16), and terminal lug (28). Fasten the screw (26) with the nut (27) in place.

(3) Replace the tuning core holding assembly (33), and secure it with the five screws (23) and ten washers (24 and 25). Replace the screw (19) and washers (20 and 21) that secure the loop clamp (22) (holding the RF cable).

(4) Check to see that the inside of RF shield (8) has been coated with Dow Coming RTV 3140,3144, or 3145 for insulation. Replace the RF Shield (8) using the two screws (1) and four washers (2 and 3), and secure the terminal lug (7), using the screw (4) and two washers (5 and 6).

1 Screw, machine pan hd No. 2,3/ 16-inch
2 Lockwasher, flat No. 2
3 Washer, flat No. 2
4 Screw. machine pan hd No. 2, *3/* 16-inch
5 Lockwasher, flat No. *2*
6 Washer, flat No. 2
7 Terminal lug No. 2, 7/8-inch.
8 Shield, RF
9 Capacitor, fixed (A16AlC1)
10 Capacitor, variable (A16AJC2)
11 Choke, RF (A16A1L1)
12 Capacitor, fixed (A16A1C3)
13 Nut, plain (p/o item 10)
14 Washer, flat No. 10
15 Spacer, insulator, top
16 Bracket, l ngle
17 Spacer, insulator bottom
18 Terminal lug No. 4, 7/8-inch
19 Screw, machine pan hd No. 2, 7/8.inch
20 Lockwasher. split No. 2
21 Washer, flat No. 2
22 Clamp, loop
23 Screw, machine pan hd No. 2, 3/4-inch
24 Lockwasher, split No. 2
25 Washer, flat
26 Screw, Phillips hd No. 6, 3/8-inch
27 Nut, self-locking No. *4*
28 Terminal lug No. 6
29 Disk, insulator. capacitor
30 Disk, insulator, capacitor
31 Sleeve, tuning
32 Housing, cavity
33 Tuning core holding assembly

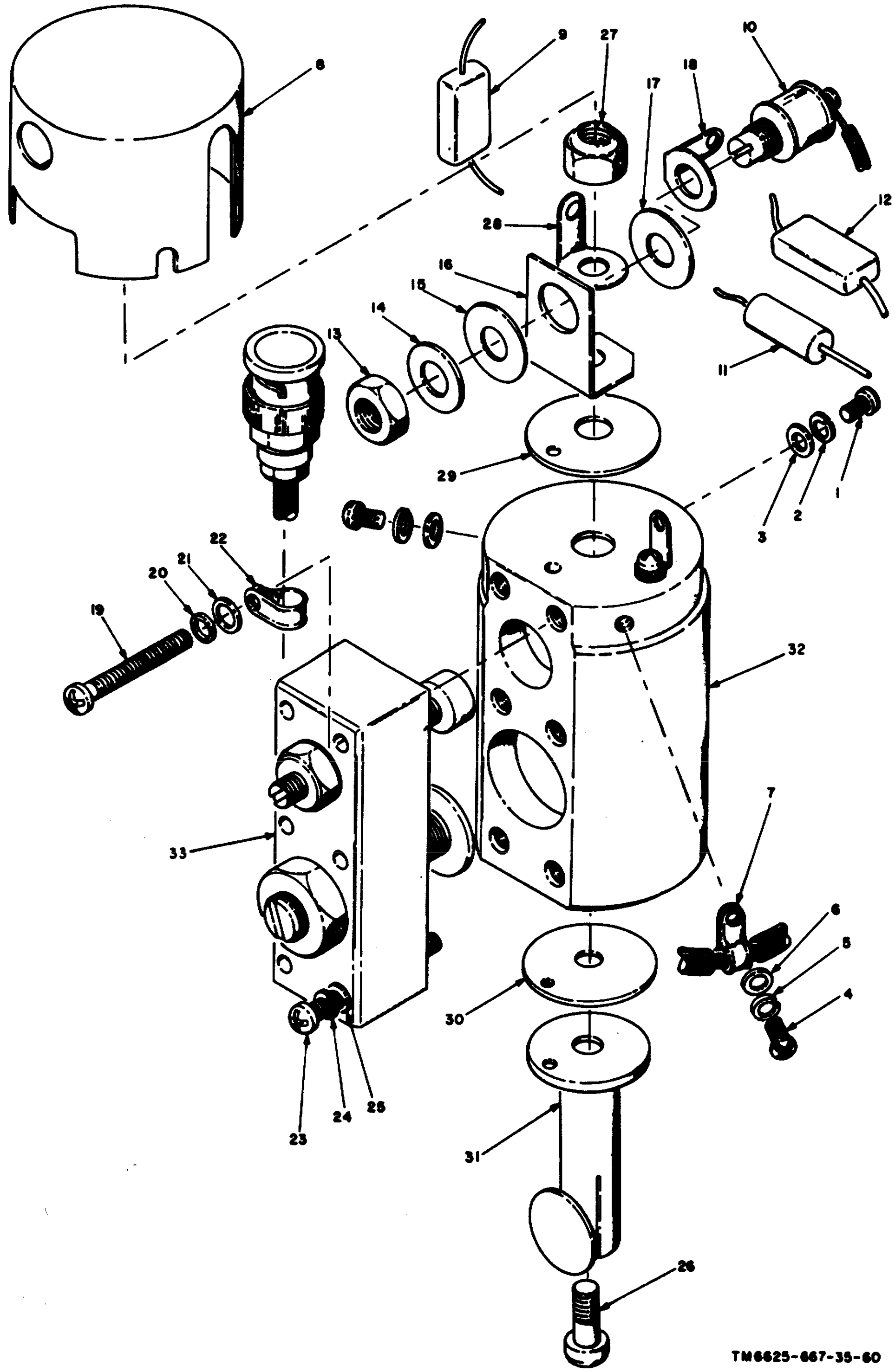


Figure 6-1. Cavity A16A1Z1, exploded view..

CHAPTER 7

DEPOT OVERHAUL STANDARDS

NOTE

See Chapter 7.1 For procedures Using AN/TPM-25A.

7-1. Applicability of Depot Overhaul Standards

The tests outlined in this chapter are designed to measure the performance capability of a repaired equipment. Equipment that is to be returned to stock should meet the standards given in these tests.

7-2. Applicable References

a. Repair Standards. Applicable procedures of the depots performing these tests and the general standards for repaired electronic equipment given in TB SIG 355-1, TB SIG 355-2, and TB SIG 355-3 form a part of the requirements for testing this equipment.

b. Technical Publications. The technical publications applicable to the equipments to be tested are indicated below:

Equipment and subject	*Publication*
Operator's and Organizational and Maintenance Manual Teat Set, Transponder AN/APM-123(V)1, AN/APM-123(V)2, and AN/APM-123(V)3 (NSN 6625-00-948-0071).	TM 11-6625-667-12
General Support and Depot Maintenance Manual: Teat Set, Transponder AN/APM-123(V)l, AN/APM-123(V)2, and AN/APM-123(V)3 (NSN 6625-00-948-0071).	TM 11-6625-667-45

c. Modification Work Orderss. Perform all modifitation work orders applicable to this equipment before making the tests specified. DA Pam 310-4 lists all available MWO's.

7-3. General Requirements

The majority of the depot overhaul standards tests shall be performed using the test setups shown in figures 7-1 and 7-1.1. Make initial connections arid adjustments described in paragraphs 7-3.1 or 7-3.2 and modify these as required for the individual tests. Two test procedures are provided for those tests that use test equipment that is replaced by Radar Test Set AN/UPM-137A. Paragraph 7-3.1 and figure 7-1 describe the initial setup and adjustments for the tests without the AN/UPM-98A and paragraph 7-3.2 and figure 7-1.1 describe the initial setup and adjustment for the tests using the AN/UPM-137A. For all of the test procedures, refer to figure 3-6 for test point location and figure 3-7 for adjustment control location.

7-3.1. Initial Test Procedures Using AN/UPM-98A or AN/UPM-98B

a. Use the equipment in (1) through (6) below to make the connections shown in figure 7-1. Connect the AN/URM-64 to the CM-77/USM.

(1) Oscilloscope AN/USM-281A.
(2) Frequency Meter AN/USM-207.
(3) Comparator, Frequency CM-77A/USM.
(4) Modulator MD-796.
(5) Generator, Signal AN/URM-64A.
(6) Test Set, Radar AN/UPM-98.

NOTE

Either the AN/UPM-98A or the AN/UPM-98B may be used for all procedures.

b. Turn on the AN/URM-64, AN/USM-207, and CM-77A/USM. Allow l-hour warm-up period

c. Set the AN/USM-207 controls as indicated below:

DIRECT/HETERODYNE switch: HETERODYNE
VOLTAGE switch: 10V
FREQ TUNING-MC: 200
POWER: TRACK
FUNCTION: FREQ.
SENSITIVITY: PLUG IN

d. Set the AN/URM-64A FUNCTION control to CW, ATTENUATOR control to -9 dBm, and SIGNAL FREQUENCY control to 1,090 mc.

e. Turn on all test equipment that was not turned on previously.

f. Tune the CM-77A/USM FREQUENCY MEGACYCLES dial for zero beat indication. Observe the indication on the AN/USM-207. Add 200 to the number and multiply the result by five. The result should be 1,090 ± 1 MHz. If it is not, adjust the AN/URM-64 until it is.

g. Connect the output of the MD-796 as shown in figure 7-1.

h. Set the AN/USM-281 controls as follows

POWER: ON
Sweep Display Switch: Delayed
Delayed TIME/DIV; 5 µsec
Man TIME/DIV; 10µsec
Sweep MODE AUTO
MAIN SLOPE: –
DELAYED SLOPE: -
DIV DELAY: .02
Main Trigger Source Switch: EXT.
DISPLAY: A
A VOLT/DIV: 5
A POLARITY: + UP
A Input Coupling Switch: AC

i. Connect the rest of the equipment as shown in figure 7-1.

j. Press and lock and test set PRESS TO TEST switch; set the MODE switch to 1, CODE switch to 7777 and FUNCTION switch to SYSTEM.

k. Set the controls of the AN/UPM-98 SIF CODER unit as follows:

CODE: 7777
FUNCTION: N
SUB PULSE SELECT: Cl
SUB PULSE POSITON: O
LEVEL: HI
PULSE WIDTH: 0.45

/. Connect oscilloscope CHANNEL A to A8TP2 and observe the detected video. Adjust the AN/UPM-98 AMPLITUDE control for a convenient amplitude of pulse.

m. Connect the oscilloscope CHANNEL A to test point A4TP5 and CHANNEL A to A8TP6.

n. Set the AN/UPM-98 XTAL MARK SYNC controls as indicated below:

Control	*Position*
SYNC SELECT	-EXT.
SUP	MAXIMUM CCW
TRIGGER DELAY	To the point where the first pulse at oscilloscope CHANNEL A is delayad 5 microseconds from the leading edge of the second puke at CHANNEL B.

7-3.2. Initial Test Procedures Using AN/UPM-137A

a. Use AN/UPM-137A to make connections shown in figure 7-1.l.

b. Set and adjust test set controls as indicated below:

Control	*Position*
FUNCTION	SYSTEM
MODE	1
CODE(A, B, CA D)	0000
ISLS	OFF
PUSH TO TEST	Released
DIR/RAD	RAD

c. Set and adjust AN/UPM-137A rf signal generator as indicated below:

Control	*Position*
OUTPUT ATTEN 0-100 dbm	-6 dbm
TRANSMITTER-XMTR FREE	XTAL
TRANSMITTER-CW *SOURCE*	EXT 1090 MHz

e. Set AN/UPM-137A Interrogator Signal Simulator TRANSMITTER-XMTR FREQ to XTAL.

e. Set and adjust AN/UPM-137A SIS generator as indicated below;

Control	*Position*
SIF 1 CODER-FUNCTION SEA....................	N
SIF 1 CODER-CODE	0000
SIF 1 CODER-WIDTH ADJ . .	Approx. center
SIF 1 CODER-SUBST PULSE SEL...................	OFF
MIXED VIDEO-MIXED VID SEL..................	SIP 1
PRF-RANGE MULT	EXT.
TRIGGERS-DELAY TRIG (µSEC)-DLY RANGE MuLT	X4
TRIGGERS-DELAY TRIG (µSEC)-MULT1-11.......	6.0

7-4. Receiver Frequency and Bandwidth

NOTE

When the AN/URM-64 frequency is changed, the POWER SET meter of the AN/URM-64 should be reset to 0.

Connect the equipment as shown in figure 7-1. Set and adjust the controls as described in paragraph 7-3.1.

a. Decrease the AN/URM-64 rf output with the ATTENUATOR control until the teat set barely indicates ACCEPT and then increase the AN/URM-64 rf output 3 dB.

b. Use the AN/URM-64 SIGNAL FREQUENCY control to decrease the frequency until the test set barely indicates ACCEPT. Use the AN/USM-207 and the CM-77A/USM to determine the AN/URM-64 output frequency. Note this frequency.

c. Reconnect the AN/URM-64 to the MD-796. Increase the AN/URM-64 frequency until the test set just barely indicates ACCEPT. Using the AN/USM-207 and CM-77A/USM, measure and note the frequency.

d. Subtract the frequency obtained in *b* above from that obtained in c above. The results should be 6.5 ± 1 MHz.

e. Add the two frequency values determined in *b* and *c* above and divide by two. The results should be 1,090 ± .5 MHz.

f. Set and adjust AN/UPM-137A oscilloscope as indicated below:

Control	*Position*
HORIZONTAL-SYNC	EXT DC-
DISPLAY-CHAN A/ALT/ CHANT	ALT
VERTICAL-CHAN A-AC/DC.	DC
VERTICAL-CHAN A-75 Ω IN/OUT..	OUT
VERTICAL-CHAN A-VOLT/DIV	5
VERTICAL-CHAN B-AC/DC.	DC
VERTICAL-CHAN B-75 Ω IN/OUT	5
VERTICAL-CHAN B-VOLT/DIV..	OFF
CALIBRATORS-XTAL MARK (μSEC)	OFF
HORIZONTAL-SWEE DELAY (μSEC)-DLY RANGE MULT	X400
HORIZONTAL-SWEEP DELAY (μSEC)-MULT 1-11	As required for proper display.

g. Turn on AN/UPM-137A and test set and allow 5-minute warmup.

h. Press test set PUSH TO TEST and turn to LOCK position. Test set ACCEPT indicator should light.

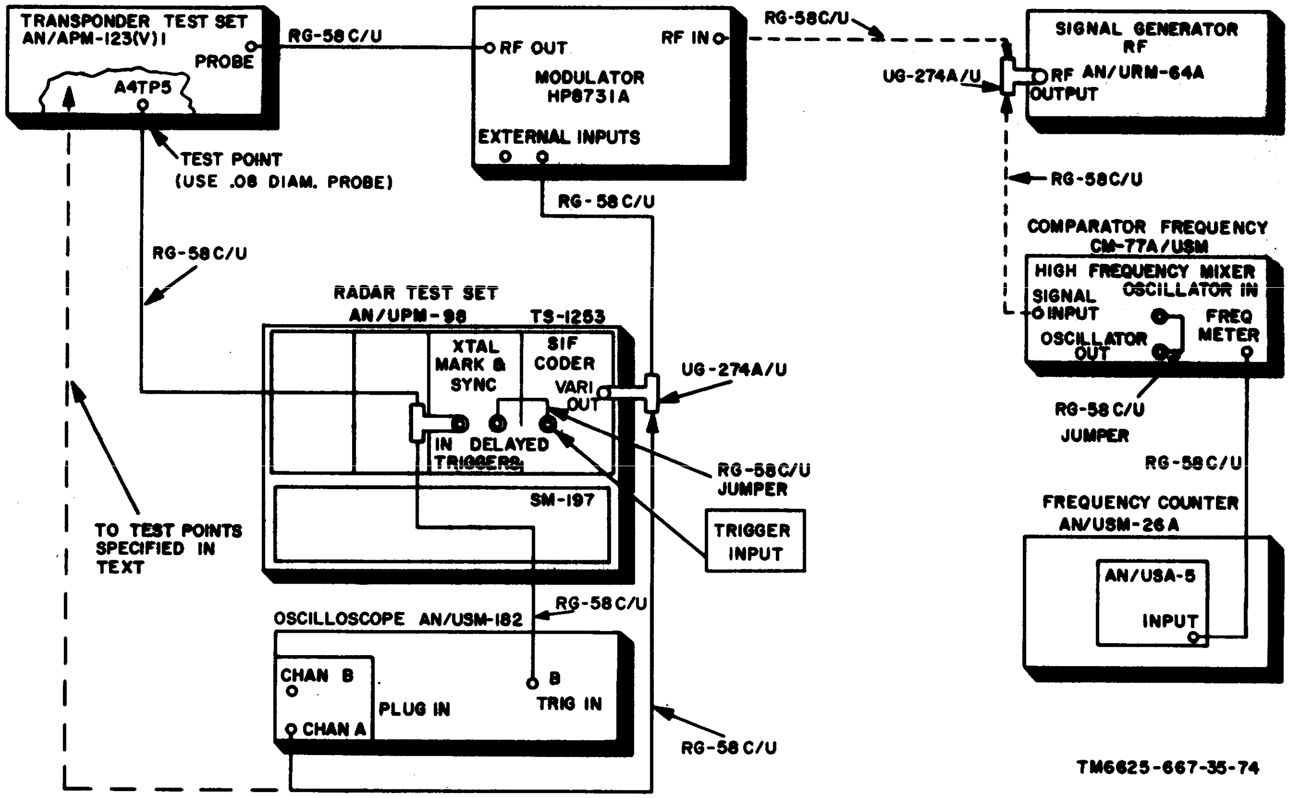


Figure 7-1. Receiver frequency, sensitivity, and bandwidth test setup.

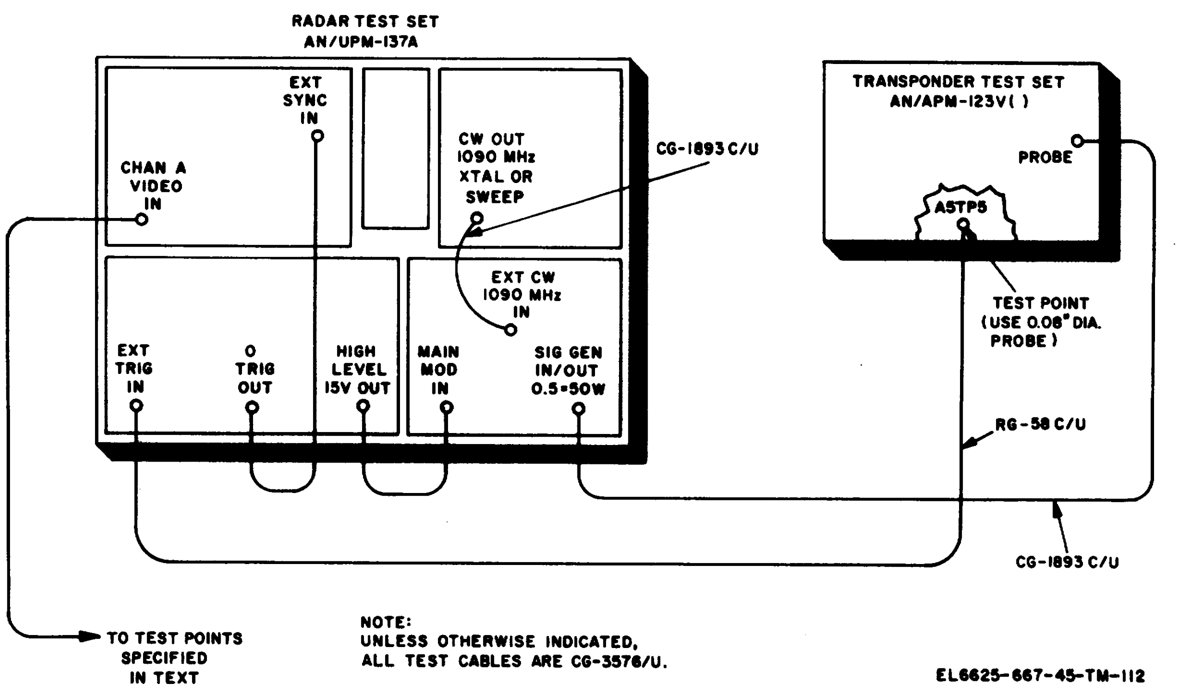


Figure 7-1.1 Receiver frequency, sensitivity, and bandwidth test setup using AN/UPM-137A

7-4.1. Receiver Frequency and Bandwidth Using AN/UPM-137A

Connect the equipment as shown in figure 7-1.1. Set and adjust the controls as described in paragraph 7-3.2.

a. Disconnect cable from set set test point A5TP5 and connect to AN/UPM-137A interrogator signal simulator TRANSMITTER-SWEEP SYNC OUT jack.

b. Connect AN/UPM-137A interrogator signal simulator TRANSMITTER-SWEPT FREQ MARKERS jack to AN/UPM-137A oscilloscope VERTICAL CHAN B-VIDEO IN jack,

c. Connect AN/UPM-137A oscilloscope VERTICAL–CHAN A–VIDEO IN jack to test set test point A8TP2.

d. Set AN/UPM-137A interrogator signal simulator TRANSMITTER-XMTR FREQ switch to SWEEP, SIS generator PRF-RANGE MULT switch to EXT +, SIS generator TRIGGERS-DELAY TRIGGERS-DLY RANGE MULT switch to X400, SIS generator TRIGGERS-DELAY TRIG (µSEC)-MULT 1-11 control to 4.6, oscilloscope HORIZONTAL SYNC switch to EXT DC +, oscilloscope HORIZONTAL-TIME/DIV switch to 50 µsec, and rf signal generator OUTPUT ATTEN 0-100 dBm to -10.

e. Adjust AN/UPM-137A SIS generator TRIGGERS-DELAY TRIG (µSEC)-MULT 1-11 control for maximum amplitude of signal display on AN/UPM-137A oscilloscope GHANA.

f. Adjust AN/UPM-137A rf signal generator OUTPUT ATTEN 0-100 dBm control until signal displayed on AN/UPM-137A oscilloscope CHAN A just saturates.

g. Adjust AN/UPM-137A rf signal generator OUTPUT ATTEN 0-100 dBm control -3 dBm from setting of *f* above.

h. Adjust AN/UPM-137A oscilloscope VERTICAL-CHAN B-VERT POSN control until top of pulse coincides with center horizontal graticule.

i. Adjust AN/UPM-137A rf signal generator OUTPUT ATTEN 0-100 dBm control to setting of *f* above.

NOTE

Frequency is determined by using swept frequency markers as a reference and extrapolating. The center marker is 1090 MHz and the markers on each side are 3,5, 10, and 29 MHz, respectively, from the center marker.

j. Decrease AN/UPM-137A SIS generator TRIGGERS-DELAY TRIG (µSEC)-MULT 1-11 control until top of pulse displayed on CHAN A reaches center graticule. Note frequency at this point as *f.*

k. Increase AN/UPM-137A SIS generator TRIGGERSDELAY TRIG (µSEC}MULT 1-11 control until top of pulse displayed on CHAN A again reaches center graticule. Note this frequency as F2.

l. Subtract F1 and F2 to determine 3 dB bandwidth, It should be 6.5 ± 1 MHz.

m. Add F1 to F2 and divide by two to determine the center frequency, it should be 1,090 ± 0.5 MHz.

7-5. Receiver Sensitivity Using AN/UPM-98

a. Connect the equipment as shown in figure 7-1 and adjust the controls as described in paragraph 7-3.

b. Remove the cable from the PROBE input on the AN/APM-123 and connect it to the TS-779/U through the MX-2144A. Remove the modulation and the bias voltage and measure the output wattage. Set the output of the AN/URM-64 for -9 dBm.

c. Connect the output cable from the MD-796 back to the PROBE jack. Reapply the bias and modulation connection.

d. Adjust control A8R5 until an ACCEPT condition is obtained.

7-5.1. Receiver Sensitivity Using AN/UPM-137A

Connect the equipment as shown in figure 7-1.1. Set and adjust the controls as described in paragraph 7-3.2.

a. Set AN/UPM-137A rf signal generator OUTPUT ATTEN 0-100 dBm control to - 15dBm and then slowly adjust cw until test set ACCEPT indicator just lights.

b. Add AN/UPM-137A rf signal generator OUTPUT ATTEN 0-100 dBm control setting to cable and tenuation marked on cable connected to test set PROBE jack to determine sensitivity. Sensitivity should be -9 ±1 dBm.

NOTE

If necessary, adjust the sensitivity by first adjusting the AN/UPM-137A rf signal generator OUTPUT ATTEN 0-100 dBm control to -9 dBm minus the attenuation marked on the cable connected to the test set PROBE jack and then adjusting test set sensitivity control A8R5 until the test set barely indicates ACCEPT.

7-6. Video Enable Delay and Gating Tests

Connect the equipment as shown in figure 7-1, Set and adjust the controls as described in paragraph 7-3.

a. Disconnect the oscilloscope CHANNEL A cable from the AN/UPM-98, and connect the cable to test point A10TP5.

b. Measure the delay from the leading edge of the second pulse at CHANNEL B to the trailing edge of the pulse at CHANNEL A. The video enable delay should be 1.8 ± 0.5 microsecond.

NOTE

If necessary, adjust module A10 video enable delay control A10R7 to obtain proper delay.

c. Disconnect the oscilloscope CHANNEL A and CHANNEL B cables from thir test points.

d. Connect the CHANNEL A cable to test point A8TP2 and the CHANNEL B cable to test point A9TP4. Measure the delay between the leading edge of the last pulse at CHANNEL A and the trailing edge of the pulse at CHANNEL B. The delay should not exceed 6 microseconds.

7-6.1. Video Enable Delay and Gating Tests Using AN/UPM-137A

Connect the equipment as shown in figure 7-1.1. Set and adjust the controls as described in paragraph 7-3.2.

a. connect AN/UPM-137A oscilloscope VERTICAL-CHAN A-VIDEO IN jack to test set test point A10TP5 and AN/UPM-137A oscilloscope VERTICAL-CHAN B-VIDEO IN jack to test set test point A5TP3.

b. Measure delay from leading edge of second pulse at CHAN B to trailing edge of pulse at CHAN A. Video enable delay should be 1.8 **±0.5** microseconds.

NOTE

If necessary, adjust test set module A10 video enable delay control A10R7 to obtain proper delay.

c. Connect AN/UPM-137A oscilloscope VERTICAL-CHAN A-VIDEO IN jack to test set test point A9TP2 and VERTICAL-CHAN B-VIDEO IN jack to test point A9TP4.

d. Measure delay between leading edge of last pulse at CHAN A and trailing edge of pulse at CHAN B. Delay should not exceed 6 microseconds.

7-7. Video Reply and Comparison puke Width Test

Connect the equipment as shown in figure 7-1. Set and adjust the controls as described in paragraph 7-3.

a. Disconnect the oscilloscope CHANNEL A cable from teat point A8TP2 and connect the cable to test point A1lTP1.

b. Set the test set and AN/UPM-98 code controls to 0010.

c. Set the oscilloscope TIME BASE A TIME/CM control to 0.2 microsecond.

d. Adjust the DELAY TIME MULTIPLIER control to position the pulse for pulse width measurement.

e. Measure the video pulse width, It should be 0.7 (+0.0, - 0.05) microsecond.

NOTE

If necessary, adjust module All pulse width control Al1R6 to obtain the required performance standard.

f. Disconnect the oscilloscope CHANNEL A cable from test point A1lTP1 and connect the cable to test point A11TP2. The width of the comparison pulse should be 0.5±0.01 microsecond.

NOTE

If necessary, adjust comparison pulse width control A11R15 to obtain the required performance standard.

7-7.1. Video Reply and Comparison Pulse Width Test Using AN/UMP-137A

Connect the equipment as shown in figure 7-1.1. Set and adjust the controls as described in paragraph 7-3.2.

a. Connect AN/UPM- 137A oscilloscope VERTICAL-CHAN A-VIDEO IN jack to test set test point A1lTP1.

b. Set test set CODE switches to 0010.

c. Set AN/UPM-137A SIS generator SIF 1 CODER code switches (A, B, C, D) to 0010.

d. Set AN/UPM-137A oscilloscope HORIZONTAL-TIME/DIV switch to .2 µsec, DISPLAY-CHAN A/ALT/CHAN B switch to CHAN A, and VERTICAL-CHAN A-VOLT/DIV switch to 2.

e. Adjust AN/UPM-137A oscilloscope SWEEP DELAY **(µSEC)-DLY** RANGE MULT and MULT 1-

11 controls to position pulse for pulse width measurement.

f. Measure video pulse width. It should be 0.7 +0.0 -0.05 μsec.

NOTE

If necessary, adjust module All pulse width control A11R6 to obtain the required performance standard.

g. Disconnect cable from test set test point A11TP1 and connect to test point A11TP2. Width of comparison pulse should be 0.5 ± 0.01 microsecond.

NOTE

If necessary, adjust comparison pulse width control A11R15 to obtain the required performance standard.

7-8. Comparing Pulse Position Test

Connect the equipment as show in figure 7-1. Set and adjust the controls as described in paragraph 7-3.

a. Disconnect the oscilloscope CHANNEL B cable from test point A9TP4 and connect the cable to test point A11TP2.

b. Disconnect the CHANNEL A cable from the AN/UPM-98, and connect the cable to teat point A11TP1.

c. Set the oscilloscope HORIZONTAL DISPLAY control at B INTENSIFIED by A.

d. Set the TIME BASE A TIME/CM control to 0.1 μsec and TIME BASE B TIME/CM control to 0.2 μsec.

e. Adjust the DELAY TIME MULTIPLIER control until the second pulse of the train on CHANNEL A is intensified.

f. Set the oscilloscope HORIZONTAL DISPLAY control at A DEL'D BY B. The C1 pulse of each train should be 0bserved.

NOTE

If necessary, carefully adjust the DELAY TIME MULTIPLIER control to center these pulses on the display.

g. Determine whether the pulse at CHANNEL B is centered with respect to the pulse at CHANNEL A.

NOTE

If necessary, adjust control A7R1 in module A7 to center the pulse as accurately as possible.

h. Determine as in g above, whether each of the pulses listed below is centered by adjusting the oscilloscope DELAY TIME MULTIPLIER control clockwise to position them. The pulses should be observed in the order given.

NOTE

If necessary, adjust the indicated control to center the pulse.

Pulse	*Control*	*Pulse*	*Control*
A1	ATR2	D1	A7R8
C 2	A7R3	B2	A7R9
A2	A7R4	D2	A7R10
C4	A7R5	B4	A7R11
A4	A7R6	F2	A7R13
B1	A7R7		

i. Set the AN/UPM-98 SIF CODER unit FUNCTION control to ID.

j. Set the test set FUNCTION control to I/P and the MODE control to position 2.

k. Adjust the oscilloscope DELAY TIME MULTIPLIER control clockwise until the pulses are observed. Determine whether the I/P pulses are. aligned as in *g* above.

NOTE

If necessary, adjust control A7R14 to center the CHANNEL B pulse within the CHANNEL A pulse.

7-8.1. Comparing Pulse Position Test Using AN/UMP-137A

Connect the equipment as shown in figure 7-1.1. Set and adjust the controls as described in paragraph 7-3.2.

a. Connect AN/UPM- 137A oscilloscope VERTICAL-CHAN A-VIDEO IN jack to test set test point A11TP1 and AN/UPM-137A oscilloscope VERTICAL-CHAN B-VIDEO IN jack and test set test point A11TP2.

b. Adjust AN/UPM-137A oscilloscope controls as necessary to observe C1 pulse of both displays.

c. Determine whether pulse displayed on AN/UPM-137A oscilloscope CHAN A is centered with respect to pulse at CHAN A.

NOTE

If necessary, adjust control A7R1 in module A7 to center the pulse as accurately as possible.

d. Repeat *b* and *c* above for following pulses and adjust indicated control, if necessary. Pulses should be observed and adjusted in order given.

Pulse	*Control*	*Pulse*	*Control*
A1	A7R2	D1	A7R8
C2	A7R3	B2	A7R9
A2	A7R4	D2	A7R10

C4 . . . . A7R5
A4 . . . . A7R6
B1 . . . . A7R7
B4 . . . . A7R11
F2 . . . . A7R13

e. Set AN/UPM-137 SIS generator SIF 1 CODER-FUNCTIONAL SEL switch to I/P.

f. Set test set FUNCTION switch to I/P and MODE switch to 2.

g. Repeat *b* and *c* above for I/P pulses and adjust A7R14, if necessary, to center pulses.

7-9 Read Delay, Error Detector, and Function (Controls) Test

Connect the equipment as shown in figure 7-1. Set and adjust the controls as described in paragraph 7-3.

a. Disconnect the oscilloscope CHANNEL A cable from test point A11TP1 and connect the cable to test point A1OTP6 (module A10).

b. Measure to make sure that the width of the **pulse at CHANNEL A is 150 ± 10 μsec.**

c. Disconnect the oscilloscope CHANNEL A cable from test point A10TP6, and connect the cable to test point A11TP3.

d. Set the oscilloscope HORIZONTAL DISPLAY control to B INTENSIFIED BY A, TIME BASE A TIME/CM control to 0.1 μsec and TIME BASE B TIME/CM control to 0.2 μsec.

e. Adjust the DELAY TIME MULTIPLIER control until the pulse at the oscilloscope CHANNEL A is intensified.

f. Set the HORIZONTAL DISPLAY control to A DEL'D BY B.

g. Measure to make sure that the width of the pulse at oscilloscope CHANNEL A is 0.35 ± 0.01 μsec.

NOTE

If necessary, adjust control A11R30 to obtain the required performance standard.

h. Set the test set and AN/UPM-98 controls for each mode as indicated below. The test set ACCEPT indicator should light for each of the modes. SWEEP DELAY range dial on the AN/UPM-98 should be set to 1 to 11 for Modes 1, 2, and 3A. Adjust SWEEP DELAY-COARSE or FINE control to obtain acceptance. SWEEP DELAY range dial should be on 5-50 for MODE C. Adjust SWEEP DELAY-COARSE or FINE control to obtain acceptance.

	AN/APM-123V switch		AN/UPM-98 switch	
Mode	Code	Function	Code	Function
1	0000	I/P	0000	EMER
C	7774	I/P	7774	ID
1	7700	EMER	7700	EMER
2	7777	SYSTEM	7777	N
3/A	0000	SYSTEM	0000	N
1	0000	SYSTEM	0000	N
1	1111		1111	
1	2222		2222	
1	3333		3333	
1	4444		4444	
1	5555		5555	
1	6666		6666	
1	7777		7777	
1	0000	FREQ-POWER	0000	

i. Set the test set FUNCTION control to SELF TEST. The ACCEPT indicator should light.

7-9.1. Read Delay, Error Detector, and Function (Controls) Test Using AN/UPM-137A

Connect the equipment as shown in figure 7-1.1. Set and adjust the controls as described in paragraph 7-3.

a. Connect AN/UPM-137A oscilloscope VERTICAL-CHAN A-VIDEO IN jack to test set test point A10TP6.

b. Measure width of pulse display on CHAN A. It should be 150 ± 10 μsec.

c. Connect AN/UPM-137A oscilloscope VERTICAL-CHAN A-VIDEO IN jack to test set test point A11TP3.

d. Measure width of pulse displayed on CHAN A. It should be 0.35 ± 0.01 μsec.

NOTE

If necessary, adjust control A11R30 to obtain the required performance standard.

e. Set test set and AN/UPM-137A SIS generator controls for each mode as indicated below. Set AN/UPM-137A SIS generator MIXED VIDEO-MIXED VID SEL switch to SIF 1,2. The test set ACCEPT indicator should light for each setting.

	Test set		AN/UPM-137A	
Mode	Code	Function	Code	Function
1	7700	EMER	7700	EMER
2	7777	SYSTEM	7777	N
C	7704	I/P	7704	I/P
3/A	0000	SYSTEM	0000	N
1	0000	SYSTEM	0000	N
1	1111	SYSTEM	1111	N

	Test set		AN-UPM-137A	
Mode	Code	Function	Code	Function
1	2222	SYSTEM	2222	N
1	3333	SYSTEM	3333	N
1	4444	SYSTEM	4444	N
1	5555	SYSTEM	5555	N
1	6666	SYSTEM	6666	N
1	7777	SYSTEM	7777	N
1	7700	I/P*	7700	I/P
1	0000	FREQ.-POWER	0000	N
ANY	ANY	SELF-TEST	ANY	ANY

*Set AN/UPM-137A SIS generator SIF 2 CODE R-CODE switches to 7700 and adjust SIF 2 CODER-TRIG DELAY ADJ control unit first pulse of SIF 2 train coincides with I/P pulse of SIF 1 train.

7-10. Reply Evaluator Test

Connect the equipment as shown in figure 7-1, and adjust the controls as described in paragraph 7-3. Multimeter ME-26B/U will also be used; instructions are provided in a through *h* below.

a. Set the ME-26B/U SELECTOR switch to (+) and the RANGE switch to 10V. Connect the dc probe to test point A12TP2 (module A12) and common lead to test point A13TP2 (module A13).

b. Set the AN/UPM-98 controls to 7777. Adjust the ME-26B/U ZERO control to zero its indication.

c. Set the AN/UPM-98 CODE switches to 7767. Note the ME-26B/U voltage indication.

d. Adjust the AN/UPM-98 SUB PULSE POS control in the negative (-) direction until the ME-26B/U voltage indication is 50 percent of that noted in *c* above. The test set REJECT indicator should light. If it is not lighted, proceed with *f* below.

e. Adjust the AN/UPM-98 SUB PULSE POS control in the positive (+) direction until the ME-26B/U voltage indication is 20 percent of that noted in c above, Reset the AN/UPM-98 code switches to 7777. The test set ACCEPT indicator should light. If it is not lighted, proceed with *f* below.

f. Adjust the AN/UPM-98 SUB PULSE POS control in the negative (-) direction until the ME-26B/U voltage indication is 65 percent of that noted in *c* above.

g. Adjust control A12R19 until the test set ACCEPT and REJECT indicators glow alternately.

h. Adjust the AN/UPM-98 SUB PULSE POS control to the center (0) position, and repeat the procedures in *b* through e above.

7-10.1. Reply Evaluator Test Using AN/UPM-137A

Connect the equipment as shown in figure 7-1.1. Set and adjust the controls as described in paragraph 7-3.2.

a. Set ME-26B/U SELECTOR switch to (+) and RANGE switch to 10V. Connect common lead to A13TP2 (ground) and dc probe to A12TP2.

b. Set AN/UPM-137A SIS generator SIF 1 CODER-code (A, B, C, D) switches to 7777.

c. Set test set CODE switches to 7777.

d. Adjust AN/UPM-137A SIS generator SIF 1 CODER-SUBST PULSE POSN control completely clockwise.

e. Adjust ME-26B/U ZERO ADJ for zero meter indication.

f. Adjust AN/UPM-137A SIS generator SIF 1 CODER-SUBST PULSE POSN control to 0. Note ME-26B/U indication.

g. Adjust AN/UPM-137A SIS generator SIF 1 CODER-SUBST PULSE POSN control, in either direction, until dc voltage indicated ME-26B/U is 80 percent of that noted in *f*. Test set ACCEPT indicator should be lighted. If not lighted, proceed to step *i*.

h. Adjust AN/UPM-137A SIS generator SIF 1 CODER-SUBST PULSE POSN control, in either direction, until dc voltage indicated on ME-26B/U is 50 percent of that noted in *f*. Test set REJECT indicator should be lighted. If not lighted, proceed to *i* below.

i. Adjust AN/UPM-137A SIS generator SIF 1 CODER-SUBST PULSE POSN control, in either direction, until dc voltage indicated on ME-26B/U is 65 percent of that noted in *f*. Adjust control A12R19 until test set ACCEPT and REJECT indicators light alternately. Repeat *g* and *h* above.

7-11 through 7-13. Transmitter Frequency, Power Out-put, and Pulse Characteristic Tests.(Deleted)

NOTE

To perform the frequency, power output, and pulse characteristic test, perform the procedures in paragraph 3-4.

CHAPTER 7.1

DEPOT OVERHAUL STANDARDS USING AN/TPM-25A

7.1-l. Applicability of Depot Overhaul Standards

The tests outlined in this chapter are designed to measure the performance capability of a repaired equipment. Equipment that is to be returned to stock should meet the standards given in these tests.

7.1-2. Applicable References

a. Repair Standards. Applicable procedures of the depot performing these test and the general standards for repaired electronic equipment given in TB SIG 355-1, TB SIG 355-2, and TB SIG 355-3 form a part of the requirements for testing this equipment.

b. Technical Publications. The technics publications applicable to the equipments to be tested are indicated below:

Equipment and subject	*Publication*
organizational maintenance Manual: Test Set, Transponder AN/APM-123V	TM 11-6625-667-12
DS, GS, and Depot Maintenance Manual: Test Set, Transponder AN/APM-123V	TM 11-6625-667-35

c. Modification Work Orders. Perform all modification work orders applicable to this equipment before making the tests specified. DA Pam 310-4 lists all available MWO's.

7.1-3. General Requirements

General requirements for depot overhaul tests consist of the depot system timing setup shown in figure 7.1-1 and the depot overhaul standards basic test setup as shown in figure 7.1-2, which will be used and modified in the test, as required.

7.1-4. Initial Setup Procedures Using AN/TPM-25A

a. Use the equipment listed below or authorized substitute for depot overhaul standards tests. Connect this equipment as shown in figure 7. 1-1, depot system timing setup.

(1) Oscilloscope AN/USM-182 with preamplifier, Video AM-3174/USM.

(2) Radar Test Set AN/TPM-25A.

(3) Generator, Pulse AN/UPM-15A.

b. Set the oscilloscope controls as indicated in the chart below.

Control	*Position*
HORIZONTAL DISPLAY	"A" DEL 'D BY "B"
TIME BASE B TRIGGER SLOPE	EXT(–)
TIME DELAY MULTIPLIER	00
TIME BASE B TIME/CM	5µS
TIME BASE A STABILITY	Completely cw
TIME BASE A TIME/CM	1 ms
TIME BASE A TRIGGERING MODE '	AC

c. Press and lock the test set PRESS-TO-TEST switch, set the MODE switch to 1, CODE switches to 7777, and FUNCTION switch to SYSTEM.

d. Set the AN/TPM-25A controls as indicated in the chart below.

Control	*Position*
REPLIES panel:	
MODULATION SEL	SIF
REPLY WIDTH	0.45
SIF REPLY CODE	7777
SUB PULSE SEL	OFF
RANGE DELAY SEL (SEC)	0100
GATING PASS	00
GATING INHIBIT	00

Control	*Position*
M4 JAMMING	0
PRT SEL(SEC)	Immaterial
TRIG SEL INT DCD/EXT	EXT
SIG GEN FUNCTION	FIXED FREQ
NORM INTERLEAVE	NORM
SUM ATTEN	-6dB
MEASUREMENT FUNCTION SEL	PWR

e. Turn on the AN/TPM-25A, AN/UPM-15A, AN/USM-182, and the transponder test set.

f. On the AN/USM-182, observe the positive going 2.17 ms prf pulse from A5TP5 and the delayed prf pulse from the AN/UPM-15A.

g. Adjust the AN/UPM-15A PULSE DELAY as required to position the delayed pulse approximately .5 ms before the trailing edge of the prf pulse. Continue adjustment as necessary until the transponder test set ACCEPT lamp is on.

h. Without disturbing any equipment setting, shut all equipment off and connect the test equipment as shown in figure 7.1-2, depot overhaul standards basic test.

i. Turn all equipment on and note that transponder test set ACCEPT lamp is on.

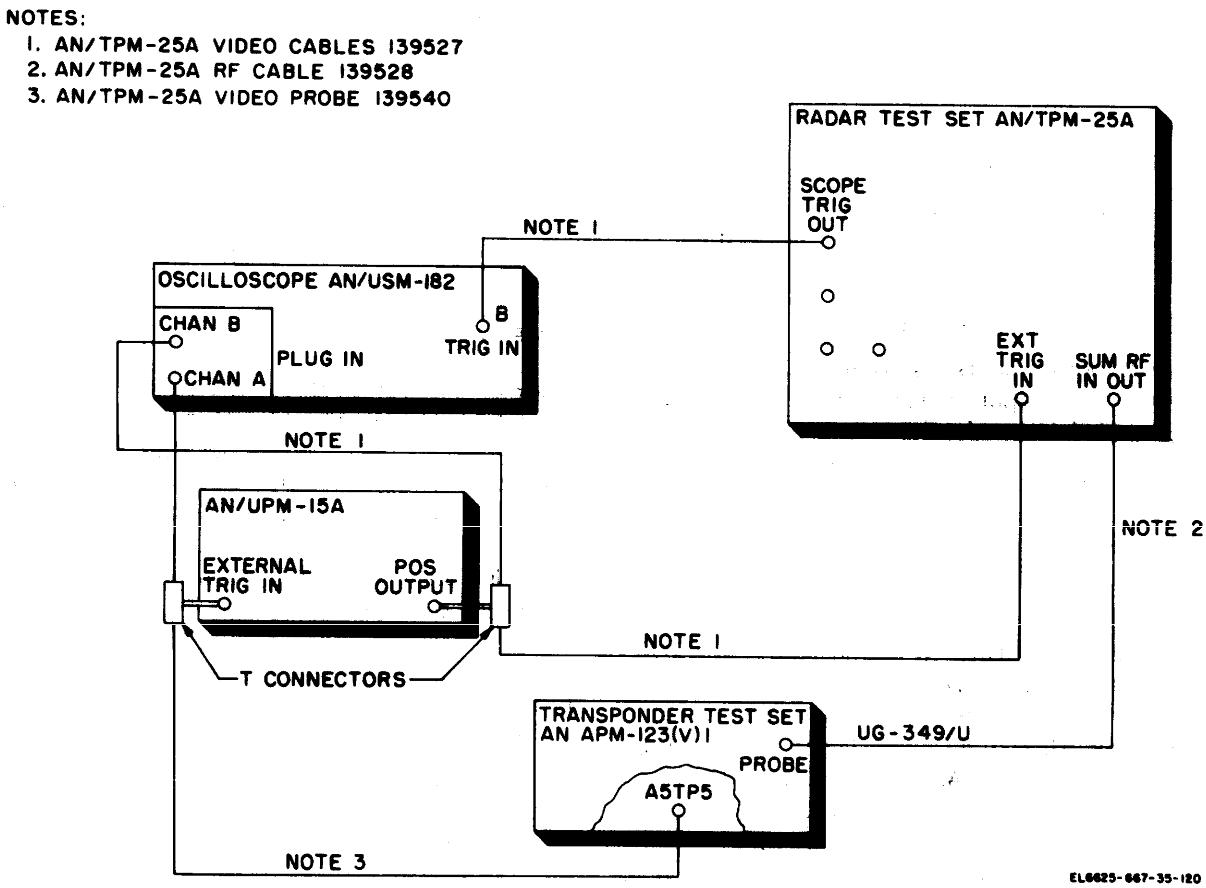


Figure 7.1-1. Depot system timing setup using AN/TPM-25A.

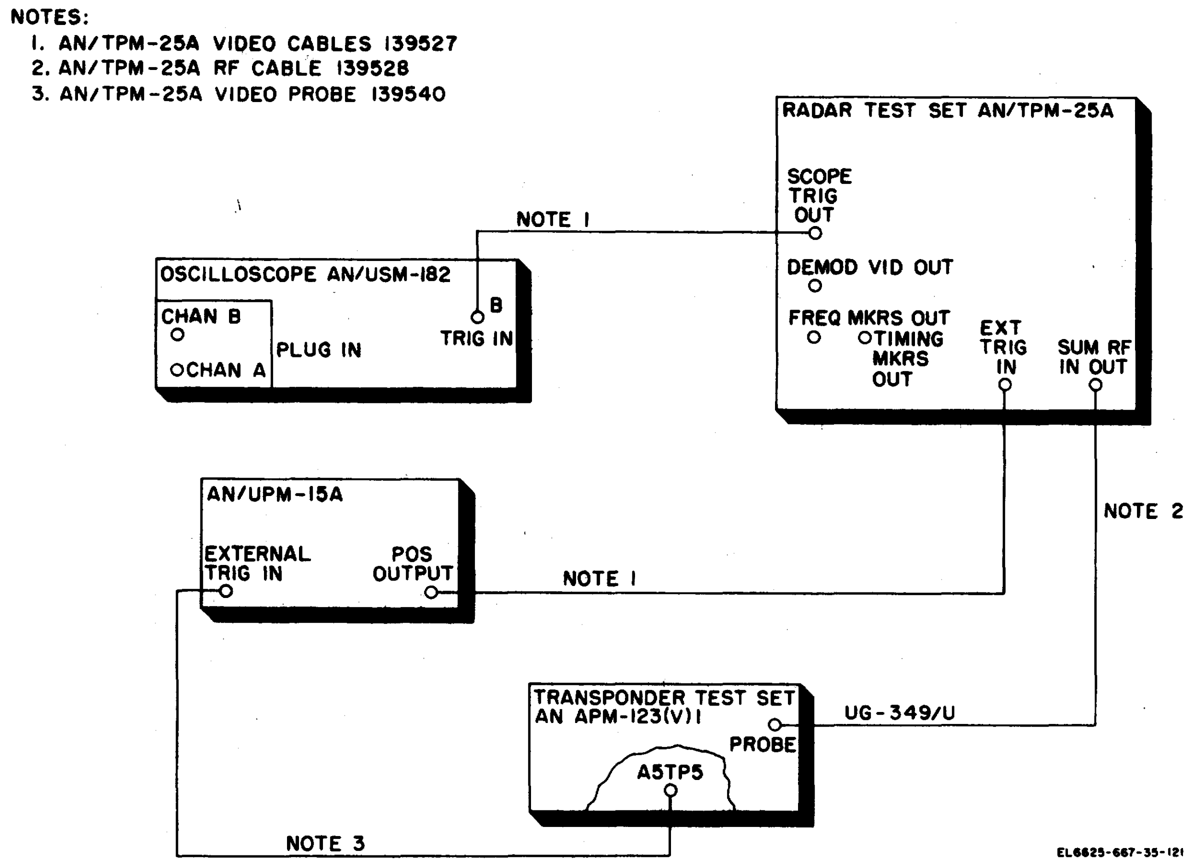


Figure 7.1-2 Depot overhaul standards basic test setup.

7.1-5. Receiver Frequency and Bandwidth

a. Perform the initial setup procedures given in paragraph 7.1-4.

b. Connect AN/TPM-25A cable 139527 between AN/TPM-25A FREQ MKRS OUT and AN/USM-182 CHANNEL B input.

c. Connect AN/USM-182 CHANNEL A input to A8TP2 on the AN/APM-123.

d. On the AN/TPM-25A, make the following control changes:

REPLIES SIF REPLY CODE	0000
SIG GEN FUNCTION	SWP ±5 MHz

e. On the AN/USM-182, make the following control changes:

TIME BASE A TIME/CM	.5 ms
TIME BASE B TIME/CM	20 µs
DELAY TIME MULTIPLIER	09

f. On the test set, set CODE switches to 0000.

g. On the AN/USM-182, adjust DELAY TIME MULTIPLIER to position the center (1090 MHz frequency marker on the center graticule of the oscilloscope. Note that the ±1 MHz markers appear on vertical lines two divisions from the center. Each divison on the oscilloscope represents .5 MHz.

h. While observing the frequency markers on CHANNEL 3 and the reply video on CHANNEL A, adjust AN/TPM-25A MEASUREMENT FREQ MEAS dial to position the reply video in line with the center frequency marker. Note the test set, ACCEPT lamp is on.

i. Observe the oscilloscope as in *b* above, and adjust AN/TPM-25A MEASUREMENT FREQ

MEAS dial counterclockwise until the test set REJECT lamp is on, and then clockwise until the ACCEPT lamp just turns on.

j. Note the position of the outside pulse with respect to center (1090 MHz) frequency marker. Calculate the frequency at which the outside pulse appears by subtracting .5 MHz for each division on the oscilloscope. Note this frequency as F1.

k. Using the procedure in j above, adjust the AN/TPM-25A MEASUREMENT FREQ MEAS dial clockwise and then counterclockwise to determine the upper frequency. Note this frequency as F2.

l. Determine the bandwidth by subtracting Frequency F1 from frequency F2. Bandwidth Should be 6.5 +1 MHz.

m. Determine center frequency by adding frequencies F1 and F2 and then divide by two. Center frequency should be 1090 ±0.5MHz.

7.1-6. Receiver Sensitivity

a. Perform the initial setup procedures given in paragraph 7.1-4.

b. On the AN/TPM-25A, adjust the SUM ATTEN dial counterclockwise until the test set REJECT lamp is on and then clockwise until the ACCEPT lamp is just on.

c. Note AN/TPM-25A SUM ATTEN dial reading. Add this number to 1090 MHz insertion loss of AN/TPM-25A cable 139526. The result should be -9 ± 1 dBm.

NOTE

If necessary, adjust sensitivity by first adjusting the AN/TPM-25A SUM ATTEN dial to -9, dBm unless the 1090 MHz loss of AN/TPM-25A cable 139526 and then adjusting module A8 sensitivity control A8R5 until test set barely indicates ACCEPT.

7.1-7. Video Enable Delay and Gating Tests

a. Perform the initial setup procedures given in paragraph 7.1-4.

b. Connect oscilloscope CHANNEL A to A10TP5 and CHANNEL B to A10TP6.

c. Measure the delay from the leading edge of pulse on CHANNEL B to the leading edge of the pilse on CHANNEL A. The video enable delay should be 1.8 ±0.5 µs.

NOTE

If necessary, adjust module Al0 video enable delay control A10R7 to obtain proper delay.

d. Disconnect the oscilloscope CHANNEL A and CHANNEL B cables from their test points.

e. Connect the CHANNEL A cable to test point A8TP2 and the CHANNEL B cable to test point A9TP4. Measure the delay between the leading pulse on CHANNEL A and the trailing edge of the pulse on CHANNEL B. The delay should not exceed 6 µs.

7.1-8. Video Reply and Comparison Pulse Width Test

a. Perform the initial test setup procedures given in paragraph 7.1-4.

b. Connect the oscilloscope CHANNEL A test point A11TP1.

c. Set the test set CODE and AN/TPM-25A SIF REPLY CODE controls to 0010.

d. Set the oscilloscope TIME BASE A TIME/CM control to 0.2 µs.

e. Adjust the DELAY TIME MULTIPLIER control to position the pulse for pulse width measurement.

f. Measure the video pulse width. It should be 0.7 (+0.0, -0.05) µs.

NOTE

If necessary, adjust module All pulse width control A11R6 to obtain the required performance standard.

g. Disconnect the oscilloscope CHANNEL *A* cable from test point A11TP1 and connect the cable to test point A11TP2. The width of the comparison pulse should be 0.5 ±0.01 µs.

NOTE

If necessary, adjust comparison pulse width control A11R15 to obtain the required performance standard.

7.1-9. Composition Pulse Position Test

a Perform the initial setup procedures given in paragraph 7.1-4.

b. Connect the oscilloscope CHANNEL B cable to test point A11TP2.

c. Connect the CHANNEL A cable to test point A11TP1.

d. Set the oscilloscope HORIZONTAL

DISPLAY control at "B" INTENSIFIED BY "A".

e. Set the TIME BASE A TIME/CM control to 0.1 µs and TIME BASE B TIME/CM control to 0.2 µs.

f. Adjust the DELAY TIME MULTIPLIER control until the second pulse of the train on CHANNEL A is intensified.

g. Set the oscilloscope HORIZONTAL DISPLAY control at "A" DEL'D by "B". The Cl pulse of each train should be observed.

NOTE

If necessary, carefully adjust the DELAY TIME MULTIPLIER control to center these pulses on the display.

h. Determine whether the pulse at CHANNEL B is centered with respect to the pulse at CHANNEL A.

NOTE

If necessary, adjust control A7R1 in module A7 to center the pulse as accurately as possible.

i. Determine, as in *h* above, whether each of the pulses in the chart below is centered by adjusting the oscilloscope DELAY TIME MULTIPLIER control clockwise to position them. The pulses should be observed in the order given.

NOTE

If necessary, adjust the indicated control to center the pulse.

Pulse	*Control*
Al	A7R2
C2	A7R3
A2	A7R4
C4	A7R5
A4	A7R6
B1	A7R7
D1	A7R8
B2	A7R9
D2	A7R10
B4	A7R11
D4	A7R12
F2	A7R13

j. Set the AN/TPM-25 REPLIES MODULATION SEL switch to I P M2/3.

k. Set the test set FUNCTION control to I/P and the MODE control to position 2.

l. Adjust the oscilloscope DELAY TIME MULTIPLIER control clockwise until the pulses are observed. Determine whether the I/P pulses are aligned as in *h* above.

NOTE

If necessary, adjust control A7R14 to center the CHANNEL B pulse within the CHANNEL A pulse.

7.1-10. Read Delay, Error Detector, and Function (Controls) Test

a. Perform the initial setup procedures given in paragraph 7.1-4.

b. Connect the oscilloscope CHANNEL A cable to test point A10TP6 (module A10).

c. Measure to make sure that the width of the pulse at CHANNEL A is 150 ±7.5 µs.

d. Disconnect the oscilloscope CHANNEL A cable from test point A10TP6, and connect the cable to test point A11TP3.

e. Set the oscilloscope HORIZONTAL DISPLAY control to "B" INTENSIFIED BY "A", TIME BASE A TIME/CM control to 0.1 µs and TIME BASE B TIME/CM control to 0.2 µs.

f. Adjust the DELAY TIME MULTIPLIER control until the pulse at the oscilloscope CHANNEL A is intensified.

g. Set the HORIZONTAL DISPLAY control to "A" DEL'D by "B".

h. Measure to make sure that the width of the pulse at oscilloscope CHANNEL A is 0.35 ±0.01 µs.

NOTE

If necessary, adjust control A11R30 to obtain the required performance standard.

i. Set the test set and AN/TPM-25A controls for each mode as indicated in the chart below. The AN/TPM-123 ACCEPT indicator should light for each of the modes.

	AN/APM-123V switch A		AN/TPM-25A			
MODE	CODE	FUNCTION	SIF REPLY	CODE	MODULATION	SEL
1	7700	1P	7777		EMER	
c	7777	1P	7777		1P M2/3	
1	7700	EMER	7700		EMER	
2	7777	SYSTEM	7777		SIF	
3/A	0000	SYSTEM	0000			
1	0000	SYSTEM	0000			
1	1111		1111			
1	2222		2222			
1	3333		3333			
1	4444		4444			
1	5555		5555			
1	6666		6666			
1	7777		7777			
1	0000	FREQ-POWER				

j. Set the test set FUNCTION control to SELF TEST. The ACCEPT indicator should light.

7.1-11. Reply Evaluator Test

a. Perform the initial setup procedures given in paragraph 7.1-4. Multimeter ME-26B/U will also be used in these procedures.

b. Set the ME-26B/U SELECTOR switch to (+) and the RANGE switch to 10V. Connect the dc probe to test point A12TP2 (module A12) and common lead to test point A13TP2 (module A13).

c. Adjust the ME-26B/U ZERO control to zero its indication.

d. Set the AN/TPM-25A SIF REPLY CODE switches to 7767. Note the ME-26B/U voltage indication.

e. Adjust the AN/TPM-25A SUB PULSE POS SELECT switch to VARY and adjust VARY control in the negative(–) direction until the ME-26B/U voltage indication is 50% of that noted in *d* above. The AN/APM-123 REJECT indicator should light. If it is not lit, proceed with *g* below.

f. Adjust the AN/TPM-25A SUB PULSE POS VARY control in the positive (+) direction until the ME-26B/U voltage. indication is 80% of that noted in *d* above. The test set ACCEPT indicator should light. If it is not lighted, proceed with g below.

g. Adjust the AN/TPM-25A SUB PULSE POS VARY control in the negative (–) direction until the ME-26B/U voltage indication is 65% of that noted in *d* above.

h. Adjust control A12R19 until the test set ACCEPT and REJECT indicators glow alternately.

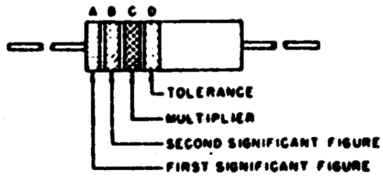
i. Adjust the AN/TPM-25A SUB PULSE VARY POS control to the center (0) position, and repeat the procedrues in *c* through *f* above.

CHAPTER 8
DIAGRAMS

Note. Chapter 8 contains the color code illustrations for resistors and capacitors and the diagrams showing the circuitry, wiring, and parts of the AN/APM-l23V( ).

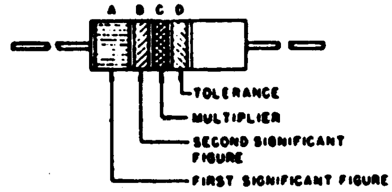
COLOR CODE MARKING FOR MILITARY STANDARD RESISTORS

COMPOSITION-TYPE RESISTORS



BAND A— Equal Width Band Signifies Composition-Type

WIREWOUND-TYPE RESISTORS



BAND A— Double Width Signifies Wire-wound Resistor

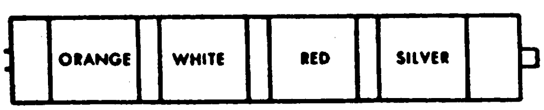
COLOR CODE TABLE

BAND A		BAND B		BAND C		BAND D	
COLOR	FIRST SIGNIFICANT FIGURE	COLOR	SECOND SIGNIFICANT FIGURE	COLOR	MULTIPLIER	COLOR	RESISTANCE TOLERANCE (PERCENT)
BLACK	0	BLACK	0	BLACK	1		
BROWN	1	BROWN	1	BROWN	10		
RED	2	RED	2	RED	100		
ORANGE	3	ORANGE	3	ORANGE	1,000		
YELLOW	4	YELLOW	4	YELLOW	10,000	SILVER	± 10
GREEN	5	GREEN	5	GREEN	100,000	GOLD	± 5
BLUE	6	BLUE	6	BLUE	1,000,000		
PURPLE (VIOLET)	7	PURPLE (VIOLET)	7				
GRAY	8	GRAY	8	SILVER	0.01		
WHITE	9	WHITE	9	GOLD	0.1		

EXAMPLES OF COLOR CODING

BAND

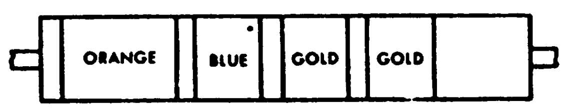
A B C D*



3 9 X100 ± 10%

BAND

A B C D*



3 6 X0.1 ± 5%

NOMINAL RESISTANCE	3,900 Ohms	3.6 Ohms
RESISTANCE TOLERANCE	± 10 percent	± 5 percent

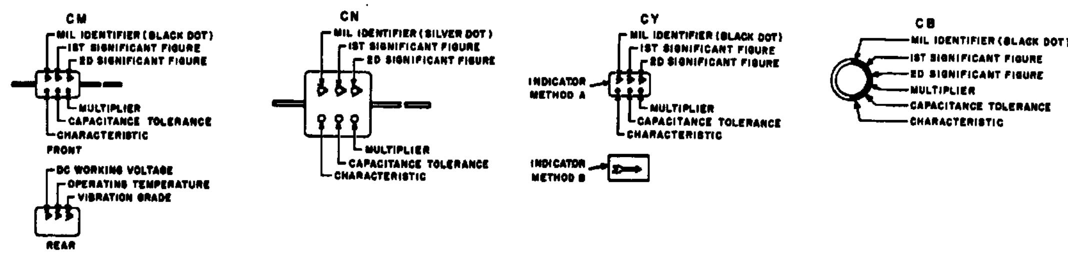
STD-R2

*If Band D is omitted, the resistor tolerance is ± 20%, and the resistor is not Mil-Std.

Figure 8-0.1. Color code marking for MIL-STD resistors.

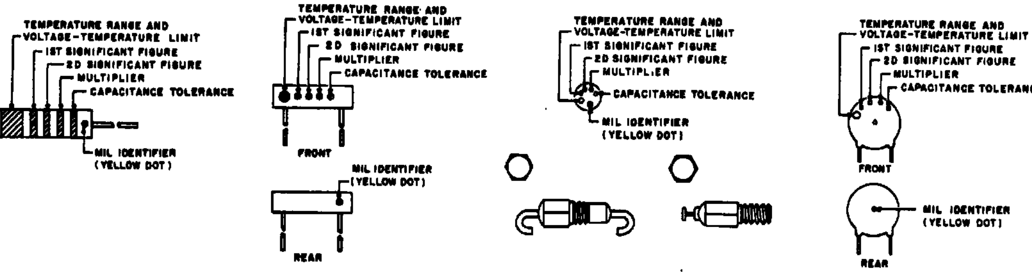
COLOR CODE MARKING FOR MILITARY STANDARD CAPACITORS

GROUP I Capacitors, Fixed, Various-Dielectrics, Styles CM, CN, CY, and CB



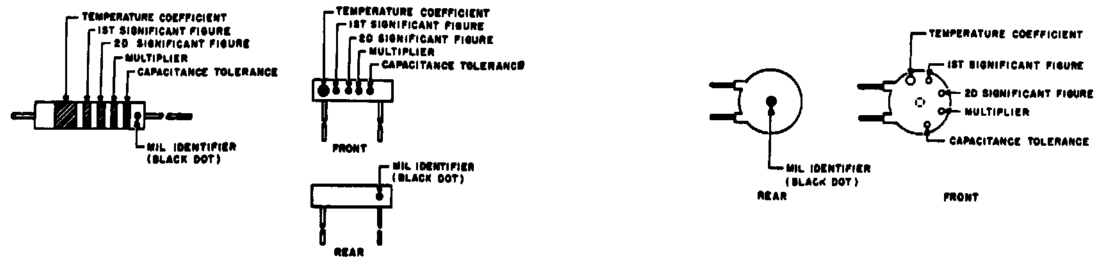
MICA-DIELECTRIC | PAPER-DIELECTRIC | GLASS-DIELECTRIC, GLASS CASE | MICA, BUTTON TYPE

GROUP II Capacitors, Fixed Ceramic-Dielectric (General Purpose) Style CK



AXIAL LEAD | RADIAL LEAD | FEED-THROUGH | STAND-OFF | DISK-TYPE

GROUP III Capacitors, Fixed, Ceramic-Dieletric (Temperature Compensating) Style CC



COLOR CODE TABLES

TABLE I – For use with Group I, Styles CM, CN, CY and CB

COLOR	MIL ID	1st SIG FIG	2nd SIG FIG	MULTIPLIER[1]	CAPACITANCE TOLERANCE				CHARACTERISTIC[2]				DC WORKING VOLTAGE	OPERATING TEMP. RANGE	VIBRATION GRADE
					CM	CN	CY	CB	CM	CN	CY	CB	CM	CM	CM
BLACK	CM, CY CB	0	0	1			± 20%	± 20%		A				−55° to +70°C	10–55 cps
BROWN		1	1	10					B	E		B			
RED		2	2	100	± 2%		± 2%	± 2%	C		C			−55° to +85°C	
ORANGE		3	3	1,000		± 30%			D			D	300		
YELLOW		4	4	10,000					E					−55° to +125°C	10–2,000 cps
GREEN		5	5		± 5%				F				500		
BLUE		6	6											−55° to +150°C	
PURPLE (VIOLET)		7	7												
GREY		8	8												
WHITE		9	9												
GOLD				0.1			± 5%	± 5%							
SILVER	CN				± 10%	± 10%	± 10%	± 10%							

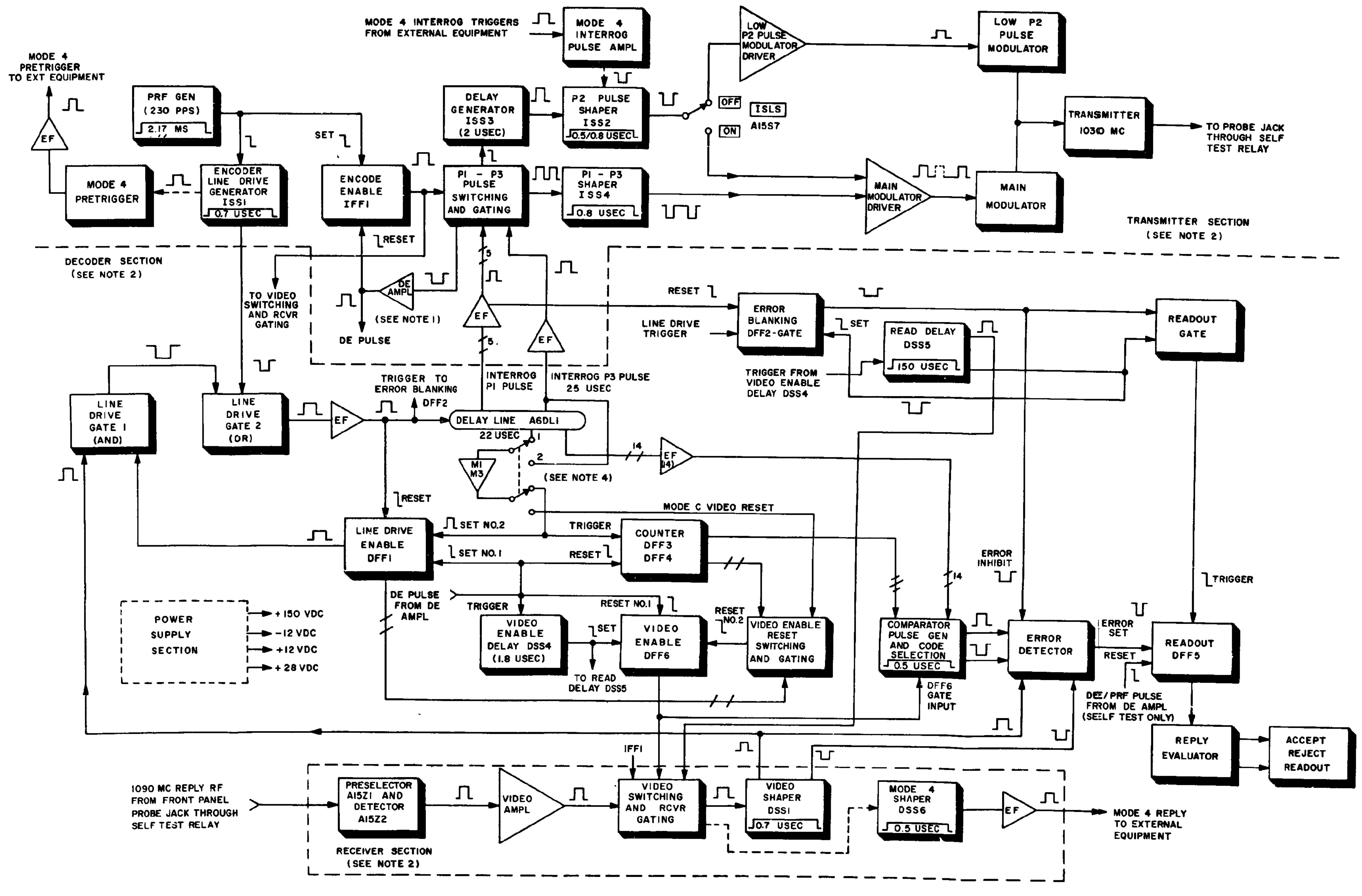
TABLE II – For use with Group II, General Purpose, Style CK

COLOR	TEMP. RANGE AND VOLTAGE – TEMP. LIMITS[3]	1st SIG FIG	2nd SIG FIG	MULTIPLIER[1]	CAPACITANCE TOLERANCE	MIL ID
BLACK		0	0	1	± 20%	
BROWN	AW	1	1	10	± 10%	
RED	AX	2	2	100		
ORANGE	BX	3	3	1,000		
YELLOW	AV	4	4	10,000		CK
GREEN	CZ	5	5			
BLUE	BV	6	6			
PURPLE (VIOLET)		7	7			
GREY		8	8			
WHITE		9	9			
GOLD						
SILVER						

TABLE III – For use with Group III, Temperature Compensating, Style CC

COLOR	TEMPERATURE COEFFICIENT[4]	1st SIG FIG	2nd SIG FIG	MULTIPLIER[1]	CAPACITANCE TOLERANCE		MIL ID
					Capacitances over 10uuf	Capacitances 10uuf or less	
BLACK	0	0	0	1		± 2.0uuf	CC
BROWN	−30	1	1	10	± 1%		
RED	−80	2	2	100	± 2%	± 0.25uuf	
ORANGE	−150	3	3	1,000			
YELLOW	−220	4	4				
GREEN	−330	5	5		± 5%	± 0.5uuf	
BLUE	−470	6	6				
PURPLE (VIOLET)	−750	7	7				
GREY		8	8	0.01			
WHITE		9	9	0.1	± 10%		
GOLD	+100					± 1.0uuf	
SILVER							

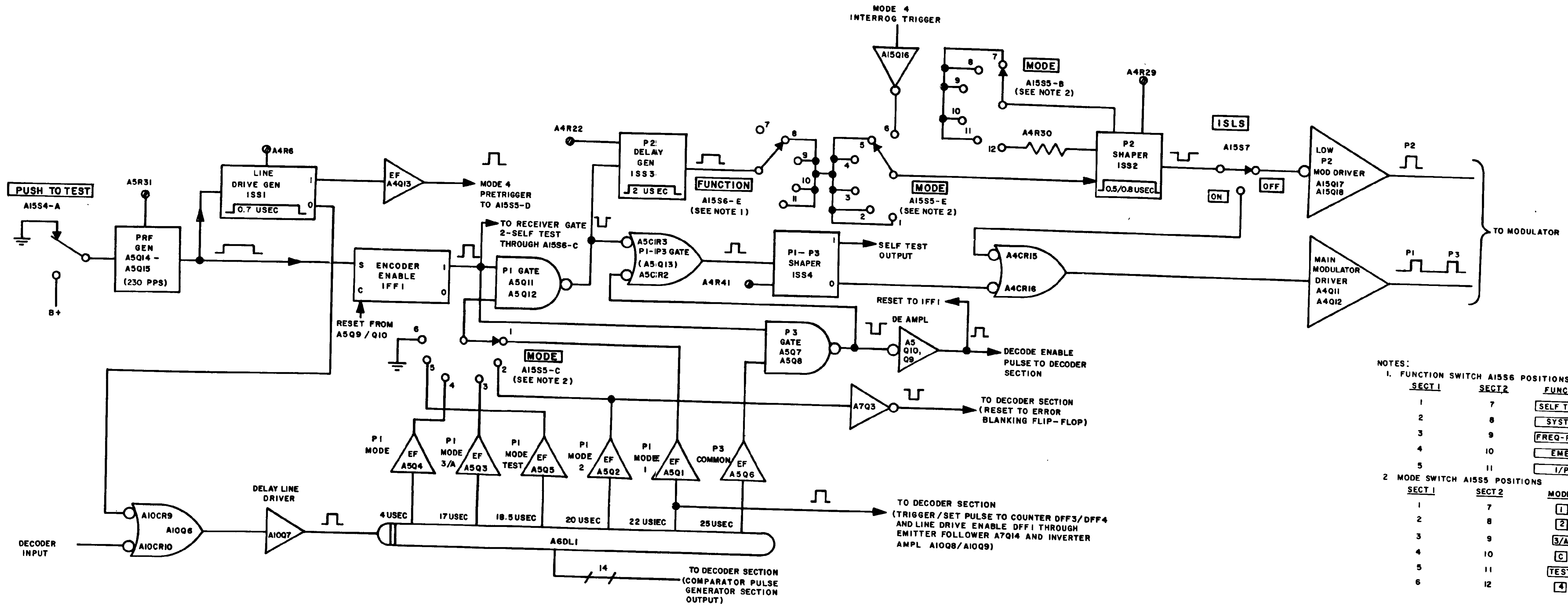
1. The multiplier is the number by which the two significant (SIG) figures are multiplied to obtain the capacitance in uuf.
2. Letters indicate the Characteristics designated in applicable specifications: MIL–C–5, MIL–C–91, MIL–C–11272, and MIL–C–10950 respectively.
3. Letters indicate the temperrature range and voltage-temperature limits designated in MIL–C–11015.
4. Temperature coefficient in parts per million per degree centigrade.



NOTES:

1. THE ABBREVIATION DE IS USED FOR DECODE ENABLE PULSE
2. ALL TEST SET SECTIONS SHOWN ARE PART OF TS-1809/APM-123(V). ENCLOSURES ARE USED TO SEPARATE FUNCTIONAL SECTIONS TO SIMPLIFY DESCRIPTION
3. SYMBOLS ⫽ INDICATE NUMBER OF SIGNAL LINES. A NUMERAL INDICATES MORE THAN FOUR LINES
4. MODE SWITCH A15S5-H FUNCTIONAL DIAGRAM (ABBREVIATED) POSITION 1 ALL MODES EXCEPT MODE C, POSITION 2 IS MODE C (ONLY)

Figure 8-1. Test set generator, block diagram.



NOTES:

1. FUNCTION SWITCH A15S6 POSITIONS

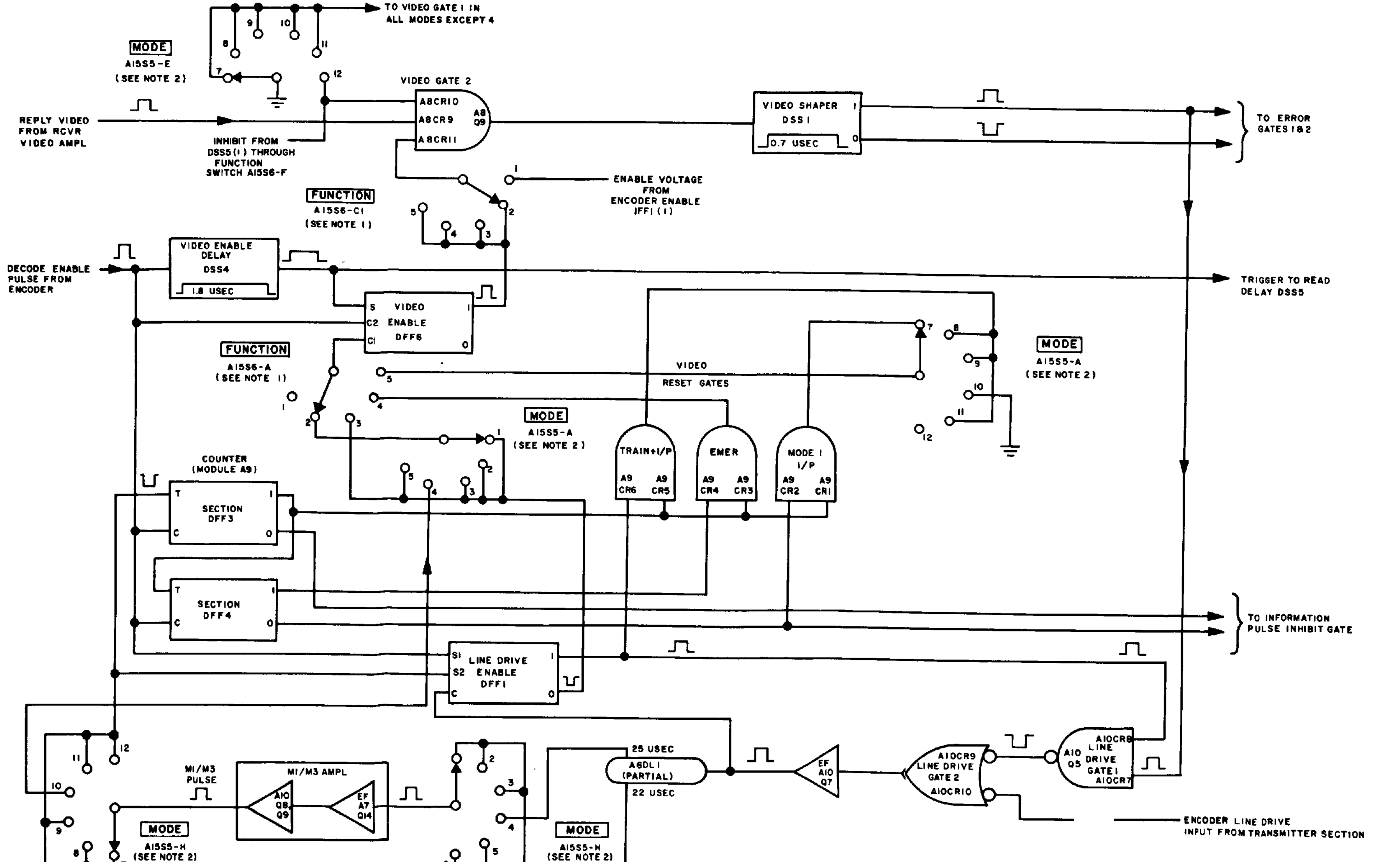
SECT 1	SECT 2	FUNCTION
1	7	SELF TEST
2	8	SYSTEM
3	9	FREQ-POWER
4	10	EMER
5	11	I/P

2 MODE SWITCH A15S5 POSITIONS

SECT 1	SECT 2	MODE
1	7	1
2	8	2
3	9	3/A
4	10	C
5	11	TEST
6	12	4

TM6625-667-35-8

Figure 8-2. Encoder, logic diagram.



NOTES:

1. FUNCTION SWITCH A13S6 POSITIONS

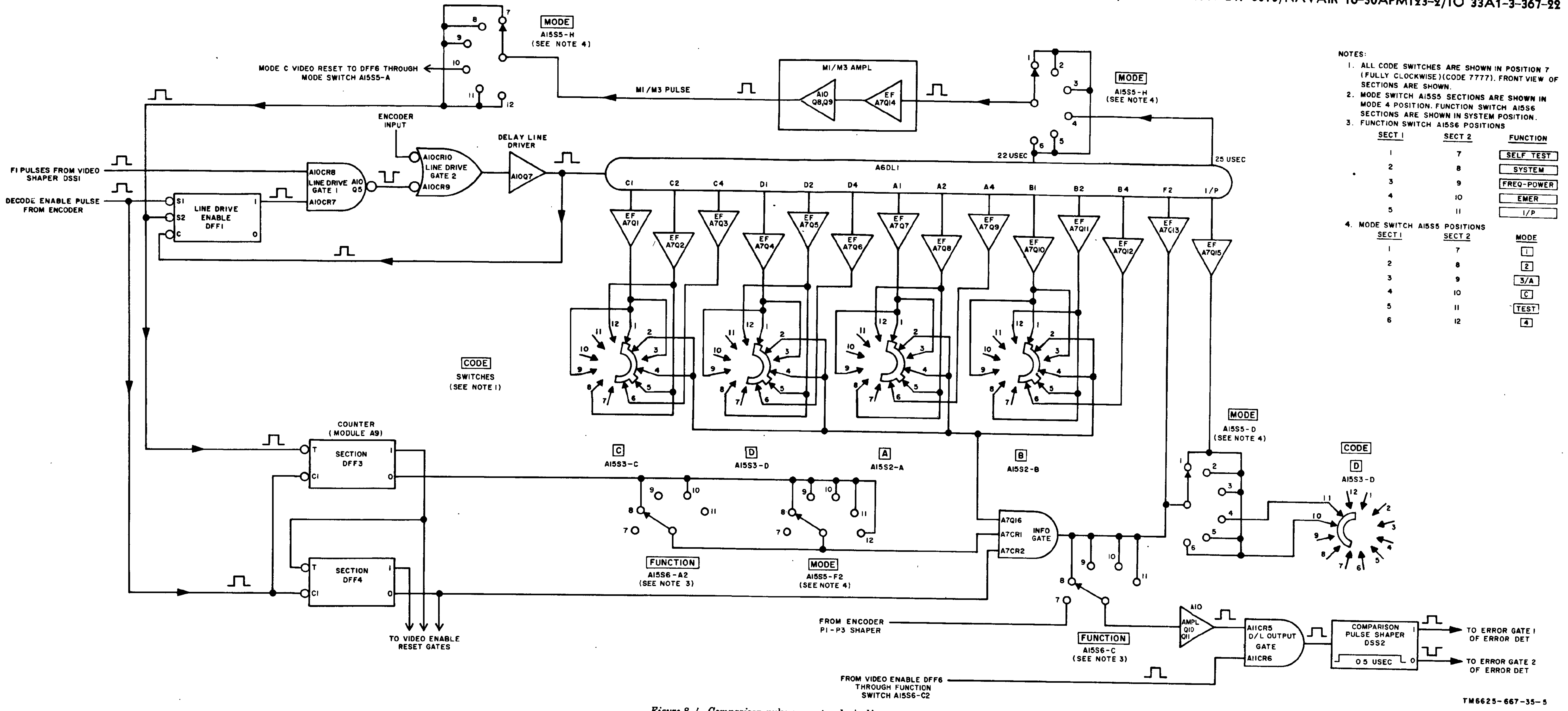
SECT. 1	SECT. 2	FUNCTION
1	7	SELF TEST
2	8	SYSTEM
3	9	FREQ POWER
4	10	EMER
5	11	I/P

2. MODE SWITCH A15S5 POSITIONS

SECT. 1	SECT. 2	MODE
1	7	1
2	8	2
3	9	3/A
4	10	C
5	11	TEST
6	12	4

TM6625-667-35-6

Figure 8-3.



NOTES:

1. ALL CODE SWITCHES ARE SHOWN IN POSITION 7 (FULLY CLOCKWISE)(CODE 7777). FRONT VIEW OF SECTIONS ARE SHOWN.
2. MODE SWITCH A15S5 SECTIONS ARE SHOWN IN MODE 4 POSITION. FUNCTION SWITCH A15S6 SECTIONS ARE SHOWN IN SYSTEM POSITION.
3. FUNCTION SWITCH A15S6 POSITIONS

SECT 1	SECT 2	FUNCTION
1	7	SELF TEST
2	8	SYSTEM
3	9	FREQ-POWER
4	10	EMER
5	11	I/P

4. MODE SWITCH A15S5 POSITIONS

SECT 1	SECT 2	MODE
1	7	1
2	8	2
3	9	3/A
4	10	C
5	11	TEST
6	12	4

Figure 8-4. Comparison pulse generator, logic diagram.

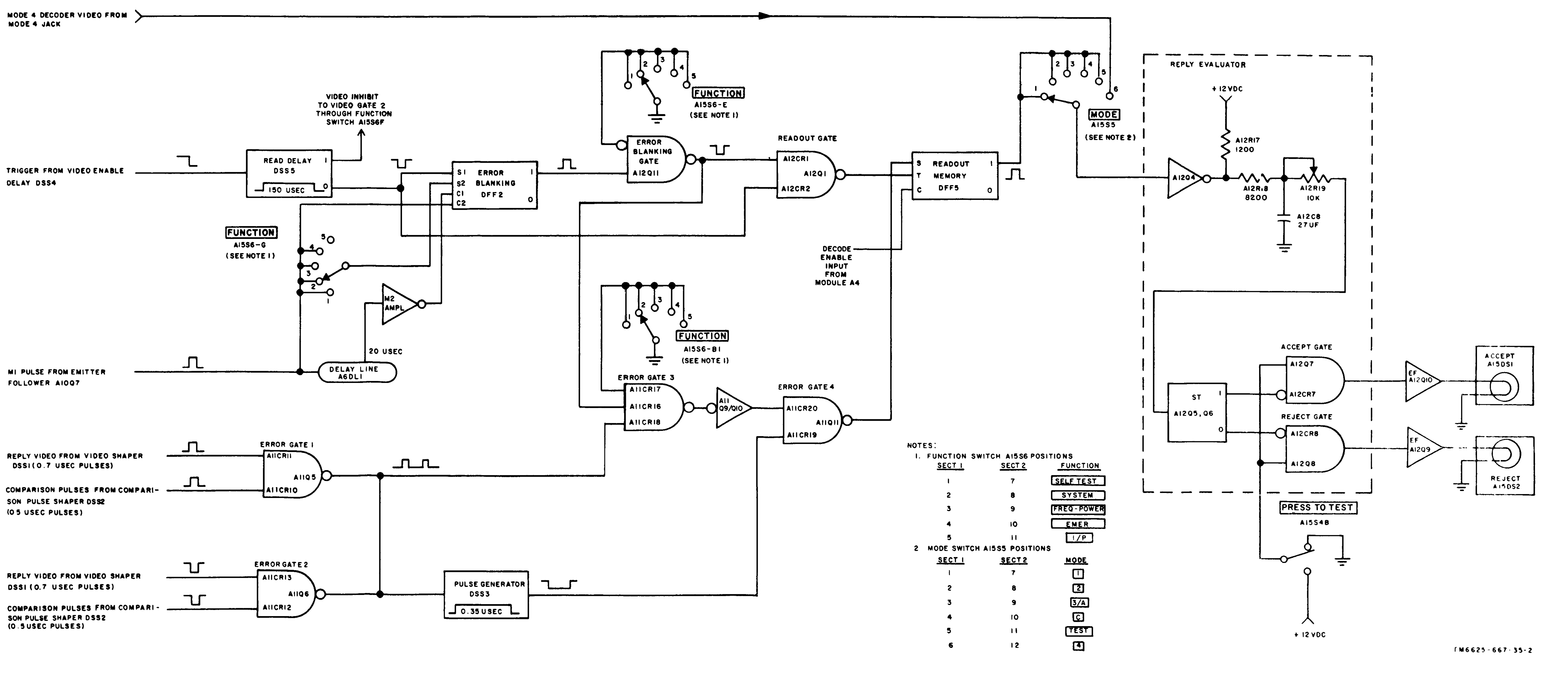
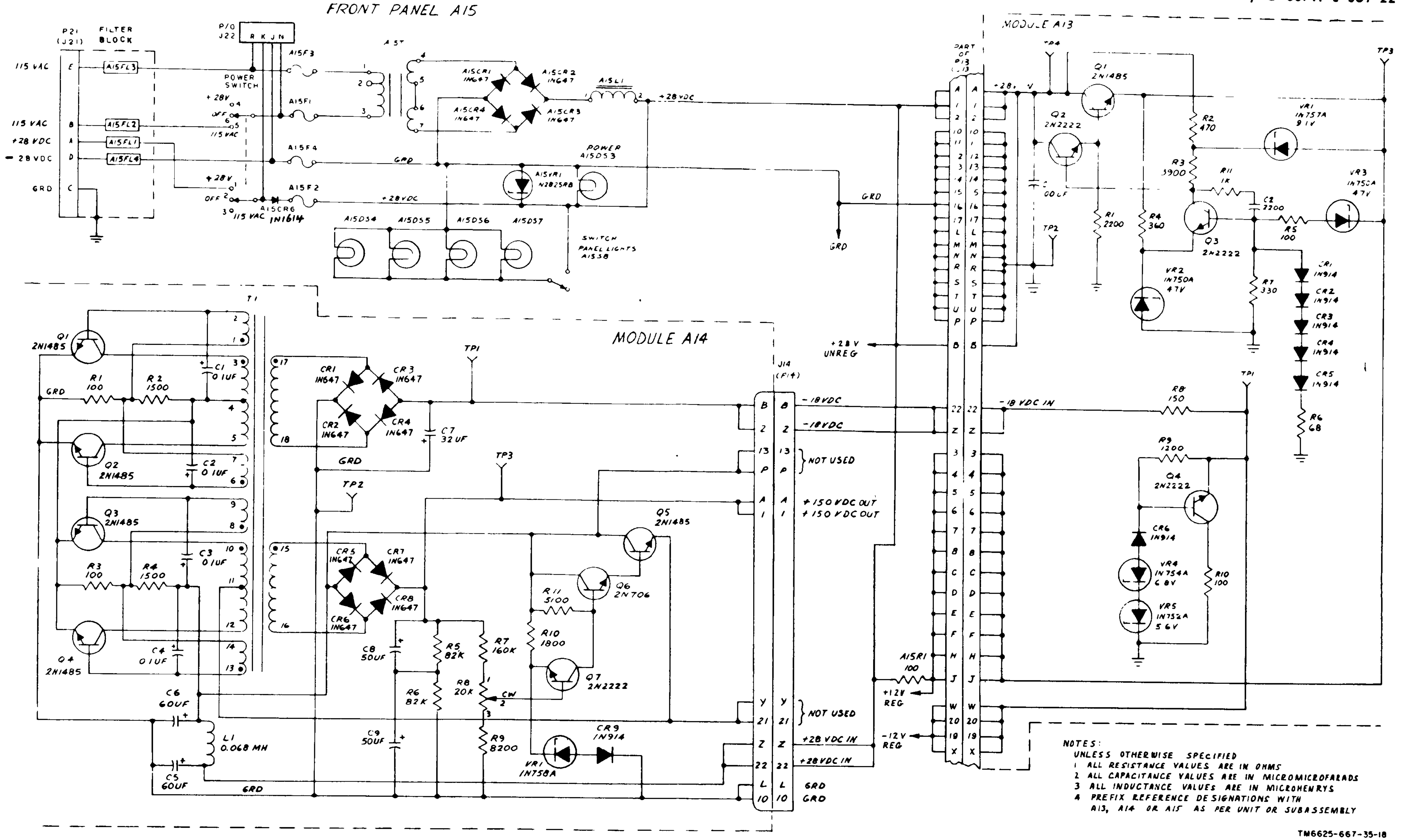


Figure 8-5. Error detector circuit, logic diagram.



TM6625-667-35-18

Figure 8-6. Power supply section, schematic diagram.

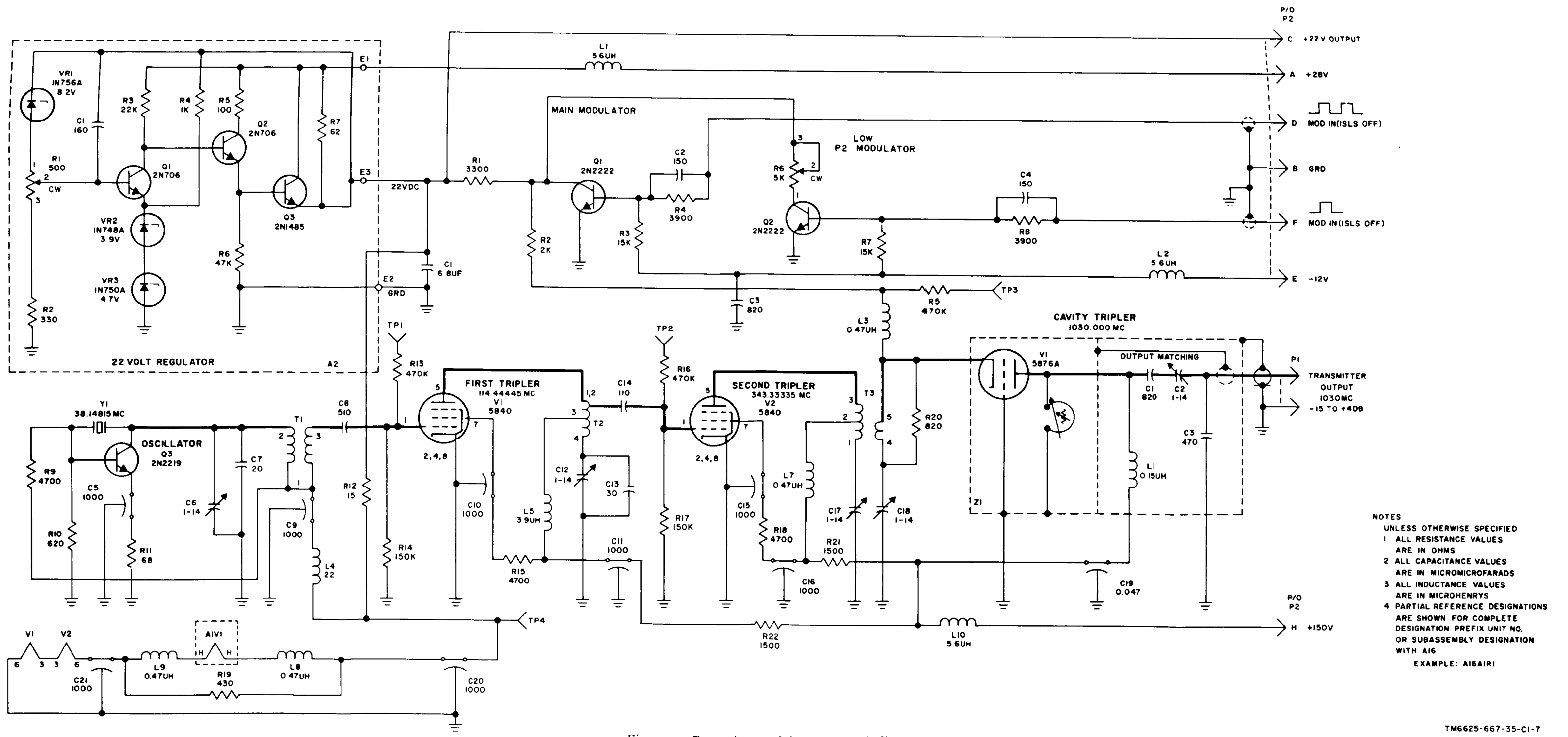


Figure 8-7. Transmitter-modulator, schematic diagram.

NOTES:
UNLESS OTHERWISE SPECIFIED
1. ALL RESISTANCE VALUES ARE IN OHMS
2. ALL CAPACITANCE VALUES ARE IN MICROMICROFARADS
3. ALL INDUCTANCE VALUES ARE IN MICROHENRYS
4. ALL WAVEFORMS ARE IDEALIZED
5. PREFIX ALL REFERENCE DESIGNATIONS WITH A4
EXAMPLE: A4R1
A4C1
A4CR1

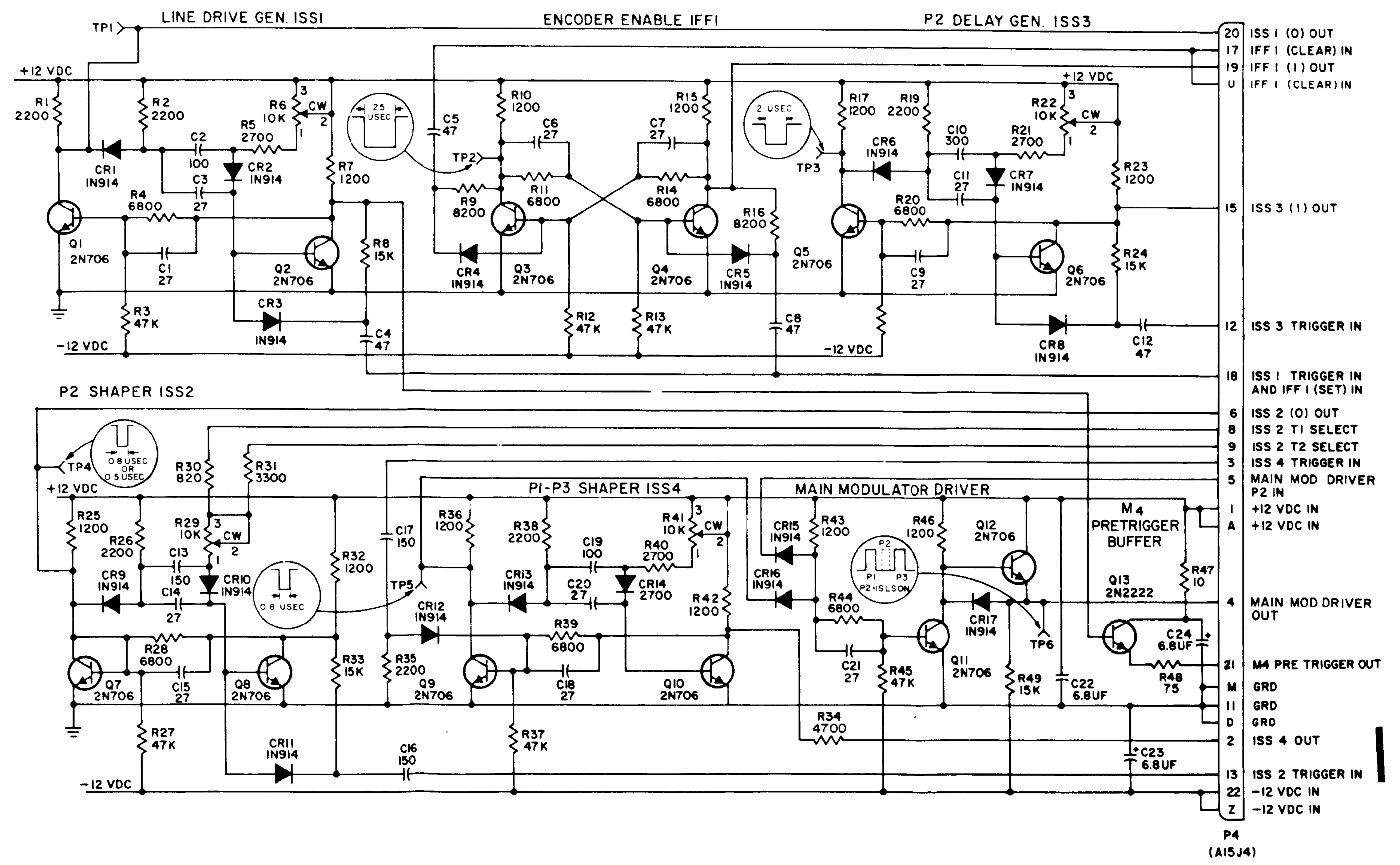


Figure 8-8. Encoder module A4, schematic diagram.

Figure 8-8.

NOTES:
UNLESS OTHERWISE SPECIFIED
1. ALL RESISTANCE VALUES ARE IN OHMS
2. ALL CAPACITANCE VALUES ARE IN MICROMICROFARADS
3. ALL INDUCTANCE VALUES ARE IN MICROHENRYS
4. ALL WAVEFORMS ARE IDEALIZED
5. PREFIX ALL REFERENCE DESIGNATIONS WITH A5
EXAMPLE: A5R1
A5C1
A5CR1

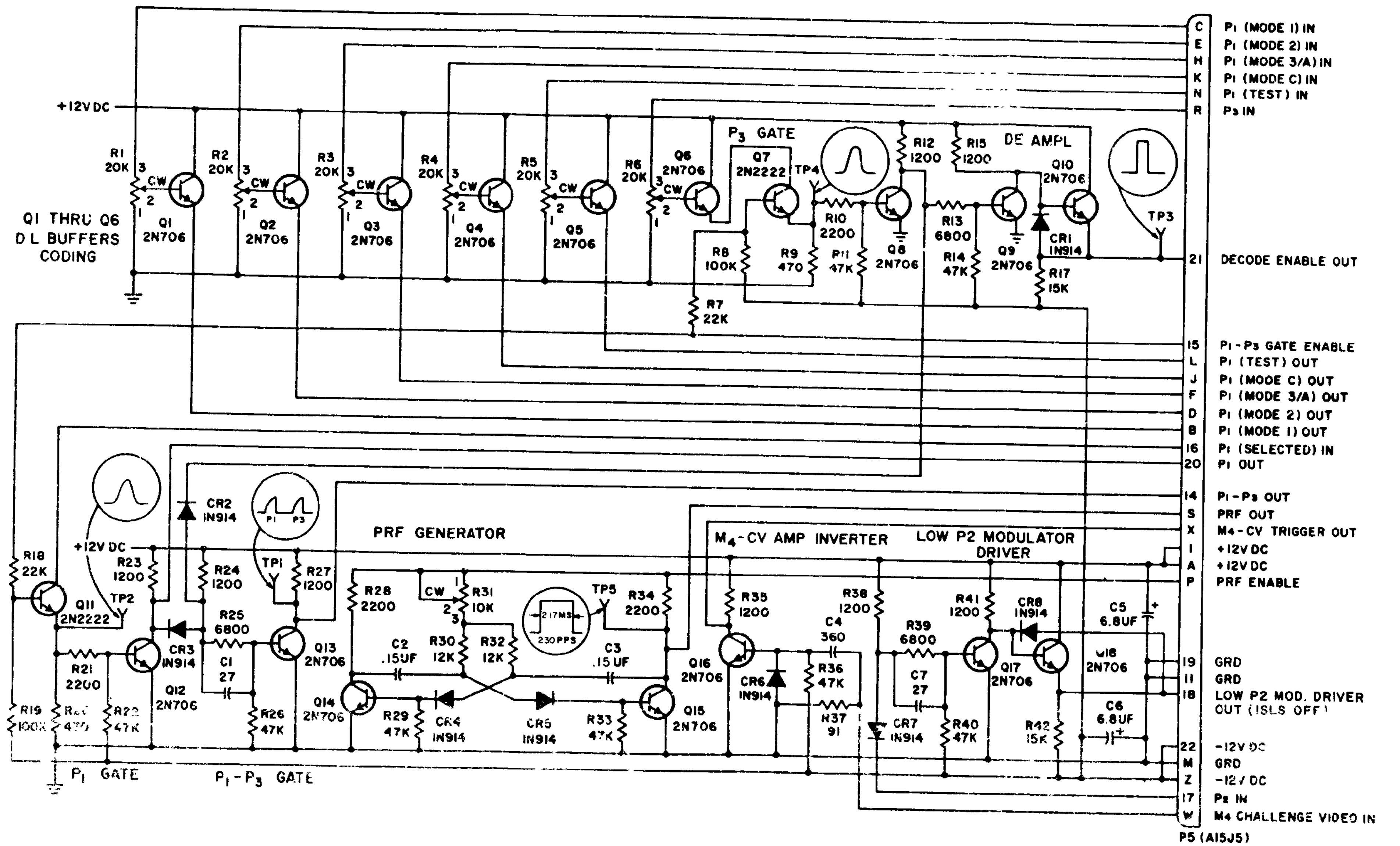


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Figure 8-9. Encoder module A5, schematic diagram

NOTES:
UNLESS OTHERWISE SPECIFIED
1. ALL RESISTANCE VALUES ARE IN OHMS
2. ALL CAPACITANCE VALUES ARE IN MICROMICROFARADS
3. ALL INDUCTANCE VALUES ARE IN MICROHENRYS
4. PREFIX ALL REFERENCE DESIGNATIONS WITH A7
EXAMPLE: A7R1
A7C1
A7CR1

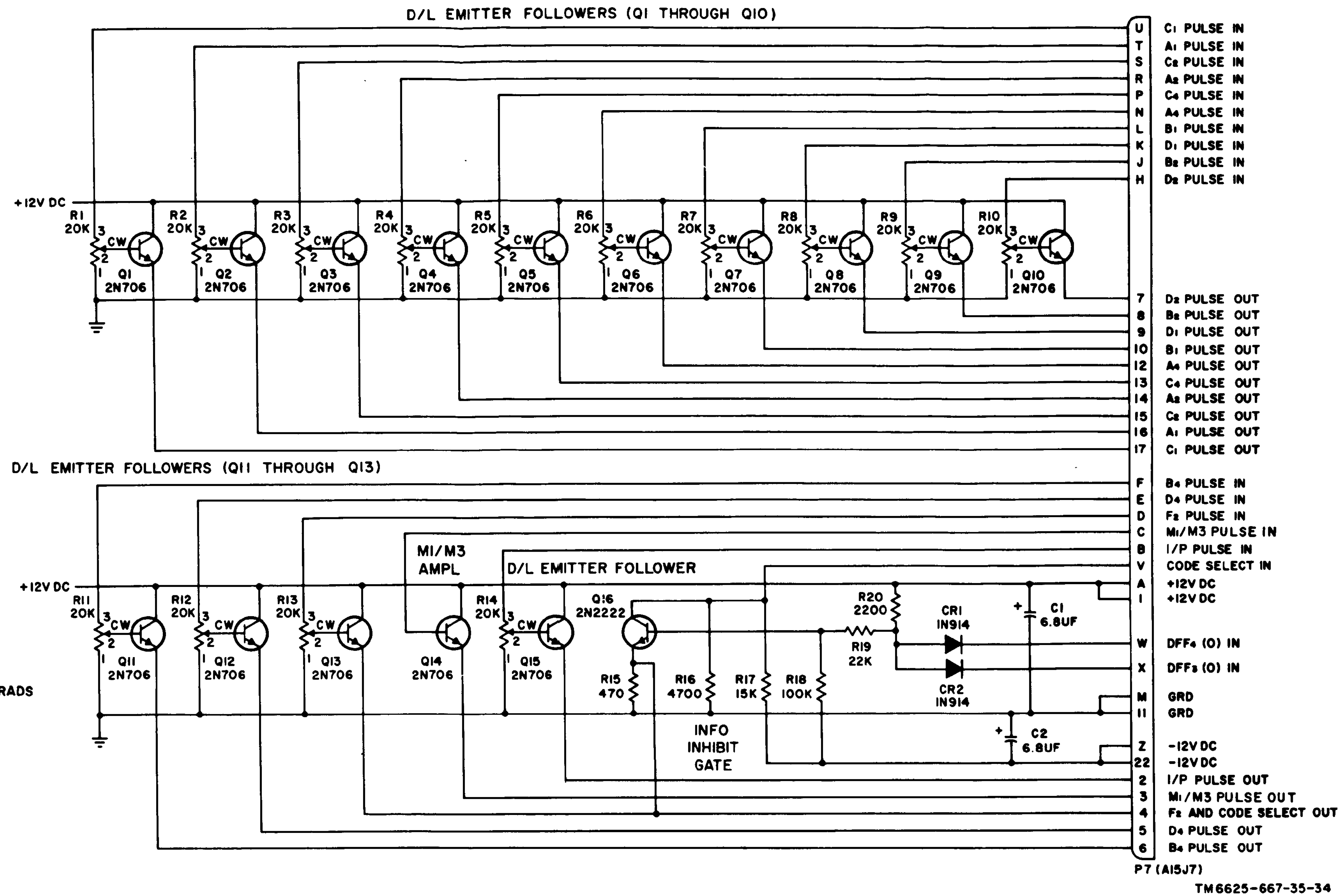
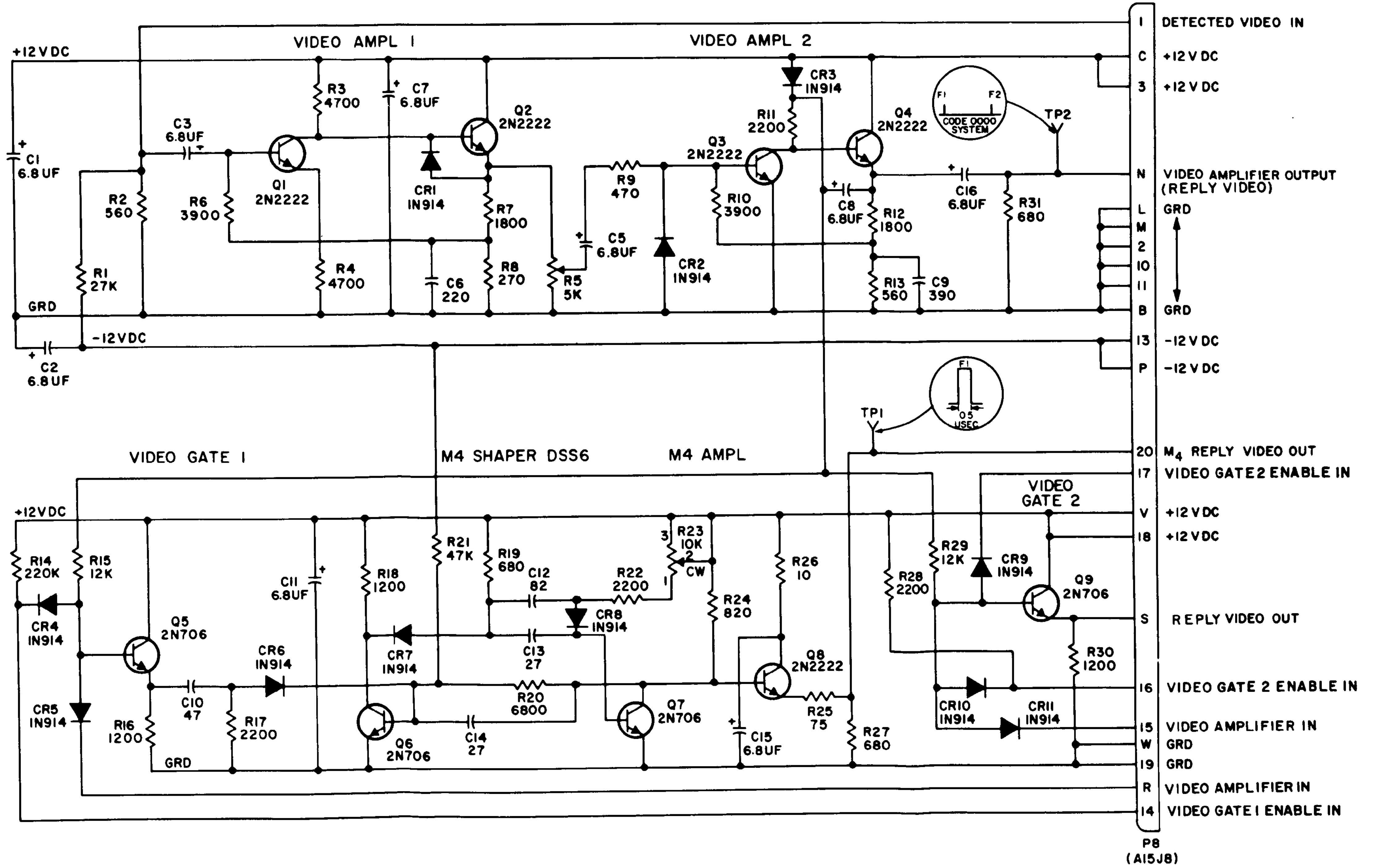


Figure 8-10. Decoder module A7, schematic diagram.

Figure 8-10.



NOTES:
UNLESS OTHERWISE SPECIFIED
1. ALL RESISTANCE VALUES ARE IN OHMS
2. ALL CAPACITANCE VALUES ARE IN MICROMICROFARADS
3. ALL INDUCTANCE VALUES ARE IN MICROHENRYS
4. ALL WAVEFORMS ARE IDEALIZED
5. PREFIX ALL REFERENCE DESIGNATIONS WITH A8
EXAMPLE: A8R1
A8C1
A8CR1

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NOTES:
UNLESS OTHERWISE SPECIFIED
1. ALL RESISTANCE VALUES ARE IN OHMS
2. ALL CAPACITANCE VALUES ARE IN MICROMICROFARADS
3. ALL INDUCTANCE VALUES ARE IN MICROHENRYS
4. ALL WAVEFORMS ARE IDEALIZED
5. PREFIX ALL REFERENCE DESIGNATIONS WITH A9
EXAMPLE: A9R1
A9C1
A9CR1

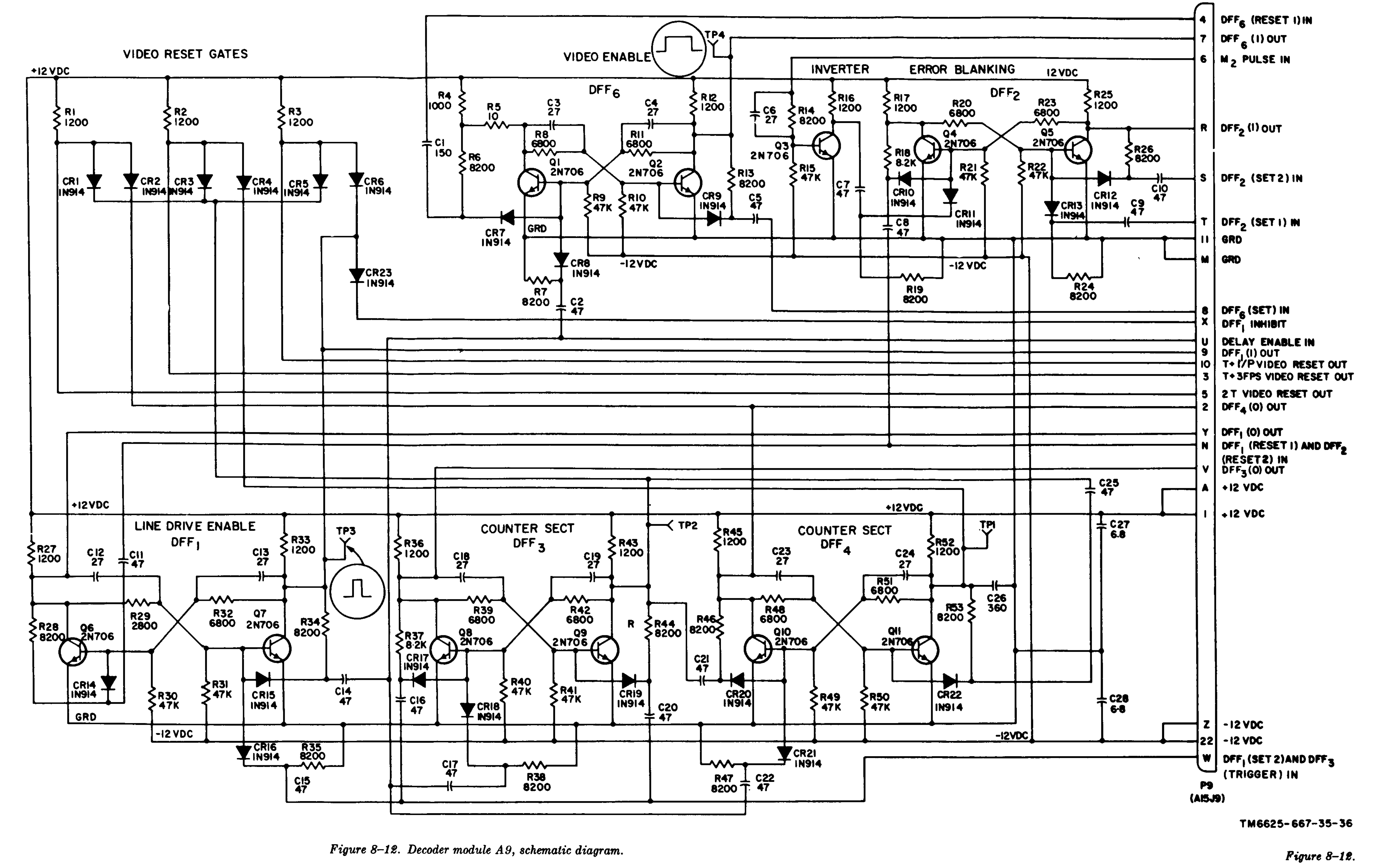

Figure 8-12. Decoder module A9, schematic diagram.

Figure 8-12.

NOTES:
UNLESS OTHERWISE SPECIFIED
1. ALL RESISTANCE VALUES ARE IN OHMS
2. ALL CAPACITANCE VALUES ARE IN MICROMICROFARADS
3. ALL INDUCTANCE VALUES ARE IN MICROHENRYS
4. ALL WAVEFORMS ARE IDEALIZED
5. PREFIX ALL REFERENCE DESIGNATIONS WITH A10
EXAMPLE: A10R1
A10C1
A10CR1

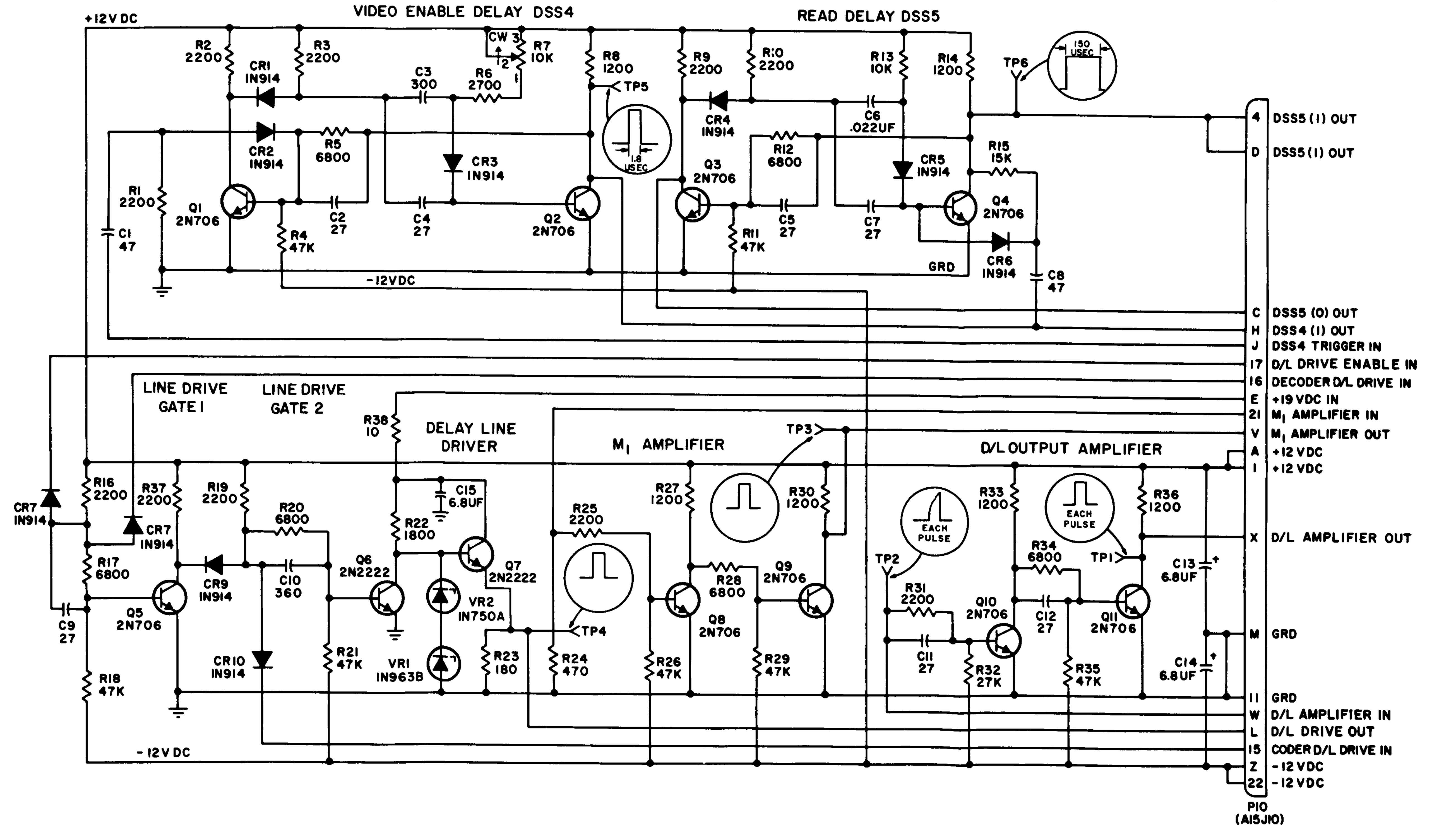

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Figure 8-13. Decoder module A10, schematic diagram.

NOTES:
UNLESS OTHERWISE SPECIFIED
1. ALL RESISTANCE VALUES ARE IN OHMS
2. ALL CAPACITANCE VALUES ARE IN MICROMICROFARADS
3. ALL INDUCTANCE VALUES ARE IN MICROHENRYS
4. ALL WAVEFORMS ARE IDEALIZED
5. PREFIX ALL REFERENCE DESIGNATIONS WITH A11
EXAMPLE: A11R1
A11C1
A11CR1

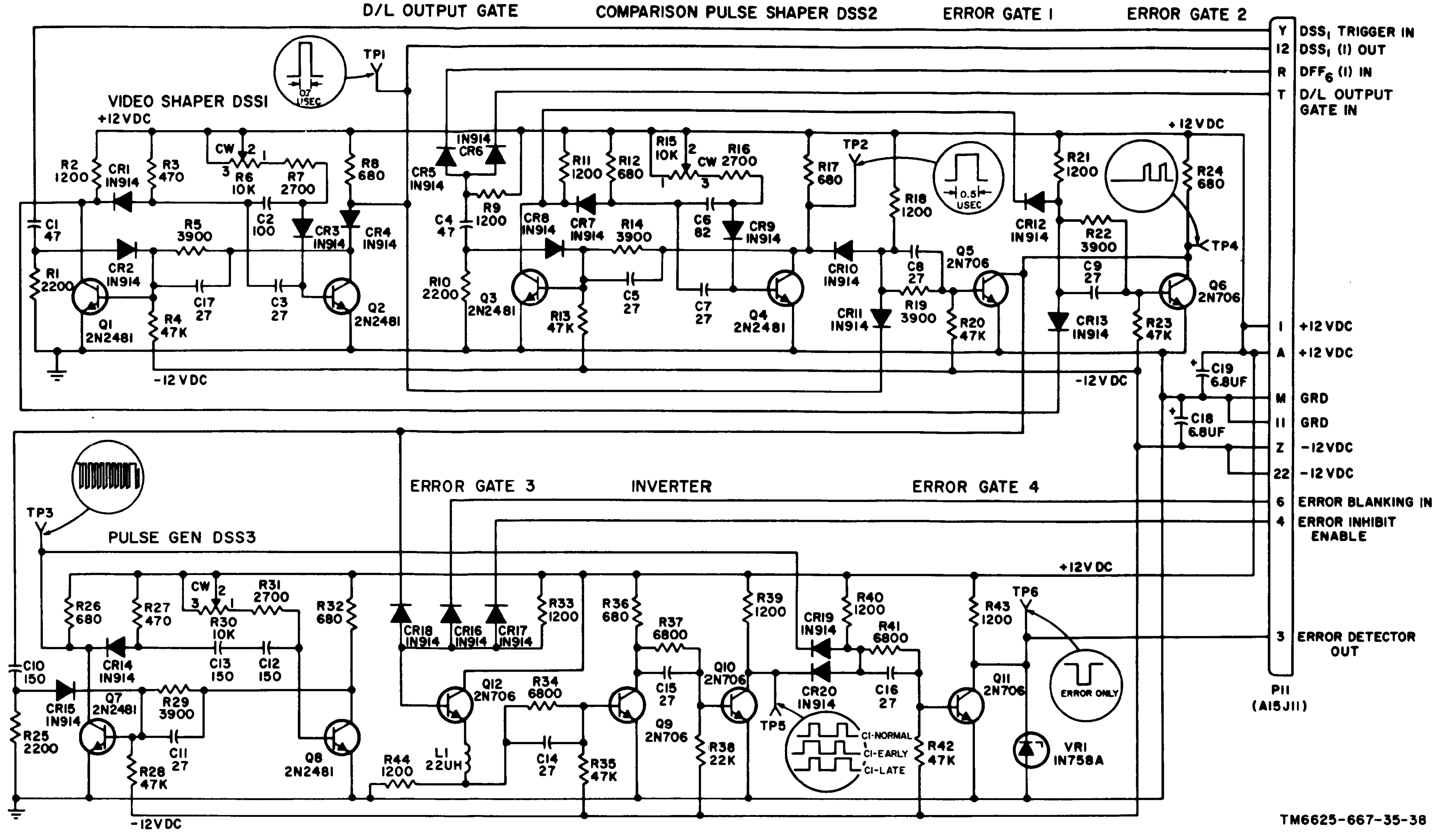


Figure 8-14. Decoder module A11, schematic diagram.

Figure 8-14.

NOTES:
UNLESS OTHERWISE SPECIFIED
1. ALL RESISTANCE VALUES ARE IN OHMS
2. ALL CAPACITANCE VALUES ARE IN MICROMICROFARADS
3. ALL INDUCTANCE VALUES ARE IN MICROHENRYS
4. ALL WAVEFORMS ARE IDEALIZED
5. PREFIX ALL REFERENCE DESIGNATIONS WITH A12
EXAMPLE: A12R1
A12C1
A12CR1

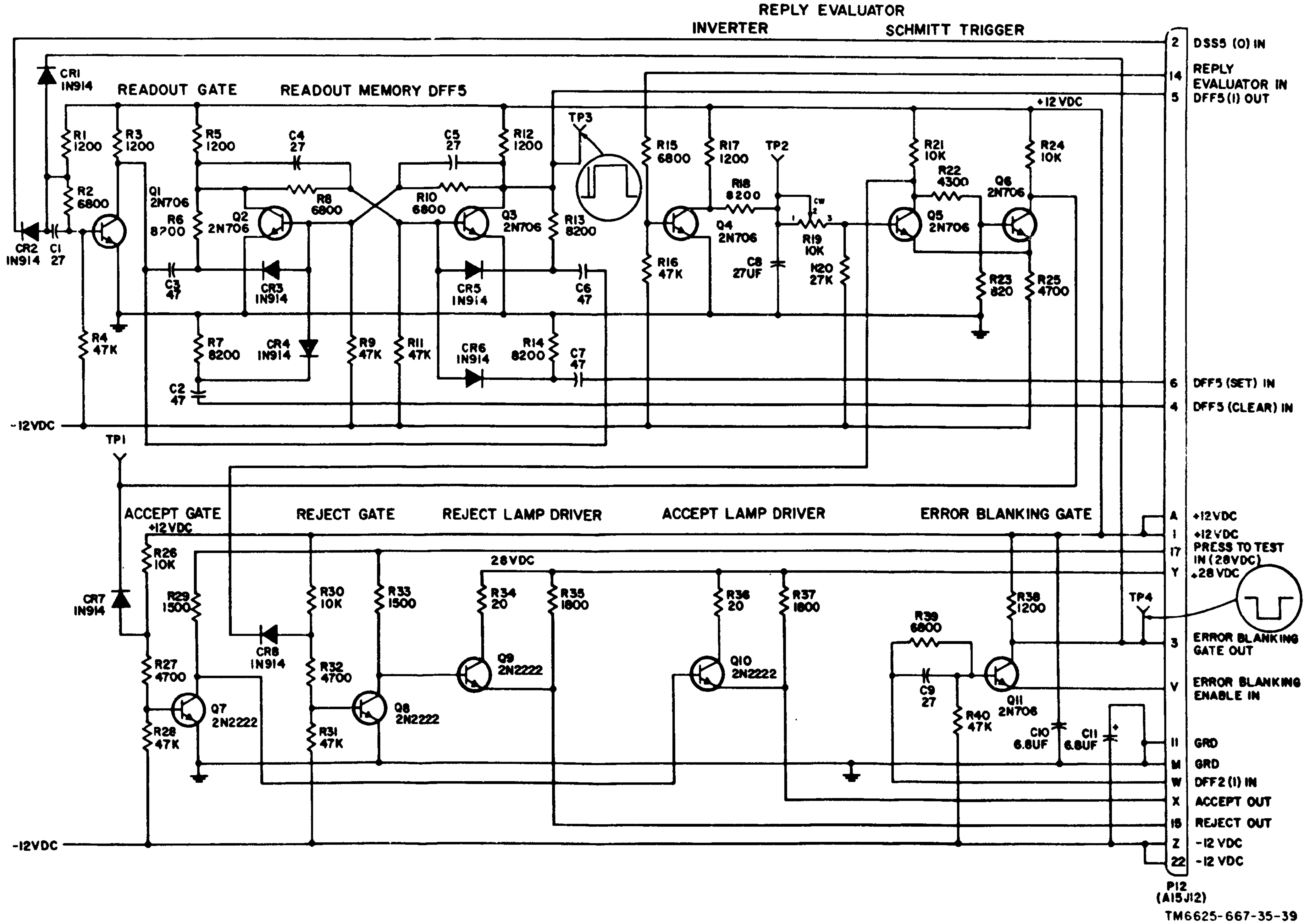
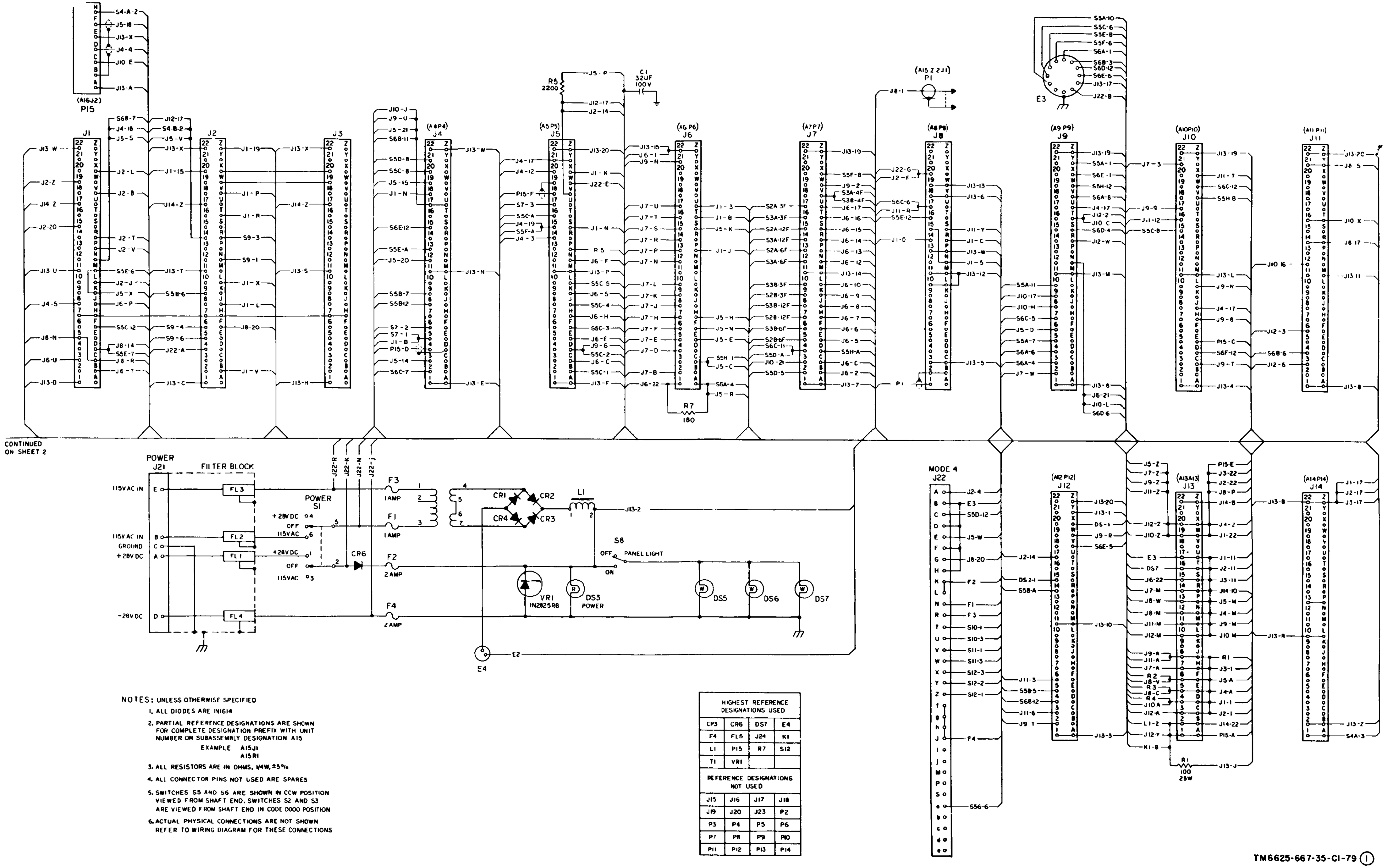


Figure 8-15. Decoder module A12, schematic diagram.



NOTES: UNLESS OTHERWISE SPECIFIED

1. ALL DIODES ARE IN1614
2. PARTIAL REFERENCE DESIGNATIONS ARE SHOWN FOR COMPLETE DESIGNATION PREFIX WITH UNIT NUMBER OR SUBASSEMBLY DESIGNATION A15

   EXAMPLE A15J1
   A15R1
3. ALL RESISTORS ARE IN OHMS, 1/4W, ±5%
4. ALL CONNECTOR PINS NOT USED ARE SPARES
5. SWITCHES S5 AND S6 ARE SHOWN IN CCW POSITION VIEWED FROM SHAFT END. SWITCHES S2 AND S3 ARE VIEWED FROM SHAFT END IN CODE 0000 POSITION
6. ACTUAL PHYSICAL CONNECTIONS ARE NOT SHOWN REFER TO WIRING DIAGRAM FOR THESE CONNECTIONS

HIGHEST REFERENCE DESIGNATIONS USED			
CP3	CR6	DS7	E4
F4	FL5	J24	K1
L1	P15	R7	S12
T1	VR1		
REFERENCE DESIGNATIONS NOT USED			
J15	J16	J17	J18
J19	J20	J23	P2
P3	P4	P5	P6
P7	P8	P9	P10
P11	P12	P13	P14

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Figure 8-16 ①. Front panel A15, schematic diagram (part 1 of 2).

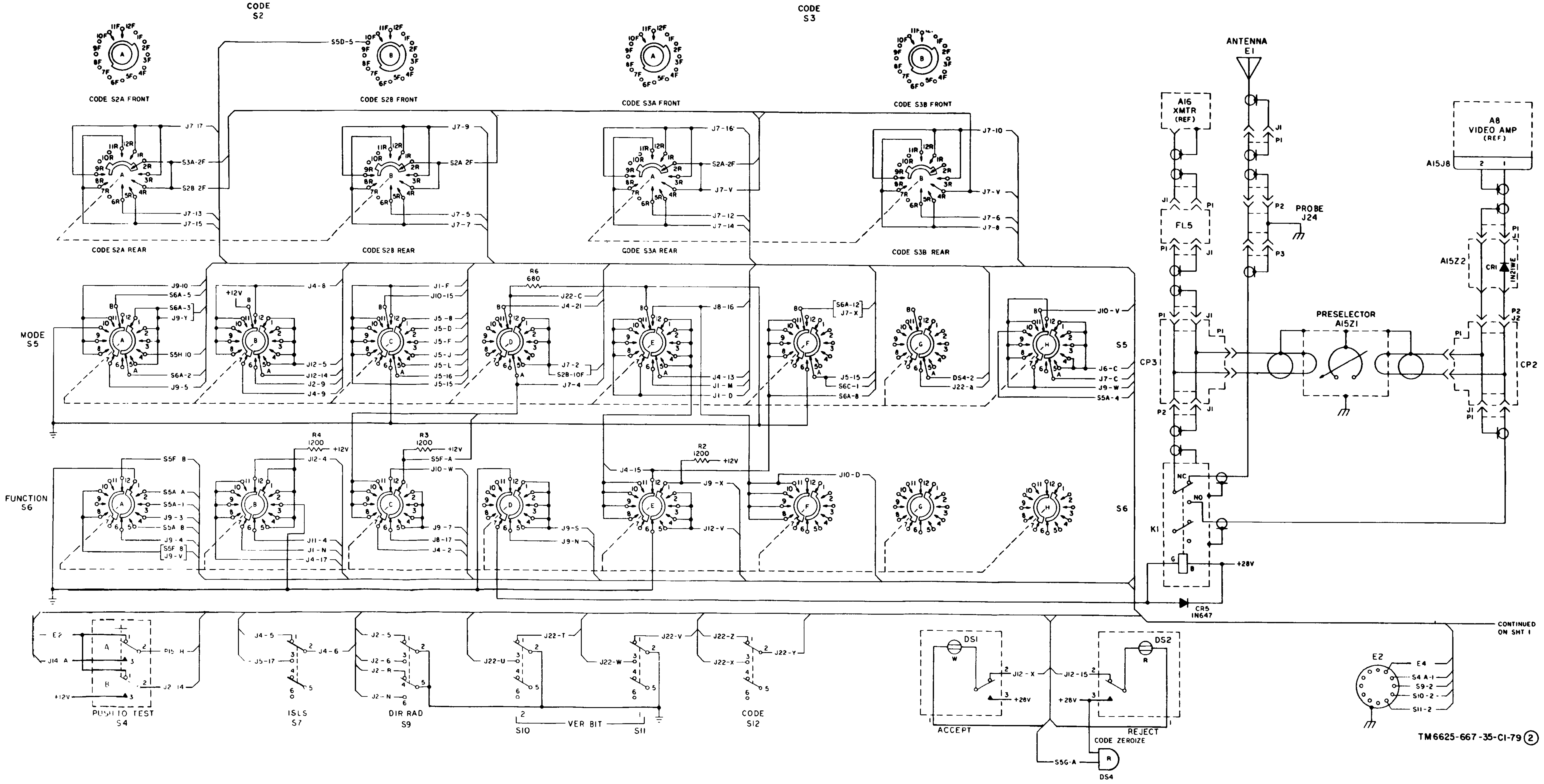
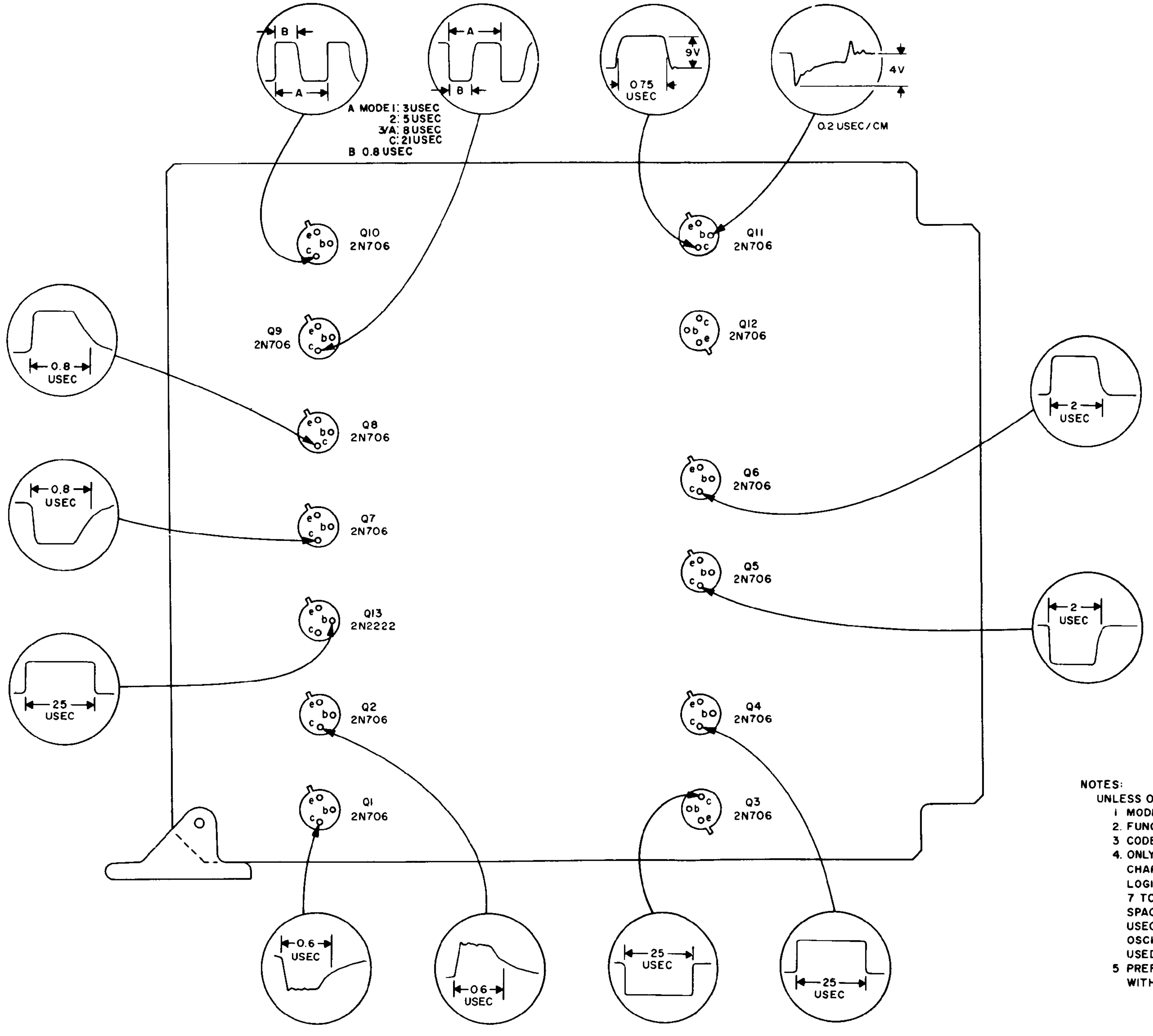


Figure 8-16 (2). Front panel A15, schematic diagram (part 2 of 2).



NOTES:
UNLESS OTHERWISE INDICATED
1 MODE SWITCH SET AT 1
2. FUNCTION SWITCH SET AT SYSTEM
3 CODE SWITCHES SET AT 7777
4. ONLY THE ESSENTIAL WAVEFORM CHARACTERISTICS ARE INDICATED, LOGIC LEVELS RANGE BETWEEN 7 TO 12 VOLTS. DURATION AND SPACING ARE INDICATED IF ESSENTIAL. USEC/CM VALUES GIVEN INDICATE OSCILLOSCOPE CONTROL SETTINGS USED TO OBSERVE WAVEFORM.
5 PREFIX ALL REFERENCE DESIGNATIONS WITH A4

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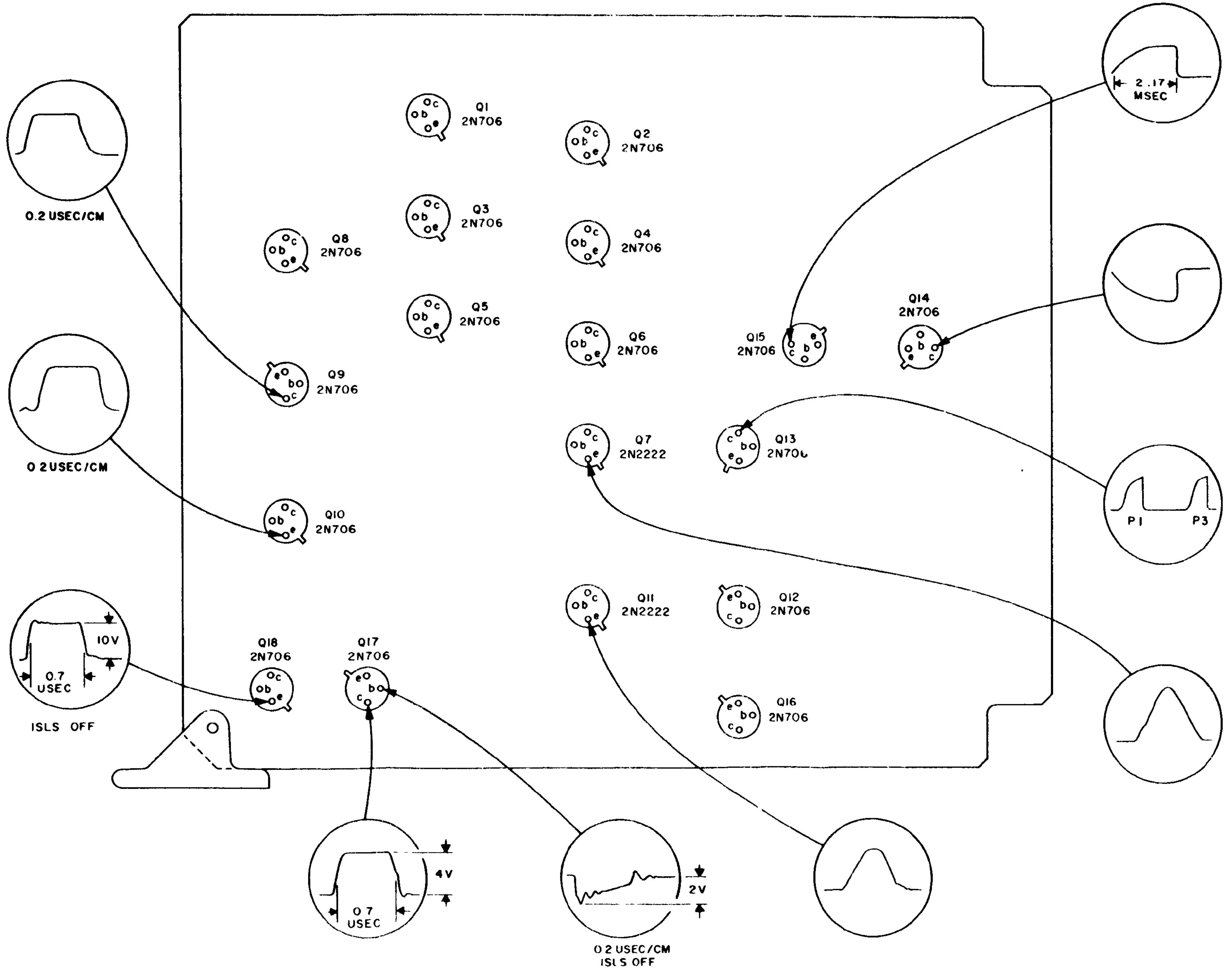
Figure 8-17. Encoder module A4, transistor socket waveforms.

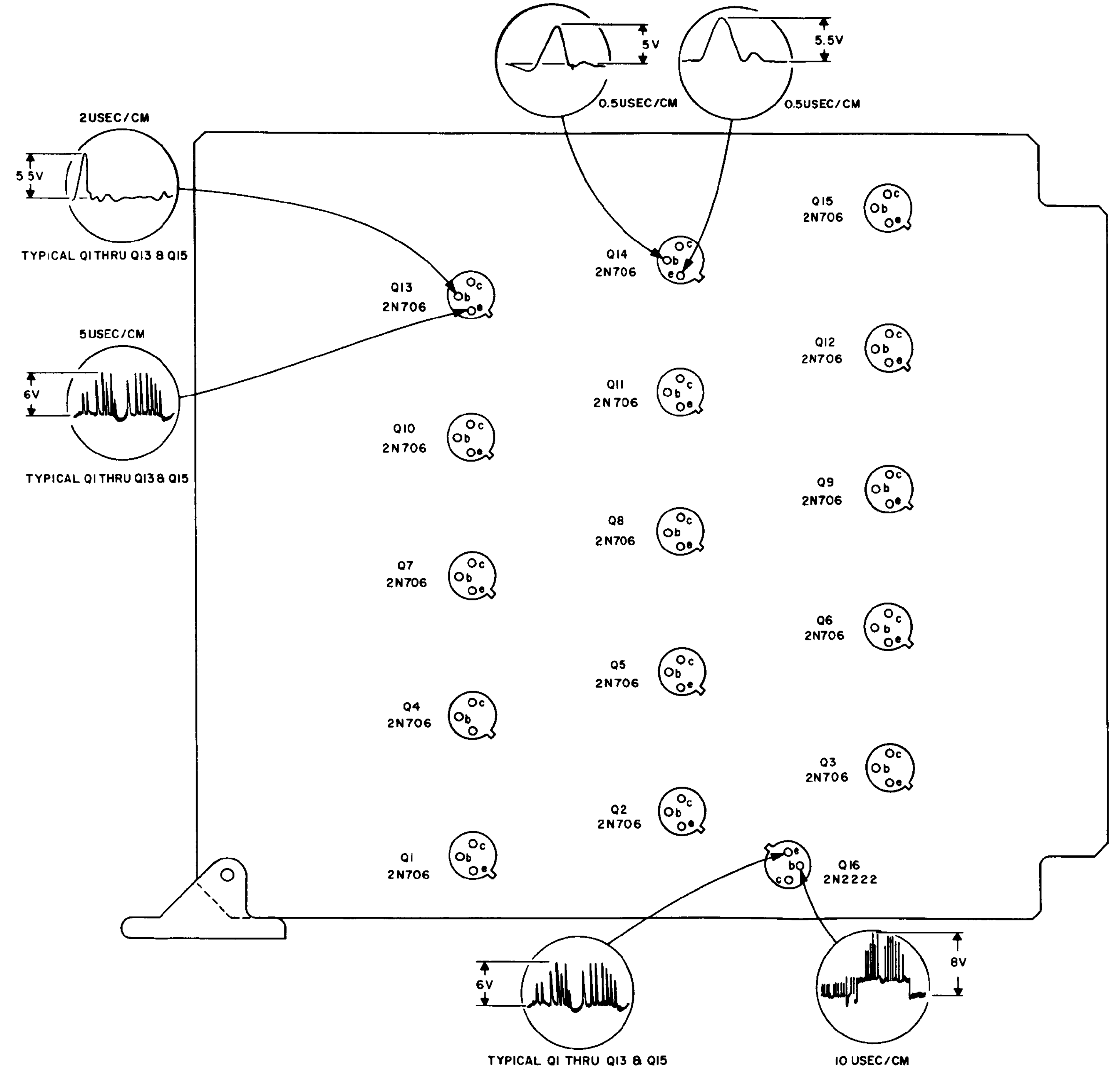
Figure 8-17.



NOTES:
UNLESS OTHERWISE INDICATED
1 MODE SWITCH SET AT 1
2. FUNCTION SWITCH SET AT SYSTEM
3 CODE SWITCHES SET AT 7777
4. ONLY THE ESSENTIAL WAVEFORM CHARACTERISTICS ARE INDICATED, LOGIC LEVELS RANGE BETWEEN 7 TO 12 VOLTS. DURATION AND SPACING ARE INDICATED IF ESSENTIAL USEC/CM VALUES GIVEN INDICATE OSCILLOSCOPE CONTROL SETTINGS USED TO OBSERVE WAVEFORM.
5 PREFIX ALL REFERENCE DESIGNATIONS WITH A5

TM6625 667-35-25

Figure 8-18. Encoder module, transistor socket waveforms.



NOTES:
UNLESS OTHERWISE INDICATED
1. MODE SWITCH SET AT I
2. FUNCTION SWITCH SET AT SYSTEM
3. CODE SWITCHES SET AT 7777
4. ONLY THE ESSENTIAL WAVEFORM CHARACTERISTICS ARE INDICATED, LOGIC LEVELS RANGE BETWEEN 7 TO 12 VOLTS. DURATION AND SPACING ARE INDICATED IF ESSENTIAL. USEC/CM VALUES GIVEN INDICATE OSCILLOSCOPE CONTROL SETTINGS USED TO OBSERVE WAVEFORM.
5. PREFIX ALL REFERENCE DESIGNATIONS WITH A7

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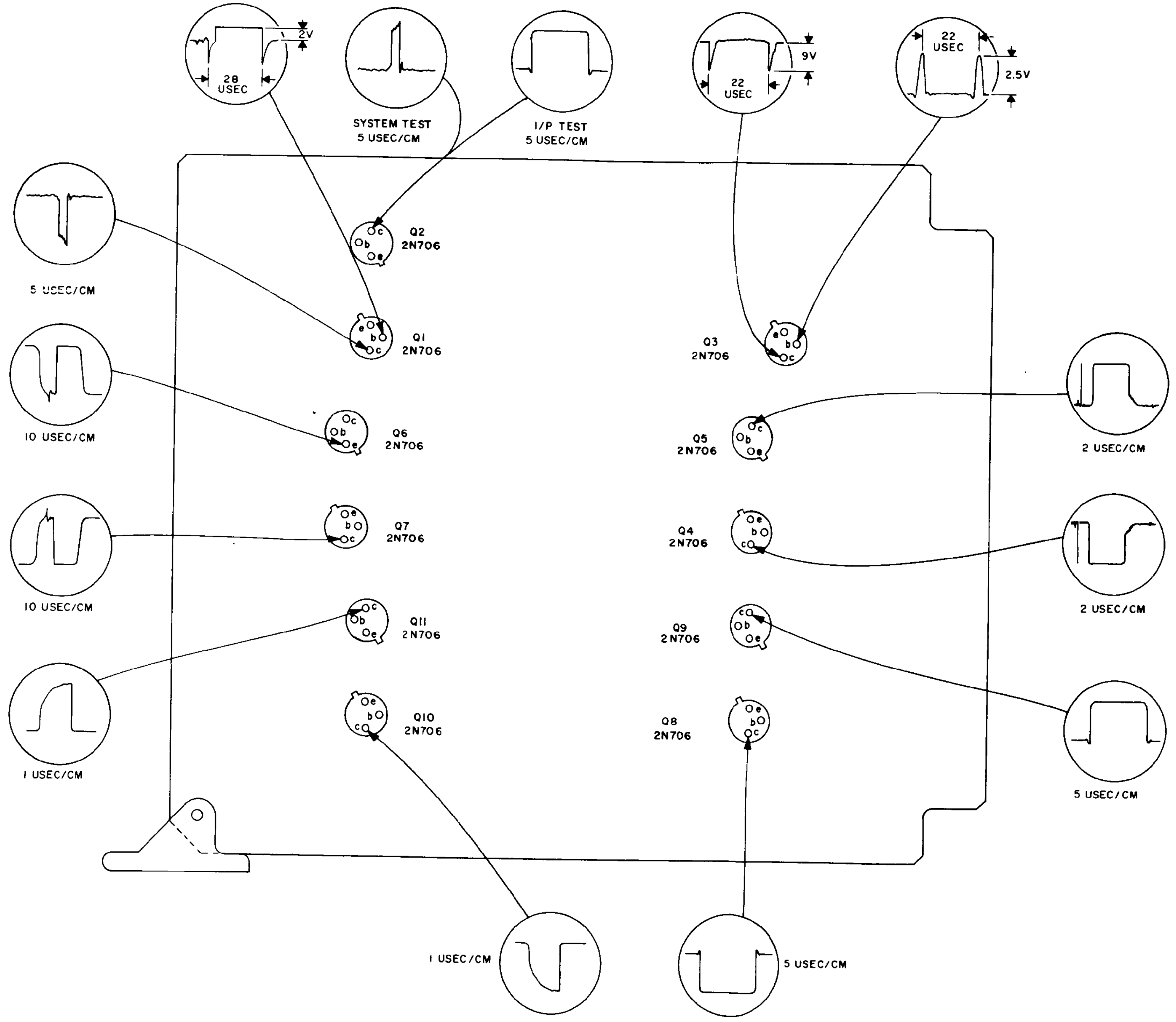
Figure 8-19. Decoder module A7, transistor socket waveforms.

Figure 8-19.



NOTES
UNLESS OTHERWISE INDICATED
1 MODE SWITCH SET AT I
2 FUNCTION SWITCH SET AT SYSTEM
3 CODE SWITCHES SET AT 7777
4 ONLY THE ESSENTIAL WAVEFORM CHARACTERISTICS ARE INDICATED, LOGIC LEVELS RANGE BETWEEN 7 TO 12 VOLTS. DURATION AND SPACING ARE INDICATED IF ESSENTIAL. USEC/CM VALUES GIVEN INDICATE OSCILLOSCOPE CONTROL SETTINGS USED TO OBSERVE WAVEFORM.
5 PREFIX ALL REFERENCE DESIGNATIONS WITH A9

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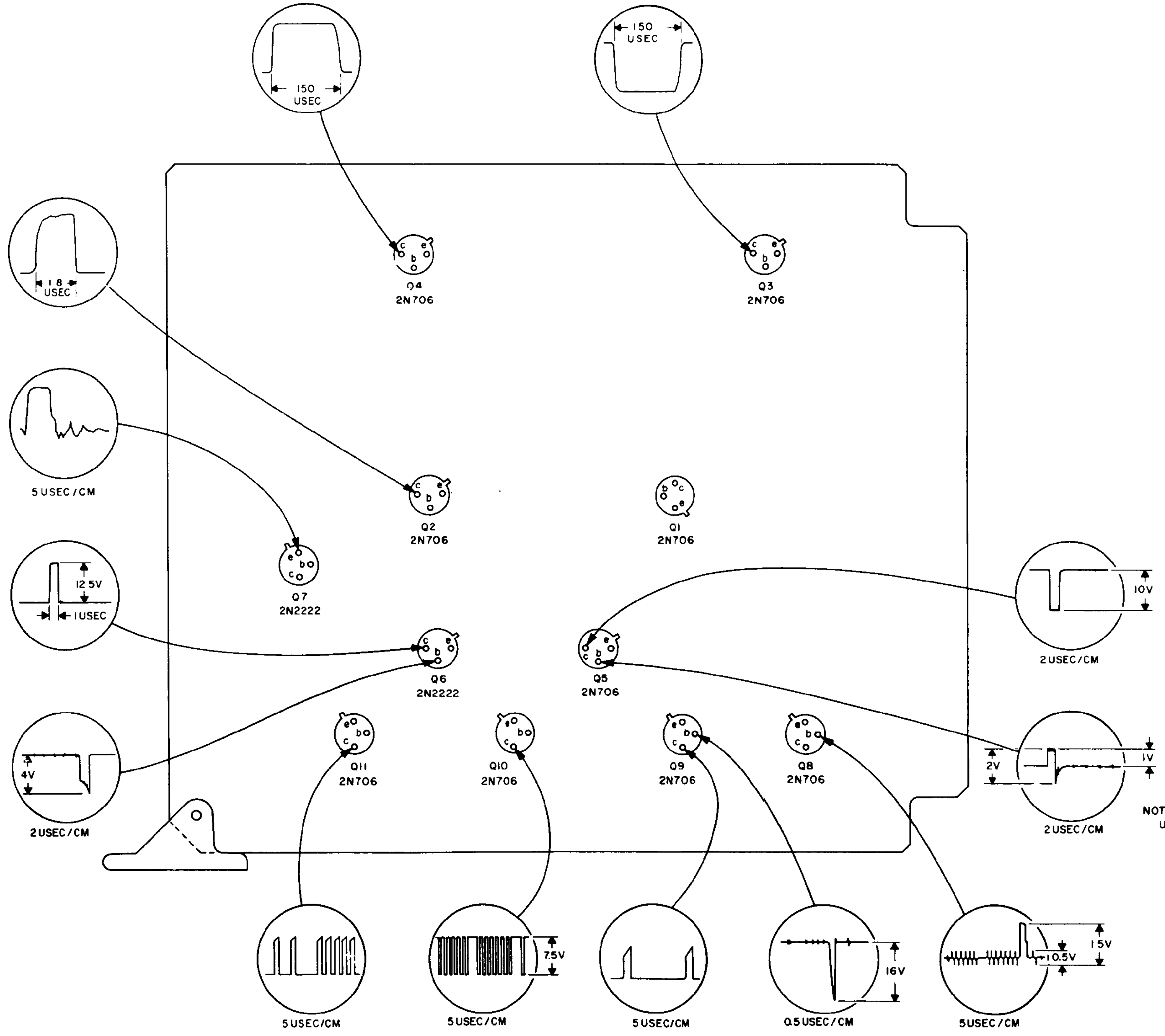
Figure 8-20. Decoder module A9, transistor socket waveforms.

Figure 8-20.



NOTES:
UNLESS OTHERWISE INDICATED
1. MODE SWITCH SET AT I
2. FUNCTION SWITCH SET AT SYSTEM
3. CODE SWITCHES SET AT 7777
4. ONLY THE ESSENTIAL WAVEFORM CHARACTERISTICS ARE INDICATED, LOGIC LEVELS RANGE BETWEEN 7 TO 12 VOLTS. DURATION AND SPACING ARE INDICATED IF ESSENTIAL. USEC/CM VALUES GIVEN INDICATE OSCILLOSCOPE CONTROL SETTINGS USED TO OBSERVE WAVEFORM.
5. PREFIX ALL REFERENCE DESIGNATIONS WITH A10

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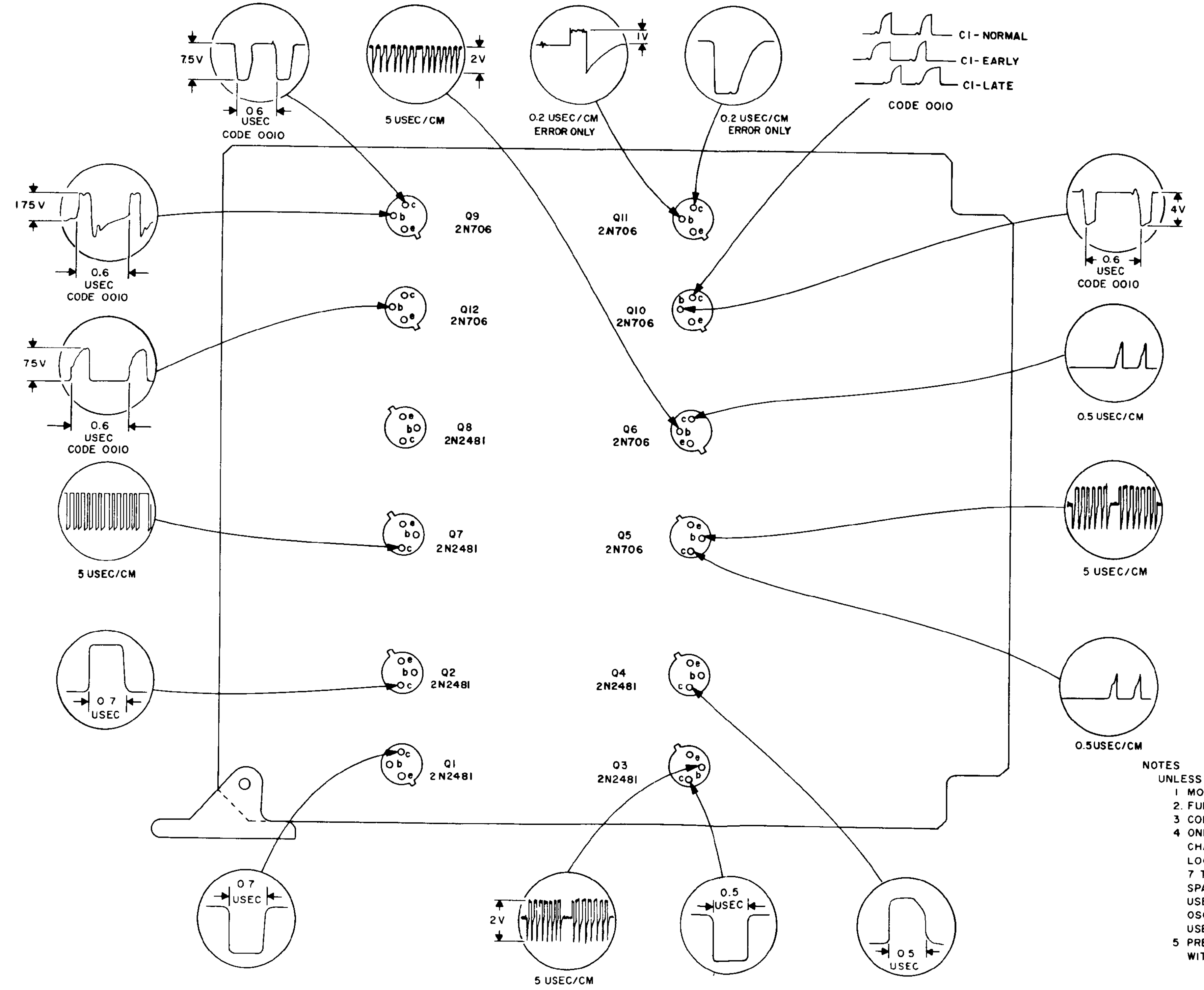
Figure 8-21. Decoder module A10, transistor socket waveforms.

Figure 8-21.

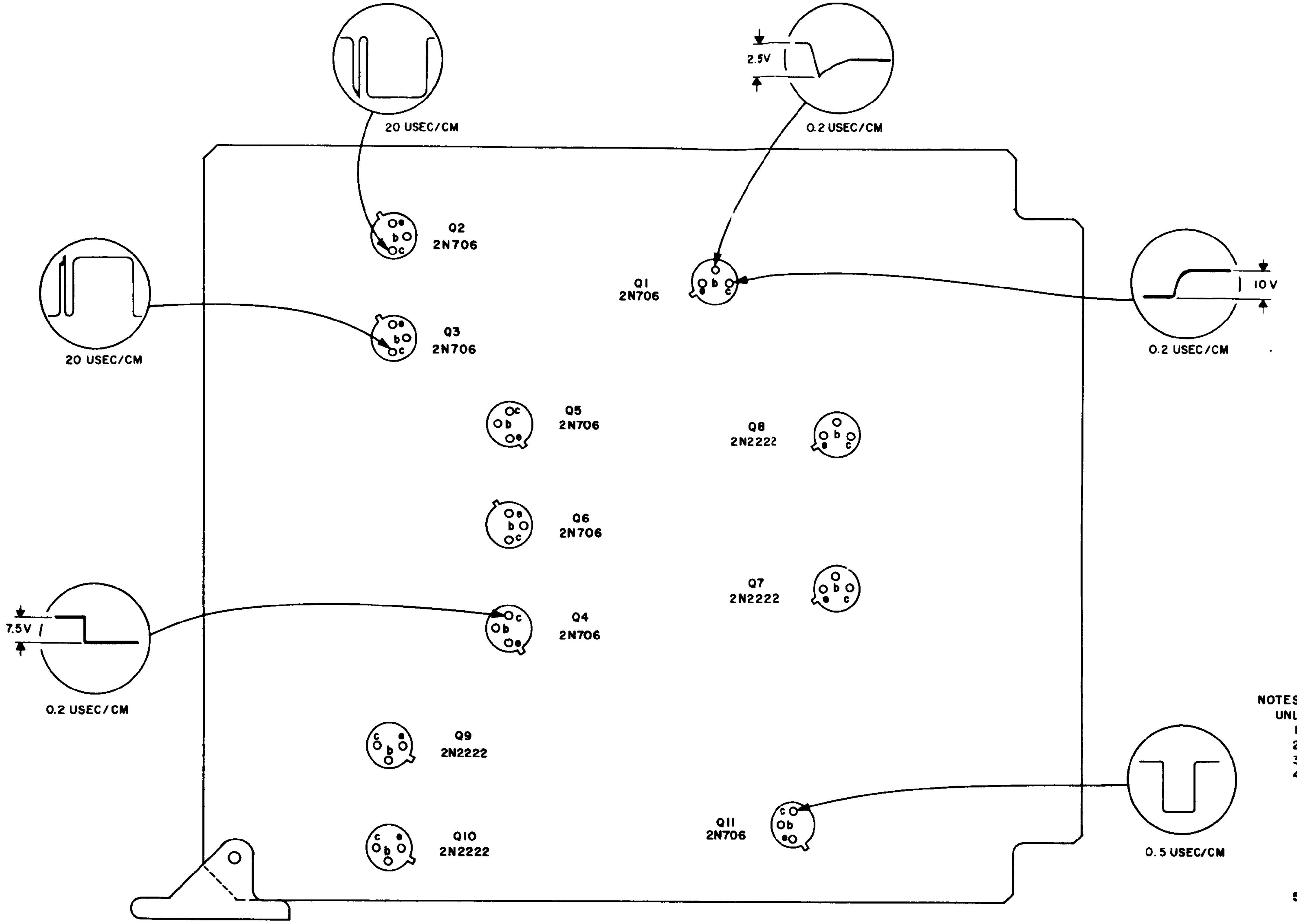


NOTES
UNLESS OTHERWISE INDICATED
1 MODE SWITCH SET AT 1
2. FUNCTION SWITCH SET AT SYSTEM
3 CODE SWITCHES SET AT 7777
4 ONLY THE ESSENTIAL WAVEFORM CHARACTERISTICS ARE INDICATED, LOGIC LEVELS RANGE BETWEEN 7 TO 12 VOLTS. DURATION AND SPACING ARE INDICATED IF ESSENTIAL. USEC/CM VALUES GIVEN INDICATE OSCILLOSCOPE CONTROL SETTINGS USED TO OBSERVE WAVEFORM.
5 PREFIX ALL REFERENCE DESIGNATIONS WITH A11

TM6625-667-35-28

Figure 8-22. Decoder module A11, transistor socket waveforms.

Figure 8-22.



NOTES:
UNLESS OTHERWISE INDICATED
1. MODE SWITCH SET AT 1
2. FUNCTION SWITCH SET AT SYSTEM
3. CODE SWITCHES SET AT 7777
4. ONLY THE ESSENTIAL WAVEFORM CHARACTERISTICS ARE INDICATED, LOGIC LEVELS RANGE BETWEEN 7 TO 12 VOLTS. DURATION AND SPACING ARE INDICATED IF ESSENTIAL. USEC/CM VALUES GIVEN INDICATE OSCILLOSCOPE CONTROL SETTINGS USED TO OBSERVE WAVEFORM.
5. PREFIX ALL REFERENCE DESIGNATIONS WITH A12

TM6625-667-35-53

Figure 8-23. Decoder module A12, transistor socket waveforms.

Figure 8-23.

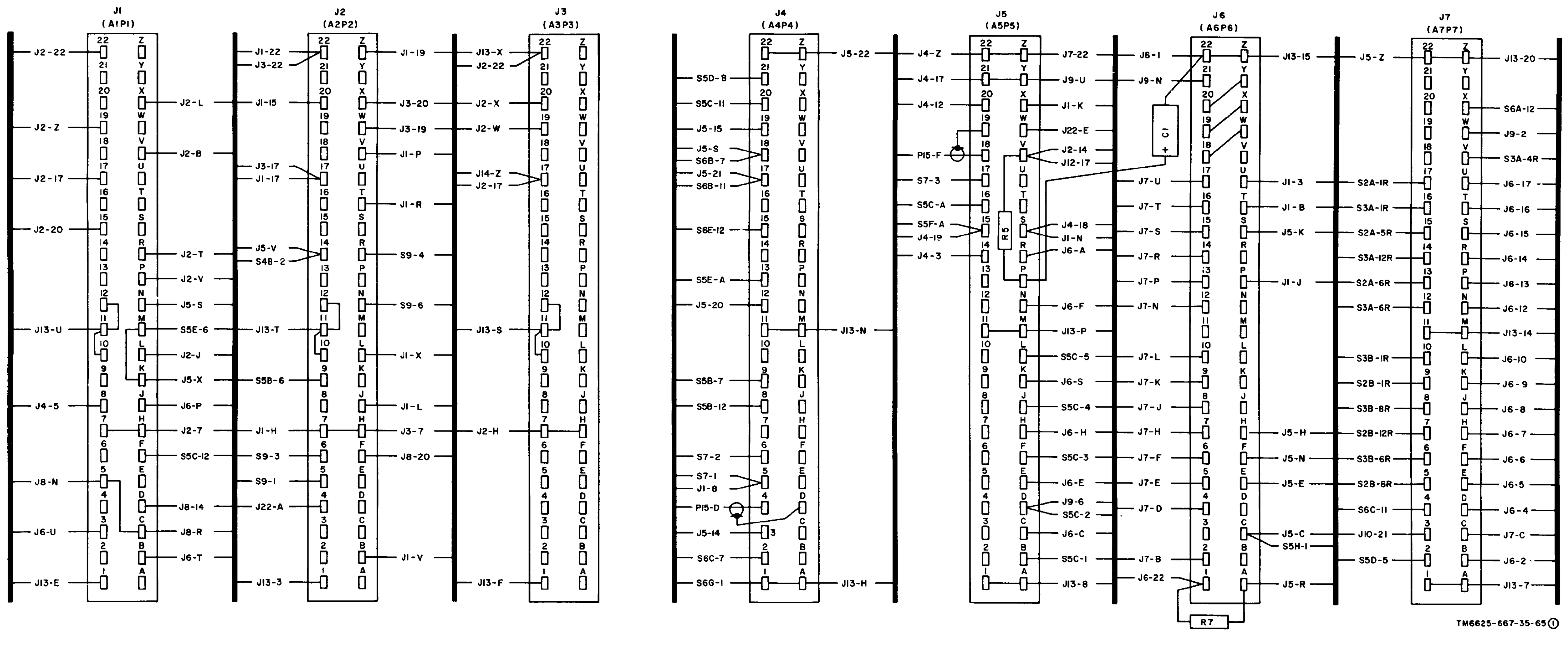
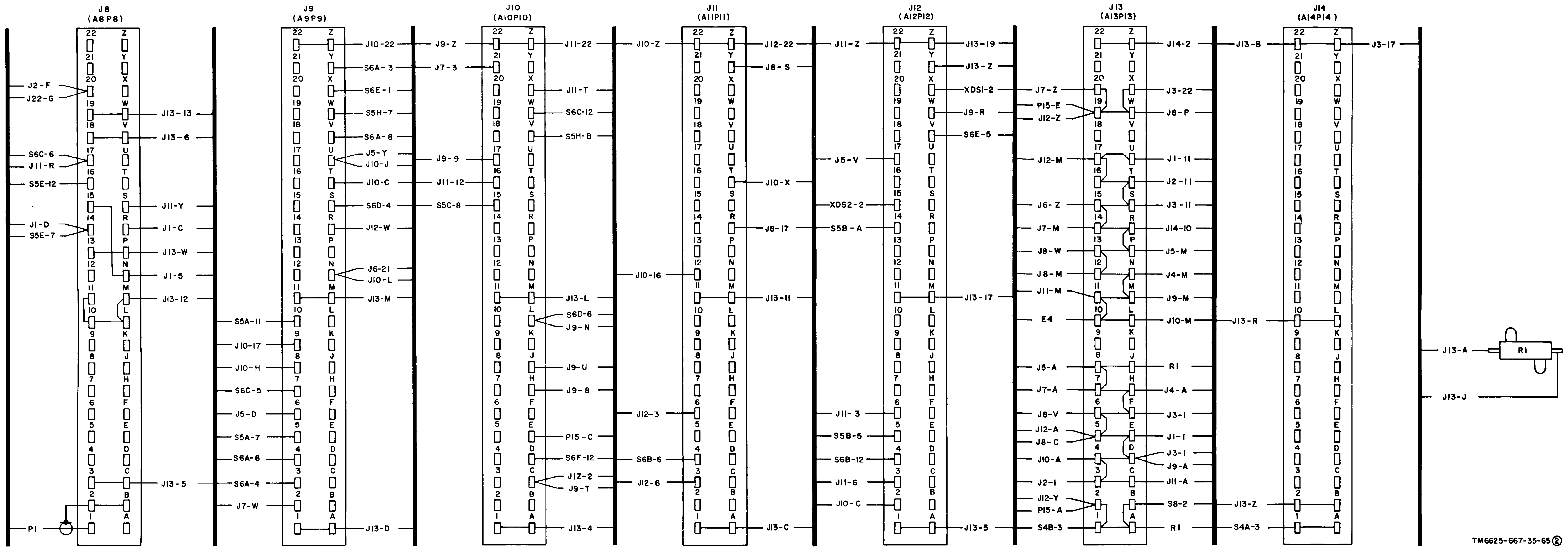


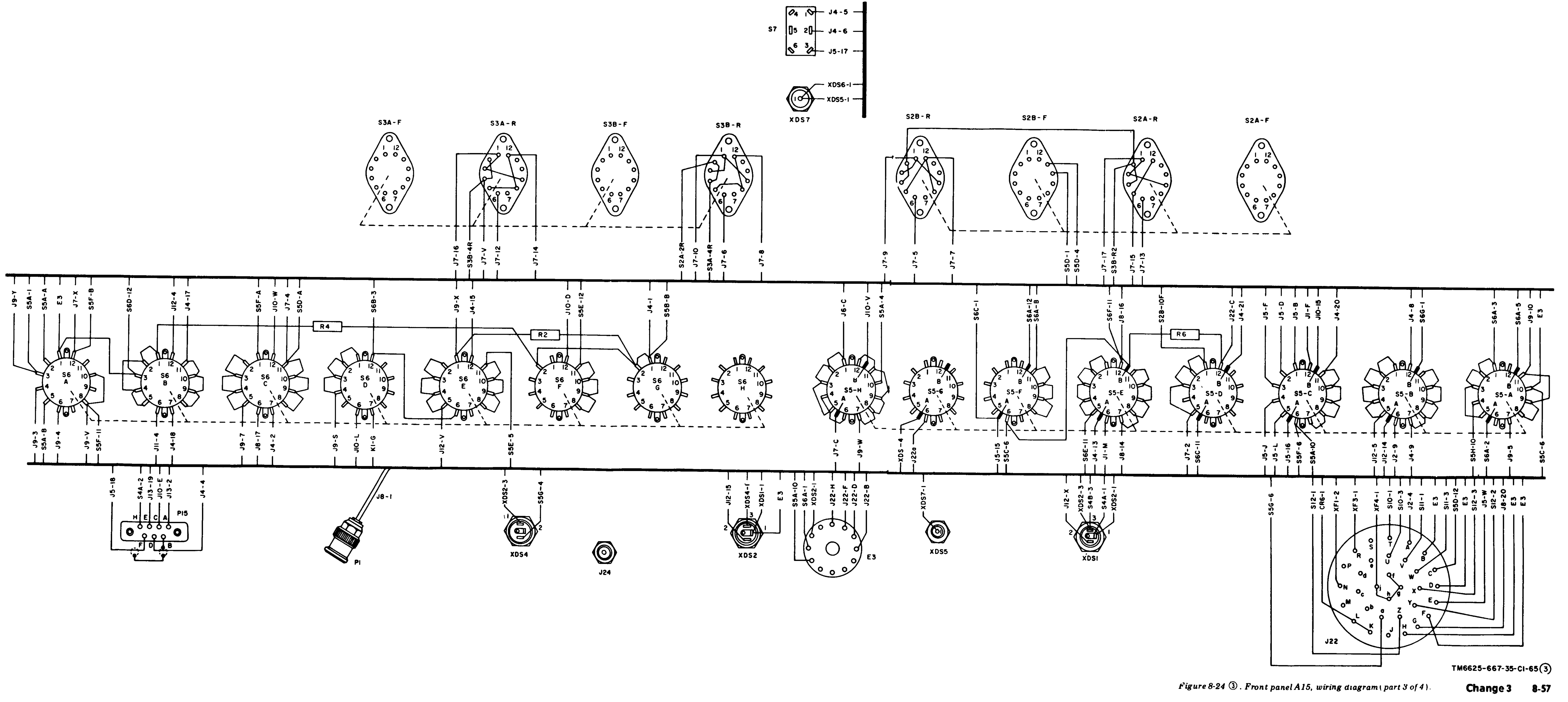
Figure 8-24 (1). Front panel A15, wiring diagram (part 1 of 4)



TM6625-667-35-65②

Figure 8-84②. Front panel A15, wiring diagram (part 2 of 4).

Figure 8-84. (2/4)



TM6625-667-35-C1-65(3)

Figure 8-24 (3). Front panel A15, wiring diagram (part 3 of 4).

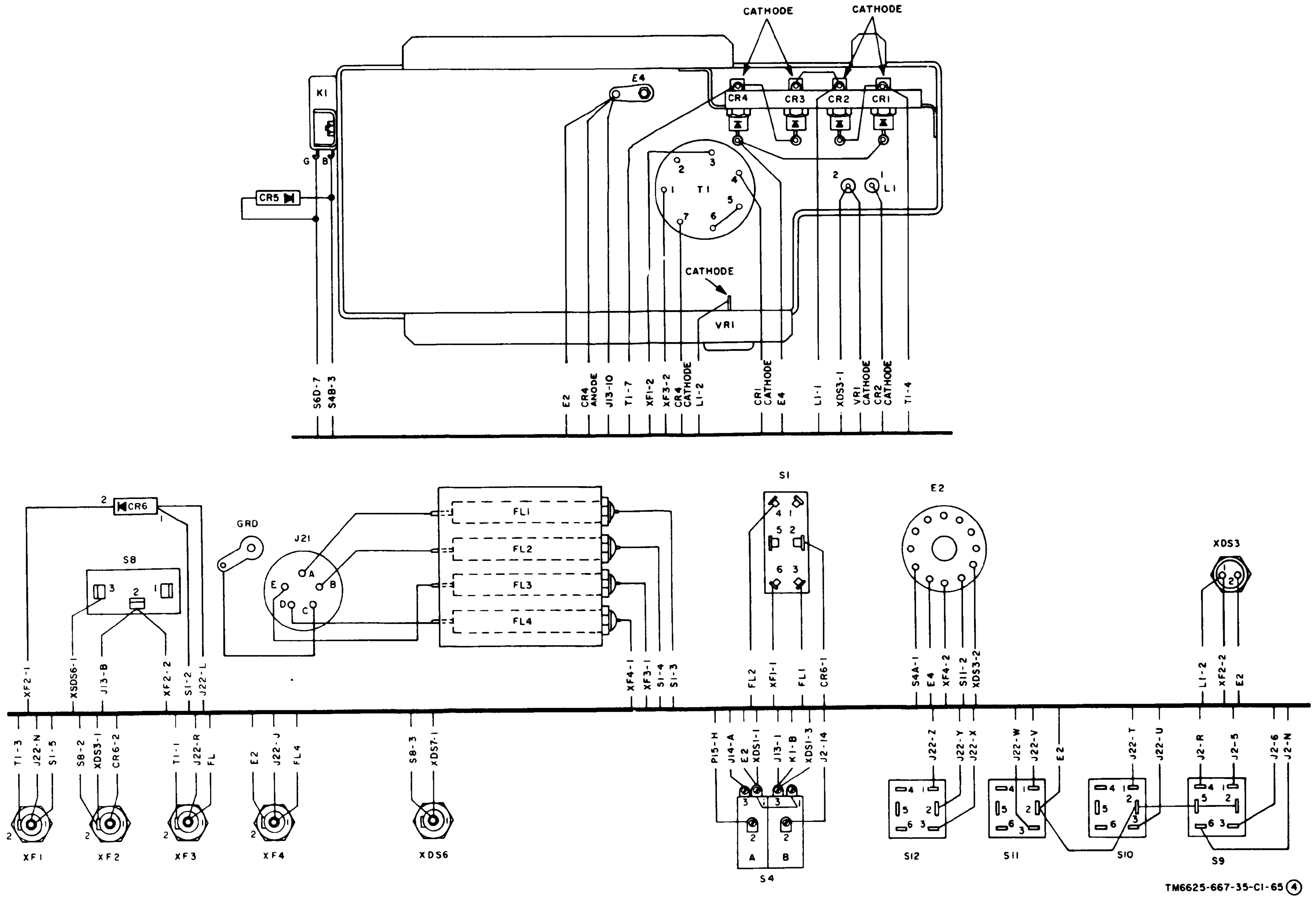


Figure 8-24(4). Front panel A15, wiring diagram (part 4 of 4).

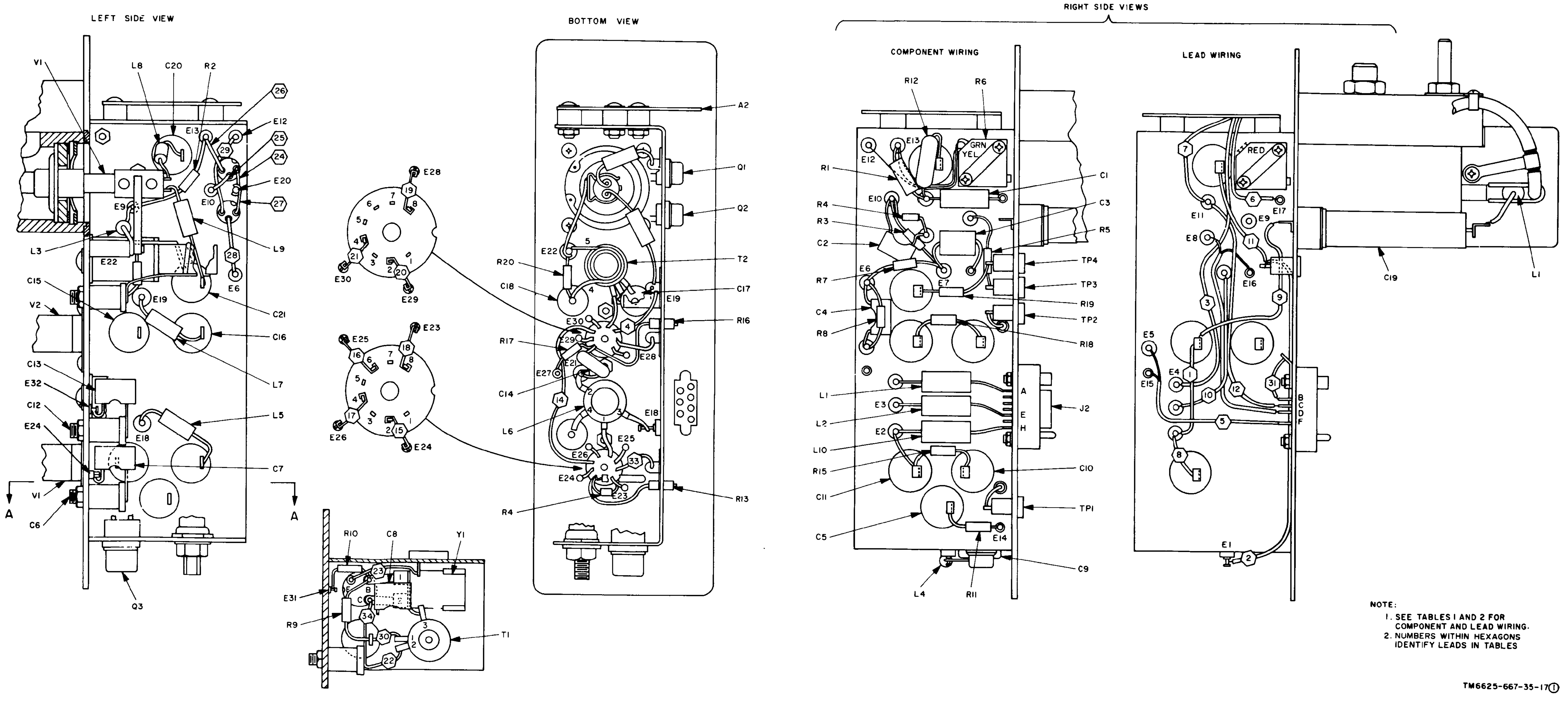
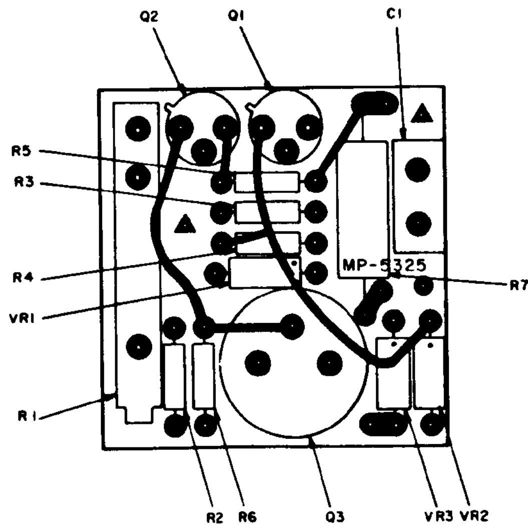
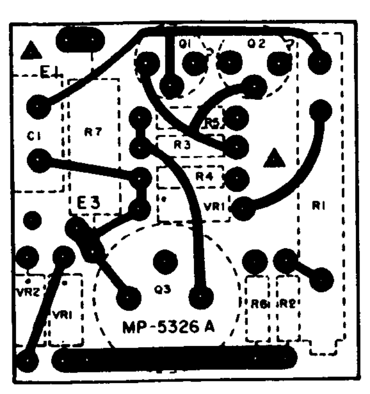


Figure 8-25①. Transmitter A16, wiring diagram and parts location (part 1 of 2).

Figure 8-25. (1/2)





BOARD A2

TABLE 1 COMPONENT WIRING DATA		
REF DES	FROM	TO
A16 R1	E13	E11
R2	E13	E9
R3	E10	E7
R4	E10	E8
R5	E9	TP3
R6	3 (GRN)	E12
R6	2 (RED)	E13
R6	1 (YEL)	E13
R7	E6	E7
R8	E5	E6
R9	C9	XQ3 PIN B
R10	XQ3 PIN B	GRD E31
R11	C5	GRD E14
R12	C20	E11
R13	XV1 PIN 1	TP1
R14	XV1 PIN 1	GRD E23
R15	C10	C11
R16	XV2 PIN 1	TP2
R17	XV2 PIN 1	GRD E27
R18	C15	C16
R19	C21	TP4
C1	E11	GRD E17
C2	E8	E10
C3	E7	GRD E16
C4	E5	E6
C7	C6	GRD E24
C8	XV1 PIN1	T1 PIN 3
C13	C12	GRD E32
A1L1	—	C19
L1	E4	J2 PIN A
L2	E3	J2 PIN E
L3	E22	E9
C14	E21	XV2 PIN 1
L4	C9	E1
L5	C11	E18
L6	TERM 4	C12
L6	TERM 3	E18
L6	TERM 2	E21
L6	TERM 1	XV1 PIN5
L7	C16	E19
L8	C20	A1XV1-H1
L9	C21	A1XV1-H2
L10	E2	J2 PIN H
T2	TERM 1	C17
T2	TERM 2	E19
T2	TERM 3	XV2 PIN5
T2	TERM 4	C18
A16 T2	TERM 5	E22

TABLE 2 WIRING DATA		
WIRE NO.	FROM	TO
1	C16	E2
2	E1	TP4
3	E4	A2E1
4	C21	XV2 PIN6
5	E5	J2 PIN F
5	SHLD	GRD E15
6	GRD E17	A2E2
7	E11	A2E3
8	E2	C11
9	C16	C19
10	E3	E7
11	C20	TP4
12	J2 PIN C	E11
13	E8	J2 PIN D
13	SHLD	GRD E16
14	XV1 PIN 3	XV2 PIN3
15	GRD E24	XV1 PIN 2
16	GRD E25	XV1 PIN6
17	GRD E26	XV1 PIN 4
18	GRD E23	XV1 PIN 8
19	GRD E28	XV2PIN8
20	GRD E29	XV2 PIN2
21	GRD E30	XV2 PIN4
22	C6	T1 PIN2
23	XQ3 PIN E	C5
24	XQ1 PIN E	GRD E20
25	XQ1 PIN B	E10
26	XQ1 PIN C	E13
27	XQ2 PIN E	GRD E20
28	XQ2 PIN B	E6
29	XQ2 PIN C	E12
30	C9	T1 PIN 1
31	J2 PIN B	E33
32	C15	XV2 PIN7
33	C10	XV1 PIN7
34	C6	XQ3 PINC
35	E22	CLIP

NOTES:

1. WIRE NO. (NO. ENCLOSED BY HEXAGON) REFERS TO WIRE NO. SHOWN IN TABLE 2
2. RESPECTIVE VIEWS MAY ONLY DEPICT PARTIAL WIRING. ALL VIEWS SHOULD BE REFERRED TO FOR COMPLETE WIRING OF ITEMS
3. RUN WIRE DIRECTLY FROM TERMINAL TO TERMINAL IN THE SHORTEST POSSIBLE MANNER WITH SUFFICIENT SLACK TO PREVENT BREAKAGE UNDER VIBRATION
4. REFERENCE DESIGNATIONS SHOWN IN APPROX LOCATIONS FOR CLARITY
5. POSITIVE END OF A16C1 TO BE WIRE TO E11
6. RESPECTIVE VIEWS MAY ONLY DEPICT PARTIAL MOUNTING OF HARDWARE & COMPONENTS. ALL VIEWS SHOULD BE REFERRED TO FOR HARDWARE & COMPONENTS MOUNTING LOCATION
7. SOLDER TERMINAL OF SOCKET XY1 DIRECTLY TO PIN "B" & PIN "C" OF SOCKET XQ3
8. PREFIX ALL REFERENCE DESIGNATIONS WITH A16

TM6625-667-35-17(2)

Figure 8-25(2). Transmitter A16, wiring diagram and parts location (part 2 of 2).

Figure 8-25. (2/2)

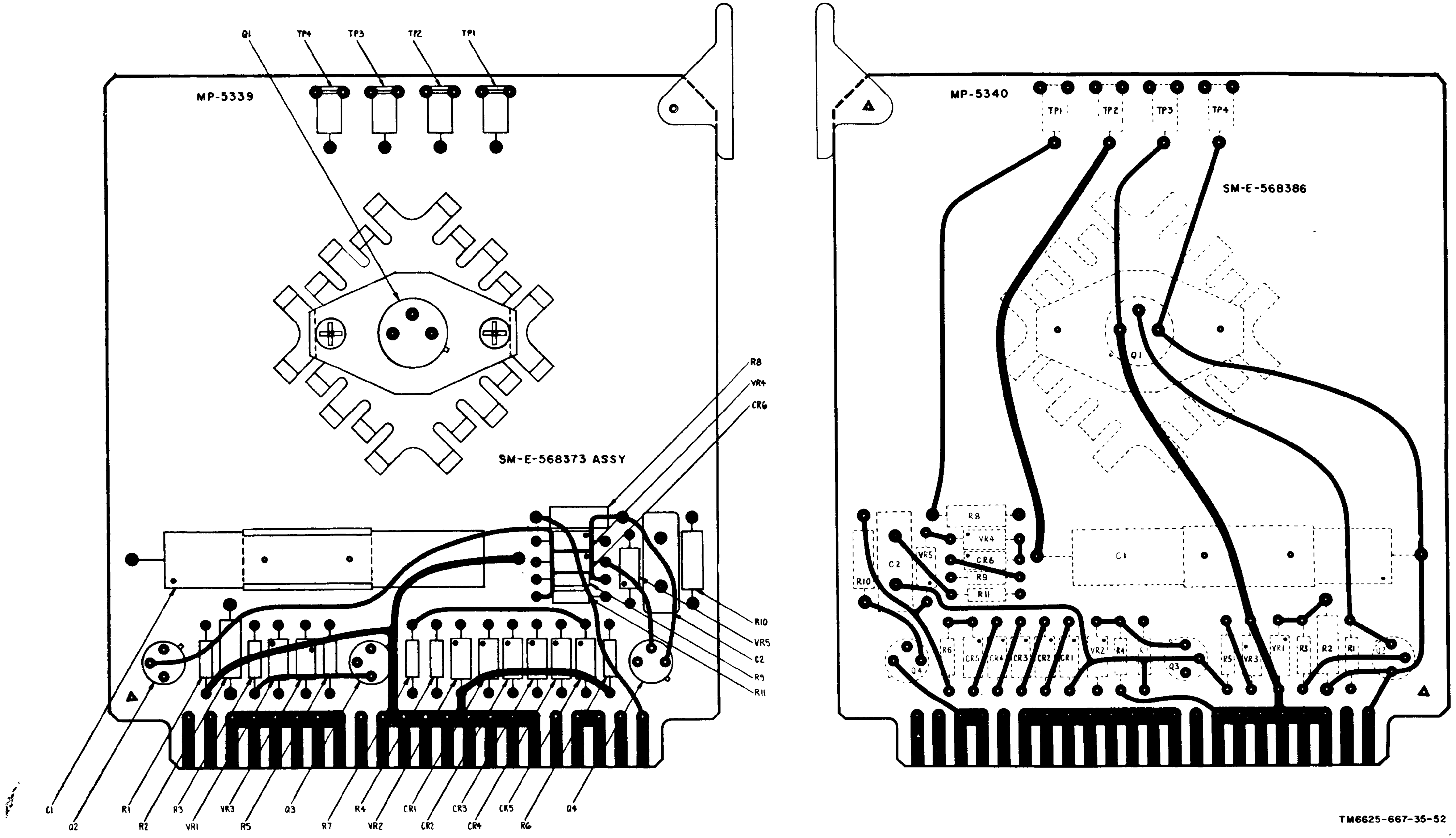


Figure 8-26. 12-volt regulator module A13, wiring diagram and parts location.

Figure 8-26.

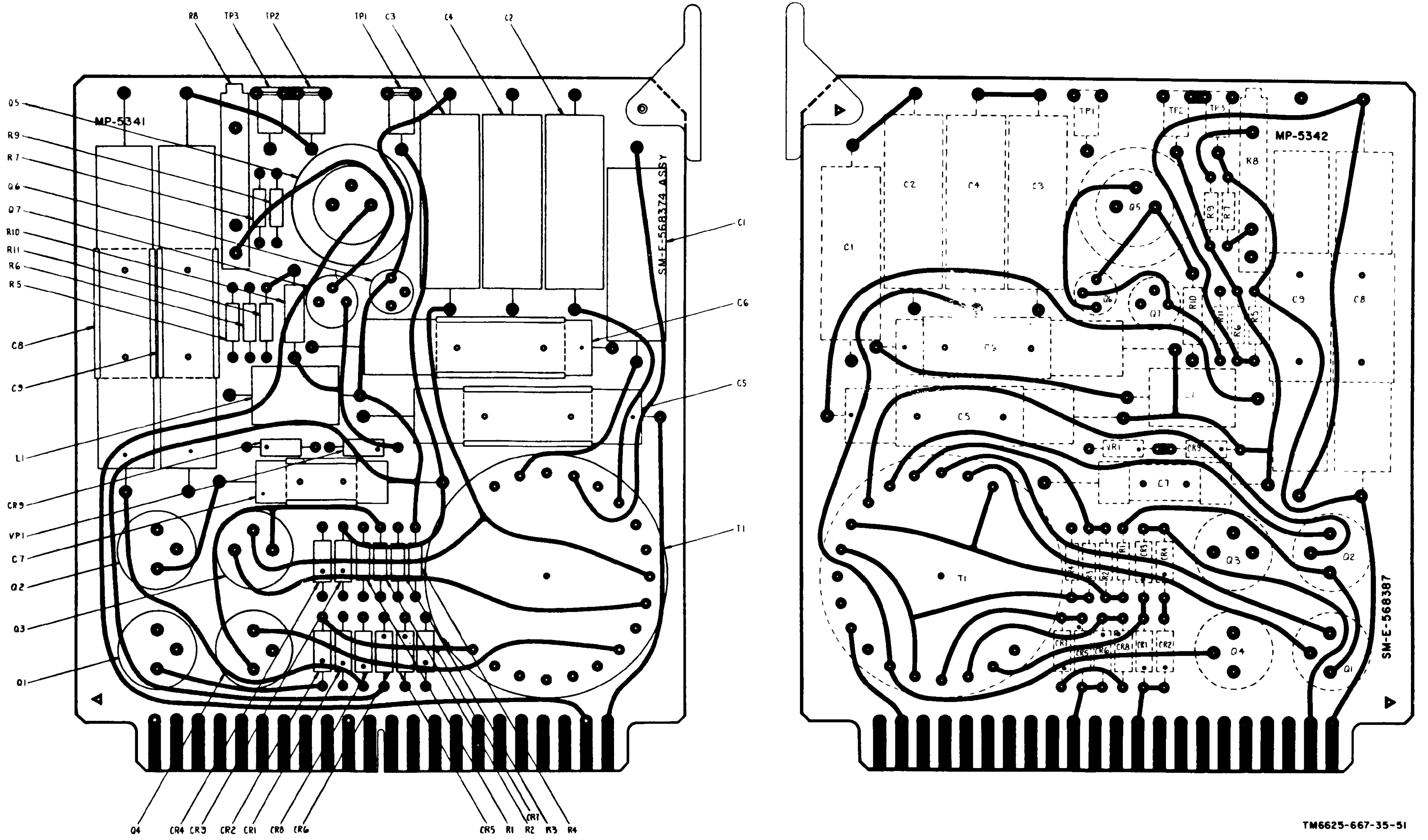


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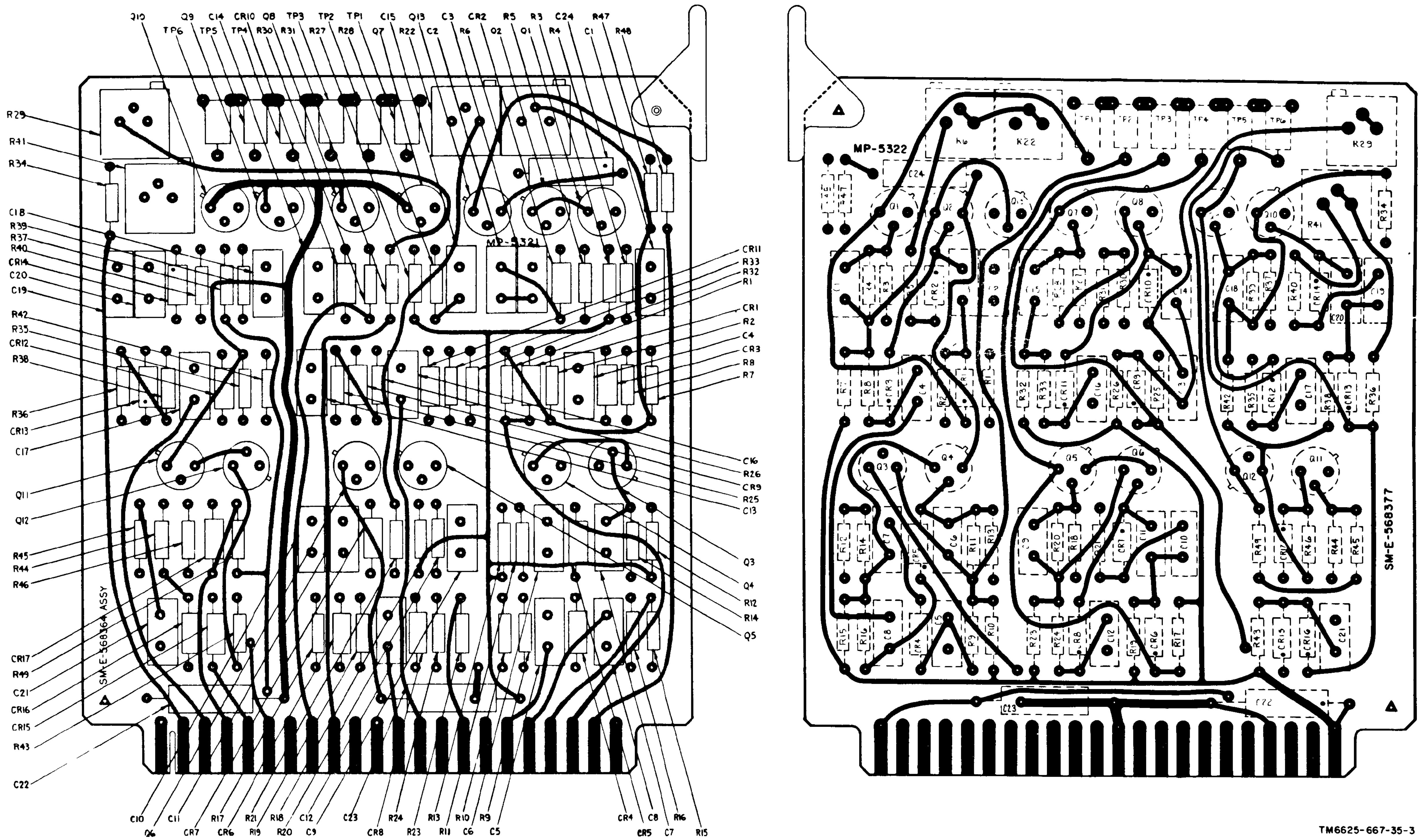
Figure 8-27. 150-volt power supply module A14, wiring diagram and parts location.

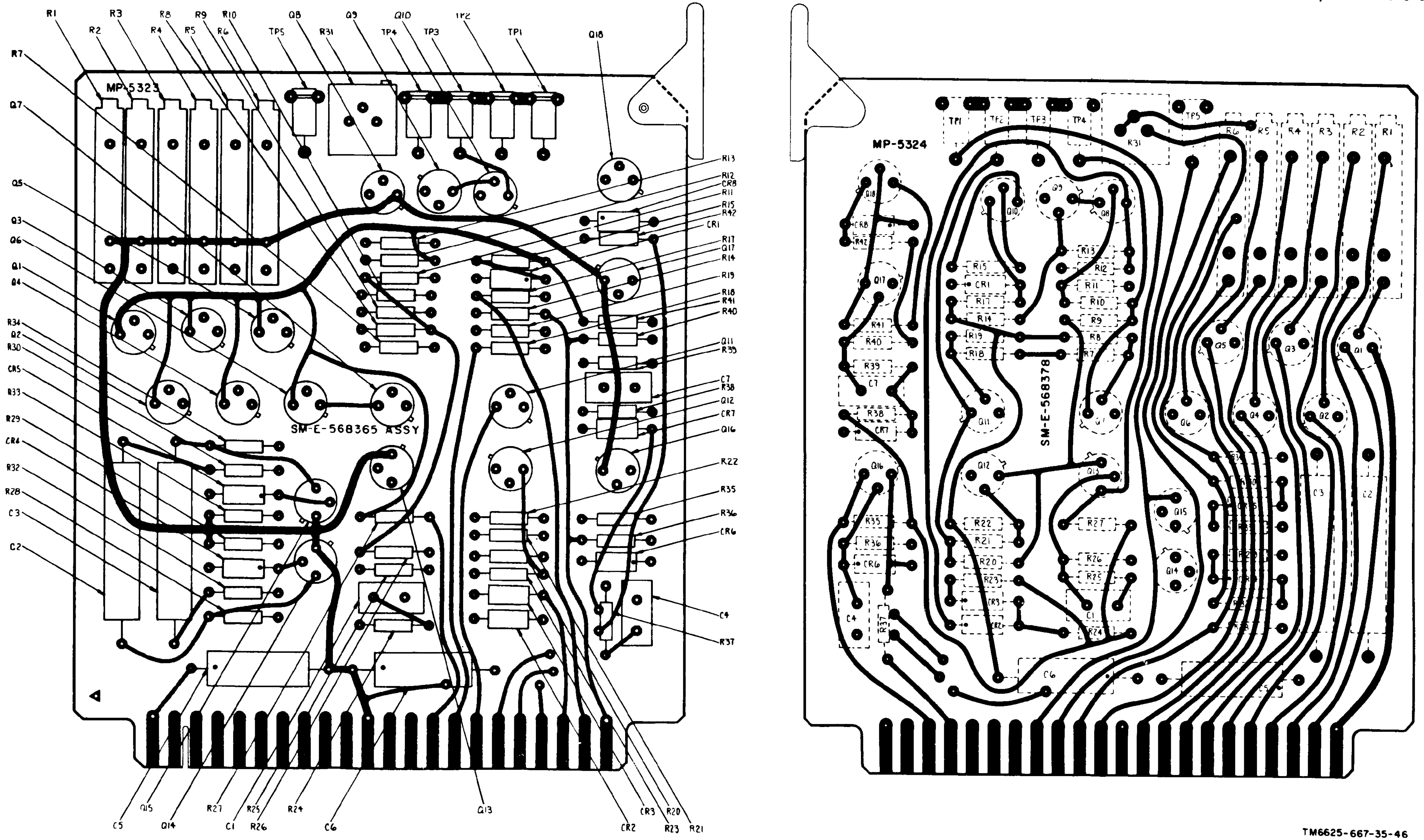
Figure 8-27.



TM6625-667-35-3

Figure 8-28. Encoder module A4, wiring diagram and parts location.

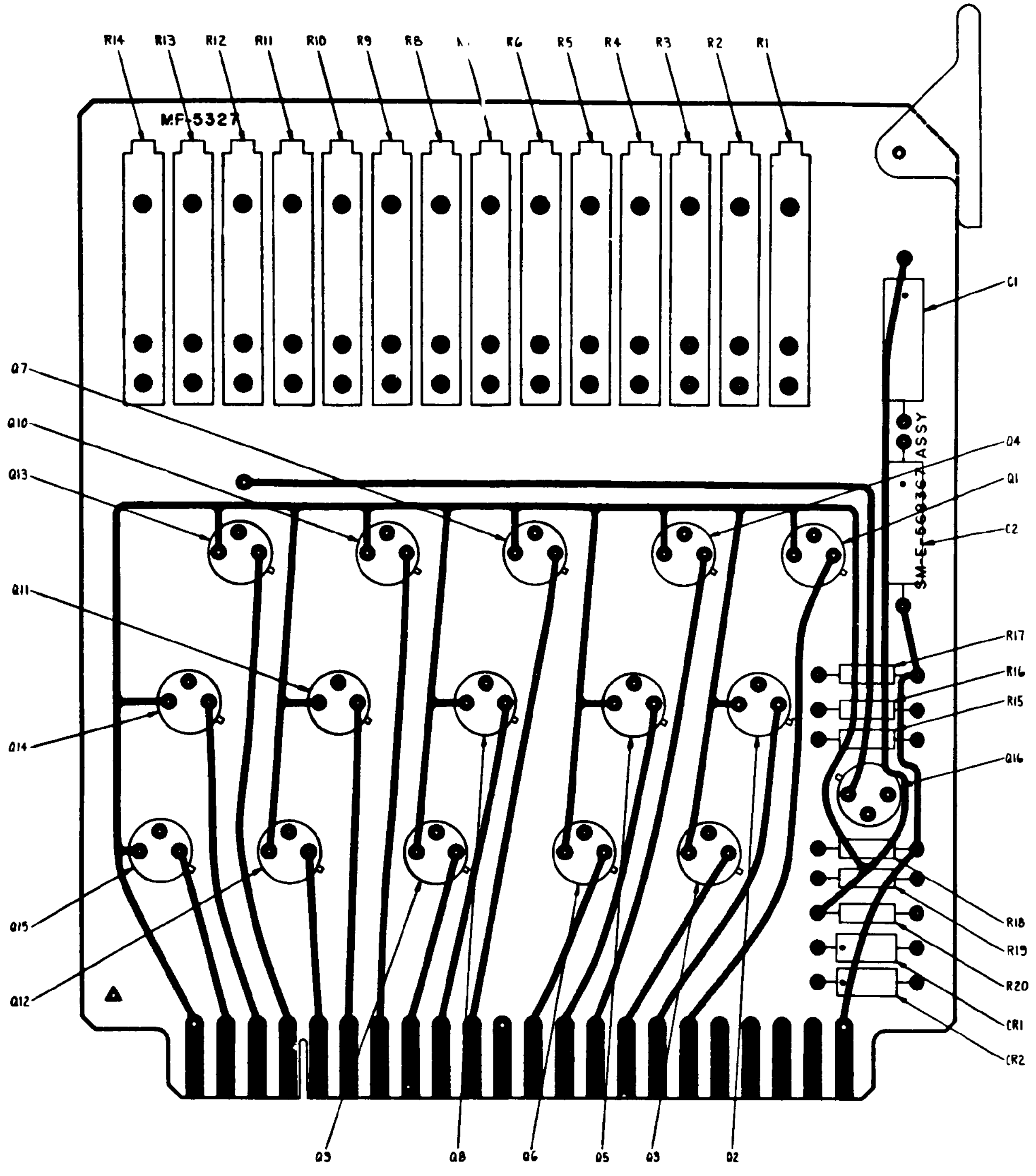
Figure 8-28.



TM6625-667-35-46

Figure 8-29. Encoder module A5, wiring diagram and parts location.

Figure 8-29.



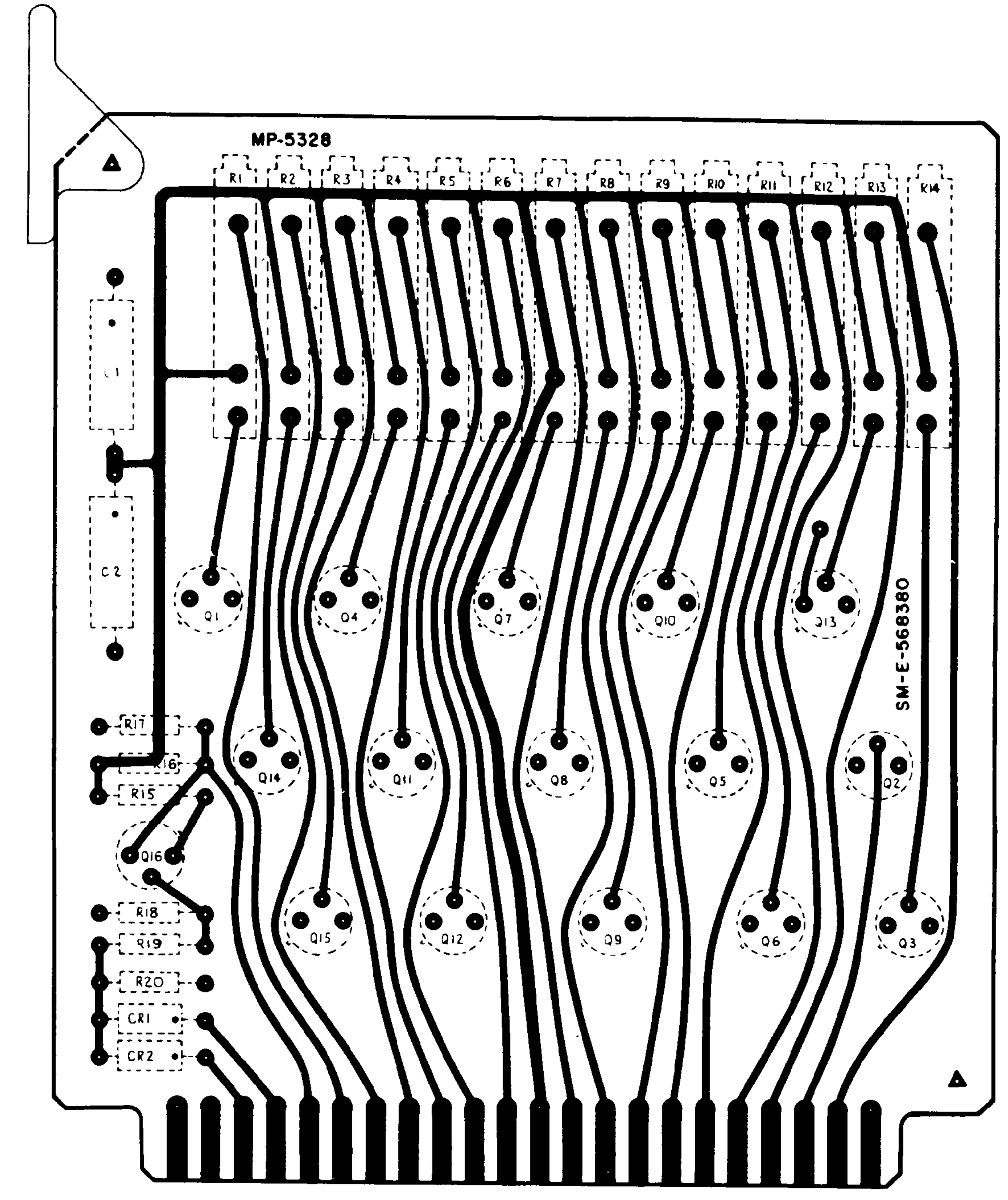


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Figure 8-30. Decoder module A7, wiring diagram and parts location.

Figure 8-30.

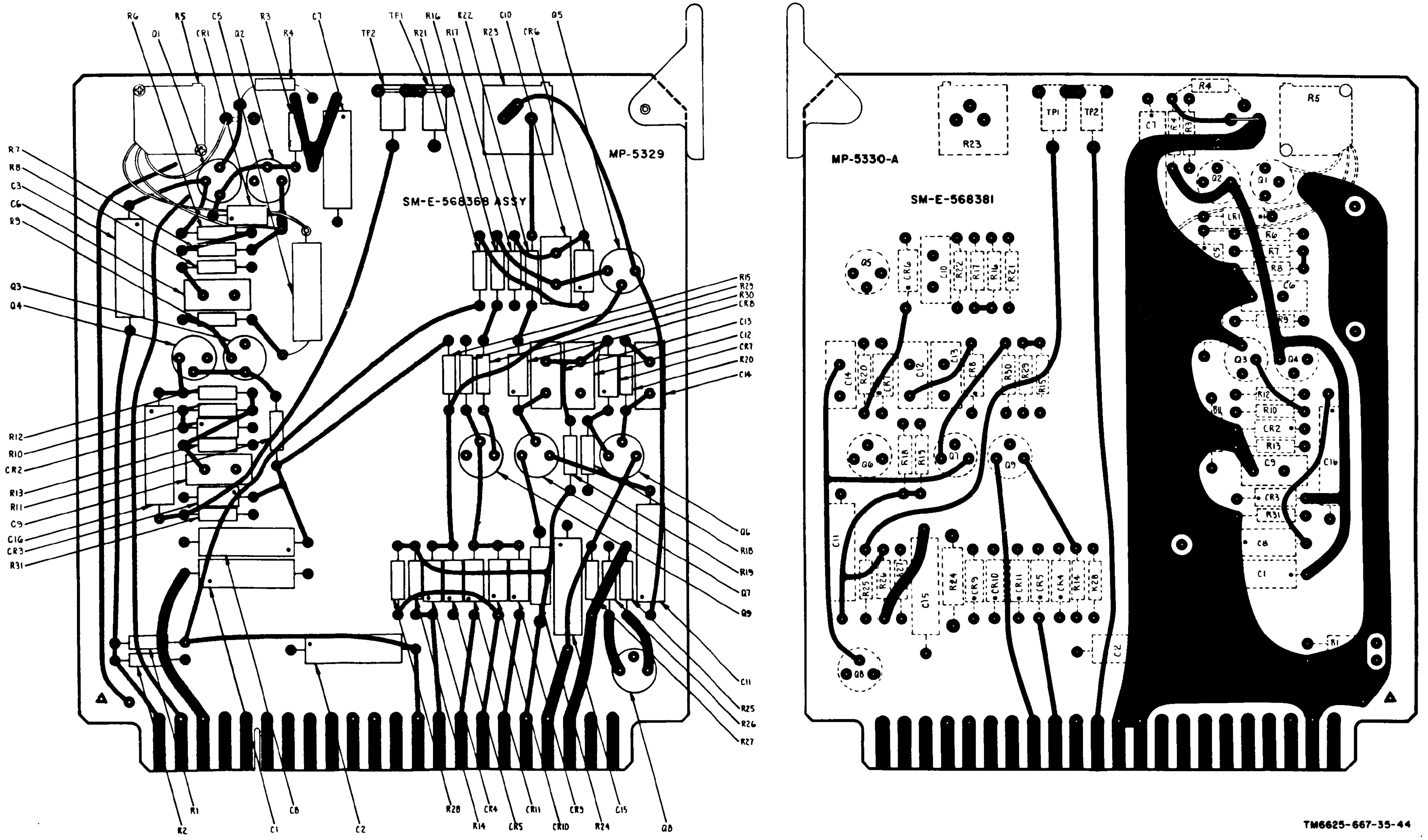
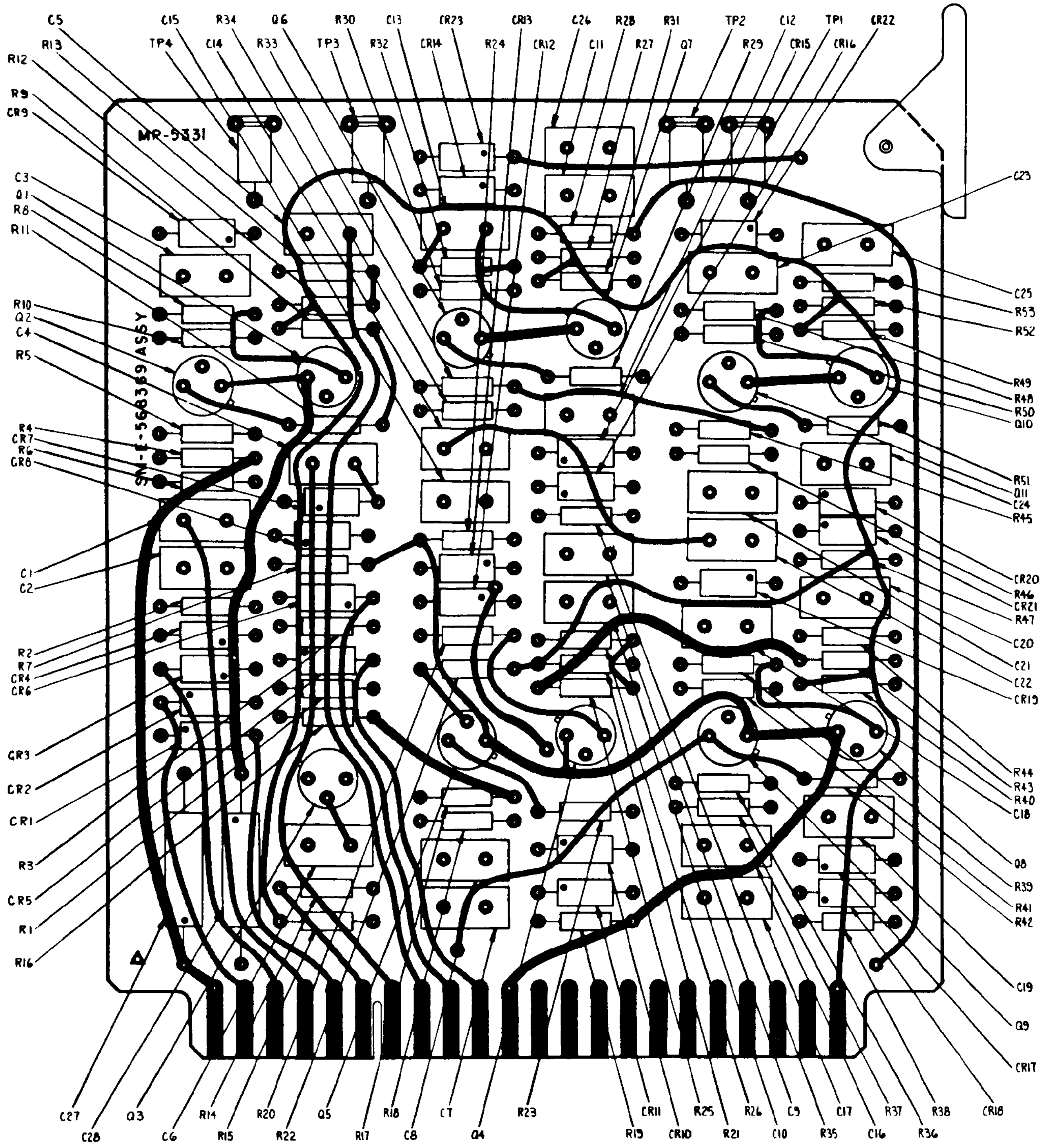
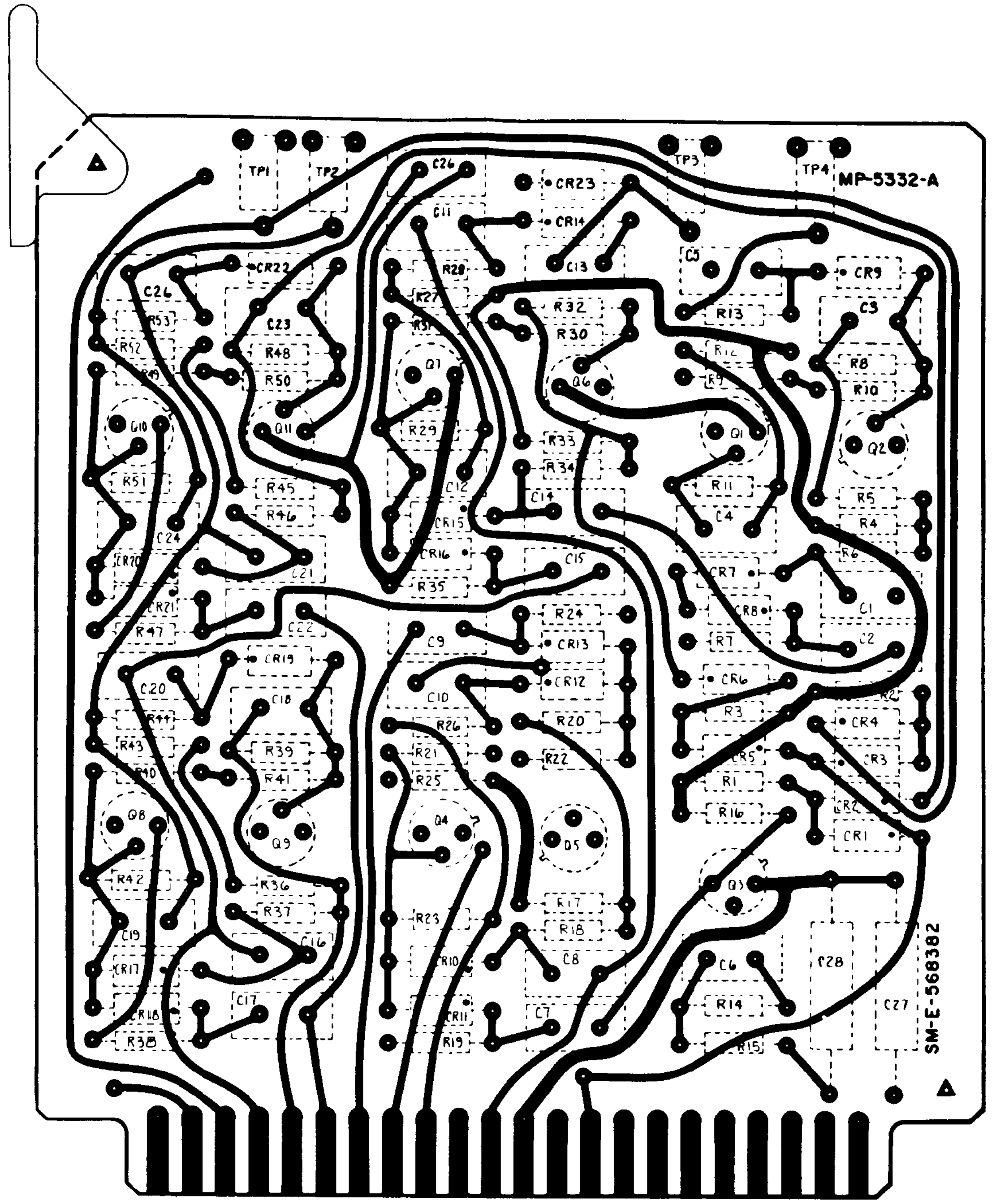


Figure 8-31. Decoder module A8, wiring diagram and parts location.

Figure 8-31.





TM6625-667-35-50

Figure 8-32. Decoder module A9, wiring diagram and parts location.

Figure 8-32.

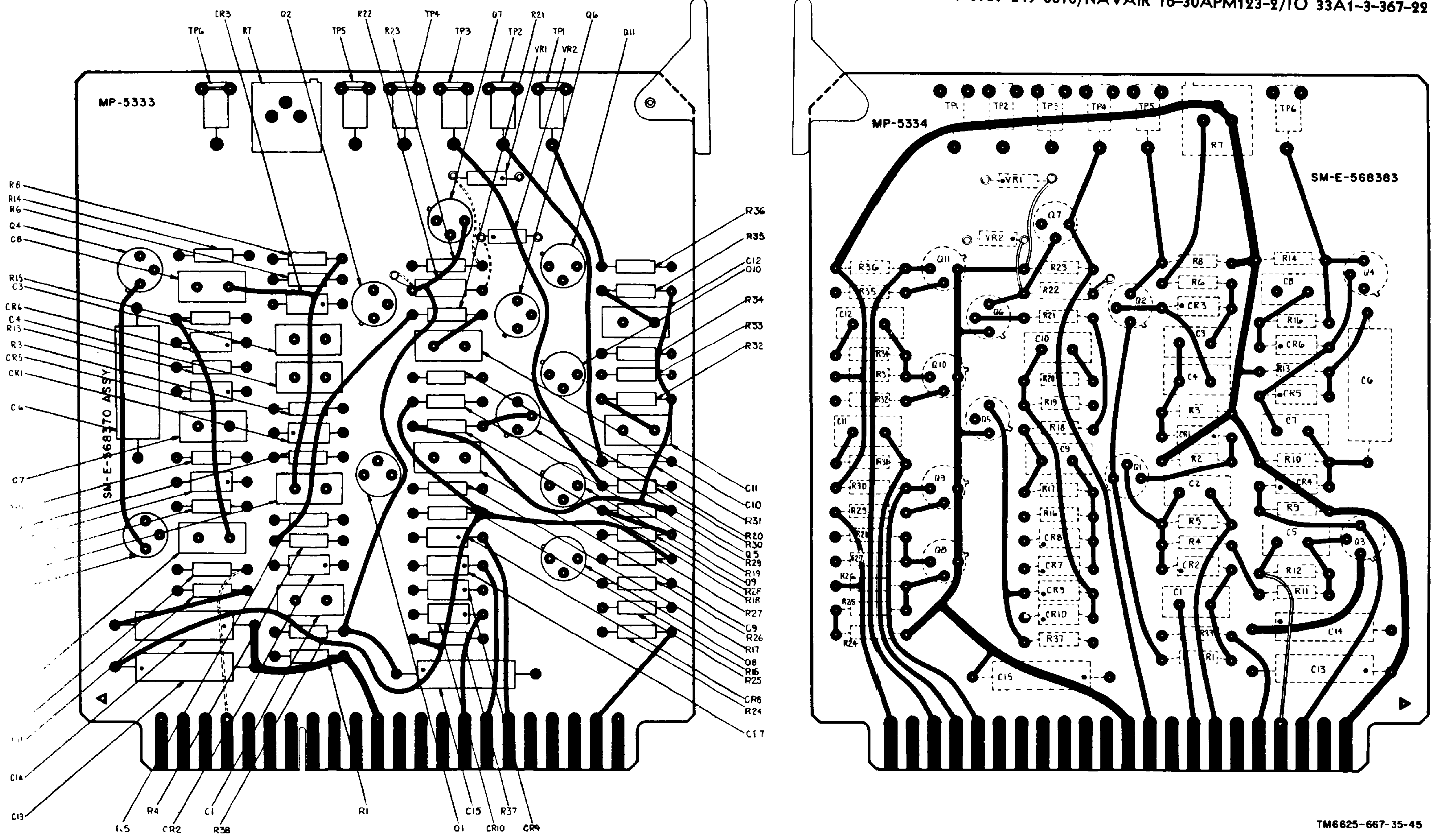


Figure 8-33. Decoder module A10, wiring diagram and parts location.

Figure 8-33.

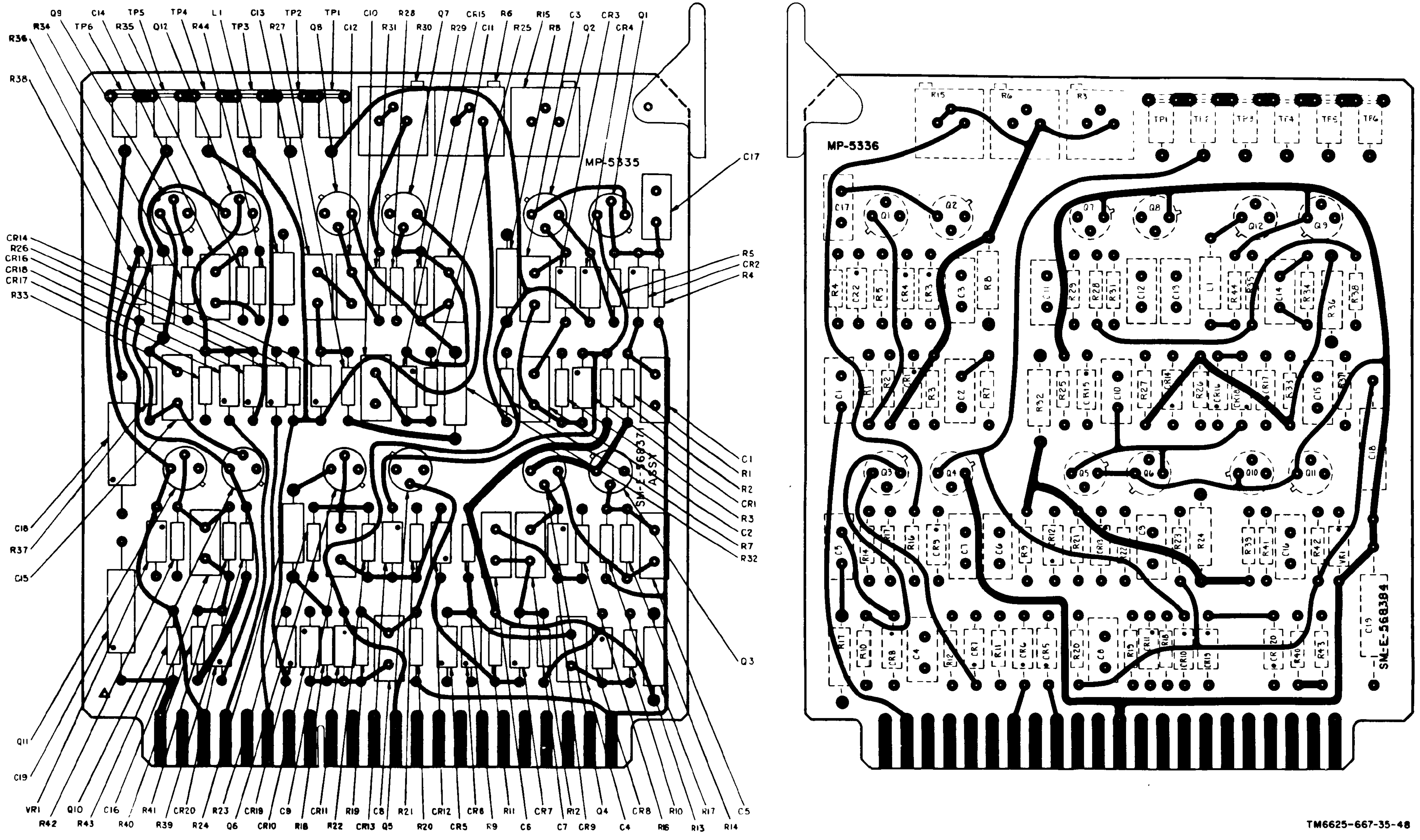


Figure 8-34. Decoder module A11, wiring diagram and parts location.

Figure 8-34.

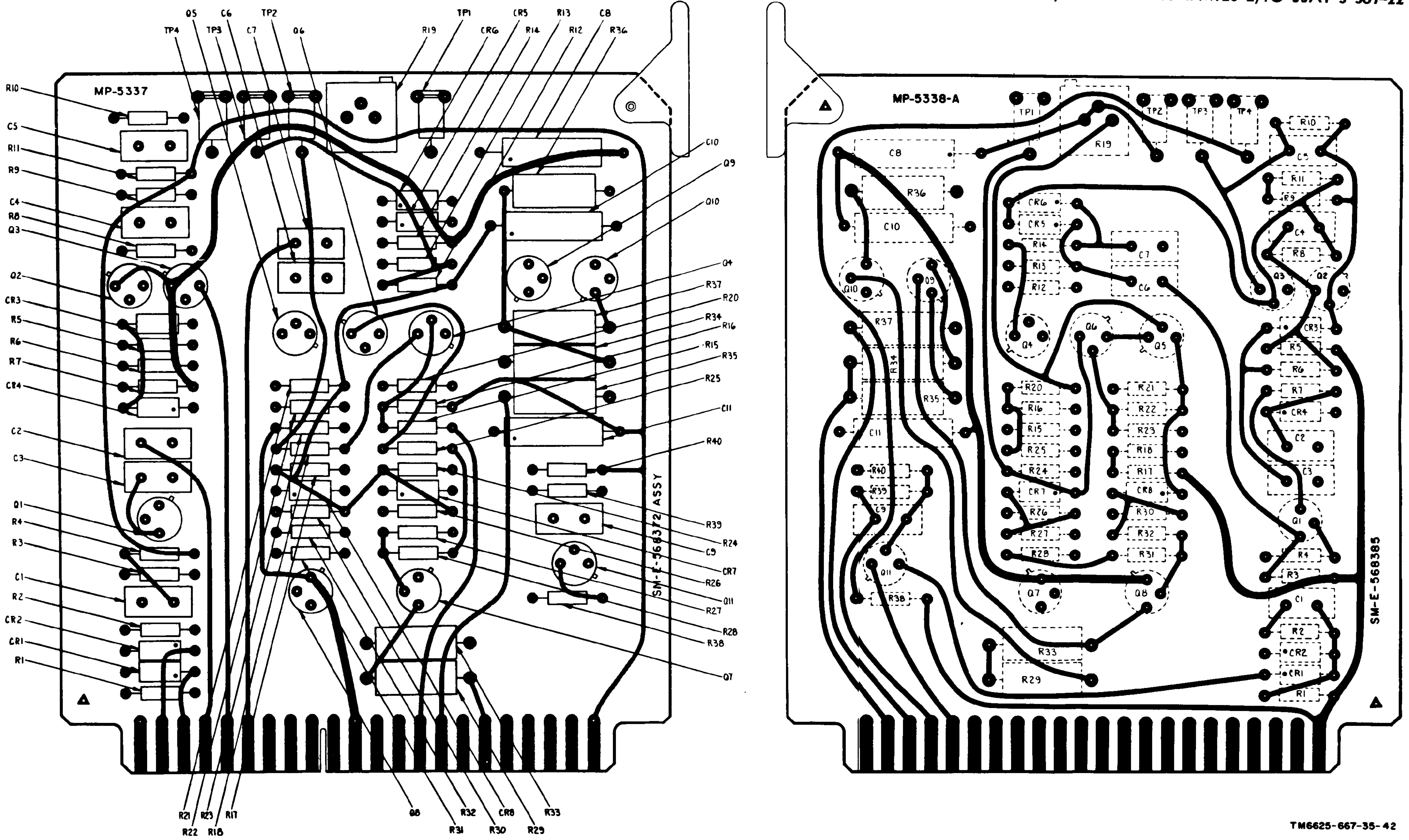


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Figure 8-35. Decoder module A12, wiring diagram and parts location.

Figure 8-35.

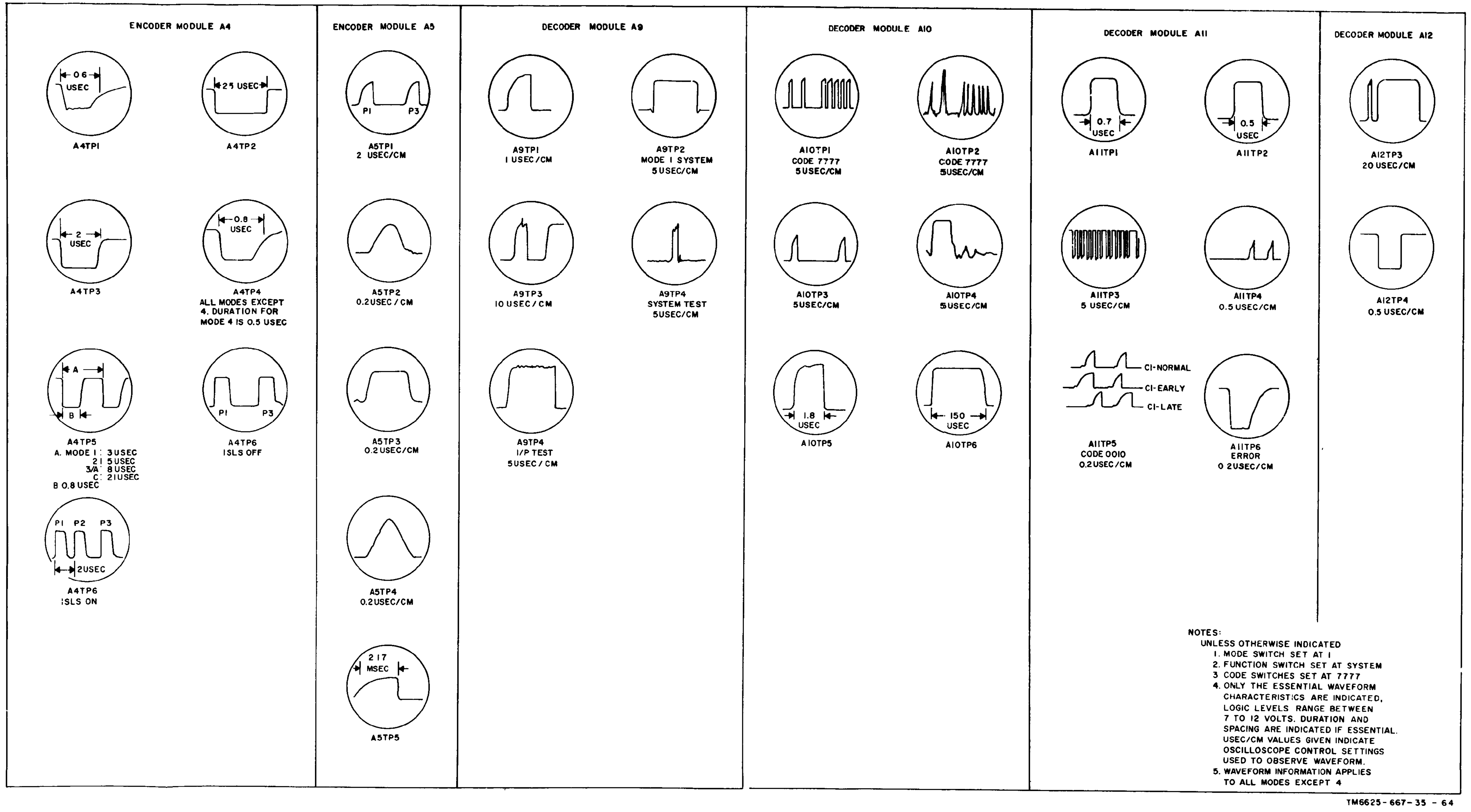

Figure 8-36. Test point waveform diagram.

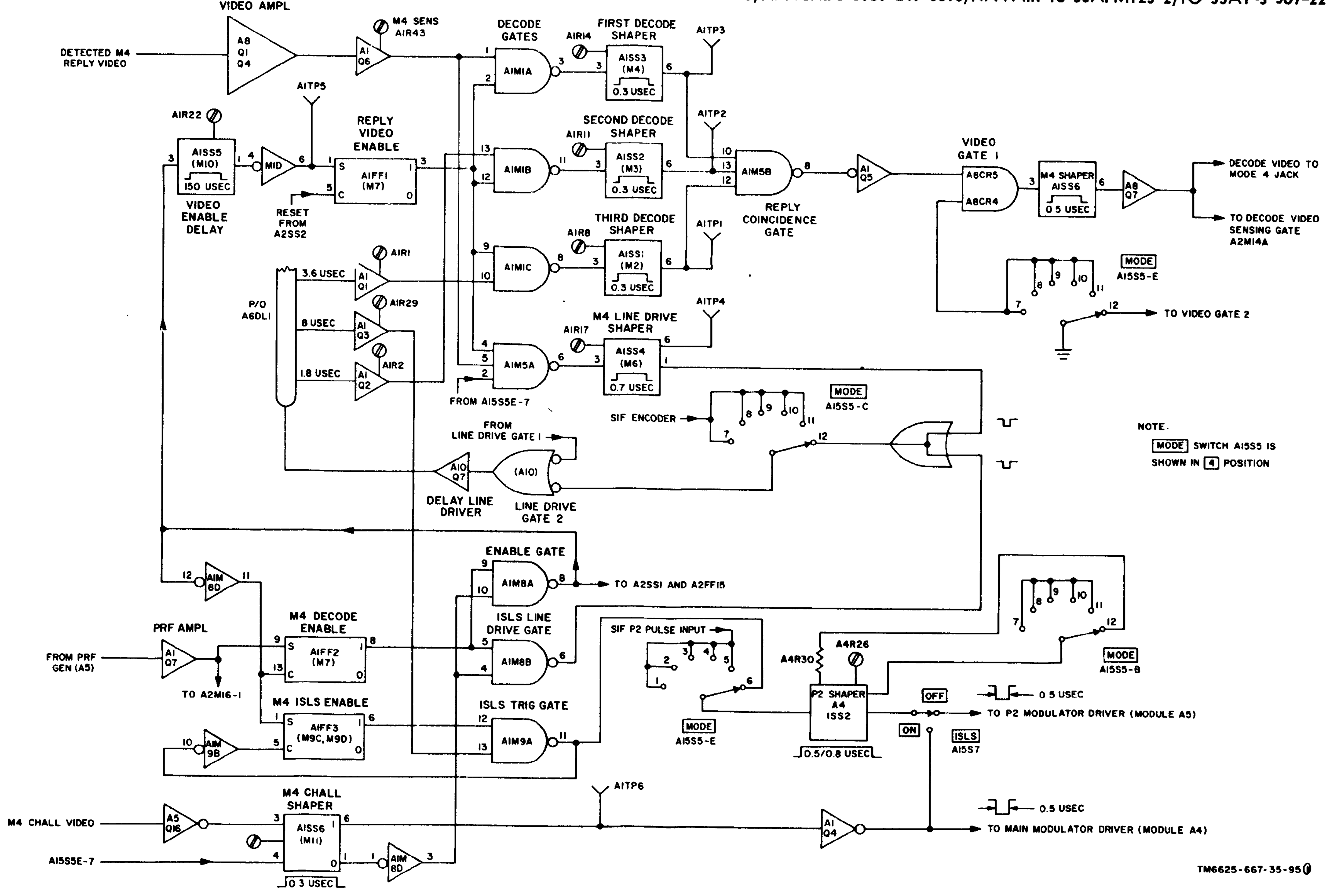

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Figure 8-38①. Mode 4 section, logic diagram (part 1 of 2).

Figure 8-38. (1/2)

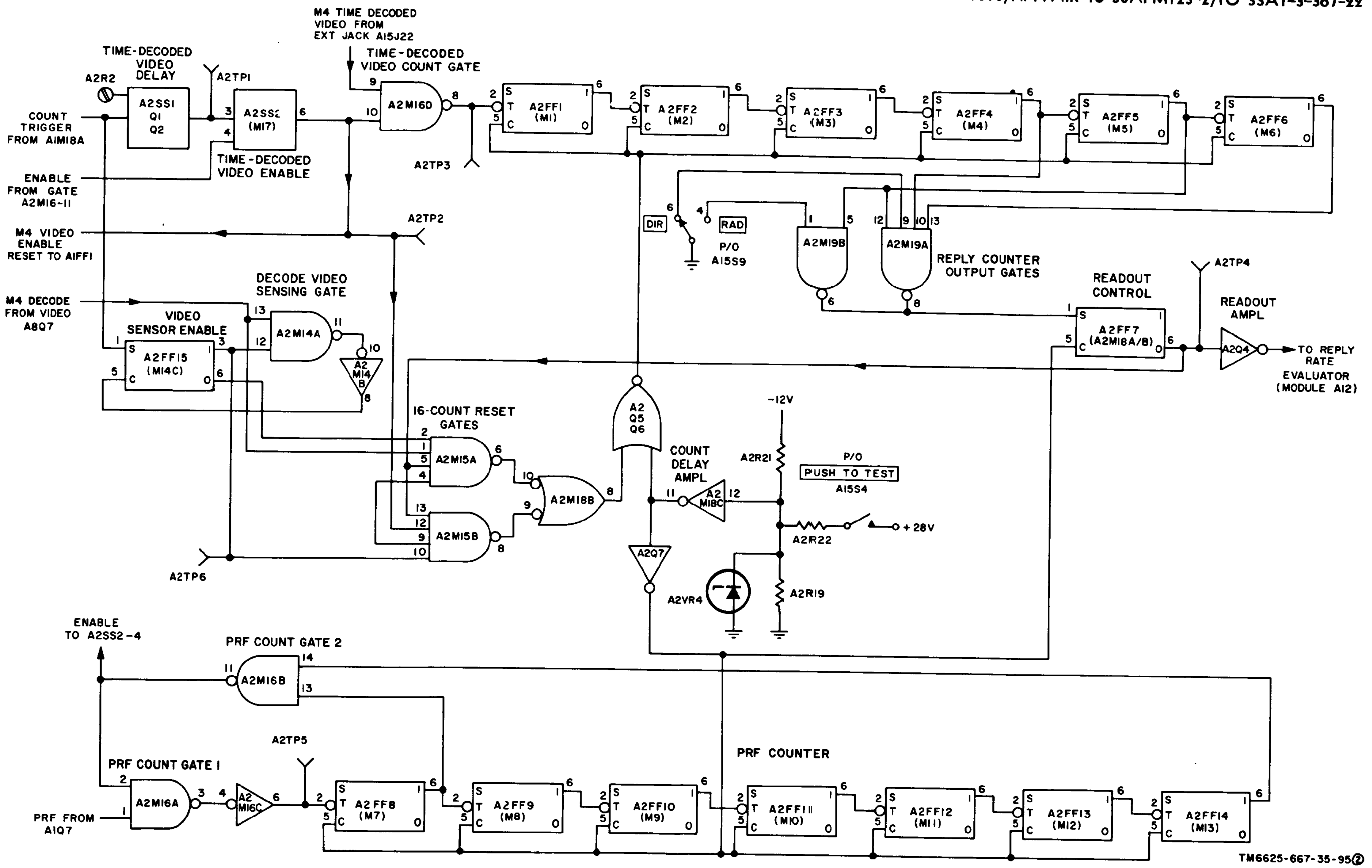
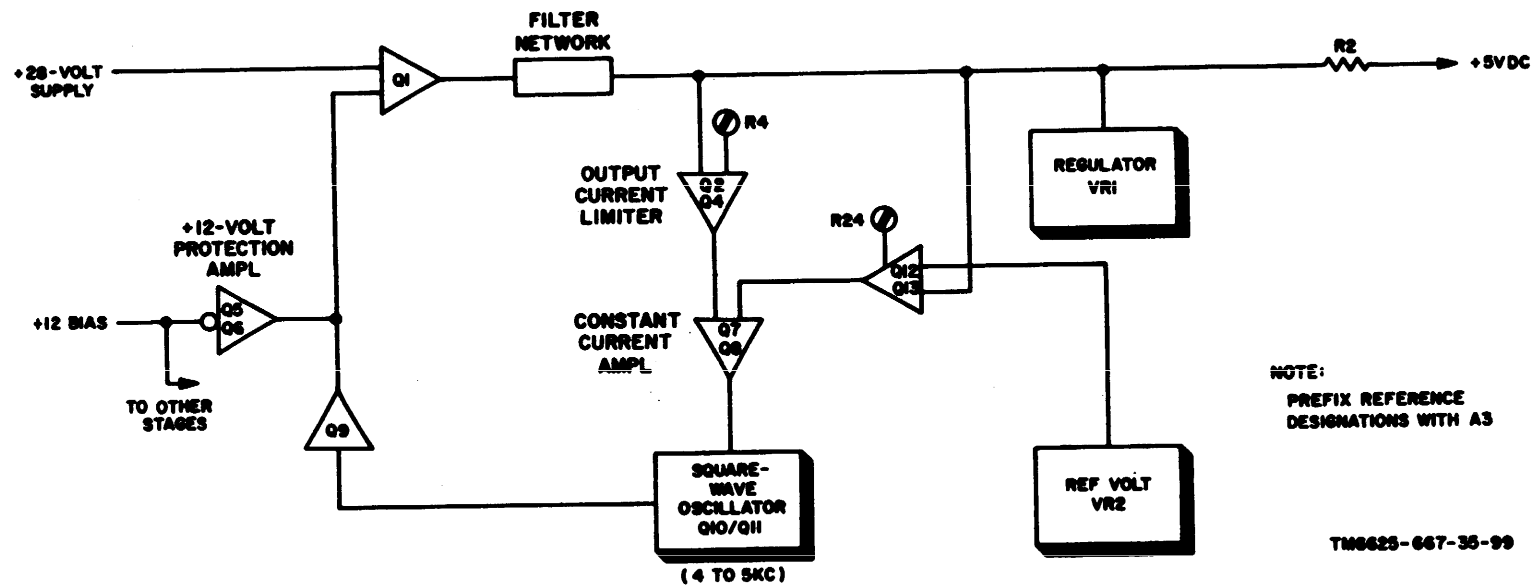
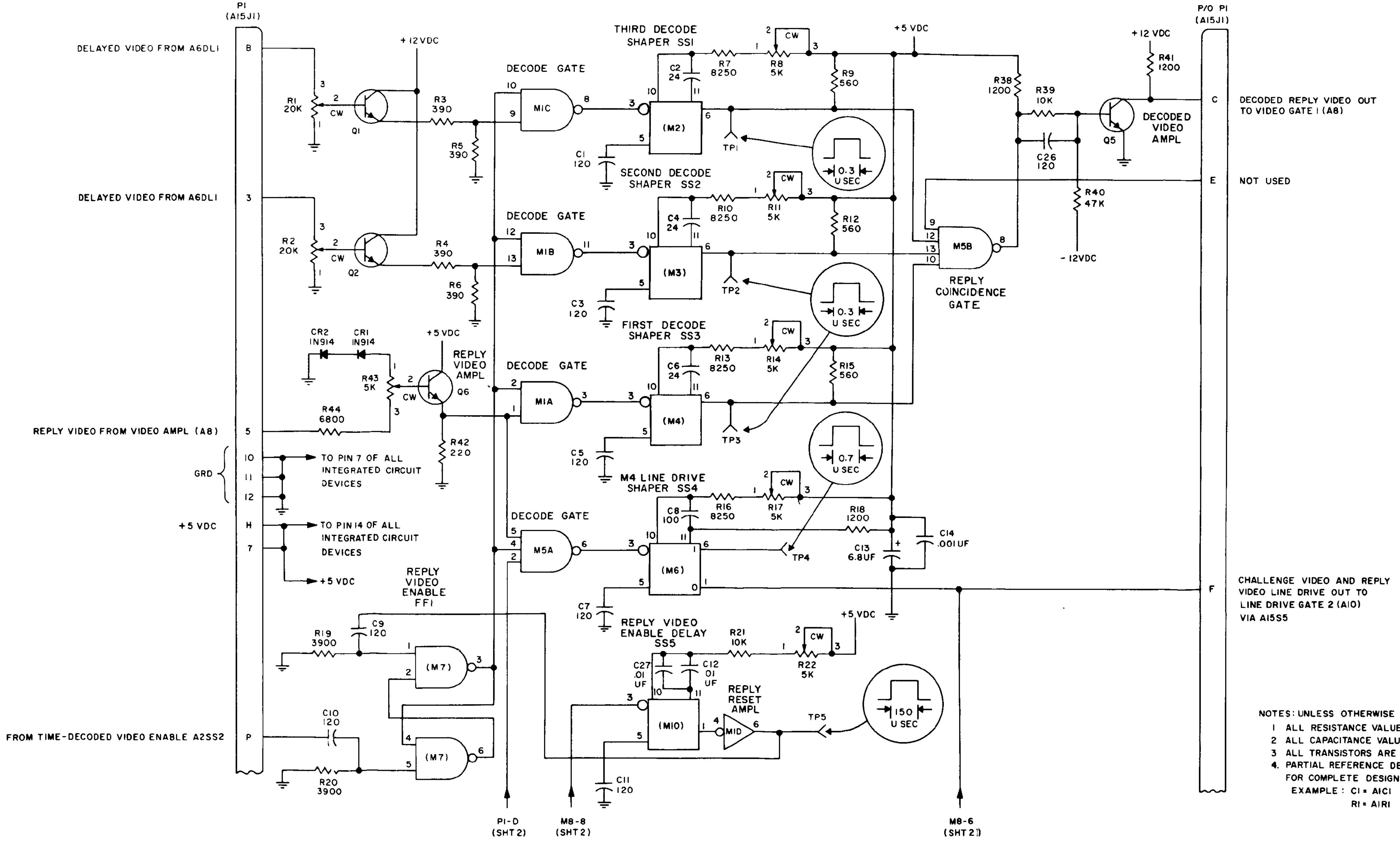


Figure 8-38②. Mode 4 section, logic diagram (part 2 of 2).

Figure 8-38. (2/2)



Fiigure 8-39. 5-volt regulator module A3, block diagram.



NOTES: UNLESS OTHERWISE SPECIFIED
1 ALL RESISTANCE VALUES ARE IN OHMS
2 ALL CAPACITANCE VALUES ARE IN UUF
3 ALL TRANSISTORS ARE 2N2222
4. PARTIAL REFERENCE DESIGNATIONS ARE SHOWN. FOR COMPLETE DESIGNATION PREFIX WITH A1.
EXAMPLE: C1 = A1C1
R1 = A1R1

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Figure 8-40①. Mode 4 module A1, schematic diagram (part 1 of 2).

Change 4

Figure 8-40. (1/2)

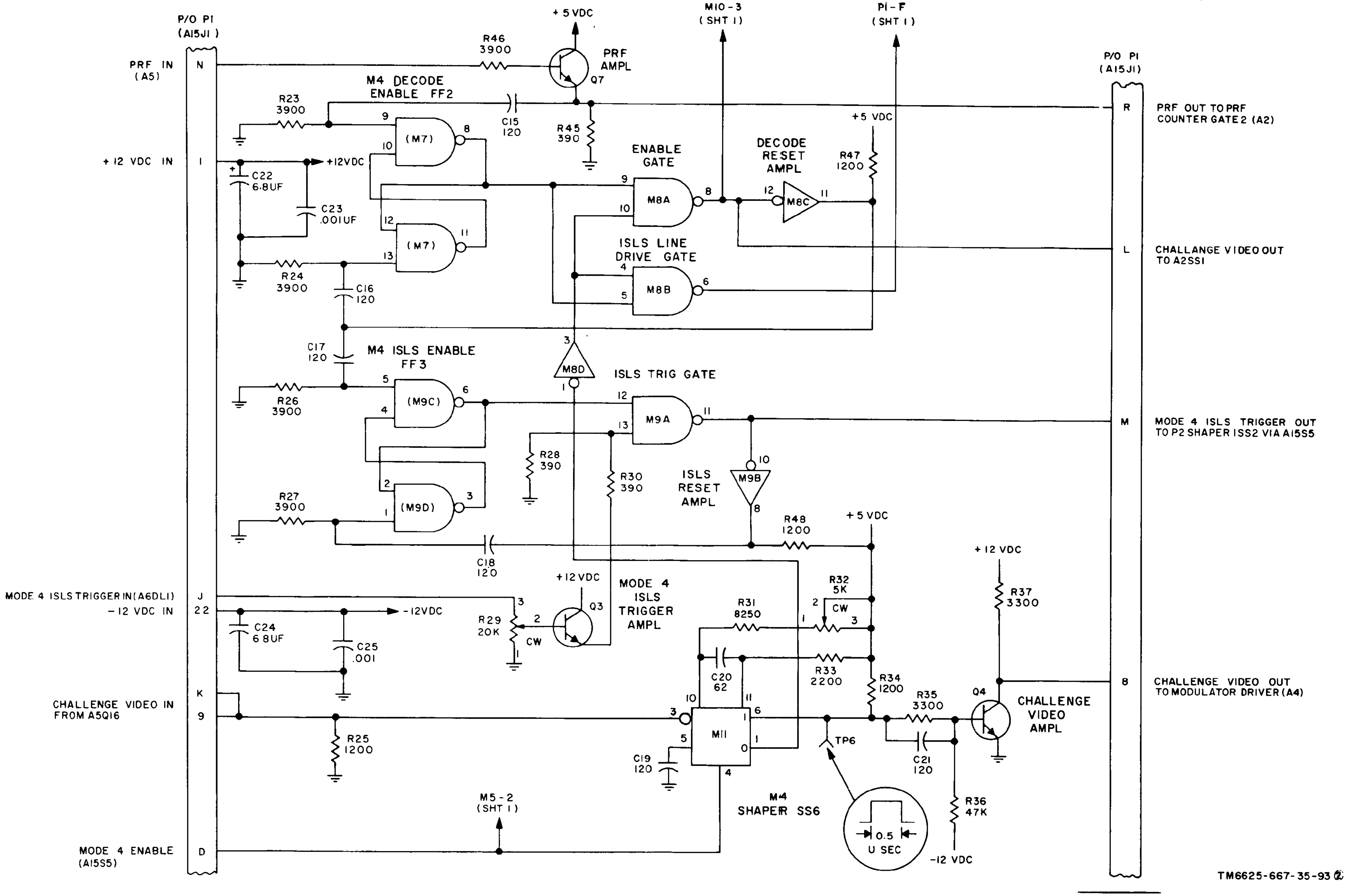
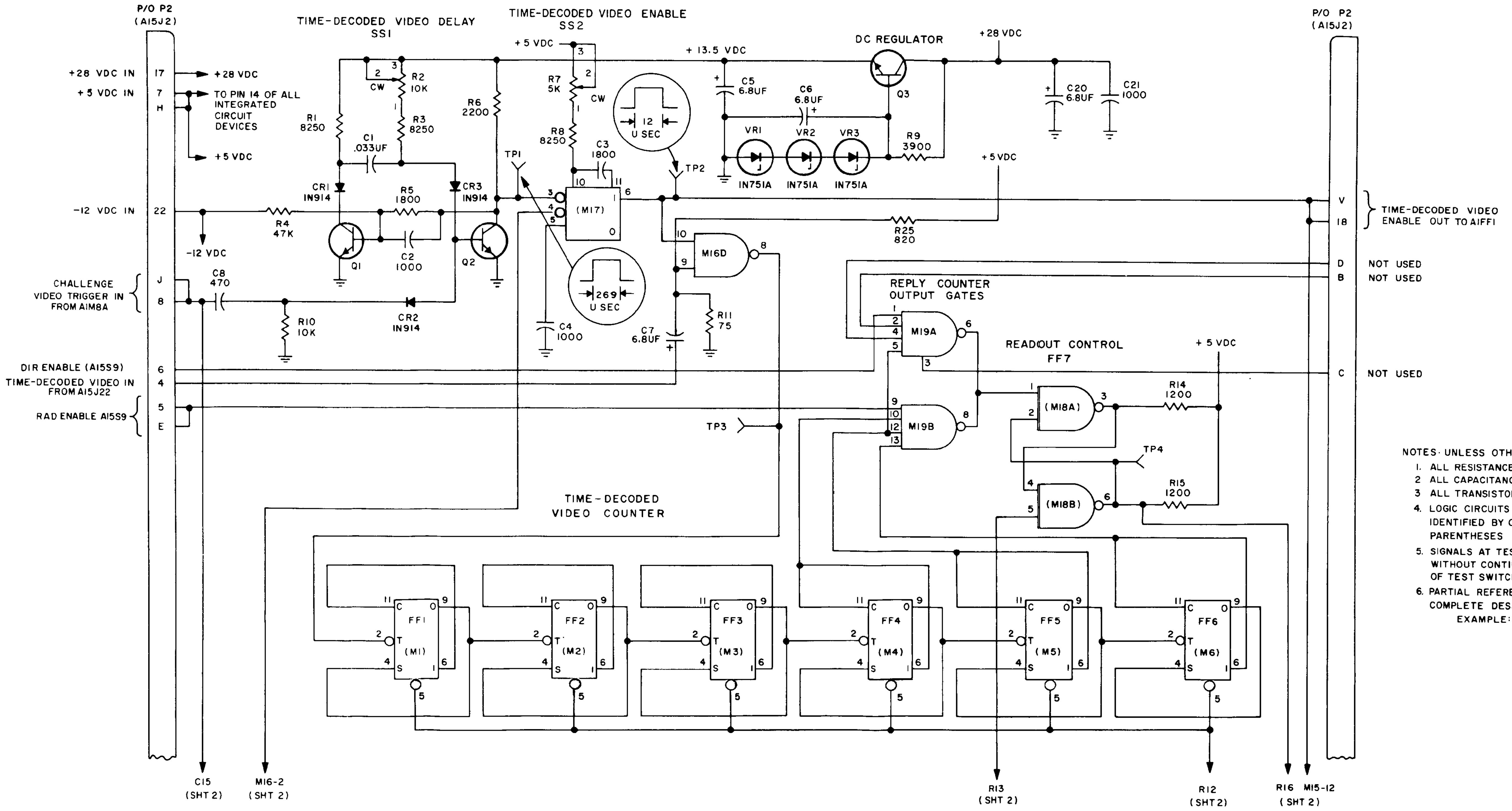


Figure 8-40②. Mode 4 module A1, schematic diagram (part 2 of 2).



NOTES: UNLESS OTHERWISE SPECIFIED

1. ALL RESISTANCE VALUES ARE IN OHMS
2. ALL CAPACITANCE VALUES ARE IN UUF
3. ALL TRANSISTORS ARE 2N2222
4. LOGIC CIRCUITS DESIGNATED FF AND SS ALSO ARE IDENTIFIED BY COMPONENT DESIGNATOR IN PARENTHESES
5. SIGNALS AT TEST POINTS CAN NOT BE OBSERVED WITHOUT CONTINUAL RAPID PUSHING AND RELEASING OF TEST SWITCH.
6. PARTIAL REFERENCE DESIGNATIONS ARE SHOWN. FOR COMPLETE DESIGNATION, PREFIX WITH A2 EXAMPLE: R1 = A2R1 C1 = A2C1

Figure 8-41①. Mode 4 module A2, schematic diagram (part 1 of 2).

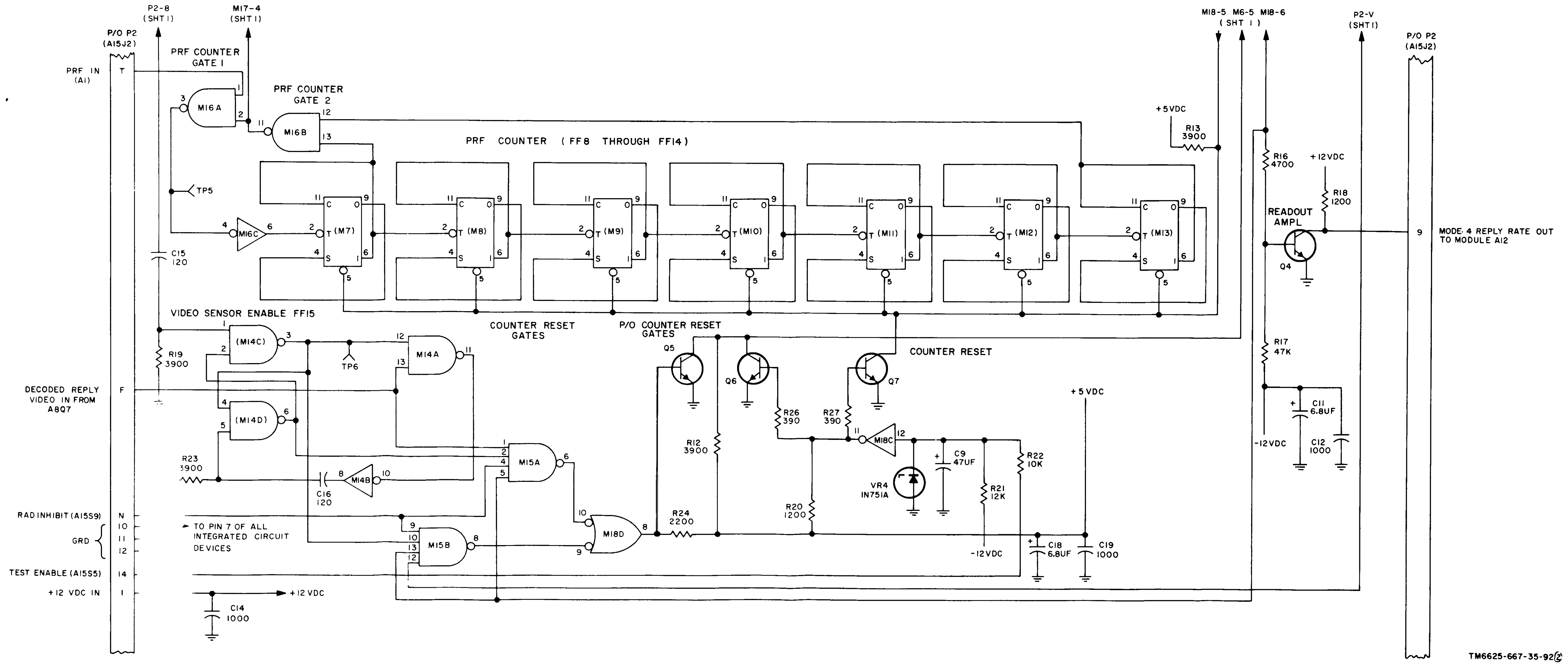


Figure 8-41②. Mode 4 module A2, schematic diagram (part 2 of 2).

Change 4

Figure 8-41. (2/2)

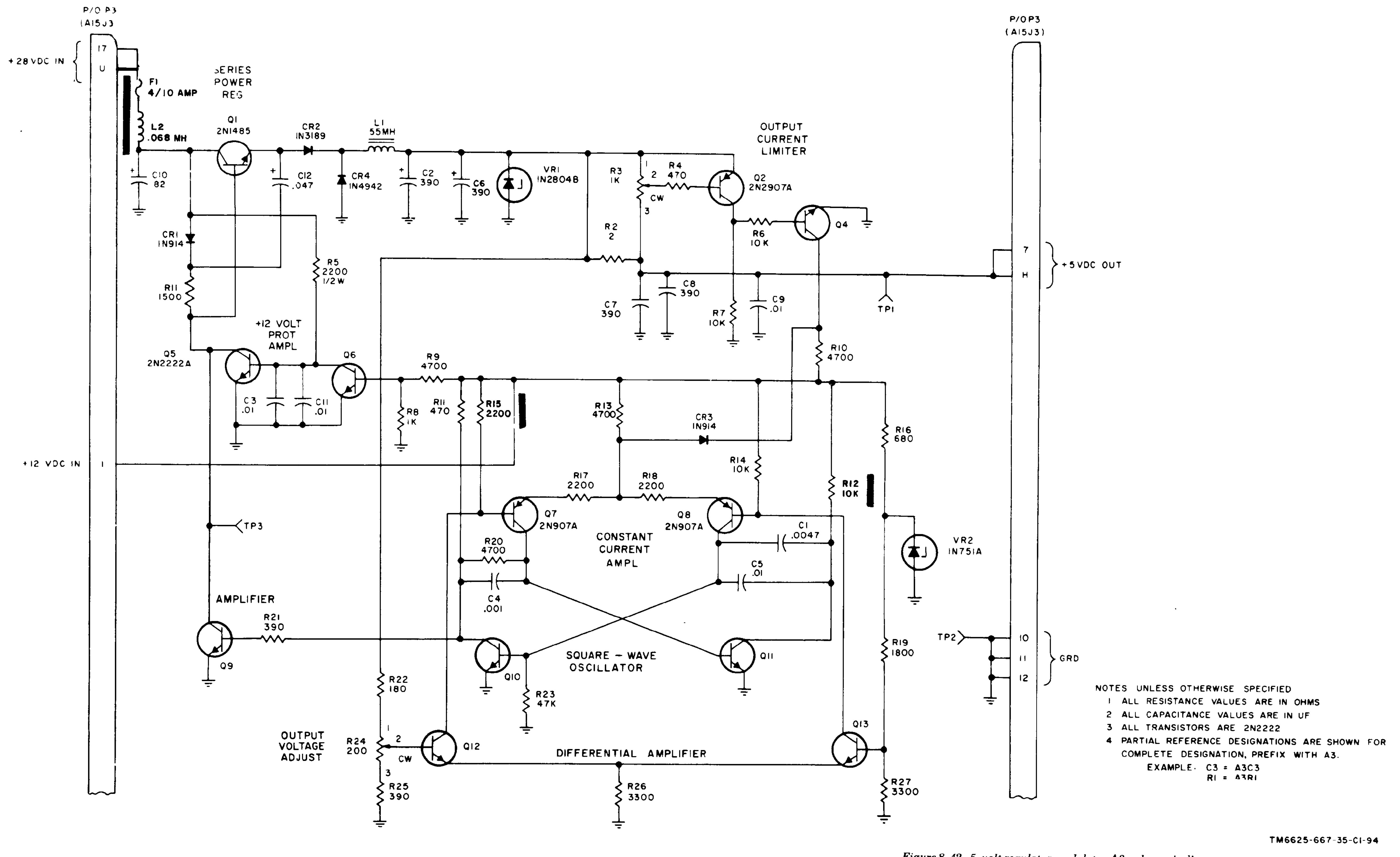
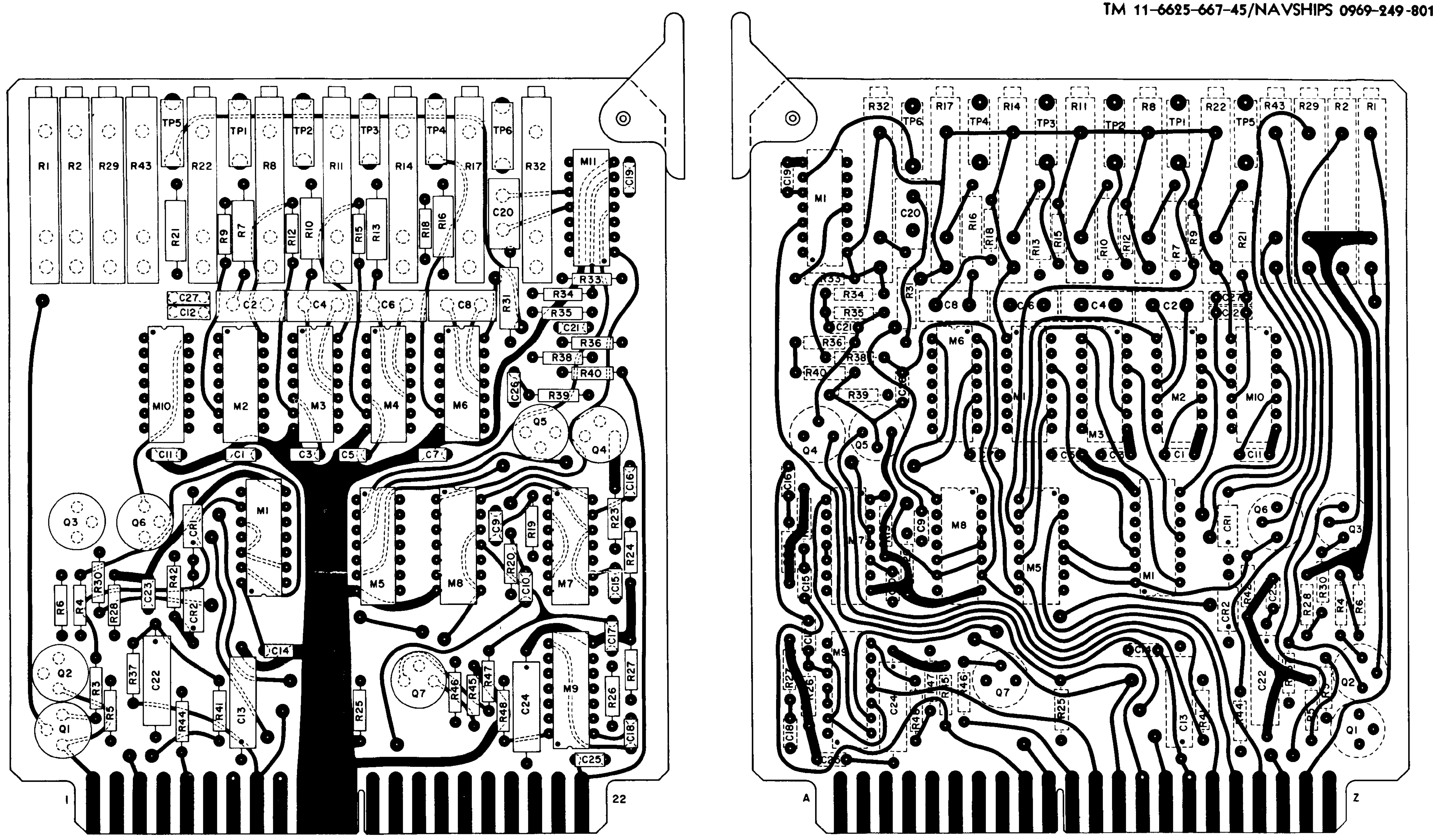


Figure 8-42. 5-volt regulator modulator A3, schematic diagram



NOTES:
UNLESS OTHERWISE SPECIFIED
1. DIODE POLARITY
ANODE
2. CAPACITOR POLARITY
POSITIVE
3. INTEGRATED CIRCUIT DEVICE ORIENTATION
PIN NO. 1.
OTHER PINS ARE NUMBERED IN COUNTERCLOCKWISE SEQUENCE WHEN VIEWED FROM COMPONENT SIDE
4. INDICATES COMPONENTS ON OTHER SIDE OF BOARD
5. PREFIX ALL REFERENCE DESIGNATIONS WITH A1
EXAMPLE: R2 IS A1R2
C3 IS A1C3

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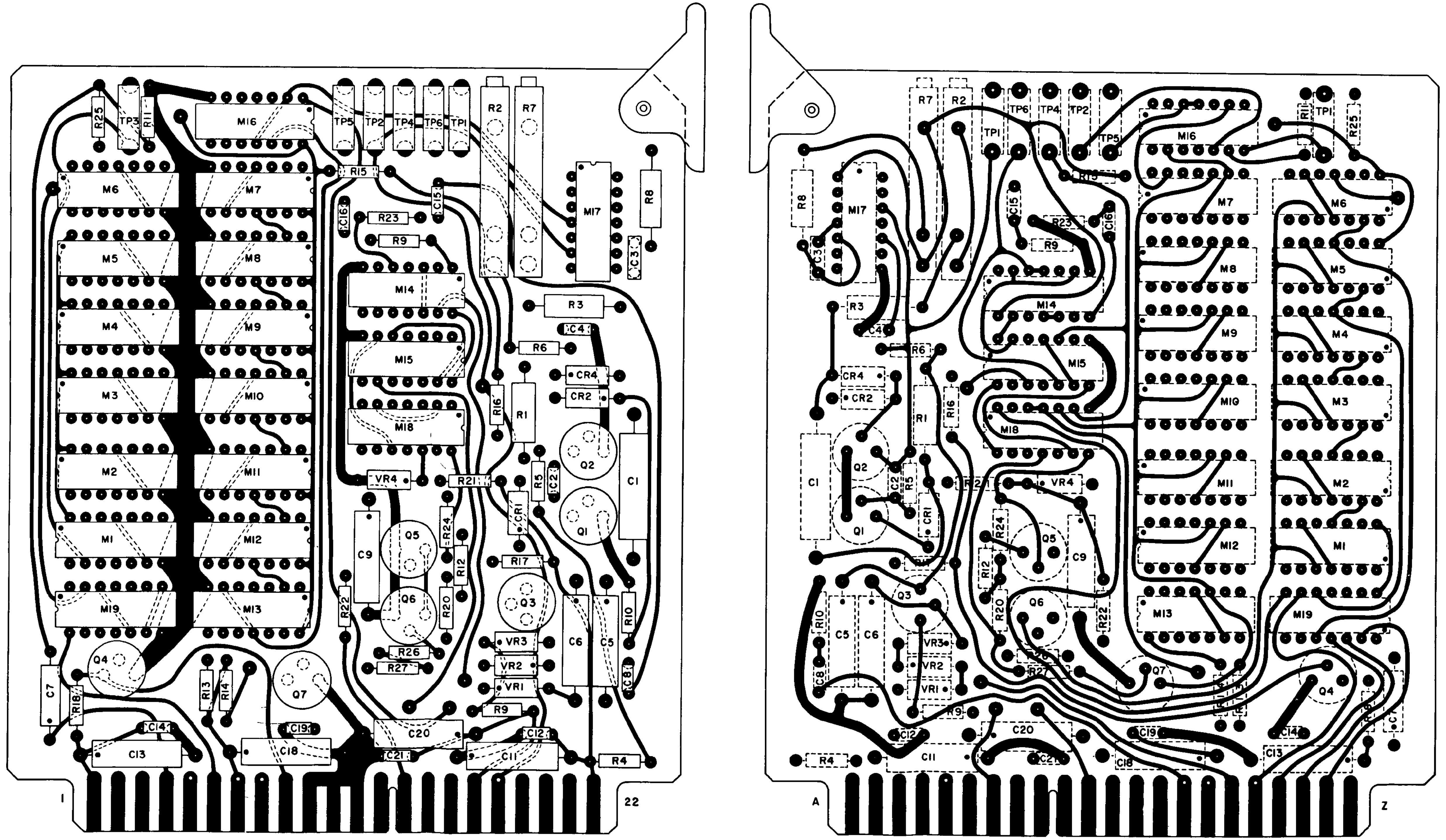
Figure 8-43. Mode 4 module A1, parts location diagram.

Figure 8-43.



NOTES:
UNLESS OTHERWISE SPECIFIED
1. DIODE POLARITY
ANODE
2. CAPACITOR POLARITY
POSITIVE
3. INTEGRATED CIRCUIT DEVICE ORIENTATION
PIN NO. 1.
OTHER PINS ARE NUMBERED IN COUNTERCLOCKWISE SEQUENCE WHEN VIEWED FROM COMPONENT SIDE.
4. INDICATES COMPONENTS ON OTHER SIDE OF BOARD
5. PREFIX ALL REFERENCE DESIGNATIONS WITH A2
EXAMPLE: R2 IS A2R2
C3 IS A2C3

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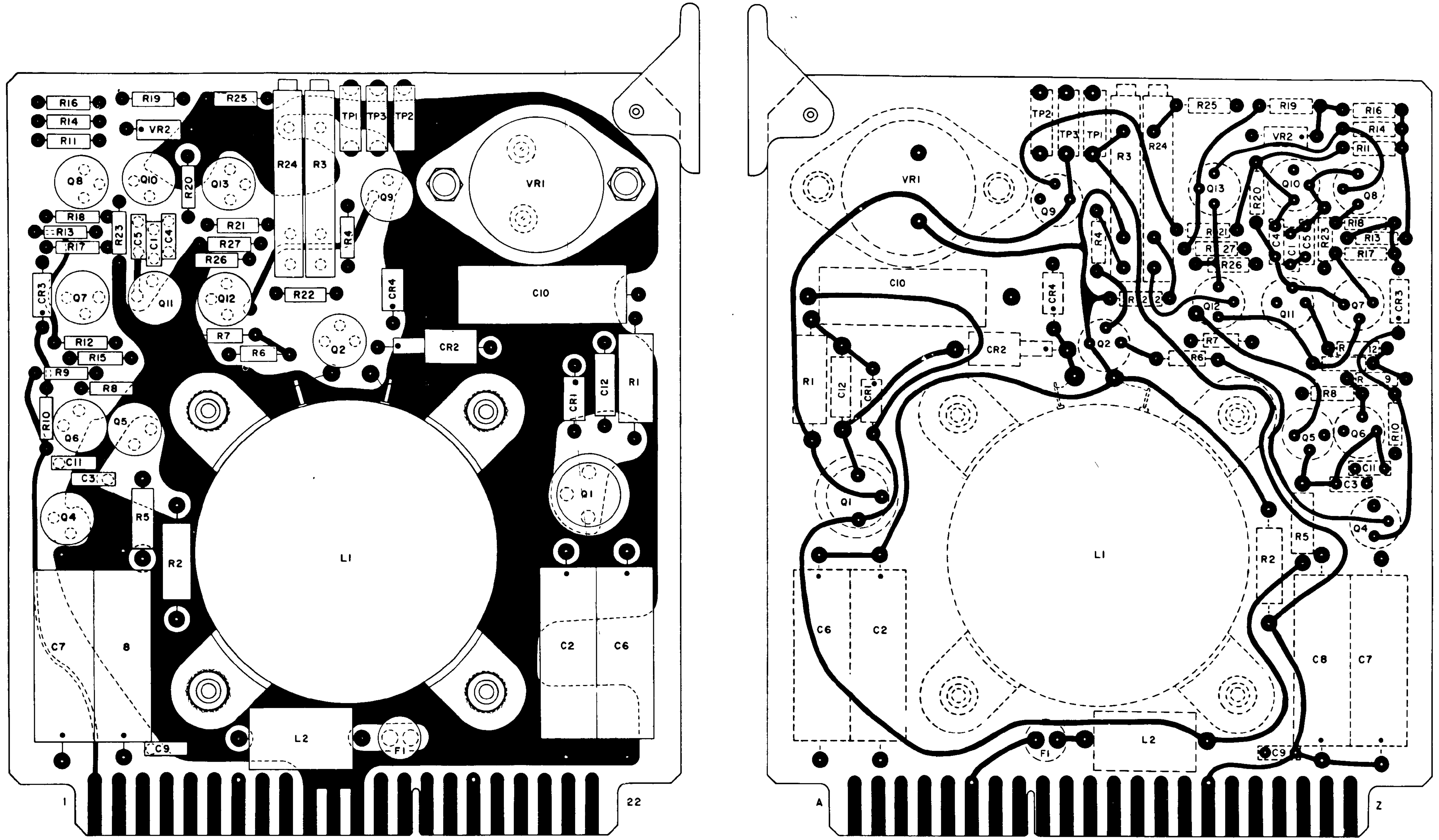
Figure 8-44.

Figure 8-44. Mode 4 module A2, parts location diagram.



NOTES:
UNLESS OTHERWISE SPECIFIED
1. DIODE POLARITY

CATHODE

2. CAPACITOR POLARITY

POSITIVE

3. INDICATES COMPONENTS ON OTHER SIDE OF BOARD
4. PREFIX ALL REFERENCE DESIGNATIONS WITH A3

EXAMPLE: R2 IS A3R2

C3 IS A3C3

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Figure 8-45. 5-volt regulator module A3, parts location diagram.

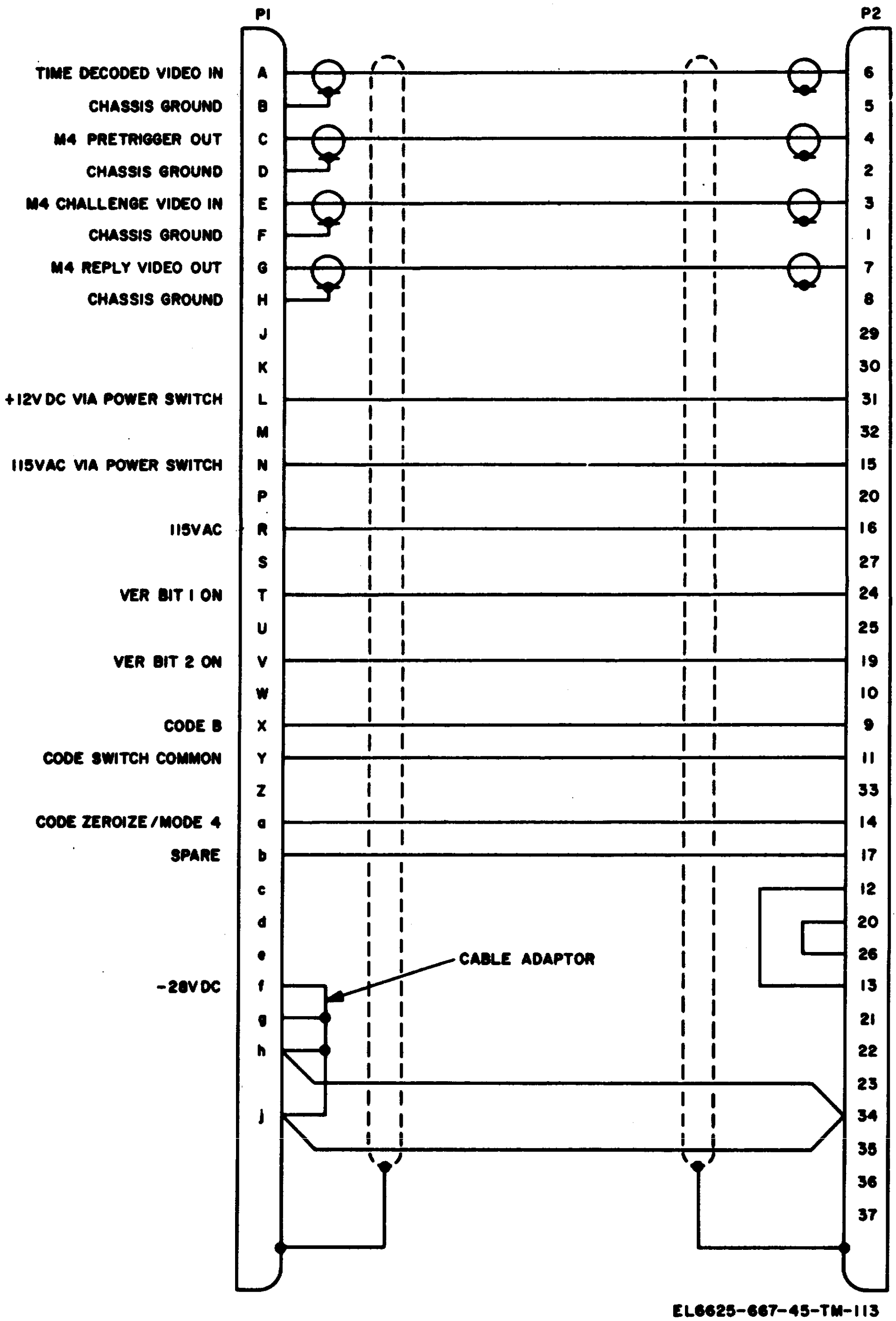

Figure 8-46. Cable assembly, special purpose, electrical CX12216/APM-123(V) schematic diagram.

APPENDIX

REFERENCES

Following is a list of applicable references that should be available to the direct and general support and depot repairman of Test Set, Thransponder AN/APM-123(V) 1:

DA Pam 310-4	Index of Technical Manuals, Technical Bulletins, Supply Manuals (types 7, 8, and 9), Supply Bulletins, and Lubrication Orders
DA Pam 310-7	Index *of* Modification Work Orders
SB 11-573	Painting and Preservation Supplies Available for Field Use for Electronics Command Equipment
TB SIG 355-1	Depot Inspection Standard for Repaired Signal Equipment
TB SIG 355-2	Depot Inspection Standards for Refinishing Repaired Signal Equipment
TB SIG 355-3	Depot Inspection Standard for Moisture and Fungus Resistant Treatment
TB SIG 364	Field Instructions for Painting and Preserving Electronics Command Equipment
TM 11-1242	Crystal Rectifier Test Sets TS-268A/U, TS-268A/U, TS-268B/U, TS-268C/U, TS-268D/U, and TS-268E/U
TM 11-5057	Frequency Meter AN/USM-26
TM 11-6625-433-15	Wattmeters AN/URM-98 and AN/URM-98A
TM 11-6625-200-12	Organizational Maintenance Manual: Multimeter ME-26A/U, ME-26B/U, ME-26C/U, and ME-26D/U
TM 11-6625-274-12	Operator's and Organizational Maintenance Manual: Test Sets, Electron Tube TV-7/U, TV-7A/U, TV-7B/U, and TV-7D/U
TM 11-6625-299-15	Operator, Organizational, Field and Depot Maintenance Manual: Signal Generators AN/URM-64 and AN/URM-64A
TM 11-6625-403-14	Operator, Organizational, and Field Maintenance Manual: Radar Test Set AN/UPM-98
TM 11-6625-539-15	Operator, Organizational, Field and Depot Maintenance Manual: Test Set, Transistor TS-1836/U
TM 11-6625-667-12	Organizational Maintenance Manual: Test Set, Transponder AN/APM-123(V)1
TM 38-750	Army Equipment Record Procedures

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