HARRIS
DRACON DIVISION

TS21 Craft Test Set

Identification, Operation, and Maintenance

MODELS

21800-081
21800-082
21800-084
21800-087
21800-088
21800-089

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TS21 CRAFT TEST SET

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1. GENERAL INFORMATION

1.01 This section provides identification, description of apparatus, method of operation, functional description, and maintenance information for the TS21 Craft Test Set manufactured by the Dracon Division of the Harris Corporation, Camarillo, California.

1.02 Whenever this section is reissued, the reason for reissue will be found in this paragraph.

1.03 The Dracon TS21 Craft Test Set (Figure 1) is a modern self-contained line-powered combination handset used by installers, repairmen, linemen, and other telephone personnel for line testing and for temporary communications.

1.04 The Dracon TS21 employs the latest in solid-state circuit design to provide either a DTMF (tone) or rotary-dial (pulse) output from the built-in keypad module. It contains many other features not found in conventional test handsets.

Fig. 1 - TS21 Craft Test Set

2. IDENTIFICATION

PURPOSE

- To provide a modern craftperson's test set incorporating several new features.
- To provide a test handset combining both tone and pulse capability.
- To provide additional testing capabilities.

APPLICATION

- Outside plant installation and repair.
- Central office frame and switchtrain testing.
- PABX and station equipment installation and troubleshooting.
- All other applications presently employing a conventional craft test handset.

DESIGN FEATURES

- Equipped with built-in push-button dial.
- Provides both tone and pulse dialing.
- Dialing mode is a switch-selectable.
- Keypad may be switched in or out of circuit.
- Operates in either talk or monitor mode.
- Mute switch for use in noisy locations.
- Permits checking telephone line polarity.
- Crystal-controlled, integrated-circuit design.
- Low-consumption line-powered circuitry.
- Unaffected by polarity reversal of the line.
- Contains non-slip rubber pad on the handle for hands-free use.
- High-impact case with spring-loaded belt clip.
- Last-number redial.

AVAILABLE CORD TERMINATIONS

- Alligator clips with an insulation-piercing spike.
- Alligator clips with an insulation-piercing spike and a bed-of-nails.
- 346-A plug (for Central office use).
- 346-A plug and a 1500-ohm switchable resistor (used to simulate long loops).

ELECTRICAL CHARACTERISTICS

- Refer to Table A for the TS21 operating parameters and signaling specifications.

TABLE A
ELECTRICAL SPECIFICATIONS

PARAMETER	WORKING LIMITS
Maximum Loop Resistance	2000 ohms at 48 Vdc
Minimum Loop Current	20 mA
Typical Talk Impedance	150 ohms
Minimum Monitor Impedance	6 kohms at 1 kHz
PULSE OUTPUT	
Pulsing Range	9.5 pps to 10.5 pps
Percent Break	60% ± 2%
Interdigital Interval	1000 ms typical
Leakage During Break	400 uA max. at 54 Vdc
TONE OUTPUT	
Tone Frequency Error	± 1% maximum
Level Per Tone Pair	−9 dBm to +2 dBm
Amplitude Difference	4 dB maximum

Specifications are subject to change without notice.

DIMENSIONS AND WEIGHT

- The set is 9 1/16" (24.60 cm) long, 2 1/16" (6.82 cm) wide, and 3 1/16" (9.36 cm) high.
- The maximum weight is 21 ounces (600 gm).

ORDERING GUIDE

- Refer to Table B to select the model containing the desired features and the appropriate cord.

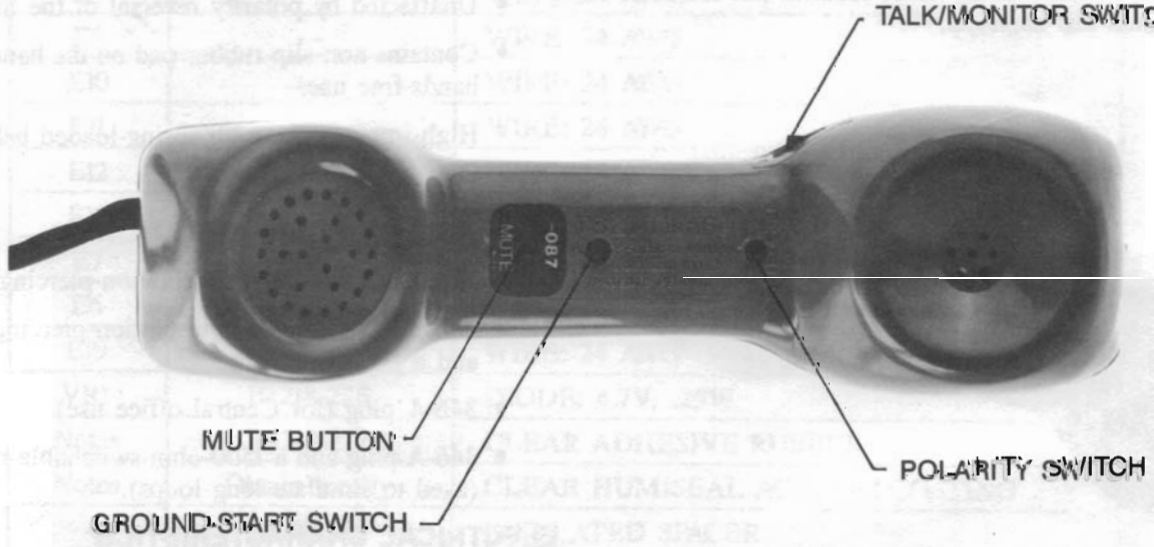


Fig. 2 - TS21 Handset Assembly—Transmitter and Receiver Side

TABLE B

ORDERING GUIDE

MODEL NUMBER	CORD TYPE	LENGTH	LEADS	TERMINATION	GROUND START SWITCH
21800-081	STD	5 Feet	2	Alligator Clips	
21800-082	SBN	5 Feet	2	Alligator Clips with Bed-of-Nails	
21800-084	SP	1 Foot	2	346-A Plug	
21800-087	3W	5 Feet	3	Alligator Clips	X
21800-088	SPR	1 Foot	2	346-A Plug with 1500-ohm switchable resistor	
21800-089	SBN-OS	5 Feet	2	Off-Set Alligator Clips with Bed-of-Nails	

3. DESCRIPTION OF APPARATUS

HANDSET ASSEMBLY

3.01 The TS21 Craft Test Set (Figures 2 and 3) has a two-piece case made of high-impact plastic. The case is specially contoured to fit the shoulder and is equipped with a non-slip rubber pad to facilitate hands-free use. The case also comes equipped with a heavy-duty spring-loaded clip located on the transmitter end of the case. The keypad module and associated switches are located on the back of the unit at the receiver end of the case. Additional switches are mounted on the side and inside of the handgrip.

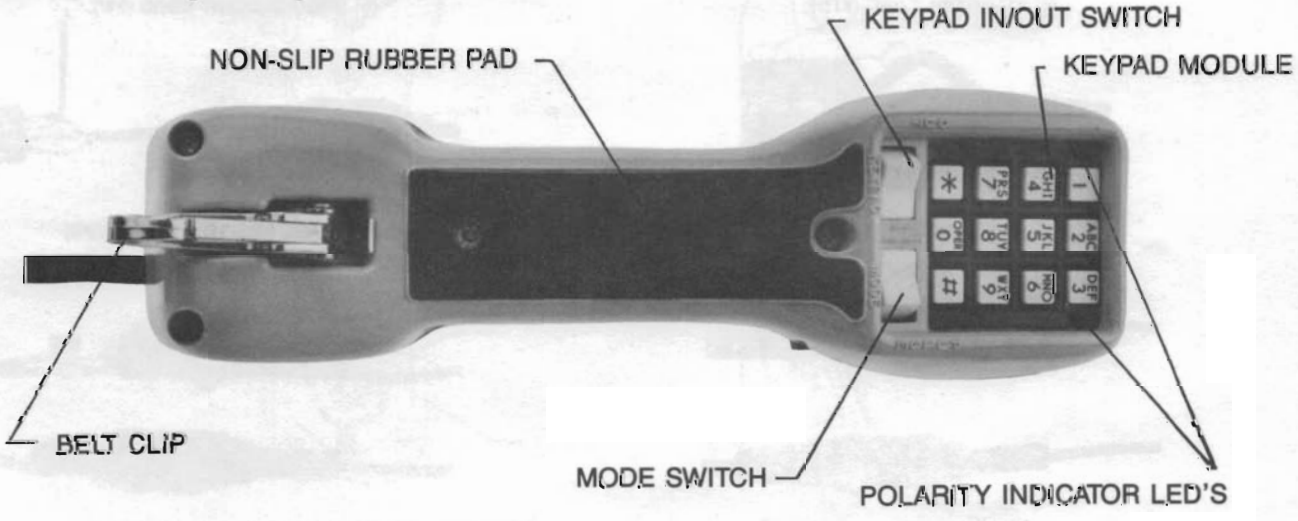


Fig. 3 - TS21 Handset Assembly—Dial Side

CORD ASSEMBLIES

3.02 ***Standard Cord (STD):*** This cord is approximately 5 feet long and consists of one red and one black fabric-covered tinsel conductor. Each conductor has an alligator clip which is offset 20 degrees to minimize clip shorting. The thumb handle and heel of each clip is covered with a rubber boot. The clips contain insulation-piercing spikes. See Figure 4 (a).

3.03 ***Ground Start Cord (3W):*** This cord is approximately 5 feet long and consists of one red, one black, and one green fabric-covered tinsel conductor. Each conductor is fitted with an alligator clip of the same type found on the standard cord. Pressing the optional ground-start button connects the green (ground) conductor to the red (ring) conductor inside the test set. See Figure 4 (b).

3.04 ***Plug Cord (SP):*** This cord is approximately 1 foot long and is fitted with a 346A male plug. This allows the test set to be used with a variety of different test cords equipped with a matching 471A female connector. See Figure 4 (c).

3.05 ***Plug and Resistor Cord (SPR):*** This cord is approximately 1 foot long and is fitted with a 346A male plug and a switchable 1500-ohm resistor. When switched in, the resistor is inserted in series with the ring side of the cord to simulate a long loop condition. See Figure 4 (d).

3.06 ***Standard Cord with Bed-of-Nails (SBN):*** This cord is identical to the standard cord except that each alligator clip is equipped with a bed-of-nails in addition to the insulation-piercing spike, and the clips are not offset as are the clips on the standard cord. See Figure 4 (e).

3.07 ***Standard Cord with Bed-of-Nail and Offset Clips (SBN-OS):*** This cord is identical to the SBN cord (see 3.06) except that the clips are offset 20 degrees to minimize clip shorting. See Figure 4 (f).

SWITCHES AND INDICATORS

3.08 ***Talk/Monitor Switch:*** The **TALK/MONITOR** switch is a black rocker switch located on the side of the test set near the receiver (Figure 2). In the **T (TALK)** position, it establishes an off-hook condition for dialing and talking. In this mode, the test set performs as a common battery telephone. In the **M (MONITOR)** position, the switch removes the transmitter from the circuit and provides a high-impedance coupling to the line. This allows monitoring of the line without disrupting a conversation in progress, data or signaling transmission.

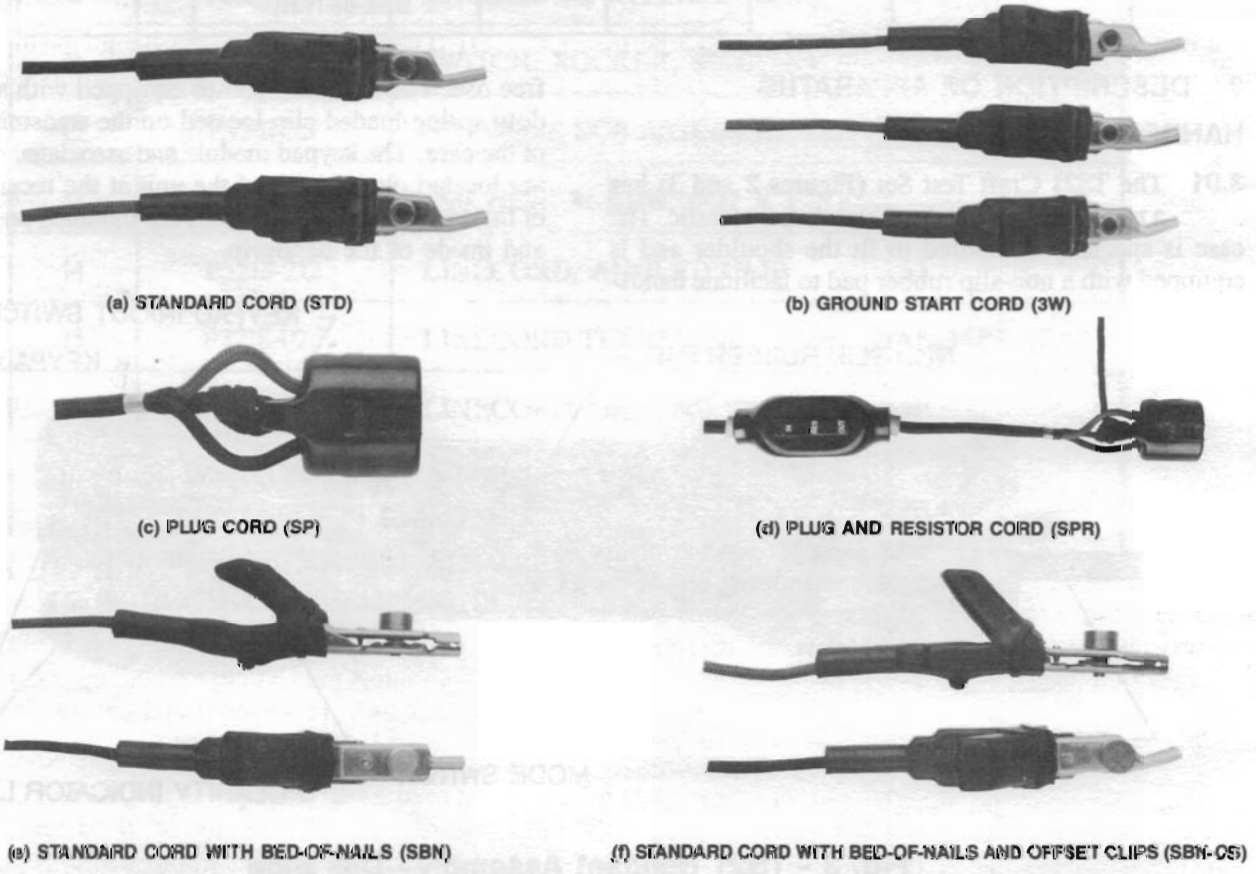


Fig. 4—TS21 Cord Assemblies

3.09 ***Mode Switch:*** The **MODE** switch is a white rocker switch located on the bottom right of the keypad (Figure 3). This switch selects either tone or pulse dialing. In the **TONE** position, the switch selects the DTMF output. In the **PULSE** position, it selects the rotary-dial output.

3.10 ***Keypad Switch:*** This is a white rocker switch located in the bottom left corner of the keypad (Figure 3). When the switch is set to the **IN** position, the test set operates as a modern electronic telephone instrument. The **IN** position is used for all normal communications functions. Set to the **OUT** position, the switch bypasses the electronics including the keypad. In this mode, dialing is not possible and the test set operates at much lower voltages. The **OUT** position is recommended when testing at or near the loop limit or testing on dry circuits. The **OUT** position is also useful when the test set is used for local communications with another craftsperson when talk battery is supplied by a local battery source such as that provided by "TONES" or other types of installer test equipment.

3.11 ***Keypad Module:*** The keys on the keypad module are used for dialing. There are twelve keys which are recessed into the receiver end of the case to provide both physical protection to the keypad and to prevent accidental key operation (Figure 3). The actual mode of dialing, either tone or pulse, is determined by the seting of the **MODE** switch described in paragraph 3.09.

3.12 ***Polarity Switch and LEDs:*** The POLARITY push-button switch is located on the inside of the handgrip, just under the receiver (Figure 2). The polarity indicators consist of a green (or yellow on earlier models) LED located in the upper left-hand corner of the keypad bezel and a red LED in the upper right-hand corner. The **POLARITY** switch and the LEDs are used to determine the polarity of a telephone line.

NOTE: The Dracon TS21 is not polarity sensitive. It will function normally regardless of the polarity of the line.

3.13 ***Mute Switch:*** The **MUTE** push-button switch is located on the inside of the handgrip, just above the transmitter (Figure 2). When pressed, this switch shorts out the transmitter to improve the reception in noisy locations.

3.14 ***Ground Start Switch (Model 087 only):*** The **GROUND START** push-button switch is located midway between the **MUTE** and the **POLARITY** switches (Figure 2). When pressed, this switch connects the green lead (ground) to the red lead (ring), initiating a ground-start seizure of a trunk.

4. METHOD OF OPERATION

ORIGINATING A CALL

4.01 To place a call:

(1) Position the **TALK/MONITOR** switch to **M**.

(2) Connect the black test clip to the tip and the red test clip to the ring of the circuit to be used.

(3) Listen in the handset to ensure that the selected line is idle.

(4) Position the **KEYPAD** switch to **IN**.

(5) Set the **MODE** switch for the desired type of dialing. **TONE** for DTMF or **PULSE** for rotary-dial.

(6) Position the **TALK/MONITOR** switch to **T** and listen for dial tone (where furnished).

(7) When dial tone is received, key in the desired telephone number on the keypad.

NOTE: When pulse dialing is selected, the number may be keyed in at any speed. Digits will automatically outpulse at the correct rate.

(8) Upon termination of the call, return the **TALK/MONITOR** switch to the **M** position.

CALLING OVER A GROUND-START TRUNK

4.02 To place a call over a ground-start trunk:

(1) If your test set is equipped with the ground-start option, connect the green wire to a ground.

(2) Perform steps (1) to (6) of paragraph 4.01 (no dial tone will be heard at this time).

(3) Press the **GROUND START** push-button, on the TS21 and hold it down. (If the TS21 is not equipped with a **GROUND START** push-button, apply a temporary ground to the ring side of the line cord with a piece of wire).

(4) As soon as dial tone is heard, release the **GROUND START** push-button (or remove the temporary ground).

(5) Perform steps (7) and (8) of paragraph 4.01.

CHECKING POLARITY

4.03 To determine the polarity of the telephone line:

(1) Position the **TALK/MONITOR** switch to **M**, with **KEYPAD** and **MODE** switches in any position.

(2) Connect the test clips to the tip and ring of the circuit to be checked and ensure it is idle.

(3) Press the **POLARITY** push-button:

The red LED will light if the red test clip is connected to tip (+) and the black to ring (−).

The green or yellow LED will light if the red test clip is connected to ring (−) and the black to tip (+).

MONITORING AND TESTING

4.04 To monitor or test a line:

(1) Position the **TALK/MONITOR** switch to **M** with **KEYPAD** and **MODE** switches in any position.

(2) Connect the test clips to the circuit under test.

(3) Proceed to monitor or test the line. In this high-impedance mode, traffic will not be disrupted.

OPERATING OVER LONG OR DRY LOOPS

4.05 To use the test set on low-voltage or dry loops:

(1) Position the **KEYPAD** switch to **OUT**.

(2) Position the **TALK/MONITOR** switch to **M**, with the **MODE** switch in any position.

(3) Connect the test clips to the tip and ring of the circuit and listen to ensure that it is idle.

(4) Position the **TALK/MONITOR** switch to **T** for testing or two-way communication.

NOTE: Dialing is not possible in this mode. The keypad has been bypassed to increase the loop limit of the set. All other functions perform normally.

OPERATING IN NOISY LOCATIONS

4.06 Reception in noisy areas can be improved by operating the **MUTE** push-button switch when listening and releasing it when talking. This switch bypasses the transmitter to eliminate background noise.

LAST NUMBER REDIAL

4.07 In the **PULSE** mode only, the last number dialed (17 digits or shorter) can be automatically redialed by using the following procedure:

(1) Go on-hook (**TALK/MONITOR** switch to **M**) for at least 0.5 seconds.

(2) Set the **TALK/MONITOR** switch to **T**.

(3) Press the # key.

NOTE: In the **PULSE** mode, the last number dialed (17 digits maximum) is retained in the unit's memory. If, after switching back to **T**, a key other than # is pressed the number will be cleared from memory. If power is removed from the tip and ring, the unit will retain the number in memory for at least 2 minutes.

5. FUNCTIONAL DESCRIPTION

5.01 The TS21 Craft Test Set provides the means for communications and testing in the central office as well as in the field. The various models offer a variety of options to meet different operating conditions. A circuit schematic of all the models is shown in Figure 8.

5.02 The TS21 provides three distinct modes of operation. They are the monitor mode for listening and testing without disturbing a conversation in progress, talking and dialing for normal communications, and the long- or dry-loop mode for use when the telephone line voltage is too low to power the electronic circuitry of the set. In the latter mode, pulse or tone dialing is not possible.

MONITOR MODE

5.03 *Monitor Circuit (Figure 5):* When the **TALK/MONITOR** switch is placed in the **M** position, the transmitter is disconnected from the line, and a high-impedance transmission path is established from the tip and ring conductors to the receiver via monitor transformer T1 in conjunction with capacitor C1. C1 is a dc-blocking capacitor to prevent the seizure of the central office while the set is in the monitor mode. The settings of the **KEYPAD IN/OUT** and **MODE** switches have no effect on the operation of the set in this mode.

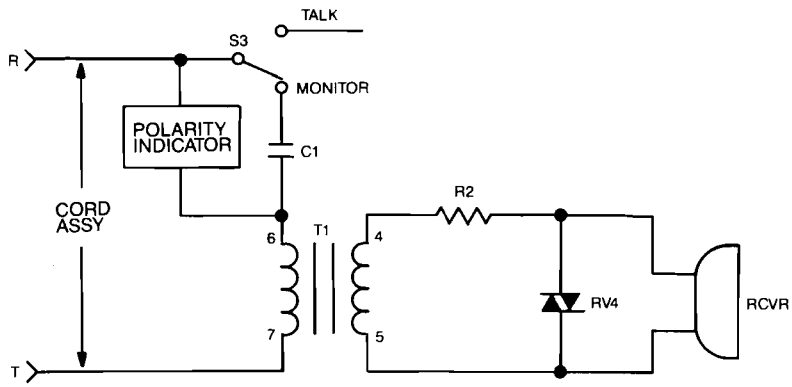


Fig. 5 - Condensed Functional Schematic of TS21 Test Set (Monitor Mode).

5.04 *Polarity Indicator:* The polarity of the telephone line can be determined by pressing the **POLARITY** switch, connecting the two LEDs across tip and ring. If DS101 (green or yellow LED) lights, ground is on the tip and battery is on the ring. If DS102 (red LED) lights, battery is connected to tip and ground to ring. Transformer winding pins 6 and 7 limits current flow to protect the LEDs. The polarity test can be performed in any mode.

TALKING AND DIALING MODE

5.05 With the **TALK/MONITOR** switch in the **T** position and the **KEYPAD IN/OUT** switch in the **IN** position, the TS21 is in the normal talking mode and the electronic circuitry is enabled to permit tone or pulse dialing.

5.06 ***Transmission Path (Figure 6):*** With the **KEYPAD IN/OUT** switch in the **IN** position, a talking and signaling path is established from the tip conductor to the ring conductor via the following components and circuitry: S4 (section C) **KEYPAD IN/OUT** switch, the polarity guard BR101, the signaling section mute transistor Q109, RV4, S4 (section A) **KEYPAD IN/OUT** switch, the transmitter receiver circuits, S4 (section B) **KEYPAD IN/OUT** switch, RT1, polarity guard BR101, and S3 (TALK position) **TALK/MONITOR** switch. RV4 is a silicon-carbide varistor used to limit the maximum output level of the receiver and prevent acoustic shocks to the user. C2 passes voice signals to the receiver, but blocks dc which could damage the receiver's permanent magnet. T1 is a hybrid transformer that reduces sidetone while not affecting transmit and receive levels.

5.07 ***Ground Start Switch (Model 087 only):*** The **GROUND START** push-button switch and 3-conductor cord are available on model 087, and are used to facilitate the testing of ground start trunks in a PBX. When placing an outgoing call from the PBX, the **GROUND START** switch is pressed, connecting ground to the ring side of the trunk. As soon as the central office recognizes the ground start signal and returns dialtone, the **GROUND START** switch can be released.

5.08 ***Mute Switch:*** The **MUTE** push-button switch is used in noisy locations. When depressed, it shorts out the transmitter. Background room noise is no longer able to pass from the transmitter to the receiver as sidetone, improving reception of the distant party's conversation. The **MUTE** switch is pressed while listening and released for talking.

5.09 ***Power Supply (Figure 7, following page):*** Polarity guard BR101 is a 400 PIV diode used to assure that the correct voltage polarity is always applied to the set's power supply and other electronic circuitry. Zener diode VR1, in conjunction with a power supply transistor drop, comprise a 4.0 V regulated power supply for the set's electronic circuitry. Capacitor C3 filters the supply voltage and stores energy to operate the set during momentary line interruptions and during the break intervals of dial pulsing. Capacitor C3 also provides the voltage required for the redial memory, for up to two minutes, when the unit is not connected to a source of battery.

5.10 ***Keypad:*** The keypad comprises twelve nonlocking pushbuttons with two make contacts each, and is used for entering the digits to be dialed. Each time a button is depressed, a "column" signal and a "row" signal are transmitted in "2-out-of-7" code to a tone/pulse repertory-dialer integrated circuit.

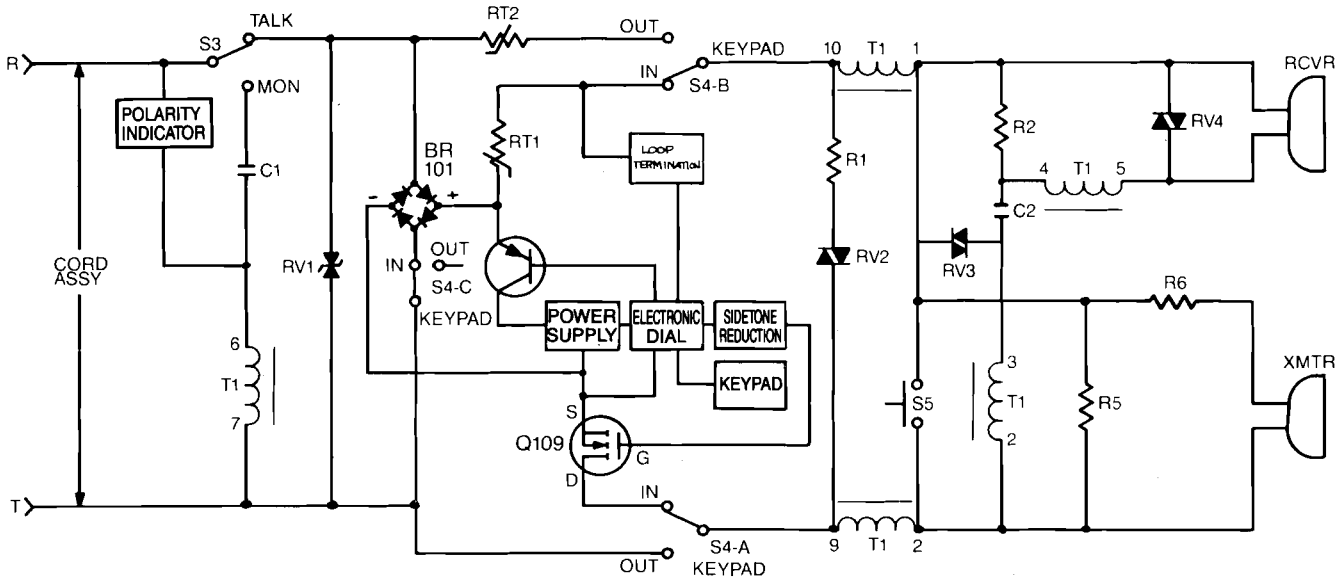
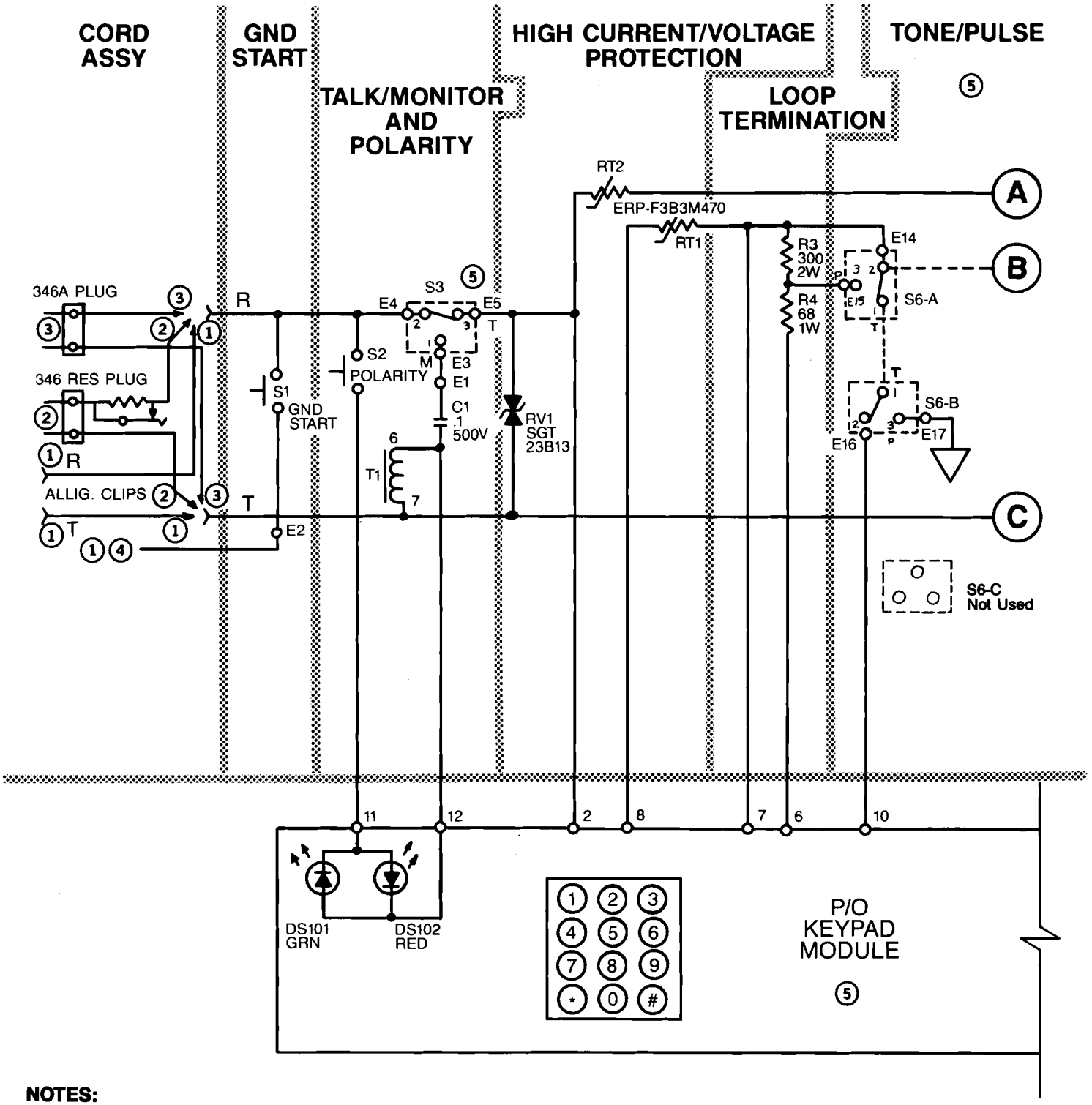


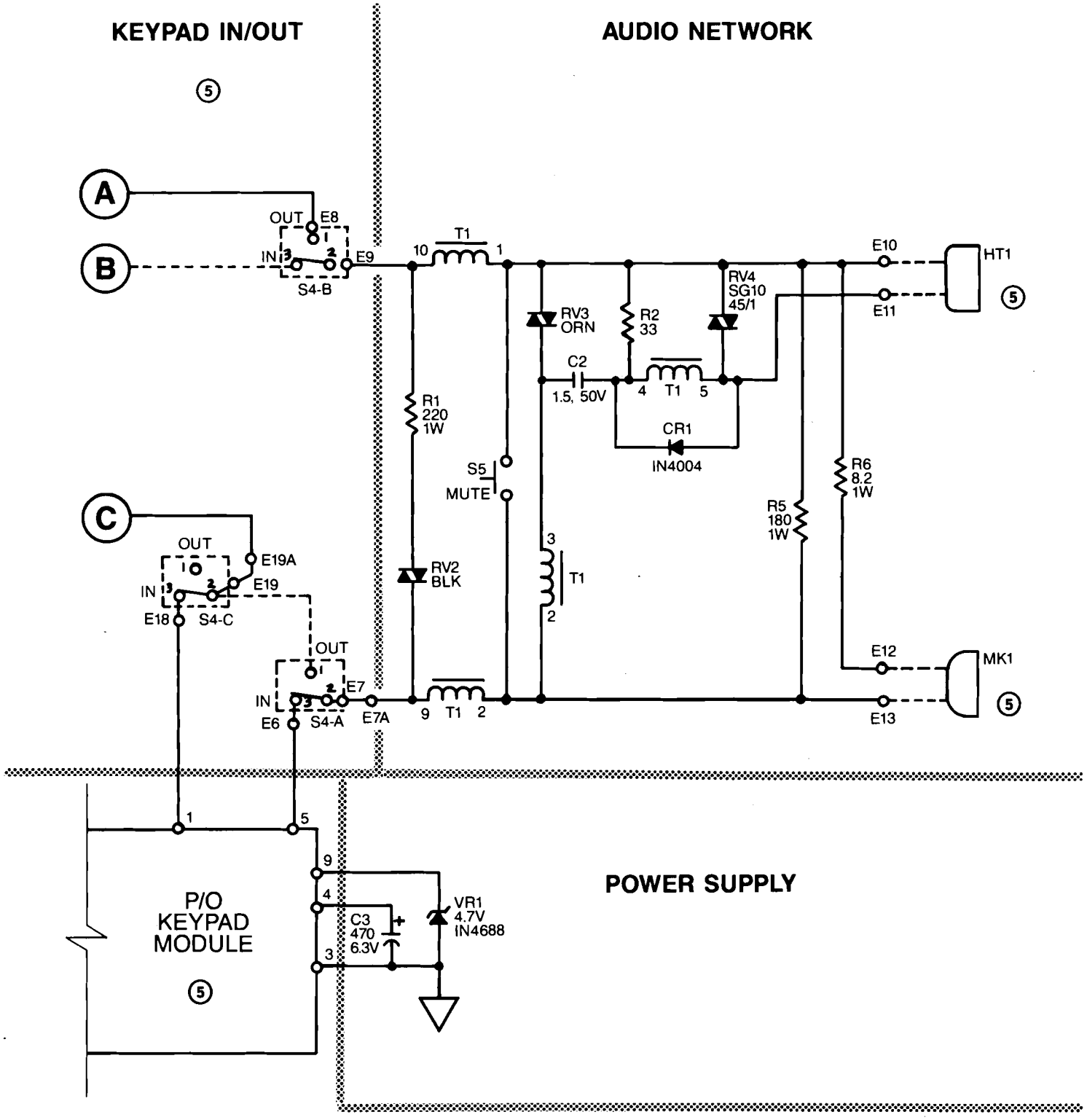
Fig. 6 - Condensed Functional Schematic of TS21 Test Set (Talking and Dailing Mode)



NOTES:

① ALLIGATOR CLIPS (MODELS -081, -082, -087, -089).
② RESISTOR PLUG (MODEL -088).
③ 346A PLUG (MODEL -084).
④ GROUND START FEATURE (MODEL -087).
⑤ NOT MOUNTED ON PRINTED CIRCUIT BOARD.

Fig. 7 - Schematic, TS21 Craft Test Set (Sheet 1 of 2).



ALL RESISTORS ARE IN OHMS, ¼W, 5%, CARBON COMP.
ALL CAPACITORS ARE IN MICROFARADS, 20%, 50V.

Fig. 7 - Schematic, TS21 Craft Test Set (Sheet 2 of 2).

LONG OR DRY LOOP MODE

5.11 The electronic circuitry of the TS21 will not function beyond the TS21's normal loop limit of 2300 ohms (2000 ohms line plus 300 ohms instrument), due to the low voltage. It then becomes necessary to bypass the keypad by operating the **KEYPAD IN/OUT** switch to the **OUT** position. The **TALK/MONITOR** switch and **MODE** switch may be in either position. In this mode, the TS21 transmission loop limit is extended to 2500 ohms. It also allows subjective testing of dry circuits by allowing inductive noise to be heard. In this mode, neither tone nor pulse dialing is possible.

5.12 ***Transmission Path (Figure 8):*** With the **KEYPAD IN/OUT** switch in the **OUT** position and the **TALK/MONITOR** switch in the **T** position, a talking path is established from the tip conductor to the ring conductor via the following components and circuits: S4 (section A) **KEYPAD IN/OUT** switch, transmitter/receiver circuit, S4 (section B) **KEYPAD IN/OUT** switch, RT2, and S3 (TALK position) **TALK/MONITOR** switch.

6. CIRCUIT TESTS

6.01 Circuit testing information is provided as an aid in diagnosing and locating trouble in the TS21 Craft Test Set. The tests are also used to verify that the TS21 set is performing according to specification. Analysis of the reported trouble may be helpful in narrowing the search for the source of trouble. Otherwise it will be necessary to conduct all of the circuit tests until the trouble is encountered.

6.02 Once the particular area of malfunction has been identified, it will be necessary to test the individual circuit components to locate the source of the trouble. For detailed information on the component tests, refer to Part 7 of this practice.

DISASSEMBLY

6.03 It is not necessary to disassemble the test set to perform routine circuit tests, but disassembly is necessary to locate and replace defective components. To disassemble the TS21 Craft Test Set, proceed as follows:

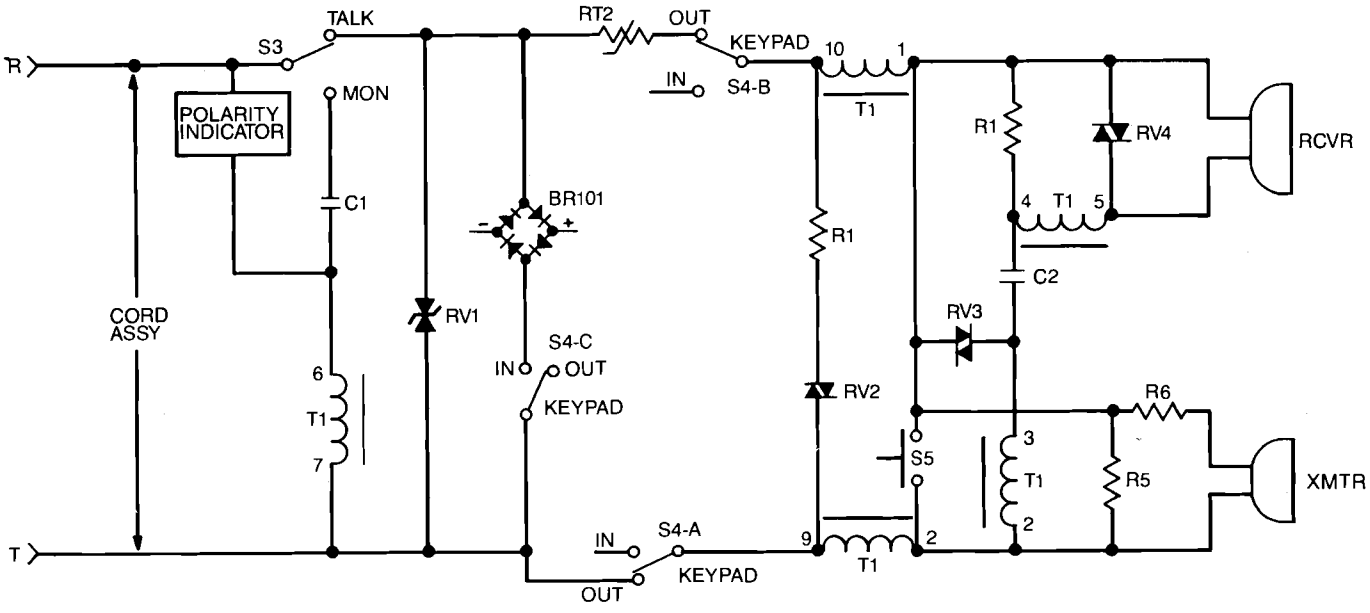


Fig. 8 - Condensed Functional Schematic of TS21 Test Set (Long or Dry Loop Mode)

6.04 To open the housing:

(1) Remove the five screws that hold the front and rear housing together (see Figure 9).

(2) Separate the front and rear housing and place them as shown in Figure 10.

Caution: The front part of the housing may bind around the **TALK/MONITOR** switch. Use gentle pressure to free it.

Note: Arranging the two parts of the case as shown in Figure 10 reduces the risk of accidentally pulling loose the receiver or transmitter wires.

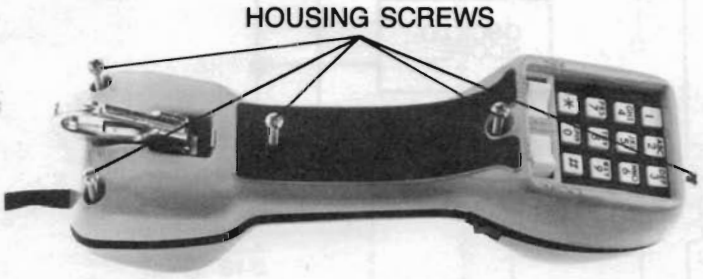


Fig. 9 - Location of Housing Screws

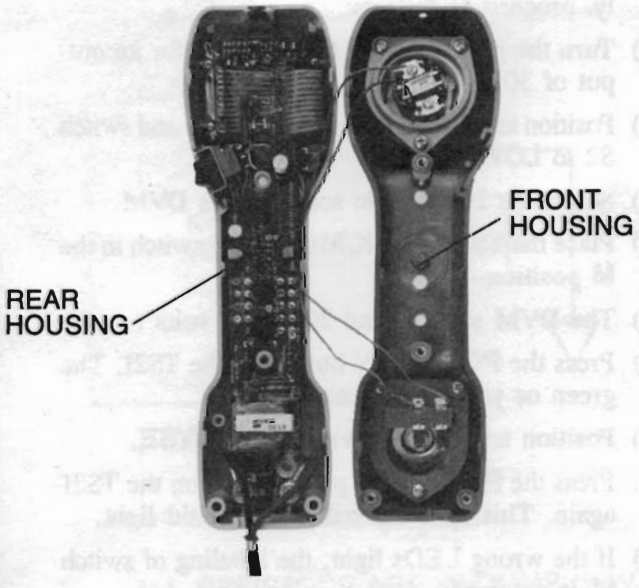


Fig. 10 - TS21 Craft Test Set Shown Disassembled

6.05 To free the printed circuit board:

(1) Remove the screws that fasten the line cord leads to the printed circuit board.

6.06 To remove the line cord:

(1) Remove the screw that fastens the line cord strain-relief braid to the rear housing.

(2) Lift the circuit board slightly and pull the cord leads and strain-relief braid out of the housing.

6.07 To remove the transmitter:

(1) Remove the three phillips-head screws from the transmitter's plastic retainer.

(2) Remove the plastic retainer.

(3) Remove the transmitter.

(4) Remove and inspect the large rubber washer (replace the washer if necessary).

6.08 To remove the receiver:

(1) Loosen the receiver terminal screws and unsolder the wire leads from the receiver.

(2) Remove the three phillips-head screws from the receiver's plastic retaining ring.

(3) Remove the retainer ring.

(4) Remove the receiver.

TESTS

6.09 The following tests are required to ensure the proper operation of the lineman's test set and to locate the portion of the circuitry containing a malfunction.

- Loop test
- DTMF test
- Pulse test
- Polarity test
- Transmitter test
- Power supply test

6.10 Test Apparatus: The following test equipment is required for these tests:

- Digital voltmeter (DVM)
- Milliammeter
- Oscilloscope with a 1X (non-attenuating) probe

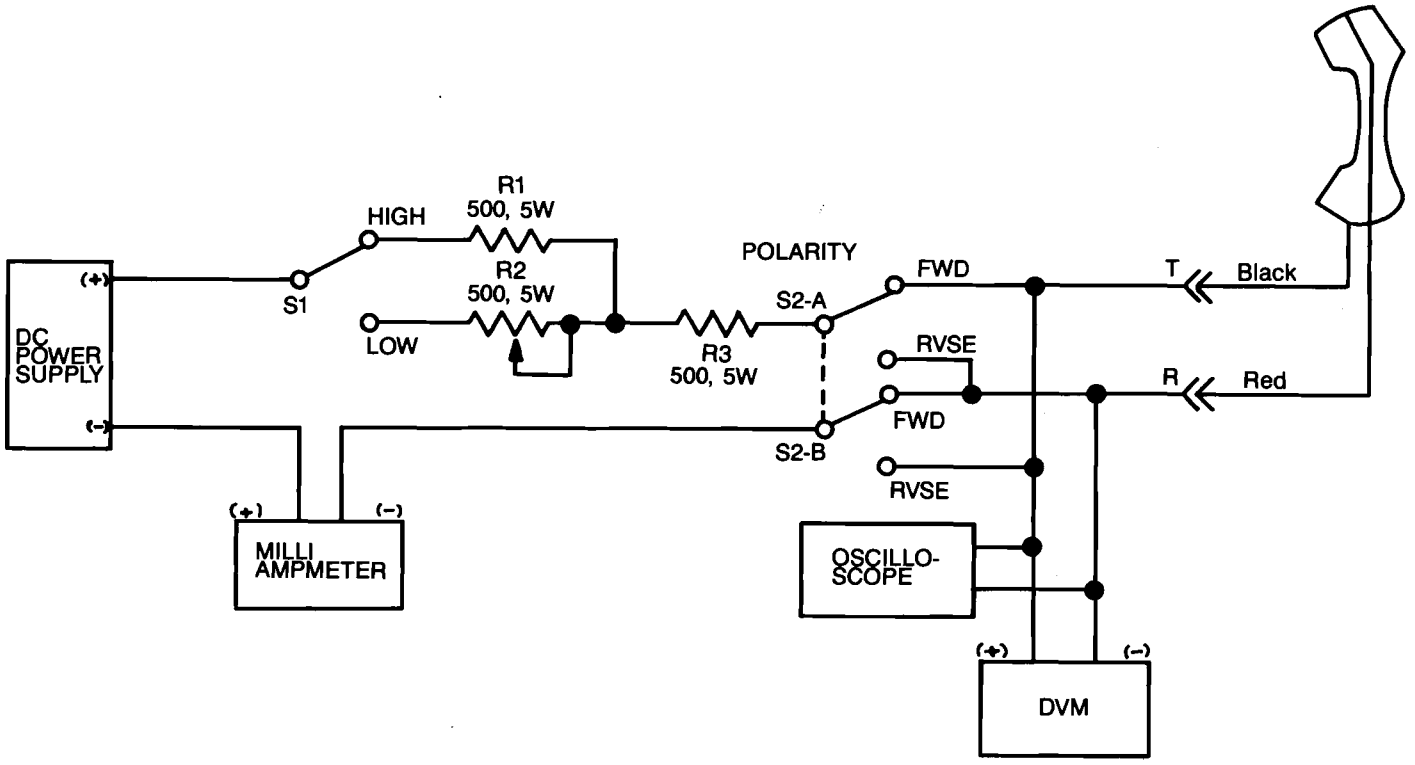


Fig. 11 - Test Equipment Connections for Circuit Tests

- Variable power supply capable of supplying 20 Vdc to 120V Vdc and up to 1.5 amperes
- Oscillator with a 600-ohm output impedance and a capability of supplying a 1 kHz tone at a level of −10 dBm
- Magnavox X183 Telecoupler or equivalent
- Four 500-ohm, 5-watt wirewound resistors
- Two double-pole, double-throw toggle switches

6.11 ***Preparation:*** To perform any of the following tests, it is first necessary to wire up a test fixture in accordance with Figure 11. Proceed as follows:

(1) Wire the four resistors and the two switches as shown in Figure 11.

(2) Label the switches and terminal points as shown in Figure 11.

(3) Connect the dc power supply, switch S1 and S2, and the milliammeter as shown in Figure 11.

(4) Connect the black and red test clips of the TS21 to the points designated (T) and (R).

(5) Also connect the oscilloscope and the DVM to the points designated (T) and (R).

6.12 To check that the test fixture is working properly, proceed as follows:

(1) Turn the power supply on and set it for an output of 30 ± 0.5 volts.

(2) Position test fixture switch S1 to **FWD** and switch S2 to **LOW**.

(3) Select the 200-volt dc scale on the DVM.

(4) Place the TS21's **TALK/MONITOR** switch in the **M** position.

(5) The DVM should read 30 ± 0.5 volts .

(6) Press the **POLARITY** button on the TS21. The green or yellow LED should light.

(7) Position test fixture switch S1 to **RVSE**.

(8) Press the **POLARITY** push-button on the TS21 again. This time the red LED should light.

(9) If the wrong LEDs light, the labeling of switch S1 is reversed.

(10) If a LED fails to light and the DVM shows less than 30 ± 0.5 volts, the test setup is incorrect.

(11) If a LED fails to light with the DVM reading 30 ± 0.5 volts, the TS21 may be defective (see paragraph 6.19).

6.13 *Loop Test:* The loop test is required to measure the TS21 power consumption and to check the voltage at the set's input. An improper voltage or current reading is indicative of a malfunction and its possible cause. Proceed with the loop test as follows:

(1) Set the power supply voltage to 30 ± 0.5 volts.

(2) Position test fixture switch S2 to **LOW**.

(3) Select the 200-volt dc scale on the DVM.

(4) Select the 200 mA scale on the milliammeter.

(5) Connect the TS21 to the test fixture terminals as shown in Figure 11.

(6) Position the TS21 **TALK/MONITOR** switch to **M**.

(7) The DVM should read 30 ± 0.5 volts.

(8) The milliammeter should not indicate more than 12 microamperes.

(9) Position the TS21 **TALK/MONITOR** switch to **T**.

(10) Position the TS21 **KEYPAD** switch to **IN**.

(11) Position the TS21 **MODE** switch to **TONE**.

(12) The DVM should read between 4 and 8 volts.

(13) The milliammeter should indicate between 22 and 26 milliamperes.

6.14 In the event that the TS21 failed to pass the loop test, a defective component may be the cause. For detailed testing of suspected components, refer to Part 7 of this practice. For a parts list, refer to Part 8. If the loop test provided an improper reading on the milliammeter or voltmeter, the cause may be one of the following:

(a) Low or no current:

—Broken wire from the **TALK/MONITOR** switch to the circuit board.

—Broken wire from the keypad **IN/OUT** switch to the circuit board.

—Broken wire from the transmitter to the circuit board.

—Keypad module (see paragraph 7.06).

(b) Higher than specified voltage:

—Same as above.

—Defective transmitter.

(c) Lower than specified voltage:

—Keypad module (see paragraph 7.06).

6.15 *DTMF Test:* The dual-tone test is required to check the DTMF circuitry for proper tone frequency, waveform and dual-tone operation. Proceed with the test as follows:

(1) Position the TS21 **TALK/MONITOR** switch to **T**.

(2) Position the TS21 **MODE** switch to **TONE**.

(3) Position the TS21 **KEYPAD** switch to **IN**.

(4) Set the power supply output to 30 ± 0.5 volts.

(5) Position test fixture switch S2 to **LOW**.

(6) Set channel 1 of the oscilloscope for 1 Vac per division and 1 ms sweep per division.

(7) Ensure that a 1X probe is being used.

(8) Position the ground-level scope trace to the center of the screen.

(9) Set the DVM to read ac voltage.

(10) Press the keypad (#) key and hold it down.

(11) The milliammeter should indicate between 20 and 24 milliamperes.

(12) The DVM should indicate a minimum of 0.4V.

(13) The oscilloscope should show the clean and non-distorted waveform of Figure 12.

DUAL TONES

Fig. 12 - Proper Duel-Tone Waveform

(14) Adjust the scope trigger and time base to display a single waveform.

(15) Repeat steps (11) through (13) for every keypad key in sequence.

(16) Each key shall produce a waveform similar to that of Figure 12.

(17) Waveforms similar to those shown in Figure 13 are unacceptable for the reasons indicated.

ONE TONE ABSENT

BOTH TONES ABSENT

DUAL TONES WITH CLIPPED PEAKS AND/OR NOISE

Fig. 13 - Improper Dual-tone Waveforms

(18) Position test fixture switch S1 to **RVSE** to reverse the polarity of the test fixture.

(19) Repeat steps (10) to (17) above. The same results should be obtained.

6.16 If one or more digits fail to pass the dual-tone test, as indicated by an improper or intermittant waveform or by the absence of one or both tones, one or more of the following components may be defective:

—Loop termination resistors

—The **MODE** switch

—The keypad **IN/OUT** switch

—The keypad module (see paragraph 7.06)

These components may be tested in accordance with the test procedures for components described in Part 7 of this practice.

6.17 ***Pulse Test:*** The pulse test checks the amplitude and the make and break intervals of the dial pulses generated by the TS21 during pulse dialing. The test is required to ensure that the dial pulses are adequate to operate the switching equipment in the central office over the longest loop permitted by the TS21 specifications. Proceed with the pulse test as follows:

(1) Position the TS21 **MODE** switch to **PULSE**.

(2) Set the power supply for an output of 30 volts.

(3) Position test fixture switch S2 to **LOW**.

(4) Set channel 1 of the oscilloscope for 5 Vdc per division and 10 ms sweep per division.

(5) Position the ground-level scope trace to the bottom of the screen.

(6) Press the key for the digit (1) on the keypad.

(7) The scope should indicate a pulse amplitude of 17 to 20 volts during the break interval.

(8) During the make and nondialing intervals, the scope should show a dc level of 6 to 10 volts.

(9) The break interval should be 58% to 62% of one cycle and 58 to 62 ms in duration.

(10) The make interval should be 38% to 42% of one cycle and 38 to 42 ms in duration.

(11) Figure 14 shows the waveform and amplitude of a proper train of dial pulses.

(12) Repeat steps (6) through (10) for all other digit keys on the TS21 keypad.

(13) Set the power supply for an output of 120 volts.

(14) Position test fixture switch S2 to **HIGH**.

(15) Set channel 1 of the oscilloscope for 20 volts per division.

(16) Repeat steps (5) through (12). The dial pulses should meet the same requirements.

(17) Position test fixture switch S1 to **RVSE** to reverse the power supply polarity.

(18) Repeat steps (2) through (16). The test results should be the same as before.

6.18 If the dial pulses fail to meet the foregoing requirements, are intermittent, or if certain keys fail to generate digits or if no pulses are generated, one or more of the following components may be defective:

—Loop termination resistor.

—The mode switch.

—The keypad **IN/OUT** switch.

—The keypad module (see paragraph 7.06).

6.19 ***Polarity Test:*** The polarity test is required to check the polarity sensing function of the TS21 and the operation of the LEDs. Proceed with the polarity test as follows:

(1) Set the power supply output for 30 ± 0.5 volts.

(2) Position test fixture switch S2 to **LOW**.

(3) Position test fixture switch S1 to **FWD**.

(4) Press the TS21 **POLARITY** push-button switch. The green or yellow LED should light.

(5) Position test fixture switch S1 to **RVSE**.

(6) Press the TS21 **POLARITY** push-button switch again. This time the red LED should light.

(7) If either LED fails to light, check the LED. If both LEDs fail to light, check the line cord, the TS21 **POLARITY** push-button switch, and transformer winding pins 6 and 7.

Refer to Part 7 for testing components and Part 8 for the parts index.

6.20 ***Transmitter Test:*** The transmitter test is required to verify that the voltage output of the transmitter meets the minimum requirements when energized with a known sound-pressure level. Proceed with the transmitter test as follows:

(1) Set the power supply for an output of 120 volts.

(2) Position the test fixture switch S2 to **HIGH**.

(3) Connect the oscillator to the acoustic coupler as specified by the coupler manufacturer.

(4) Place the TS21 Craft Test Set in the acoustic coupler's handset cradle.

(5) Set the oscillator output for 1 kHz at a level of −10 dBm.

(6) Set the digital voltmeter to read ac voltage.

(7) The DVM should indicate 0.1 volts ac or more.

(8) Set the power supply output for 30 ±0.5 volts.

(9) Position the test fixture switch S2 to **LOW**.

(10) The digital voltmeter indication should continue to meet the requirements of step (7).

6.21 If there is no voltage indication, check for broken wires from the transmitter to the printed circuit board. If the reading of the digital voltmeter is less than 0.1 volt ac, check the output voltage of the unit's power supply as described in paragraph 6.22. If the power supply voltage is correct, test the transmitter in accordance with the instructions contained in Part 7.

6.22 ***Power Supply Test:*** The following procedure checks the voltage output of the dialer IC, VR1 and (+) side of BR101.

(1) Disconnect the test set from the test fixture and disassemble it, as described in paragraph 6.03.

(2) Reconnect the disassembled test set to the test fixture.

(3) Set the test set **KEYPAD IN/OUT** switch to **IN** and the **TALK/MONITOR** switch to **T**.

(4) Set the test fixture power supply for 30 Vdc.

(5) Set test fixture switch S2 to **LOW**.

(6) Using a separate voltmeter check the following pins on the keypad module. All measurements are with reference to Pin 3.

(a) Pin 4 - Voltage shall be between 2.5 Vdc to 4.0 Vdc.

(b) Pin 9 - Voltage shall be between 3.0 Vdc to 4.5 Vdc.

(c) Pin 8 - Voltage shall be between 3.0 Vdc to 5.0 Vdc.

If the power supply test provided an improper reading on voltmeter then one or more of the following components may be defective:

—VR1

—C3

—Keypad module

7. COMPONENT TESTS

7.01 Test procedures for the major components of the TS21 test handset are included to assist in identifying defective elements and clearing trouble. For those components which are not mentioned, standard test procedures should be used. The components to be tested are those pertaining to that portion of the circuitry identified through the circuit testing of Part 6 as malfunctioning. A complete parts index listing all components is provided in Part 8 of this practice.

7.02 ***Tests:*** Test procedures are provided for the following component parts of the TS21 test handset.

- Varistor RV4
- Keypad module
- Line cord and test leads
- Transmitter
- Receiver
- All switches

7.03 ***Test Apparatus:*** The following test equipment is required for these tests:

- Digital voltmeter (DVM)
- Ohmmeter
- Oscilloscope with a 1X (non-attenuating) probe
- Variable power supply capable of supplying 0 volts to 120 volts dc
- Small soldering iron suitable for soldering on printed circuit boards containing ICs
- Desoldering tool suitable for removing components from printed circuit boards

7.04 ***Preparation:*** For component testing, the TS21 will have to be disassembled as described in paragraph 6.03. The TS21 shall be disconnected from the test fixture except for those tests requiring that the TS21 be powered.

CAUTION: When removing components from the printed circuit board, first remove the silicon rubber coating, then completely desolder the leads; otherwise the metal feed-throughs may be pulled loose. All coating must be replaced.

7.05 ***Varistor RV4 Test:*** This test is required to determine if varistor RV4 is shorted. To perform the test, lift one end of varister, set the ohmmeter to the high-resistance scale and apply it across the varistor. The meter should indicate open circuit.

7.06 ***Keypad Module Test:*** This test is required to determine if the keypad module is functioning properly.

Proceed with the keypad module test as follows:

A. PULSE MODE

(1) Set the TS21 **TALK/MONITOR** switch to **T.**

(2) Set the TS21 **KEYPAD** switch to **IN.**

(3) Set the TS21 **MODE** switch to **PULSE.**

(4) Set the text fixture power supply for 30 Vdc.

(5) Set test fixture switch S2 to **LOW.**

(6) With voltmeter reference to Pin 3 of the keypad module, check the following pins:

(a) Pin 5 - Voltage shall be between 0.1 Vdc to 0.5 Vdc.

(b) Pin 6 - Voltage shall be between 2.0 Vdc to 4.0 Vdc.

(7) Connect the oscilloscope across Pins 3 and 5 of the keypad module.

(8) Press any keypad key. The oscilloscope should show a proper train of dial pulses with amplitude similar to Figure 14.

B. TONE MODE

(1) Set the TS21 **MODE** switch to **TONE.**

(2) Press each keypad key in sequence.

(3) A dual tone signal should be generated each time.

(4) Check the ribbon cable for scratches across the conductors.

(5) If the trouble has not been located, replace the keypad module with one that is known to be good.

(6) Repeat steps (A) to (B) with the new keypad module.

7.07 ***Line Cord Test:*** The line cord test is required to determine if there is an open, high-resistance, or intermittent condition in the line cord. Proceed as follows:

(1) Apply an ohmmeter across each conductor and make sure the resistance is zero.

(2) Check for an intermittent condition by wiggling each conductor and observing the ohmmeter.

(3) Set the power supply to 50 Vdc.

(4) Connect one line cord test clip to one of the power terminals.

(5) Tap the other test clip to the other power terminal.

(6) A loud click should be heard in the TS21 receiver each time the terminal is tapped.

7.08 ***Transmitter Test:*** This test is required to check the transmitter resistance with an ohmmeter. It should read between 75 and 350 ohms.

7.09 ***Receiver Test:*** This test is required to determine if the receiver element is defective. Proceed with the test as follows:

(1) Replace the receiver with a known good receiver and test its operation.

(2) If the line cord is known to be good, test the receiver per Steps (3) and (6) of paragraph 7.07.

(3) If the receiver fails to function, check for broken wires.

7.10 ***Switch Test:*** Switches can be checked for proper operation by measuring their contact resistance while power is removed from the TS21. Switches should also be checked for accumulations of oil, dirt, moisture, and mechanical obstructions.

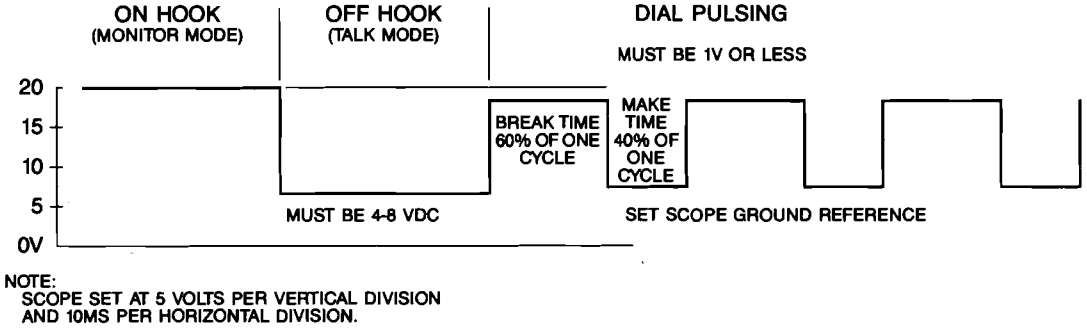


Fig. 14—Proper Waveform for Dial Pulses

8.0 PARTS INDEX

8.01 The following Figures and associated Tables are provided as a guide to help you identify both electrical and non-electrical components of the TS21 Craft Test Set.

Table C - Parts List - Front Housing Assembly
Figure 15 - Front Housing and Components

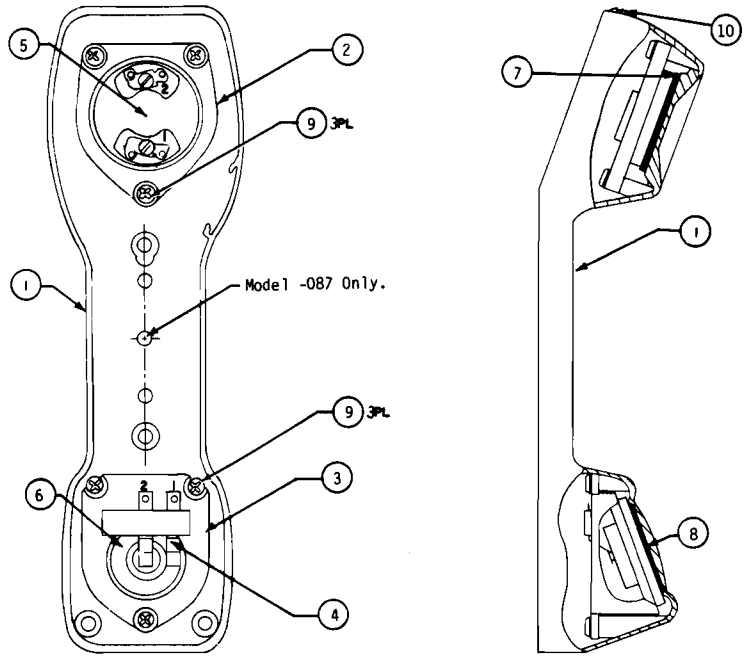
Table D - Parts List - Rear Housing Assembly
Figure 16 - Rear Housing and Components

Table E - Parts List - Printed Circuit Board
Figure 17 - Printed Circuit Board Layout

TABLE C

PARTS LIST — FRONT HOUSING ASSEMBLY

ITEM	PART NUMBER	DESCRIPTION
1	P3218-137	FRONT CASE ASSEMBLY, DARK BLUE
2	P3218-031	RECEIVER-RETAINER
3	P3218-032	TRANSMITTER-RETAINER
4	P3218-038	TERMINAL SPRING
5	P3218-229	TELEPHONE RECEIVER
6	P3218-071	TELEPHONE TRANSMITTER
7	P3218-112	RECEIVER WASHER
8	P3218-073	TRANSMITTER WASHER
9	P3218-098	SCREW: 6-20 X ½
10	P3218-070	MACHINE SCREW: 6-32 X ⅜

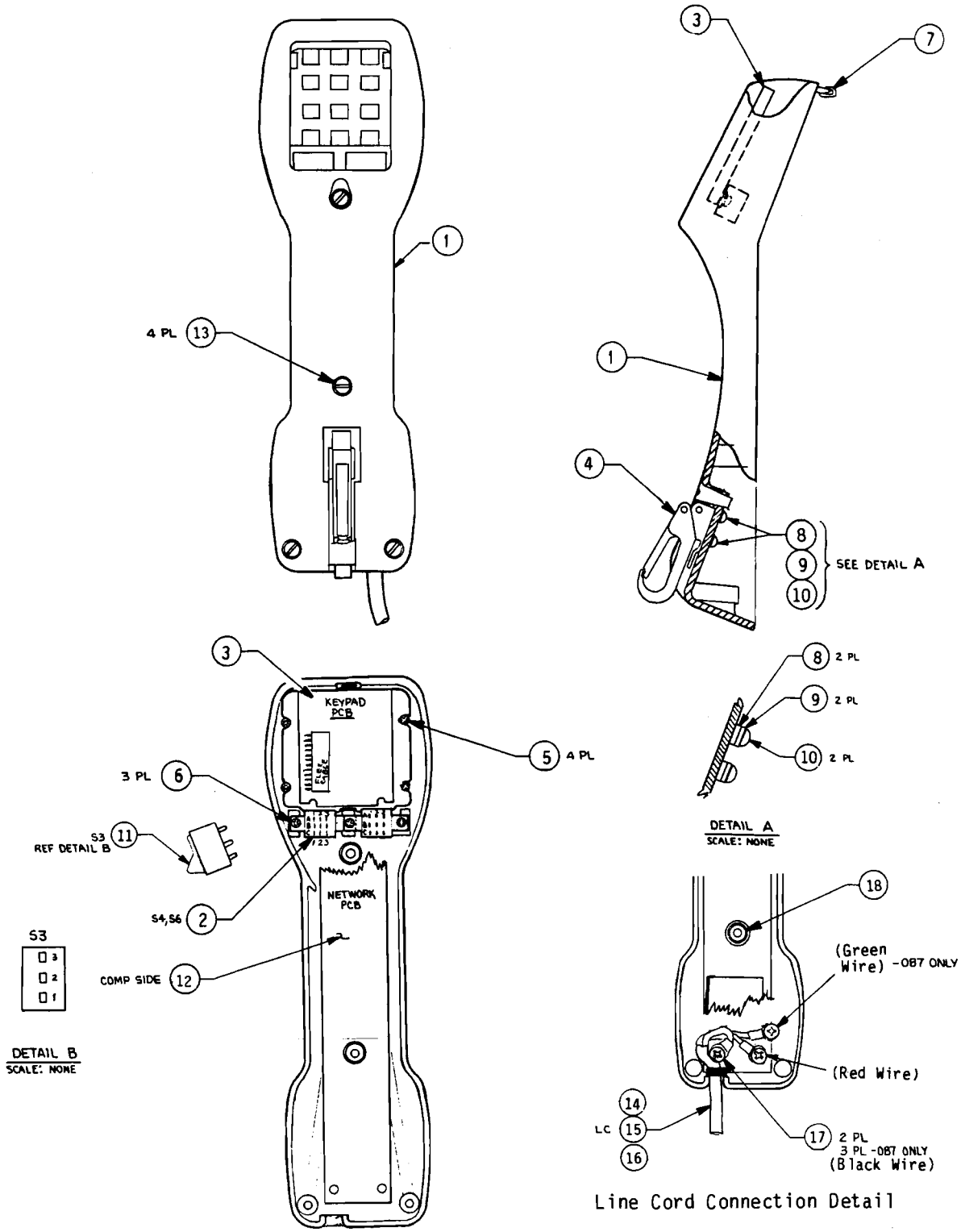


Notes: Tighten screw 9 to 10 in/lbs. maximum.

Fig. 15 - Front Housing Assembly

TABLE D
PARTS LIST — REAR HOUSING ASSEMBLY

ITEM	PART NUMBER	DESCRIPTION
1	P3218-136	REAR CASE ASSEMBLY, LIGHT BLUE
2	P3218-033	S4, S6 SWITCH: ROCKER 3PDT
3	P3218-203	KEYPAD MODULE ASSEMBLY TS21
4	P3218-214	BELT CLIP: LARGE
5	P3218-066	SCREW: 2-32 X ⅜
6	P3218-097	SCREW: 2-32 X ¼
7	P3218-053	SELF-RETAINING FASTENER
8	P3218-215	MACHINE SCREW: 6-32 X ¼
9	P3218-216	WASHER: #6, FLAT
10	P3218-217	WASHER: #6, INTERLOCKING
11	P3218-205	SWITCH: ROCKER, SPDT
12	P3218-211	NETWORK PCB ASSEMBLY TS21 (SEE FIGURE 17)
13	P3218-094	MACHINE SCREW: 6-32 X 1
14	P3218-212	LINECORD, ANGLED CLIP
15	P3218-028	LINECORD THERMAL PLASTIC, STANDARD CLIP
16	P3218-025	LINECORD, GROUND START, 3W
17	P3218-213	MACHINE SCREW: 4-40 X ⅜
18	P3218-052	NEOPRENE TUBING



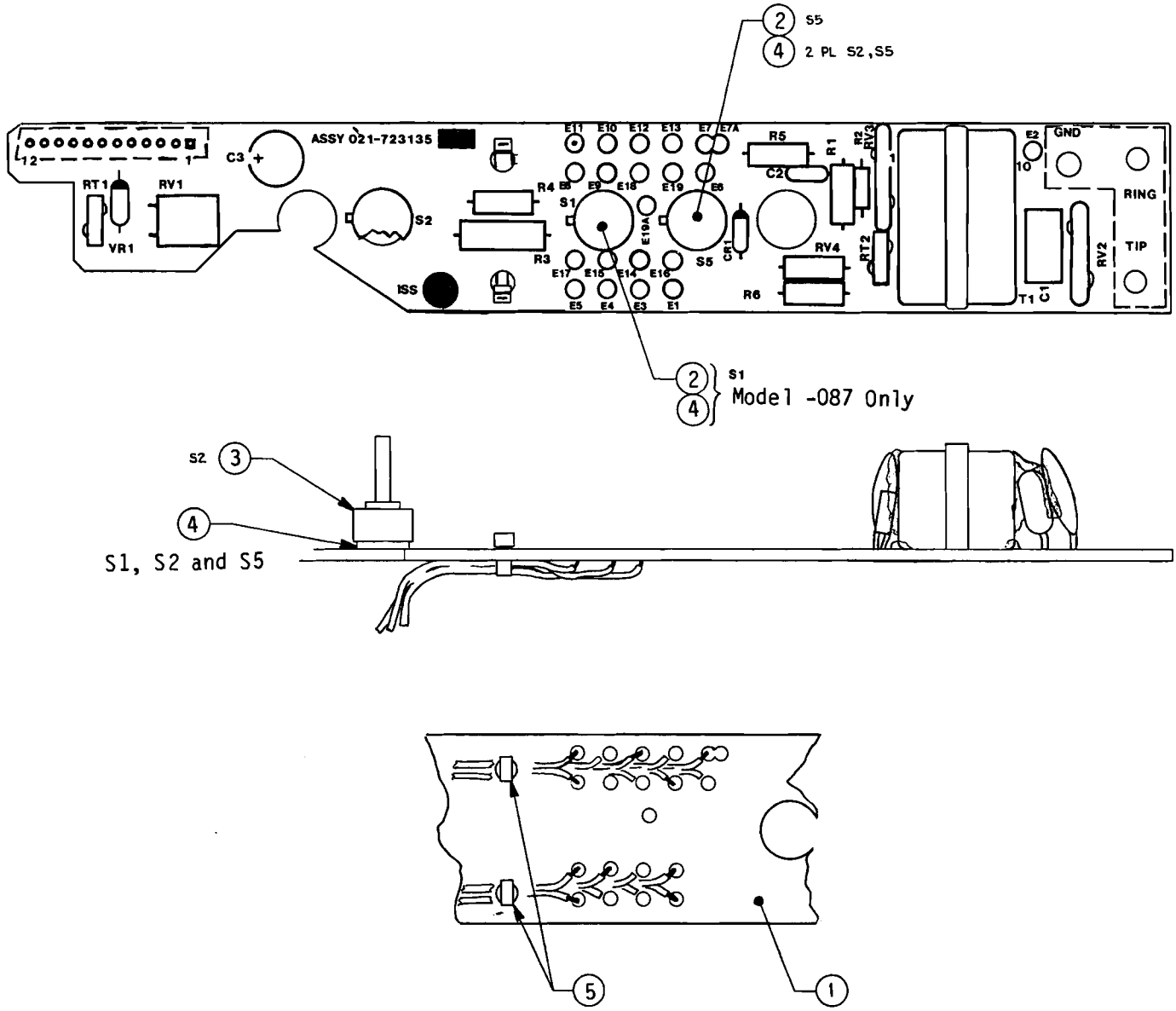
Line Cord Connection Detail

Notes:
1. Tighten screws 5 and 6 to 3 in/lbs.
2. Tighten screws 8, 9 and 10 to 6.5 - 7.5 in/lbs.
3. Tighten screws 13 to 10 in/lbs.
4. Tighten screws 17 to 6 in/lbs.

Fig. 16 - Rear Housing and Components

TABLE E
PARTS LIST — PRINTED CIRCUIT BOARD

ITEM	PART NUMBER	DESCRIPTION
1	P3218-211	COMPLETE NETWORK PCB, TS21
RV1	P3218-173	SURGE SUPPRESSOR: 230V
RT1, RT2	P3218-161	FUSE-RESISTOR, RESETTABLE, 40V
RV2	P3218-163	VARISTOR: 8.8-10.8V, 10 MA
RV3	P3218-162	VARISTOR: 7.1-8.8V, 10 MA
RV4	P3218-079	VARISTOR: 6.6V
2	P3218-034	S1, S5 SWITCH: SPST
C1	P3218-143	CAP: .1UF, 500V
C2	P3218-063	CAP: 1.5UF, 50V
C3	P3218-219	CAP: 470UF, 6.3V
R1	P3218-155	RESISTOR: 220 OHM, 1W
T1	P3218-144	TRANSFORMER
R4	P3218-220	RESISTOR: 68 OHM, 1W
R2	P3218-221	RESISTOR: 33 OHM, ¼W
CR1	P3218-225	DIODE: 1A, 400V
R5	P3218-222	RESISTOR: 180 OHM, 1W
R6	P3218-223	RESISTOR: 8.2 OHM, 1W
R3	P3218-224	RESISTOR: 300 OHM, 2W
3	P3218-035	S2 SWITCH: SPST
33	P3218-165	BOOT
E3	—	WIRE: 24 AWG
E4	—	WIRE: 24 AWG
E5	—	WIRE: 24 AWG
E10	—	WIRE: 24 AWG
E11	—	WIRE: 24 AWG
E12	—	WIRE: 24 AWG
E13	—	WIRE: 24 AWG
E7	—	WIRE: 24 AWG
E6	—	WIRE: 24 AWG
E19	—	WIRE: 24 AWG
VR1	P3218-226	DIODE: 4.7V, .25W
Notes	P3218-227	CLEAR ADHESIVE RUBBER
Notes	Obtain locally	CLEAR HUMISEAL ACRYLIC COATING
4	P3218-228	INSULATED SPACER
5	P3218-218	CABLE TIE



Notes:

1. Recoat PCB as required using Dow Corning 1-2577 Conformal Coating, or equivalent.
2. Reinstall Protective boot (P/N P3219-165) over switches S1, S2 and S5.
3. Bend components C1, RV2, RV3 and RT2 towards T1 and secure to T1 using P/N P3218-227. Tack corners of T1 using same material.

Fig. 17 - Printed Circuit Board