

MAINTENANCE AID

TS-21 Model 21800-000  
-001  
-006  
-007

DRACON P/N  
023-710125-023

## "THEORY OF OPERATION"

### 1. GENERAL

1.01 This chapter provides a general overview of the electrical operation of the TS21.

### 2. CIRCUIT CONTROL AND SIGNALING

2.01 All TS21 circuit control, signaling and muting is provided by transistor switching.

2.02 DTMF signaling is accomplished by an integrated circuit controlled by a high stability crystal. This design insures that DTMF tone frequencies are consistently within industry accepted limits.

2.03 Pulse signaling is accomplished by an integrated circuit controlled by a high stability resonator. Pulsing speed and break accuracy is assured by this design.

### 3. POWER REGULATION

3.01 The TS21 operates on a regulated power supply derived from the telephone line voltage. This prevents telephone line high voltage surges from damaging circuit components while allowing the unit to function properly over long loops.

3.02 In addition to the integral power supply regulation; a varistor provides additional protection against high transient voltages on the telephone line.

3.03 The receiver circuitry incorporates a varistor to protect the test set user from sound level pressures that could cause damage to the ear.

3.04 All TS21 ICs are the CMOS type. The lower power requirements of the CMOS ICs insure low telephone line loading.

### 4. LINE POLARITY

4.01 The TS21 is not polarity sensitive. A Bridge Rectifier functions as a polarity guard, allowing the TS21 to operate in either polarity.

4.02 Polarity indication is provided by LEDs (Light Emitting Diodes).

### 5. MODES OF OPERATION

5.01 The TS21 has two basic operating modes; the Talking or normal operating mode and the Monitor mode.

5.02 Talking Mode: The Talking mode is selected by placing the TALK/MONITOR switch in the "T" position and the network in either position. The Talking mode is the normal operation mode. In this mode, the TS21 operates as a modern telephone instrument and either DTMF or pulse signaling may be selected with the MODE switch.

5.03 Monitor Mode: The Monitor mode is selected by placing the TALK/MONITOR switch in the "M" position. The network switch and the MODE switch may be in either position. The Monitor mode is a high impedance listen/test mode. This allows the user to monitor the telephone line without disrupting voice communications or data transmissions.

## 1. SWITCH FUNCTIONS

1.01 Talk/Monitor switch: The Talk/Monitor switch is a black rocker switch located on the side of the test set, near the receiver. 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 and electronics from the circuit and provides a high impedance coupling to the line. This allows line monitoring without disrupting conversations, data or signaling.

1.02 Mode Switch: The Mode switch is a white rocker switch located in the bottom right of the key bezel. This switch selects either DTMF or dial pulse signaling output. In the "TONE" position, the switch selects DTMF output. In the "PULSE" position, the switch selects dial pulse output.

1.03 Network In/Out Switch: Located adjacent to the Mode switch on the key pad bezel, this switch selects either of two transmission modes. In the "IN" position the TS21 operates like a modern telephone instrument, with an electronic transmission network. The "IN" position should be used for all normal talking, monitoring, and signaling functions.

With the Network switch in "OUT" position, the usefulness of the TS21 as a troubleshooting tool is multiplied, because the transmission network is then switched out of the circuit, allowing "transparent" testing of the line. The sounds from the receiver can greatly assist a skilled craftsperson in locating open circuits, shorts, crosses, and grounds.

1.04 The Keypad: The keys on the keypad are used for signaling (dialing). There are twelve keys on a bezel which is recessed into the receiver end of the case to provide both physical protection to the keypad and prevent accidental key operation.

1.05 Polarity Switch and LEDs: The Polarity switch is a small black button located on the inside of the handgrip, just under the

receiver. The polarity LEDs are an amber LED in the upper left corner of the key bezel and a red LED in the upper right corner. The Polarity switch and LEDs are used to test line polarity. The procedure for conducting a polarity check is explained in 2.02.

Note: The Dracon TS21 is not polarity sensitive. The test set will function normally when connected to the line in either polarity.

1.06 Mute Switch (optional): The Mute switch is located on the inside of the handgrip, just above the transmitter. When pressed, this button mutes the transmitter, thereby allowing better audible reception in noisy areas.

## 2. OPERATION

### 2.01 Signaling:

- (1) Position the Talk/Monitor switch to "M",  
(The Network and Mode switch may be in either position.)
- (2) Connect the test clips to the tip and ring of the circuit to be used and insure that it is idle.
- (3) Position the Network switch to either position.
- (4) Position the Mode switch to the type of signaling required. ("TONE" for DTMF or "PULSE" for dial pulse.)
- (5) Position the Talk/Monitor switch to "T" and verify that a dial tone is received (when furnished).
- (6) Enter the desired number on the keypad.

Note: When "PULSE" is selected, the number may be keyed in at any rate. Digits will automatically outpulse at the correct rate.

- (7) To terminate the call, return the Talk/Monitor switch to "M".

### 2.02 Polarity Check:

- (1) Position the Talk/Monitor switch to "M".  
(The Network and Mode switch may be in either position.)
- (2) Connect the test clips to the tip and ring of the circuit to be used and insure that it is idle.

(3) Press the Polarity button:

If the red LED illuminates, the red test clip is connected to the tip (+) and the black to the ring (-).

If the amber LED illuminates, the red test clip is connected to the ring (-) and the black to the tip (+).

Caution: Operation of the Polarity button on a busy circuit may cause annoying clicks or service interruptions.

2.03 Line Monitoring/Testing:

- (1) Position the Talk/Monitor switch to "M".  
(The Network and Mode switch may be in either position.)
- (2) Connect the test clips to the tip and ring of the circuit under test.

Note: With the Talk/Monitor switch set to "M", a high impedance condition is established which allows monitoring or testing without disrupting traffic on the line.

3. TEST SET DISASSEMBLY

3.01 To Open the Case:

- (1) Remove the five screws that hold the case together.
- (2) Separate the two parts of the case and lay them cord end toward you, PC board to your left.

CAUTION: The front part of the case will bind around the Talk/Monitor switch. Use gentle pressure to free it.

Note: Arranging the two parts of the case as described in #2 above will reduce the risk of accidentally pulling loose the receiver or transmitter wires.

3.02 To Free the PC Board:

- (3) Remove the screws that connect the line cord leads to the circuit board.

3.03 To Remove the Line Cord:

- (4) Remove the screw that fastens the cord strain relief braid to the case.
- (5) Lift the circuit board slightly and pull the cord leads and stay-connect braid out of the case.

3.04 To Remove the Transmitter:

- (6) Remove the three phillips screws from the transmitter's plastic retainer.
- (7) Remove the plastic retainer.
- (8) Remove the transmitter.
- (9) Remove and inspect the rubber gasket. (Replace the gasket if necessary.)

3.05 To Remove the Receiver:

- (10) Loosen the receiver terminal screws and disconnect the spade connectors from the receiver.
- (11) Remove the three phillips screws from the receiver's plastic retainer.
- (12) Remove the retainer.
- (13) Remove the receiver.
- (14) Remove and inspect the rubber gasket. (Replace the gasket if necessary.)

TS-21 PARTS LIST

BD. REF.	DESCRIPTION	P/N
Metal	Connector, Flex Cable	038-20029-144
U1	I.C. Hex Inverter (CMOS)	076-20212-013
U2	I.C. Tone Dialer	076-20212-063
U3	I.C. Pulse Dialer	076-20212-052
U4	SIP Resistor Pak, 1 Meg, $\frac{1}{4}$ W, 5%	066-20156-022
T1	Transformer	080-21801-001
Y1	Crystal 3.579545 MHz	086-20032-162
Y2	Resonator, Ceramic, 455 KHz	086-20116-026
BR1	Rectifier, Bridge	074-20135-053
Q9	Transistor	084-20260-055
Q5	Transistor	084-20260-069
Q3	Transistor	084-20255-032
Q4,6	Transistor, Selected	084-20260-089
Q1,2,8,10	Transistor	084-20260-043
VR2	Diode, Zener, 3.9V	074-20141-044
CR3	Varistor, MOV	074-20140-007
CR5	Varistor	067-20134-009
CR1	Diode, Signal	074-20017-120
CR14,15	Diode	074-20135-029
C2	Capacitor, Cerm, .002uf, $\pm 20\%$ , 1KV	059-20018-118
C3	Capacitor, Tant, 100uf, $\pm 20\%$ , .10V	059-20128-117
C4	Capacitor, Cerm, .01uf, $\pm 5\%$ , 100V	059-20018-181
C6	Capacitor, Cerm, 4700pf, $\pm 10\%$ , 100V	059-20018-182
C7,8	Capacitor, Cerm, 100pf, $\pm 20\%$ , 50V	059-20018-150
C9	Capacitor, Cerm, 1uf, $\pm 20\%$ , 50V	059-20018-090
C10	Capacitor, Cerm, .01uf, $\pm 20\%$ , 50V	059-20018-095

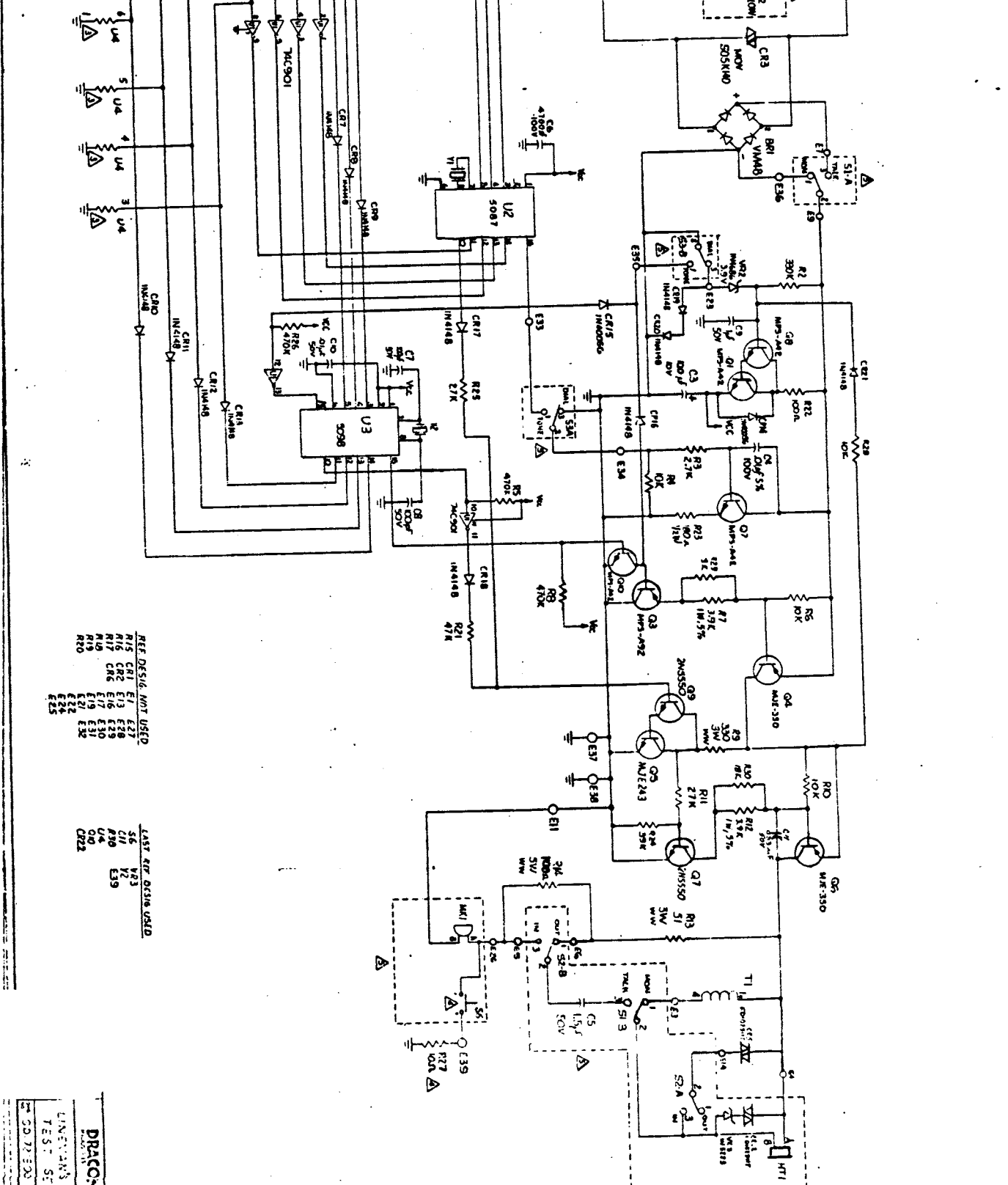
C11	Capacitor, Cerm, .033uf, $\pm 20\%$ , 50V	059-20018-140
R22	Resistor, Carb, 100uf, $\pm 5\%$ , $\frac{1}{4}W$	060-01003-041
R3	Resistor, Carb, 2.7K, $\pm 5\%$ , $\frac{1}{4}W$	060-02704-041
R4,28	Resistor, Carb, 10K, $\pm 5\%$ , $\frac{1}{4}W$	060-01005-041
R7,25	Resistor, Carb, 27K, $\pm 5\%$ , $\frac{1}{4}W$	060-02705-041
R6,21	Resistor, Carb, 47K, $\pm 5\%$ , $\frac{1}{4}W$	060-04705-041
R2	Resistor, Carb, 330K, $\pm 5\%$ , $\frac{1}{4}W$	060-03306-041
R5,8,26	Resistor, Carb, 470K, $\pm 5\%$ , $\frac{1}{4}W$	060-04706-041
R23	Resistor, Carb, 180 , $\pm 5\%$ , $\frac{1}{4}W$	060-01803-041
R1	Resistor, W.W., 1.5K, $\pm 5\%$ , 2W	062-21504-044
R13	Resistor W.W., 51 $\pm 5\%$ , 3W	062-25102-045
R9	Resistor, W.W., 330 , $\pm 5\%$ , 3W	062-23303-045
R14	Resistor, W.W., 100 , $\pm 5\%$ , 5W	062-21003-046
S4	Switch, P.B. Momentary - Polarity	034-20062-259
	Conformal Coating	DOW-RTV
	Cover, Plastic, RCVR/XMTR, Light Blue Half	035-21823-000
	Retainer, Receiver	035-21837-001
	Retainer, Transmitter	035-21836-001
	Terminal, Spring	020-21841-001
HT1	Receiver, Telephone	091-20085-053
MK1	Transmitter, Telephone	091-20085-052
	Washer, Receiver, Neoprene	036-21830-001
S1	Switch, DPDT, T/M	034-20062-995
	Insert, Brass #6, Type H	025-Temp80-040
	Washer, XMTR, No Stick Type	036-21861-001
	Terminal, Spade, Rec. Lugs	037-20015-154
VR3	Diode, Zener, 2.7V, $\pm 10\%$ , $\frac{1}{4}W$	074-20017-003



CR22	Varistor	067-21034-001
	Cork, Shoulder Support	077-21828-001
	Clip, Belt	024-21810-001
	Retainer, Keyboard, Gold Plate	020-21838-001
	Bezel, Metal Plate	020-21832-000
	Assy Cable, Linecord	087-21806-001
S5	Keypad, MATRIX	
S3,S2	Switch, DPDT, BBM, ON-ON	034-20062-999
DS1	Diode, Light Emitting, Red	074-20137-024
DS2	Diode, Light Emitting, Yellow	074-20137-023
	Extrusion, U-Channel 1"	030-20147-004
C5	Capacitor, Cerm, 1.5uf, 50V	059-20018-180
	Fastener, Self-Retaining	025-20014-164
S6	Mute Switch - Mounts on Housing	034-20062-260
C12	Capacitor, Cerm, .01uf, $\pm 20\%$ , 50V	059-20018-095

- 1. ALL CAPACITORS ARE 100% .50V.
- 2. NOT MOUNTED ON P.C. BOARD.
- 3. 56 & R27 TO BE USED ONLY ON -002 UNITS.
- 4. U4 IS A SLP

NOTES: UNLESS OTHERWISE SPECIFIED.

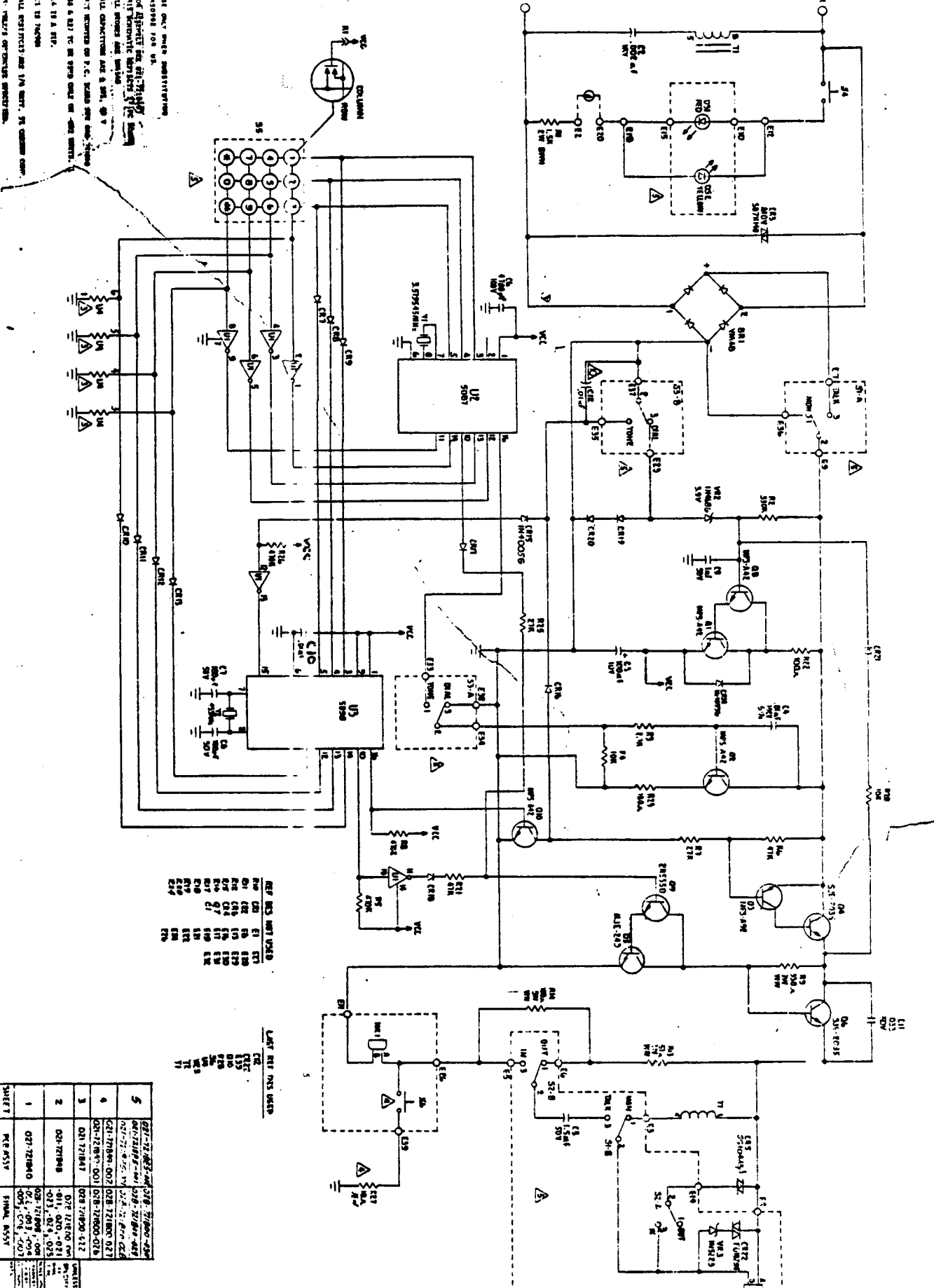


REF DESIGN, NOT USED

R15	CR1	E7	E27
R16	CR2	E13	E28
R17	CR3	E16	E29
R18	CR4	E19	E30
R19	CR5	E21	E31
R20	CR6	E24	E32
		E25	
		E26	
		E27	
		E28	
		E29	
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		E31	
		E32	
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		E34	
		E35	

LAST REF DESIGN USED

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1. DRACOM  
 2. LINEARS  
 3. TS1 SET  
 4. SHEET 1 OF 1  
 5. REVISED 10-1-62

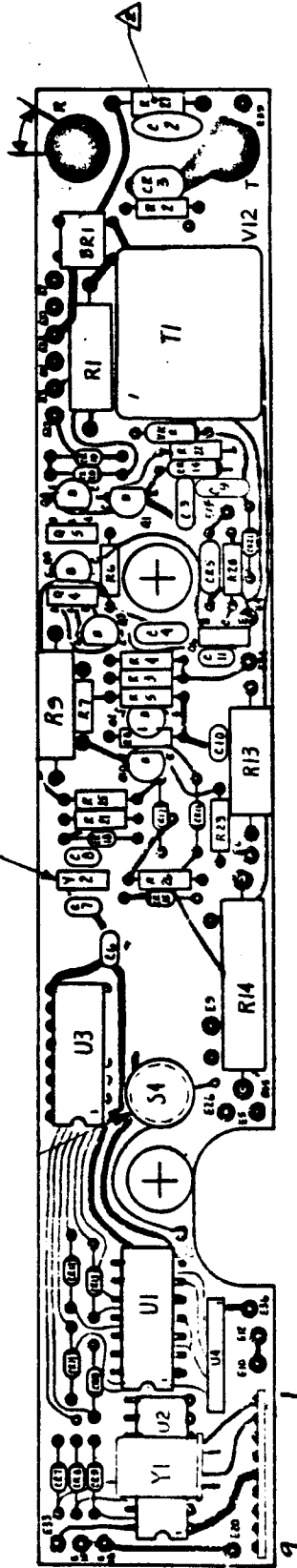
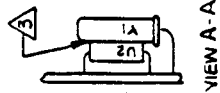
1. DRACOM  
 2. LINEARS  
 3. TS1 SET  
 4. SHEET 1 OF 1  
 5. REVISED 10-1-62

1. DRACOM  
 2. LINEARS  
 3. TS1 SET  
 4. SHEET 1 OF 1  
 5. REVISED 10-1-62

1. DRACOM  
 2. LINEARS  
 3. TS1 SET  
 4. SHEET 1 OF 1  
 5. REVISED 10-1-62

SHEET	REV	DESCRIPTION	DATE
1	1	DRACOM LINEARS TS1 SET	10-1-62
2	2	DRACOM LINEARS TS1 SET	10-1-62
3	3	DRACOM LINEARS TS1 SET	10-1-62
4	4	DRACOM LINEARS TS1 SET	10-1-62
5	5	DRACOM LINEARS TS1 SET	10-1-62

DRACOM  
 LINEARS  
 TS1 SET  
 SHEET 1 OF 1  
 REVISED 10-1-62



2 Resistor R27 used on -002 assy. only

3 Secure Y1 as shown in view A-A with RTV

4 Bend Y2 as far as surrounding components with RTV

# SPECIAL INSTRUCTION

SI NO. A  
DATE 2/11/82

**SUBJECT**  
Field Modification

**ORIGINATOR** Cust. Serv.  
**APPROVAL**

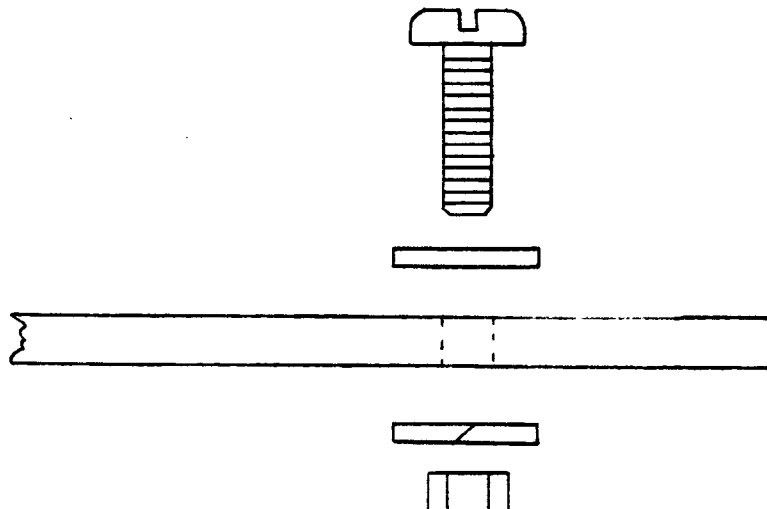
**EFFECTIVE DATE**

This instruction provides for the repair of test set models 21800-000 through 21800-008 where the plastic housing has failed at the line cord mounting stand-offs. This alternate line cord fastening method consists of a 4-40 x 3/8" pan head machine screw, a #4 flat washer and a #4 hex nut.

Although the P.C. board will now float within the housing, it will not present any problems since the board cannot move far enough to cause any damage. Remember to install the line-cord spade tip under the flat washers when making this alteration.

### DRACON PART NUMBERS

4-40 x 3/8" machine screw	025-20186-206
#4 flat washer	025-20165-010
#4 lock washer	025-20015-020
#4 hex nut	025-20017-020



SHEET 1 OF 1

# SPECIAL INSTRUCTION

SI NO. B

DATE 2/11/82

**SUBJECT**  
Housing Replacement

**ORIGINATOR** Cust. Serv.

**APPROVAL**

**EFFECTIVE DATE**

This instruction outlines the updating of test set models 21800-000 through -008 where the dark blue half is to be replaced.

An improved housing is now available. However, several modifications are required to adapt the old printed circuit board to the new dark blue half.

1. The ring side of the P.C. board must be elongated slightly to allow for the attachment of the line cord to the dark blue half. See Diagram B-1.
2. The P.C. board must be updated to accept the new style keypad. See instruction C; but disregard step #6.
3. The new keypad should be mounted to the dark blue half before securing the tip and ring leads to the P.C. board.

Please note that the network switch is now labeled keypad, but still serves the same function.

#### Ordering Information:

Dark Blue Half	P/N 024-21863-002
Light Blue Half	P/N 024-21862-002
Keypad	P/N 024-21875-001

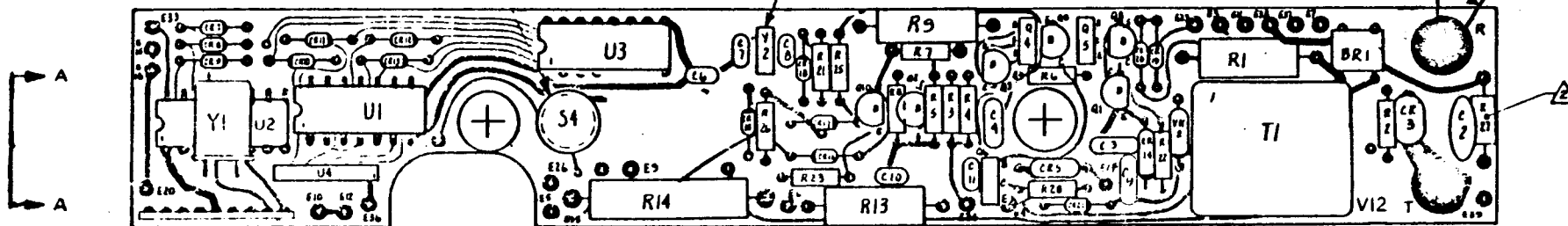
(Both Dark and Light blue halves constitute one housing)

SHEET 1 OF 2



VIEW A-A

FILE OR GRIND OUT MATERIAL ONLY  
FROM THE 3 O'CLOCK TO 5 O'CLOCK  
POSITION UNTIL MOUNTING HOLE  
ALIGNS WITH BRASS INSERT.



② Resistor R27 used on -002 assy. only

③ Secure Y1 as shown in view A-A with RTV

④ Bend Y2 as far as surrounding components with RTV

# SPECIAL INSTRUCTION

SI NO. C  
DATE 2/11/82

## SUBJECT

Keypad Modification

## ORIGINATOR

Cust. Serv.

## EFFECTIVE DATE

## APPROVAL

For updating test set models 21800-000 through -008 to the latest version keypad, perform the following modifications:

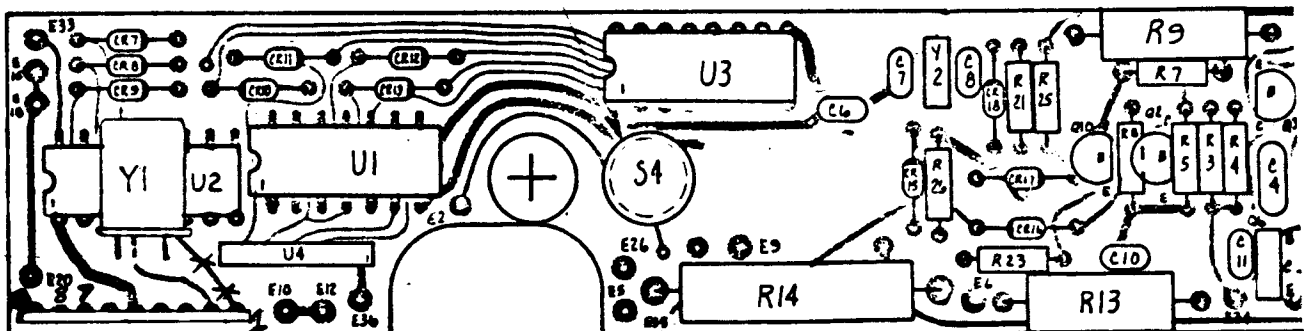
1. Cut the circuit trace of keypad pin 1 on top of the board.  
(See below)
2. Cut the circuit trace of keypad pin 8 on bottom of board.  
(See below)
3. Add 30 AWG insulated wire from keypad pin 1 to pin 3 of I.C. U2.
4. Add 30 AWG insulated wire from keypad pin 8 to pin 5 of I.C. U2.
5. Add 30 AWG insulated wire from pin 9 of keypad ribbon cable to pad E12 on P.C. board.
6. Add 30 AWG insulated wire from pin 10 of keypad ribbon cable to pad E20 on P.C. board.
7. Place new keypad into the dark blue half and secure in place with the special retainer and use the new screws.
8. Remove old keypad connector pins and solder new keypad leads to the P.C. board. Renew RTV coating over the exposed pins.

Ordering Information KEYPAD KIT 23075-000 CONTAINS THE FOLLOWING:

Retainer P/N 020-21877-001

Keypad P/N 024-21875-001

Screws P/N 025-20256-006



1) Cut between X's

2) Make similar cut on underside of board.

SHEET 1 OF 1

**DRACON**

A FARINON COMPANY

DEV ENGR NO. 104-01 REV 01