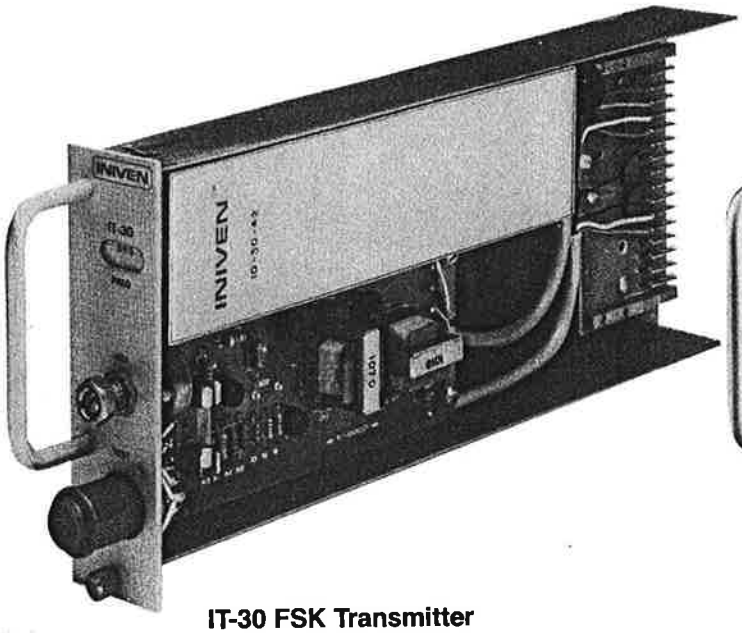
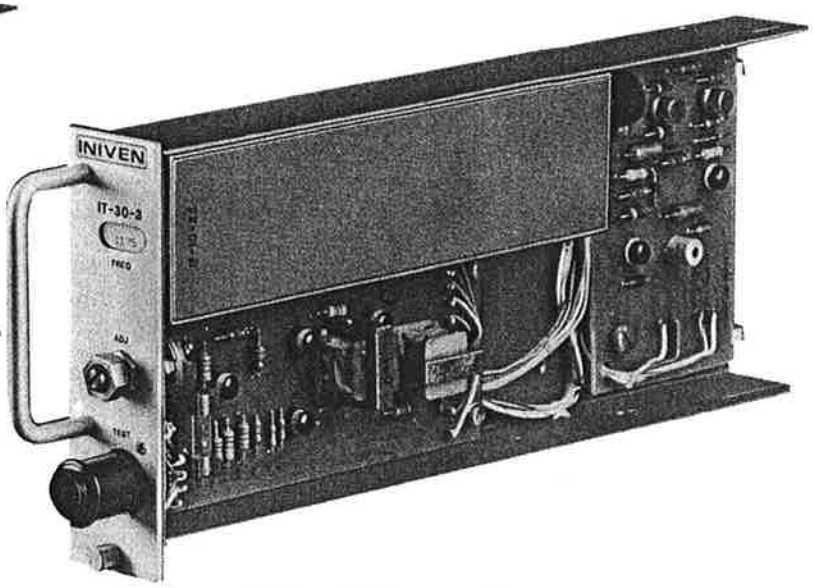
INIVEN™

FSK TONE TRANSMITTER IT-30/IT-30-3

INSTRUCTION MANUAL



IT-30 FSK Transmitter



IT-30-3 FSK Transmitter

1. DESCRIPTION

1.1 The IT-30 is a frequency-shift-keyed (FSK) tone transmitter intended for use in remote supervisory control, remote telemetering, and data transmission. The transmitter may be operated in a two-frequency or a three-frequency mode.

1.2 In the three-frequency mode, the IT-30 normally transmits a center frequency signal, and may be keyed to transmit either a higher (Mark) frequency or a lower (Space) frequency.

1.3 In the two-frequency mode, two types of operation are available:

(1) Space-hold operation in which the IT-30 normally transmits a Space signal, and may be keyed to transmit a Mark signal.

(2) Mark-hold operation in which the IT-30 normally transmits a Mark signal, and may be keyed to transmit a Space signal.

1.4 The IT-30 may be keyed by either external contacts or by application of voltages to the keying terminals.

1.5 The operating frequencies of the IT-30 transmitter are determined by the single plug-in IO-30 module. Each IO-30 module is individually labeled by its center frequency (in Hz). This number also appears in the front-panel cutout of the IT-30 transmitter.

1.6 The IT-30-3 transmitter is basically identical to the IT-30 configuration except that a "flasher" (flip-flop) circuit has been added. When both Mark and Space are keyed, the flip-flop circuit keys the transmitter alternately Mark — Space, which activates both relays of the IR-30-M receiver.

2. SPECIFICATIONS

Output Level: Front panel adjustment. Continuously adjustable to +5 DBM

Output Impedance: 600 ohms nominal with rising characteristics outside the passband

Keying Methods: Contact closure or voltage level

Keying Speed: Limited by channel spacing and channel bandwidth (refer to table)

Frequency Range: 365 Hz to 3500 Hz (refer to Table 8-2 for complete list of available frequencies

Channel Spacing: Refer to Table 8-2

Frequency Shift: Dependent upon channel selection (refer to Table 8-2 for complete list of frequency shifts available)

Power Requirement: 32mA nominal at 12 VDC ±10%

Protection: ½ A fuse located internally (on printed circuit card A1); protects against excessive current drain within transmitter module

Temperature Range: −30°C to +60°C

Weight: 2¾ lb. approx. (1.25 Kg)

3. FEATURES

3.1 Output Level Adjustment — an output level adjustment (ADJ) control is accessible on the front panel of the IT-30. This control allows the transmitter output level to be adjusted up to a maximum of +5 DBM.

3.2 Test Socket — A TEST socket is located on the transmitter front panel. For normal operation, a plug is installed in this socket. When the plug is removed for testing, the transmitter output is disconnected from terminals 3 and 4 of the terminal block. The TEST socket provides access to the following functions:

PIN NUMBER	FUNCTION
1 and 2	Tone output
3	Positive side of 12Vdc power supply input
4	Negative side of 12 Vdc power supply input
5 and 3	Mark keying input
6 and 3	Space keying input
7 and 3	Carrier keying input

3.3 Optional Keyed-Carrier Operation — a jumper located on the connector board assembly can be removed for keyed-carrier operation (see Figures 2, 3 and 4).

4. THEORY OF OPERATION

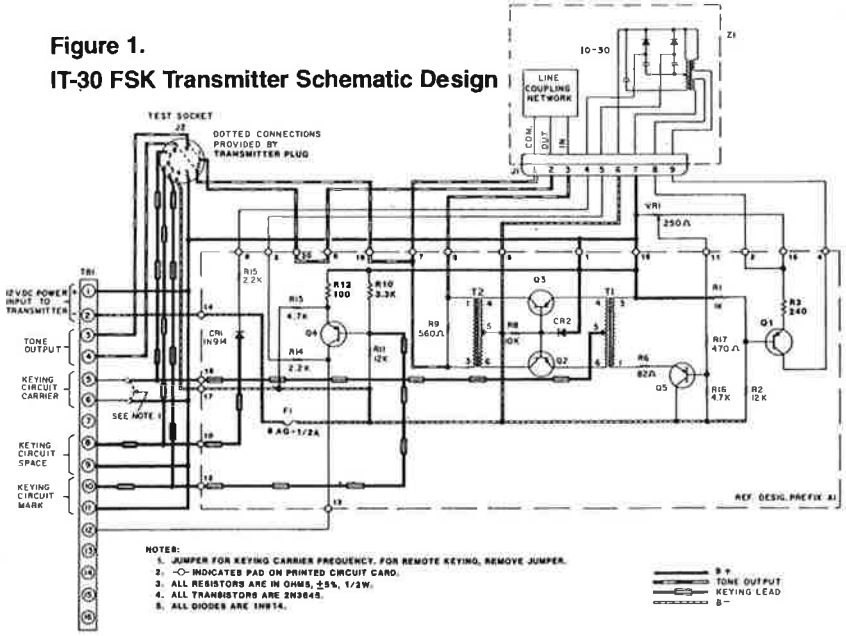
4.1 The IT-30 transmitter (see Figure 1) consists of a stable audio oscillator, a push-pull amplifier, and a line-coupling network. The line-coupling network and oscillator tank circuit are contained within a plug-in module (IO-30).

4.2 The oscillator is composed of a transistor Q1; biasing resistors R1, R2 and R3; and oscillator tank circuit IO-30. The resonant frequency of the tank circuit can assume any one of three values depending upon the status of the keying inputs to the IT-30. When a Space is keyed, an additional capacitive element is switched into the tank circuit, thus decreasing its resonant frequency. Keying a Mark cuts off keying transistor Q4 which in turn removes a capacitive element from the tank circuit. This increases the resonant frequency of the tank circuit. When neither Space nor Mark is keyed, the oscillator operates at its nominal center frequency. As long as power is applied, the oscillator is in continuous operation.

4.3 The oscillator output signal appears across potentiometer VR1 and is applied to emitter follower Q5. The emitter follower isolates the oscillator circuit from load variations. Transformer T1, in the emitter circuit of Q5, couples the signal to the push-pull power amplifier. The push-pull amplifier consists of transistors Q2 and Q3 (connected in a common-base configuration), output transformer T2, and biasing network CR2 and R8. Diode CR2 and R8 hold the bases of Q2 and Q3 slightly negative to eliminate crossover distortion. The amplifier is in operation only when the emitters of Q2 and Q1 are returned to B+. This voltage can be applied continuously or intermittently. The transmitter is configured for continuous operation (a jumper is connected across the carrier keying input terminals). For intermittent (keyed carrier) operation, this jumper is removed, and a key is connected to the carrier input keying terminals. The transmitter generates a tone only when the carrier input terminals are keyed.

4.4 The output of the push-pull amplifier is coupled to the line-coupling network by transformer T2. The line-coupling network isolates the transmitter from voltage variations on the transmission line and presents a 600-ohm output impedance to the line at the nominal frequency. Swamping resistor R9 ensures that a constant impedance is presented to the line-coupling network.

Figure 1.
IT-30 FSK Transmitter Schematic Design



IT-30-3 (See Figure 2)

4.5 The IT-30-3 transmitter has an added circuit card (A2) which allows, effectively, simultaneous keying of Mark and Space. The circuit consists of multivibrator oscillator Q1 and Q2, and driver transistors Q3 and Q4. The Mark and Space keying inputs are applied to the emitters of Q4 and Q3, respectively.

4.6 When neither is "Keyed," there is no return path for Q3 or Q4 and, therefore, no collector voltage supplied to Q1 and Q2. The multivibrator oscillator is quiescent and the transmitter produces only center frequency.

4.7 When Mark **or** Space is keyed (to + 12 V), a return path is completed to only one-half of the multivibrator Q1 or Q2 and it remains quiescent; however, sufficient base current is supplied to the driver transistor (Q3 or Q4) to turn it on and "key" Mark **or** Space.

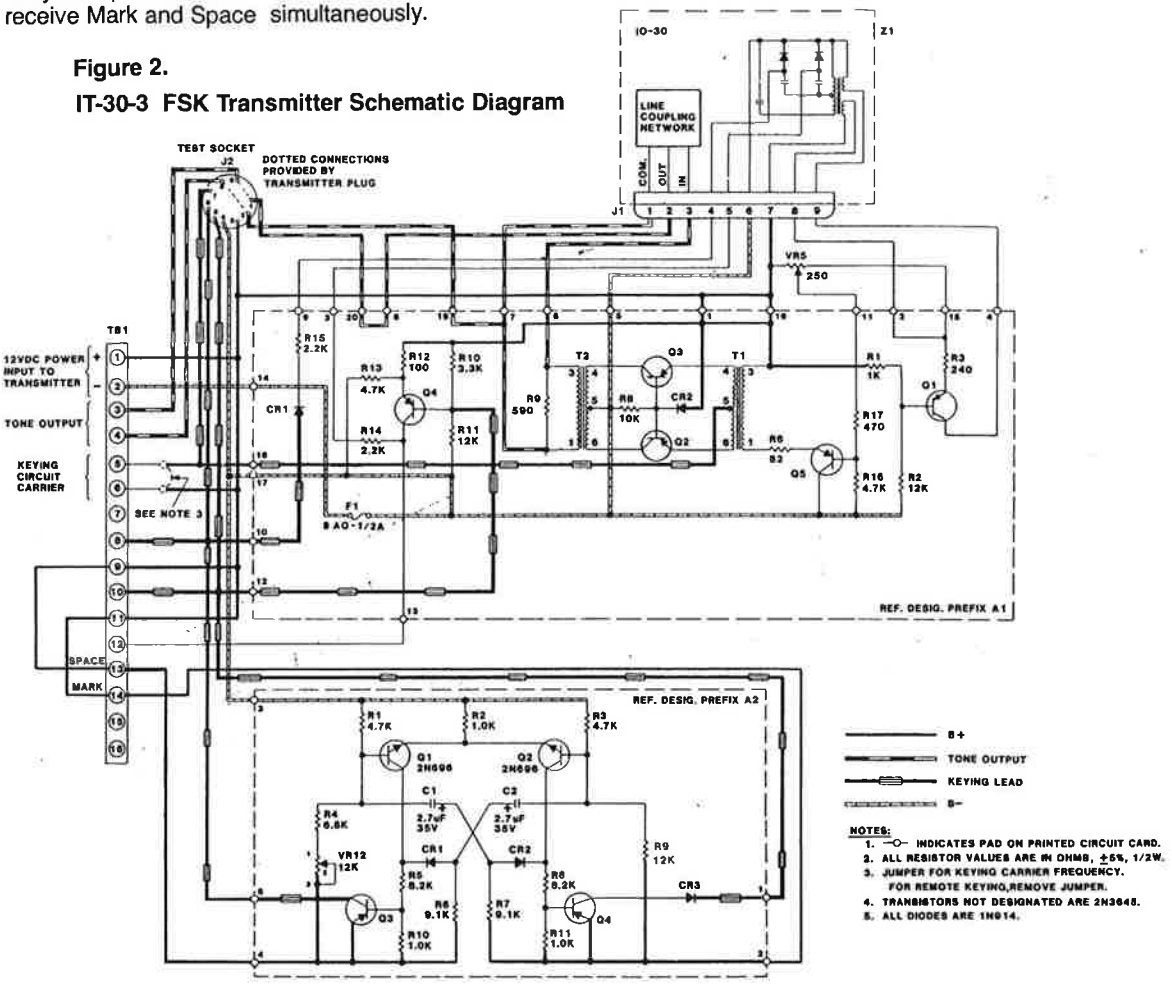
4.8 When **both** Mark and Space is keyed (to + 12 V), a return path is supplied to both halves of the multivibrator oscillator (Q1 and Q2) through the driver transistors (Q3 and Q4) and, because of the cross-connected coupling through C1 and C2,

the circuit oscillates at a frequency determined by the values of C1, C2, R4, R5, R6, R7, R8, R9 and VR12. This alternately turns Q3 and Q4 "off." The tone transmitter output, then, consists of alternate pulses of Mark and Space frequencies. The FSK receiver employs additional capacitive filtering to allow **both** Mark and Space relays to operate and "hold" between pulses, or, in effect, to receive Mark and Space simultaneously.

4.9 The rate of pulsing is factory set at approximately 20 PPS and VR12 allows adjusting the duty cycle so that **equal** periods of Mark and Space can be obtained.

Figure 2.

IT-30-3 FSK Transmitter Schematic Diagram



5. INSTALLATION

5.1 Mechanical Installation

The IT-30 transmitter is shipped with the IO-30 tank circuit (module Z1) mounted in place, the nine-pin plug inserted into the TEST socket, the terminal block assembly plugged into connector TB1, and four 6-32 mounting screws partially screwed into the terminal block assembly.

The transmitter is normally mounted in an IX-3 or IX-11 mounting frame, or into a cradle-type frame. To install the transmitter into the frame, proceed as follows:

(1) Remove mounting screws from terminal block.

(2) Push the transmitter, with terminal block attached, into the frame.

(3) Secure the transmitter to the frame, using the knurled retaining screw on the front panel. Precaution must be taken when aligning the front panel screw with the hole in the frame to prevent damage to the front panel.

(4) At the rear of the frame, use the 6-32 screws provided to fasten the terminal block securely to the frame. The IT-30 can now be removed from (and installed into) the frame by using the front-panel knurled retaining screw.

5.2 Terminal Block Connections

All electrical connections are made to the terminal block at the rear of the frame. (see Figure 4):

IT-30

TERMINAL	FUNCTION
1	**Positive (+) side of 12 Vdc power supply input**
2	**Negative (−) side of 12 Vdc power supply input**
3 and 4	**Tone output**
5 and 6	**Carrier keying input (optional — refer to para. 5.3)**

NOTE

An internal jumper located on terminal board TB1 keys the carrier (terminals 5 and 6). Remove the jumper for external carrier control.

7	**Not used**
8 and 9	**Space keying input (for current keying — refer to para. 5.6)**

NOTE

Closing the circuit between terminals 8 and 9 causes the transmitter to send Space frequency. (Terminal 9 is internally connected to terminal 1.)

10 and 11	**Mark keying input (for current keying — refer to para. 5.6)**

NOTE

Closing the circuit between terminals 10 and 11 causes the transmitter to send Mark frequency. (Terminal 11 is internally connected to terminal 1.) If the Mark keying circuit and the Space keying circuit are both open, the transmitter will send center frequency.

12	**Used in two-frequency operation only (refer to para. 5.4)**

NOTE

Terminal 12 is used in special cases where it is desired to key the Mark frequency with a Form "B" contact. The return circuit is terminal 11. Transistor A1Q4 must be removed from its socket when this keying circuit is used.

13 and 16	**Not used**

IT-30-3

TERMINAL	FUNCTION
1	**Positive (+) side of 12 Vdc power supply input**
2	**Negative (−) side of 12 Vdc power supply input**
3 and 4	**Tone output**
5 and 6	**Carrier keying input (optional — see para. 5.3)**
7	**Not used**
9 and 14	**Mark keying input**
11 and 13	**Space keying input**

(Terminals 9 and 11 are internally connected to terminal 1 [+])

5.3 Continuous-Carrier or Keyed-Carrier Operation

The IT-30 is configured to provide continuous-carrier operation. To convert the transmitter to keyed-carrier operation, remove jumper on the terminal board assembly, TB1 (see Figures 1, 2 and 3).

5.4 Two-Frequency of Three-Frequency Operation

The transmitter is configured to provide three-frequency operation. To convert to two-frequency Space-hold operation, connect a jumper from terminal 8 of the terminal board to terminal 12. Key Mark between terminals 10 and 11. To convert to two-frequency Mark-hold operation, connect a jumper from terminal 8 of the terminal board to terminal 12 and remove transistor Q4. Key Space between terminals 8 and 9.

5.5 Selective and Simultaneous Keying of Mark and Space

Mark or Space, or both, may be keyed to provide selective or simultaneous relay operation at the receiver end of the transmission circuit by use of the IT-30-3 FSK transmitter. This transmitter version, which incorporates circuit card A2, is discussed in detail in para. 4.5 through 4.9.

5.6 Mark and Space Keying using Current Sources

Current sources used for Mark or Space keying should be 4 mA to 6 mA in magnitude and should have an output impedance in excess of 100K ohms. These requirements are met by most general-purpose transistors.

5.7 Operational Test — Output Level Adjustment

The following equipment is required to test the operation and set the output level of the IT-30/IT-30-3 FSK Tone Transmitters.

Test Adapter	**INIVEN**	
Multimeter	**Simpson**	**Model 260 (or equivalent)**
Frequency Counter	**Fluke**	**Model 1900A (or equivalent)**

5.8 Preparation for Adjustment. Prepare the transmitter for output level adjustment as follows:

(1) Disconnect transmitter plug from TEST socket.

(2) Insert plug of Test Adapter into TEST socket of transmitter.

(3) Install a 600 ohm resistor between terminals 1 and 2 of the Test Adapter.

5.9 Adjustment Procedure. Adjust the output level of the transmitter as follows:

(1) Set Multimeter to 2.5 VAC scale and insert test leads into jacks 1 and 2 of Test Adapter.

(2) Rotate ADJ potentiometer, on front panel of transmitter, to obtain an indication in accordance with Table 8-1.

(3) Proceed to paragraph 5.10 or 5.11 as appropriate for model of transmitter.

5.10 Model IT-30 Operation Test. Test operation of the transmitter as follows:

(1) Connect test leads of Frequency Counter to jacks 1 and 2 of Test Adapter. Note frequency indication.

(2) Install a jumper between terminals 3 and 5 of Test Adapter while observing Frequency Counter for an upward shift in frequency indication.

(3) Remove jumper from terminals 3 and 5 and install between terminals 6 and 3 while observing Frequency Counter for a downward shift in frequency indication.

(4) Remove jumper from Test Adapter.

(5) Disconnect Frequency Counter from Test Adapter.

(6) Remove Test Adapter plug from TEST socket of transmitter and install transmitter plug.

5.11 Model IT-30-3 Operation Test. Test operation of the transmitter as follows:

(1) Connect test leads of Frequency Counter to terminals 1 and 2 of Test Adapter. Note frequency indication.

(2) Install a jumper between terminals 11 and 14 of terminal block at rear of transmitter while observing Frequency Counter for an upward shift in frequency indication.

(3) Remove jumper from terminals 11 and 14 of terminal block and install between terminals 9 and 13 while observing Frequency Counter for a downward shift in frequency indication.

(4) Reinstall jumper between terminals 11 and 14 so that terminals 11 to 14 and 9 to 13 are jumpered.

(4) Disconnect Frequency Counter from Test Adapter.

(6) Set Multimeter to 50 VDC scale and insert test leads into jacks 4 (−) and 6 (+) of Test Adapter. Indication should pulsate at about 30 Vdc.

(7) Remove Multimeter test lead from jacks 5 (+) of Test Adapter and insert into jack 6 (+). Indication should pulsate at about 30 Vdc.

(8) Remove jumpers from terminal block of transmitter.

(9) Disconnect Multimeter from Test Adapter.

(10) Unplug Test Adapter from TEST socket and install transmitter plug.

5.12 Electrical Grounding

To reduce ground loop interference effects, it is necessary that the chassis of each tone unit be grounded. When the tone unit is mounted in an IX-3, IX-11 or cradle-type frame, a good earth ground on the relay racks or other equipment on which the frame is installed is necessary. Station batteries or other power supplies with grounded negative or positive leads can be employed in place of regular INIVEN power supplies.

When individual tone transmitters are operated out of the frame, the transmitter chassis should be connected to the earth ground.

6. MAINTENANCE

This section contains corrective maintenance procedures that can be used in conjunction with the operation test and output level adjustment procedures in Section 5.

6.1 The module you have purchased has been thoroughly inspected and tested in accordance with our specifications. The module does not require preventive maintenance. However, it is recommended that signal levels be checked and adjusted every 6 months.

6.2 In-plant quality assurance procedures specify transmission levels that vary for "hardware" and "system" orders. Testing the modules, in either case, is over a transmission link simulating a telephone circuit (600 ohms impedance) with a loss of −25 dbm from origin to destination. The attenuation and frequency response of the circuit is due to a number of factors which cannot be duplicated at the factory. The factors include:

(1) Distance between stations.

(2) Diameter and length of wire used in transmission circuit.

(3) Actual impedance of transmission circuit.

(4) Inductance and capacitance of transmission circuit.

Any references to transmit levels in the manual is a factory setting and must be reset in the field in accordance with the output level adjustment procedures in paragraphs 5.7 through 5.11 and Table 5-1.

6.3 Quick-Check — Table 6-1 contains quick-check procedures designed to isolate trouble in the majority of cases. When use of these procedures fails to locate the cause of the malfunction, refer to Section 4 for detailed theory of operation and the referenced schematics as an aid in signal tracing.

Test equipment required for troubleshooting are the same as those used to perform operation test and output level adjustment.

Table 6-1. Quick Check Malfunction Isolation System Checks

SYMPTOM	POSSIBLE CAUSE	REMEDY
	SYSTEM CHECKS	
No inputs or outputs at control station.	Power failure of commercial power or IP power supply.	Check voltage.
	Transmission circuit failure.	Call telephone company or responsible agency.
Intermittent operation of some tone receivers at master station.	Signal level shifted due to transmission circuit change.	Check all tone receivers to see if sensitivity has been affected. If so, notify responsible agency of change in circuit attenuation.
Tone receivers in "off" condition exhibit erratic and unsteady symptoms when checked using multimeter and Test Adapter.	Transmitter outputs set too high.	Check with telephone company or responsible agency for correct settings. For quick reference refer to Table 8-1.
	Telephone company circuit trouble.	Call telephone company and advise of problem.
	Grounded telephone company circuit or defective filter or oscillator.	Determine if ground is on telephone line or due to tone equipment by measuring each side of line to ground with line connected and then disconnected from equipment. If ground is on line, call telephone company. If ground is due to tone equipment, if may be caused by a defective oscillator or filter. Pull out each module in turn while monitoring ground with multimeter until absence of low resistance indication signifies module containing defective filter or oscillator.

Table 6-1. Quick Check Malfunction Isolation system Checks (Cont.)

SYMPTOM	POSSIBLE CAUSE	REMEDY
	IT30/IT30-3 CHECKS	
No tone output (Mark, Center, or Space)	Transmitter plug not in socket	Replace test plug or jumper 1 to 9 and 2 to 8 of TEST socket.
	Fuse defective	Replace fuse.
	Q1 defective	Replace transistor.
	Q5 defective	Replace transistor.
	Jumper between terminals 5 and 6 of TB1 removed.	Add jumper, Center frequency will be transmitted until either Mark or Space is keyed.
	IO-30 defective	Replace with IO-30 of same or different frequency and check for output.
Maximum output reduced (less than 1 Vac or +2dbm)	Q2 or Q3 defective	Replace transistors, one at a time.
No Mark output	Q4 defective	Replace transistor.
	IO-30 oscillator defective	Replace with IO-30 of same or different frequency and check for output.
No Space output	IO-30 defective	Same as above.
Space on continuously	IO-30 defective	Same as above.
Mark on continuously	Q4 defective	Replace transistor.

7. PARTS LIST

The following parts list is included to facilitate maintenance of the IT-30 and IT-30-3 FSK tone transmitters. All parts are listed in order of their reference signations, as applicable.

7.1 IT—30 TRANSMITTER ASSEMBLY SERIES (See Figure 3)

The "Usable on Code" column identifies parts/assemblies which apply to only one particular transmitter model:

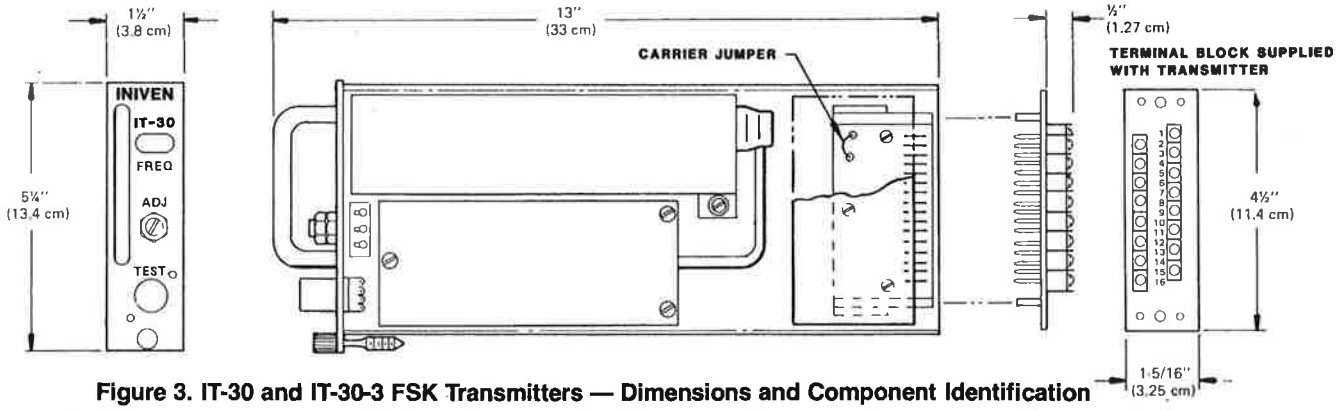


Figure 3. IT-30 and IT-30-3 FSK Transmitters — Dimensions and Component Identification

REF DESIG	DESCRIPTION	QTY	USABLE ON CODE	PART NUMBER	MFR
	IT-30 Transmitter Assy		A	CC1088-00	
	IT-30-3 Transmitter Assy		B	C1108-00	
J1	• CONNECTOR, Socket	1		401A2	Connector Corp.
	• BOOT, Socket			C860 w/o H	Methode
	• HANDLE	1		230-18AL832C	Promptus Elec.
	• FACEPLATE	1	A	06B1088-OIN	INIVEN
	• FACEPLATE	1	B	06B1108-OIN	INIVEN
	• SCREW, Captive	1		08A1088-OIN	INIVEN
J2	• CONNECTOR, Socket	1		417A4	Connector Corp.
P2	• PLUG, Transmitter	1		CMS1603-M9X	INIVEN
TB1	• CONNECTOR BOARD ASSY	1		CC1101-00	INIVEN
Z1	• OSCILLATOR ASSY	1		*IO-30-XXXX-YY	INIVEN
VR1	• RESISTOR, VARIABLE, 250 ohm, 2W	1		380C2-250-Z	Clarostat
A1	• PRINTED CIRCUIT BOARD ASSY (See figure 5 for breakdown)	1		AD1088-OZN	INIVEN
A2	• PRINTED CIRCUIT BOARD ASSY (See figure 6 for breakdown)	1	B		INIVEN

*For complete ordering number substitute frequency for XXXX and substitute shift for YY.

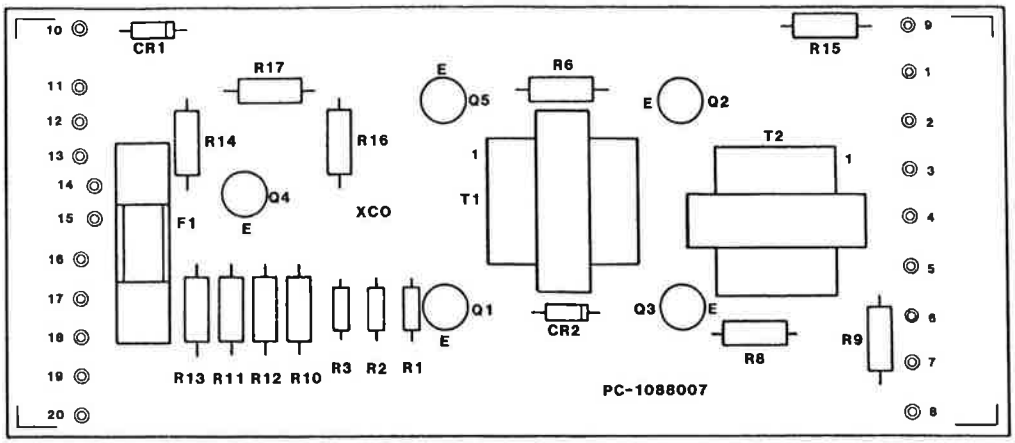


Figure 4. Printed Circuit Board Assembly A1

REF DESIG	DESCRIPTION	QTY	USABLE ON CODE	PART NUMBER	MFR
A1	PRINTED CIRCUIT BOARD ASSY	1		AD1088-02N	INIVEN
CR1, CR2	• DIODE	2		1N914	
F1	• FUSE	1		8AG-½AMP	
Q1-Q5	• TRANSISTOR	5		2N3645	Fairchild
	• SOCKET, Transistor	5		3-LPS-B	Cinch
R1	• RESISTOR, 1K, ¼W, 5%	1		RCF07J102	
R2	• RESISTOR, 12K, ¼W, 5%	1		RCF07J123	
R3	• RESISTOR, 240 ohm, ¼W, 5%	1		RCF07J241	
R6	• RESISTOR, 82 ohm, ½W, 5%	1		RCF20J820	
R8	• RESISTOR, 10K, ½W, 5%	1		RCF20J103	
R9	• RESISTOR, 560 ohm, ½W, 5%	1		RCF20J561	
R10	• RESISTOR, 3.3K, ½W, 5%	1		RCF20J332	
R11	• RESISTOR, 12K, ½W, 5%	1		RCF20J123	
R12	• RESISTOR, 100 ohm, ½W, 5%	1		RCF20J101	
R13, R16	• RESISTOR, 4.7K, ½W, 5%	2		RCF20J472	
R14, R15	• RESISTOR, 2.2K ½W, 5%	2		RCF20J222	
R17	• RESISTOR, 470 ohm, ½W, 5%	1		RCF20J471	
T1	• TRANSFORMER	1		CC1070-00	INIVEN
T2	• TRANSFORMER	1		CC1019-00	INIVEN

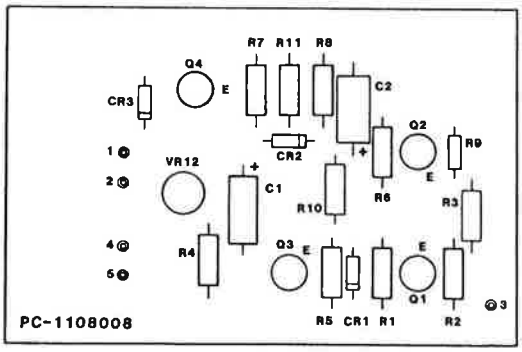


Figure 5. Printed Circuit Board Assembly A2

REF DESIG	DESCRIPTION	QTY	USABLE ON CODE	PART NUMBER	MFR
A2	PRINTED CIRCUIT BOARD ASSY	1	B	AD1108-OZN	INIVEN
CR1-CR3	• DIODE	3	B	1N914	
C1, C2	• CAPACITOR, Tant., 2.7μf, 35V, 20%	2	B		
Q1, Q2	• TRANSISTOR	2	B	2N696	
Q3, Q4	• TRANSISTOR	2	B	2N3645	
	• PAD, Transistor	4	B	502-120	Bivar, Inc.
R1, R3	• RESISTOR, 4.7K, ½W, 5%	2	B	RCF20J472	
R2, R10, R11	• RESISTOR, 1K, ½W, 5%	3	B	RCF20J102	
R4	• RESISTOR, 6.8K. ¼W, 5%	1	B	RCF07J682	
R5, R8	• RESISTOR, 8.2K, ½W, 5%	2	B	RCF20J822	
R6, R7	• RESISTOR,. 9.1K, ½W, 5%	2	B	RCF20J912	
R9	• RESISTOR, 12K, ¼W, 2%	1	B	RCF07J123	
VR12	• RESISTOR, Variable, 10K, ½W, 20%	1	B	103-10K53-11	Spectrol

8. ORDERING INFORMATION

8.1 When ordering please specify:

1. Model Number — Center Frequency — Shift, i.e. IT-30-1775-25 would specify a Model IT-30 transmitting at the center frequency of 1775 Hz with a shift to 1800 Hz to transmit Mark and a shift to 1750 Hz to transmit Space. (±25Hz shift)
2. Special Features or Options

8.2 Refer to Table 8-2 for a complete list of available frequencies.

Table 8-1. Suggested Multiple Tone Transmitter Output Levels

WHEN INFORMATION IS NOT AVAILABLE FROM TELEPHONE CO.

NUMBER OF TONE CHANNELS ON LINE	RECOMMENDED LEVELS DBM	RMS VOLTS (600μ)
1	0	0.78
2	—3	0.55
3	—5	0.45
4	—6	0.40
5	—7	0.35
6 to 7	—8	0.30
8 to 10	—10	0.25
12 to 16	—12	0.20
17 to 25	—13	0.17

Table 8-2.

Channel Center Frequency (Hz)

Channel No.	Series Half Band Width	25	30	35 or 42	60	85
	Channel Spacing (Hz)	100	120	170	240	340
	Baud Rate	50	60	80	120	170
-01		365	420	425	480	850
-02		465	540	595	720	1190
-03		565	660	765	960	1530
-04		665	780	935	1200	1870
-05		765	900	1105	1440	2210
-06		865	1020	1275	1680	2550
-07		965	1140	1445	1920	2890
-08		1075	1260	1615	2160	3230
-09		1175	1380	1785	2400	
-10		1275	1500	1955	2640	
-11		1375	1620	2125	2880	
-12		1475	1740	2295	3120	
-13		1575	1860	2465	3360	
-14		1675	1980	2635		
-15		1775	2100	2865		
-16		1875	2220	2975		
-17		2000	2340	3145		
-18		2100	2460	3315		
-19		2200	2580	3485		
-20		2300	2700			
-21		2400	2820			
-22		2500	2940			
-23		2600	3060			
-24		2700	3180			
-25		2800	3300			
-26		2900	3420			
-27		3000				
-28		3100				
-29		3200				
-30		3300				
-31		3400				
-32		3500				