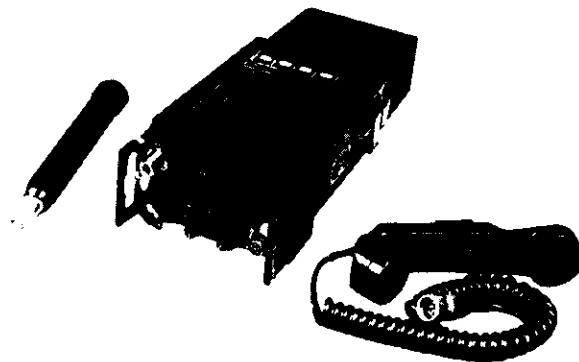


OPERATOR'S MANUAL
LST-5C
LIGHTWEIGHT SATELLITE TRANSCEIVER



MOTOROLA INC.

Government Electronics Group

OPERATOR'S MANUAL
LST-5C
LIGHTWEIGHT SATELLITE TRANSCEIVER

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LST - 5C

MOD

SELECT
MODE

CUR

MOVE
CURSOR
FLASHING DIGIT

SET

CHANGE
CURSOR
DIGIT

STO

DISPLAY
FREQ.TO
MEMORY

PUSH MOD/CUR
FOR PANEL LIGHTS

DISPLAY MODES

FUNCTIONS

1. FREQUENCY

FM AM CT SCN BCN
308.985 CH3
AM XLO PT OFF OFF

PRESET CHANNEL
AND FREQUENCY

FM AM CT SCN BCN
308.985 2-3
AM XLO PT OFF OFF

T AND R
CHANNEL

2. CONFIG- URATION

FM AM CT SCN BCN
0-0-0 0-0
AM XLO PT OFF OFF

OPERATING
MODES

3. SELCAL

FM AM CT SCN BCN
SEL 99 43
AM XLO PT OFF OFF

SELCAL CODES
00-00 = OFF

4. METER

FM AM CT SCN BCN
||||| 516
AM XLO PT OFF OFF

RCV. SIGNAL
STRENGTH

FM AM CT SCN BCN
||||| P0
AM XLO PT OFF OFF

XMT PWR OUT

5. MODEM CONTROL

FM AM CT SCN BCN
6PS 24 00
AM XLO PT OFF OFF

1200/2400 bps
MODEM ON/OFF

6. PWR OUT ADJUST

FM AM CT SCN BCN
P0 Adj 14
AM XLO PT OFF OFF

2 WATT STEPS



MOTOROLA INC.

TABLE OF CONTENTS

Paragraph		Page
	SECTION 1. INTRODUCTION	
1.1	General Information	1-1
1.2	Abbreviations and Glossary	1-2
1.3	Equipment Description	1-4
1.4	Features	1-4
1.5	LST-5C System	1-4
1.5.1	Transceiver	1-6
1.5.2	Antenna	1-6
1.5.3	Battery Case	1-6
1.5.4	Power Supply — AC (LSAD-100)	1-6
1.5.5	Handset H-189/GR	1-6
1.5.6	Remote-Control Unit (RCU)	1-6
1.5.7	Cable Assembly (Remote Control)	1-6
1.5.8	Cable Assembly (TSEC/KY-57)	1-7
1.5.9	Cable Assembly (TSEC/KY-58, -65, -75)	1-7
1.5.10	Optional Antennas	1-7
1.6	Minimum Equipment Requirement	1-7
1.7	Reference Data	1-8
	SECTION 2. OPERATION	
2.1	General Information	2-1
2.2	Controls, Indicators and Connectors	2-1
2.3	Operational Procedures	2-6
2.3.1	General Information	2-6
2.3.2	Equipment Setup	2-6
2.3.2.1	Turning on the Unit	2-7
2.3.2.2	Entering Preset Data	2-7
2.3.2.3	Storing Preset Frequencies	2-7
2.3.2.4	Selecting Operating Modes	2-9
2.3.2.5	Selecting Transmit and Receive Channels	2-10
2.3.2.6	Setting Selective Call Codes	2-11
2.3.2.7	Selecting Meter Display	2-12
2.3.2.8	Selecting Baud Rate and Turning Modem On	2-12
2.3.2.9	Adjusting Transmit Power	2-13
2.3.3	Operating Procedures	2-14
2.3.3.1	Siting	2-14
2.3.3.2	Unencrypted LOS Operation	2-14
2.3.3.3	Encrypted LOS Operation	2-14
2.3.3.4	Satellite Operation	2-15
2.3.3.5	Remote-Control Operation	2-16
2.3.3.6	Retransmit Operation	2-17
2.3.3.7	PT or CT LOS Relay Operation	2-17
2.3.3.8	CT Satellite Relay Operation	2-19

TABLE OF CONTENTS (Cont)

Paragraph		Page
	2.3.3.9 Scan Operation	2-19
	2.3.3.10 Beacon Operation	2-21
	2.3.3.11 SELCAL Operation	2-21
	2.3.3.12 Cancellation of Presets	2-22
	2.3.3.13 Front Panel Illumination	2-22
	2.3.3.14 Radio Lockup	2-22
	SECTION 3. INSTALLATION	
3.1	General Information	3-1
3.2	Assembly and Preparation for Use	3-1
	3.2.1 Unpacking the Radio Set	3-1
	3.2.2 Checking Unpacked Equipment	3-1
	3.2.3 Installing or Replacing the Battery	3-1
	3.2.4 Attaching the Handset	3-2
	3.2.5 Attaching the Antennas	3-2
3.3	Compatible Communications Security Devices	3-3
3.4	Remote Operation	3-6
	3.4.1 RCU Control	3-6
	3.4.2 Computer Control	3-7
	3.4.2.1 X-Mode Connector	3-7
	3.4.2.2 Data Rates and Logic Levels	3-7
	3.4.2.3 Data Exchange Protocol	3-8
	3.4.2.4 Timing Restrictions	3-9
	3.4.2.5 Commands	3-9
	3.4.3 PT Retransmit Operation	3-13
	3.4.4 CT Retransmit Operation	3-14
	3.4.5 Modem Operation	3-14
	3.4.6 Interface Characteristics	3-15
	3.4.7 LST-5C Data Interface for Narrow Band Operation	3-15
	3.4.7.1 Description	3-15
	3.4.7.2 Timing	3-16
	3.4.7.3 DIFF/Non-Diff Selection	3-17
	3.4.7.4 Synchronous/Asynchronous	3-18

LIST OF ILLUSTRATIONS

Figure		Page
SECTION 1. INTRODUCTION		
1-1	LST-5C Radio Set	1-1
1-2	LST-5C System Components	1-5
1-3	LST-5C Minimum System Requirement	1-7
SECTION 2. OPERATION		
2-1	Front Panel Controls, Indicators and Connectors	2-2
2-2	Encrypted LOS Operation — Block Diagram	2-15
2-3	Remote-Control Operation — Block Diagram	2-17
2-4	PT Retransmit Operation — Block Diagram	2-18
2-5	CT Retransmit Operation — Block Diagram	2-18
SECTION 3. INSTALLATION		
3-1	LST-5C to TSEC/KY-57 — Interconnect Cable Diagram	3-3
3-2	LST-5C to TSEC/KY-58 — Interconnect Cable Diagram	3-4
3-3	LST-5C to TSEC/KY-65 — Interconnect Cable Diagram	3-4
3-4	LST-5C to TSEC/KY-75 — Interconnect Cable Diagram	3-4
3-5	LST-5C to AN/CSZ-1 (Sunburst Processor) — Interconnect Cable Diagram	3-5
3-6	LST-5C to ANDVT Interconnect Cable Diagram	3-5
3-7	Remote-Control Cable Diagram	3-6
3-8	Remote-Control Operation — Block Diagram	3-7
3-9	Typical Data Transfer	3-8
3-10	PT Retransmit Cable Diagram	3-13
3-11	DIP Switch	3-14
3-12	Differential Encoding/Decoding Diagrams	3-17
3-13	Interface Timing Diagrams	3-18

LIST OF TABLES

Table		Page
SECTION 1. INTRODUCTION		
1-1	Operating Parameters	1-8
1-2	Mechanical Data	1-10
1-3	Environmental Data	1-10
SECTION 2. OPERATION		
2-1	Front Panel Controls, Indicators, and Connectors	2-3
2-2	Display Modes	2-4
2-3	Storing Preset Frequencies	2-8
2-4	Selecting Operating Modes	2-9
2-5	Selecting Transmit and Receive Channels	2-10
2-6	Setting SELCAL Codes	2-11
2-7	Selecting Baud Rate and Turning Modem On	2-12
2-8	Adjusting Transmit Power	2-13
2-9	Selecting Scan Channel	2-20
SECTION 3. INSTALLATION		
3-1	Remote-Control Command Codes	3-9
3-2	Power Connector J1 (M24308/3-1) Signal Characteristics	3-15
3-3	HDST Connector J4 (GC-283F-1-050) Signal Characteristics	3-15
3-4	X-MODE Connector J2 (MS3114E16-26) Signal Characteristics	3-15

SECTION 1. INTRODUCTION

1.1 GENERAL INFORMATION

This manual provides operation and maintenance instructions for the LST-5C Radio Set shown in Figure 1-1. The radio set is a lightweight UHF transceiver, suitable for voice or data communications in line-of-sight or via satellite on either 25-kHz bandwidth or 5-kHz bandwidth channels.

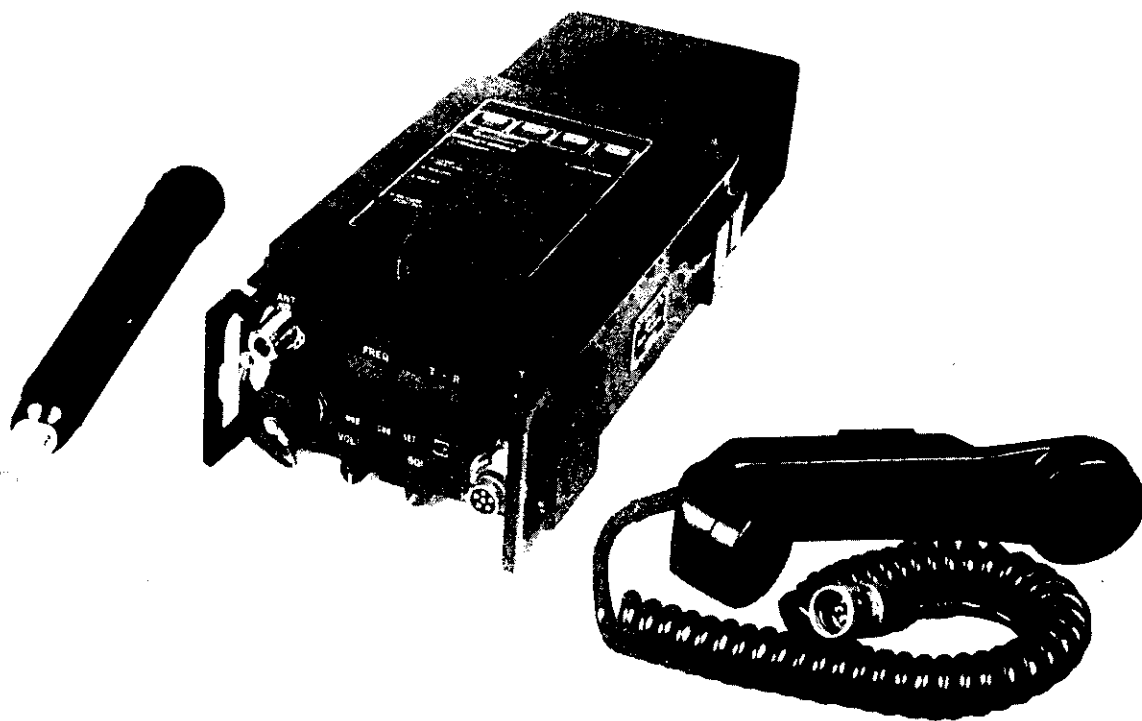


Figure 1-1. LST-5C Radio Set

1.3 EQUIPMENT DESCRIPTION

The LST-5C Radio Set is an FM/AM, UHF transceiver used for half-duplex, line-of-sight or satellite communications. It is suitable for manpack, vehicular or fixed-station applications. The radio set can be used with other AM or FM radios operating in the military UHF frequency band with 25-kHz or 5-kHz channels. Using the built-in modem, the radio provides narrowband (5-kHz) at data rates of 1200 and 2400 bps. The LST-5C Radio Set is all-weather operational and can be remotely controlled. The radio can also be operated with other equipments, including the following:

- Any UHF antenna with a 50-ohm impedance, 3.0:1 maximum VSWR, and 35-watt capability in the operating frequency band
- A variety of COMSEC equipments
 - Vinson — TSEC/KY-57 and TSEC/KY-58
 - Parkhill — TSEC/KY-65 and TSEC/KY-75
 - ANDVT/KYV-5
 - AN/CSZ-1 (Sunburst Processors)
- An external 50-ohm speaker
- Conditioned power from a power source of +21 to +32V
- Remote-control unit
- Computer for remote operation
- A retransmit cable in the relay mode

1.4 FEATURES

The LST-5C Radio Set has the following features:

- Microprocessor-controlled, fully synthesized transceiver
- 35,000 channels in the range of 225 to 400 MHz (5-kHz channel spacing)
- Self-contained modem
 - Data rates: 1200, 2400 bps
 - Shaped BPSK at 2400 bps
 - Adaptable modem interface
- Differential encoding
- Remote control of all functions
- Seven display functions
 - Nine-channel frequency memory
 - CT/PT, FM/AM, XHI/XLO, SCN and BCN modes
 - Select-call/conference call
 - Meter for received signal strength and power out
 - Adjustable band rate
 - Adjustable transmitter power
 - Real-time clock

1.5 LST-5C SYSTEM

The components of the LST-5C system (shown in Figure 1-2) may be selected and purchased as required.

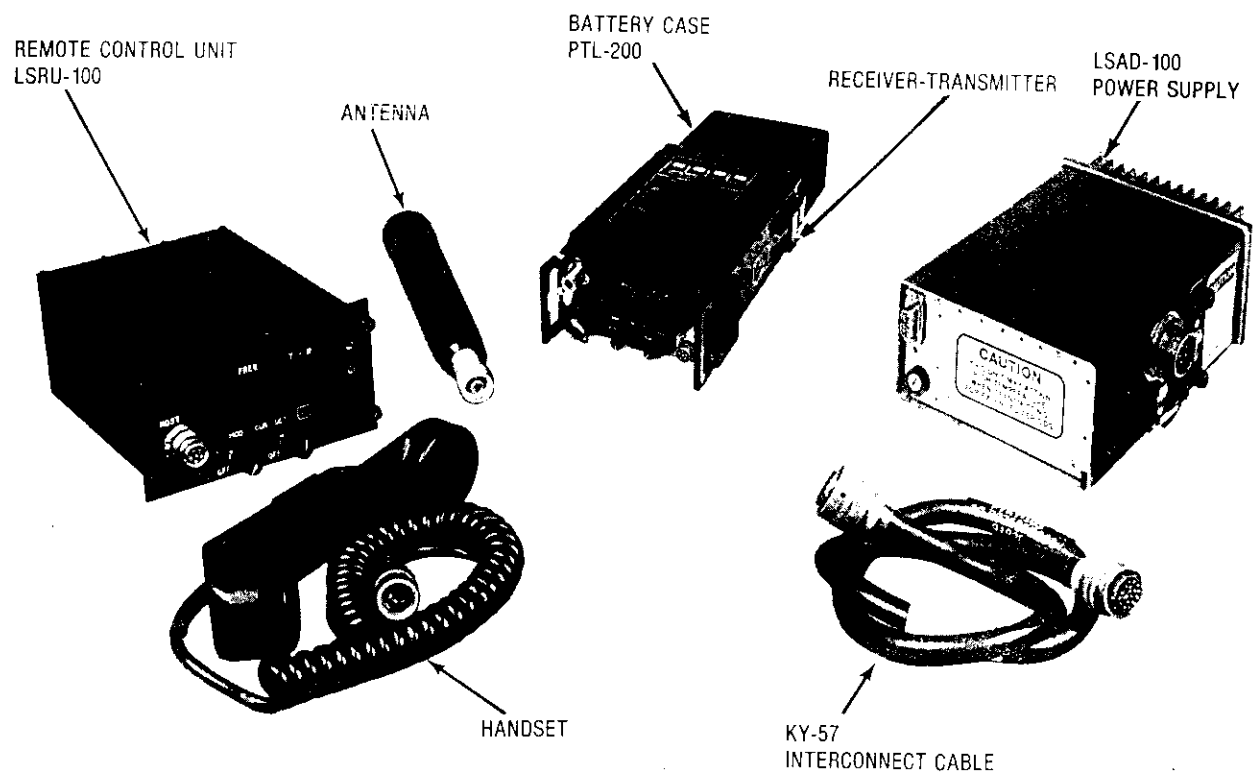


Figure 1-2. LST-5C System Components

1.5.1 TRANSCEIVER

The transceiver consists of nine replaceable assemblies in a cast-aluminum housing. All controls and operating connectors are located on the front panel. The battery connector is located on the rear panel. The front panel components are protected by handles and a hinged, fold-down front cover. Hand-operated latches attach the battery pack. When the top cover, containing the modem, is properly attached, the transceiver is water-tight.

1.5.2 ANTENNA

The antenna is a ten-inch, broadband, vertical antenna that is attached to the transceiver front panel by a Type N connector. This antenna is used for short-range, LOS communications.

WARNING

Electromagnetic radiation from the antenna can damage eyes and other body tissue when the unit is transmitting.

- * **While the unit is transmitting in the AM XHI or FM XLO modes, do not hold the antenna closer than 4 inches to any part of the body.**
- * **While the unit is transmitting in the FM XHI mode, do not hold the antenna closer than 16 inches to any part of the body.**
- * **DO NOT stand directly in front of the antenna when the unit is using the satellite antenna.**

1.5.3 BATTERY CASE

WARNING

Lithium batteries are used in the LST-5C Radio Set. Lithium batteries contain hazardous and reactive materials. Dispose of used batteries according to the prescribed lithium battery handling plan. DO NOT THROW THE BATTERIES IN UNCONTROLLED TRASH. Improper handling, reverse-current operation or high environmental temperatures may cause internally generated heat, fire, explosion or release of toxic materials and gases.

The battery case is a drawn aluminum can with clamps for attaching it to the transceiver. An internal connector mates with the battery, which slides into the case. A safety circuit is also mounted in the battery case to disconnect the battery from the transceiver when the battery voltage drops to 21 ± 0.5 Vdc. The battery case is designed for use with a lithium battery (BA-5590). A nickel-cadmium battery (BB-590) may be substituted.

1.5.4 POWER SUPPLY - AC (LSAD-100)

The LSAD-100 power supply will power the LST-5C radio from a 110/220-Vac source or from 11-32 Vdc.

1.5.5 HANDSET H-189/GR

The handset contains a microphone and receiver for transmitting and receiving audio signals. A retractable cord with a 6-pin connector attaches to the radio front panel. A push-to-talk switch is mounted in the handset handle.

1.5.6 REMOTE-CONTROL UNIT (RCU)

The remote-control unit (RCU) can control the radio set from a distance of up to 100 feet. The RCU's front panel controls and display are identical to those on the radio and operate in exactly the same way. Cables are connected from J1 to the X-mode connector on the transceiver and from J2 to the RADIO connector on the TSEC/KY-57. These two connectors are located on the rear panel of the RCU. The H-189/GR can be connected to the HDST front panel connector for nonsecure remote operation.

With the RCU operating, the radio can be controlled from either location; the displays on the units will track each other.

1.5.7 CABLE ASSEMBLY (Remote Control)

A shielded cable assembly up to 100 feet long connects the remote-control assembly to the transceiver. The water-tight cable contains 26 wires. Section 3 of this manual contains a wiring diagram for this cable.

1.5.8 CABLE ASSEMBLY (TSEC/KY-57)

A shielded, three-foot long cable assembly connects the transceiver to a TSEC/KY-57 for secure operation. This water-tight cable assembly also connects the remote-control assembly to a TSEC/KY-57 for remote control in the secure (CT) mode. A schematic diagram of this cable can be found in Section 3 of this manual.

1.5.9 CABLE ASSEMBLY (TSEC/KY-58, -65, -75)

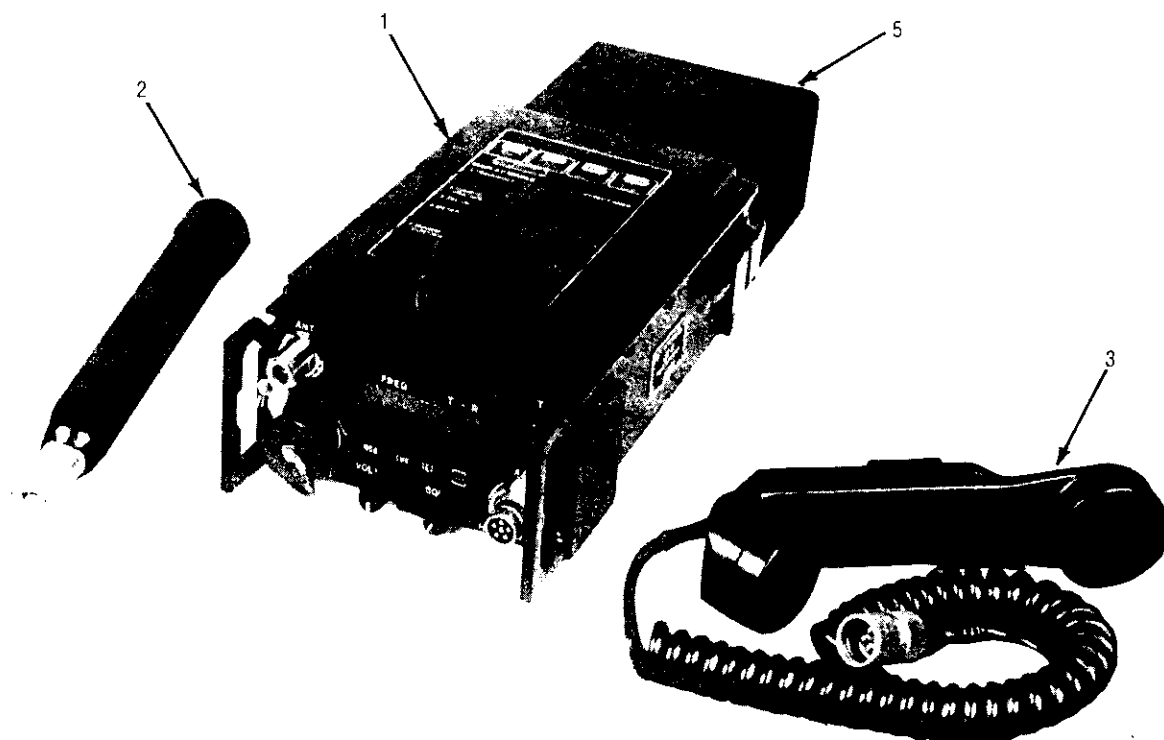
Wiring diagrams for the TSEC/KY-58, -65, and -75 cables are shown in Section 3 of this manual.

1.5.10 OPTIONAL ANTENNAS

Various other antennas are available for satellite use, ranging from portable models to base-station and aircraft types.

1.6 MINIMUM EQUIPMENT REQUIREMENT

As a minimum, the items shown in Figure 1-3 are required for an LOS system.



Find No.	Qty. Req.	Code Ident.	Part No.	Nomenclature
1	1	94990	01-P22963H003	Receiver-Transmitter
2	1	94990	85-P25399B001	Antenna, UHF
3	1	80063	SM-C-544226	Handset, H-189/GR
4	1		MS3116E16-26P	Connector, X-mode
5	1	94990	01-P25380B001	Battery Box

Figure 1-3. LST-5C Minimum System Requirement

1.7 REFERENCE DATA

The operating parameters of the LST-5C Radio Set are listed in Table 1-1. The physical characteristics are listed in Table 1-2, and the environmental specifications are listed in Table 1-3.

Table 1-1. Operating Parameters

Characteristics	Specifications
General	
Frequency Range	225.000 to 399.995 MHz
Tuning Increments	5 kHz
Stability	1 ppm
Preset Channels	9
Modulation	AM, FM, BPSK, SBPSK
Operating Modes	
Plain Text (PT)	AM or FM
Cipher Text (CT)	AM or FM, BPSK, SBPSK
T-R	Relay mode, receive on 1 of 9 preset channels, transmit on 1 of 9 present channels.
Beacon	Transmit an emergency audio sweep on any selected frequency.
Scan	Scan any 2 of 9 preset channels. Transmit on a third preset channel.
SELCAL	75 selective call codes, 1 conference call code.
Bandwidths	
IF Selectivity	± 15 kHz, 6 dB down
PT Audio (FM/AM)	300 to 3500 Hz (± 3 dB)
CT (FM/AM)	10 - 10, 240 Hz (± 3 dB)
Receiver Characteristics	
Sensitivity (10 dB Sinad)	
AM	-- 110 dBm, 1 kHz modulation at 70%
FM (PT)	-- 119 dBm, 1 kHz modulation at ± 8 kHz deviation
FM (CT)	-- 117 dBm, 1 kHz modulation at ± 8 kHz deviation
Input Impedance	50 ohms nominal
Image Response	60 dB down (typical)
Spurious Response	80 dB down (typical)
Squelch	Manual adjust, carrier-level squelch
Transmitter Characteristics	
High-Power Output	
AM	5 watts (± 2 dB)
FM	18 watts (± 2 dB)
Low-Power Output	
AM	2 watts (± 2 dB)
FM	5 watts (± 2 dB)
Select Power Mode	Power adjustable in \approx 2-watt steps, 2 to 18 watts in FM.
Modulation	
AM (PT or CT)	70% nominal at 1 kHz
FM (PT or CT)	± 8 kHz deviation nominal at 1 kHz modulation
Spurious Outputs	-- 60 dB below fundamental
Harmonic Outputs	-- 40 dB below fundamental

Table 1-1. Operating Parameters (Cont)

Characteristics	Specifications
Transmitter Characteristics (Cont)	
Output Impedance Protection Power Voltage Current Battery Life BB-590/U BA-5590/U Fuse	50 ohms nominal No damage from open or short circuits at the antenna port. +21 to +32V 2.25 amps maximum at +24V 4.3 hours 17 hours with 9:1 ratio receive-to-transmit in 18-watt mode 4 amperes in transceiver
Modem Characteristics	
Modulation 1200 bps 1200 bps 2400 bps 2400 bps Demodulation Bit-error rate (10^{-3}) 1200 bps 2400 bps	BPSK Differentially encoded BPSK Shaped BPSK Differentially encoded BPSK 39 dB C/N ₀ 43 dB C/N ₀
Data Interface	
Frequency Levels Modulator Demodulator	± 50 ppm MIL-STD-188C-114 (unbalanced) Internal clock for differential encoding Supplies data and edge-coherent clock

Table 1-2. Mechanical Data

Characteristics	Specifications
Transceiver	
Height	3.75 inches
Width	6.0 inches
Depth	9.3 inches
Weight	8.6 pounds
Battery Case	
Height	2.8 inches
Width	5.3 inches
Depth	5.4 inches
Weight	5.0 pounds with BB-590/U 3.2 pounds with BA-5590/U
Remote-Control Assembly (Dimensions are behind front panel and exclude rear connectors)	
Height	3.12 inches
Width	4.75 inches
Depth	6.0 inches
Weight	2.1 pounds

Table 1-3. Environmental Data

Characteristics	Specifications
Temperature (Operating)	− 29°C (− 20°F) to + 55°C (+ 130°F)
Humidity	95% relative
Altitude (operating)	15,000 feet, MSL

SECTION 2. OPERATION

2.1 GENERAL INFORMATION

This section provides information for operating the LST-5C system: a functional description of all operating controls, indicators and connectors, and procedures for manual and preset operations.

WARNING

Electromagnetic radiation from the antenna can damage eyes and other body tissue when the unit is transmitting.

- * While the unit is transmitting in the AM XHI or FM XLO modes, do not hold the antenna closer than 4 inches to any part of the body.
- * While the unit is transmitting in the FM XHI mode, do not hold the antenna closer than 16 inches to any part of the body.
- * DO NOT stand directly in front of the antenna when the unit is using a satellite antenna.

NOTE

Lithium Battery Pre-Conditioning

When using the BA-5590/U lithium battery, Motorola recommends that the user consult MIL-B-49430(ER), "MIL-SPEC, Batteries, non-rechargeable, Lithium sulfur dioxide", and MIL-B-49430/3D (ER) "MIL-SPEC, Battery, non-rechargeable, Lithium, sulfur dioxide BA-5590/U." Particular attention should be paid to the paragraphs relating to voltage delay of the BA-5590/U.

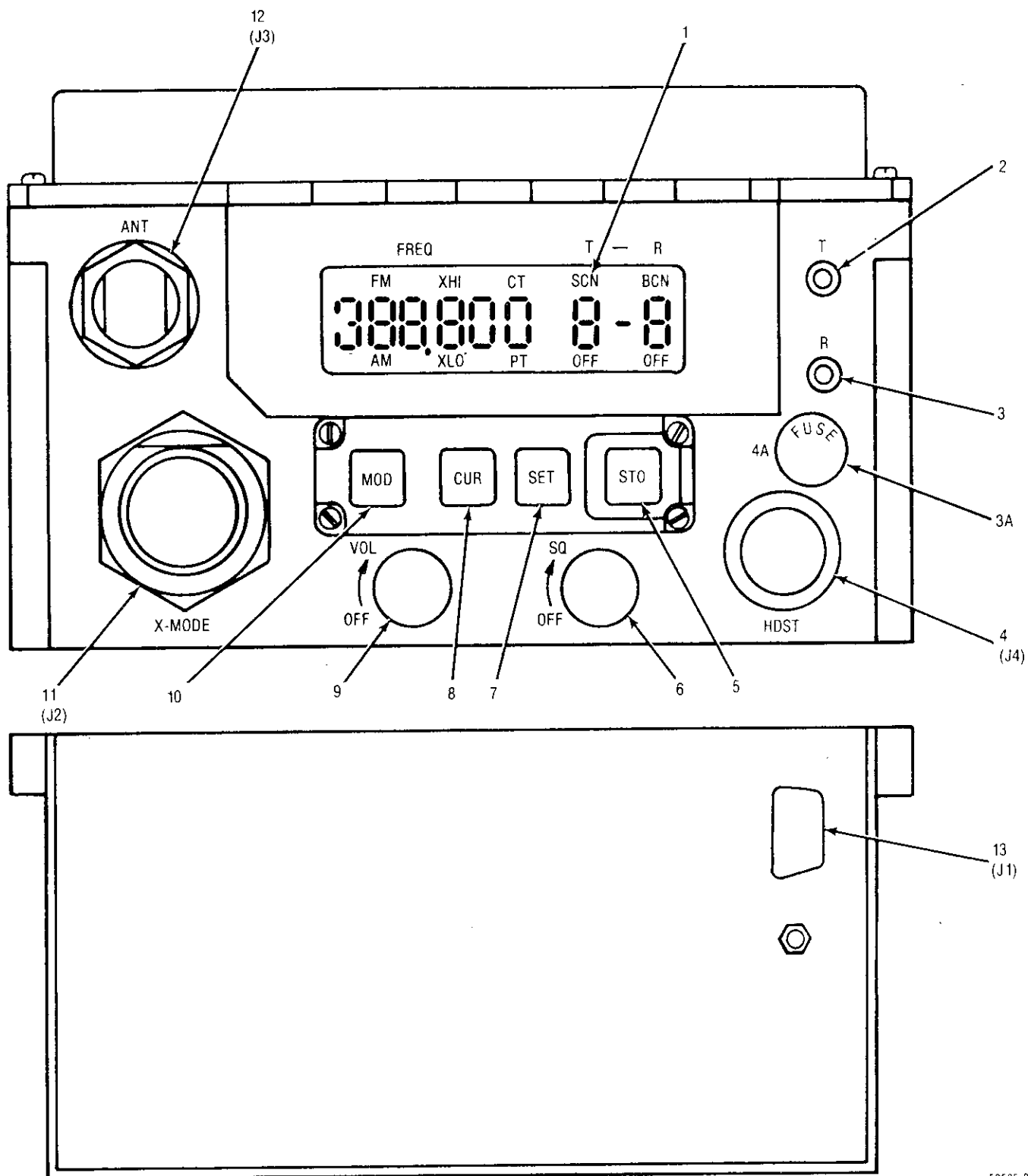
If lithium batteries are not properly pre-conditioned, the following conditions occur:

1. When the radio is keyed, the voltage sensing circuit in the battery pack will cause power shutdown.
2. The radio may be repeatedly turned on, but will continually have power shutdown when the radio is keyed.

Should these conditions occur, contact Motorola GEG for information or assistance.

2.2 CONTROLS, INDICATORS AND CONNECTORS

The LST-5C Radio Set uses a microprocessor for most control and display functions. Four operator key switches are used with a liquid crystal display (LCD) to set and store frequencies and to select operating modes. Separate volume and squelch controls are provided to adjust the handset audio level and the receiver squelch threshold. The controls, indicators and connectors shown in Figure 2-1 are explained in Table 2-1. The seven display modes are shown and explained in Table 2-2.



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Figure 2-1. Front Panel Controls, Indicators and Connectors

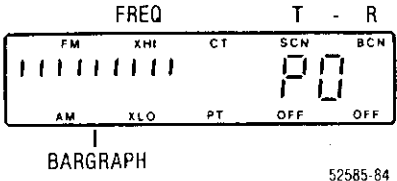
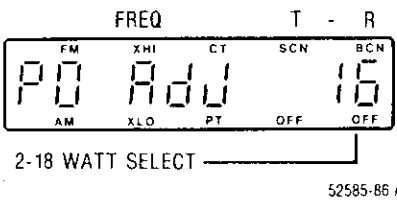
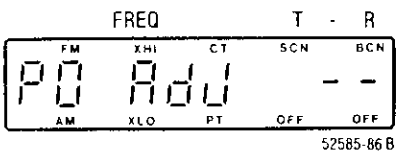
Table 2-1. Front Panel Controls, Indicators, and Connectors

Find No.	Control Indicator, Connector	Type	Function
1	Liquid crystal display (LCD)	7-segment display	Alpha-numeric display with seven modes.
2	T	Red LED	When lit, indicates transmit on.
3	R	Green LED	When lit, indicates receiver is unsquelched.
3A	4A	Fuse, TO-18	Power input circuit protection.
4	HDST	6-pin audio connector	Handset connector for H-189/GR or H-250/U handset (J4)
5	STO	Pushbutton membrane switch	Used in display Mode 1 to store displayed frequency in selected PRESET channel. Note This switch is protected by a raised ridge to prevent accidental changes to stored frequencies.
6	SQ/OFF	Rotary control with switch	Sets squelch threshold or turns squelch off, for remote control.
7	SET	Pushbutton membrane switch	Used with the display modes to select frequencies, channels and operating modes.
8	CUR	Pushbutton membrane switch	Used in the display modes to locate the cursor position (indicated by the flashing digit or character).
9	VOL/OFF a) OFF b) VOL	Rotary control with switch	Full CCW position turns radio off. Continuously variable control adjusts handset audio level.
10	MOD	Pushbutton membrane switch	Selects one of the display/control modes.
11	X-MODE	26-pin connector	Connects radio to peripheral devices such as COMSEC equipment, remote-control unit, test equipment and other radios for retransmit (J2).
12	ANT	N-type RF connector	Connects UHF antenna (J-3).
13	J1	9-pin connector located on back panel	Power input and control connector.

Table 2-2. Display Modes

Mode	LCD Display	Function
1. Frequency Select 1a. Frequency/Presets		Six leftside digits display operating frequency – 100, 10, 1 MHz and 100, 10, 5 kHz, respectively. The three rightside digits display the chosen preselect channel. Solid decimal point indicates synthesizer is locked; blinking decimal point indicates no lock.
1b. Frequency/T-R		Three dashes " - - " in the place of the rightside digits denote another preset channel that can be used to store a frequency, but cannot be used in the T-R or scan modes.
2. Configuration		The three rightside digits display the preselect channel for transmit (left) and for receive (right). This mode is primarily used in relay and SATCOM operation where transmit and receive frequencies are different. The 2 channels to be scanned in the scan mode are also selected in the T-R mode.
3. Select Call (SELCAL)		Displays five boxes whose position above or below a center reference line indicates the radio's operating modes: FM/AM - modulation XHI/XLO - transmit power CT/PT - audio bandpass: wideband (CT) narrowband (PT) SCN/OFF - scan mode on/off. BCN/OFF - beacon mode on/off.
4. Meter 4a. Signal Strength		Enables selective or conference call operation and displays selected transmit (left) and receive (right) call codes.
		In the receive mode, the leftside bargraph displays the relative signal strength of the received signal. The maximum number of bars is 12.

Table 2-2. Display Modes (Cont)

Mode	LCD Display	Function
4b. Power Out		In the transmit mode, when the handset push-to-talk button is pushed, the leftside bargraph displays the transmitter output power in ≈ 2 watts per mark.
5. Modem Control		Turns the modem on or off (provided radio is in FM mode), and allows either 1200 bps or 2400 bps operation (12 or 24 on the display).
6. Power-Out Adjust		Allows selection of transmitter output power from 2 to 18 watts in 2-watt steps.
		Two dashes in place of the rightside digits revert the power control to XHI/XLO as selected in the Configuration mode.

2.3 OPERATIONAL PROCEDURES

2.3.1 GENERAL INFORMATION

The transceiver can be used for operation once it has been installed as described in Section 3. The radio is micro-processor-controlled from instructions selected at the front panel. The frequency is tuned in either by selecting one of ten preset channels or by manually setting up the operating frequency on the LCD display. The preset frequencies are stored in memory after installation and may be changed any time the radio is turned on. The memory is maintained using a lithium keep-alive battery that allows the presets to be stored even when the power is turned off or the radio battery is removed. When transmitting and receiving on the same frequency, the unit displays that frequency on the frequency display; when transmitting and receiving on different frequencies, the unit displays the receive frequency while receiving and the transmit frequency while transmitting.

The following list illustrates some common operator errors. Please check this list before going on to more detailed troubleshooting.

- Beacon and Scan must be turned off before cursor will move.
- Radio must be in FM/CT mode to operate modem.
- Radio must be in FM mode before Power Adjust will operate.
- When leaving the Power Adjust mode (selecting—), the radio will default to FM and High Power mode.
- To go into FM Low Power mode, Power Adjust must be set to—.
- When operating under local control and PO Adjust, if the selected operating channel is changed, the radio will default to high power.
- When operating under remote control (RCU or computer) and PO Adjust, the PO Adjust variable power level will remain in effect until changed by the operator.
- When modem is on, SELCAL will not operate.
- Do not key radio when SELCAL is set to 00 in transmit and anything except 00 in receive. If radio is keyed, it must be reset.
- Do not use CH— for a scanning channel. However, CH— may be used as a transmit channel while in scan mode operation.
- Do not attempt to power the radio through the X-mode connector.
- Do not attempt to provide power to external equipment (i.e., PTPC-100, TSEC/KY-58) via X-mode connector pins W and V. These devices should be powered via X-mode connector pin G as long as total load does not exceed 500 mA.
- Several conditions should be avoided when using the LOS antenna attached to front panel of the LST-5B.
 - 1) Do not transmit with cover removed from transceiver.
 - 2) Use only vendor supplied power supply.
 - 3) Do not use unshielded cables to X-mode connector.

CAUTION

To avoid damage to equipment, do not hook-up to X-mode pin Y (SYNC LK) if the connecting signal logic differs from 5V/0V logic. Refer to Section 3.4.6 Interface Characteristics.

2.3.2 EQUIPMENT SET-UP

The operating procedures given in the following paragraphs provide instructions for turning on the power and for using the normal operating modes of the LST-5C Radio Set.

2.3.2.1 Turning on the Unit

Before performing the following steps, refer to paragraph 2-2 for the locations and functional description of the controls and indicators.

1. Make sure the radio set is connected for operation according to the installation instructions in Section 3.
2. Turn on the radio set by turning the VOL control clockwise.
3. Set the VOL control for the desired volume (the SQ control must be in maximum counter clockwise position).
4. Adjust the SQ control for the threshold by advancing clockwise slowly, just until the noise stops and the green "R" light goes out. Advancing the control further will reduce the sensitivity of squelch break.

2.3.2.2 Entering Preset Data

All preset data is stored in an internal, non-volatile memory. The power battery can be changed without disturbing the preset data. The radio set is turned on by turning the VOL control clockwise. The display shows the last display in use when the radio was turned off, except that BCN and modem will always be off at turn-on.

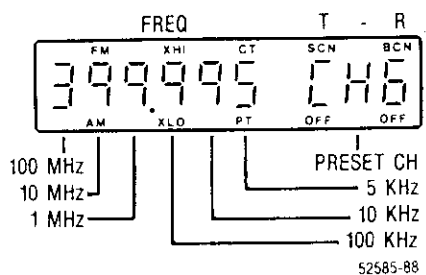
NOTE

After all presets and operating modes have been selected, the cursor should be set off the screen to prevent unwanted changes if the SET key is inadvertently pushed.

2.3.2.3 Storing Preset Frequencies

Ten frequencies from 225.000 to 399.995 MHz can be stored in preset channels CH1 to CH9 and in "--" with 5-kHz tuning increments. In the Frequency/Presets display (Mode 1a), a solid decimal point indicates the synthesizer is phase-locked. A flashing decimal point indicates that the synthesizer is not phase-locked and that a fault exists. Frequencies cannot be stored when the decimal point is flashing. Improper frequency settings from 200.000 to 224.995 MHz cannot be entered. When storing frequencies in preset channels, you must select the desired preset channel's number before setting the frequency. Preset frequencies are stored as shown in Table 2-3.

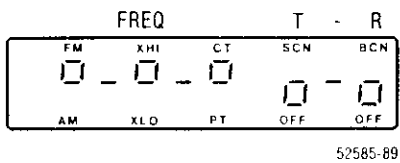
Table 2-3. Storing Preset Frequencies

Action	Control	Indication
1. Select Frequency/Presets display (Mode 1a).	MOD key	
2. Select preset channel:		
a. Set cursor to PRESET channel area.	CUR key	Flashing PRESET channel area.
b. Select desired preset channel.	SET key	Set CH1 to CH9 or "-- --".
3. Set 100-MHz frequency:		
a. Set cursor to 100-MHz digit.	CUR key	Flashing 100-MHz digit.
b. Select 100-MHz digit.	SET key	Set 2 or 3.
4. Set 10-MHz frequency:		
a. Set cursor to 10-MHz digit.	CUR key	Flashing 10-MHz digit.
b. Select 10-MHz digit.	SET key	Set 0 to 9.
5. Set 1-MHz frequency:		
a. Set cursor to 1-MHz digit.	CUR key	Flashing 1-MHz digit.
b. Select 1-MHz digit.	SET key	Set 0 to 9.
6. Set 100-kHz frequency:		
a. Set cursor to 100-kHz digit.	CUR key	Flashing 100-kHz digit.
b. Select 100-kHz digit.	SET key	Set 0 to 9.
7. Set 10-kHz frequency:		
a. Set cursor to 10-kHz	CUR key	Flashing 10-kHz digit.
b. Select 10-kHz digit.	SET key	Set 0 to 9.
8. Set 5-kHz frequency step:		
a. Set cursor to 5-kHz digit.	CUR key	Flashing 5-kHz digit.
b. Select 5-kHz digit.	SET key	Set 0 or 5.
9. Store displayed frequency into selected preset channel.	STO key	
Repeat steps 2 through 9 to change frequency stored in any other preset channel.		
10. Set cursor off display.	CUR key	No flashing digits.

2.3.2.4 Selecting Operating Modes

Five operating modes are selected by using the Configuration display (Mode 2). In this mode, the cursor has six positions, one for each of the five functions, plus the sixth one which puts the cursor off the screen. The operating modes are set as shown in Table 2-4. (The SCN and BCN functions cannot be used simultaneously.)

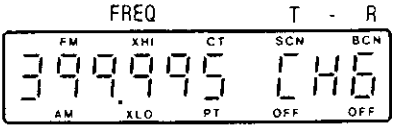
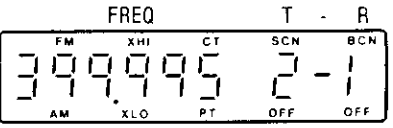
Table 2-4. Selecting Operating Modes

Action	Control	Indication
1. Select Configuration display (Mode 2).	MOD key	
2. Set for FM or AM operation:		
a. Set cursor to FM/AM.	CUR key	Flashing FM/AM character.
b. Select FM or AM.	SET key	Box above reference line for FM. Box below reference line for AM.
3. Select high or low transmit power:		
a. Set cursor to XHI/XLO.	CUR key	Flashing XHI/XLO character.
b. Select XHI or XLO.	SET key	Box above reference line for high power. Box below reference line for low power.
4. Set for cipher text (CT) or plain text (PT):		
a. Set cursor to CT/PT.	CUR key	Flashing CT/PT character.
b. Select CT or PT.	SET key	Box above reference line for cipher text. Box below reference line for plain text.
5. Set scan mode (SCN) on or off:		
a. Set cursor to SCN/OFF.	CUR key	Flashing SCN/OFF character.
b. Select scan mode on or off.	SET key	Box above reference line for scan on. Box below reference line for scan off.
6. Set beacon mode (BCN) on or off.		
a. Set cursor to BCN/OFF.	CUR key	Flashing BCN/OFF character.
b. Select beacon mode on or off.	SET key	Box above reference line for beacon on. Box below reference line for beacon off.
7. Set cursor off display.	CUR key	No flashing digits.

2.3.2.5 Selecting Transmit and Receive Channels

The T-R channels are selected whenever operation with different transmit and receive frequencies is required – for instance, during relay or satellite operation. The scan mode also requires T-R selection for the channels to be scanned. T-R channels are set as shown in Table 2-5.

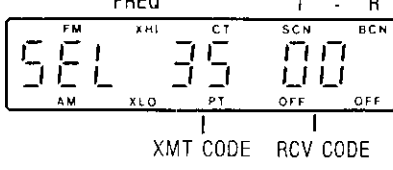
Table 2-5. Selecting Transmit and Receive Channels

Action	Control	Indication
1. Select Frequency/Presets display (Mode 1a).	MOD key	 <p>52585-92</p>
2. Select transmit and receive channel:		
a. Set cursor to T-R position.	CUR key	Flashing channel characters.
b. Run through channels until two numbers appear.	SET key	 <p>52585-93</p>
c. Set cursor to transmit channel.	CUR key	Flashing digit under T.
d. Select transmit channel.	SET key	Set 1 to 9.
e. Set cursor to receive channel.	CUR key	Flashing digit under R.
f. Select receive channel.	SET key	Set 1 to 9.
g. Set cursor off display.	CUR key	No flashing digits.

2.3.2.6 Setting Selective Call Codes

Selective and conference call codes are set on the SELCAL display (Mode 3). One conference call code and seventy-five selective call codes are available. Call codes are set as shown in Table 2-6.

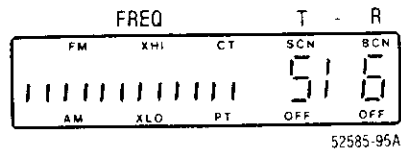
Table 2-6. Setting SELCAL Codes

Action	Control	Indication
1. Select SELCAL display (Mode 3).	MOD key	 <p>52585-94</p>
2. Set transmit call code digits:		
a. Set cursor to transmit call code tens digit.	CUR key	Flashing XMT code tens digit.
b. Select tens digit.	SET key	Set 0 to 9 or C.
c. Set cursor to transmit call code ones digit.	CUR key	Flashing XMT code ones digit.
d. Select ones digit.	SET key	Set 0 to 9.
3. Set receive call code digits:		
a. Set cursor to receive call code tens digit.	CUR key	Flashing RCV code tens digit.
b. Select tens digit.	SET key	Set 0 to 9 or C.
c. Set cursor to receive call code ones digit.	CUR key	Flashing RCV code ones digit.
d. Select ones digit.	SET key	Set 0 to 9.
4. Set cursor off display.	CUR key	No flashing digits.
EXAMPLES – SELECTED CODES 00-00 SELCAL mode inactive. C -00 Transmit conference code. Receive SELCAL inactive. 46-35 Transmit SELCAL code 46. Receive SELCAL code 35. 02-02 Transmit and receive SELCAL code 2.		

2.3.2.7 Selecting Meter Display

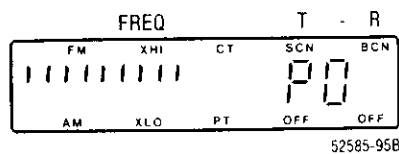
The Meter display (Mode 4) measures two functions:

- **Received signal strength.** When the unit is receiving, the Signal Strength display (Mode 4a) shows the relative signal-strength level in a bargraph on the lower left side. "SIG" appears on the right.



This mode can be used to optimize antenna direction.

- **Transmit output power.** When the unit is transmitting, the Power Out display (Mode 4b) shows the power out in a bargraph (2 watts per bar) on the upper right side. "PO" appears on the right.



This mode can be used to determine the integrity of the antenna.

2.3.2.8 Selecting Baud Rate and Turning Modem On

The built-in modem is controlled through the Modem Control display (Mode 5). Using this mode, the operator can select between 1200 bps and 2400 bps and turn the modem OFF or ON (provided radio is in FM mode), as shown in Table 2-7.

Table 2-7. Selecting Baud Rate and Turning Modem On

Action	Control	Indication
1. Select Modem Control display (Mode 5).	MOD key	<p>The display shows 'bPS 12' on the left and 'OFF' on the right. Above the display are labels: FREQ, T, R, FM, XHI, CT, SCN, BCN. Below the display are labels: AM, XLO, PT, OFF, OFF. The identifier 52585-96 is at the bottom right.</p>
2. Select baud rate.		
a. Set cursor to 12 or 24 position.	CUR key	Flashing 12 or 24.
b. Select 1200 or 2400 bps.	SET key	
3. Turn modem ON.		
a. Set cursor to OFF.	CUR key	Flashing OFF.
b. Select modem ON.	SET key	<p>The display shows 'bPS 12' on the left and 'ON' on the right. Above the display are labels: FREQ, T, R, FM, XHI, CT, SCN, BCN. Below the display are labels: AM, XLO, PT, OFF, OFF. The identifier 52585-97 is at the bottom right.</p>
4. Set cursor off display.	CUR key	No flashing characters.

2.3.2.9 Adjusting Transmit Power

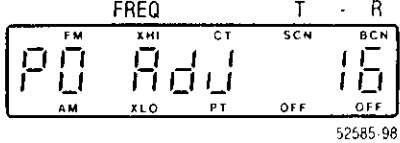
The LST-5C's transmit output power can be adjusted (in Mode 6) in 2-watt steps between 2 watts and 18 watts.

This power adjustment cannot be made in the AM operating mode. To leave the PO Adjust mode, select—. When leaving the PO Adjust mode, the radio will default to FM and High Power mode.

When operating under local control and PO Adjust, if the selected operating channel is changed, the radio defaults to High Power. When operating under remote control (RCU or computer), the PO Adjust variable power level will remain in effect until changed by the operator.

Transmit power is adjusted as shown in Table 2-8.

Table 2-8. Adjusting Transmit Power

Action	Control	Indication
1. Select Power-Out Adjust display (Mode 6).	MOD key	 52585-98
2. Set cursor over the power-select channel.	CUR key	Flashing digits.
3. Select power level.	SET key	Set 2 to 18 watts.
4. Set display to Frequency/Presets (Mode 1a).		

2.3.3 OPERATING PROCEDURES

2.3.3.1 Siting

The LST-5C Radio Set operates in the UHF frequency band; therefore, siting of the radio greatly affects its operating range. The longest range is normally obtained when a direct line-of-sight (LOS) is maintained between the radios. Use of hilltop or tower locations will increase the LOS range. Location in valleys with intervening hills, behind buildings or in dense woods may reduce or prevent communications. If possible, avoid locations near electrical interference sources, such as power and telephone lines, and radars.

2.3.3.2 Unencrypted LOS Operation

The following procedure allows unencrypted LOS operation.

1. Attach the UHF antenna and H-189/GR handset to the radio set.
2. Turn the radio set on by rotating the VOL control clockwise.
3. Set the SQ control to OFF and set the VOL control until noise is heard in the handset.
4. Using the Configuration display (Mode 2), select the operating modes per Table 2-4. The SCN and BCN modes must be set at OFF.
5. Using the Frequency/Preset display (Mode 1a), set the operating frequency or select the preset channel per Table 2-3.
6. To transmit, hold the H-189/GR handset push-to-talk switch down while talking into the handset mouthpiece.
7. To receive, release the PTT switch and listen to the handset earpiece.
8. To eliminate the background noise from the handset earpiece when no received signal is present, turn the SQ control clockwise just until the green light goes out. If the control is set to the full clockwise position, received signals cannot be heard.

2.3.3.3 Encrypted LOS Operation

To operate with data from an input device instead of voice from a handset, the KY57/KY58 must be switched to the time delay (TD) mode.

The following procedure allows encrypted LOS operation.

1. Attach the UHF antenna and TSEC cable to the radio set.
2. Turn the radio set on by rotating the VOL control clockwise.
3. Using the Configuration display (Mode 2), select the operating modes per Table 2-4. The SCN and BCN modes must be set at OFF.
4. Using the Frequency/Preset display (Mode 1a), set the operating frequency or select the preset channel per Table 2-3.
5. Set the SQ control as in step 8 above.
6. Connect the TSEC/KY-57 security device and the H-189/GR as shown in Figure 2-2.
7. The radio is ready for encrypted voice or data operation. Operating instructions for the TSEC/KY-57 are found in *OPERATOR'S MANUAL, TM-11-5810-156-OP-1*.

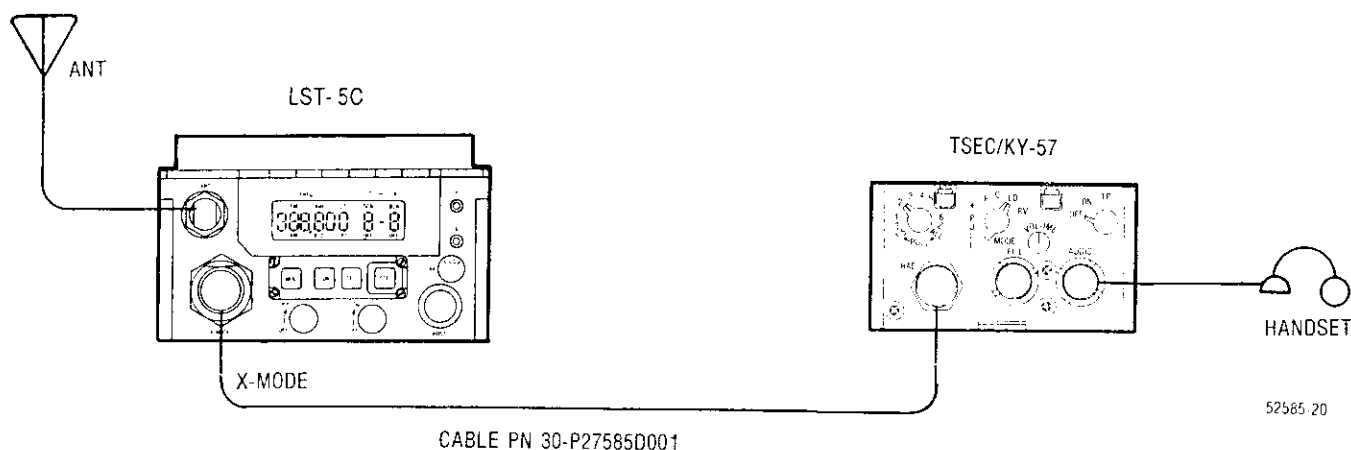


Figure 2-2. Encrypted LOS Operation – Block Diagram

2.3.3.4 Satellite Operation

Operation via satellite requires the LST-5C to transmit on one frequency (uplink), while it receives on another (downlink). The LST-5C operates using satellite channels with bandwidths of either 25 kHz or 5 kHz. With a 25 kHz channel, the modulation mode will be FM for PT voice and when using KY-57 or -58 in the CT mode. Due to bandwidth restrictions, a 5 kHz channel can only be used with phase-shift keying (PSK) modulation. (The modem is used for PSK modulation.) The input data device must operate at a baud rate of either 1200 bps or 2400 bps.

On some satellite channels, the uplink power level may be restricted to a maximum level of effective isotropic radiated power (EIRP). EIRP is the combination of transmitter power plus antenna gain minus any cable loss that might be present.

EIRP is generally expressed in dBWs. The LST-5C's output power can be adjusted in 2-watt steps so as not to exceed the maximum EIRP. The following procedure determines the maximum output from the LST-5C:

1. Determine maximum allowed EIRP, in dBW.
2. Subtract the gain of the satellite antenna used. Some of the more popular satellite antennas and their gains are listed here:

ANTENNA	GAIN
DM C120	6 dB
DM C125-1	5 dB
DM C121-1	10 dB
DM C122-2	12 dB

3. Add cable loss. (Ignore this if cable length is less than 12 feet.)
4. Convert the result (transmitter output power) from dBW to watts as follows:

dBW	WATTS	dBW	WATTS
13	20	7	5
12	16	6	4
11	12.5	5	3
10	10	4	2.5
9	8	3	2
8	6	2	1.5

For 25-kHz operation, do the following:

1. Attach the satellite antenna to the radio set.
2. Point the antenna towards the satellite.

WARNING

Antennas used for satellite communications concentrate the transmitter signals into beams of high-energy electromagnetic radiation. Do not stand in front of such antennas while they are transmitting. Serious damage to eyes and other human tissue can result.

3. Turn the radio set on by rotating the VOL control clockwise.
4. Using the Configuration display (Mode 2), select the operating modes (FM, XHI, and CT) per Table 2-4. The SCN and BCN modes must be set at OFF.
5. Using the Frequency/T-R display (Mode 1b), select the preset transmit and receive channels as shown in Table 2-5.
6. Adjust the SQ control to a position just sufficient to turn off the green light.
7. Connect a TSEC/KY-57 COMSEC device and the handset or data input device as shown in Figure 2-2.
8. Adjust power to the required level using Table 2-9.
9. The radio set is now ready for satellite-channel operation at 25 kHz. Operating instructions for the TSEC/KY-57 are found in *OPERATOR'S MANUAL, TM-11-5810-256-OP-1*.

For 5-kHz channel operation, do the following:

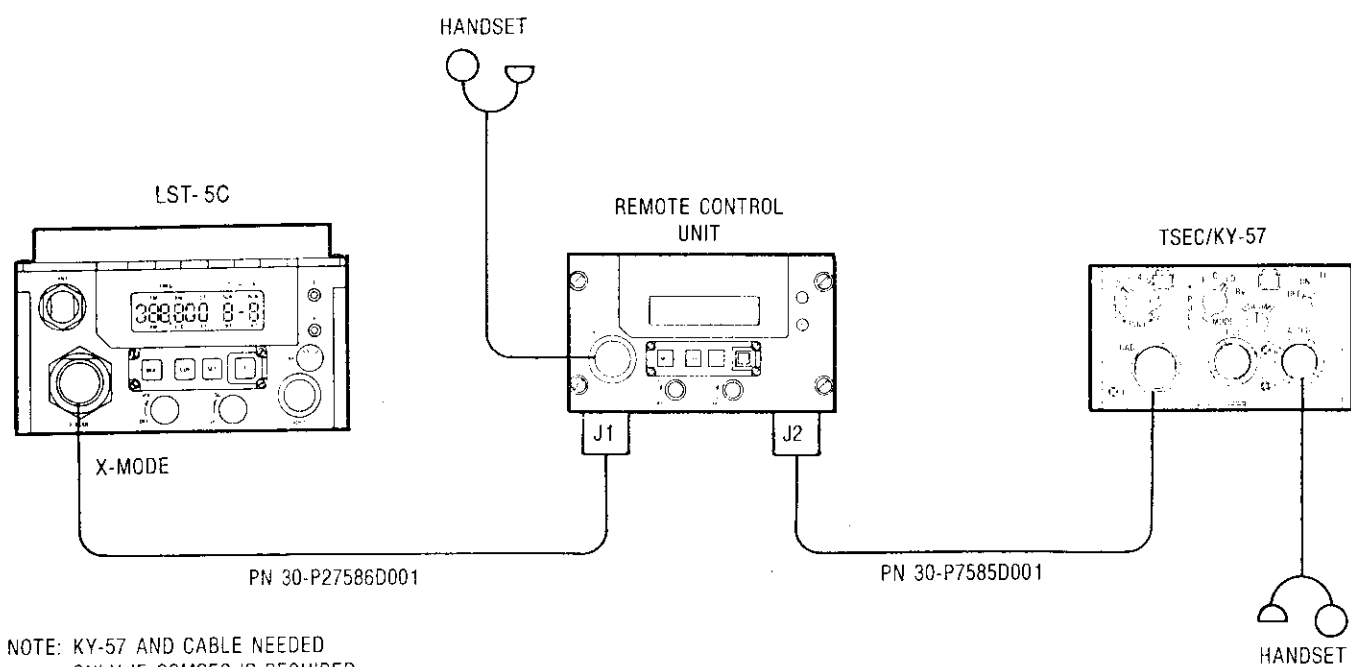
1. Attach the satellite antenna to the radio set.
2. Point the antenna toward the satellite.
3. Turn the radio set on by rotating the VOL control clockwise.
4. Using the Configuration display (Mode 2), select the operating modes (FM, XHI and CT). The SCN and BCN modes must be set at OFF.
5. Using the Frequency/T-R display (Mode 1b), select the preset transmit and receive channels as shown in Table 2-5.
6. Select baud rate and turn the modem ON per the steps shown in Table 2-7.
7. Attach input data device.
8. Using Table 2-8, adjust power not to exceed the EIRP level.
9. The radio set is now ready for satellite operation at 5 kHz.

2.3.3.5 Remote-Control Operation

Remote control of the radio set with units separated up to 100 feet may be accomplished by connecting the units as shown in Figure 2-3.

The remote-control unit's control functions, including the storage of preset data, are identical to control functions on the radio set's front panel.

1. For unencrypted voice operation, connect the handset to the remote-control unit's front panel, and follow the instructions for unencrypted LOS operation (paragraph 2.3.3.2).
2. For encrypted operation, follow the instructions for encrypted LOS operation (paragraph 2.3.3.3) or for satellite operation (paragraph 2.3.3.4).
3. For operation with the remote-control unit, the VOL and SQ controls on the radio must be set at OFF.



52585-21

Figure 2-3. Remote-Control Operation – Block Diagram

2.3.3.6 Retransmit Operation

The radio set can be used in a relay, retransmit mode with either plain text (PT) or cipher text (CT) in LOS communication or, when used in a satellite relay, in CT only with a TSEC/KY-57 or -58. Figure 2-4 shows a block diagram of PT retransmit operation. Figure 2-5 shows a block diagram of CT operation.

NOTE

In the retransmit mode, radio sets may need to be up to 50 feet apart, with operating frequencies at least 60 MHz apart. This prevents the transmitter of one radio set from blanking the receiver of the second radio set.

2.3.3.7 PT or CT LOS Relay Operation

The following procedure allows operation in PT or CT LOS relay.

1. Attach the UHF antenna and handset or data device to each radio.
2. Turn on Radio Set 1 by rotating the VOL control clockwise.
3. Using the Frequency/T-R display (Mode 1b), select the T and R channels assigned to Radio Set 1.
4. Using the Configuration display (Mode 2), select FM or AM, XHI or XLO, and PT or CT.
The SCN and BCN modes must be set at OFF.
5. Turn the SQ control clockwise until the green light goes out. This control must be set when no signal is present.
6. Repeat steps 1 through 5 using Radio Set 2, selecting the T and R preset channels assigned to Radio Set 2.
7. Connect the two radio sets as shown in Figure 2-4 or Figure 2-5.

The radio sets are now ready for PT or CT retransmit operations. In PT, the handset can monitor voice signals; however, the microphone is not connected. Therefore, the relay operator cannot enter the network in the retransmit mode. In CT, the relay operator cannot monitor the CT traffic.

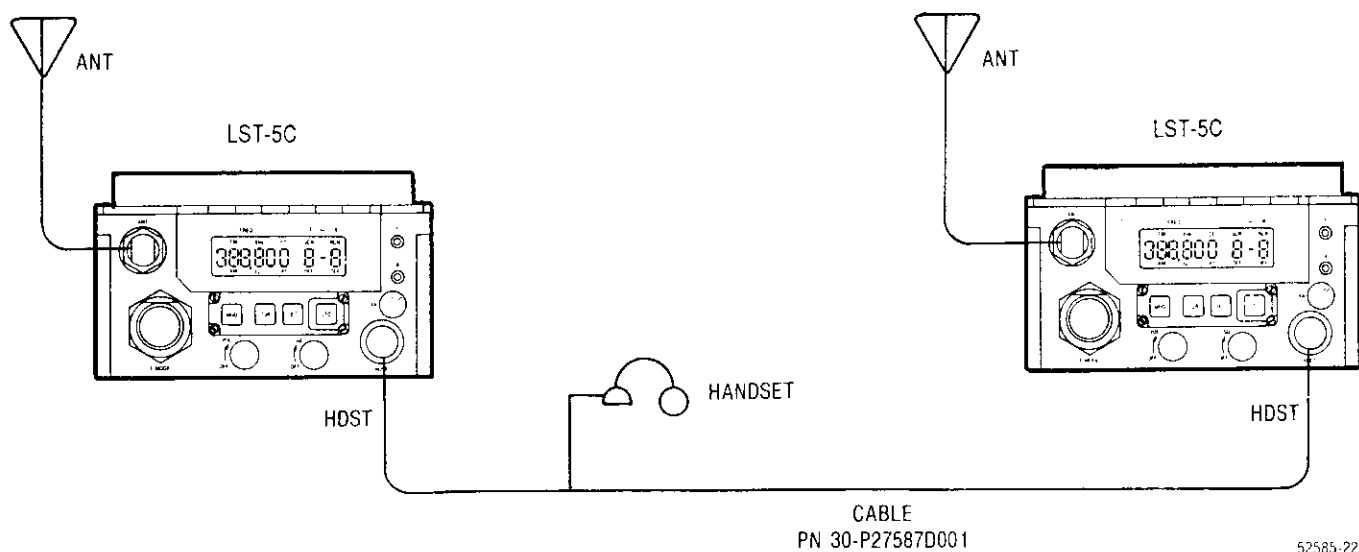


Figure 2-4. PT Retransmit Operation – Block Diagram

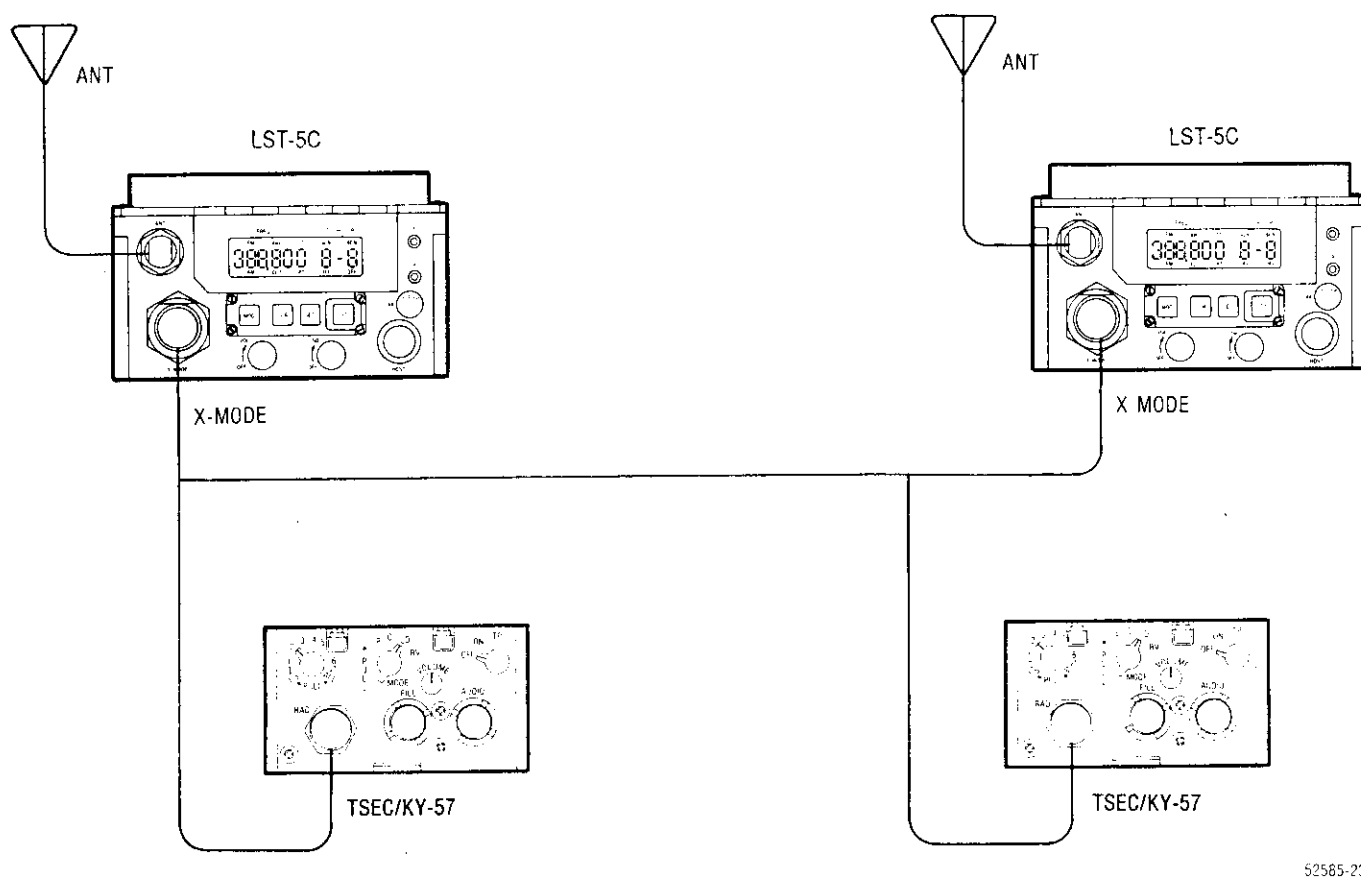


Figure 2-5. CT Retransmit Operation – Block Diagram

2.3.3.8 CT Satellite Relay Operation

Because the CT-detect circuits in the KY-57 or -58 are used for retransmit, satellite relay can only work in the CT mode. Do the following to set up and operate a satellite relay station:

1. Perform steps 1 through 6 of paragraph 2.3.3.7, using a satellite antenna.
2. Using the Configuration display (Mode 2), select CT.
3. Connect the two radio sets as shown in Figure 2-5.

The radio sets are now ready for satellite retransmit operation.

2.3.3.9 Scan Operation

The scan mode (SCN) may be operated in two ways:

- The radio set receives and transmits on any two of the nine preset channels. After two channels are selected, each channel is alternately monitored for half a second. When a signal is detected on one of the channels, the scan is stopped, and the radio receives and transmits on that channel. Channel scanning resumes eight seconds after the last signal reception or transmission. When the operator initiates a call in the scan mode, the radio will transmit on the channel selected under "T".
- The radio set will receive any two of the nine preset channels and transmit on one of the ten stored frequencies. After two receive channels and a transmit channel are selected, each receive channel is alternately monitored for half a second. When a signal is detected on one of the channels, the scan is stopped, and the radio set receives on that channel and transmits on the third channel. As with the first method, channel scanning resumes eight seconds after the last signal reception or transmission. The operator can initiate a call on the transmit channel; scanning will resume immediately after release of the handset key. The eight-second delay occurs when the scan is stopped by a received signal.

Operation in the scan mode requires that the receiver squelch be set so that the green light is off when no signal is being received. During the two-channel scan, the Frequency/Presets display (Mode 1a) reads "SCAN".


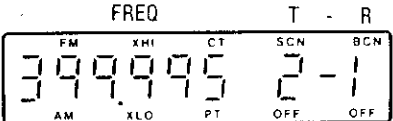
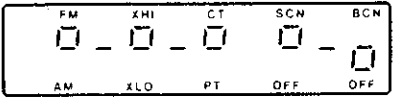


When a signal is received or the operator is transmitting, the display shows the operating frequency and the number of the preset channel. Three constraints apply to the scan mode:

- The BCN and SELCAL modes are disabled whenever the SCN mode is on.
- Changes to the Frequency/T-R display (Modes 1a and 1b) and to the Configuration display (Mode 2) (excluding controlling the SCN mode) cannot be made when the SCN mode is on.
- The Frequency/T-R display (Modes 1a and 1b) and the Configuration display (Mode 2) are the only display modes that can be viewed during SCN mode operation.

Select channels in the SCN mode as follows:

1. With the radio on, set the SQ control so that the green light is off. Be sure when you set the SQ control that a signal is not present in the receiver.
2. Follow the steps in Table 2-9.

Table 2-9. Selecting Scan Channel

Action	Control	Indication
1. Select SQ threshold: a. Select Frequency/Presets display (Mode 1a).	SQ Cont MOD key	Green light is off.  52585-101
b. Set cursor to PRESET position.	CUR key	Flashing channel area.
c. Select T-R display (Mode 1b).	SET key	 52585-102
d. Set cursor to "T" position.	CUR key	Flashing digit under T.
e. Select first SCN channel.	SET key	Set 1 to 9.
f. Set cursor to "R" position.	CUR key	Flashing digit under R.
g. Select second SCN channel.	SET key	Set 1 to 9.
2. Set SCN mode: a. Select Configuration display (Mode 2).	MOD key	 52585-103
b. Set cursor over SCN/OFF.	CUR key	Flashing SCN/OFF.
c. Select SCN mode on.	SET key	Box above reference line for SCN on.
d. Return to Frequency/Presets display (Mode 1a).	MOD key	 52585-104
The radio set will now receive and transmit on either channel when a signal is detected on either channel. To scan two channels in receive and to transmit on a third, do the following:		
3. Follow steps 1 and 2 above. a. Set cursor to PRESET position.	CUR key	Both digits will be flashing.  52585-105
b. Select transmit channel.	SET key	Set "--" or CH1 to CH9.
4. Set SCN mode: Follow step 2 above.		

2.3.3.10 Beacon Operation

When the beacon mode is active, a swept frequency tone from 200 Hz to 3800 Hz is modulated on the transmitter carrier. Four constraints apply to the BCN mode:

- The SCN mode cannot be used when the BCN is on.
- The SELCAL mode cannot be used when the BCN is on.
- Changes to the Frequency/T-R display (Modes 1a and 1b) and to the Configuration display (Mode 2) (excluding controlling the BCN mode) cannot be made when the BCN mode is on.
- The Frequency/T-R display (Modes 1a and 1b) and the Configuration display (Mode 2) are the only display modes that can be viewed during BCN mode operation.

The BCN mode is turned on as described in Table 2-4, step 6. The BCN mode may be shut off by turning the radio set off or by setting the BCN mode to OFF on the Configuration display (Mode 2).

2.3.3.11 SELCAL Operation

The SELCAL mode provides codes for 75 selective calls and one conference call. These codes address individual radios in a multiradio net.

Conditions for use of SELCAL are as follows:

- SELCAL can only be used with encrypted voice (CT).
- Transmission and reception of selective call codes can only occur when the SELCAL Mode 3 is displayed and activated — that is, the display must be set to something other than "00-00".
- When the SELCAL mode is active, the receive audio and receive CT data outputs are disabled until the proper call code is decoded.
- SCN and BCN modes cannot be used with the SELCAL mode.
- When a selective or conference call code has been received and properly decoded, the front panel display will flash on and off until the transmitter is activated.
- For SELCAL satellite operation, the SQ control must be off. A green receive light indicates the radio is unsquelched. The SQ control may be used for LOS operation.

Two SELCAL link set-ups are possible:

- Two-way
- Conference call

The SELCAL two-way link is established as follows:

1. The calling operator momentarily presses the PTT switch, transmitting the first handshake sequence.
2. The called radio(s) acknowledges the sequence with a flashing front panel display and automatically transmits its own handshake sequence (indicated by a red transmit light) to the calling radio.
3. The calling radio acknowledges the called radio's sequence with a flashing front panel display. This flashing continues until the calling operator pushes the PTT switch.

The setup of the two-way SELCAL link is now complete, and the operators are able to talk.

To establish a conference call, select "C" as the calling radio's SELCAL transmit code, as shown in Table 2-6. The calling radio can now call any radio that is in the active SELCAL mode.

To drop the SELCAL link, do one of the following:

1. Press the PTT switch (100 ms or less).
2. Press the STO key.
3. Turn the SQ control fully clockwise (15 sec).

To re-establish the SELCAL link, repeat the procedures for one of the two link set-ups.

2.3.3.12 Cancellation of Presets

The operator can quickly erase all preset conditions by holding the MOD key down while turning the radio set ON.

The following things will happen:

- The display goes to Mode 1.
- All stored frequencies go to 225.000 MHz.
- The PRESET digits go to "--".
- T-R channels go to "1-1".
- All configurations go to the low position.
- SELCAL goes to "00-00".
- The cursor goes off screen.

2.3.3.13 Front Panel Illumination

Front panel lamps light up the display at night. Turn on these lamps by simultaneously pressing the MOD and the CUR key. The lamps turn off 10 seconds after the last key stroke.

2.3.3.14 Radio Lockup

If the radio appears to be locked up:

- Power down and then power up.
- If the above doesn't clear the problem, perform 2.3.3.12.

SECTION 3. INSTALLATION

3.1 GENERAL INFORMATION

This section contains information necessary for preparing the LST-5C Radio Set for use. Included is information on packaging and on installation of the battery, handset and antenna. Also provided are computer interface information and interconnect cable diagrams for connection to the most commonly used peripheral equipment, such as remote-control units and COMSEC equipment.

3.2 ASSEMBLY AND PREPARATION FOR USE

3.2.1 UNPACKING THE RADIO SET

When packed for shipment, the components of the LST-5C Radio Set are placed in an inner carton. A moisture/vapor-proof barrier is placed around the inner carton. This package is then placed in an outer carton that is sealed with tape.

Unpack the radio set as follows:

1. Open the outer carton. Open the moisture/vapor-proof barrier that covers the inner carton.
2. Remove and open the inner carton.
3. Remove the fillers.
4. Remove all radio set components.

3.2.2 CHECKING UNPACKED EQUIPMENT

After unpacking it, check the equipment as follows:

1. Inspect the equipment for possible damage incurred during shipment. If the equipment has been damaged, notify your supervisor.
2. Check to see that the equipment is complete.

3.2.3 INSTALLING OR REPLACING THE BATTERY

The radio set system was designed to use lithium battery BA-5590, but a rechargeable Nicad battery BB-590 may also be used.

WARNING

Lithium organic batteries or cells are used in this equipment. They can be hazardous if misused or tampered with before, during, or after discharge. The following precautions must be strictly observed to prevent injury to personnel or damage to equipment:

- * DO NOT heat, incinerate, crush, puncture, disassemble or otherwise mutilate the batteries.
- * DO NOT shortcircuit, recharge or bypass internal fuse.
- * DO NOT store in equipment during periods of nonuse for more than 30 days.
- * TURN OFF the equipment immediately if you (1) detect that the battery compartment is becoming unduly hot, (2) hear battery cells venting (hissing), or (3) smell irritating sulphur dioxide gas. Remove the battery only after it is cool (after 30 to 60 minutes), and dispose of it by following approved procedures.

NOTE

Lithium Battery Pre-Conditioning

When using the BA-5590/U lithium battery, Motorola recommends that the user consult MIL-B-49430 (ER), "MIL-SPEC, Batteries, non-rechargeable, Lithium sulfur dioxide", and MIL-B-49430/3D (ER) "MIL-SPEC, Battery, non-rechargeable, Lithium, sulfur dioxide BA-5590/U." Particular attention should be paid to the paragraphs relating to voltage delay of the BA-5590/U.

If the lithium batteries are not properly pre-conditioned, the following conditions occur:

1. When the radio is keyed, the voltage sensing circuit in the battery pack will cause power shut-down.
2. The radio may be repeatedly turned on, but will continually have power shutdown when the radio is keyed.

Should these conditions occur, contact Motorola GEG for information or assistance.

To replace the battery in the battery case, follow these instructions.

1. Turn off the radio set by turning the VOL/OFF control to OFF. Unlatch the battery case from the transceiver.
2. Pull the battery case away from the transceiver, disconnect the battery connector, and slide the battery out of the battery case.
3. Slide the new battery into the battery case and connect the battery connector.
4. Insert the battery case into the rear skirt of the transceiver, fastening it into place with the two latches.

3.2.4 ATTACHING THE HANDSET

Attach the handset to the HDST connector.

3.2.5 ATTACHING THE ANTENNAS

For LOS operation, attach the UHF antenna to the ANT connector.

CAUTION

Several conditions should be observed when using the LOS antenna:

- 1) Do not transmit with cover removed from transceiver.*
- 2) Use only vendor-supplied power supply.*
- 3) Use only NSA approved shielded cables to X-mode connector.*

For satellite operation, attach the satellite antenna through the antenna cable to the ANT connector. Cable length should not exceed 20 feet, and the cable must be free of kinks or other damage.

WARNING

Electromagnetic radiation from the antenna can damage eyes and other body tissue when the unit is transmitting.

* While the unit is transmitting in AM XHI or FM XLO, do not hold the antenna closer than 4 inches to any part of the body.

* While the unit is transmitting in FM XHI, do not hold the antenna closer than 16 inches to any part of the body.

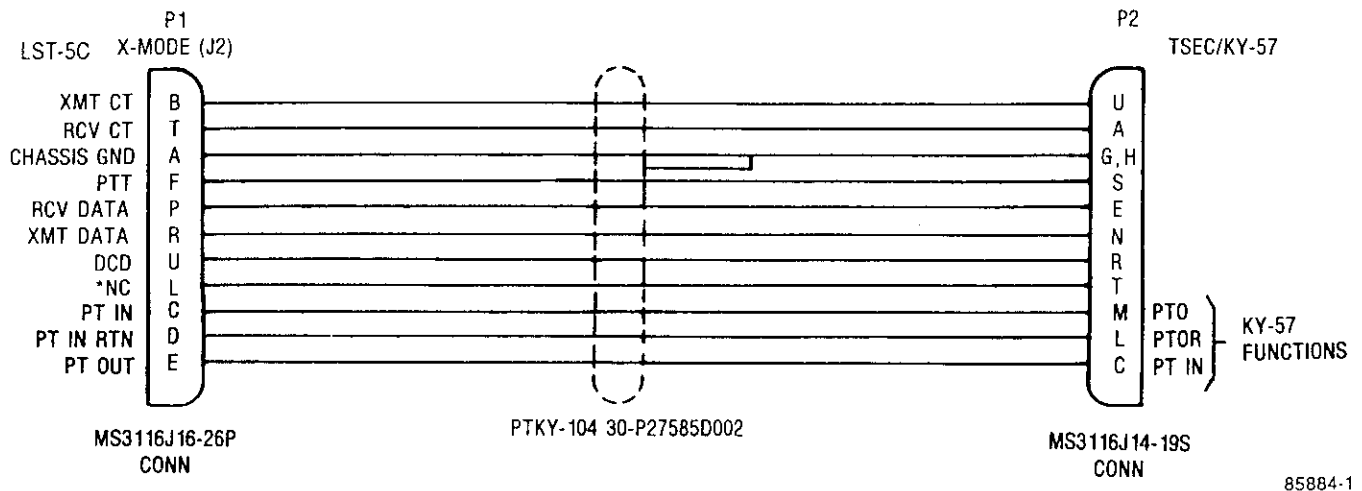
* When the unit is using a satellite antenna, DO NOT stand directly in front of the antenna.

3.3 COMPATIBLE COMMUNICATIONS SECURITY DEVICES

The LST-5C Radio is compatible with the AN/CSZ-1 (Sunburst Processor) as well as the following narrow and wideband COMSEC devices:

Narrowband	Wideband
TSEC/65 (Parkhill)	TSEC/57 (Vinson)
TSEC/75 (Parkhill)	TSEC/58 (Vinson)

Figures 3-1 through 3-6 show the interconnect cable diagrams for each device.



*NC WITH MODEM A10 SWITCH S1 SET TO INTERNAL CONTROL (FACTORY SETTING). FOR ADDITIONAL CONTROL OPTIONS, REFER TO FIGURE 3-11 AND PARAGRAPH 3-4.5.

Figure 3-1. LST-5C to TSEC/KY-57 – Interconnect Cable Diagram

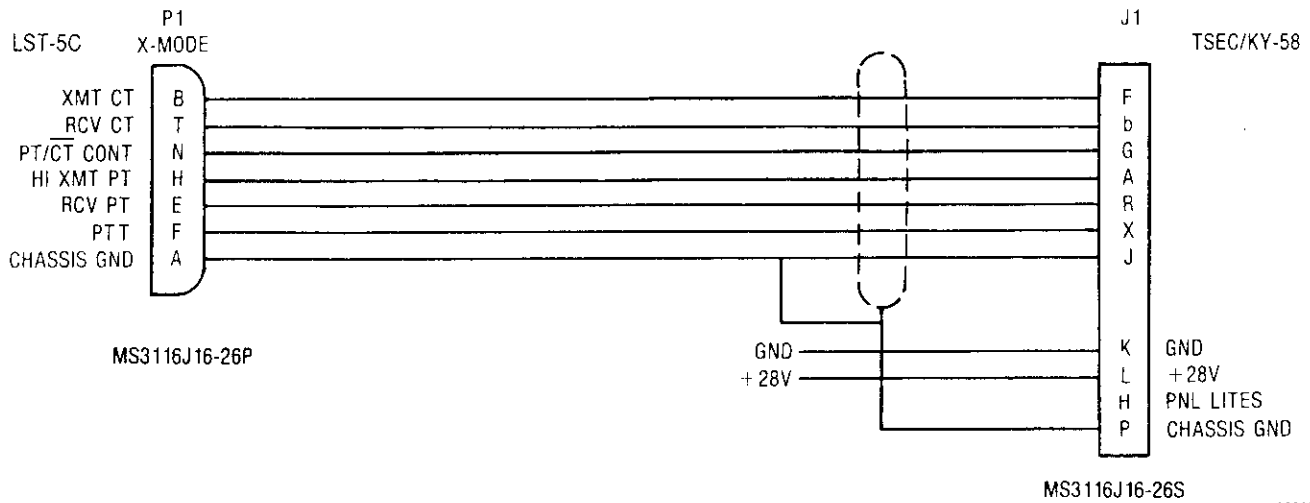


Figure 3-2. LST-5C to TSEC/KY-58 - Interconnect Cable Diagram

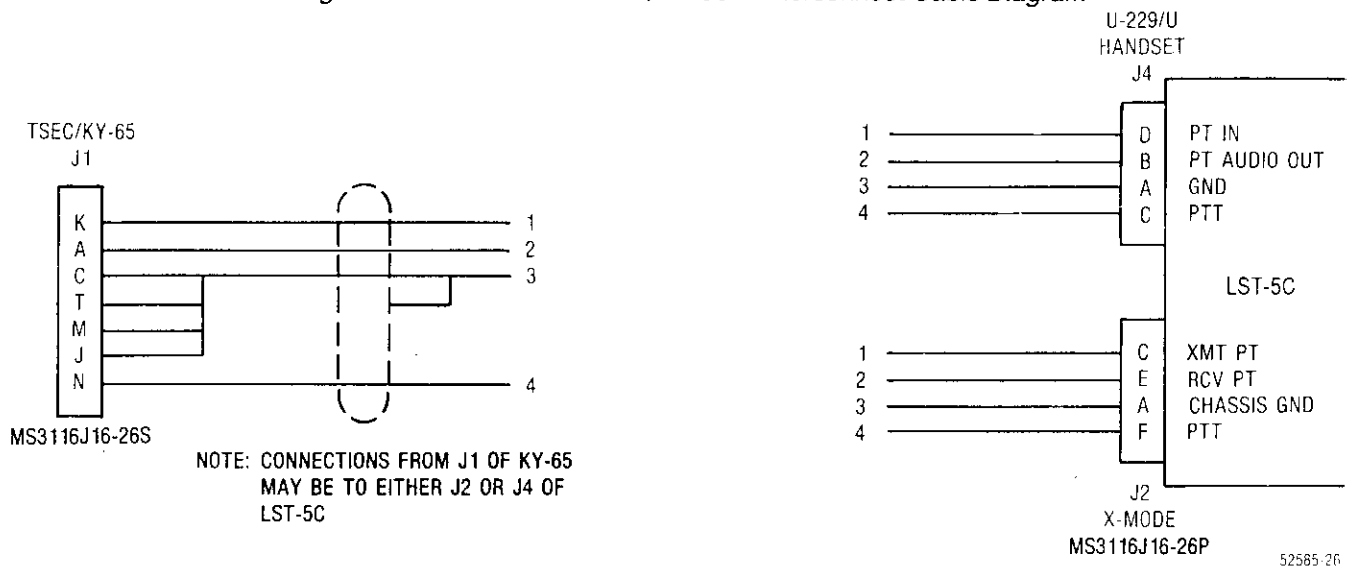


Figure 3-3. LST-5C to TSEC/KY-65 - Interconnect Cable Diagram

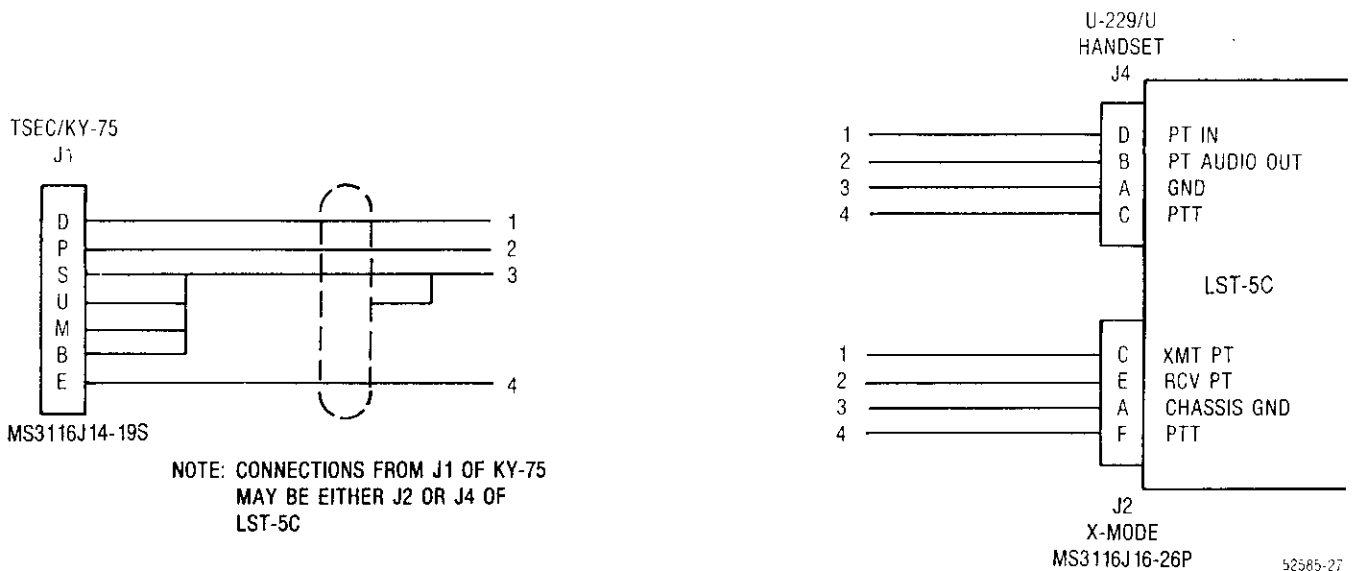
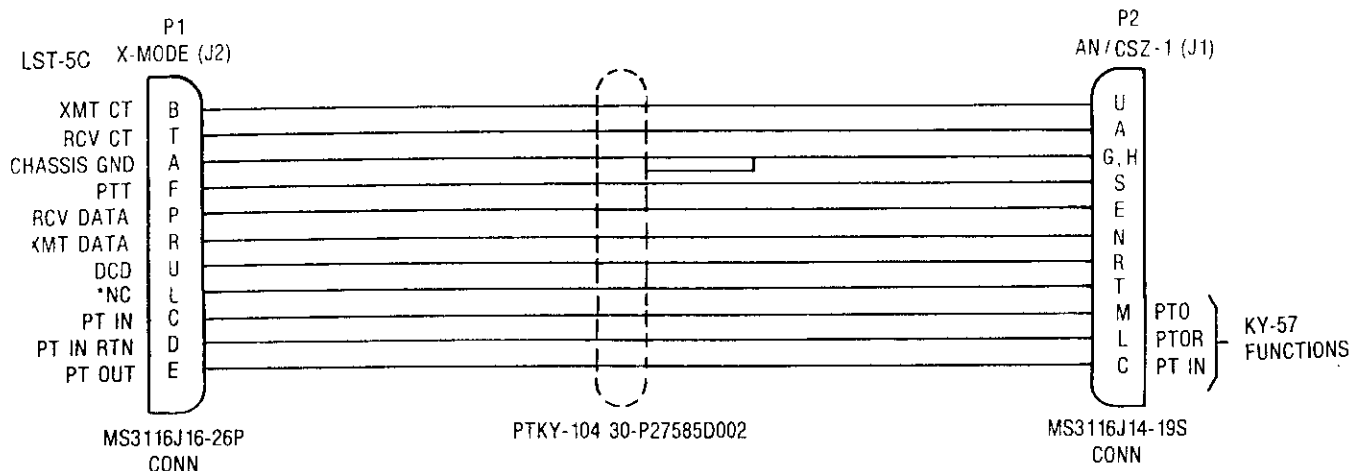


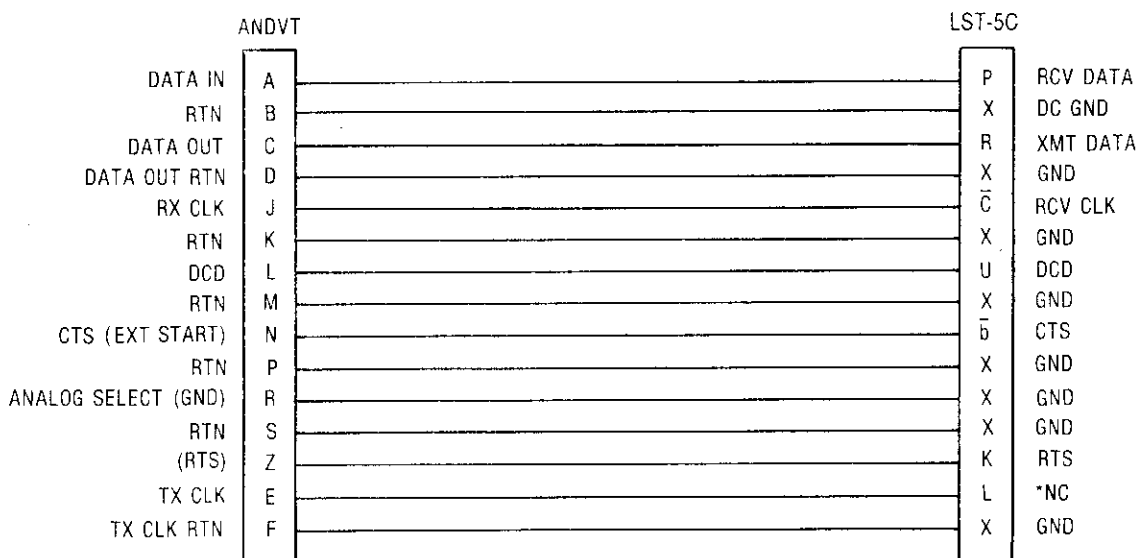
Figure 3-4. LST-5C to TSEC/KY-75 - Interconnect Cable Diagram



*NC WITH MODEM A10 SWITCH S1 SET TO INTERNAL CONTROL (FACTORY SETTING). FOR ADDITIONAL CONTROL OPTIONS, REFER TO FIGURE 3-11 AND PARAGRAPH 3-4.5.

85884-2

Figure 3-5. LST-5C to AN/CSZ-1 (Sunburst Processor) – Interconnect Cable Diagram



*NC WITH MODEM A10 SWITCH S1 SET TO INTERNAL CONTROL (FACTORY SETTING). FOR ADDITIONAL CONTROL OPTIONS, REFER TO FIGURE 3-11 AND PARAGRAPH 3-4.5.

85884-3

Figure 3-6. LST-5C to ANDVT – Interconnect Cable Diagram

3.4 REMOTE OPERATION

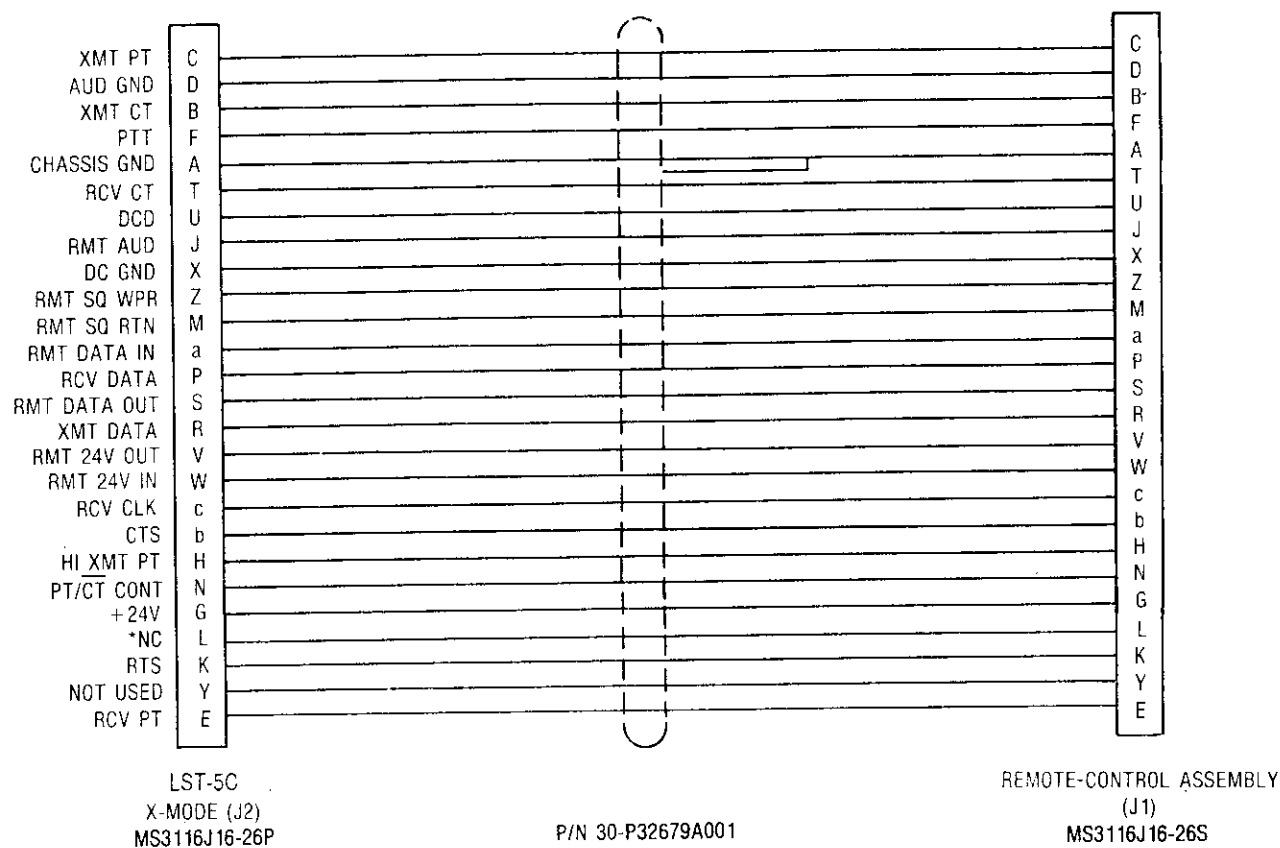
There are two methods of remote operation of the LST-5C via the X-mode connector. The first method uses the remote-control unit (RCU). The second method uses a computer to control the functions of the radio.

3.4.1 RCU CONTROL

The LST-5C Radio Set can be operated remotely to a distance of up to 100 feet, with a remote-control unit and the remote-control cable shown in Figure 3-7.

A block diagram of the remote-control hookup is shown in Figure 3-8.

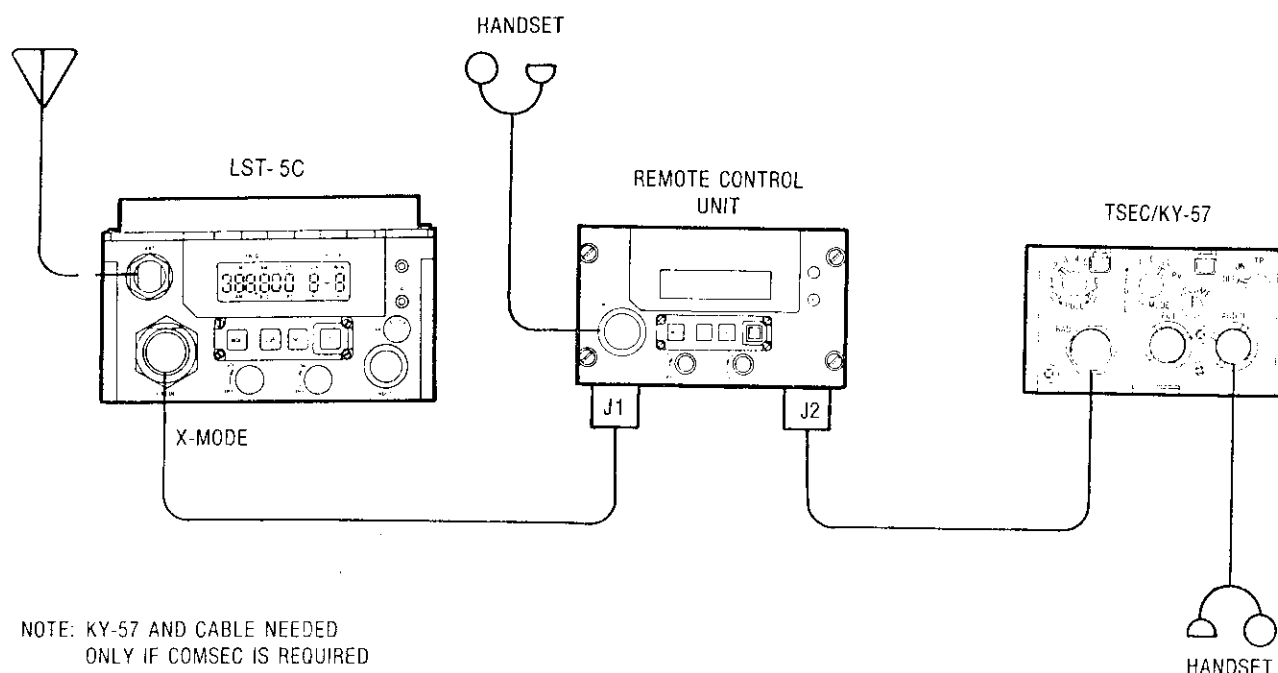
The RCU operates the radio the same way the radio's own front panel does. The RCU's front panel controls send serial ASCII data streams through the X-mode connector between the radio and the RCU. The radio reacts to the data stream as though its own front panel were in control.



85884-4

*NC WITH MODEM A10 SWITCH S1 SET TO INTERNAL CONTROL (FACTORY SETTING). FOR ADDITIONAL CONTROL OPTIONS, REFER TO FIGURE 3-11 AND PARAGRAPH 3-4.5.

Figure 3-7. Remote-Control Cable Diagram



52585-30

Figure 3-8. Remote-Control Operation – Block Diagram

3.4.2 COMPUTER CONTROL

Using a computer to control the radio requires the computer to communicate with the radio using the same serial commands that the RCU employs. The same protocol procedures (the ACK/NAK handshake) that the RCU employs are not necessary for computer operation. If the computer operator desires to use the handshake procedure, the Interrogation command (+1) must be sent to the radio. To terminate the handshake procedure, the command (+0) must be sent to the radio or the radio must be turned off and then turned on again. Following is interface information and a list of remote-control commands required for computer control.

3.4.2.1 X-Mode Connector

Three X-mode pins are used for remote radio operation:

PIN	DESCRIPTION
D	Ground
S	Remote Data Out (ASCII data from the radio)
a	Remote Data In (ASCII data to the radio)

3.4.2.2 Data Rates and Logic Levels

The data rate is 1200 bps \pm 5%. The data code is serial 8-bit ASCII including even parity, one start bit, and two stop bits. The logic levels for the three-wire serial interface are as follows:

PIN	DESCRIPTION	IMPEDANCE	LOGIC LEVEL
D	Ground		–0.3V to 0.8V
S	Remote Data Out	470 ohms	3.0V to 5.0V ("0") –6.0V to –5.5V ("1")
a	Remote Data In	7 kilohms	3.0V to 15V ("0") –15V to 0.8V ("1")

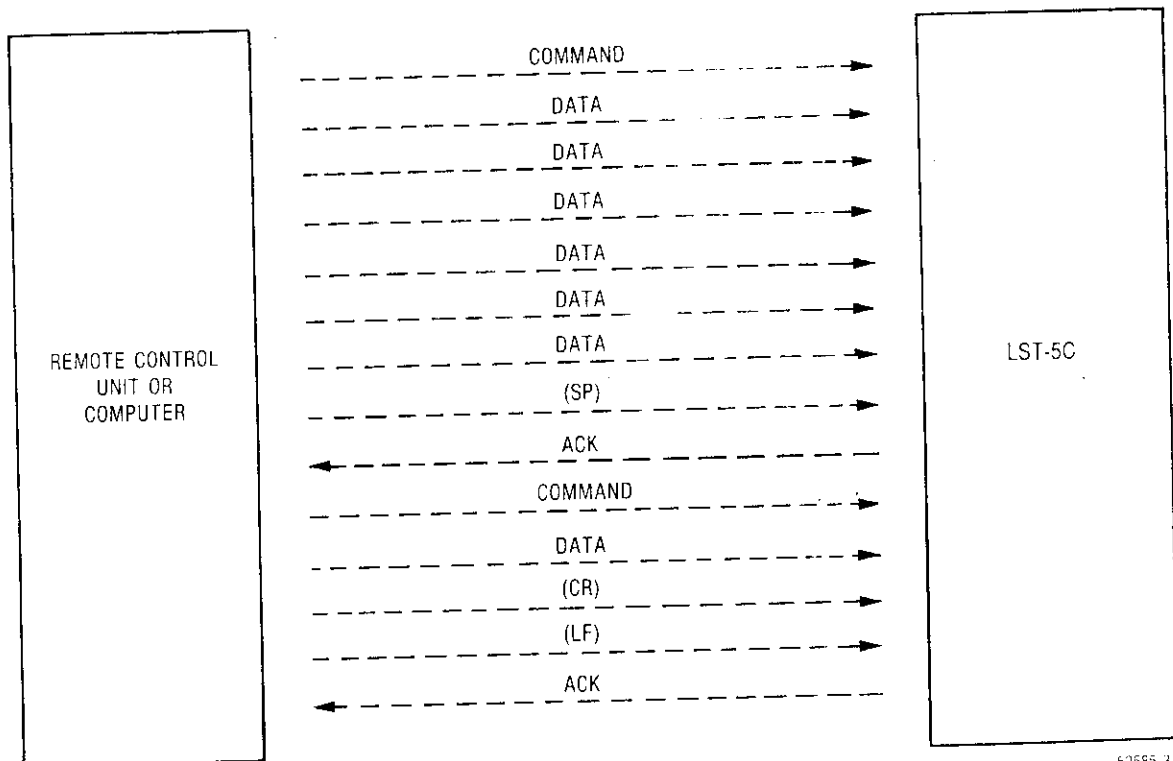
3.4.2.3 Data Exchange Protocol

Data is transmitted using an ASCII format. Characters are sent in strings that make up commands; each string has one command character, followed by from one to six data characters, and terminated by a carriage return and a line feed (<CR>/<LF>). A command string can also be terminated with a space if another command string is to follow it. The terminator must be sent immediately after the string to ensure valid memory at power-down, and the last string sent must be terminated with a <CR>/<LF>. Sending many strings in quick succession can be facilitated by allowing the space and using a keyboard to directly enter data. The available commands are summarized later in this section.

Each character includes one even parity bit. If, after checking all characters of the string, the program finds no parity errors, it returns an ASCII acknowledge (ACK), indicating a successful transmission. The terminal then queries the receiver to acknowledge (ACK or NAK).

Several situations, however, can cause an unsuccessful data exchange. The first is a parity error in any character of the received string; the second is a character rendered unrecognizable but whose parity still checks out good. In both these cases, an ASCII NAK is sent after the terminator is received, and the command string is sent again. The third case is the compromise of either the ACK or the NAK (i.e. there is a parity error or some other character is received). In this case, the sender assumes an error and resends the command string; because the commands are all absolute, this will cause no problem. Figure 3-9 shows a typical data transfer sequence: for example, the Time/Data Update or a Frequency Preset Update command, followed by one other command.

Some commands are sent only from the radio or only to the radio, but the protocol here remains the same in both directions. Again, if more than one command string is to be sent in succession, each command string must be followed by a <CR>/<LF> or a space and then acknowledged; the last string is then followed by a <CR>/<LF>.



52563-31

Figure 3-9. Typical Data Transfer

3.4.2.4 Timing Restrictions

Some commands to the radio may cause responses from the radio. Since the radio is not full-duplex, data coming into it will not be recognized while the radio is sending data out. Therefore, wait 300 msec before sending more data.

Following is a list of situations that apply to these restrictions:

- The radio has made a transmit-to-receive or receive-to-transmit transition.
- The radio is squelched or unsquelched.
- The radio has received a power-up string of commands from the RCU or computer. The RCU, at power-up, sends the radio all the information necessary to configure the radio exactly like the RCU. Under computer control, the radio will come up at power-on in the configuration it was in when last turned off. Therefore, if, under computer control, a certain radio configuration is required at power-up, the program must send a string of commands to initialize the radio to the desired state.

CAUTION

Do not transmit voice or data while remote commands are being sent or received.

3.4.2.5 Commands

The following set of alphanumerics represents a serial stream of data from the RCU or computer to the radio. This stream comes at power-up, after the RCU's interrogation has determined which radio command set to use and if protocol is necessary. (Interrogation is not necessary for computer control of the radio).

```
A00 B00 D0 M0 N1 O1 P0 S0 T0 X1 Y0 Z0 V0 U0 R0 J0 F0 H1 @1 T1
$000000 %1 #0 0225000 1225000 2225000 3225000 4225000 5225000
6225000 7225000 8225000 9225000 !0 *0 <CR> <LF>
```

This data stream completely configures the radio. Table 3-1 explains the radio remote commands.

Table 3-1. Remote-Control Command Codes

Code	Name	Description
Handshake Codes		
+ 1	Remote ID Interrogation (Not required under computer control.)	Initially sent out by the RCU to determine which LST-5 version is in use so the RCU knows which command set to use and if protocol is necessary.
	Radio ID Interrogation Response (Not required under computer control.)	Sent out by the radio in response to an interrogation from the RCU. "J" followed by an ASCII digit 2 identifies modified LST-5s. "J" followed by an ASCII digit 5 identifies LST-5A/Cs. LST-5s send no identifier.
General Operations Codes		
D	Display Mode	"D0" – Frequency mode (Mode 1). "D1" – Configuration mode (Mode 2). "D2" – SELCAL mode (Mode 3). "D3" – Meter mode (Mode 4). "D4" – Modem Control mode (Mode 5). "D5" – Power Out Adjust mode (Mode 6). "D6" – Clock mode (Mode 7).
K	Key Entry	Indicates one of the four front panel pushbuttons has been pressed. "K0" – MOD key. "K1" – CUR key. "K2" – SET key. "K3" – STOR key.

Table 3-1. Remote-Control Command Codes (Cont)

Code	Name	Description
General Operations Codes (Cont)		
F #	Transmit Mode (Usually an output from the radio.)	"^0" – radio in transmit. "^1" – radio in receive.
	Transmit Power-Out/Signal-Strength Indicator	"F1" – transmit power out is to be displayed. "F0" – received signal strength is to be displayed.
	Power Out Adjustment (# followed by 0 to 9)	"#0" – transmit power out in FM is determined by XHI/XLO selection in the Configuration mode. "#1" – transmit power out in FM is 2 watts. "#2" – transmit power out in FM is 4 watts. "#3" – transmit power out in FM is 6 watts. . . . "#9" – transmit power out in FM is 18 watts.
Configuration Codes		
M	Modulation Mode	"M1" – FM. "M0" – AM.
S	Scan ON/OFF	"S1" – scan ON. "S0" – scan OFF.
T	Text Mode	"T1" – cipher text (CT). "T0" – plain text (PT).
!	Transmit Power	"!1" – transmit high power. "!0" – transmit low power.
*	Beacon ON/OFF	"*1" – beacon on. "*0" – beacon off.
Channel-Select Codes		
N	Receive (Scan 0) Channel ("N" followed by an ASCII digit from 0 to 9)	Indicates the receive channel.
O	Transmit (Scan 1) Channel ("O" followed by an ASCII digit from 0 to 9)	Indicates the transmit channel.
P	Preset Channel Select ("P" followed by an ASCII digit from 0 to 9, or an ASCII ":", which stands for a hex "A")	Selects/indicates which preset channel is displayed. "P0" – "----". "P1" – CH1. . . . "P9" – CH9. "P:" – T-R.

Table 3-1. Remote-Control Command Codes (Cont)

Code	Name	Description
Frequency Control Codes		
& 0-9	Operating Frequency ("&" followed by six digits)	Changes the frequency settings. When the frequency is changed in the RCU (by using the SET key), this code is sent to the radio. When using a computer to control the radio, the operator can use either this code or the Operating Frequency/Channel codes to change the frequency.
	Operating Frequency/Channel (ASCII digit 0 to 9 followed by six digits)	<p>Selects/indicates preset channel and frequency. The frequency must be 225000 to 399995 in increments of 5. Although any number of presets can be changed at a time, the preset command(s) must be concluded with <LF>.</p> <p>0 – Frequency Preset Channel " - - -". 1 – Frequency Preset Channel 1. 2 – Frequency Preset Channel 2. 3 – Frequency Preset Channel 3. . . . 9 – Frequency Preset Channel 9.</p>
Indicator Codes		
C	Scan Channel Indicator (Output from the radio)	"C0" – The right channel was detected during the scan. "C1" – The left channel was detected during the scan.
L	Lock Indicator for the Synthesizer (Output from the radio)	"L0" – synthesizer unlock. "L1" – synthesizer lock.
Q	Squelch Active Indicator	"Q0" – squelch is off. "Q1" – squelch is on.
W	Scanning Wait Indicator (Output from the radio)	"W1" – waiting on a channel (not scanning, unsquelched). "W0" – scanning.
G	Bargraph Increments (Output from the radio – "G" followed by an ASCII digit from 0 to 9, ":", ";", "<", "=", or ">", representing hex digits from 0 to F respectively)	Indicates the number of bars to be displayed.

Table 3-1. Remote-Control Command Codes (Cont)

Code	Name	Description
Cursor Codes		
X	Frequency-Select Cursor Position ("X" followed by an ASCII digit 0, 1 or 6)	"X0" – cursor is off-screen. "X1" – cursor is over the far left LCD digit. "X6" – cursor is over the far right LCD digit.
Y	Configuration Cursor Position ("Y" followed by an ASCII digit 0, 1 or 5)	"Y0" – cursor is off-screen. "Y1" – cursor is over the far left LCD digit. "Y5" – cursor is over the far right LCD digit.
Z	SELCAL Cursor Position ("Z" followed by an ASCII digit from 0 to 2)	"Z0" – cursor is off-screen. "Z1" – cursor is over the transmit call code. "Z2" – cursor is over the receive call code.
V	Power-Out/Signal-Strength Cursor Position ("V" followed by ASCII digit 0 or 1)	"V0" – cursor is off-screen. "V1" – cursor is over the far right three LCD digits.
U	Modem Cursor Position ("U" followed by an ASCII digit from 0 to 2)	"U0" – cursor is off-screen. "U1" – cursor is over the bps LCD digits. "U2" – cursor is over the far right three LCD digits (ON/OFF).
R	Power-Out Adjust Cursor Position ("R" followed by ASCII digit 0 or 1)	"R0" – cursor is off-screen. "R1" – cursor is over the far right two LCD digits.
J	Time/Date Cursor Position ("J" followed by an ASCII digit 0 or 1)	"J0" – cursor is off-screen. "J1" – cursor is over the far left LCD digits.
Modem Control Codes		
H	Modem Bits-per-Second	"H1" – 1200-bps rate. "H0" – 2400-bps rate.
@	Modem OFF/ON	"@1" – modem off. "@0" – modem on.
SELCAL Codes		
A 1's '10's	Receive SELCAL Code ("A" followed by an ASCII)	Selects/indicates the receive code. N = 10's digit AN = 1's digit
B 1's '10's	Transmit SELCAL Code ("B" followed by an ASCII)	Selects/indicates the transmit code. N = 10's digit BN = 1's digit
E	SELCAL Indicator Active	"E1" – flashes the display. "E0" – turns the flashing off.

Table 3-1. Remote-Control Command Codes (Cont)

Code	Name	Description
Real-Time Clock Codes		
I	Time or Date Display Indicator	"I1" – the time display. "I0" – the date display.
\$	Time or Date Data ("\$" followed by a six-digit BCD number)	Represents the time in the form of HHMMSS. Represents the date in the form of YYMMDD.
%	Day-of-the-Week Indicator ("%" followed by a digit from 1 to 7)	"%1" – Sunday. "%2" – Monday. . . . "%7" – Saturday.

3.4.3 PT RETRANSMIT OPERATION

PT retransmit requires a retransmit cable as shown in Figure 3-10. This configuration will operate in LOS transmission only.

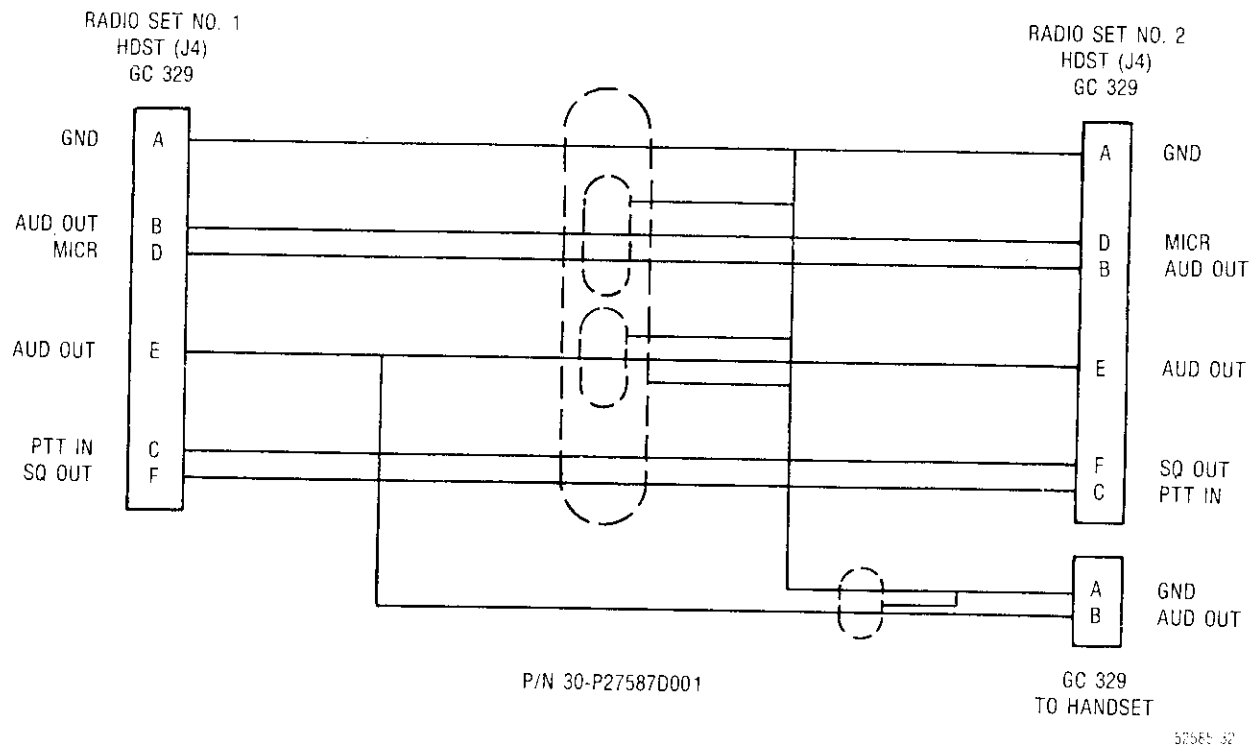


Figure 3-10. PT Retransmit Cable Diagram

3.4.4 CT RETRANSMIT OPERATION

For information contact: Len Keifer or Duane Moore at Motorola GEG (602) 441-3710, or (602) 441-4380.

3.4.5 MODEM OPERATION

A four-section rocker-type DIP switch, S1, located on the Modem assembly, A10, allows the operator to select several options. Figure 3-11 shows the factory set selections of S1. The down positions of the rocker switches are the shaded areas in Figure 3-11. The positions of the DIP switch (S1) for the selectable options are as follows:

- Internal differential control: S1-1 down position – right, S1-4 down position – left.
- Internal non-differential control: S1-1 down position – left, S1-4 down position – right.
- External differential control: S1-1 down position – left, S1-4 down position – right. Pin L of X-mode cable connection strapped to ground.
- External non-differential control: S1-down position – left, S1-4 down position – right. Pin L of X-mode cable connection not grounded.

NOTE

These instructions apply to radios with Modem assembly 01-P22955H003. For other radios, see appropriate operation manual.

*For external control of Diff/Non Diff, both S1-1 and S1-4 positions must be selected.

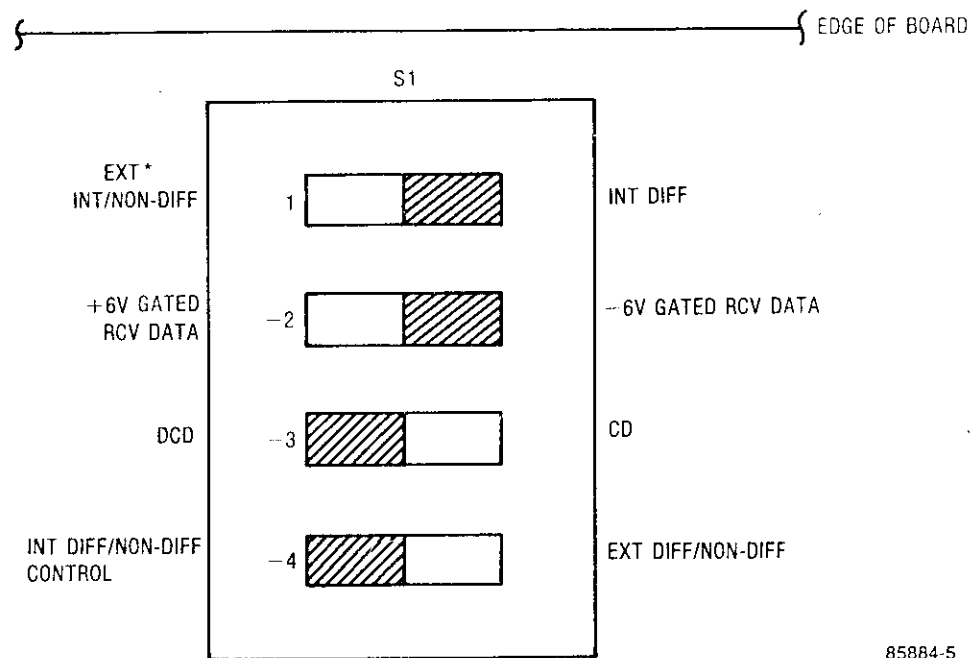


Figure 3-11. DIP switch

3.4.6 INTERFACE CHARACTERISTICS

Tables 3-2, 3-3, and 3-4 list the interface characteristics of the signals on the LST-5C power, HDST (handset), and X-MODE connectors, respectively. Connector reference designation and part number are given in each table title.

Table 3-2. Power Connector J1 (M24308/3-1) Signal Characteristics

Pin	Function
1	Power control: 21-30 Vdc input.
3	21-30 Vdc input.
5	Dc ground.
6	Power control: 21-30 Vdc input.
7	21-30 Vdc input.
9	Dc ground.

Table 3-3. HDST Connector J4 (GC-283F-1-050) Signal Characteristics

Pin	Function
A	Ground.
B	Plain-text audio output 1.6 Vrms nominal at maximum volume setting with a 50-ohm load.
C	Push-to-talk (PTT). Ground to transmit.
D	Microphone input. 1 mV nominal for full modulation into a 150-ohm load.
E	Plain-text audio output. Connected to pin B.
F	Receiver squelch. Outputs 0-5 Vdc with a 100K-ohm pull-up to 5 Vdc; 10K to Gnd.

Table 3-4. X-MODE Connector J2 (MS3114E16-26S) Signal Characteristics

Pin	Signal Label	Function	Impedance	Level
A	CHASSIS GND	Chassis Ground	—	—
B	XMT CT	Cipher Text Input	3.3K-ohms	12 ± 1 Vp-p
C	XMT PT	Plain Text Input	150 ohms	1 mVrms
D	AUD GND	Audio Ground	—	—
E	RCV PT	Plain Text Output	50 ohms	1.6 Vrms
F	PTT	Push To Talk Input		5 Vdc
		Receive	32K-ohms	5 Vdc
		Transmit	32K-ohms to +5 Vdc	Gnd
G	+24V OUT	+24 Vdc Output	Battery or power source	500 mA maximum drain
H	HI XMT PT	Hi-Level PT In	47K-ohms	0.3 Vrms
J	REM AUD	Remote Audio Out	1500 ohms	0.23 Vrms
K	RTS	Request To Send	50K-ohms	± 5.3 Vdc
L	EXT DIFF/NON DIFF OR NC	Ext Diff/Non Diff Control or NC	50K-ohms or Open	Gnd/ +5V or Open
M	RMT SQ RTN	Remote Squelch Return	—	—
N	PT/CT CONTROL	Plain Text/Cipher Text Control	150K-ohms	24 Vdc (PT); open (CT)
P	RCV DATA	Receive Data Out	30 ohms	± 5.3 Vdc
R	XMT DATA	Transmit Data In	50K-ohms	± 5.3 Vdc
S	RMT DATA OUT	Remote Data Out	470 ohms	Logic low: 3-5.2 Vdc Logic high: -5.5 to -6 Vdc

Table 3-4. X-MODE Connector J2 (MS3114E16-26S) Signal Characteristics (Cont)

Pin	Signal Label	Function	Impedance	Level
a	RMT DATA IN	Remote Data In	6.8K-ohms	Logic low: 3-15 Vdc Logic high: 0.3 to - 15 Vdc
b	CTS	Clear to Send	30 ohms	± 5.3 Vdc
c	RCV CLK	Receive Clock Output	30 ohms	± 5.3 Vdc
T	RCV CT	Cipher Text Output	20K-ohms	≥ 1.5 Vp-p
U	DCD	Data Carrier Detect	30 ohms	± 5.3 Vdc
V	RMT 24V OUT	Power Control Out	—	24 Vdc at 7 mA
W	RMT 24V IN	Power Control In	—	24 Vdc at 7 mA
X	DC GND	Dc Ground	—	—
Y	SYNC LK	Synthesizer Lock Signal	—	Locked: 3-5.2 Vdc Unlocked: 0 Vdc
Z	RMT SQ WPR	Remote Squelch Wiper	100K-ohms	0-6 Vdc, 1 mA max.

Notes: All I/O data lines are MIL-STD-188C-114 compatible, with unbalanced outputs. All MIL-STD-188C-114 inputs are also unbalanced, with protection circuits. Differentially encoded mode is selected internally. Data Carrier Detect line may be inverted internally. Clear To Send line may be inverted internally. Receive data in the differently encoded mode may be inverted internally. Positive transitions of the Receive Clock signal are lined up with the receive data transitions.

3.4.7. LST-5C DATA INTERFACE FOR NARROW BAND OPERATION

3.4.7.1. Description

The modem provides either 1200 bps biphase shift-keying (BPSK), or 2400 bps shaped-biphase shift-keying (SBPSK). The 1200 bps BPSK is used with data devices that transfer data at 1200 bps. The 2400 bps SBPSK mode is used with 2400 bps encrypted voice systems such as Sunburst Processor or ANDVT, or other data devices that transfer data at 2400 bps.

In either 1200/2400 bps the modem is capable of encoding and decoding the data differentially (DIFF/NON-DIFF). If the differential mode is selected, both the transmitting and receiving station must be set to the differential mode.

The DIFF mode of operation is selected to ensure that the received data is always in phase with the transmitted data. In the NON-DIFF mode, a 50% chance exists that the received data, presented to the data device, will be inverted (180° out of phase) from the transmitted data. This is due to the two possible lock states (0° and 180°) of the Costas loop, used to demodulate the carrier in the receive modem.

The only disadvantage with using the DIFF mode is the fact that approximately 0.5 dB of system sensitivity is lost, which, except for those systems with very marginal links, is insignificant.

Figure 3-12 shows an example of differential encoding and decoding. The principle used is that the encoder will cause a data transition (1 to 0 or 0 to 1) at the encoder output (2 and 3) if the input data bit was a "1" (1), and there will not be a transition if the input data bit was a "0". On the receive side, the decoder will look at two encoded bits to determine if there was a data transition, or not. If there was a transition then it is decoded as a "1", if not, it is decoded as a "0" (4). From this, it can be seen that the decoded data (4) is always in phase with the original data (1) regardless of the phase of the encoded data, or the phase of the Costas loop (2 and 3).

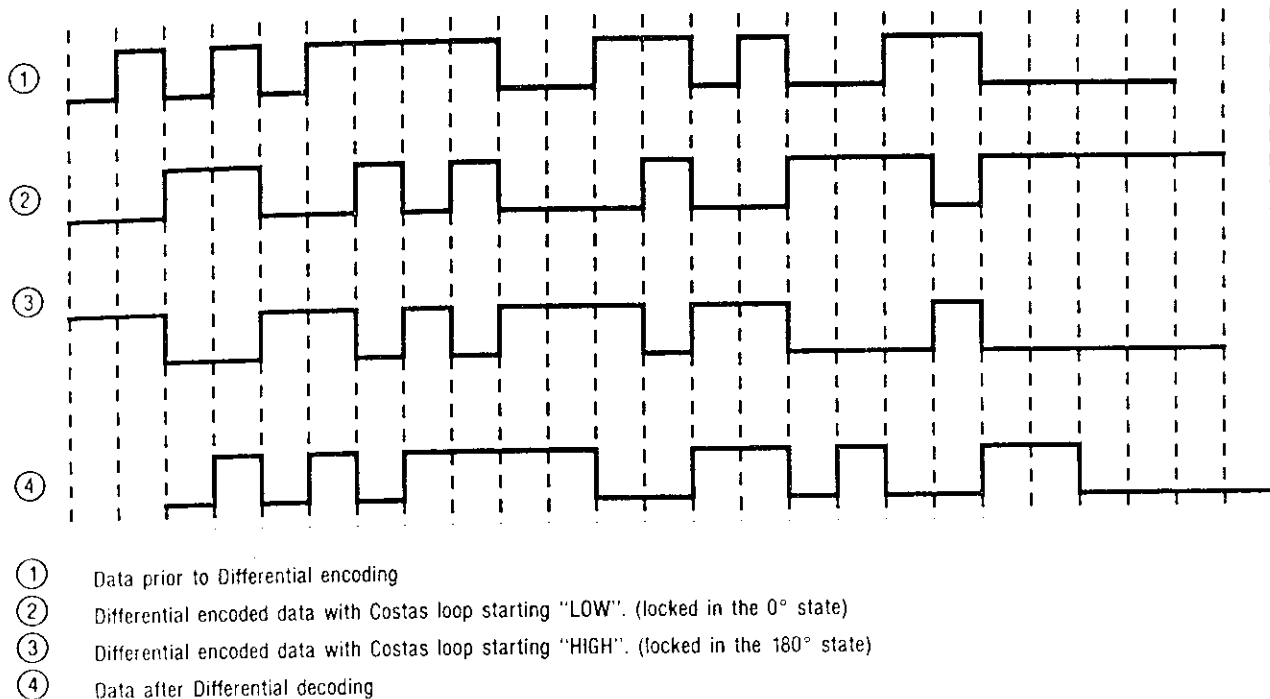


Figure 3-12. Differential Encoding/Decoding Diagrams

3.4.7.2. Timing

Figure 3-13 shows the timing diagram for the interface between the modem and the data device.

When the LST-5C receives an RTS (Request-To-Send) signal from the data device, it keys the transmitter and, after 300 ms, returns a CTS (Clear-To-Send)-signal to the data device. The first 170 ms is required to allow the LST-5C synthesizer to lock-up and the transmitter to come up to power. During the next 130 ms the UHF carrier is transmitted, which allows the Costas loop in the receive modem to lock to the transmitted carrier. The transmit data device must then provide an 80 to 100 ms preamble to allow the transmit and receive modem bitsyncs to lock. The preamble must be a pattern with transitions, such as a 10101 pattern. This is required to generate the data clocks. Once the bitsyncs are locked, intelligence data can be sent. If the data is interrupted, i.e. constant 1s or 0s for 16 bits or more, the bitsyncs loose lock and the preamble needs to be repeated.

If a compatible crypto device is used, the crypto device's preamble will lock the modem bitsync, and the chance of having constant 1s or 0s for 16 bits is nil.

The XMT signal from the transmitter and the RCV signal in Figure 3-13 are shown as binary data signals, but actually are phase modulated UHF rf signals. If the DIFF mode is selected, these modulating signals will be differentially encoded versions of the XMT data from the data device. The jitter shown at the start of those signals occurs because the transmit modem bitsync has not yet locked. The RCV signal is then used to lock the receive bitsync. Until the receive modem bitsync locks, the RCV Clock and the RCV DATA will also be unstable.

The DCD (data-on-carrier-detect) will go "HI" when it detects even unstable data on the carrier. This line is used to alert the receiving data device that data is coming.

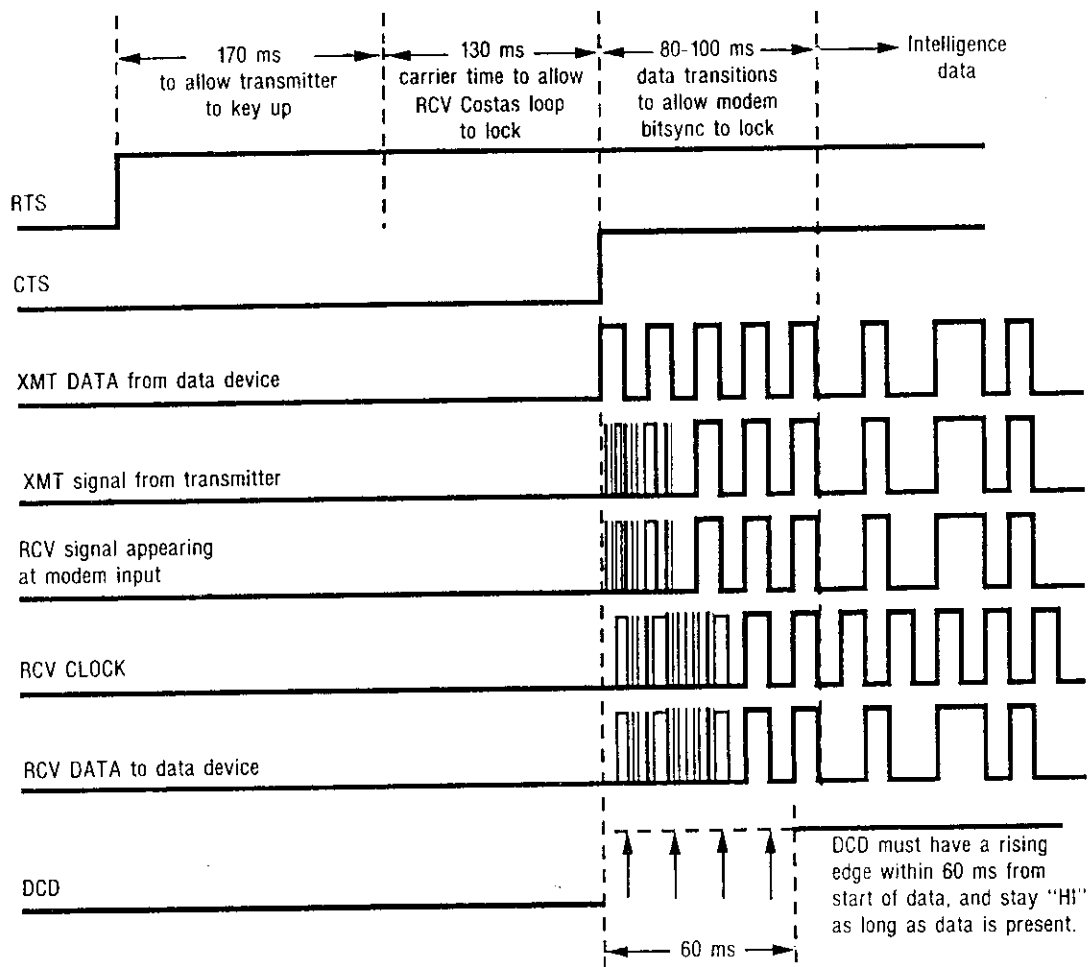


Figure 3-13. Interface Timing Diagrams

3.4.7.3 Diff/Non-Diff Selection

The selection between DIFF/NON-DIFF mode is done with a four section DIP switch located on the modem assembly. The radio cover, which contains the modem, must be removed to reach this switch. The -H003 modem allows the operator to set the switch selections so that external control of DIFF/NON-DIFF is possible. In that case, pin L of the X-mode connector must be grounded to select DIFF, and be open to select NON-DIFF. Information on selecting switch positions is found in paragraph 3.4.5. Interface characteristics of the X-mode connector, such as function, impedance and signal levels are found in Table 3-4.

3.4.7.4. Synchronous/Asynchronous

The LST-5C modem essentially operates in the asynchronous mode; that is, a transmit clock from the data device is not required to transfer data.