4430MN0031 RV B5

OPERATION AND MAINTENANCE MANUAL

FOR THE

ORE OFFSHORE

LXT TRACKING SYSTEM

(MODELS 4430B, 4213B & 4113B)

ORE Offshore, East Falmouth, MA 02536-4420 USA
Phone: 508 495 3200 Fax: 508 495 4500 www.ore.com

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SECTION 1

INTRODUCTION

1.0 INTRODUCTION

This manual provides the user with information on the installation, operation and maintenance of the ORE International LXT Tracking System. The Models covered are 4430A Command/Display Unit, 4213B Hydrophone and the 4113B Deck Cable.

This manual contains the following sections:

1.0 Introduction and Specifications
2.0 Installation
3.0 Theory of operation
4.0 Operation
5.0 Maintenance

In addition, the following appendices are included:

A. Parts List
B. Diagrams & Schematics

1.1 SYSTEM OVERVIEW (SEE FIGURE 1-1)

The LXT Tracking System consists of a Command/Display Unit (CDU), a deck cable and a hydrophone assembly.

The LXT Tracking System is a portable, easy to install and operate, ultrashort baseline (USBL) acoustic tracking system designed for tracking ROVs, towed vehicles and seabed beacons. It can also be used for a variety of other subsea applications including data acquisition via simple telemetry. It provides a reliable and repeatable means of establishing bearing (or depression angle if the target is below the hydrophone) and slant range to underwater targets. Up to two underwater transponders or a transponder and a responder can be tracked simultaneously. The system can be used as a stand-alone sub-sea positioning system or it can be integrated with a surface navigation system to provide absolute position.

Other equipment that is required but not part of the LXT System includes a sound source such as an ORE Offshore Model 4330B Multibeacon. A means of supporting the hydrophone over the side of the vessel is also required. See section two for installation details.

A typical Tracking System consists of the following components.

ITEM	PART NUMBER	DESCRIPTION	QTY
Shipboard:			
1.	4430AB0032	MODEL 4430B COMMAND/DISPLAY UNIT	1
2.	4213AB0013	MODEL 4213B HYDROPHONE ASSEMBLY	1
3.	4113AB0002	MODEL 4113B DECK CABLE	1
4.	4430MN0031	LXT SYSTEM MANUAL	1
Subsea:			
5.	4330B OMNI	MODEL 4330B MULTIBEACON, 1000M CODE 1,2,3,4 or 5	1
6.	4324-0007	MODEL 4324C BATTERY CHARGER & MANUAL	1
7.	4324-0010	CHARGERS PIGTAIL, 4330 SERIES	
8.	4330MN0003	MODEL 4330B MULTIBEACON MANUAL	1

1.2 COMMAND/DISPLAY UNIT (CDU)

The Model 4430A CDU is packaged in a portable, rugged, splash- resistant case (completely watertight when closed) and uses two easily read Liquid Crystal Displays that are ideal for open boat tracking operations. Both LCD's have variable contrast and a backlight for readability in almost any condition. One display is a boat shape with a compass rose around it marked in 10° increments. The two active responder symbols move around this, indicating a bearing to the targets. When the boat is over the top of a target, the symbol jumps to the center of the display. This positional display also indicates the confirmation, the interrogation and the subsequent replies from the transponders. The second LCD is a two line by twenty character (2 x 20) alphanumeric type that shows each active target symbol, the bearing to the target and the slant range. It is also used for setting of the system and target parameters.

System set up uses a five button keypad that allows the operator to toggle through and select basic operating parameters. This easy to understand menu provides the operator with selection of basic parameters for normal tracking operations. Setup/data output can also be accomplished when connected to a computer via the RS-232C serial communications port from a terminal emulation program.

The system can be powered from either an AC source, 90- 260VAC/47-440 Hz, or from a DC source, 20-60VDC.

Other optional capabilities/features include, responder tracking, data telemetry from a compatible telemetry transponder, analog compass interface to reference targets with respect to north and analog depth interface.

Front Panel Functions (see figure 1-2)

LINE POWER SWITCH

The main power on/off switch, located at the lower right corner of the panel, is labelled LINE. This switch turns the power on/off for both the AC or the DC power inputs.

KEYPAD

A five function key pad labelled <-, ->, SELECT, MENU/TRACK and HELP are used in conjunction with the alphanumeric display to modify the parameter settings for the system.

ALPHANUMERIC DISPLAY

The alphanumeric display, when in the tracking mode, displays the target number, slant range, bearing and warning code for each target. When in the menu mode it shows the various menus and their respective parameters. The display is a transflective type with an electrolum-inescent backlight for readability in most any light condition.

BEARING DISPLAY

The bearing display, located to the left of the alphanumeric display, is a compass rose with 36 segments per target. Target number one is a pentagon shape and target number two is a circle. Segments are activated to give a visual representation of each target's bearing. In the lower left corner of the bearing display is a segment to indicate when the interrogation signal occurs. In the upper left corner of the display are segments (pentagon and circle) that indicate when each target reply is received. Also in the upper right corner of the display is a battery low indicator, (BAT LOW).

AC LINE

The AC line input located in the upper left corner of the panel, labelled LINE, is a standard IEC connector/cable. This AC input will accept any line voltage from 90 to 260 VAC/47-440 Hz directly.

AC FUSE

The AC line fuse is located directly above the AC LINE input.

DC INPUT

The DC input connectors are located to the right of the LINE input connector. The connectors are standard banana jacks.

DC FUSE

The DC fuse is located directly above the DC input connectors.

HYDROPHONE CONNECTOR

The hydrophone connector located in the upper right corner of the panel interfaces the CDU with the Model 4213B hydrophone. Refer to section two for pin assignments.

I/O CONNECTOR (OPTIONAL)

The I/O connector located to the left of the hydrophone connector provides interface to ....

- Analog Compass input; to reference target to north.
- Analog depth input; to provide a depth output on the RS-232C port at the time of the data reception used for post processing.
- Interrogate key-out signal; a key pulse that is in sync with the interrogation signal.
- Serial Comm. Port, RS-232C; bi-directional serial port, provides interface to a computer for logging of data and setting of parameters. (Needed for collection of telemetry data and analog depth output.)
- External key in; for synching the LXT with an external key source.
- Power; provides minimal external power for auxiliary equipment, +5 @ 50 mA, ±12 @ 25 mA.
- Responder Trigger; provides an isolated key pulse for use with a responder sound source.

Refer to section two for pin assignments.

VOLUME

The volume control, located below the hydrophone connector, adjusts the audio level of the received signals. The speaker is located behind the grill pattern that is just to the left of the I/O connector.

PRESSURE RELIEF VALVE

The valve is located on the case just to the left of the carrying handle. It should be left open to compensate for differences in ambient pressure during transport. When operating it should be closed to maintain its splash resistant integrity.

1.3 HYDROPHONE

The hydrophone Model 4213B is housed in a PVC pressure case. The hydrophone contains multiple receiving elements and preamplifiers,as well as, an interrogation element. The multiple receiving elements measure the phase differences of incoming acoustic signals, which are used by the CDU to determine the azimuth and depression angle of the target.

NOTE: The hydrophone does not contain a vertical reference unit (VRU) to compensate for pitch and roll motion.

1.4 DECK CABLE

The Model 4113B deck cable connects the hydrophone to the CDU. Refer to section two for proper connection of the deck cable to the hydrophone.

1.5 ACCESSORIES

ACOUSTIC SOURCES

The ORE Multibeacon series transponders are recommended for LXT operation. The 4330 series Multibeacons are configurable for responder or transponder operation. The 4320 series Multibeacons are configurable for responder or transponder operation but can also be configured for telemetering of data with an optional telemetry module.

1.6 SPECIFICATIONS

PERFORMANCE SPECIFICATIONS:

Transponder or Responder
Bearing*

Relative Accuracy	5°
Repeatability Accuracy	0.5°
Resolution	
Numeric disp. & RS-232C	0.1°
Bearing LCD	10°

* Actual bearing accuracies will depend upon sound source characteristics, ambient noise, sea state, etc..)

Slant Range	
Accuracy	± 1 meter (with 1500 m/s sound velocity)
Resolution of SR counter	0.3 meters
Resolution	
Numeric disp. & RS-232C	0.1 meters

ELECTRICAL SPECIFICATIONS:

Receive Signal Specifications

Frequencies	See table 1-1.
Pulse duration	1.3 ms minimum
Ratio of signal to wideband noise	> 20 dB

Transmitter Output Specifications

Frequencies	See table 1-1.
Pulse Width	10 ms
Repetition Interval	2, 4, 6 or 8 seconds
Output Power	500 Watts into 300 õ
Sound Pressure Level	17 & 19 kHz, nominal 193 dB re 1 µPa @ 1 m. (horizontal plane)

Programmed Turn Around Time

Transponder	15 ms
Responder	1 ms

External Key Input(I/O option)	Optically coupled, requires positive TTL key pulse
Key Output (I/O option)	TTL, negative pulse
Responder Trigger Output (I/O option)	TTL, negative pulse (not isolated)
Liquid Crystal Displays (LCD)	Transflective with EL panel bklite

Serial Port (I/O option)

Type	RS-232C
Baud Rate	9600 bps
Start Bits	1
Data Bits	8
Stop Bits	1
Parity	None

Analog Inputs (depth & compass) (I/O option)

Minimum Voltage	0.0 VDC
Maximum Voltage	6.0 VDC
Adjustable in Increments of	0.1 VDC (via terminal or computer)

Telemetry (I/O option)

Reply Frequency	1 kHz below primary frequency
Zero delay	100 ms after primary reply
Full scale delay	1000 ms after primary reply
Output on RS-232C	XXX ms/900 ms (operator to scale for the sensor in use)
Accuracy	0.11% of full scale

Power Requirements

Line	90 to 260 V, 47-440 Hz, 40 W, ~1 A (does not require switching for 115 to 230 VAC ranges)
DC	20 to 60 VDC, ~ 40 W Operating on two 12V (24VDC) lead acid batteries (marine type) the unit will operate for approximately 8 hours.

C A U T I O N

Do NOT apply power to both the AC power input and the DC power input at the same time. Internal damage may result. Disconnect one before connecting the other.

ENVIRONMENTAL SPECIFICATIONS:

Command/Display Unit (CDU)	
Operating Temperature	-10° to +55°
Storage Temperature	-40° to +70°
Humidity	10% to 95% non-condensing
Hydrophone	
Operating Temperature	-4° to +40°
Storage Temperature	-40° to +70°
Humidity	Watertight to 100 ft WD (30m)
Vessel Speed	up to 6 knots (depending on hydrophone mounting arrangement)

PHYSICAL SPECIFICATIONS:

Command/Display Unit, Model 4430A

Height	7.5 inches (19 cm)
Width	18.5 inches (47 cm)
Length	14.5 inches (37 cm)
Weight	25 lbs (11.4 kg)

Watertight (when lid is closed) ABS case with pressure relief valve.

Hydrophone Assembly, Model 4213B

Length	17 inches (43 cm)

Diameter	2.9 inches (7.4 cm)
Weight	5 lbs. (2.3 kg) in air

Deck Cable, Model 4113B

Length	50 feet (15 m)
Diameter	cable: 0.5 inches (1.3 cm) subsea connector: 1.5 in. (3.8 cm) surface connector: 1.2 in. (3 cm)
Weight	7 lbs. (3.2 kg) in air

DEFAULT TARGET CHARACTERISTICS

The code numbers 1-5 are preset to the following frequencies for a medium frequency hydrophone. **If the hydrophone is not medium frequency - see addendum.**

TARGET CODE	INTERROGATE FREQ. (transponder only)	RECEIVE FREQ. (transponder or responder)
CODE 1	17 kHz	23 kHz
CODE 2	19 kHz	25 kHz
CODE 3	17 kHz	27 kHz
CODE 4	19 kHz	29 kHz
CODE 5	17 kHz	30 kHz

TABLE 1-1

NOTE: The values in table 1-1 are the default settings for codes 1-5. Other frequencies than those listed can be entered via the RS-232C serial port. Other parameters are also variable via the serial communications port including output pulse width and repetition interval. See section four for details on serial input parameters.

SECTION 2

INSTALLATION

2.0 INSTALLATION

This section includes instructions for implementing a hydrophone mounting assembly, making proper attachment of the deck cable and also the CDU panel interconnects.

2.1 HYDROPHONE INSTALLATION

The manner and location in which the hydrophone assembly is mounted on the vessel is the single most critical element in the overall performance of the tracking system. In choosing a mounting location the operator should keep in mind that the LXT System is by nature an extremely sensitive acoustic system. The hydrophone assembly must be in a position to "hear" the acoustic signals coming from the transponder or responder in use. Mount the hydrophone as far as possible from noise sources such as, propellers and operating thrusters, echo sounder transducers, main engines, generators and other acoustic systems.

Ideally, the hydrophone should be mounted far enough from the nearest reflector to allow the direct arrival of a signal from the acoustic source before a reflected signal arrives. The minimum recommended distance between the hydrophone and the nearest reflector is one meter*. It is also important to keep the hydrophone below the level of the vessel's keel for 360-degree coverage.

$$* \text{ 1 meter } = \frac{\text{1.33 milliseconds x 1500 meters/second}}{\text{2 way travel time}}$$

NOTE: In some applications even though the hydrophone is over one meter directly away from the hull, a signal can be reflected from an area along the keel and arrive within 1.3 ms of the direct arrival thus causing interference. In these instances the hydrophone should be lowered further away from the hull.

System performance can be degraded by "multipath," or underwater signal reflections and reverberation. To minimize the possible effects of multipath, choose a hydrophone location that is as far away as possible from any surface that would make a good reflector of an acoustic signal. Any hard plate or structure near the hydrophone has a potential to reflect signals into the hydrophone. The air-water interface is also an extremely efficient acoustic reflector. Avoid any locations that would place the hydrophone in the proximity of bubbles.

Consult the nearest ORE representative for additional information on a specific installation.

2.1.1 MOUNTING ASSEMBLY

The main function of the mounting assembly is to support the hy- drophone vertically in the water. Mount it a reasonable distance from the vessel's hull and below the level of the keel. The mounting should be rugged enough to withstand the expected forces during the planned operation, and easy to raise and lower. The type and size of the mounting recommended for the LXT System hydrophone will vary with the size of the surface vessel and the intended application.

Transiting to/from operating locations with the hydrophone deployed is not recommended.

In general, consider the following when designing the hydrophone mounting.

1. The mounting pipe should be long enough to position the hydrophone below the vessel keel when in the vertical position.

2. The pipe used should be stiff enough to prevent vibration or strumming when the vessel is underway.

3. Attach the pipe to the side of the vessel so that the pipe and hydrophone assembly can be easily removed and set on board, if required, to tie the vessel up alongside other vessels or at dockside.

4. The entire assembly should be easy to raise and lower with available manpower or winches.

5. Hydrophone heading (referenced by the index mark) should align with vessel heading. For maximum bearing accuracy a mechanical bearing adjustment must be fabricated into the mount as the LXT does not accept an entered offset from the front panel or serial communications port. The mount should be fabricated to allow the rotation of the hydrophone to correct for any bearing misalignment during installation (see section 2.1.3 Bearing Offset Adjustment). Some locking arrangement should be used to maintain the calibrated bearing.

6. Forward and aft guys are used to hold the mounting pipe in vertical position.

See Figure 2-1 for example of mounting arrangement.

2.1.2 ATTACHING HYDROPHONE TO MOUNT

The hydrophone centerline, or zero bearing, is indicated by the index mark (mark is just above the potted section of the hydrophone which is in alignment with the slot in the top of the case) and is generally aligned so that it corresponds to the vessel heading. Most operations requiring a portable tracking system will be on various vessels of opportunity, and require a quick and temporary mounting.

Fasten the hydrophone to an angle bracket (not supplied), (see appendix B, LXT Hydrophone Mount, 4213BM0010) aligning the slot in the top of the case with the alignment pin (bolt). Using screw clamps secure the hydrophone to the proposed angle bracket. Align the screw clamps with the grooved areas on the hydrophone case.

Feed the deck cable, Model 4113B, through the hydrophone extension pipe. Connect the deck cable to the hydrophone, refer to section 2.2.

Fasten the hydrophone and angle bracket to the extension pipe. Use screw eyes or other fasteners for fore and aft guy attachments.

Using the "V" of the angle bracket as a guide, align the hydrophone (mark is facing forward) with the vessel centerline as closely as possible. Lock in place.

Use some variation of the procedure in 2.1.3 to remove hydrophone bearing offset.

INSERT HYDROPHONE MOUNTING ARRANGEMENT FIGURE 2-1

INSERT 4213BE0012 LXT HYDROPHONE MOUNT FIGURE 2-2

2.1.3 BEARING OFFSET ADJUSTMENT

1. Measure the distance (d) from the vessel centerline to the hydrophone location as shown in Figure 2-3.

NOTE: Almost all vessels have a centerline weld or seam that runs fore and aft the deck that can be used for alignment purposes. If your vessel has a seamless deck, you will have to measure the vessel beam and determine the true centerline.

2. Weight a line to suspend the acoustic tracking source vertically in the water.

3. As far forward on the vessel as possible, hang the weighted acoustic beacon over the side at the same distance from the vessel centerline as the hydrophone. (position B1 in Figure 2-3.) It may be necessary to use a length of pipe or a boathook to extend the weighted line the required distance. The beacon should be slightly deeper than the hydrophone.

4. Turn the LXT system on and set it up to track the beacon in use. (Refer to section three) If you have aligned the mounting bracket correctly, the system will track the beacon at or very near the zero degree azimuth.

5. If you have designed a mount that can rotate while in the vertical position, you can rotate the hydrophone until you obtain the correct reading.

6. To check the bearing value determined in step 5, take the weighted beacon line to the stern of the vessel and again hang it straight down at the same distance from the vessel centerline as the hydrophone (position B2 in Figure 2-3).

   The transponder bearing should now be 180 degrees on the LXT display.

7. A further cross check can be performed by taking the weighted beacon to a position directly across the vessel from the hydrophone (position B3 in Figure 2-3). The target bearing display should now read either 090 or 270 degrees, depending on which side of the vessel the mounting is located.

2.2 DECK CABLE

Before connecting the deck cable to the hydrophone end cap, check that the hydrophone connector male pins are clean (and straight) and that the molded o-ring section of the connector has been cleaned and lubricated. Also clean the female pins within the deck cable underwater connector and clean and lubricate the neoprene rubber sealing section.

The underwater connectors can be cleaned with denatured alcohol using cotton swabs or tissues. A barium based o-ring lubricant* is supplied for this purpose and is recommended over silicone-based lubricants. Exercise care to avoid contamination of the hydrophone by any type of grease or oil.

C A U T I O N

DO NOT use silicone grease to lubricate the o-rings. Should silicone come in contact with the hydrophone potting, proper sound transfer from water to hydrophone will be prevented. Attempting to remove silicone from the hydrophone can damage the potting material.

Mating the deck cable to the hydrophone: Slide the strain relief back from the deck cable underwater connector. Line up the dot on the rubber molded end with the groove in the hydrophone plastic molded connector. Push the rubber molded connector over the hydrophone connector.

NOTE: The groove in the rubber molded connector fits into the raised plastic molded section of the hydrophone connector.

Grasp the rubber molded section with one hand and push towards the hydrophone releasing any air trapped within the connection. Slide strain relief back over rubber molded section and thread on to hydrophone connector. DO NOT over tighten strain relief.

Mating the deck cable to the Command/Display Unit requires aligning up the pin in the cable end with the bulkhead on the CDU and pushing until the connectors latch. Make sure the bulkhead connector on the CDU has its foam rubber sealing gasket installed at the bottom of its plastic insert.

* Parker o-ring lubricant.
Parker Seal
P.O. Box 11751
Lexington, KY 40512

Refer to caution below for disassembly of underwater cable connections.

C A U T I O N

Whenever underwater connectors are disassembled, or pressure cases opened, water is drawn into the cavity formed by the separating parts. This water, particularly salt water, enters as a fine spray and coats the electrical contacts and other parts inside. It is extremely important to minimize this buildup of moisture and salt, as it causes corrosion and voltage breakdown, particularly on power leads which have high voltages present (890 volts at transducer, for example). Therefore a thorough cleaning is required, preferably immediately after opening the parts. It is also helpful to rinse in fresh water and remove excess water from parts prior to opening.

NOTES FOR PROPER CARE OF UNDERWATER CABLES:

DO	Lubricate connectors before mating.
DO	Keep cables free from dirt and salt.
DO	Secure cables with tie wraps or tape so they won't work free.
DO	Route cables where they won't get pinched or crushed by deployment or moving machinery.
DO	Periodically clean cable contacts with a cleaner/degreaser. Lubricate with clean lubricant after cleaning.
DO	Check cables with a VOM & megger periodically for electrical integrity.
DON'T	Walk on cables.
DON'T	Bend cables near the connectors.
DON'T	Use damaged cables with bad or questionable contacts. They will damage their mating half.
DON'T	Hang things on cables.
DON'T	Use cables for towing or pulling.
DON'T	Bend the connectors when mating or disconnecting.
DON'T	Clean cables with light hydrocarbon solvents (i.e. acetone, lacquer thinner, paint thinner).

2.3 COMMAND/DISPLAY UNIT

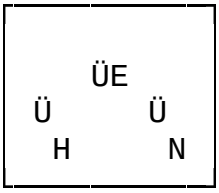
When the Model 4430A cover is closed and latched and the pressure relief valve is tightened the unit is watertight (zero pressure rating). It can withstand the effects of rain and salt spray. When the cover is open and the LINE, I/O and HYDROPHONE connectors are mated the unit is sealed but the mated connections are not. DO NOT expose the IEC line power connector, the I/O connector or the hydrophone connector to an environment that will allow an ingress of water to the connections. See caution below for applying power.

2.3.1 LINE VOLTAGE

The line connector is a standard IEC type cable strain relieved at the panel. The unit accepts from 90 to 260 VAC/47-440 Hz @1 Amp directly, (no switching required for 115/230 operation.)

The IEC end of the strain relieved LINE cable is wired as shown below. Typically the hot is the brown wire, the neutral is the blue wire and the earth is the green wire.

IEC end of LXT LINE cable



Male Pins

For AC line operation mate the IEC connector to a suitable power source.

2.3.2 DC VOLTAGE

The DC input jacks are standard banana jacks. The red terminal is for the positive lead and the black is for the negative lead. The unit accepts from 20 to 60 VDC @ 5 Amps. Listed below are various cable conductor sizes and their respective maximum lengths, which allow for a voltage drop of about 1 Volt.

CONDUCTOR SIZE	MAXIMUM LENGTH
#16 AWG	24 feet
#14 AWG	37 feet
#12 AWG	60 feet

For DC operation connect a DC source to the DC-in banana jacks or unscrew the red and black DC-in banana jack knobs and insert up to a #14 AWG wire into the hole in the connector base. Screw the knobs down tight onto wire.

C A U T I O N

Do NOT apply power to both the AC power input and the DC power input at the same time. Internal damage may result. Disconnect one before connecting the other.

2.3.3 I/O CONNECTOR (OPTIONAL)

The I/O connector provides an interface for various options within the LXT System. The 19-pin I/O connector contains wiring for the following options...

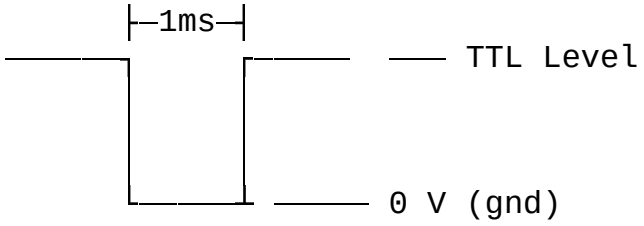
A. Serial Comm. port, RS-232C bi-directional (9600 baud, 1 stop, no parity)
B. Responder Trigger out (TTL negative pulse)
C. Normal Interrogation key out (TTL negative pulse)
D. External Key in (TTL positive pulse)
E. Analog Compass input (0.1 to 5.1 VDC = 0° to 360°)
F. Analog Depth input (0.0 to 6.0 VDC = % /FS per UOM)
G. Minimal power for driving external sensors.

2.3.3.1 SERIAL COMMUNICATIONS PORT

The RS-232C serial port is a bi-directional link for use with a terminal or computer. The LXT can output tracking information via this port and also receive data for control of most parameters. See section three for output format and parameter mnemonics.
The interface is designed to act as a "DCE" (Data Communications Equipment) device. It follows the XON/XOFF protocol. Data transmitted FROM the LXT (TXD) goes to pin 18 of the I/O connector. The data transmitted TO the LXT (RXD) goes to pin 17 of the I/O connector. Common is connected to pin 19.
Refer to Figure 2-5 for diagram of I/O connections.

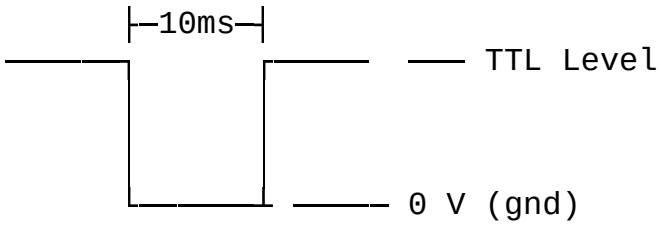
2.3.3.2 RESPONDER TRIGGER OUT

The responder trigger out is a 1 ms negative going TTL pulse. The driver is an open collector TTL gate with a 330 Ω pull up resistor. The responder trigger-out pulse is only available when a target has been selected as a responder. The trigger-out pulse is wired to pin 10 of the I/O connector and the common is on pin 1.
Refer to Figure 2-5 for diagram of I/O connections.



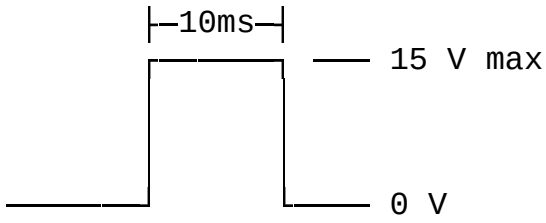
2.3.3.3 INTERROGATION KEY OUT

The interrogation key out occurs when a transponder is being interrogated via the LXT internal transmitter. This is used to sync up other external equipment to the interrogation sequence. The repetition interval must be compatible with the LXT system, e.g., 2 seconds minimum interval. The default output signal is a 10 ms negative going TTL pulse. The driver is an open collector TTL gate with a 330 õ pull up resistor. The key-out pulse is wired to pin 13 of the I/O connector and the common is on pin 1. Refer to Figure 2-5 for diagram of I/O connections.



2.3.3.4 EXTERNAL KEY IN

The external key in is an optically coupled input. This is used to sync the transponder or responder cycle with an external key source. The input requires a 1 to 10 ms positive going pulse at a level between 4 and 15 volts peak to peak. The positive key-in signal is wired to pin 5 of the I/O connector and the common is wired to pin 6. Refer to Figure 2-5 for diagram of I/O connections.



2.3.3.5 ANALOG COMPASS IN

The analog compass input is used to reference the targets to north instead of the bow of the vessel. The analog input requires a 0.1 to 5.1 VDC signal, representing 0° and 359.9° respectively.

NOTE: This range can be changed via the optional communications interface. See section 4.0 for more details.

The compass analog signal input is wired to pin 11 of the I/O connector and its common is wired to pin 9. Refer to Figure 2-5 for diagram of I/O connections.

2.3.3.6 ANALOG DEPTH IN

The analog depth input is provided to allow the operator to correlate the position of the target with its depth for post processing. The depth data is sent out the communications port after receipt of a valid reply from target #1.

NOTE: The LXT does NOT use this depth information for any internal calculations.

The operator inputs the full scale of the analog depth sensor and its minimum and maximum voltage via the serial communications port. The LXT outputs a depth proportional to the differential voltage setting (max volt - min volt) and the full scale of the sensor. The LXT defaults to a minimum (zero) voltage of 0.0 VDC and a maximum (full scale) voltage of 6.0 VDC. There is no conversion, for example from feet to meters or other units of measure, within the LXT. The depth output on the RS-232C is in the units that the full scale was entered in.

Example: Minimum voltage = 1.5 VDC
Maximum voltage = 5.5 VDC
Full Depth Span = 500 meters
Analog voltage in = 3.5 VDC

$$\text{Output on comm port} = \frac{(5.5 - 1.5)}{500\ \text{m}} = \frac{3.5\ \text{V}}{X}$$

$X = 437.5$ m

The depth analog signal input is wired to pin 12 of the I/O connector and its common is wired to pin 9. Refer to Figure 2-5 for diagram of I/O connections.

SECTION 3

PRINCIPLES OF OPERATION

3.0 PRINCIPLES OF OPERATION

The LXT measures and analyzes sound pressure waves from an acoustic sound source, transponder or responder. The signal is received by a hydrophone to determine target position relative to the tracking ship. The hydrophone converts the received acoustic signals into electrical signals and sends them to the LXT microprocessors.

The LXT system uses an ultra-short baseline, phased-array hydrophone containing sound transducing elements arranged at the vertices of an equilateral triangle. Each element is spaced less than half a wavelength away from each of the other elements in the array. When a sound wave impinges upon the array it strikes one element first, then one of its neighbors, and finally the remaining element. The sound wave, as sensed by any element in the array, will appear out of phase with the wave as sensed by the other elements in the array. The phase differences between the elements in the array provide the information required to calculate a three-dimensional vector from the array to the sound source.

A transponder emits a sound pulse in response to a specific acoustic interrogation pulse from the LXT transmitter. A responder is triggered via a wire connecting the responder and the CDU. The system uses this timing information to calculate directly the slant range of the target, assuming the average velocity of sound in the water column and the turnaround time of the transponder or responder are known.

The relative bearing (α) and depression angle (ß) of the target being tracked are determined by measuring the phase differences of the sound waves for each hydrophone element. The bearing (or azimuth) of the target is measured in degrees relative to the hydrophone heading (see Figure 3-1). The depression angle is formed by the intersection of a horizontal plane and a line drawn from the hydrophone to the target. When a target is at a depression angle of 62° or greater the bearing measurement displayed on the CDU LCD changes to the measured depression angle.

NOTE 1: To eliminate the jumps between calculating the bearing and calculating the depression angle at the 62-degree depression angle, hysteresis is incorporated into the software within the LXT.

NOTE 2: The slant range is the straight line distance from the hydrophone to the target. The travel time of the sound wave between the sound source and the hydrophone is used to calculate the slant range directly. The horizontal range is the projection of the slant range on a horizontal plane and is NOT calculated within the LXT.

The slant range (SR) is calculated from the known velocity of sound in the water column (V), the transponder or responder turnaround time or delay (D) and the measured time (T) between transmitted pulse and received reply by:

$$SR = V \times \frac{(T-D)}{2}$$ in transponder mode, and:

$SR = V \times (T-D)$ in responder mode.

NOTE: The velocity of sound value used within the calculations of the LXT is 1500 meters/second.

Horizontal range (HR) can be calculated by one of two methods, depending on the calculated value of the depression angle (ß) from the horizontal.

When the target is within a 56 degree cone (value of (ß) greater than 62 degrees), horizontal range (HR) can be calculated by:

$$HR = SR \cos ß$$

When outside the 56 degree cone (values of (ß) less than 62 degrees), as the target moves to positions which are between the hydrophone horizon and a 62 degree depression angle, the measured depression angle accuracy degrades due to physical constraints of the measuring hydrophone. (As the target approaches the horizon, the angle becomes unmeasurable.) In this situation, the target depth (measured, analog or telemetry) and the measured slant range can be used to calculate horizontal range by:

$$HR = SR - Z$$

or...

$$HR = SR \cos \left(\sin^{-1} \frac{Z}{SR}\right)$$

Where "Z" = target depth - hydrophone depth

By using the bearing (α) and horizontal range (HR) calculations above, an X and Y value can be computed by:

$$X = HR * \sin \tau$$

If $\alpha >= 0°$ and $< 90°$ then $\tau = \alpha$
If $\alpha >= 90°$ and $< 180°$ then $\tau = 180° - \alpha$
If $\alpha >= 180°$ and $< 270°$ then $\tau = -1 \times (\alpha - 180°)$
If $\alpha >= 270°$ then $\tau = -1 \times (360° - \alpha)$

$$Y = ´ HR¨ - X¨$$

If $\alpha >= 90°$ and $< 270°$ then $Y = -1 \times Y$

The system microprocessors, located in the CDU (Command Display Unit), receive information from the hydrophone array for each received pulse. They convert that information into a real-time bearing and slant range relative to the hydrophone, shown in the bearing display and the numeric display.

The distance X is the projection of the horizontal range on a vertical plane perpendicular to the centerline of the vessel and passing through the hydrophone. The distance Y is the projection of the horizontal range on a vertical plane parallel to the centerline of the ship and passing through the target. X, Y and HR form a right triangle. Depth (Z) is the depth of the target below the hydrophone.

Under ideal conditions the transducing element plane is parallel to the surface of the water and perpendicular to a vertical plane through the vessel centerline. In a real application the vessel and hydrophone will be in motion due to the effects of pitch and roll, and the system will therefore have inaccuracies due to this motion. See Table 3-1.

Figure 3-2, the System Block Diagram, presents an overview of the LXT system. The individual components of the system function as described in the following sections.

3.1 HYDROPHONE ASSEMBLY (MODEL 4213)

The hydrophone assembly (Figure 3-3) consists of the hydrophone, pressure case and preamplifiers. In the hydrophone, the three receiving elements and the transmitting element, are potted and attached to the PVC base, and connected to the pressure case. In the pressure case/electronics package, each of the three elements feeds a 24 dB amplifier stage. Regulated power for the amplifiers and drivers is sent down the deck cable from the Filter/Limiter Board located in the CDU. The inductor that tunes the interrogation ceramic in the 17 to 20 kHz band is also located within the hydrophone assembly pressure case.

3.2 FILTER LIMITER BOARD

The preamplifiers within the hydrophone assembly are connected to the CDU Filter/Limiter Board via the deck cable. This board contains three separate amplifiers, wideband filters and signal drivers for each of the three elements within the hydrophone assembly. The clipped output signals from the Filter/Limiter Board are sent to the Signal Processor Board via the Interface Board.

INSERT WIRING BLOCK DIAGRAM FIGURE 3-2

NOTE: The rotation of the vessel about its X-axis, a line drawn perpendicular to the vessel centerline at its midpoint, is known as pitch. Roll is the rotation of the vessel about the vessel centerline, or Y-axis. In table 3-1 a positive pitch indicates a bow up motion while a positive roll indicates a vessel motion towards starboard.

TABLE 3-1

BEAR-ING	DEP. ANGLE	ROLL	PITCH	ACTUAL BEARNG	ACTUAL DP ANG	diff BEARNG	diff DEP ANGLE
0°	15°	10°	0°	357.3°	14.8°	2.7°	0.2°
0°	15°	0°	10°	0.0°	5.0°	0.0°	10.0°
0°	15°	10°	10°	357.4°	4.8°	2.6°	10.2°
0°	62°	10°	0°	341.9°	60.4°	18.1°	1.6°
0°	62°	0°	10°	0.0°	52.0°	0.0°	10.0°
0°	62°	10°	10°	346.0°	50.8°	14.0°	11.2°
0°	85°	10°	0°	296.7°	78.8°	63.3°	6.2°
0°	85°	0°	10°	0.0°	75.0°	0.0°	10.0°
0°	85°	10°	10°	326.0°	72.0°	34.0°	13.0°
0°	15°	20°	0°	354.8°	14.1°	5.2°	5.9°
0°	15°	0°	20°	0.0°	5.0°	0.0°	10.0°
0°	15°	20°	20°	354.9°	5.8°	5.1°	9.2°
0°	62°	20°	0°	327.2°	56.1°	32.8°	5.9°
0°	62°	0°	20°	0.0°	42.0°	0.0°	20.0°
0°	62°	20°	20°	337.4°	38.3°	22.6°	23.7°
0°	85°	20°	0°	284.3°	69.4°	75.7°	9.3°
0°	85°	0°	20°	0.0°	65.0°	0.0°	20.0°
0°	85°	20°	20°	319.7°	58.2°	40.3°	44.7°

Table 3-1 shows an example of how pitch and roll motion can affect the accuracy of the system. There are two sets of examples, one with 10° vessel motion and one with 20° vessel motion, both at various depression angles. Note that even when there is a 20° pitch and roll vessel motion and a target is at the horizon (depression angle less than 15°), there is only a 5° error in bearing. Also note that as the depression angle increases the effects of pitch and roll become more prevalent.

3.3 SIGNAL PROCESSOR BOARD

Each of the three signals is sent from the differential line drivers on the Filter/Limiter Board to the Signal Processor Board and clipped by the differential receiver. The phase differences between the leading edges of the signals are measured and stored in RAM for later transmission to the main CPU board. When a valid signal is detected, the Signal Processor Board and transfers the RAM contents, starting with the most recent phase count data, to the main CPU via the PC Bus interface.

3.3.1 DETECTION CIRCUITRY

The "A" channel hydrophone signal is used in the detection circuitry. It is mixed with a Local Oscillator, then fed to a filter. The filter outputs go to a peak detector/threshold system, which can generate an interrupt for the CPU. The detector outputs also control the interrogation and reply segments in the bearing LCD, and the peak detector circuit provides signals for the audio generators. The audio circuitry provides an indication of the strength of the signal received at the chosen frequency.

3.3.2 DATA TRANSFER

When the interrupt generated by the detection circuitry is recognized by the CPU, the following sequence of events occurs, resulting in the transfer of all of the raw data over the PC bus interface to the main CPU board. All counting and data collection is halted, the COMPASS and ANALOG DEPTH signals are digitized and stored, and an interrupt is sent to the main CPU board to initiate data transfer. The main CPU board, when ready, will read the raw data, including COMPASS and ANALOG DEPTH data. At the end of the transfer, data acquisition is begun again.

3.3.3 TRANSMIT SIGNAL

Transmitter parameters, such as frequency, repetition rate, and pulse duration, are selected via the keypad or communications port and immediately sent to the SPB, where generation of the transmit signals occurs. The frequency is latched, and a Phase Lock Loop generates the actual signal. The repetition rate and duration are controlled by a Programmable Interval Timer. An external input can also be used to trigger the transmitter (for transponder operation) or the responder trigger out (for responder operation) in place of the internal repetition rate generator.

In transponder or responder mode, the transmit signal starts a timer, which is stopped and read after receipt of a valid reply. This timer determines the transit time which is translated by the main CPU board into slant range.

SECTION 4

OPERATION

4.0 OPERATION

This section describes setup and operation of the LXT tracking system. It details the setup via the front panel keypad and also from the serial communications port.

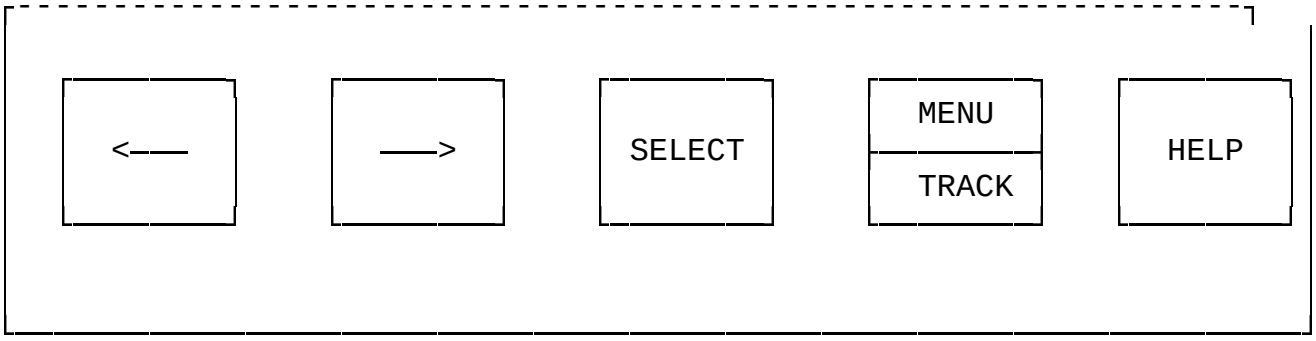
4.1 CONTROL PANEL

The control panel consists of a keypad, an alphanumeric display and a bearing display as shown in Figure 4-1. It is used to set up control parameters, perform diagnostics and display tracking information. The alphanumeric display has two modes, set up or menu mode and tracking mode. Commands and control parameters are entered into the unit when in the menu mode. A numeric bearing and slant range are displayed on the alphanumeric display when in the tracking mode. The bearing display shows a graphical representation of the targets bearing. When the menu mode is active tracking is disabled. At power up the system is activated using the previously setup parameters. NOTE: When the system is at the menu screen the serial port is disabled. The control panel has priority over the serial port.

4.1.1 KEYPAD

Setup/configuration is performed via a five switch keypad located on the front panel of the unit. The MENU/TRACK key toggles between the setup/configuration menu display and the tracking display. The RIGHT & LEFT ARROW keys toggle through the menu selections by bracketing the selected function or parameter, e.g. <TARGET>. The SELECT key selects the bracketed function or parameter. The HELP key displays a simple message expanding the three letter abbreviation to its full word, e.g.<FIL> = Filter.

The physical layout of the keypad is shown below.



4.1.2 TARGET DATA DISPLAY

This display is a two line alphanumeric type LCD backlit with an electroluminescent panel. When in the tracking mode it shows the target symbol (pentagon or circle), slant range, bearing or depression angle and a system or target warning code. When in the menu mode, available options are displayed in a hierarchical fashion. The keypad arrow keys control the LCD contrast when the Tracking Display is activated. The right arrow decreases the contrast and the left arrow increases the contrast.

Tracking Display Example:

TRACKING DISPLAY

(pentagon)

+		R		5	6	3	2	.	9	M		B	3	5	9		W		
0		R		3	1	5	7	.	4	M		D		4	8		W		

(circle)

A description of the Tracking display data is shown below.

The pentagon symbol in the upper left corner of the LCD represents target number one. All data on line number one pertains to target number one (pentagon). The letter "R" denotes that the data following it is the slant range to the target. The "M" following the slant range value denotes that the unit of measure is in meters. A menu selection allows the changing of the unit of measure of slant range to either yards "Y" or feet "F". The next data group after the slant range can be either a bearing or a depression angle. The letters "B" and "D" following the slant range unit of measure distinguishes between a bearing value or a depression angle value. A bearing value is calculated and displayed when a targets depression angle is less than 62° and a depression angle value is calculated and displayed when the depression angle is greater than 62° . If the compass mode is activated from the menu or the serial port, an "N" with an arrow underneath it is shown after the compass data to symbolize that the targets are displayed with respect to north instead of the bow of the vessel. The last data field is the warning code. See section 4.3 for warning messages. This is a code that alerts the operator to a possible problem with the tracking of the target. The data fields for targets one and two are identical, and are displayed on line numbers one and two, respectively.

NOTE: On the Bearing display the pentagon is also used as the symbol for target number one and the circle target number two. However, on the serial communications port the number "1" is transmitted to the terminal or computer to represent the pentagon and the number "2" is sent to represent the circle. See section 4.9 for format of serial port data.

4.1.3 BEARING DISPLAY

The bearing display is an LCD with an electroluminescent panel backlight. It indicates the angle to a target relative to the hydrophone or if in compass mode with respect to north. Two indicators, a pentagon and a circle, show the relative bearing to a target when its depression angle is between 0° and 62.0° . If the angle is between 62.1° and 90° the target position is shown in the center of the display to indicate that the target is almost directly below the hydrophone.

At the periphery of the bearing display are indicators for the out-going interrogation signal (or responder key signal) and each target reply. Also there is an indicator for low battery (indicates when the +5 VDC supply is below +4.85 VDC). The interrogation signal or key signal, located in the lower left corner of the display, is a horn symbol and the reply symbols, located in the upper left corner of the display, are a pentagon and circle.

The keypad arrow keys control the LCD contrast when the Tracking Display is activated. The right arrow decreases the contrast and the left arrow increases the contrast.

4.1.4 VOLUME CONTROL

The volume control varies the audible output of the acoustic energy within the frequency band of the tracked targets. The pitch of the audio signal is related to the frequency of the receiver, so that if two targets are being tracked, they can be distinguished by their relative pitches. For example, if the CDU is set to code 1 (23 kHz), when the reply is received and the reply indicator flashes, a 908 Hz audible tone is heard from the speaker output. If a signal is ± 1 kHz off the center frequency, the signal can still be heard but may not trip the detector or flash the LCD reply indicator.

Without a sound source in the water (transponder or responder), listening to the noise and viewing the reply indicators allows the operator to determine if there is some in-band noise that is interfering with the target. If the background noise is high enough to trigger the detector (reply indicator flashing with threshold set to low) then either eliminate the interference (e.g. turn off echo sounder or other interfering sound source) or change the CDU target code, which changes the receive frequency to another band. Determining the source of interference can be difficult because it does not always have to be at the frequency of the target. I.e., the detection circuit consists of a local oscillator that is set 6 kHz above the target frequency, a mixer and a 6 kHz narrow band filter. The mixer combines the target frequency with the local oscillator to produce a difference frequency of 6 kHz. A 6 kHz signal can also be produced if the local oscillator mixes with a signal that is 6 kHz above it. For example, if a target frequency is 23 kHz, the local oscillator is 29 kHz, and an extraneous source produces 35 kHz, both the target and extraneous source will be detected.

4.2 MENU

Pressing the MENU/TRACK key toggles the display into the menu mode. The menu structure is shown in figure 4-2. The LEFT and RIGHT ARROW keys bracket the various main and intermediate menu commands. The SELECT key activates the bracketed command. To bring up the menu display press the MENU/TRACK key to view the main menu screen. The main menu display is shown below.

MENU DISPLAY

<	T	A	R	G	E	T	>	S	Y	S	T	E	M		T	E	S	T	
	D	E	F	A	U	L	T												

The parameter in brackets will be the one selected when SELECT is pressed. Pressing the right arrow key brackets the next parameter to the right. If the parameter at the end of the first line is bracketed, pressing the right arrow causes the first parameter on the second line to be bracketed, i.e., the brackets wrap around at the ends of the lines. Pressing the left arrow reverses the direction and bracket the next parameter to the left. When at the main menu or the parameter selection menu and the MENU/TRACK key is pressed the display returns to the TRACKING display. When at the intermediate menu and MENU/TRACK key is pressed the display returns to the MAIN menu.

4.2.1 MAIN MENU

The main menu consists of four commands, TARGET, SYSTEM, TEST and DEFAULT. The TARGET menu is the top menu for the parameters concerning target setup. The SYSTEM menu is the top menu for parameters that are non-target related or concern the system. The TEST menu is the top menu that allows the operator to select a specific self test function to perform. The DEFAULT command sets all the target and system parameters to their default condition. If DEFAULT is selected, a second menu is displayed which asks "ARE YOU SURE?". This allows the operator to answer NO and maintain the previously saved parameters. If YES is selected all previously saved parameters will return to their default condition. See section 4.2.2 for listing of default parameters.

LXT SYSTEM MENU STRUCTURE

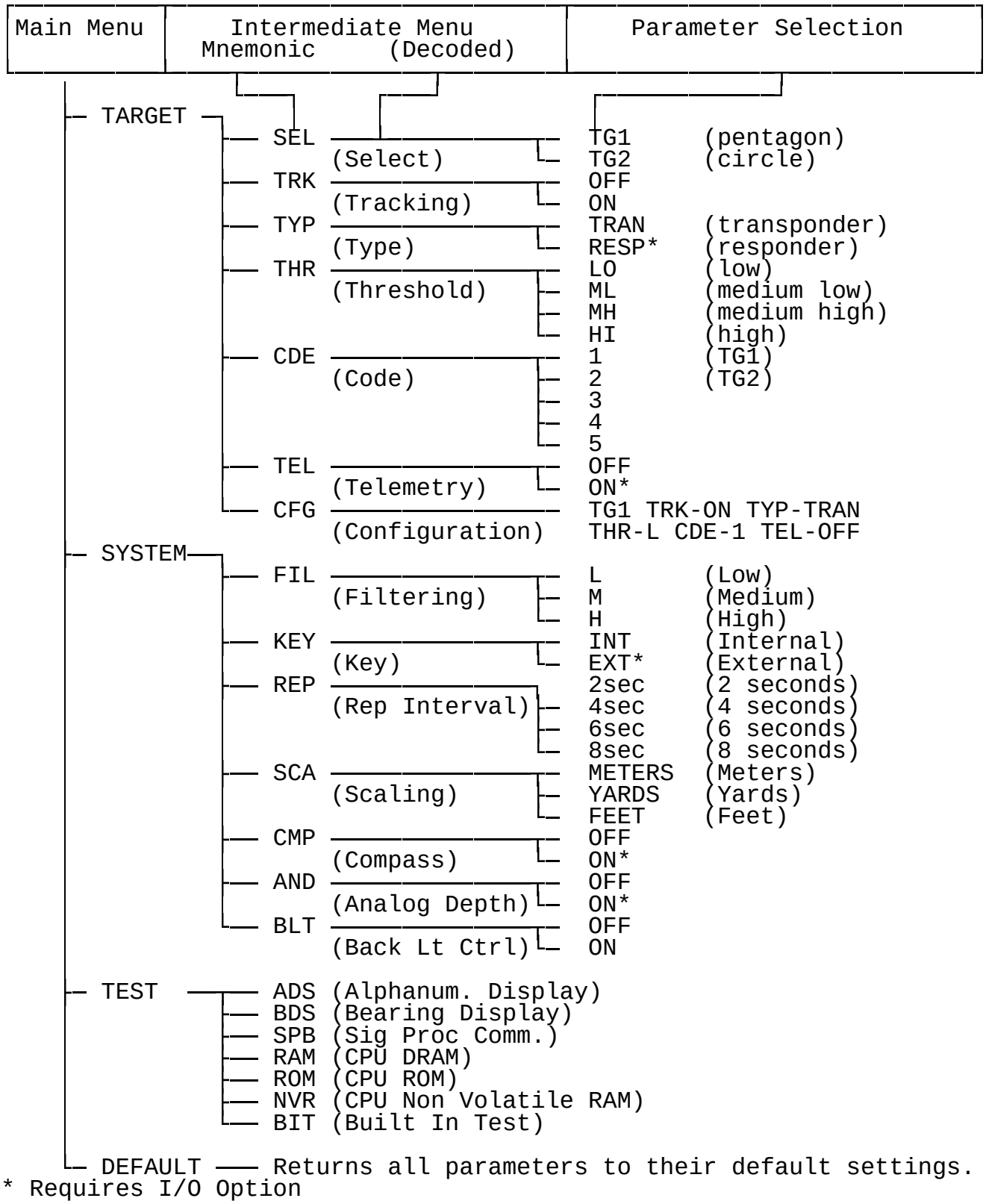


FIGURE 4-2

4.2.2 MENU DEFAULT SETTINGS

TARGET PARAMETERS

Select (SEL)	Target 1
Tracking (TRK)	Target 1 = ON, Target 2 = OFF
Type (TYP)	Transponder
Threshold (THR)	Low
Code (CDE)	Target 1 = code 1, Target 2 = code 2 (See table 4-1)
Telemetry (TEL)	OFF (100 ms zero delay , 1000 ms full scale delay, 900 ms span)
Configuration (CFG)	N/A

SYSTEM PARAMETERS

Filtering (FIL)	Low
Key Generator (KEY)	Internal
Repetition Interval (REP)	2 seconds
Scaling (SCA)	Meters
Compass (CMP)	OFF (0.1 V zero, 5.1 V full scale)
Analog Depth (AND)	OFF (0.0 V zero, 5.0 V full scale)
Back Light Control (BLT)	OFF

Other default settings non-menu related:

Turn Around Time	Transponder 15 ms, Responder 1 ms.
Transmit pulse width	Transponder, 10 ms
Responder Trigger	1 ms
Velocity of Sound	1500 meters/sec

4.2.3 TARGET INTERMEDIATE MENU

The TARGET menu is shown below. It shows that target number one is the selected target and that the SELECT command is bracketed.

TARGET MENU

T	G	1	<	S	E	L	>	T	R	K		T	Y	P		T	H	R	
	C	D	E		T	E	L		C	F	G								

SELECT (SEL): This command selects either target number one or target number two. The selected target is the one in which any changes in target parameters will reflect. For example, if TG1 is the selected target and the threshold setting was then changed to medium-low, only target number one would have its threshold changed to medium-low. Target number two threshold would remain as previously set. Target number one is the pentagon and target number two is the circle. Serial Port Command: SEL

TRACKING (TRK): This command turns tracking ON or OFF for the selected target. Serial Port Command: TRK

TYPE (TYP): This command changes the target type to either transponder or responder. NOTE: The transponders default turn around time is set to 15 ms and the responders is set to 1 ms. The transponder should have an interrogation lock-out time of at least 1.5 seconds. Serial Port Command: TYP

THRESHOLD (THR): This command changes the selected target threshold level. There are four settings for the threshold; Low, Medium Low, Medium High and High. As the threshold level is increased, only stronger signals are accepted and weak signals which could be caused by extraneous noise in the water are rejected. Serial Port Command: THR

CODE (CDE): The code command changes the selected target interrogation and reply frequencies using a unique code which corresponds to a group of preset values. There are five codes which can be selected. The interrogation frequency is the signal that is transmitted, see Table 4-1 below. Serial Port Command: CDE. Also see XFR, RFR, TAT & PLW.

TELEMETRY (TEL): This command turns the telemetry function ON or OFF for the selected target. This function is only valid when the I/O option is installed. With the TELEMETRY function activated the LXT can be used as a data acquisition system when coupled with a suitable telemetering transponder or responder. The delay time between two replies of a telemetering transponder can be configured to be proportional to, for example, roll, pitch, heading (compass), temperature, altitude, depth, etc.. The first reply from the telemetering device is used by the LXT to compute its range and bearing and is referred to as its navigation reply. The second reply is the telemetry reply whose frequency in the LXT is defaulted to 1 kHz below the navigation reply. The LXT starts a counter on the navigation reply and stops it on the telemetry reply. The counter value is converted to milliseconds and transmitted out the serial communications port. The operator must scale this value for the sensor in use. See example below. Serial Port Command: TEL. Also see TFR.

Example: A telemetry sensor has a 1000 m pressure gauge. Telemetry data from serial port reads 376.3.

$$\text{Scaled Output Ratio} = \frac{900\ \text{ms}}{1000\ \text{units}} = \frac{376.3\ \text{ms}}{X\ \text{meters}} \qquad X = 418.1\ \text{meters}$$

The telemetry zero delay is equal to 100 milliseconds from the navigation reply. The full scale delay is 1000 milliseconds from the navigation reply. See Figure 4-2.

The following table reflects a medium frequency hydrophone. **If the hydrophone is not medium frequency - see addendum.**

TARGET CODES vs SOUND SOURCE SPECIFICATIONS			
TARGET CODE	INTERROGATION FREQUENCY (transpdr only)	REPLY FREQUENCY	TELEMETRY FREQUENCY
CODE 1	17.0 kHz	23.0 kHz	22.0 kHz
CODE 2	19.0 kHz	25.0 kHz	24.0 kHz
CODE 3	17.0 kHz	27.0 kHz	26.0 kHz
CODE 4	19.0 kHz	29.0 kHz	28.0 kHz
CODE 5	17.0 kHz	30.0 kHz	29.0 kHz
NOTE: The interrogation pulse width from the LXT is 10 ms. The turn around time for a transponder is 15 ms and a responder is 1 ms. All of these settings and the frequencies can be changed via the serial communications port. Reply and telemetry frequencies are the same for both transponder and responder.			

TABLE 4-1

CONFIGURATION (CFG): This command displays the configuration of the selected target. An example of the target configuration display is shown below. Serial port command: See CFG.

TARGET CONFIGURATION

T	G	1		T	R	K	-	O	N			T	Y	P	-	T	R	A	N
T	H	R	-	L	O		C	D	E	-	1		T	E	L	-	O	F	F

4.2.4 SYSTEM INTERMEDIATE MENU

The SYSTEM menu is shown below.

SYSTEM MENU

S	Y	S	<	F	I	L	>	K	E	Y		R	E	P		S	C	A	
	C	M	P		A	N	D		B	L	T								

FILTERING (FIL):

The filtering command modifies the filtering level for both targets. The filtering command instructs the system to perform a combination of data averaging (smoothing), velocity filtering and range gating on a time series of position measurements. The amount of filtering is determined by selecting one of three filtering levels. See table below.

Smoothing is the linear averaging of a series of position measurements. Smoothing occurs on the bearing, depression angle and slant range data on both the alphanumeric display and the serial port.

Velocity Filtering is a technique of rejecting any target position changes that are unlikely due to an assumed maximum target velocity and elapsed time since last update. The velocity filter is preset to use 4.5 meters per second velocity plus 50% of slant range to compute maximum target velocity.

Range Gating eliminates any unwanted signal detections that occur at a time when no response is expected. The range gate is based on a "window" of ± 50 ms of the expected arrival.

Serial port command: FIL.

FILTER LEVEL	Smoothing	Range Gate	Velocity Filter
LOW	3	OFF	OFF
MEDIUM	6	± 50 ms	OFF
HIGH	9	± 50 ms	4.5m/s + 50% SR

Example of High Filtering Level: When a filtering level of high is selected, the system performs the "range gate" function on the received reply to see if it is within the specified time window. If it is within the window then the data is processed further and is checked to see if it exceeds the maximum target velocity (4.5 meters/second + 50% of SR). If the data passes the velocity check, then the slant range and bearing or depression angle data is averaged with the last eight good replies.

NOTE: A fast turning ship can cause the target to appear to be travelling at excessive speeds and can be rejected by the velocity filter. With a compass interfaced to the LXT, this effect is greatly reduced.

NOTE: Once tracking is established and the operator changes the display to the menu mode, and remains there for approximately eight seconds, the filtering history and averaging is reset. This is to reduce the likelihood of errors occurring, once tracking is resumed, due to the possible dynamic motion of a tracked target within the eight second period.

KEY (KEY): The key command changes the key source from either the internal (INT) LXT key rate generator or an external (EXT) source. NOTE: Application of an external source requires the I/O option. Serial port command: KEY.

REPETITION RATE (REP): This command varies the repetition interval of the internal key source. The repetition interval is the time between interrogations of the transponder or responder. The preset rates are two seconds, four seconds, six seconds and eight seconds. Serial port command: REP, also see XRI.

SCALING (SCA): This command changes the scaling of the slant range data to either meters, yards or feet. The default setting is meters. This command affects the data on both the LCD display and the serial communications port. Serial port command: SCA.

COMPASS (CMP): This command turns the compass mode ON or OFF. The default voltage range setting of the analog signal is 0.1 VDC = 0.0° and 5.1 VDC = 359.9° . The KVH flux gate compass is compatible with this input. These settings can be modified from the serial port if required. NOTE: Application of the compass mode requires the I/O option. Serial port command: CMP. Also see CVL & CVH.

ANALOG DEPTH (AND): This command turns the analog depth ON or OFF. The default voltage range setting is 0.0 VDC = 0 units and 5.0 VDC = full scale units. The units are entered via the serial port and the LXT scales the analog voltage to the entered units, e.g. meters, yards or feet. The LXT does NOT use this data for any of its calculations for positional data. It is provided to the operator for use in correlating the LXT positional data with the sound sources depth, i.e., for post processing or calculation of real time X, Y, Z. For example, an ROV has an internal depth sensor whose output is connected to the LXT. If the operator is viewing the positional data on the serial port, i.e. bearing and slant range, the ROV depth will be presented also to give a better representation of the exact position of the ROV. This

data could also be logged for post processing. Serial port command: AND. Also see DVL, DVH, DSP.

BACK LIGHT (BLT): The back light command enables or disables the LCD electroluminescent panel automatic shut-off timer. With the back light control OFF, the EL panels turn themselves off if the keypad has not been used within a period of three minutes. With the back light control ON,the EL panels remain on all the time. See note below. Serial port command: BLT.

NOTE: The EL panels have a lifetime of approximately 1,000 hours. There is a gradual decrease in intensity from the start. At 1,000 hours the intensity level is reduced by 50%.

4.2.5 TEST INTERMEDIATE MENU

TEST MENU

T	S	T	<	A	D	S	>	B	D	S		S	P	B		R	A	M	
	R	O	M		N	V	R		B	I	T								

ALPHANUMERIC DISPLAY TEST (ADS): Alphanumeric Display Test. Tests all individual segments of the display. Each character in the two line, twenty character display is blocked into five horizontal by seven vertical segments. All segments of each character are turned on in sequence starting from the top left corner of the display and ending at the bottom right. As the second row is being turned on, the first row is being turned off (1-20) in the same sequence. After character forty turns on the second row is turned off in the same sequence (21-40). The test is performed once and then the display returns to the main menu. This test checks the logic from the CPU board through the Interface Board to the Alphanumeric display. Serial port command: TST 0.

ADS CHARACTER TEST

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40

BEARING DISPLAY(BDS): The bearing display test checks the LCD segments in the bearing display. The test starts with all the segments on initially, including the peripheral segments which consist of the interrogation indicator, the pentagon and circle reply indicators and the low battery indicator. The pentagon bearing indicators turn on starting at the 0° bearing and continue in sequence going clockwise. The circle bearing indicators turn on starting at 0° and continue in sequence going counterclockwise. When both sets of segments reach their ends (at 360°) they start erasing themselves in the same sequence and also turn on their respective boat center segments. A message appears in the alphanumeric display, Running "BDS", when the test is in process. The test is performed once and the display returns to the main menu. This test checks the CPU parallel port operation and the bearing display electronics interface and LCD. Serial port command: TST 1.

SIGNAL PROCESSOR BD (SPB): This test checks the communication bus between the signal processor board and the CPU. The alphanumeric display shows the number of passes or tests performed and the number of errors that have occurred. This counter has a maximum number of 9999 tests at which time the word "MAX" is displayed and the tests continue. (If invoked from the serial port the test number will go above the 9999 maximum limit.) Pressing any key, except the help key, halts the test and the display returns to the main menu. A few errors per 1000 passes is not uncommon. When the tests show continuous errors then a problem exists. When running the test longer than three minutes, the EL backlight automatically goes out, thus extending its lifetime. To view the status without turning off the test press the help key and the backlight turns on without interruption of test. Serial port command: TST 2.

RANDOM ACCESS MEMORY (RAM): This test checks the integrity of the dynamic RAM on the CPU board. The alphanumeric display shows the number of passes or tests performed and the number of errors that have occurred. This counter has a maximum number of 9999 tests at which time the word "MAX" is displayed and the tests continue. (If invoked from the serial port the test number will go above the 9999 maximum limit.) Pressing any key, except the help key, halts the test and the display returns to the main menu. When running the test longer than three minutes, the EL backlight automatically goes out, thus extending its lifetime. To view the status without turning off the test press the help key and the backlight turns on without interruption of test. Serial port command: TST 3.

TYPICAL TEST DISPLAY

R	A	M	<	Q	U	I	T	>										
P	a	s	s		1	3	6		+	E	r	r	o	r	s			0

READ ONLY MEMORY (ROM): This test checks the program EPROM on the CPU board. This test performs a check-sum of the PROM and compares it with the check-sum stored in a known location within the PROM. If the check-sums compare then the EPROM passes the test. The alphanumeric display shows the number of passes or tests performed and the number of errors that have occurred. This counter has a maximum number of 9999 tests at which time the word "MAX" is displayed and the tests continue. (If invoked from the serial port the test number will go above the 9999 maximum limit.) Pressing any key, except the help key, halts the test and the display returns to the main menu. When running the test longer than three minutes, the EL backlight automatically goes out, thus extending its lifetime. To view the status without turning off the test press the help key and the backlight turns on without interruption of test. Serial port command: TST 4.

NON VOLATILE RAM (NVR): The non-volatile ram test checks the battery backed up ram located on the CPU board. If the system "forgets" its previous set-up then this test would show if the battery backed up memory was functional. The non-volatile ram is a single module which includes the ram and a battery which is specified to last several years. Serial port command: TST 5.

BUILT IN TEST (BIT): This is an overall system test. A simulated signal is generated in the Signal Processor Board to produce a detection and subsequent simulated target. The alphanumeric display shows the simulated target slant range (R) and depression angle (D) and the bearing display shows a target position in the center of the display (target below hydrophone). This test checks most functions on the Signal Processor Board including phase counters, phase count RAM, receivers/detectors, transmitter burst and also many of the hardware functions on the CPU board such as the CPU, numeric co-processor and bus drivers. Serial port command: TST 6.

BUILT-IN-TEST DISPLAY

T		R				5	6	.	2	M		D		9	0		W		
B	I	T	<	Q	U	I	T	>										

4.3 WARNING MESSAGES

WARNING CODE LISTING	
CODE	DESCRIPTION
NULL	No errors detected
TARGET WARNINGS:	
1	Unusable signal received
2	Target outside range gate
3	Slant range cannot be determined
5	Target velocity excessive
6	No recent replies
8	Simultaneous reply warning
TELEMETRY WARNINGS:	
21	Unusable telemetry signal received
22	Telemetry signal outside range gate
23	Telemetry timing out of range (100 - 1000 ms)
26	No recent telemetry replies

All warning codes will be shown for each target on the alphanumeric display. No new positional data will be updated on the display for warnings less than 20. No data will be sent out the serial port for warnings less than 20. For warnings above 20 (telemetry warnings) all positional data are updated on both the display and the serial port. The telemetry data will not be updated on the serial port.

EXPLANATION OF WARNING CODES	
CODE	DESCRIPTION

0 No error. The warning code zero (0) does not appear on the screen or sent out the serial port interface, but is a null character, indicating no warning.

1 Unusable signal received. Signal received, but Track- point unable to calculate a position. This could have been due to acoustic noise contaminating the incoming signal or to other causes. The reply LCD indicator and the audio may indicate valid detection of a signal but no position data is updated.

2 Signal timing error. Signal was received, but six con- secutive signals from a transponder or responder were outside of range gate timing window. (Filter levels on MED or HI.) This does not necessarily indicate a problem, since the signals may be echoes, which should be rejected. Alternatively, the range gate may have lost its lock on the signal and several more pings may be required for the range gate to re-acquire the target. No position data is updated. If minimum range is enabled and the signal or unwanted signal falls within the minimum range window, range gate will automatically open up every sixth reply.

3 Range cannot be determined. This will occur in transpond or respond mode if the calculated range is zero. This can happen if a pinger is interfering with the responder or transponder. No position data is updated.

5 Target velocity excessive. Target velocity, based on the change in position since the last up-date exceeds 10 knots. This filter takes advantage of the fact that tracked targets cannot move very fast. This warning can occur at filter level "HI". No position data is updated.

NOTE: A rapidly turning ship can make the target appear to move fast and can cause this warning.

6 No recent replies. This message will appear if valid signal has not occurred recently.

8 Simultaneous reply error. Two replies from separate targets are detected at the same time. Although the system can detect two replies, it can only deal with one set of phase measurements instantaneously. No position data is updated.

22 Signal timing error. Telemetry signal was received but 6 consecutive signals were outside of the range gate timing window. No position data is updated.

23 Telemetry timing out of range. Telemetry time is either less than the zero delay of 100 ms or is greater than the full scale delay of 1000 ms. No position data is updated.

26 No recent telemetry replies.

4.4 START UP

Before turning on the LXT Command Display Unit (CDU) make sure the that only an AC supply or a DC supply is connected to the unit.

C A U T I O N

Do NOT apply power to both the AC power input and the DC power input at the same time. Internal damage may result. Disconnect one before connecting the other.

Make sure that the hydrophone cable is attached to the LXT. Insure that the transponders or responders meet the specifications for the tracking system, i.e. interrogation frequency, reply frequency, turn around time (delay), interrogation pulse width, reply pulse width and lock-out time.

NOTE: Any 4213B hydrophone can be coupled with the LXT CDU. There is no calibration EPROM associated with the hydrophones that requires installation within the CDU.

Turn the LINE switch ON. At power up the alphanumeric LCD shows the ORE logo and the firmware revision. While the alphanumeric LCD is performing its power up functions the bearing LCD performs a self test, displaying all segments. Once power up is complete the system returns to the tracking mode. The default setting is for target number one (pentagon) to be active and target number two to be off. If the unit was used previously with different settings then those settings will be reinstated.

The LCD contrast can be varied by pressing the left or right arrow keys while the display is in the tracking mode. Pressing and holding the left arrow key lowers the contrast, for sunlight conditions, conversely, pressing and holding the right arrow key increases the contrast for reduced ambient light conditions. Adjust the contrast for existing conditions. Once desired contrast is achieved, release arrow key and save the contrast setting in CMOS RAM by pressing the MENU/TRACK key twice, the next time the CDU is turned on the previous contrast setting will be in effect. Also temperature can affect LCD contrast. When the temperature nears zero degrees C, the contrast is reduced and the segments become barely visible. Increase the contrast by pressing and holding the right arrow key. Conversely if the temperature is above about 40° C, the contrast is increased and the segments begin to turn black. Reduce the contrast by pressing and holding the left arrow key. If the unit will be used at that temperature again save the setting by pressing the MENU/TRACK key twice.

Perform self tests to verify CDU operation. See section 4.2.5.

Check the configuration set up of the tracked target by pressing the MENU/TRACK key, press the SELECT key to select the target menu, press the right arrow key to bracket the configuration mnemonic then press SELECT to initiate the configuration command. The display shows the target number selected, the tracking status (ON or OFF), the type of sound source tracking (transponder or responder), the threshold setting (L,ML,MH,H), the target code (1-5) and telemetry status (ON or OFF). Press the MENU/TRACK key to return to the tracking display. Refer to section 4.2 for modification to the above parameters.

With the hydrophone on deck the system can be given a basic check to determine if the sound sources and hydrophone are operational. Keep in mind that the range and bearing information will be random and incorrect. If the sound source is set to the proper code, signal detection will begin immediately and a range and bearing or depression angle will be displayed on the Alphanumeric LCD.

4.5 TRACKING VIA CONTROL PANEL

Once satisfied that the start up has proven the system integrity, the hydrophone can be lowered into the water (refer to section 2.1 for hydrophone installation and zero bearing checking) and the sound source deployed. The system should now be tracking and the following observed:

- The bearing in the alphanumeric display is reading approximately the correct angle to the sound source in the water.
- The slant range shown in the alphanumeric display is reading approximately the correct distance from the sound source.
- The target symbol (pentagon or circle) in the bearing display agrees with the target symbol in the alphanumeric display and its bearing angle agrees with the data in the alphanumeric display.
- The interrogation indicator at the bottom left corner of the bearing display flashes at the rate equivalent to the set repetition interval.
- The reply indicator in the top left of the bearing display agrees with the tracked target symbol and flashes in coincidence with the audio signal.

The ORE International series of Multibeacons have a typical output source level of 184 dB re 1 µPa @ 1 meter. This sound pressure level will typically provide a maximum range of 1000 to 1500 meters to a target under good conditions.

For data-output/control from the serial communications port (I/O option), refer to section 4.9.

To establish tracking in responder mode (I/O option), check that the target type is set to responder (RESP) and that the proper cable connection is made from the CDU I/O connector to the responder module. Verify responder triggering on deck prior to deployment.

NOTE: The responder trigger out is a TTL compatible negative going pulse. It is defaulted to a pulse width of 1 ms. Also, when a target is set up as a responder the interrogation frequency for code is not applicable.

To establish two transponder tracking, refer to section 4.2, Menu, for enabling of target number two (circle). Press MENU/TRACK key to view main menu, with TARGET selection bracketed press SELECT key to view target intermediate menu. Press right arrow key to bracket SEL command and press SELECT to view status. Press right arrow key to bracket target number two (TG2) and press SELECT. Select TARGET again and then tracking (TRK). Change the tracking status from OFF to ON. Check the code for target number two and change if necessary. Target number two should be ready to track.

To Track telemetry transponders (I/O option), turn the telemetry function on under the TARGET menu. The system automatically sets the telemetry receive frequency to 1 kHz below its navigation frequency. A telemetry transponder is similar to a normal transponder except it outputs two replies instead of one. The time delay between the two replies of a telemetering transponder is proportional to the span of its sensor output. The minimum delay is 100 ms and the maximum delay is 1000 ms. This dual reply can be heard on the audio as one signal followed by another. At minimum delays the LCD reply indicator may not show two distinct flashes as the reply detector pulse has been lengthened to compensate for the slow response time of the liquid crystal element. At longer delays the two replies should be distinguishable. The telemetry data is output to the serial port in milliseconds (0 to 900).

System acoustic performance can be degraded by:

Ambient noise	(sea state, weather, other vessels, etc.)
Vessel noise	(electrical and mechanical)
Tracking vehicle noise	(transponder listening problem)
Flow noise	(vessel speed related)
Multipath	(shallow waters)
Shadow zones	(ray bending due to refraction in media with high temperature gradients)

See section 4.6 for acoustic problems affecting operation.

4.6 ACOUSTIC PROBLEMS AFFECTING OPERATION

The most significant acoustic problems encountered in any tracking operation are multipath and noise. As explained in section 2.1, multipath occurs when an acoustic signal travelling through water encounters a surface having a different density and is reflected and then received by the tracking system in addition to the direct (desired) signal.

Typical reflectors include ships' hulls, gas pipelines, marine risers and other subsea structures. The air-water interface is an important acoustic reflector; air and gas bubbles, the ship's wake and the water surface are potential causes of multipath. A sharp thermocline, causing a marked change in water density, can also act as a reflector.

Since a reflected signal exhibits the same acoustic characteristics as the original signal, the tracking system can have difficulty differentiating between the two. Filtering and threshold levels can screen out false signals in many cases. In a high multipath environment, however, false signals may be accepted and the operator will observe erratic range and bearing values for the target being tracked.

The LXT reply indicators and audio signals can help to identify multipath problems. Multiple replies and audio signals may indicate that the system is detecting reflected signals.

A reflection off an object very close to the hydrophone, however, can be received so closely behind the direct signal that it is impossible for the human eye and ear to discern a separation between the corresponding reply indicator and audio signals. Although this type of multipath is not apparent from observing the reply indicator or listening to the audio, it may affect tracking by mixing with the original signal, resulting in an incorrect or erratic bearing.

In general, proper installation of the hydrophone will reduce the incidence of multipath interference. The hydrophone should be mounted well below the hull, to allow for the direct arrival of signals from the beacon, and as far as possible from sources of electrical and mechanical noise (main engines, generators, echo sounder transducers, etc.) or turbulence caused by the ship's wake, propellers, etc.

4.6.1 HYDROPHONE MULTI-PATH PROBLEMS

A transponder emits an acoustic signal of a known frequency in response to an acoustic interrogation pulse sent from the LXT transmitter. A potential disadvantage in using a transponder is that both the interrogate pulse and the transponder's response may be subject to multipath. Also see section 4.6.2.

A responder replies acoustically to an electrical interrogation pulse from the LXT. Like a transponder, a responder provides the timing information needed to measure slant range directly, but the interrogation pulse is not subject to the acoustic interference associated with a transponder. However, because a responder must be electrically connected to the tracking system, it may not be a feasible option for some operations.

Transponder or responder replies normally, but signals are distorted by multipath. When multipath is affecting transponder or responder replies, try the following:

1. Change the threshold setting.

   If the reflector is very close, the multipath signal may be interfering with the original signal, and a lower threshold may improve the situation by detecting earlier, before the reply pulse is corrupted by multipath.

2. Change pulse width of beacon.

   The LXT receiver detects signals with a pulse width of 1.3 ms minimum. If a beacon has a longer pulse width than 1.3 ms, more energy is emitted into the water which can compound the multipath situation. Reducing the pulse width to 1.3 ms may reduce the reflected signals to a level where it will be rejected by the system, which still receives the direct signal.

3. Change filter setting.

   In operation with a transponder, you may see more than one flash of the reply signal indicator following each flash of the interrogation indicator. The audio may sound like a series of echoes, or a quick double pulse (like the double report of a rifle shot). These are indications of multipath but do not necessarily indicate a problem, since in transponder or responder mode, with filtering off, The LXT ignores all but the first signal received after an interrogation signal and with filtering on, ignores signals not within the range gate (time window).

If the multipath occurs long enough after the first arrival, the system accepts the first arrival, with filtering changed to low, and rejects all others.

If signals from some other source arrive before the direct arrival from the target then the implementation of range gating may enhance performance. Changing the filter setting to medium or high enables the range gate system. Once the range gate locks on to the correct reply, the system should detect the correct one and reject the undesired ones.

4. Reconfigure System.

When operating in responder or transponder mode, multipath interference is limited to cases where the direct arrival of the acoustic reply is blocked or reflected.

If this occurs, it may be necessary to reconfigure the system so that the hydrophone is in a position to receive the direct signal. For example, the hydrophone may not be mounted far enough below the ship's keel to receive a direct signal from a responder on the other side of the ship.

Avoid an operation where a towfish is tracked behind the vessel near the water surface, so that the direct signal from the beacon is reflected or attenuated by the ship's wake. Either tow the fish off-center, out of the ship's wake, or sink the responder below the wake.

When operating in and around subsea structures, there will always be a number of locations where there is no direct path between the responder and the hydrophone, and the operator should expect occasional multipath interference in these situations. A higher filter setting may help somewhat under these conditions by rejecting signals that are clearly from the wrong direction.

4.6.2 ACOUSTIC PROBLEMS IN TRANSPONDER MODE

A high noise and/or multipath environment may cause any of the following situations:

A. Transponder cannot "hear" interrogate pulse.

In an extremely noisy environment, it may be impossible for the transponder to distinguish an interrogate pulse in the noise flooding its receivers. In the worst case, the transponder simply won't reply, and is essentially lost for tracking purposes. A responder is a better choice for such an environment.

B. Transponder accepts noise or extraneous signals at the correct interrogate frequency.

In this case, transponder replies will be random and uncoordinated with the interrogate pulses. The operator may observe correct bearing information although range is random and incorrect. To determine whether this is the case, change the target type to a responder, disabling the transmitter, and observe whether the transponder is still replying. If it is, the operator should try to identify and eliminate the source of the false interrogate signal or noise. If the source cannot be eliminated, it will be necessary to change the interrogate frequency (target code), or switch to responder operation, or possibly reduce the sensitivity of the transponder receiver.

C. Reflected interrogate signals cause extra transponder replies.

Most transponders are designed with a 'lock-out' (usually 1.5 - 1.75 seconds), or a limit on the rate at which the transponder can reply, to prevent extra transponder replies from occurring. The operator should be aware of such a limitation, so that he does not interrogate at a rate too fast for the transponder.

In rare circumstances, the transponder can be replying to a distant reflection of the interrogate signal in addition to the direct signal. (The reflected signal comes in after the lock-out.) If this is the case, the operator will observe correct bearing values with erratic ranges as above, but the transponder will stop replying when the target is changed to a responder, and begin replying when the target is changed back to a transponder, still with erratic ranges. If this is occurring, the operator should increase the transponder's lock-out time and use a longer interrogate interval.

4.7 SHUTDOWN

The LINE switch on the Command Display Unit shuts power off. It is important to bear in mind that the parameters in use when power is turned off are automatically recalled when power is next turned on. This is true in the case of inadvertent power shut off, as well as intended power off. Parameters can be saved for several years with the power off. Note that selecting DEFAULT when power is next applied will erase all previously entered parameters and return all values to the default settings. See section 4.2.2 for DEFAULT settings.

After shutting power off, disconnect cables attached to the front panel. Close the CDU lid and snap shut. Close the pressure port as long as the unit is not being shipped via air freight, in which case the port should be left open to prevent a pressure differential from damaging the unit. Do NOT pack the inside lid of the CDU with paraphernalia that would vibrate and damage the clear window areas of the overlay. Even the power cord or manual that is not buffered from the overlay can damage the surface.

4.8 EMERGENCY OPERATION WITH PINGERS

The ORE Offshore model 4320A Multibeacons have a pinger reversion option which turns the transponder or responder into a pinger if no interrogation has occurred in approximately thirty (30) seconds. This allows recovery of a towed vehicle if its umbilical has been severed. In an emergency situation such as this a pinger can be tracked while the unit is set up for a transponder or responder. Decrease the repetition interval to increase the update rate on the display. The acoustic return will be asynchronous with the interrogation but the bearing information will be correct. This would allow the operator to "home-in" on the source until it is directly below the hydrophone.

4.9 SERIAL PORT COMMUNICATIONS (I/O OPTION)

The serial port is a bi-directional RS-232C communications link. Its baud rate is fixed at 9600 bps. The protocol is 8 data bits, 1 stop bit, 1 start bit and no parity. See section 2 for wiring. The LXT outputs target positional information and other tracking information. It can also accept control information for set up of most tracking parameters, see section 4.9.2. The serial port is only active when the LXT is in the TRACK mode. If the CDU is in the MENU mode, no data will be sent out the port and the unit will accept no control parameters, i.e., both the tracking and the RS-232C port are disabled when in the keypad entry mode.

Help can be obtained on the various RS-232C parameters by typing "hlp". This gives a simple help message in which more specific help may be found. For example...

HLP

```
 'n' denotes numeric entry
(Use the BACK SPACE key to erase last character entered)
(Use the DEL key to erase the command being entered)

CTRL-C: System Reset (use with care)
CTRL-E: Event Mark
CTRL-X: Clears Menu Tests

HLP=display HeLP    ,n=1:TRG,2:SYS,3:WARN
CFG=see CFG settings, ( SELected target )
MSG=display MeSsaGe , display text on LCD
TST=select TeST     , n = test number
```

Pressing the keyboard's control key and 'c' at the same time (CTRL-C) causes a system reset. Tracking will resume, following initialization, using the previously entered parameters. The CDU outputs the same heading as if power was initially applied.

```
CPU speed: NORMAL




     Welcome to the ORE LXT System




Initializing.....
```

Pressing CTRL-E transmits header information on the RS-232C communications port. The header shows the revision of the software installed and the order or sequence of the transmitted data.

```
O.R.E. LXT System  Model 4430  Rev # 1.00
# SR(m)   BRG   DA   HDG   DEPTH  TEL WARN
```

Pressing CTRL-T allows the serial port to clear the CDU following some selftest routines that do not return the system to the tracking window thus locking out the RS-232C port. E.g., "ADS" selftest.

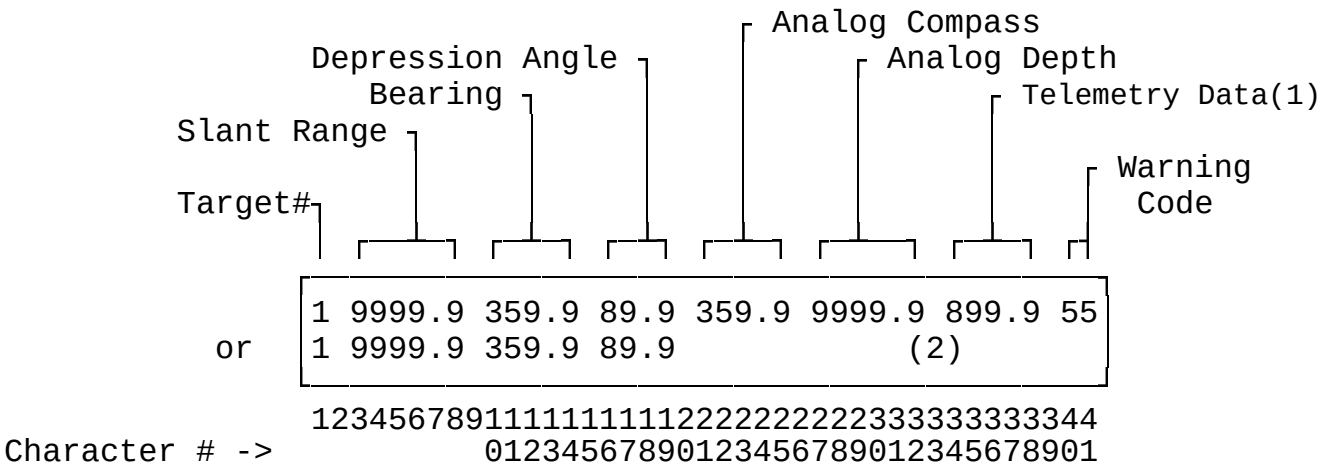
4.9.1 DATA OUTPUT FROM SERIAL PORT

The RS-232C serial port will output the following tracking information. A line of data is sent out at each valid reply from a sound source. If the reply is not accepted due to a warning code between 1 and 20, no data will be transmitted. If a telemetry warning occurs (21-26), valid positional information is transmitted but the telemetry data is in error. The nature of the error corresponds to the assigned warning code.

The following parameters are transmitted after each valid reply:

1. The Target number, 1 pentagon or 2 circle.
2. Slant Range (Scale as set under system menu or serial port parameter, SCA)
3. Bearing in Degrees (with respect to hydrophone)
4. Depression Angle (with respect to hydrophone)
5. Analog Compass Heading in Degrees (outputs spaces if compass turned off under the SYSTEM menu or if serial port command, CMP 0 is initiated)
6. Analog Depth in UNITS (outputs data proportional to the sensors input parameters as set by serial port commands, AND, DSP, DVL, DVH) (outputs spaces if analog depth turned off under SYSTEM menu)
7. Telemetry Data in UNITS ("X" parts per 900ms) (outputs spaces if telemetry turned off under TARGET menu)
8. Warning Code

SERIAL DATA OUTPUT FORMAT:



Fixed 41 character length not including CR and LF. Protocol fixed at 8 data bits, 1 start bit, 1 stop bit and no parity.

NOTE 1: The telemetry data is the difference between the navigation pulse and the telemetry pulse in milliseconds. (100 - 900 ms)

NOTE 2: If telemetry or analog options are not activated, spaces will be inserted instead of data.

4.9.2 CONTROL OF PARAMETERS FROM SERIAL PORT

Full parameter set-up capabilities are also available from the serial port. They include all the parameters from the LXT control panel plus others. The serial port allows entry of parameter settings also, such as receive, interrogate and telemetry frequencies in 500 Hz increments. This allows the operator to fine tune the system to his needs if faced with a non-standard beacon.

Mnemonic:	**CFG**
Purpose:	To view all of the selected target's parameters.
Syntax:	CFG
Parameters:	none

For example, cfg command outputs....

```
TARGET #1    * Tracking: ON     Type: TRAN

XMITTER      * Freq = 17.0 kHz  Pulse = 10.0 mS  Interval =  2.0 Sec
             * Xmit and Key Out ON

RECEIVER     * Freq = 23.0 kHz
             * Threshold: LO  Filtering: LO  TAT =  15.0 mS

COMPASS      * ON  * Lo Volt = 0.1  Hi Volt = 5.1

ANALOG DEPTH* ON  * Lo Volt = 0.0  Hi Volt = 5.0  Span =  100.0
```

Mnemonic:	**AND**
Purpose:	Enables and disables analog depth mode. When an external analog depth sensor is connected to the LXT System, the analog voltage is converted to a depth and sent out the serial port as part of the data string for target #1 only. The LXT System does not use the depth data for any calculations. It is only made available to the operator for use on an external computing device for calculating horizontal distances.
Syntax:	AND n
Parameters:	n=0 Turns analog depth OFF. n=1 Turns analog depth ON.
Related Cmds:	DVL, DVH, DSP

Mnemonic: **BLT**
Purpose: Enables and disables the LCD EL panel backlight control.
Syntax: BLT n
Parameters: n=0 Turns backlight control OFF so that the EL panels will be turned OFF if a front panel key has not been pressed for 3 minutes. n=1 Turns backlight control to ON so that the EL panels stay ON all the time.

NOTE: The EL panels have a lifetime of approximately 1,000 hours. There is a gradual decrease in intensity from the start. At 1,000 hours the intensity level is reduced by 50%.

If hydrophone is not medium frequency - see addendum - parameters change.
Mnemonic: **CDE**
Purpose: To vary the selected target's interrogation and transmit frequencies.
Syntax: CDE n
Parameters: n=1 Receive 17 kHz, xmit 23 kHz, telemetry 22 kHz
n=2 Receive 19 kHz, xmit 25 kHz, telemetry 24 kHz
n=3 Receive 17 kHz, xmit 27 kHz, telemetry 26 kHz
n=4 Receive 19 kHz, xmit 29 kHz, telemetry 28 kHz
n=5 Receive 17 kHz, xmit 30 kHz, telemetry 29 kHz
Related Cmds: RFR, XFR, TFR

Mnemonic: **CMP**
Purpose: Enables and disables compass mode. When an external flux gate compass is connected to the LXT System, the targets will be referenced to North instead of the bow of the vessel. The RS-232C data string will also contain the compass heading.
Syntax: CMP n
Parameters: n=0 Turns the compass mode OFF.
n=1 Turns the compass mode ON.
Related Cmds: CVL, CVH

Mnemonic: **CVL**
Purpose: Change the low voltage set point for the external analog compass. The low voltage set point corresponds to the 0° compass heading.
Syntax: CVL d, CVL d.d
Parameters: d Enter the voltage that corresponds to the voltage output from the analog compass when at a 0° heading. E.g., CVL 0.0. NOTE: This parameter is not saved in memory and reverts to the default setting after power is turned off.
Minimum: 0.0
Maximum: 5.9
Increment: 0.1
Default: 0.1
Related Cmds: CMP, CVH

Mnemonic:	**CVH**
Purpose:	Change the high voltage set point for the external analog compass. The high voltage set point corresponds to the 359.9° compass heading.
Syntax:	CVH d, CVH d.d
Parameters:	d Enter the voltage that corresponds to the voltage output from the analog compass when at a 359.9° heading. E.g., CVL 3.6. NOTE: This parameter is not saved in memory and reverts to the default setting after power is turned off. Minimum: 0.1 Maximum: 6.0 Increment: 0.1 Default: 5.1
Related Cmds:	CMP, CVL

Mnemonic:	**DSP**
Purpose:	Changes the span of the analog depth sensor.
Syntax:	DSP dd, DSP ddd, DSP dddd
Parameters:	d Enter the span of the analog depth sensor, i.e. the depth in meters, feet, etc. that coincides with the maximum voltage out. E.g., DSP 500.0. NOTE: This parameter is not saved in memory and reverts to the default setting after power is turned off. Minimum: 1 Maximum: 1000 Increment: 0.1 Default: 100
Related Cmds:	AND, DVL, DVH

Mnemonic:	**DVL**
Purpose:	Change the low voltage set point for the external analog depth sensor. The low voltage set point corresponds to the zero depth analog output from the sensor.
Syntax:	DVL d, DVL d.d
Parameters:	d Enter the voltage that corresponds to the voltage output from the analog depth sensor when at zero depth. E.g., DVL 0.0. NOTE: This parameter is not saved in memory and reverts to the default setting after power is turned off. Minimum: 0.0 Maximum: 5.9 Increment: 0.1 Default: 0.0
Related Cmds:	AND, DVH, DSP

Mnemonic: **DVH**
Purpose: Change the high voltage set point for the external analog depth sensor. The high voltage set point corresponds to the zero depth analog output from the sensor.
Syntax: DVH d, DVH d.d
Parameters: d Enter the voltage that corresponds to the voltage output from the analog depth sensor when at maximum depth. E.g., DVL 5.0. NOTE: This parameter is not saved in memory and reverts to the default setting after power is turned off.
Minimum: 0.1
Maximum: 6.0
Increment: 0.1
Default: 5.0
Related Cmds: AND, DSP, DVL

Mnemonic: **FIL**
Purpose: Change the filtering level of both targets.
Syntax: FIL n
Parameters: n=0 Filter level set to low.
n=1 Filter level set to medium.
n=2 Filter level set to high.

FILTER LEVEL	Smoothing	Range Gate	Velocity Filter
Filtering LW:	3	OFF	OFF
Filtering MD:	6	± 50 ms	OFF
Filtering HI:	9	± 50 ms	4.5m/s + 50% SR

Mnemonic: **HLP**
Purpose: Returns Help information on the RS-232C port to the external communications equipment.
Syntax: HLP, HLP n
Parameters: n=0 Basic help parameters such as CTL, HLP, CFG, etc..
n=1 Target help
n=2 System help
n=3 Warning Message help

Mnemonic: **KEY**
Purpose: Sets the keying mode of the LXT System.
Syntax: KEY n
Parameters: n=0 Key mode set to internal.
n=1 Key mode set to external.

Mnemonic: **MNR**
Purpose: Allow software lockout of an unwanted signal inside the frequency band of operation. Every sixth reply the minimum range window will open. (See error code 2)
Syntax: MNR n (m, yd or ft)
Minimum: 0

Maximum: 1000
Default: 0

Mnemonic: **MSG**
Purpose: To send a message to the operator of the LXT console while monitoring the RS-232C port. The message string will appear in the lower line of the alphanumeric display and remain there for approximately 5 seconds.
Syntax: MSG text string
Parameters: text string = a string of ACSII keyboard characters, up to 20 in length. E.g., MSG LUNCH TIME!

Mnemonic: **REP**
Purpose: Changes the repetition interval for both targets.
Syntax: REP n
Parameters: n=0 Sets the repetition interval to 2 seconds.
n=1 Sets the repetition interval to 4 seconds.
n=2 Sets the repetition interval to 6 seconds.
n=3 Sets the repetition interval to 8 seconds.
Related Cmds: XRI

Mnemonic: **SCA**
Purpose: Changes the scaling of the slant range data for both targets.
Syntax: SCA n
Parameters: n=0 Sets the units of the slant range data to meters.
n=1 Sets the units of the slant range data to yards.
n=2 Sets the units of the slant range data to feet.

Mnemonic: **SEL**
Purpose: Selects either target number 1 or number 2. Once selected, all changes to parameter settings are relative to this target.
Syntax: SEL n
Parameters: n=1 Target #1 or the Pentagon.
n=2 Target #2 or the Circle.

Mnemonic: **TEL**
Purpose: Enables telemetry for the selected target. Telemetry data is sent out the RS-232C port in milliseconds. It is the time difference between the primary navigation reply of the transponder and the telemetry reply (0 to 900 ms). The telemetry frequency is automatically set to 1 kHz lower than the primary navigation reply.
Syntax: TEL n
Parameters: n=0 Telemetry OFF
n=1 Telemetry ON
Related Cmds: TFR

Mnemonic: **THR**
Purpose: To vary the selected target's threshold.
Syntax: THR n
Parameters: n=0 Low threshold (Greatest sensitivity)
n=1 Medium Low threshold
n=2 Medium Hi threshold
n=3 High threshold

Mnemonic: **TRK**
Purpose: To enable or disable tracking for the selected target.
Syntax: TRK n
Parameters: n=0 Turn tracking OFF.
n=1 Turn tracking ON.

Mnemonic: **TST**
Purpose: To perform a selftest function.
Syntax: TST n
Parameters: n=0 Alphanumeric display test.
n=1 Bearing display test.
n=2 Signal Processor Communication self test.
n=3 CPU RAM test.
n=4 CPU ROM test.
n=5 CPU Non-Volatile RAM test.
n=6 Built In Test.
Refer to section 4.2.5 for description of test parameters.

Mnemonic: **TYP**
Purpose: To change the type of target in use.
Syntax: TYP n
Parameters: n=0 Transponder
n=1 Responder

The following are optional parameter setting commands for fine tuning the system or for using non standard sound sources.

Mnemonic: **CON**
Purpose: Is used to set a target depression angle limit. The limit is the maximum calculated depression angle of the target before changing from bearing indicator to"approximately-at-boresite" indicator, on the bearing display, and also changing from a bearing value to a depression angle on the alphanumeric display.
Syntax: CON dd
Parameters: dd Enter the depression angle (the angle from the horizon down) in degrees. E.g., CON 60. If targets depression angle is calculated at 62°, target symbol jumps to center of bearing display and the bearing value changes to depression angle on the alphanumeric display.
Minimum: 45.0

Maximum: 80.0
Increment: 0.1
Default: 62

Mnemonic: **PLW**
Purpose: Changes the selected target transmit pulse width.
Syntax: PLW dd, PLW d.d, PLW dd.d
Parameters: d Enter the transmit pulse width in milliseconds.
E.g. PLW 5.
Minimum: 1.0
Maximum: 15.0.
Increment: 0.1
Default: 10

If hydrophone is not medium frequency - see addendum - parameters change.

Mnemonic: **RFR**
Purpose: Changes the selected target receive frequency.
Syntax: RFR dd, RFR dd.d
Parameters: dd Enter the receive frequency in kHz. E.g. RFR 23.5.
Minimum: 22.0 (7)
Maximum: 30.0 (47)
Increment: 0.5
Default: See Table 4-1.
Related Cmds: CDE

Mnemonic: **TAT**
Purpose: Changes the turn around time parameter. The TAT should agree with the turn around time setting on the transponder of the selected target.
Syntax: TAT d, TAT d.d, TAT dd
Parameters: d Enter the transponder turn around time in milliseconds.
E.g. TAT 15.0.
Minimum: 0.0
Maximum: 125.0
Increment: 0.1
Default: 15.0

Mnemonic: **TFR**
Purpose: Changes the selected target telemetry frequency.
Syntax: TFR dd, TFR dd.d
Parameters: dd Enter the telemetry receive frequency in kHz. dd may be anywhere from 21 to 29 in increments of .5.
E.g. TFR 22.5.
Minimum: 21.0
Maximum: 29.0
Increment: 0.1
Default: See Table 4-1.
Related Cmds: CDE

Mnemonic:	**XFR**
Purpose:	Changes the LXT interrogation frequency for the selected target.
Syntax:	XFR dd, XFR dd.d
Parameters:	dd Enter the reply receive frequency in kHz. E.g. XFR 23.5. Minimum: 16.0 (5) Maximum: 30.0 (30) Increment: 0.5 Default: See Table 4-1.
Related Cmds:	CDE

Mnemonic:	**XRI**
Purpose:	Changes the transmit repetition (transponder interrogation) interval.
Syntax:	XRI d, XRI d.d, XRI dd.d
Parameters:	d Enter the interrogation interval in seconds. E.g. XRI 2.5. Minimum: 1.0 Maximum: 20.0 Increment: 0.1 Default: 2.0
Related Cmds:	REP

SECTION 5

MAINTENANCE

5.0 MAINTENANCE

The Model 4430A LXT Tracking System requires no scheduled maintenance. The Hydrophone assembly should be rinsed with fresh water following each use, to remove any salt water and fouling build-up. If the system will not be used for an extended period, all components should be stored in the original packing case, or secured and covered with plastic if the original materials are not available.

After shipping or following a storage period, the self-test diagnostics can be run when the system is ready for operation.

The unit contains no user serviceable parts inside. Also due to the complexity of the assembly it is recommended that the complete unit be returned to ORE for repair and/or upgrades.

5.1 FUSE REPLACEMENT

Disconnect the line cord before replacing the fuse. The fuse is located on the AC power supply. The fuse must be unsoldered from the PC board and replaced with an equivalent type. Replace with a 1 Amp (3AG) fuse for either 115 or 230 VAC operation.

5.2 PCB HANDLING

When removed from its enclosure (pressure case), the PCB's should be stored or shipped in anti-static bags. Never stack one PCB on top of another. Always separate PCB's with suitable packing material.

5.3 BATTERY BACKED-UP RAM

The battery backed-up RAM module located on the CPU board has a life expectancy of several years. This means that all previous set-up parameters are stored in this module and retrieved upon power up. If the previous set-up parameters are not returning following a power up, and the "NVR" self-test passes, then the battery backed-up RAM module should be replaced.

5.4 CABLE (4113B-V1289) CHECKS

If cable damage is suspected do the following tests to check the cable integrity. Refer to DWG # 4113BA0006-V1289 (Figure 2-4) for wiring schematic.

1. Check the continuity of each conductor. The conductor resistance is ~ 0.8 Ω per 100 feet, e.g., check continuity from pin 1 at the hydrophone end to pin 1 of the CPM mating end. There should be approximately 1 ohm of resistance for a 100 foot cable.

2. Check to see if the voltage breakdown is within specification. Make sure the cable is disconnected from the CPM and hydrophone before performing any of these tests.

The voltage breakdown should be greater than 400 volts RMS between pin 1 and pin 4 (twisted pairs) of the underwater connector, no breakdown should occur. Check all pairs; pin 3 to 8, pin 2 to 5 and pin 6 to 7.

The voltage breakdown should be greater than 400 volts RMS between each conductor and its shield. When 400 VRMS is applied between pin 1 and pin 4 of the CDU mating end, no breakdown

should occur. Check each conductor to shield; pin 3 to pin 1, pin 8 to pin 1, pin 2 to pin 1, pin 5 to pin 1, pin 6 to pin 1 and pin 7 to pin 1.

The voltage breakdown should be greater than 100 volts RMS between separate shields. When 100 VRMS is applied between pin 6 and pin 3 of the CDU mating end, no breakdown should occur. (N/A V1289 CABLE)

The voltage breakdown should be > 500 VDC between any shield and the water. Seal one end of the cable with a dummy connector and the other end connect a mating pigtail cable. Immerse the assembly in salinated water so that the cable is completely submerged and the mating cable conductors are available out of the water to apply high voltage. Apply 500 VDC between the water and pin 5 of the CDU mating end. No breakdown should occur.

5.5 TRANSMITTER BOARD REPLACEMENT

1. Disconnect power to the LXT CPM.
2. Remove the four screws holding the Transmitter Board to the base plate.
3. Locate the three connectors, TR-P1, TR-P2 and TR-P4. Unplug these connectors from the Transmitter Board and remove board from the chassis. Reverse order for re-assembly.

5.6 SIGNAL PROC/CPU ASSEMBLY REPLACEMENT

1. Disconnect power to the LXT CPM.
2. Remove the SP-P5 and SP-P2 connectors from the Signal Processor Board.
3. Remove the five (5) stainless screws around the perimeter of the Signal Processor Board using a small straight blade screwdriver.
4. Disconnect the 10 pin connector CP-J2 from the CPU Board.
5. The Signal Processor/CPU assembly is replaceable as a complete assembly. Re-assemble in reverse order.

5.7 FILTER/LIMITER BOARD REPLACEMENT

Unplug the connector FL-P1 and also connector FL-P2 from the Filter/Limiter Board. Remove the six screws holding the the Filter/limiter Board to the plate. Re-assemble in reverse order.

5.8 AC POWER SUPPLY REPLACEMENT

Disconnect AC-P1 and AC-J1 connectors and the ground terminal. Remove the board by removing teh four screws that hold it to the plate. Remove board. Reverse procedure for re-assembly.

5.9 TROUBLESHOOTING

Should a problem arise during operation, refer to the following troubleshooting guide to determine possible cause and recommended action. In most cases, the problem will be easily resolved. If the action recommended by the troubleshooting guide does not correct the problem, or if the recommended action is to contact ORE International, Inc. technical assistance will be provided by the nearest office:

ORE Offshore
25 Bernard St. Jean Drive
East Falmouth, Massachusetts 02536

Phone: (508) 495-3200
FAX: (508) 495-4500
EMAIL: info@ore.com
WEB SITE: http://www.ore.com

5.9.1 MISCELLANEOUS

SYMPTOM:	Changing target data has no effect.
POSSIBLE CAUSES:	Changing data for wrong target.
ACTION:	Verify that correct target is selected. Check the SEL command on serial port or menu.

5.9.2 RS-232C PROBLEMS

SYMPTOM:	No data received or characters received are not correct.
POSSIBLE CAUSES:	Incorrect parameters.
ACTION:	Check that the interfacing equipment is set up for the correct protocol, 9600 baud, 8 data bits, 1 stop, 1 start, no parity.

or...

POSSIBLE CAUSES:	Loose RS-232C connector inside C/DU.
ACTION:	Reseat connector.

or...

POSSIBLE CAUSES:	Signals not on proper pins.
ACTION:	Use a breakout box* to determine which signals are operating. Refer to Figure 2-4 for I/O signals.

* A breakout box is a device that monitors interface signals and allows signals to be enabled, disabled, crossed over (swapped), and bussed.

5.9.3 NO TRANSMIT

W A R N I N G

THE TRANSMITTER BOARD OUTPUTS VOLTAGES IN EXCESS OF 800 V P-P. THIS VOLTAGE IS PRESENT AT TR-P4 AND THE HYDROPHONE OUTPUT CONNECTOR CH-J1.

SYMPTOM:	No transmit LCD indicator
POSSIBLE CAUSES:	If TRANSMITTER parameters set correctly, then SPB is faulty.
ACTION:	Replace SPB.

SYMPTOM:	Transmit LCD indicator OK. But no sound from transmitter board inside CDU. (May need to remove panel from case to hear it.)
POSSIBLE CAUSES:	Connector to transmitter board loose or defective.
ACTION:	Check connector and plug.

or...

POSSIBLE CAUSES:	Transmitter board defective.
ACTION:	Replace board.

SYMPTOM:	Transmit LCD indicator OK, sound from transmit board OK, but no sound from transmitting transducer in hydrophone.
POSSIBLE CAUSES:	Output plug on transmitter board faulty or loose.
ACTION:	Check wires.

or...

POSSIBLE CAUSES:	Deck cable faulty
ACTION:	Perform check as in section 5.4.

or...

POSSIBLE CAUSES:	Transmitting transducer faulty.
ACTION:	Contact ORE Offshore

5.9.4 NO TRACKING

SYMPTOM:	No LCD reply indicator. No audio.
POSSIBLE CAUSES:	No active sound source in water.
ACTION:	Place a known compatible sound source in water. (Check frequencies settings)

or...

POSSIBLE CAUSES:	Faulty deck cable connections or water in connector.
ACTION:	Check connectors at CDU and hydrophone.

or...

POSSIBLE CAUSES:	Hydrophone or cable faulty.
ACTION:	Contact ORE Offshore

SYMPTOM:	No LCD reply indicator. Some audio signal present, but not strong enough to be detected.
POSSIBLE CAUSES:	Wrong frequency.
ACTION:	Check frequency of receiver and source.

or...

POSSIBLE CAUSES:	Threshold too high.
ACTION:	Lower threshold.

SYMPTOM:	LCD reply indicator OK, audio OK.
POSSIBLE CAUSES:	Data very poor, rejected by CDU, Warning code#1.
ACTION:	Check acoustic conditions for excessive noise, multipath, etc. See section 4.6.

SYMPTOM:	No data on RS-232C serial port.
POSSIBLE CAUSES:	Alphanumeric display not in the TRACK mode.
ACTION:	Press the MENU/TRACK button on the CDU front panel.

or..

POSSIBLE CAUSES:	Faulty Signal Processor/CPU assembly.
ACTION:	Replace Signal Processor/CPU assembly.

5.9.5 POOR TRACKING

SYMPTOM:	Erratic unreliable bearings: LCD indicator OK, single update for each transmit.
POSSIBLE CAUSES:	Shadowing (detecting a bounce instead of a direct signal.) Range may be steady but incorrect.
ACTION:	Examine geometry of system and hydrophone location.

or...

POSSIBLE CAUSES:	Signal Processor/CPU assembly is faulty.
ACTION:	Replace assembly.

SYMPTOM:	Erratic bearings and ranges.
POSSIBLE CAUSES:	Electrical Interference.
ACTION:	Shut down all possible sources to confirm cause of problem.

or...

POSSIBLE CAUSES:	Acoustical interference.
ACTION:	Refer to section 4.6.

SYMPTOM:	No audio, no tracking, no updates.
POSSIBLE CAUSES:	Faulty hydrophone.
ACTION:	Air test with known good transponder or responder.

or...

POSSIBLE CAUSES:	Faulty deck cable.
ACTION:	Perform check as in section 5.4.

SYMPTOM:	Bearing OK, range consistent but incorrect.
POSSIBLE CAUSES:	Incorrect turn around time set into transponder or responder.
ACTION:	Correct sound source turn around time or change TAT command via RS-232C serial port.

or...

POSSIBLE CAUSES:	Transmitter repetition interval too fast, detecting multipath from previous signal.
ACTION:	Change REP to a higher value.

or...

POSSIBLE CAUSES:	Using external key and KEY is set for INT or vs.

ACTION:	Set KEY command correctly.
SYMPTOM:	No return reply from sound source.
POSSIBLE CAUSES:	The transmit frequency not set to the correct frequency. (Transponder not hearing interrogation signal.)
ACTION:	Set correct target code into CDU for the interrogation frequency required or change the RFR value via RS-232C serial port.

SYMPTOM:	Transponder mode; a detection occurs immediately following a transmit interrogation. (occurs without sound source in water) (consistent short ranges.)
POSSIBLE CAUSES:	The interrogation frequency or a harmonic* of the interrogation frequency causes a false detection.
ACTION:	Check that this is the problem by changing the transmit interrogation frequency. Fix by changing the transponder's interrogation frequency.

* A harmonic is a multiple of the interrogation frequency. For example, the second harmonic of 17 kHz is 34 kHz and the third harmonic is 51 kHz. The symptom described above will occur if the second, third, or even fourth harmonic is the frequency that the Trackpoint is either listening for or is 12 kHz above what it is listening for. For example, if the Trackpoint hydrophone is a 35 - 45 kHz unit, the transponder has a transmit frequency of 39 kHz and an interrogation frequency of 17 kHz, the 17 kHz transmission from the Trackpoint will cause its receiver to detect following the output burst. This is because the third harmonic of 17 kHz is 51 kHz which is 12 kHz above the Lxt's listening frequency. The same symptom occurs if a 45 kHz transmit beacon has an interrogation frequency of 19 kHz. The third harmonic or multiple of 19 kHz is 57 kHz. This is 12 kHz above the Lxt's listening frequency of 45 kHz.

APPENDIX A:

PARTS LISTS

APPENDIX B:

DIAGRAMS AND SCHEMATICS

APPENDIX C:

GLOSSARY OF TERMS

GLOSSARY OF TERMS

Azimuth	The angle with respect to North. (0 deg. to 359 deg.) Compass Heading.
Beacon	Any underwater sound source. Sometimes abbreviated as "BCN".
Bearing	The angle from the reference point (hydrophone, other target etc..) to the target. (0 deg. to 359 deg.)
CDU	Command / Display Unit - The main processor of the LXT tracking system.
Depression Angle	The downward angle measured from the hydrophone elements to the target. (0 deg. to 90 deg.)
EPROM	Erasable Programmable Read-Only Memory. Nonvolatile memory in which data can be read from.
Horizontal Range	The distance from the hydrophone to the target on the X, Y plane. (plan view)
Hydrophone	An underwater listening device.
Interrogate	To cause a response from an underwater device such as a transponder.
Pinger	An underwater sound source which transmits at a fixed preset rate, asynchronously to a tracking device.
RS-232 Interface	A standard interface for serial communications.
Responder	An underwater sound source which responds to an electrical signal (interrogated via a hardwired link) and returns with an underwater acoustic reply. Sometimes abbreviated as "RSPDR".
Slant Range	The range from a target to the listening hydrophone. (Computed by the travel time from target to hydrophone multiplied by the speed of sound in water.)
Telemetering Beacon	Can either be a transponder or a responder. It outputs two replies in response to an interrogation. The first reply is the navigation reply for the LXT and the second reply is the telemetry reply. The time delay between the two replies is proportional to the sensor output on the telemetry xponder.
Trackpoint II	ORE Offshore’s Model 4410 USBL Tracking System. A high accuracy survey quality acoustic navigation system.
Transponder	An underwater sound source which responds to an underwater signal (device is interrogated acoustically) and returns with an underwater acoustic reply. Sometimes abbreviated as "XPDR".
Turn Around	

Time	A preset time delay, built into a transponder or responder, between when a device is interrogated and when it replies. The delay is calibrated at the xponder to compensate for variations in receiver propagation delays.
USBL	Ultra Short BaseLine - A type of acoustic navigation system which utilizes an array of receiving elements spaced very close together (within inches). (As apposed to Long Baseline Systems)
VRU	Vertical Reference Unit - Used to compensate for pitch and roll motion of the ship.
X	The port (-) to starboard (+) direction which the target is referenced to (e.g., bow of vessel or north).
Y	The aft (-) to bow (+) direction which the target is referenced to. (e.g., bow of vessel or north)
Z	The targets depth. Referenced from the plane of the hydrophone elements to the target.

APPENDIX D:

PRECAUTIONS

A "NOTE" message is used to emphasize a certain operation or condition.

NOTE: "_____."

A "CAUTION" message is noted where an operational hazard to the equipment could exist.

C A U T I O N

A "WARNING" is used where an injurious or life threatening condition to an operator, installer or troubleshooter could occur.

********** W A R N I N G **********

Routinely this system is a commercial target tracking system and should not be used as a life saving device with manned submersibles.

ORE Offshore

25 Bernard St. Jean Drive, East Falmouth, MA 02536-4420 USA

Phone: 508 495 3200 Fax: 508 495 4500 www. ore.com

APPENDIX E:

WARRANTY

WARRANTY

Incoming Inspection

If shipment is incomplete or has been visibly damaged in transit, have the transportation agent note the complaint on the freight bill. If damage is not discovered until the carton is opened call the transportation company and request an inspection by the carrier or their agent for concealed damage. This must be done within 15 days. Do not destroy carton or packing until inspected.

Damage Claims

File all claims against CARRIER enclosing proper documentation. In accordance with I.C.C. regulations, it is the responsibility of the CONSIGNEE to file the claim if shipment is made F.O.B. point of origin. Factory responsibility CEASES when carrier accepts the merchandise in good order, and title to the merchandise passes to the consignee.

Warranty

ORE Offshore warrants its products against defects in materials and workmanship for a period of one (1) year from the date of delivery. During this period, on satisfactory proof of such defects, any unit which becomes inoperative may be returned to the factory, prepaid, for repair or replacement, at the option of ORE Offshore. If the defect(s) is (are) not the result of improper usage, service, maintenance, or installation and equipment has not been damaged or abused after delivery nor modified by anyone other than an authorized employee or representative ORE Offshore, ORE Offshore, shall repair or replace at the option of ORE Offshore, the part or parts which are defective. No returns will be accepted unless prior authorization has been received from Seller and an ORE Offshore, Return Merchandise Authorization (RMA) Number has been assigned.

This warranty applies only to the original purchaser and only if the equipment has been installed and operated in accordance with the published Operation and Maintenance Manual, or in a manner approved by ORE Offshore, or its representatives.

No other warranty is express or implied and in no event shall ORE Offshore, be responsible for collateral or consequential damages.

Return Shipment

Store the packing crate and its packing material in a dry place for reshipment or future storage. Make sure when replacing unit that it is kept from shifting inside the box.

Customer Service

Should a problem arise during operation, refer to the relevant sections of this manual to determine possible cause. If necessary, technical assistance will be provided by the nearest ORE Offshore office.

ORE Offshore
25 Bernard St. Jean Drive
East Falmouth, Massachusetts 02536-4420 USA
Phone: (508) 495-3200
Fax: (508) 495-4500
Email: info@ore.com