SI-TEX®

MODEL 787

DUAL - AUTOMATIC LORAN C RECEIVER

JANUARY 1983

INSTALLATION - OPERATION MANUAL

SPECIFICATIONS

SI-TEX Model 787

	Frequency	100 KHz
	Sensitivity	Less than 5uVolts/Meter
	Maximum Input Level	0.3 Volts
	Tracking Velocity	0-40 knots
	Settling Time	3 minutes at 0 db (nom)
	Power Drain	11 - 15 VDc 0.5A NEGATIVE GROUND ONLY
	Ambient Temperature	0 - 50°C
***	Notch Filter	2 internal present, 1 optional
	ComPuNav Course Computer	Built-In For TD Operation
	Data Output	Serial Cross Track For Auto Pilot NMEA 0180 Inverted and for 755 Remote Display
	Mounting Dimensions	5.8W x 6.6H x 3.2D Inches
	Antenna Coupler with 15	May be mounted directly on extension
	Meters (49') of Cable	Pole or attached with hose clamps.
	Case Construction	Super Splash proof
	Display	LCD Backlighted
	Controls	Membrane Keyboard
	Alarms Audible	Touchtone Keyboard, Proximity Alarm
	Alarms Visual	In LCD Display for Cycle Select, Sig/Noise, Station Blink
	Options	Model 755 Remote Dual Display, Weather Resistant. 32ft. cable supplied. Flush Mount available.

*** Installation of Optional Notch filter is recommended for operation in certain areas:

a) Anywhere within 20 miles of a high power, high frequency radio transmitter such as High Seas Ship to Shore stations, High Power Navy stations on East and West Coast USA.

b) In areas where LORAN A and DECCA NAVIGATION systems are in operation, such as East and West Canada and other foreign countries of Europe and Asia.

c) The U.S. Coast Guard provides an Interference list in Loran C Users Handbook M16562.3 which describes the areas of interference.

FEATURES

Your Model 787 has been designed to provide accurate and reliable Loran C radio navigational data. The following list of features describes the capabilities which make it one of the most versatile Loran C receivers available:

* Programmable GRI for operation in most Loran C chains located throughout the world.
* Fully automatic, Microprocessor controlled operation. Once the GRI and Secondaries are selected, acquisition, cycle selection and settling are automatic.
* Automatic tracking of Master station and all useable secondaries.
* Dual LCD displays simultaneously display two TD's of the selected secondaries.
* Repeatable accuracy, 50 to 1500 Ft. depending on TD's used and the gradient of TD's.
* Always ON memory retains the entered GRI, the secondary stations selected and all data programmed or stored in 8 memory locations even when Power is turned off. Once entered the data remains stored until it is cleared.
* Auto-Start when receiver is turned on. You usually never need to enter the GRI again.
* Waypoint programming in Seven (7) memory locations.
* Immediate entry of eighth programmed waypoint.
* Memory indicators when data is entered or recalled.
* Instant Memory feature stores present position TD's in memory number 8.
* Sealed keyboard with touch-tone operation.
* Proximity alert - tone sounds at approximately 2 second intervals when within 0.5 microseconds of programmed destination.
* Elapsed time counter Hours/Minutes
* ComPuNav Operation (computerized navigation), to compute and guide you along the course to the desired destination (waypoint), automatically computes the Cross Track Error, Distance to Go (Range) and Time to Go to the destination.

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MODEL 787

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ILLUSTRATIONS

APPLICABLE LORAN-C CHAINS

GRI	M/S	STATION	CHAIN	CODING DELAY
4990	M X Y	JOHNSTON IS UPOLO PT, HAWAII KURE IS, HAWAII	CENTRAL PACIFIC	11,000 μ sec 29,000 μ sec
5990	M X Y Z	WILLIAMS LAKE, BC SHOAL COVE, AK GEORGE, WA PORT HARDY	CANADIAN WEST COAST	11,000 μ sec 27,000 μ sec 41,000 μ sec
7930	M W X Z	ANGISSOQ, GREENLAND SANDUR, ICELAND EJDE, FAROE ISLANDS CAPE RACE, NEWFOUNDLAND	NORTH ATLANTIC	11,000 μ sec 21,000 μ sec 43,000 μ sec
7960	M X Y	TOK, AK NARROW CAPE, AK SHAOL COVE, AK	GULF OF ALASKA	11,000 μ sec 26,000 μ sec
7970	M X W Y Z	EJDE, FAROE ISLANDS BO, NORWAY SYLT, GERMANY SANDUR, ICELAND JAN MAYEN, NORWAY	NORWEGIAN SEA	11,000 μ sec 26,000 μ sec 46,000 μ sec 60,000 μ sec
7980	M W X Y Z	MALONE, FL GRANGEVILLE, LA RAYMONDVILLE, TX JUPITER, FL CAROLINA BEACH, NC	SOUTHEAST U.S.	11,000 μ sec 25,000 μ sec. 43,000 μ sec 59,000 μ sec

APPLICABLE LORAN-C CHAINS (cont)

GRI	M/S	STATION	CHAIN	CODING DELAY
7990	M	SIMERI CRICHI, ITALY	MEDITERRANEAN SEA	
	X	LAMPEDUSA, ITALY		11,000 μ sec
	Y	KARGABARUN, TURKEY		29,000 μ sec
	Z	ESTARTIT, SPAIN		47,000 μ sec
8970	M	DANA, IN	GREAT LAKES	
	W	MALONE, FL		11,000 μ sec
	X	SENECA, NY		28,000 μ sec
	Y	BAUDETTE, MN		44,000 μ sec
9940	M	FALLON, NV	U.S. WEST COAST	
	W	GEORGE, WA		11,000 μ sec
	X	MIDDLETOWN, CA		27,000 μ sec
	Y	SEARCHLIGHT, NV		40,000 μ sec
9960	M	SENECA, NY	NORTHEAST U.S.	
	W	CARIBOU, ME		11,000 μ sec
	X	NANTUCKET, MA		25,000 μ sec
	Y	CAROLINA BEACH, NC		39,000 μ sec
	Z	DANA, IN		54,000 μ sec
9970	M	IWO JIMA, VOLCANO ISLAND	NORTHWEST PACIFIC	
	W	MARCUS ISLAND, JAPAN		11,000 μ sec
	X	HOKKAIDO, JAPAN		30,000 μ sec
	Y	GESASHI, JAPAN		55,000 μ sec
	Z	YAP ISLAND, U.S.A. TRUST		75,000 μ sec

APPLICABLE LORAN-C CHAINS (cont)

GRI	M/S	STATION	CHAIN	CODING DELAY
5930	M	CARIBOU, ME	NEW CANADIAN	
	X	NANTUCKET, MA		11,000 μ sec
	Y	CAPE RACE, NEWFOUNDLAND		25,000 μ sec
	Z			38,000 μ sec
9990	M	ST PAUL PRIBILOFF IS, AK	NORTH PACIFIC	
	X	ATTU, AK		11,000 μ sec
	Y	PORT CLARENCE, AK		29,000 μ sec
	Z	NARROW CAPE, AK		43,000 μ sec
5000	M	SAKHALIN		
	X	KAMCHATAKIY		11,000 μ sec
	Y	VLADIVOSTOCK		30,000 μ sec
5970		NOT AVAILABLE AT PRINTING	KOREA	

GLOSSARY OF TERMS

A partial list of terms used with Loran C is presented herein. Additional information can be obtained from the sources referenced in this manual.

Accuracy. Absolute position accuracy as opposed to repeatable accuracy.

Acquisition. (or search) is the process of establishing the approximate location in time of the master and each of the selected secondaries with sufficient accuracy to permit subsequent settling and tracking.

Additional Secondary Factors ASF. Factors accounting for variations in Loran signal velocity caused by changes in the conductivity of the earth's surface.

Antenna. A device that converts electromagnetic waves to electrical signals.

Antenna Coupler. A device that converts and pre-processes the electrical output of the antenna to the signal level and impedance necessary to drive the receiver.

Baseline. A projection of the great circle line joining the Master and Secondary stations.

Baseline Extension. An extension of the Baseline formed by projecting the Baseline through the Master and Secondary stations in either direction.

Blink. A loran system alarm warning the operator of technical problems or faulty timing at any of the loran transmitters.

Chain. A group of Loran C transmitting stations identified by a specific GRI.

Coding Delay. The difference in time of transmission between the Master and secondary station.

ComPuNav CPN. The automatic computation of Cross-track-error, distance-to-go (RANGE) and time-to-go to a Waypoint (WP) which is presented on the Loran C receiver displays.

Conductivity. The electrical properties of the earth's surface which affects the speed at which loran signals travel over ground paths. See ASF Additional Secondary Factors.

Crossing Angle. The angle-from 0 to 90 degrees- at which the two Lines of Position (LOP's) intersect.

Cross-Rate/Cross-Chain Interference. Loran signal interference crossed by signals from another chain.

Cross Track Error XTE. The computed off-course deviation (to left or right) from the course between the point of origin (PO) and the desired destination or waypoint.

Cycle Slip. Failure of the receiver to maintain synchronization and alignment of the phase code of the Loran C pulses which can cause time difference measurement errors in multiples of 10 microseconds.

Desired Destination-DD. A Waypoint - a position or location to which the Loran C user wishes to travel consisting of the intersection of two Lines of Position (LOP's).

Dual Rated Station. A loran station which operates in two loran chains.

Fully Automatic Loran Receiver. Equipment that, after the initial selection of the chain, automatically acquires the master and secondaries, settles, cycle selects, tracks the signals, and periodically updates the lines of position without manual manipulation of knobs or panel controls.

Gradient. The Time Difference separation between Lines of Position, (specified in microseconds). Gradients vary accordingly with selection of Master-Secondary pairs.

GRI-Group Repetition Interval. The time coded delay a 4 digit number used to identify the group of transmitter stations in a specified Loran C Chain.

Ground Wave. The path along the curvature of the earth which the Loran C signals follow.

In-Band Noise. Any electrical interference which occurs within the Loran C band of 90 KHz to 110 KHz.

Ionosphere. An atmospheric layer above the earth's surface, varying in altitude between 25 and 250 miles, which reflects radio waves.

Land Path Variable. The factor used to compensate for the difference in Loran C signal velocity over seawater, flat land, mountains and various terrain.

Line of Position-LOP. A graphical plot of all observation points having the same constant measured time difference (TD) between the master station and the secondary stations. The graphical plot forms the line of position printed on the Loran C Chart.

Loran C System. A long range navigation system that operates at an assigned frequency of 100 KHz. It utilizes pulsed signals from widely spaced transmitting stations and measures the difference in arrival times of the pulses to determine position relative to the transmitting stations.

Loran Fix. The position or location established by the intersection of two LOP's.

Maximum Operating Range. The maximum distance within the prime coverage area where loran reception is possible within a specified accuracy and a specified signal to noise ratio.

M-Master Station. The controlling station of the Loran C Chain which transmits the reference timing signals.

Minimum Operating Range. The range, 5 to 20 miles, wherein the receiver may not track the desired cycle, thus causing displayed errors in increments of 10 microseconds.

Notch Filters. A narrow band noise filter used to tune out interference near the Loran C Band.

Point of Origin. A starting point of a navigational operation. The position or location at the intersection of two LOP's, indicated by the receiver at the instant the ComPuNav (CPN) mode is initialized.

Receiver. A device that processes Loran signals from the antenna coupler and measures the difference in arrival time of the selected signals representing the measured parameter.

Repeatability. The ability to return to a particular position or location using Loran C navigation aids.

Secondary Station. Any transmitting station in the Chain that is not the master station. Secondaries are usually designated W, X, Y and Z and referenced to the master M station GRI.

Settle. Is the process of automatically aligning the phase codes, identifying the correct cycle zero-crossing, establishing ground-wave tracking, and indicating that time differences are valid.

Signal to Noise Ratio. The ratio of Loran signal strength, at the TIMING point, to the in-band noise.

Skywave. A Loran C signal transmission which is reflected by the ionoshpere. These signals are less accurate than the ground wave signals.

Time Difference-TD. Time difference is the time of arrival of the secondary signal minus the time of arrival of the master signal, as observed on a single receiver.

Tracking. Is the process of maintaining the synchronization of the receiver with the selected signals.

Waypoint. A destination, a position or location, to which the Loran C user wishes to travel, consisting of the intersection of two Lines of Position (LOP's).

SECTION 1.0
INTRODUCTION

This instruction book provides the operator with a description of the operating capabilities of the Model 787 Loran C Receiver and how to use it as a navigation aid. Before you install your Model 787, it is recommeneded that you read the instructions carefully and thoroughly to become familiar with the installation requirements and the operating procedures. This fundamental knowledge is essential for proper operation.

CAUTION

Your new SI-TEX Model 787 Loran C Receiver is intended for use as a Navigation Aid. Navigational information derived using your Model 787 can be accurate, however, the information should always be double-checked using other means available to determine the accuracy and reliability of the data.

Your Model 767 Receiver must be used in conjunction with certified nautical charts containing LORAN-C information. Nautical chart catalogs are available from local chart dealers who can help you determine which charts are required for your area of interest. Charts may be obtained from local chart dealers or they can be obtained by mail from the following sources.

National Ocean Survey
Distribution Division (C-44)
Riverdale, MD 20804
301-436-6990

Chart catalogs are also available from N.O.S. at no charge. The catalogs show which charts are available and whether they contain Loran C data for U.S. Coastal waters.

Canadian Hydrographic Services issues Loran C chart catalogs and charts for the Canadian East Coast, West Coast and Great Lakes areas and can be obtained from:

Canadian Hydrographic Services
Department of Fisheries and Environment
Ottawa, Ontario K1A 0E6, Canada

For other areas outside of U.S. Coastal waters, (i.e., Mexican waters and other areas of the world) chart catalogs and charts can be obtained from:

Defense Mapping Agency
Topographic Center, ATTN: DDCP
6500 Brookes Lane
Washington D.C. 20315

1.1 PRECAUTIONS WHEN USING LORAN C CHARTS

First editions of Loran C charts are based on predicted coverage rather than on actual field measurements. In most cases the predicted data is quite accurate. However, in a few instances, there may be some large errors. The user of Loran C navigation equipment should know about these problems. Loran C coverage for subsequent chart editions have to be verified by actual measurements, but the user is advised to check regularly to determine navigational changes or other problems.

The U.S. Coast Guard provides information related to Loran C and it is available from the local District offices. Write or telephone:

Loran C Education and Information
U.S. Coast Guard Headquarters (G-NRN/TP14)
Washington D.C. 20593 Telephone 202-472-5857

Owners and operators of Loran C equipment are advised to obtain a copy of the "LORAN-C USERS HANDBOOK" COMDTINST M16562.3.

The handbook provides information to the user concerning the Loran C system, the use of Loran C receivers, interference problems, nautical charts and tables and list of other sources of information useful to the navigator.

1.2 LORAN C NAVIGATION

Loran C is a valuable aid to navigation, however, it should always be used in conjunction with other navigation aids available to the mariner. The compass provides the indications for direction of travel to a destination and should always be used for navigation. Buoys, lights, landmarks, depth soundings, radar, range markers, radio direction finding and celestial observations provide additional means to establish you position and to verify information provided by your navigational instruments.

Loran C and computerized navigation systems can provide accurate navigational data. It can save travel time, increase safety and reduce cost. Various factors influence the accuracy of the system. Each component in the system contributes some error because of accuracy limitations. How you operate your navigational equipment and plot your position using charts is important. This also contributes some inaccuracies to the navigation system. The prudent mariner should never rely on any one system.

1.3 WHAT IS LORAN

LORAN is an acronym meaning Long Range Aid to Navigation. It is an electronic navigation system using shore-based radio transmitters and shipboard receivers. Loran provides the means to allow mariners to determine their position or location at sea.

Using Loran C does not require any special technical skill or knowledge. Although the Loran C system is very complex, it is not necessary to understand the system completely to use it as a navigation aid. However, a more extensive knowledge will provide more effective use of the system.

1.4 LORAN C SYSTEM

The Loran C system is a pulsed low frequency (100 KHz) hyperbolic radio-navigational system that utilizes a chain or group of shore-based transmitting stations. Each chain or group is comprised of a Master (M) transmitting station and two or more Secondary transmitting stations. The stations of the Loran C Chain transmit groups of pulses at specified Group Repetition Intervals (GRI). This GRI is used to identify the Loran C Chain for a designated area of coverage.

1.4.1 GRI Designation. The Group Repetition Interval (GRI) is specified in microseconds and the GRI for each chain is selected such, that it contains a sufficient time interval for transmission of pulse groups from each station, plus, allowing time between each pulse group, so that the signals from two or more stations cannot overlap (in time) anywhere in the coverage area.

The Group Repetition Interval rate structure used for Loran C operation will be between 40000 microseconds and 99990 microseconds.

A Loran C GRI chain is designated by the first four (4) digits of the GRI rate. For example, 7980 designates the GRI rate for the Southeastern United States Loran C chain. The GRI's for all other areas of coverage is presented in this manual.

Each station transmits one pulse group per GRI. The Master (M) pulse group consists of eight pulses spaced 1000 microseconds apart and a ninth pulse 2000 microseconds after the eighth pulse. Each secondary station pulse group consists of eight pulses spaced 1000 microseconds apart.

The ninth pulse of the Master is used to provide identification of the Master station. Secondary stations having transmission error problems also blink by turning the first two pulses of the group off and on to activate the receiver alarm circuits.

Further information related to blink codes can be obtained from the references cited in this book.

1.4.2 LORAN C CHAIN

Each Loran C chain provides navigational data for a predetermined coverage area. Within the chain, one transmitter is designated the Master (M) station and provides the basis for identification and synchronization of the Loran C chain. The other transmitters are designated as Secondary stations and for convenience are generally identified as station W, X, Y and Z and are referenced to the specific Master station. All pulsed signals transmitted by Secondary stations are synchronously timed with the Master station. These synchronized pulses are transmitted at precise time intervals, and the intervals are adjusted such that signals transmitted by each secondary will arrive at the receiver at a different time. The Loran C receiver is used to process the pulsed signals and to measure the difference in the time-of-arrival, that is, the slight difference in time required for the transmitted pulses to reach the shipboard receiver from each of the transmitters. This difference in time is referred to as Time Difference (TD). TD's are measured in microseconds (millionths of a second). Loran C derives it's accuracy from the precise measurement of the TD;s in microseconds and from the inherent stability of low frequency signal propagation.

The following examples will provide the user with a better view of the system.

The Loran C hyperbolic navigation system operates on the principle that the measurement of the difference in time-of-arrival of signals from two stations, when observed at a specific point in the coverage area, is a measure of the difference in distance from the observation point to the two stations. Thus, the Time/Distance relationship is established. Navigation using Loran C requires the use of the Master (M) station and any two Secondary stations W, X, Y or Z of the same Loran C chain, to measure the Time Difference/Distance Difference from the observation point to the two stations.

Generally, the Loran C receiver must be programmed to recognize and identify the Master station GRI of the Loran C chain. Once programmed, the receiver can measure the TD's and present them on a digital readout display. Figure 1 illustrates a typical Loran C chain configuration. The Master (M) and Secondaries W, X, Y and Z are separated by several hundred miles.

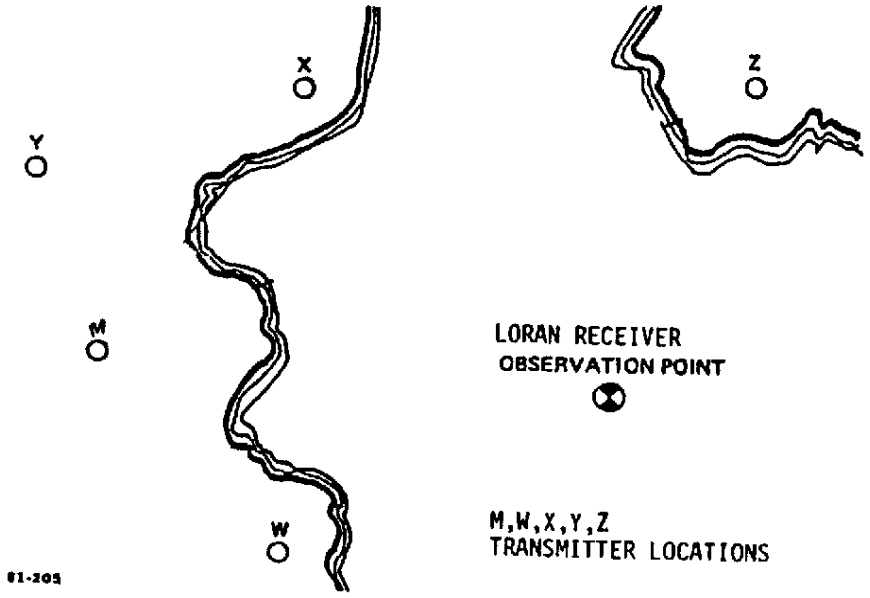


Figure 1. Typical Loran C Chain Configuration

In Figure 2, the Master (M) and two Secondaries W and X are used for an example. The Master (M) station transmits synchronized Loran C pulses at precise time intervals. The receiver, located at an observation point, synchronizes on these pulses. At precise time intervals later (after the Master station transmission), each Secondary station, W and X, transmit synchronized pulses in timed sequence. The receiver at the observation point measures the slight TD's required for each of the pulses to reach the observation point from the transmitter stations. Your Loran C receiver presents each of the measured Time Differences on the display.

In the example of Figure 2, the TD measured from station W to the observation point is designated TDW and the TD measured from station X is designated TDX. A graphical plot (a line drawn through the locus of all points) of all observation points, having the same constant measured TD (i.e., distance difference) between M and W, the two stations, is a hyperbola and this line is called a Line Of Position LOP-W relative to stations M and W. From the example of Figure 2 it can be seen that the observation point (position) is located somewhere along LOP-W plotted on the chart.

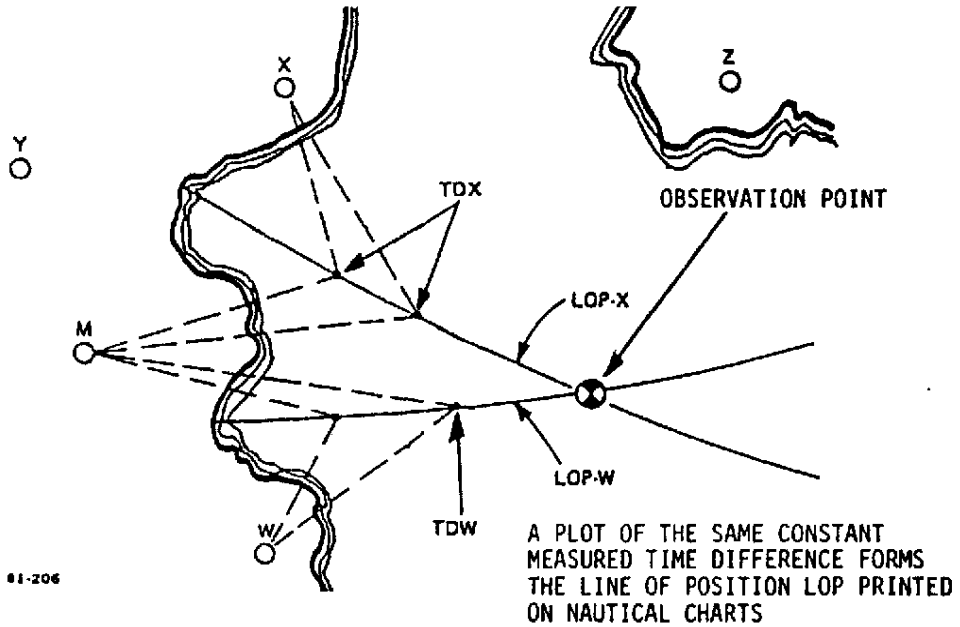


Figure 2 Sample Plots

Likewise, from the example of Figure 2, a graphical plot of the same constant measured time difference between M and X forms a Line of Position LOP-X relative to stations M and X, and it can be seen that the observation point is also located somewhere along LOP-X. These Lines of Position are plotted on a Loran C nautical chart and used as navigation aids to determine your position. The intersection or crossing point of the two LOP's is the observation point or position where the receiver is located on a boat.

Since the Time Differences TD's are measured in microseconds, the graphical lines forming the LOP's are designated in microseconds. Thus, a LOP is designated by a number, in microseconds, having the same constant measured time difference. The LOP's are plotted on Loran C nautical charts for the designated areas of coverage of each Loran C chain. The LOP numbers displayed on the receiver are compared with the same numbers on the nautical chart and the intersection of the LOP's on the chart represent your position or location in the coverage area.

The operator of a Loran C receiver can navigate to and from positions located on the Loran C charts, using the Lines of Position indicated by the receiver to determine the course to a waypoint or destinations. Arrival at a destination is indicated when the LOP's displayed on the receiver correspond to the LOP's printed on the chart.

The example presented herein used secondary stations W and X to demonstrate the use of the Loran C system. Any two secondaries can be used in combination to provide the same navigational data and any other secondary can be used to verify the data when used in conjunction with either or both of the other secondaries.

1.5 USING THE LORAN C SYSTEM FOR NAVIGATION

Use of the Loran C system begins at the receiver. The user/operator must be familiar with all of the various factors which influence and affect the accuracy when establishing position. Overall accuracy is the result of individual accuracies such as the selection of the best secondary stations, plotting a loran fix indicated by the unit and interpolation between LOP's using the charts.

1.5.1 Selecting the Chain. The first step is to decide which chain to use and which secondaries to use. In certain areas, only one chain is available. In other areas, two chains provide overlapping coverage. You must select the chain which will provide the best coverage for your area of operation.

1.5.2 Selecting the Secondaries. The second step is to decide which secondary stations to use. The two secondary stations should be chosen to provide the greatest navigational accuracy. The chains have been designed to give two LOP fixes for all of the coverage area. You can use two secondaries in one section of the coverage area and then use two different secondaries in another section of the coverage area. Or, you can use any of the secondaries to cross check the accuracy of the fix provided by the two chosen secondaries. The most important factors to consider when selecting secondaries are (1) the crossing angle of the LOP's and (2) the gradient between the secondary LOP's. The operator should choose the best combination of crossing angle and gradient to obtain the desired accuracy.

LOP CROSSING ANGLES

Choose the secondary LOP's that provide the greatest crossing angle. A crossing angle of 90 degrees would be ideal, however, this is almost never possible. Therefore, choose the best possible crossing angle. Whenever possible, do not choose LOP's which provide a crossing angle of less than 30 degrees. Choosing

LOP's less than 30 degrees does not present a measurement problem. Your receiver will measure all Time Differences with equal accuracy. The problems occur when the LOP's are used for plotting a fix and when interpolating between LOP's. It becomes difficult to establish a position on the chart when the two LOP's cross at small angles and present nearly parallel lines.

LOP GRADIENT

Choose the secondary LOP's so that the gradient, or time difference separation, Figure 3, between the LOP's represents the smallest distance per microsecond. In certain locations, a gradient of 10 microseconds between the LOP's on the chart may represent one mile distance, where as, a gradient of 10 microseconds between the LOP's of another secondary may represent five miles distance, or more, depending on the location and the distance from the Master-Secondary pair.

1.6 BASELINE EXTENSION See Figure 3

Do not use the Master-Secondary pair in the vicinity of the Baseline Extensions. When operating in these areas, the microsecond gradients change rapidly because of the hyperbolic nature of the LOP's. There is great possibility of introducing large errors in position because you may not be able to determine which side of the baseline you are on. Baseline Extensions areas are marked on the Loran C charts. When encountering these conditions, choose an alternate secondary station and avoid the use of that secondary station in the Baseline Extension area.

1.7 ASF, LANDPATH DELAY OR GRIDWARP.

Another factor to consider when using the Loran C navigation systems is the Additional Secondary Factors (ASF) or land effect, which causes a small difference in the Time Difference readings on the receiver compared to the Lines of Position (LOP's) plotted on the charts. The LOP's printed on the charts are those which you would obtain on the displays if the Loran signals traveled over an all-seawater path. However, this is not the case. The loran stations are usually located inland and the signals must travel some distance over a land path. This land effect causes the loran signals to travel slower, thus, requiring a slightly

longer time difference to reach the receiver. Loran C charts contain adjustment factors for this ASF however an average value was used for making the charts. In some locations there will be a difference, since ASF can vary with locatio'.. Future charts are expected to contain more accurate information using varying values for ASF corrections.

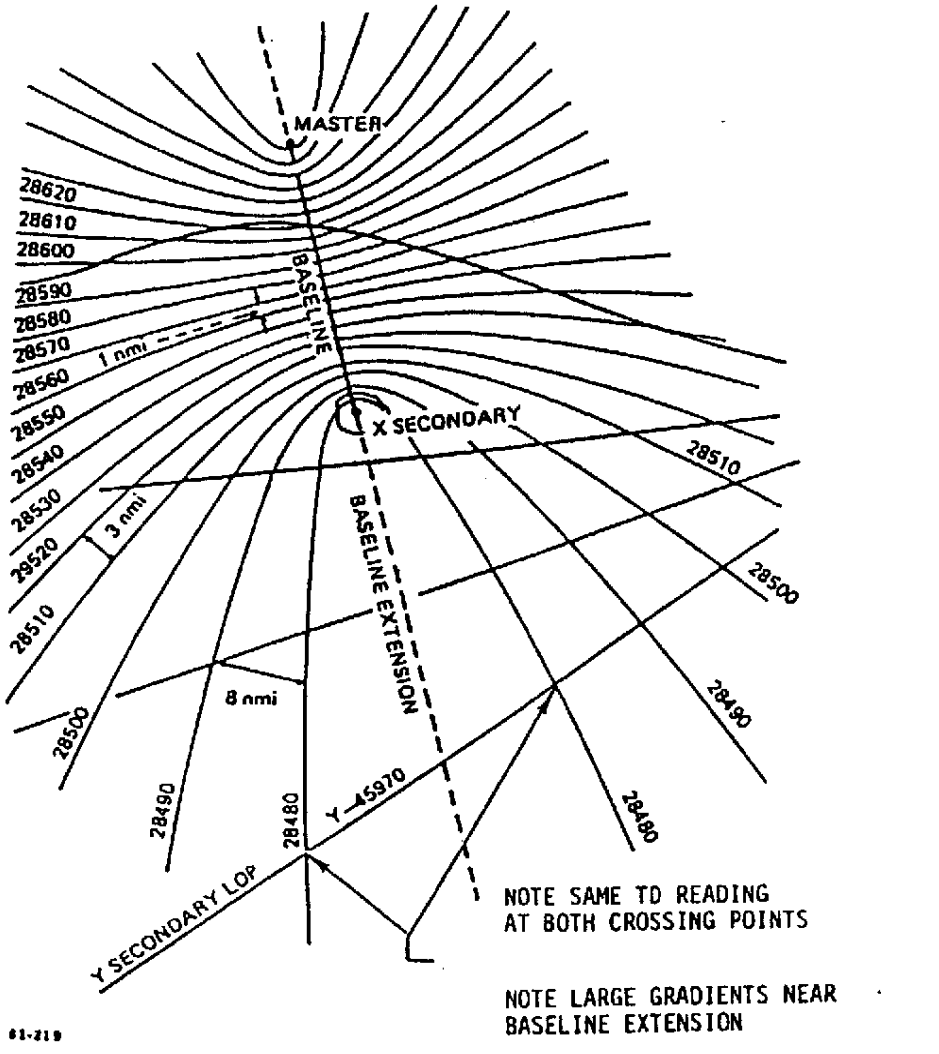


Figure 3. Baseline Extension

Converting Time Difference Microseconds to Nautical Miles.

Some nautical charts contain mileage reference scales. In most cases nautical charts use Mercator projection which generally means that the LATITUDE side of the chart is drawn to a scale of one (1) nautical mile (6000 feet) per MINUTE OF LATITUDE. Either of the above reference can be used to determine the relationship between nautical miles and microseconds for a specific area. The same conversion does not apply for all areas of the loran C chain because the gradient or spacing between the loran lines of position continue to increase as the distance from the loran stations increases. For greatest accuracy the conversion should be made about every 5 or 10 miles or 5 to 10 minutes of Latitude.

"DO NOT USE THE LONGITUDE SCALE"

Procedure:

1. Using a pair of dividers or a ruler, measure the spacing or gradient between two lines of position on the chart. Determine the number of microseconds between LOP's.
2. Transfer this same measurement to the Latitude scale or mileage reference scale. Determine the number of miles for this measurement. 1 Minute of Latitude = 1 NM = 6000 FEET.
3. Example of conversion.
   If the measurement of the LOP gradient produced 10 microseconds equal to 2.0 nautical miles on the Latitude scale,
   10 microseconds = 2.0NM = 12000 feet
   Divide all numbers by 100 to get
   0.1 microsecond = 0.02 NM = 120 feet

   Note that if the nautical mile measurement was 4.0NM then the distance in feet would be doubled, 240 feet. And if the measurement was 1.0NM, then the distance would be one-half or 60 feet per 0.1 microsecond.

ACCURACY OF LORAN

Absolute Accuracy. This is the ability to determine your geographic position using the TIME DIFFERENCES or LATITUDE-LONGITUDE measured by your Loran C receiver. The absolute accuracy of Loran C varies from 0.1 to 0.25 nautical miles (using Loran C nautical charts), depending on your location in the coverage area. Absolute accuracy should be used to know your position if you were visiting a new area or crossing an ocean.

Repeatable Accuracy. This is the ability to return to a position where you have been before and have recorded the TIME DIFFERENCE numbers or LATITUDE-LONGITUDE coordinates. By using the loran C numbers for a particular spot or location, you can obtain the greatest accuracy from Loran C. The repeatable accuracy also depends on your location in the coverage area.

Repeatable Accuracy can be more important and useful than absolute accuracy. You can take advantage of the stability of the Loran C system because the time difference numbers vary only slightly from day to day, for the same location. If you know the location of shoals, sand bars, bottom obstructions etc., you can easily avoid these areas. If you know several good fishing locations, you can return to the same spot with better accuracy.

The user is advised to obtain a copy of "Loran C Correction Tables" to determine the absolute accuracy of loran for your specific area of coverage.

LORAN C ASF CORRECTION TABLES

Pub No.	Chain/Rate
LCPUB2211100C	Canadian East Coast/5930
LCPUB2211200C	Northeast U.S./9960
LCPUB2211300C	Great Lakes/8970
LCPUB2211400C	Southeast U.S./7980
LCPUB2212100C	U.S. West Coast/9940
LCPUB2212200C	Canadian West Coast/5990
LCPUB2212300C	Gulf of Alaska/7960
LCPUB2212400C	North Pacific/9990
LCPUB221	4990
LCPUB221	5960

Each publication covers an entire chain and may be obtained from:

Defense Mapping Agency
Office of Distribution Services
Attn: DDCP
Washington, DC 20315

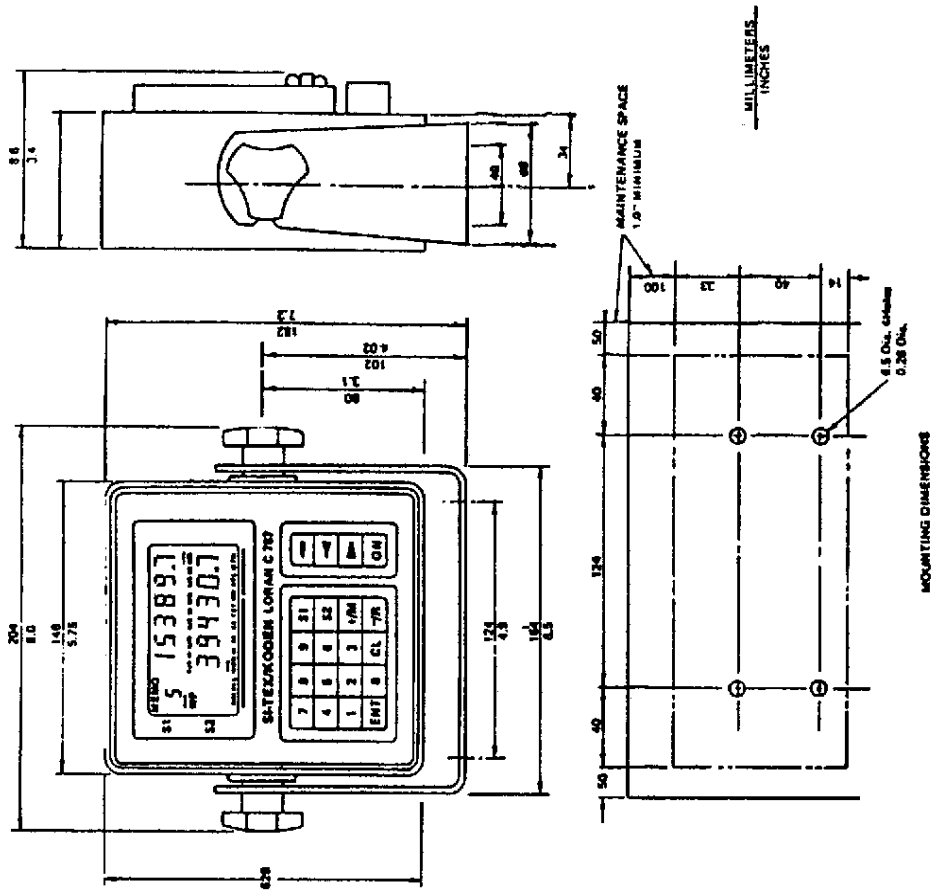


FIGURE 4. MOUNTING DIMENSIONS

SECTION 2.0
INSTALLATION

2.1 RECEIVER MOUNTING LOCATION

Your unit is designed for easy installation, however, the following recommendations are important and should be followed t obtain the most effective use of your equipment:

1. Select a convenient location for the Receiver unit which will provide access for operation and for observing the display information.

2. Install the receiver unit in a location that will provide protection from extreme weather conditions such as direct sea spray, rain and other extreme weather conditions (see Specifications). Water damage is excluded from warranty provisions.

3. Route the Power cable and antenna coupler cable as far as possible from all other electrical cables and electrical equipment that may radiate electrical noise interference.

4. Before finalizing the mounting location for the receiver and antenna coupler, operate the unit for some period of time. Observe any interference or interaction that may occur when the vessel is running and when other equipment is operated.

2.1.1 Receiver Installation. Figure 4 Mounting Dimensions, illustrates the standard table-top mounting configuration with the trunnion mounting located on the bottom of the receiver. For bulkhead or overhead mounting, the trunnion must be repositioned at the top of the receiver.

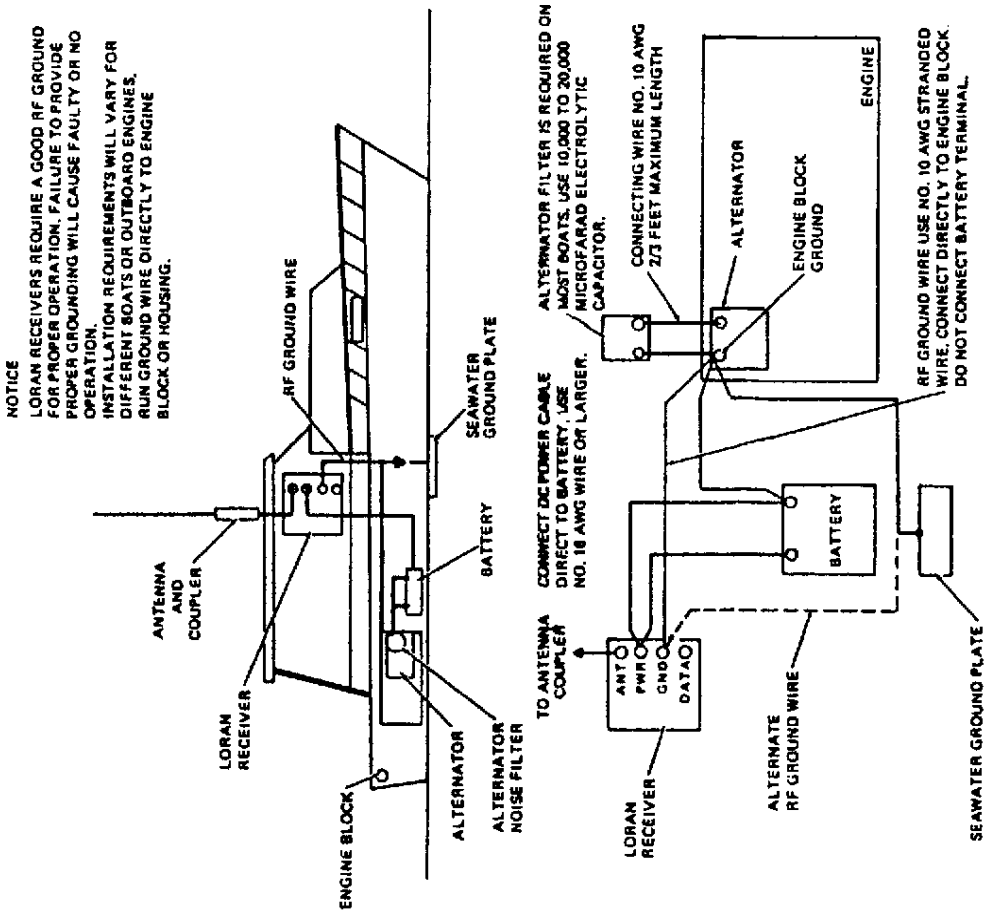


FIGURE 5. TYPICAL INSTALLATION WIRING DIAGRAM

After selecting the mounting location and position, prepare the mounting foundation as follows:

1. See Figure 4 for mounting hole dimensions.

2. The trunnion mount can be removed and used as a template for locating the mounting holes. To remove the trunnion from the unit remove the two mounting knobs on the side of the receiver. Move the receiver forward to disengage it from the mounting.

3. Use the trunnion mount to locate the mounting holes.

4. After the mounting surface has been prepared, mount the trunnion to the table top, bulkhead or overhead using four screws. Tighten all screws securely.

5. Allow adequate clearance around the receiver to provide for installation and connection of cables and ground cables.

6. Observe all precautions described for mounting location.

2.1.2 Antenna/Antenna Coupler Location. Ideally, the antenna and antenna coupler should be mounted on the highest part of the vessel. This is not always possible, however, the antenna must not be located under or within a mass of metal rigging. The metal rigging can cause blind spots within the reception area whenever the rigging is between the antenna and the transmitting station.

1. Choose a location clear of all metal rigging.

2. The antenna coupler should be mounted at least 3 feet or more from the receiver (and the remote display unit, if used).

3 Recommended locations for Antenna and Coupler.
Sail Boats-MIZZEN MAST, HORIZONTAL SPREADER, top of stern rail. Insulated backstay can also be used as an antenna.
Center Console boats-Mount on gunwale or at top of console.
Power Boats-Mount on flying bridge, cabin top or side.

4. The antenna should be mounted in the vertical position and in a location that is accessable for servicing.

5. Locate the Loran antenna as far as possible from all other antennas, particularly, medium and high grequency transmitting antennas. 6 feet horizontal distance and/or 3 feet vertical distance is recommended.

6. The signal quality should be examined at various locations to choose the best location for the antenna. See Operation Section - TEST MODE

2.1.2.1 Antenna Coupler. The Antenna Coupler is provided with 49 feet of coaxial cable and connector attached. If required for installation, the cable may be lengthened to a maximum of 150 feet or shortened to 10 feet minimum. Use type RG58A/U cable. Determine the proper length of cable before finalizing site selection. See Figure 5 for cable-to-plug connection requirements.

2.1.2.2 Antenna Selection. The antenna is not provided. The antenna coupler has been designed and tested to use a standard 7 to 8 foot fiberglass whip antenna. The top of the coupler is designed with a threaded insert (3/8" - 24 thread) to provide for direct mounting of the whip antenna to the coupler.
A long wire antenna can be used (15 feet minimum) in place of the standard whip antenna for emergency use only. Also, the antenna can be mounted remotely from the coupler using insulated wire to extend the connection to the antenna.

CAUTION

Do not use a stainless steel whip antenna. The excessive weight and size may cause physical damage to the coupler housing.

2.1.2.3 Antenna Coupler Mounting. The antenna coupler is designed to be mounted, (Figure 6) on an extension pole or swivel mount (not supplied). The lower section of the coupler housing is designed with a threaded mounting (1" - 14 thread) to mate with standard fiberglass extension poles or swivel mounts.

If a Laydown base mount is used, caulking or sealing compound must be applied around the base of the coupler and the cable entrance to prevent water leakage when coupler is in horizontal position.

As an alternative, the antenna coupler may be strapped to a vertical stanchion using stainless steel house clamps (not supplied).

2.2 POWER REQUIREMENTS AND RF GROUNDING

CAUTION Use NEGATIVE GROUND ONLY

Operating voltage range is from 11 to 15 Vdc only. No changes or adjustments are required for operation within this voltage range. A battery or power source capable of providing a continous current of 1.0 amp at 11 to 15 Vdc is required. The proximity of the power source is not important because of low power consumption. When the operating voltage exceeds 15 Vdc, the unit will shut down automatically. It will not turn ON again until voltage is returned for proper voltage.

2.2.1 Power Connection. Check and verify the power source voltage and polarity before connection to the receiver unit. A three terminal connector is supplied for power connection. Assemble the connector to the power cable before connecting the cable to the power source.

CAUTION

Reverse polarity can damage the receiver unit. Reverse polarity damage is excluded from the warranty provisions.

Do not use an external switch or circuit breaker to energize the Loran unit.

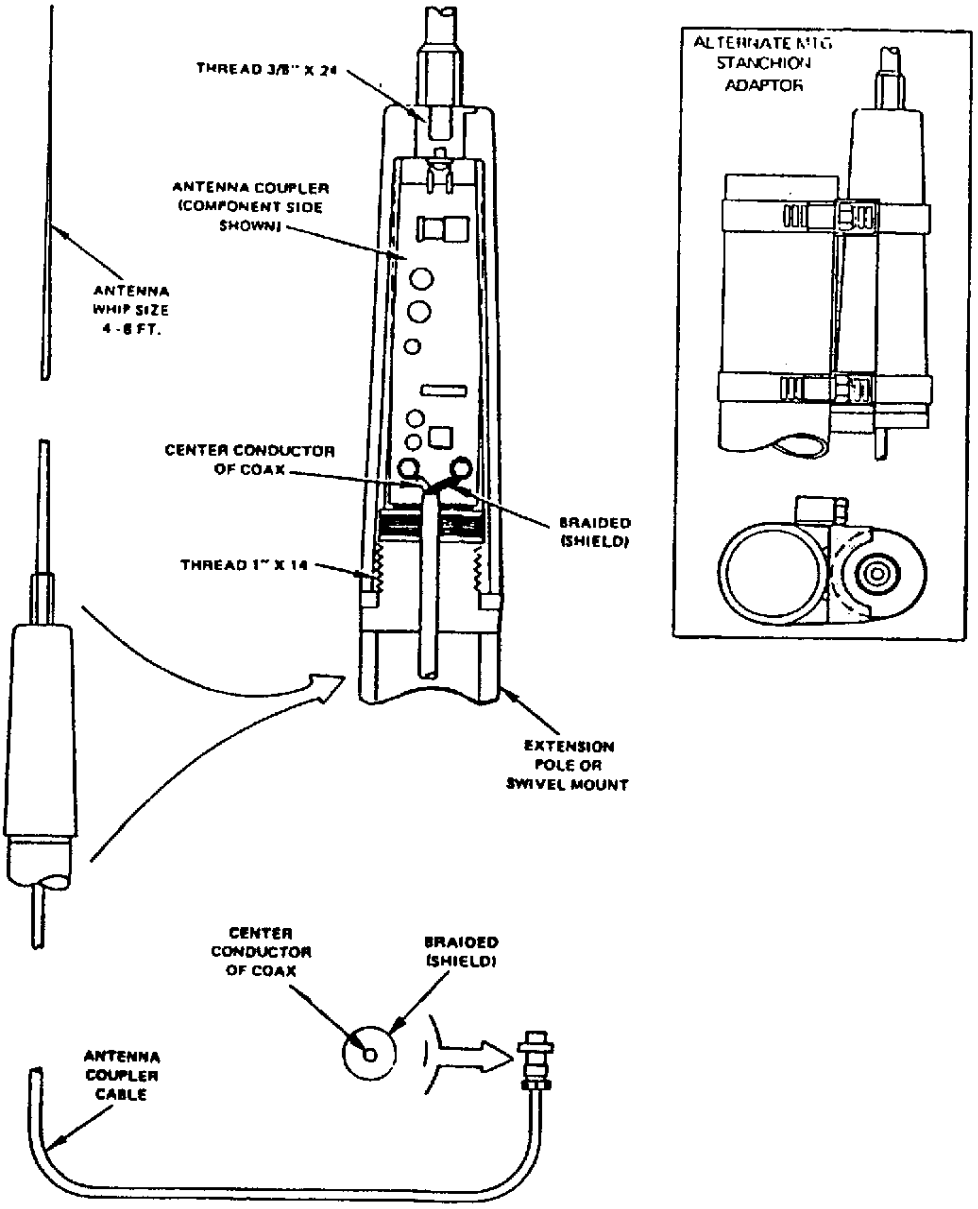
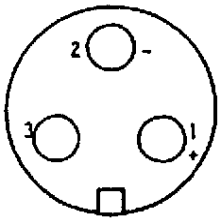


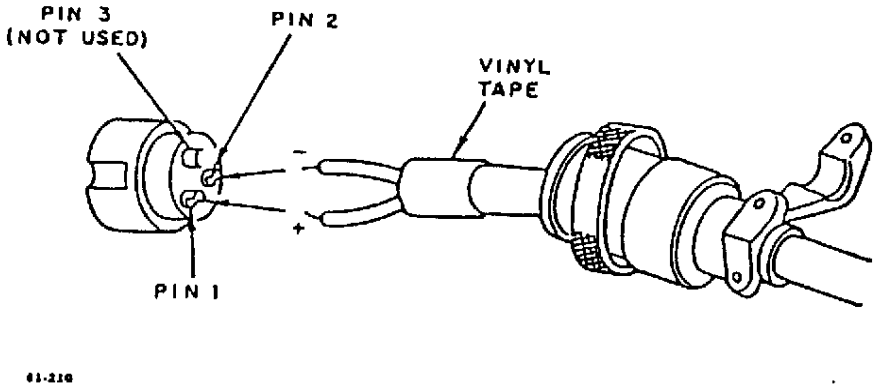
Figure 6. Antenna Coupler Mounting



DC Socket

DC Input Power Connector (Rear View)

Before connecting supply voltage to the receiver, ensure that the polarity of the DC plug is correct.



81-210

Figure 7. DC Power Plug Wiring

Observe the terminal numbers on the body of the connector and

1. Connect the positive (+) wire to connector pin 1.
2. Connect the negative (-) wire to connector pin 2.
3. Assemble the connector to the housing using the screws provided and tighten securely.
4. Exercise caution and remove all excess solder to prevent shorting between terminals and the connector housing.
5. Connect the other end of power cable directly to the battery, if possible.
6. Recheck and verify the voltage polarity before connecting the receiver.
7. Observe the keyway on the power connector when connecting to the receiver. Do not force the connection.

2.2.2 Internal Battery Power. The receiver unit contains a small battery to enable the receiver memory system to store programmed information. The batteries are rechargeable and are continuously under charge only when the Power switch is ON. If the receiver unit is inactive for a long period of time, the batteries may become discharged. The receiver must be operated ON to recharge the batteries.

If the batteries become discharged, the data stored in the memory system will be lost and the receiver will require re-initialization in accordance with specified operating procedures, when the unit is again operated ON.

NOTE

The internal batteries are soldered into the unit. If replacement is necessary, it should be done only by qualified technicians. Excessive damage can occur if they are improperly connected.

2.2.3 Radio Frequency (RF) Grounding.

NOTICE

This Loran unit requires a good RF Ground for proper operation. Failure to install a good ground will result in poor or erratic operation of the Loran and the course computer.

A wing-nut is provided on the rear panel of the receiver unit for connection of the RF ground. Use #10 AWG standard wire for connecting the receiver to the vessel's ground system. Connect ground wire directly to engine block or common seawater grounding plate. The battery negative terminal is NOT a good ground.

Certain types of boats require special grounding systems. Before finalizing the installation, be sure the grounding is effective. Grounding to the engine block may be sufficient, however, in some cases, additional grounding systems must be provided by the user.

2.2.4 Fuses and Fuseholders. Fuses are installed to protect the equipment from overload conditions. A blown fuse usually indicates a trouble condition in the equipment. If a fuse blows continously, have the equipment checked and repaired by a qualified technician.

CAUTION

Do not install a higher rated fuse. Excessive damage may result and your warranty will become invalid.

2.2.4.1 Fuse Replacement. Fuses and fuseholders are located inside the unit on the subassembly. To change fuses:

1. Remove the screws that mount the rear cover.
2. Carefully pull to withdraw the rear panel from the unit. NOTE: Cables are attached to the rear panel. Excercise caution to prevent damage.

3. Replace blown fuses with 2.0 amp in (+) line and 5.0 amp in (-) line.
4. Carefully replace the rear panel onto the unit. Be sure that cables are not broken or disconnected.
5. Replace the rear panel retaining screws.
6. Connect power cable, antenna cable and ground.
7. Operate the unit and check for proper operation.

2.5 ALTERNATOR-GENERATOR INTERFERENCE REDUCTION

Alternators and generators are the most common source of electrical interference to loran operation. In almost all cases, the engine alternator or generator will require some type of filter for noise reduction. The noise may be conducted over power cables or it may be radiated by the boats wiring system whereby it can be received at the antenna system.

SI-TEX recommends installation of a 20,000 microfarad capacitor as the best available noise filter for alternators and generators. This filter must be connected directly at the alternator terminals to be effective.

SEE INTERFERENCE SECTION FOR MORE INFORMATION ABOUT INTERFERENCE AND NOISE REDUCTION

SECTION 3.0
OPERATION

3.1 GENERAL

This section provides instruction for operation of your Loran C Receiver.

Before operating the unit, be sure that is is properly installed in accordance with the instructions of Section 2, Installation.

3.2 DESCRIPTION OF CONTROLS AND INDICATORS

All controls, switches, displays and indicators required for operation are located on the front panel. See Figure 8.

The controls consist of keyboard type push button switches, which are referred to as keys throughout this book. Operation of the controls is performed by pressing the key(s). Each time a key is pressed, the operator will hear a tone or beep to indicate that an operation has been performed. The tone is useful to indicate when a key has been pressed more than one time, so that the operator will be aware that an operation has been performed that may or may not be desireable or required.

3.2.1 POWER ON-POWER OFF-LAMP DIMMER. The ON Key is used to turn power ON and OFF and to dim the backlights in the displays. Do not use external switches or circuit breakers to turn unit on or off. After Power ON, press the ON Key once to brighten or dim the back-lights for night time viewing.
To turn power OFF, press and hold the ON Key for at least 5 seconds until display and lights extinguish.

CAUTION

Once power is OFF, the unit must remain off for 5 seconds or more.

3.2.2 OPERATING MODE INDICATORS. The operating modes are marked on the front panel in the lower part of the display window. They are divided into two groups by two white BAR shaped lines drawn below the display window.

The seven operating modes at the leftside are TD operating modes. They provide Time Difference and loran position information. The three operating modes at the right side are (CPN) ComPuNav Course Computer modes and they provide the course and steering information.

When the Power [ON] Key is pressed, a small BAR shaped indicator will appear in the display directly above one of the operating modes printed on the panel. The position of the small BAR indicates the mode of operation. The operating mode can be changed using the Operating Mode Selection Keys.

3.2.3 OPERATING MODE SELECTOR KEYS.

The four push button keys located at the lower right side of the panel are used to select the operating mode. The BAR [▬] shaped key is used to select one of the two groups of operating conditions, either loran position information of CPN Course Computer information. Each time the BAR Key is pressed, the BAR indicator will move back and forth between the CPN group and the position information group. The BAR indicator will always return to the same operating mode which was selected by the last press of the BAR Key. This is usefull to move between position information and course information while traveling a course.

The two ARROW shaped keys [◀] and [▶] are used to shift the BAR shaped mode indicator from one operating mode to another. Press the left [◀] arrow Key to move the BAR indicator toward the left to select a different operating mode. Press the right [▶] arrow Key to move the BAR indicator toward the right to select a different operating mode. These arrow keys will change the operating mode once per second within either group. The arrow keys can be pressed once or it can be held depressed for continous shifting within either group until the desired mode is selected. Release the key when the BAR indicator is above the desired operating mode.

3.2.4 NUMBERED KEYBOARD The numbered Keyboard consists of 16 keys. They are used as follows:

1. Numbered Keys [0] thru [9] are used to program the GRI for the Loran C Chain of operation, to program waypoints and to

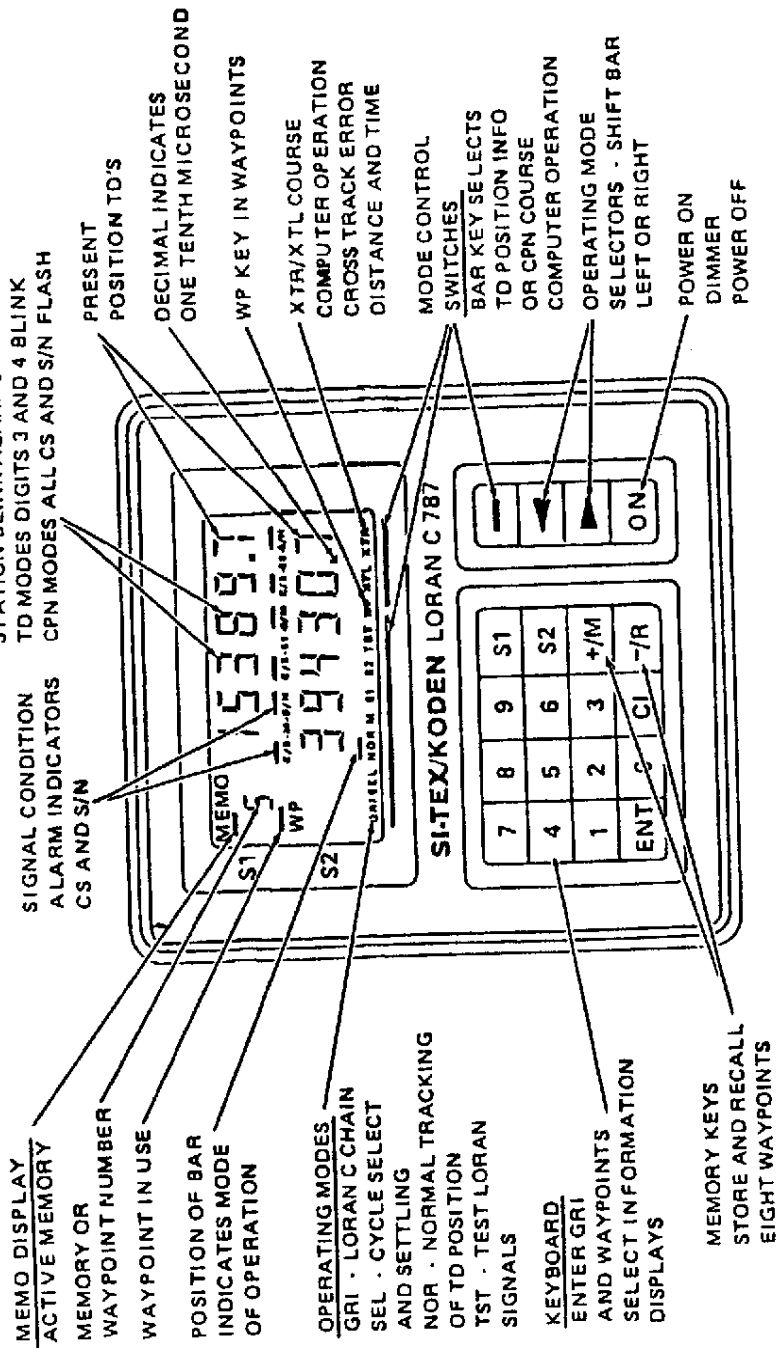


Figure 8. CONTROLS AND INDICATORS

designate memory locations for stored waypoints.

2. The [ENT] is used to enter the GRI once it has been programmed and to enter the waypoint once it has been programmed.
3. The [S1] and [S2] Keys are used to change and to select information in the S1 and S2 displays, in several different operating modes. [S2] Key is also used to select and display course information in the XTL and XTR course computer modes.
4. The [CL] (Clear) Key is used to cancel information that has been programmed into the displays. [CL] is also used to reinitialize the loran (restore cycle select process).
   [CL] cannot be used to clear information stored in memory.
5. [+/M] Key is used to store waypoints in memory.
   [-/R] Key is used to recall stored waypoints from memory.
   Number Keys are used in conjunction with [+/M] and [-/R].
6. [+/M] and [-/R] Keys are also used for special test and display operations in various modes of operation which are described in the Operations Section.

The Proper operating mode must always be selected before using the numbered keyboard. Then, keyboard operations can be performed by pressing the required keys. Depending on the mode of operation, the loran position information will be displayed, course information will be displayed or programmed data will be displayed.

Each time a key is pressed a tone will be heard, indicating that an operation has been performed.

3.2.5 DISPLAYS. The display contains two groups of six (6) digits to display loran position information and course information (in CPN Modes). The decimal point between the 5th and 6th digits indicate the TD position to 0.1 or one-tenth of a microsecond.

The S1 and S2 marked at the left side of the displays are used to identify the upper and lower displays. The S1 and S2 displays are associated with the [S1] and [S2] Keys on the keyboard when selecting or changing secondary TD's and when entering waypoints.

MEMO INDICATORS (Top left corner of display).

A MEMO number will appear in this display to show the number

of an active memory or to show the number of a waypoint entered into the course computer. A small BAR above the number indicates active memory and a small BAR below the number indicates waypoint in use.

When a waypoint is entered but not stored in any memory the display will be blank-no numbers.

STATUS ALARM INDICATORS are located in the center of the display to warn the operator of the operational condition of the loran receiver and the loran station transmitters. They are described in following paragraphs.

3.2.6 AUDIBLE ALARM AND WAYPOINT ARRIVAL ALERT

The loran receiver has a built in audible alarm which is activated for several conditions.

a. The alarm will sound each time a key is pressed and mode.
b. If a waypoint has been entered into the course computer, the waypoing arrival alarm will sound when the boat arrives within 0.5 microsecond radius of the waypoing-destination. This alarm will also sound when the loran is first turned ON if you are within 0.5 microseconds of previously entered waypoint. The tone will sound at approximately two second intervals and will continue until cancelled by pressing the [CL] Clear Key. It will not be reactivated for the same waypoing unless the vessel leaves the 0.5 microsecond radius.

NOTE

Always set the loran to NOR Normal position before pressing [CL] Key to cancel the alarm. Pressing [CL] will cause the loran to go into a cycle select mode if unit is set in GRI, SEL, M, S1, S2 Modes.

3.2.7 NOTCH (Interference) CONTROLS. Two (2) preset NOTCH filters are contained in the unit to reduce near-band interference. A third notch can be added if required. Internal adjustments are required to change the NOTCH frequencies. Adjustments are not described in this instruction book. Consult with your local dealer or the manufacturer for information.

3.2.8 STATUS ALARM INDICATORS. Status/Alarm indicators are provided to inform the operator of the operational status of the loran receiver and the Loran C Chain station transmitter. Two types of status/alarm indications are used. See Figure 9.

1. The C/S and S/N indicators located in the center section of the displays are used:

   To indicate the operational status of the loran receiver.
   To indicate Loran station BLINK alarms in Course Computer operation modes.

2. In addition, digits 3 and 4 in both displays are used to indicate loran station BLINK alarms in certain modes of operation.

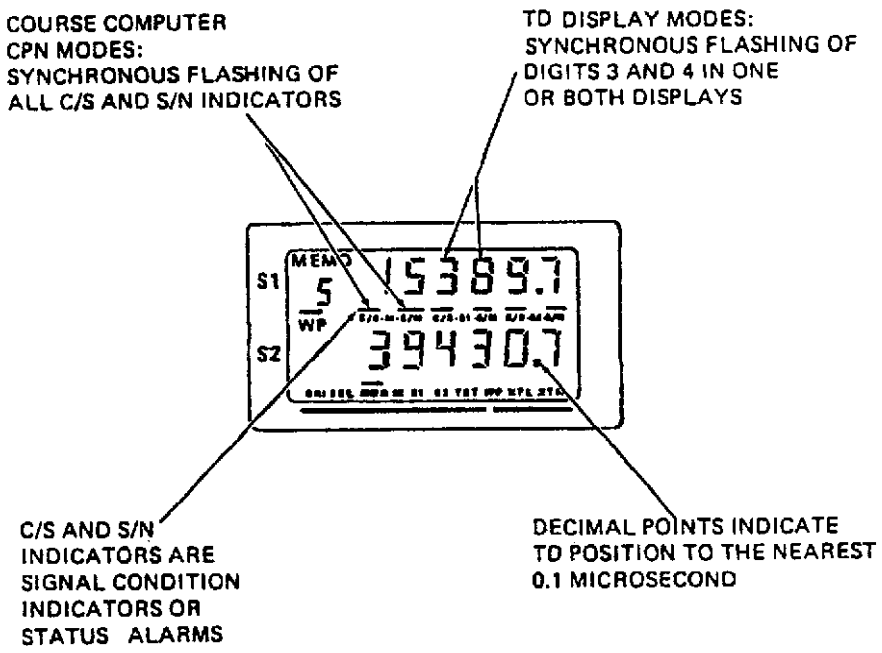
3.2.9 C/S and S/N STATUS/ALARMS. The status/alarms are arranged in three groups:

M group (M-CS and M-S/N) for the Master Station,
S1 group (S1-CS and S1-S/N) for the displayed secondary-upper display.
S2 group (S2-CS and S2-S/N) for the displayed secondary-lower display.

3.2.10 CS-CYCLE SELECT INDICATORS. The CS-Cycle Select indicators illuminate)steady-state ON) to indicate when the cycle selection process is not completed for a particular station. M-CS illuminates for the Master Station, S1-CS illuminates for the S1 Secondary station (upper display), and S2-CS illuminates for the S2 Secondary station (lower display). Settling is indicated when the CS indicators extinguish. Synchronous flashing of one or more of the CS indicators indicates receiver operational status conditions which are described in the various modes of operation. THIS MAY ALSO OCCUR because of signal propagation conditions.

3.2.11 SIGNAL/NOISE (S/N) INDICATORS. The S/N Signal to Noise indicators may illuminates (steady-state ON) periodically to indicate when the loran signal from a particular station is deteriorating. M-S/N Master station deteriorating, S1-S/N Secondary station (upper display) deteriorating. S2-S/N Secondary station (lower display) deteriorating. Synchronous

LORAN STATION BLINK ALARMS



NOTES:

C/S INDICATES CYCLE SELECT CONDITION FOR APPLICABLE STATION:
M- MASTER, S1- UPPER DISPLAY, S2- LOWER DISPLAY.
S/N INDICATES APPLICABLE STATION SIGNAL TO NOISE CONDITION.

FIGURE 9 STATUS ALARM INDICATORS
AND STATION BLINK ALARMS

flashing of one or more S/N indicators indicates receiver operational status conditions which are described in the various modes of operation.

3.2.12 BLINK ALARMS. A Blink alarm is transmitted by a Loran station when it is experiencing technical or operational problems. See Figure 9.

3.2.12.1 BLINK ALARMS-TRACKING MODES. When the displays are indicating the Time Difference (TD) information of a secondary being tracked, synchronous flashing of digits 3 and 4 indicate a station Blink for that secondary. The operator should select a different Secondary for operation. When two or more secondaries of a chain transmit a Blink alarm, the technical problem is usually with the Master station. Caution is urged when using that secondary or that chain for navigation.

3.2.12.2 BLINK ALARMS-CPN MODES. When the receiver is operating in the ComPuNav modes, Synchronous flashing of ALL CS and S/N status/alarms indicates a station Blink for one or more secondaries. The operator should reset the receiver to the SEL mode (avoid passing through TEST mode with function select key. See Note) and determine whether the Blink alarm is from one Secondary or from two or more secondaries and, if possible, select a different secondary or a different chain. Caution is urged when using the secondary or the chain for navigation.

NOTE

Once a Blink Alarm detected by the receiver, the alarm indicator will not reset automatically. To reset a Blink alarm, Set Function mode to the TEST position and then back to the SEL position. If the alarm is still being transmitted by the station, the receiver will again detect the Blink alarm and it will be indicated as previously described. Detection may require several minutes. This depends upon signal conditions.

3.3 DESCRIPTION OF OPERATING MODES.

Each operating mode is designated to perform specific operations and to display specific loran position information or course computer information. This is how they are used to obtain navigation information.

GRI Group Repetition Interval. This mode is used to enter and to change the 4 digit GRI code for the Loran C Chain of operation (See 1.4). Since each loran chain covers a specific area there is no need to change the GRI code unless you travel to a different loran coverage area.

SEL SELECT. This mode is used to permit the loran to synchronize on the loran signals for the selected chain. The synchronizing process is called ACQUISITION, CYCLE SELECT and SETTLING. All useable loran stations in the chain are automatically acquired by the loran receiver. Cycle Select is automatic but requires a short period of time for the receiver to detect and synchronize on the third cycle of the transmitted loran pulses. Settling of the receiver occurs when the receiver is completely synchronized on the master station and at least two secondary stations. The C/S Cycle Select indicators will extinguish when synchronization is completed. Then you can use the loran for navigation. Any time that the C/S indicators appear, the loran should be set to the SEL mode until the C/S indicators extinguish. When SETTLED, the loran displays your current loran position TD's. This mode is also used to select or change the displayed secondary TD's in conditions where the normally used secondaries become unuseable. Several additional operations can be performed in the SEL mode. However, they are not necessary for normal operation and are described in subsequent sections for Manually Assisted Cycle Selection, Skywave Operation and Testing Functions.

NOR NORMAL. This mode is used for AUTOMATIC TRACKING of the loran C signals. The loran displays your present loran position in the coverage area. Using the Time Difference numbers displayed by the receiver you can determine your current position or location using Loran C Nautical charts for your area.

This mode inhibits cycle selection and in normal conditions will prevent the loran from loosing synchronization with the loran signals. Once settling is completed in the SEL mode, the NOR mode should be used for loran position information. This mode can be used to change or display the present position TD's for the other Secondary stations.
This mode is the Instant Memory mode whereby the present position TD's can be instantly stored in Memory 8. The Elapsed Time clock counter can be displayed and rest in this mode.
The loran can be turned OFF in the NOR mode and when Power is turned on again, it will automatically acquire, cycle, select and settle on the previously selected TD's. This is called an AUTO-START mode of operation. However, if the loran is moved more than 30 microseconds from the position where power was turned OFF, the SEL mode should be used.

TST TEST MODE. This mode is used for several testing operations. It is used (1) to activate all segments of the display, (2) to display the signal quality of the loran signals and (3) to cancel the loran station Blink signals and all status alarm indicators. When this mode is used to cancel or clear an alarm condition, if the alarm condition remains the status alarms will again appear in the displays.

M MASTER
S1 SECONDARY UPPER DISPLAY
S2 SECONDARY LOWER DISPLAY

These modes are designed for special operational requirements and are not normally required for operation. They display the present position TD's, however, CYCLE SELECT is activated for the Master, for S1 or S2 Secondary, depending on which mode is selected. These modes can be used for Manually Assisted Cycle Select, to assist in Skywave operations and to test the receivers ability to cycle select on the Master station or the Secondary station determined by the operating mode.

WP WAYPOINT. This is a course computer mode. It is used to program and enter waypoints using the TD's of the desired destination. Waypoints can be programmed and stored in Memory 1 thru 8 and waypoints can be stored and entered into the course computer at the same time.

The WP mode is used to establish the starting point and point of origin for the current leg of a computed course. Any time the WP mode is selected, the present loran position is entered into the course computer as the point of origin and a new course to the destination is computed. All off-course conditions are cancelled and reset for the new course. Waypoints stored in memory can be transferred to a different memory in this mode.

XTL and XTR CROSS TRACK ERROR LEFT AND RIGHT.
These are Course Computer operating modes. When set to XTL or XTR, the course computer automatically computes the ON-COURSE or OFF-COURSE conditions and displays the information in the upper display. Cross Track Error is the lateral deviation from the course line to a waypoint which has been entered for navigation. The Distance to the destination (in microseconds) and displayed in the lower display. The Elapsed Time Clock Counter can be displayed and reset in this mode.

3.4 OPERATING PROCEDURE

First determine the GRI for your area of operation. The four (4) digit code can be obtained from the GRI table in this book or from Loran C nautical charts for your area of interest.

3.4.1 FIRST POWER ON OPERATION-ENTER GRI.

Repeat this procedure whenever the vessel enters an area covered by a different Loran C Chain.

1. Press the [ON] Key. The unit will come on. All zeros or some numbers may appear in the display.
   Disregard these numbers.
2. Press [◀] Key. Set BAR indicator to GRI mode.
3. Use the Keyboard. Press the four digits for the GRI code.
   Example: Press [7] [9] [8] [0] for the Southeast U.S. Chain.
   Read the GRI in the upper display. 0 0 7 9 8 0
   0 0 0 0 0 0

4. Press [ENT] Key. Read the GRI in both displays [0 0 7 9 8 0 / 0 0 7 9 8 0]

If a mistake is made press [CL] Key and repeat procedure. The GRI is now entered for your Loran C Chain of operation. It will remain stored even when power is OFF.

NOTE

If all 9's appear in the displays, the GRI has been dropped from the memory and GRI must be entered again using this procedure.

3.4.2 SELECT SECONDARY TD's FOR OPERATION.

The SEL mode is used to select and display the TD's of all Secondary stations for the GRI chain.

1. Press [▶] Key. Set BAR indicator to SEL mode. Numbers will appear in both displays. As many as four different secondaries may be displayed, depending on the GRI in use.
2. Read the TD's sequencing in both displays. Using a Loran C nautical chart, choose the two TD's with the best crossing angle (closest to 90^{0} crossing angle), provided they have adequate signal strength for your area.
3. Press [S1] Key when the desired TD numbers appear in the upper display . The upper display will stop rotating.
4. Press [S2] Key when the desired TD numbers appear in the lower display. The lower display will stop rotating. Once the TD's have been selected the loran will automatically select the same two TD's whenever power is turned ON.
5. Observe the C/S CYCLE SELECT indicators in the center of the display. These C/S indicators are most important in the operation of your loran. When they are ON they indicate the Cycle Select process has not been completed. The loran must remain in the SEL mode until all C/S indicators go out. The TD numbers may fluctuate during the settling process and the S/N indicators may also appear.

   The cycle select and settling process may require from 3 to 5 minutes depending on the signal strength and quality. When the C/S indicators go out the loran is ready to use.

3.4.2.1 CHANGING SECONDARY TD's.

Secondary TD's can be changed at any time.

1. Press ◀ or ▶ Key. Set to SEL mode.
2. Press S1 Key. The TD's will sequence in the upper display.
3. Press S1 Key again to choose different TD's and stop the rotation.
4. Repeat the procedure using S2 Key to change lower display.

Example of TD's sequencing in upper or lower displays:

Sequence	1	1 4 2 4 8.8	
	2	3 1 0 7 4.3	TYPICAL TD's FOR
	3.	4 4 7 1 3.9	7980 GRI CHAIN
	4.	6 2 8 8 7.8	

TD's will continue sequencing until secondary TD's are selected by S1 or S2 Key press.

NOTE

If all 0's appear in either dispaly, press CL Key. This will restart the Cycle Select process as described in 3.4.2. If all 0's remain in either or both displays, the loran is not receiving signals from the loran station. Check the antenna, the antenna coupler and cable connections for possible defects in the installation.

3.4.3 AUTOMATIC TRACKING OF TD's. The NOR mode is used for automatic tracking of the TD's.

Press ▶ Key. Set Mode indicator to NOR. The TD's of your present position will be indicated in the two displays. The receiver will automatically track the TD's and update the displays to indicate the current position of the vessel.

At this point, to clarify the use of the automatic tracking mode, the operator should recall that the graphical plot of all observation points having a constant measured time difference (TD) forms the Lines of Position (LOP's) which are printed on the Loran C chart. The Time Differences (TD's) measured by your

Loran C receiver and indicated in the displays, represents your present position along the Lines of Position (LOP's). The TD's are measured to 0.1 or 1/10 of a microsecond, however, the spacing or gradient between LOP's presented on the charts may be in increments of 10 to 50 microseconds. Since every possible LOP cannot be printed on the charts, the operator is required to interpolate or estimate the time differences between the LOP's printed on the chart to determine his exact position from the TD's displayed. Interpolation scales are usually printed on the Loran C chart for the users convenience. Section 4 describes conversion of microseconds to nautical miles and feet.

No further operations are required to remain in the NORM operating mode unless the Status/Alarm indicators illuminate or flash to indicate that something is wrong. Then a change may be required. Status/Alarm indicators are described in preceeding sections.

Secondaries can be changed at any time in the NORM mode using the [S1] and [S2] Keys. Observe the CS Status/Alarm indicators when selecting secondaries. Other modes of operation may be selected without interrupting or interfering with the automatic tracking of the Loran C signals.

3.4.4 NOR MODE AUTO-START POWER ON OPERATION. The loran receiver has a memory feature which retains the GRI and the TD's of the two secondaries last displayed even when power is turned OFF. It also retains the last operating mode (position of BAR indicator) when power is turned OFF. If power is turned OFF in the NOR mode, when it is turned ON again the loran will be in the NOR mode and will automatically acquire the same GRI and the same two secondaries. The cycle select and settling will be automatic unless the boat has been moved more than 30 microseconds distance. In this case, set to SEL mode when power is turned ON.

Status alarms will flash during the settling process. When the alarms go out the unit is settled and ready for operation.

3.4.5 NOR MODE-INSTANT MEMORY. Instant memory (Memory number 8) is provided to store the TD's of your present position at any time.

Instant Memory must be used in the NOR mode. The TD's stored into memory number 8 can be recalled at any time for later use.

3.4.5.1 STORE TD's IN INSTANT MEMORY.

1. Press [▶] or [◀] key. Set to NOR mode.
2. Press [+/M] Key. This activates Instant Memory number 8. The display will stop tracking and the TD's of your present position freeze in the displays. The TD's are instantly stored in Memory number 8. Memo indicator number 8 will light indicating memory in use. The 3 CS Status/Alarm indicators will flash indicating that the displays are in a non-tracking state.
3. Press [CL] Key to restore the displays to tracking the TD's.

NOTE

In the NOR mode, each time the [+/M] key is pressed the latest TD's are stored in Memory number 8. The previous entry is erased automatically. It is not necessary to clear the memory before storing the TD's.

3.4.5.2 RECALL TD's FROM INSTANT MEMORY.

1. Press [◀] or [▶] key. Set to NOR mode.
2. Press [-/R] Key. This activates Instant Memory number 8. The display will stop tracking and the Last TD's stored in memory number 8 can be read in the displays. Memory indicator number 8 will light indicating memory in use. The 3 S/N Status Alarm indicators will flash indicating that the displays are in a non-tracking state.
3. Press [CL] Key to restore displays to tracking the TD's. The TD's stored in Instant Memory number 8 can be recalled at any time or entered into the Course Computer as a waypoint. This procedure is described in paragraph 3.4.7.

Instant Memory is useful for many reasons. In case of man overboard or equipment overboard, or simply to record the TD's

of a particular position, the TD's can be instantly stored in Memory number 8.

3.4.6 DISPLAY ELAPSED TIME (NOR MODE). An Elapsed Time (ET) counter is provided. It begins counting, in hours and minutes when the power is turned ON. Elapsed time is present in the lower display and can be displayed at any time in the NOR mode.

3.4.6.1 TO READ ELAPSED TIME.

1. Press ◀ or ▶ key. Set to NOR mode.
2. Press number 9 key.
3. Read Elapsed Time in the lower display.

   00 00 min, 60 00 max
   HRS - MIN HRS - MIN
4. After a few seconds, the display will return to the tracking mode and display the TD's.

5. If immediate reset to the tracking mode is required, press CL key.
6. If reset of the Elapsed Time counter is required, press number 0 key.

   Hours and minutes will be reset to 00 00 and the count will resume.

The Elapsed Time feature is useful to measure the elapsed time of a course traveled or the time of an entire trip.

NOTE

Elapsed Time can also be displayed in the XTL and XTR mode and the procedure is described in subsequent sections.

3.4.7 COURSE COMPUTER OPERATION (CPN MODES WP, XTL and XTR).

The course computer modes are used to automatically compute and guide you along the course from a particular starting point (called Point of Origin) to a predetermined destination or waypoint. The Point of Origin is the immediate position of the vessel when the course computer is activated for the entered waypoint.

The WP mode is used to program and enter the waypoint TD's. The course computer is activated instantly by setting the BAR mode indicator from the WP position to the XTL or XTR position. After a few seconds time in the XTL or XTR mode, the course information will appear in the displays. ON-OFF COURSE (cross track error) is read in the upper display. Distance to Go and Time to Go to the waypoint is read in the lower display. It is necessary to set the vessel to the correct compass course for the waypoint before activating the course computer. Otherwise, off-course conditions will appear in the display while the vessel is being positioned to the correct compass course.

ON-OFF COURSE (Cross Track Error) is displayed when the vessel moves to left or right from the computed course. The Cross Track Error display is read in microseconds. The microseconds can be converted to distance in feet or nautical miles using the procedure in Section 4.

Distance to Go is displayed in microseconds to 0.1 microseconds The maximum distance computed is 3200 microseconds. When the distance to a waypoint is greater than 3200 microseconds, all 9's will appear in the displays. When this occurs, an intermediate waypoint should be used. See Section 4 to convert microseconds to nautical miles.

Distance to Go will decrease as vessel moves toward waypoint and will increase when vessel moves away from waypoint.

Time To Go is displayed in hours and minutes. The calculation is based on the average speed of the vessel as it moves toward the waypoint. The maximum time computed is 60 hours and the vessel must be moving to obtain the Time to Go reading. The first computations of Time to Go require about two minutes before it is displayed. Further computations are based on

the vessels average speed to the waypoint. When the vessel is not moving, the display will increase to a maximum reading of 99 HRS - 99 MIN. Erratic steering on and off course will cause the Time to Go computation to increase. The most accurate time is obtained by keeping the vessel on course using the cross track error display and the compass.

Waypoints. Seven waypoints can be stored in memories 1 thru 7 and recalled later as they are required for entry into the course computer. The waypoint TD's stored in Instant Memory 8 provides another waypoint. Any waypoint can be programmed and entered directly into the course computer for immediate use but this waypoint is not stored in any memory and it will be lost when another waypoint is entered. The waypoint number in use is read in the MEMO display.

Storing waypoints in memory is particularly useful when planning a trip and when programming along the way is not practical. This is also useful for retaining the TD's of a frequently traveled course and to retain the TD's of special locations. Once stored, the TD's remain in memory even when power is off.

CAUTION

When programming the TD's of a waypoing (destination), it is most important to remember that the TD's used for programming must always correspond to the TD's of the secondaries chosen for operation and displayed in the upper and lower displays.

Example: You have selected the 14000 secondary (S1) for operation in the upper display and the 44000 secondary (S2) for operation in the lower display. The TD's of the waypoint must be entered 14xxx.x for the S1 secondary and 44xxx.x for the S2 secondary.

When the TD's of the two selected secondaries are reversed in order, i.e., 44000 in the upper display and 14000 in the lower display, the programming of the waypoint must be reversed to correspond with the selected secondaries.

Once programmed, the other secondary stations cannot be used for computer operation unless the programmed waypoint TD's are changed to correspond with the different chosen secondaries. When the waypoint TD's do not correspond to the selected secondaries all 9's will appear in both displays and will remain in display until the waypoint is re-entered in the proper sequence.

3.4.7.1 WAYPOINT PROGRAMMING FOR COURSE COMPUTER OPERATION. Be sure the unit is settled - all alarms off. Determine the two TD's for each waypoint to be programmed. TD's must correspond with selected secondaries.

6 digits must be entered for each TD, a total of 12 digits for each waypoint.

1. Press [◀] or [▶] key.
2. Set mode indicator to WP.
3. Using the keyboard, press the six digits of the TD corresponding to S1 secondary. Read the TD in the upper display. If a mistake is made, press the [CL] key and repeat this procedure. If you press more than 6 digits the digits will overflow into the lower display. If this occurs, press [CL] key to remove overflow digits. Press [CL] twice to clear both displays. During programming the 3 CS indicators will flash indicating that the display is in a non-tracking state. Do not press [ENT] key.
4. Using the keyboard, press the 6 digits of the TD corresponding to S2 secondary. Read the TD in the lower display. If a mistake is made, press the [CL] key and repeat the procedure.

Proceed to 3.4.7.2 for Immediate Use of Waypoint.
Proceed to 3.4.7.3.to Store Waypoint In Memory and Simultaneously Enter Waypoint.

3.4.7.2 IMMEDIATE USE OF WAYPOINT FOR COURSE OPERATION. After programming the waypoint per 3.4.7.1:

1. Press [ENT] key. The waypoint TD's are entered for operation.

2. Press [▶] key. Set Mode indicator to XTL or XTR. The CS indicators will cease flashing. This initiates computer operation. Your present position is established as the Point of Origin.

Proceed to 3.4.7.5. for operation.

3.4.7.3 STORE WAYPOINT IN MEMORY. After programming the waypoing per 3.4.7.1:

1. Press [+/M] key.
2. Press any number key [1] through [7] to designate the memory location. The corresponding MEMO number will appear to indicate the memory in use and the waypoint is automatically stored in the selected memory location.
3. Press [CL] key.
4. To program and store additional waypoints, repeat the procedure of 3.4.7.1 and 3.4.7.3.

Proceed to 3.4.7.4. to recall A Stored Waypoint for Computer Operation.

To simultaneously store and enter a waypoint for Course Operation after programming a waypoing per 3.4.7.1:

1. Press [+/M] key.
2. Press only number key [1] through [7] to designate the memory location. The waypoint TD's are stored in memory.
3. Press [ENT] key. The waypoint TD's are entered for Course Operation.
4. Press [▶] key. Set Mode indicator to STR or XTL. This initiates Computer Operation. Proceed to 3.4.7.5 for Course Operation.

3.4.7.4 RECALL A STORED WAYPOINT FOR COURSE OPERATION.

1. Press [◀] key.
2. Set Mode indicator to WP.
3. Press [-/R] key (Recall). The 3 S/N indicators will flash.
4. Press any number key [1] through [7] corresponding to the memory location desired for recall. The recalled Waypoint

TD's are presented in both displays. The corresponding MEMO numbers will appear to indicate the memory in use.

5. Press any memory key [1] through [7] to recall a different memory.
6. Press [CL] Key to cancel a recalled memory location and to restore the unit to the previously selected waypoint.
7. Press [ENT] Key. The recalled waypoint TD's are entered for Course Operation. The 3 S/N indicators will cease flashing.
8. Press [▶] key. Set Mode indicator to XTL or XTR. This initiates Computer Operation. Proceed to 3.4.7.5. for Course Operation.

3.4.7.5 STEERING THE COURSE TO A WAYPOINT.

1. Enter waypoint per 3.4.7.1 or 3.4.7.4 and initiate Computer operation by setting mode indicator to XTL or XTR. The Distance to Go and Time to Go to the waypoint are calculated from the Point of Origin. The proximity alert is activated to sound when you approach the programmed waypoint. See 3.4.7.5.4.
2. CROSS TRACK ERROR is indicated in the upper display (in microseconds and tenths of microseconds).

ON-COURSE is displayed [00] No cross track error
OFF-COURSE is displayed [0.1] Min to [9.9] Max.
or [0.1] Min to [9.9] Max.

A – IS POINT OF ORIGIN OR PRESENT POSITION. THE TD'S AT THE INTERSECTION (CROSSING POINT) OF THE TWO LOP'S ARE DISPLAYED IN THE NORM MODE.

B – IS DESTINATION. THE TD'S AT THE INTERSECTION OF THE TWO LOP'S ARE PROGRAMMED INTO MEMORY FOR ComPuNav OPERATION.

C – IS THE COURSE COMPUTED BY ComPuNav. INDICATED [– – 0 0 – –] IN THE DISPLAY WHEN VESSEL IS ON COURSE.

D – IS CROSS TRACK ERROR LEFT OR RIGHT FROM THE COURSE COMPUTED BY ComPuNav. SEE NOTES.

OFF COURSE LEFT [9.9 – – – –] MAX.
IS DISPLAYED [0.1 – – – –] MIN.

OFF COURSE RIGHT [– – – – 9.9] MAX.
IS DISPLAYED [– – – – 0.1] MIN.

E – IS AN EXAMPLE OF A POSITION INDICATING CROSS TRACK ERROR TO RIGHT. THIS POSITION CAN BE RE-ESTABLISHED AS A NEW POINT OF ORIGIN IN CASE OF EXCESSIVE ERROR. ComPuNav THEN COMPUTES CROSS TRACK ERROR, DISTANCE TO GO AND TIME TO GO FROM THIS POSITION. THE TD'S ARE DISPLAYED WHEN NEW POINT OF ORIGIN IS ESTABLISHED.

F – INDICATES THE NEW COURSE FROM NEW POINT OF ORIGIN WHEN RESET TO XTE MODES.

G – INTERPOLATION BETWEEN LOP'S IS REQUIRED WHEN POINT OF ORIGIN OR DESTINATION IS NOT LOCATED EXACTLY ON LOP GRIDS PRINTED ON THE CHART.

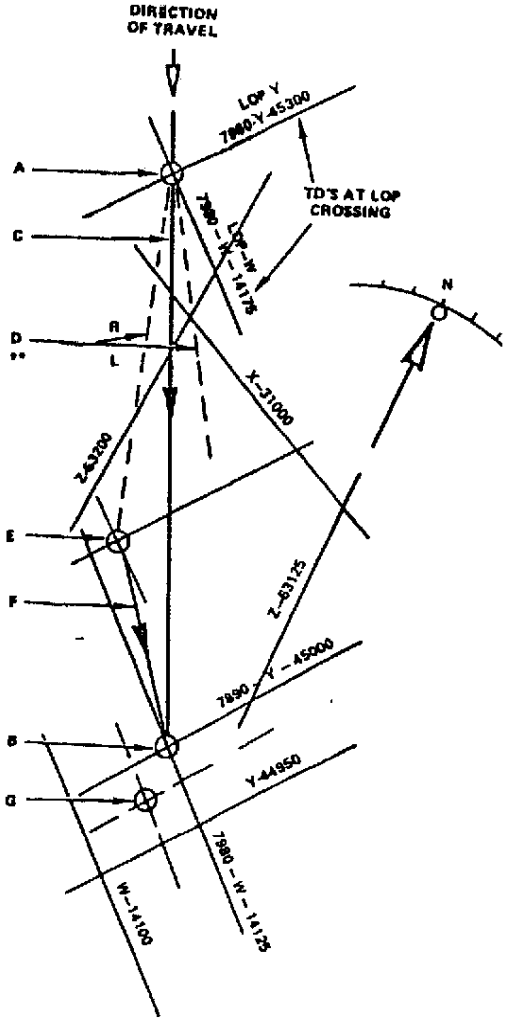
NOTES: APPROACH TO AND ARRIVAL AT DESTINATION

CROSS TRACK ERROR – COMPUTED BY THE LORAN IS DISPLAYED AS SHOWN IN D.

DISTANCE TO GO – COMPUTED BY THE LORAN IS DISPLAYED 03200.0 MAX., 000000 MIN. (MICROSECONDS). AS THE DESTINATION IS APPROACHED, THE INDICATED DISTANCE WILL DECREASE TOWARD ZERO.

TIME TO GO – COMPUTED BY THE LORAN IS DISPLAYED [60–00] MAX., [00 – 00 –] MIN. (HOURS/MINUTES). AS THE DESTINATION IS APPROACHED, THE INDICATED TIME WILL DECREASE TOWARD ZERO.

RUN PAST DESTINATION
CROSS TRACK ERROR WILL BE INDICATED THE SAME.
DISTANCE TO GO WILL INCREASE AND INDICATE DISTANCE TRAVELED.
TIME TO GO WILL INCREASE TOWARD MAXIMUM.
**WHEN READING INDICATED CROSS TRACK ERROR, OFF-COURSE LEFT INDICATES STEER TO RIGHT.



81-203

FIGURE 10. EXAMPLE OF COURSE COMPUTER OPERATION

Reversing the selected secondaries with regard to their position in the upper or lower display and reversing the order of entry for the TD's of the destination (DD) will produce reverse steering logic. It is suggested that the user always select the secondaries in the same windows, thus establishing a system of entry. Once the steering logic is established by this procedure, the steering logic will remain the same for those secondaries in your location.

3. Distance To Go and Time To Go are indicated in the lower display. Press S2 key to alternately display distance or time.

   Distance To Go - in tenths of microseconds, is displayed
   [00000.0] MIN. [03200.0] MAX.
   When the Distance To Go exceeds 3200 microseconds, all 9's will be displayed. If this occurs, the operator must program a closer waypoint.

   Time To Go - in hours and minutes, is displayed
   [00 00.] MIN. [99 99.] MAX. or [60 00]
   First calculation requires approximately two minutes. Consequently, the first time displayed will lag the real time by approximately two minutes. Subsequent computations are based on average speed.

4. Approach To Waypoint. Read the indications of distance and time in the lower display.
   Cross Track Error is indicated in the upper display.
   Distance to Go decreases toward [00000.0] microseconds
   Time to Go decreases toward [00 00.] Hours/Minutes
   Set Function indicator to NORM. Use TD's to locate position desired.

   When you approach the programmed waypoint within a radius of 0.5 microseconds, the Proximity Alert will sound at approximately two second intervals. Press CLR key to cancel the alarm.

5. Arrival At Waypoint. Read the indications in both displays. Use Distance To Go as the indication of arrival.
   Cross Track Error is indicated [00]
   Distance to Go is indicated [00000.1] or [00000.0] microseconds.
   Time to Go decreases toward [00 01.] Hours/Minutes.
   Select the next waypoint or use NORM mode to locate position desired.

6. Run Past Waypoint. Read the indications in both displays.
   Cross Track Error may be indicated in the upper display.
   Distance to Go will increase and indicate the distance traveled beyond the destination.
   Time to Go will increase and will eventually indicate [99 99]

NOTE

When the course is reversed and the approach to the waypoint is from the opposite direction, the steering direction indicated by the Cross Track Error will also be reversed if the Point of Origin has not been changed.

7. Reset Point Of Origin. When the Cross Track Error displayed indicates that you are too far OFF-COURSE, it may be desired to establish a new Point of Origin and a new course to the waypoint. Set Function indicator to WP and then back to XTL or XTR. This re-initiates Course Computer Operation.
   The TD's of your present position are entered as the new Point of Origin.
   Distance to Go and Time to Go to the waypoint are reset and are calculated from the new Point of Origin.

8. Displayed Elapsed Time (CPN Mode). When operating in the XT mode and it is desired to display the Elapsed Time, Press number [9] key. Read Elapsed Time in the lower display.
Elapsed Time is indicated [00 00.] MIN., [99 99.] MAX.
HRS.MIN HRS.MIN.

After a few seconds, the display will return to the XT mode and distance or time will be displayed.
If reset of the E.T. counter is required, Press number 0 key. Hours and minutes will be reset to [00 00.] and the count will resume.

9. Display Present Position TD'S.
Set Function indicator to NOR.
Read the TD's of your present position in both displays.

Reset Function indicator to XT. mode to resume Course operation.

3.4.8 Test Mode Operation. Before operating the unit in the Test mode, press [▶] key. Set Function indicator to SEL mode and allow sufficient time for the unit to settle. The unit must be completely settled on the desired stations before Signal Analysis test can be performed.

3.4.8.1 Alarm Cancelled. The TEST positions cancels (extinguishes) all status/alarm indications. However, when the Function indicator is reset to a different operating mode, if the status/alarm indications are again detected, the status/alarm indicators will be activated and displayed.

CAUTION

Do not set the function indicator to the TEST position during the settling process. When the alarms are cancelled (extinguished) it could be interpreted to mean that the TD's displayed are correct.

3.4.8.2 Display Segment Test. Press ▶ Key. Set Function indicator to TEST. All display segments are illuminated for approximately 3 seconds. ALL 8's appear and all Decimal points appear.

3.4.8.3 Signal Analysis.

1. After 3 seconds in the Test mode a computer analysis of the Loran signals will appear in both displays.

2. The displays may be sequencing through the Master and all operating Secondary stations approximately every 3 seconds. Press S1 key or S2 key to stop the display sequencing on the desired stations, Master or Secondary.

3. Press S1 key or S2 key to start the sequencing to select a different station, Master or Secondary.

NOTE

See Figure 10 for a description of the displayed information.

4. Observe Digit 6 (right side) of the displays. Digit 6 will display the number 4 when the receiver is completely settled. If the number 4 is not displayed, set Function indicator to SEL position and allow the receiver to settle before proceeding.

5. Digits 1 and 2 identify the stations by displaying the first two digits of the Master station GRI or the first two digits of the secondary station TD's. Digit 2 will be flashing to indicate that the numbers displayed are not Time Differences (TD's).

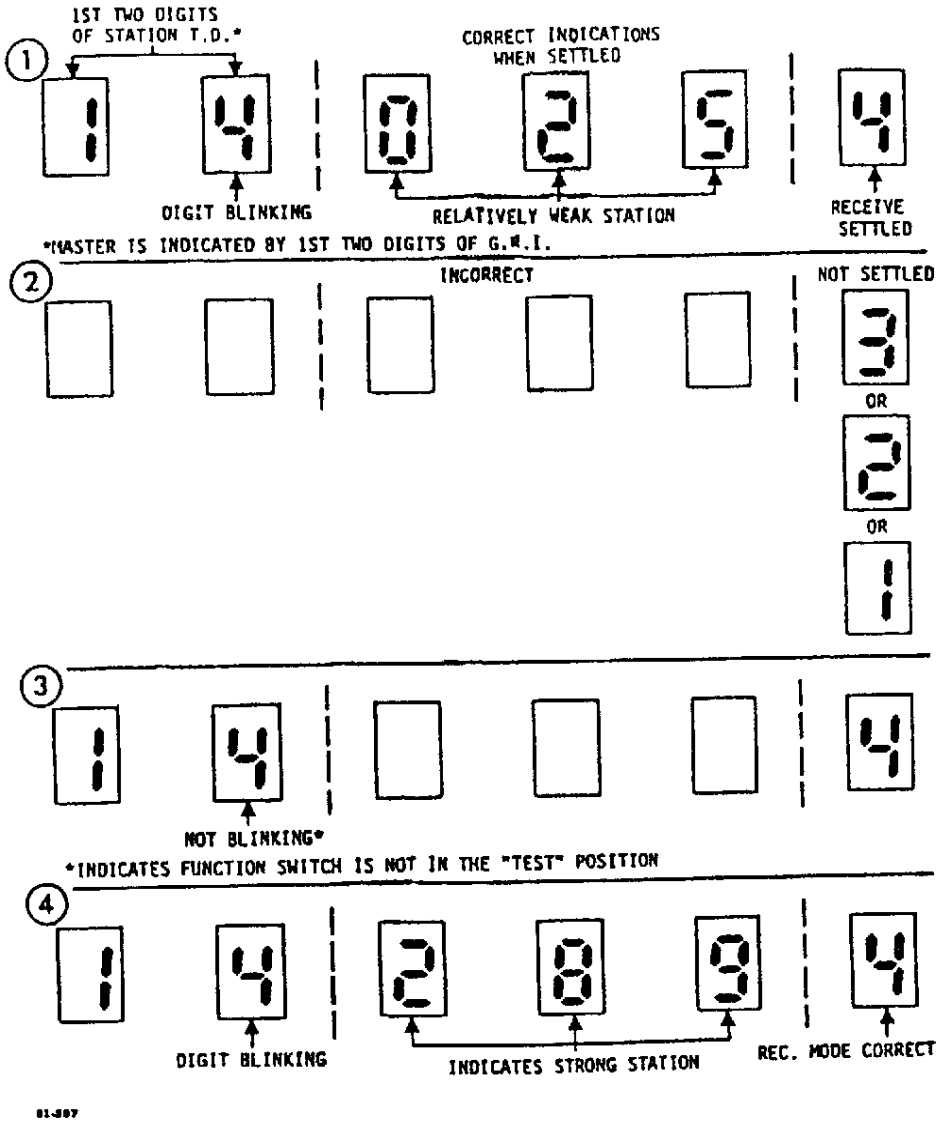


Figure 10. Sample for Signal Analysis.

The left side decimal point is not displayed. The OFF-COURSE indications can be used as indicators for steering direction to return to ON-COURSE. Se NOTE below.

CAUTION

The OFF-COURSE indications being displayed in the XTE-R and XTE-L modes cannot be used to replace sterring by a compass. They should be used as an aid to determine your compass heading. Always confirm that the compass compensation is current for your area of operation

NOTE

Cross Track Steering Indications in XTE Modes.

The cross track error indications in the display can be interpreted in either of two ways in the XTE modes:

Cross track error indications could represent the actual position of the vessel, off-course right or left. This would indicate that the operator should steer in the opposite direction to return on-course. Cross track erro indication right or left could indicate steering direction required to return on course.

In either case, steering to a direction which results in decreasing numbers will return the vessel on-course The operator must decide which method is suitable. Cross track error indications can be changed by resetting Function switch 3 to either XTE-R or XTE-L as desired. This is applicable, only when using Time Differences (TD's) for ComPuNav operation.

When cycle selection is activated, the receiver circuits can be manually activated to increase the cycle tracking point, of any or all stations, on the Loran C pulses, in increments of 10 microseconds. By increasing the cycle tracking point 30 or 40 microseconds, the receiver will attempt to synchronize on the skywave pulse, which arrives 30 to 40 microseconds later, instead of synchronizing on the ground wave pulse.

When synchronization occurs on a skywave signal from a secondary station, the TD reading indicated in the display will be 30 to 40 microseconds higher than the TD which would be indicated if the ground wave signal was used. And, depending on the distance from the station and the altitude of the ionosphere, the TD readings may stabilize at some point between 30 and 40 (perhaps 35) microseconds higher than the ground wave signal would indicate. Therefore, to determine a position using TD's derived from skywave operation on a secondary station, the operator must subtract 30 to 40 microseconds from the displayed TD, depending on how many increments of 10 microseconds the cycle tracking point was increased.

Consequently, the skywave operation will always be less accurate than the ground wave. The operator must estimate his distance from the Loran station and then increase the cycle tracking point 30 or 40 microseconds or more depending on the estimated distance. Then by observing the TD displayed, the operator can determine the difference in microseconds, between the 30 to 40 microsecond increase in the cycle tracking point and the TD reading, as they approach synchronization.

3.4.10.2 Skywave Operation - on Master and All Acquired Secondaries.

1. Press Key. Set function indicator to SEL position. This activates cycle selection for all stations. The cycle tracking point of the Master and Secondaries can be increased in increments of 10 microseconds.

2. The skywave signal can be stronger than the ground wave signal in fringe areas and therefore, can be used in fringe areas to determine approximate position.

Skywave operation is used to extend the range of operation in a GRI chain when the vessel is moving away from the chain transmitters. The Skywave position accuracy is always less accurate than the ground wave accuracy and will vary considerably, depending on the ionospheric conditions and signal conditions.

Skywave signals generally arrive at the receiver approximately 30 microseconds later, at a distance of 1000 miles from the stations, during the daytime hours. At night time, the time of arrival of the skywave can extend up to 60 or more microseconds later at the same distance, because at night time the ionospheric layer is at a higher altitude and the skywave delay is longer. Your Model 787 receiver provides a means to activate cycle selection for skywave operation.

CAUTION

The operator must understand that this type of operation is not recommended, except in cases where an approximate loran position is better than no position. Caution must be observed when using skywave operation.

The standard point on the Loran C pulse, for cycle select and tracking of the signals, is 30 microseconds time after the beginning of the Loran pulse, and skywaves do not arrive before this point. They could arrive 35 or 40 microseconds or more later in time.

2. Press +/M key 3 times to increase the cycle tracking points (of M, S1 and S2) 30 microseconds. All CS status/alarms will illuminate indicating both displays are in a non-tracking state.
3. Immediately set Function indicator to NOR and wait for tracking to occur. Several minutes may elapse before stabilization.
4. The TD readings in both displays will fluctuate somewhat, depending on the skywave distance from the stations, and will begin to stabilize on the skywave signals.
5. The CS status/alarms may or may not extinguish when the Loran is used in this manner.

If the TD readings in both displays do not begin to stabilize:

6. Reset Function indicator to SEL position.
7. Press +/M key 4, 5 or 6 times to increase the cycle tracking points 40, 50 or 60 microseconds, if required. All CS status/alarms will illuminate.
8. Immediately set Function indicator to NOR and wait for tracking to occur. The CS status/alarms may or may not extinguish.

NOTE

In this mode, although the cycle tracking points of all stations is increased, the TD's read in the displays will not necessarily increase in increments of 10 microseconds, because all of the station cycle tracking points have been increased simultaneously.

3.4.10.3 Skywave Operation - on Secondary S1 (Upper Display) only.

1. Press ▶ Key. Set Function indicator to S1 position. This activates cycle selection for S1 secondary. The cycle tracking point of S1 secondary can be increased in increments of 10 microseconds.

2. Press +/M key 3 times to increase the S1 cycle tracking point 30 microseconds. S1-CS and status/alarms will illuminate indicating the S1 display is in a non-tracking state.
3. Immediately set Function indicator to NOR and wait for tracking to occur. Several minutes may elapse before stabilization.
4. The TD readings in the S1 display will begin to stabilize at readings approximately 30 microseconds higher than would be observed using ground wave signals.
5. The S1-CS status/alarms may or may not extinguish when the Loran is used in this manner.

If the TD readings in S1 display do not begin to stabilize:

6. Reset Function indicator to S1 position.
7. Press +/M key 4, 5 or 6 times to increase the cycle tracking point 40, 50 or 60 microseconds if required. S1-CS status/alarms will illuminate.
8. Immediately set Function indicator to NOR and wait for tracking to occur. The S1 status/alarms may or may not extinguish.
9. Subtract 30 or 40 microseconds (or more) from the TD reading when using the TD for navigation, depending on how many microseconds the cycle tracking point was increased (i.e., how many times +/M key was pressed).

3.4.10.3.1 Reinitialize Secondary S1. When cycle selection is activated in the S1 position, the secondary in the upper display can be reinitialized by pressing the CL key. The S1-CS status/alarm will illuminate.

At the same time, the receiver will begin a search for additional secondaries to track. If another secondary cannot be found, the receiver will attempt to reacquire the secondary originally displayed. If another secondary is found, the receiver will acquire that secondary.

In any case, when the secondary is reacquired, the receiver must settle before using it for navigation (S1-CS alarms extinguished).

3.4.10.4 Skywave Operation - on Secondary S2 (Lower Display) only.

1. Press [▶] Key. Set Function indicator to S2 position. This activates cycle selection for S2 secondary. The cycle tracking point of S2 secondary can be increased in increments of 10 microseconds.
2. Press [+/M] key 3 times to increase the S2 cycle tracking point 30 microseconds. S2-CS status/alarms will illuminate indicating the S2 display is in a non-tracking state.
3. Immediately set Function indicator to NOR and wait for tracking to occur. Several minutes may elapse before stabilization.
4. The TD readings in the S2 display will begin to stabilize at readings approximately 30 microseconds higher than would be observed using the ground wave signals.
5. The S2-Cs status/alarms may or may not extinguish when the loran is used in this manner.

If the TD readings in the S2 display do not begin to stabilize:

6. Reset Function indicator to S2 position.
7. Press [+/M] key 4, 5 or 6 times to increase the cycle tracking point 40, 50 or 60 microseconds, if required. S2-Cs status/alarms will illuminate.
8. Immediately set Function indicator to NOR and wait for tracking to occur. The S2 status/alarms will illuminate.
9. Subtract 30 microseconds (or more) from the TD readings when using the TD readings for navigation, depending on how many microseconds the tracking point was increased (i.e., how many time -/M key was pressed).

3.4.10.4.1 Reinitialize Secondary S2. When cycle selection is activated in the S2 position, the secondary in the lower display can be reinitialized by pressing the [CL] key. The S2-CS status/alarm will illuminate.

At the same time, the receiver will begin a search for additional secondaries to track. If another secondary cannot be found, the receiver will attempt to reacquire the secondary originally displayed. If another secondary is found, the receiver will acquire that secondary. In any case, when the secondary is acquired, the receiver must settle before using it for navigation (S2-CS alarm extinguished).

3.4.10.5 Skywave Operation - on Master only.

1. Press [▶] key. Set Function indicator to M position. This activates cycle selection for Master station only. The cycle tracking point of the Master station can be increased in increments of 10 microseconds. When the tracking point of the Master station is increased, the Secondary TD readings will decrease.
2. Press [+/M] key 3 times to increase the M cycle tracking point 30 microseconds. M-CS status alarm will illuminate indicating display is in a non-tracking state.
3. Immediately set Function indicator to NOR and wait for tracking to occur. Several minutes may elapse before stabilization.
4. The TD readings in both displays will decrease by 30 microseconds and begin to stabilize at readings approximately 30 microseconds lower than would be observed using ground wave signals.
5. The M-CS status/alarm may or may not extinguish when the Loran is used in this manner.

If the TD readings in both displays do not begin to stabilize:

6. Reset Function indicator to M position.

7. Press +/M key 4, 5, or 6 times to increase the cycle tracking point, 40, 50, or 60 microseconds if required. M-CS status/alarm will illuminate.
8. Immediately set Function indicator to NOR and wait for tracking to occur. The M status/alarm may or may not extinguish.
9. Add 30 microseconds (or more) to the TD readings when using the TD's for navigation, depending on how many microseconds the cycle tracking point was increased (i.e., how many times the +/M key was pressed).

3.5 MANUALLY ASSISTED CYCLE SELECTION

The operator can manually assist the receiver to acquire and cycle select the correct cycle tracking point. This may be required when operating in areas where the receiver has difficulty in identifying the correct cycle point at which to track the Loran signals.

In areas of high noise conditions, in areas of strong signal near the Loran station, in areas of weak signal (fringe areas) at the extreme limits of coverage areas, the receiver may display incorrect time difference for one or more TD's. Also, the operation of the Loran receiver may be severely impaired when it is used in areas where TV receivers are in operation. Never operate a TV receiver while using your Loran. The TD readings displayed may be 10 to 60 microseconds higher or lower than the correct readings. The indication would be that the TD's are incorrect for a known position, such as the vessels berth or at a location where the TD's were previously measured and established. Where conditions such as this exist, the operator will observe that one or more of the Cycle Select (CS) status/alarms has not extinguished in a reasonable period of time and that the TD may be fluctuating higher or lower about some average reading, indicating that the receiver has not settled.

CAUTION

The operator must know the TD's of the location or know a very close approximate of the TD's before using these operations.

3.5.1 Manually Assisted Cycle Selection - S1 Secondary

1. Set Function to SEL position.
2. Observe the S1-CS status/alarm. If it is illuminated, cycle selection has not occured and can be assisted manually.
3. Observe the TD in the S1 display. Estimate the difference (in microseconds, higher or lower) between the TD displayed and the known TD.
4. Set Function to S1 position. Use Step 5 or Step 6.
5. Press [+/M] key to increase the cycle tracking point +10 microseconds each time the key is pressed.
6. Press [-/R] key to decrease the cycle tracking point -10 microseconds each time the key is pressed.
7. Observe the TD in the S1 display. The TD should read approximately the same as the known TD within several microseconds. Set Function to NOR and allow several minutes for the TD's to stabilize. If stabilization does not occur, the operator should move the vessel away from the area and repeat paragraph 3.4.2.

3.5.2 Manually Assisted Cycle Selection - S2 Secondary. Repeat the procedure of 3.4.1 using Function in the S2 position and by observing the S2-CS status/alarm conditions.

3.5.3 Manually Assisted Cycle Selection - Master Station

1. Press [▶] Key. Set Function to SEL position.
2. Observe the M-CS status/alarm. If it is illuminated, Master cycle selection has not occured and can be assisted manually.
3. Observe the TD's in S1 and S2 displays. Estimate the difference (in microseconds, higher or lower) between the TD's displayed and the known TD's.
4. Set Function to M position. Use Step 5 or Step 6.

5. Press [+/M] key to increase the cycle tracking point (Master +10 microseconds each time the key is pressed. The TD's in both displays will decrease -10 microseconds each time the +/M key is pressed.
6. Press [-/R] key to decrease the cycle tracking point (Master) -10 microseconds each time the key is pressed. The TD's in both displays wil increase +10 microseconds each time the -/R key is pressed.
7 Observe the TD's in both displays. The TD's should read approximately the same as the known TD's within several microseconds. Immediately set Function switch 1 to NOR
8. The S1-CS and S2-CS status/alarms may or may not extinguish when Master Cycle Select occurs. If secondary cycle select does not occur in several minutes, it may be necessary to move the vessel away from the area and repeat the procedure of 3.4.2.
9. Do not use the TD's for navigation unless the CS status/alarms extinguish.

3.6 SPECIAL TEST FUNCTIONS

Special test functions can be performed to determine the operational capabilities of the Loran receiver. These functions are normally used by test technicians and production personnel to check the receiver for proper operation and are not used for normal operation.

3.6.1 Internal Oscillator Stability. This is a display of the internal oscillator frequency deviation.

1. Press [▶] Key. Set Function indicator to TEST. Wait approximately 3 seconds for the digit display segment test to finish.
2. Press [+/M] key to display the frequency deviation. Deviation is displayed 00000.0 min., 000020.0 max.
3. Press [+/M] key to restore display to Test mode operation.

3.6.2 Manual Change of Cycle Tracking Points. The receiver cycle tracking points for the Master and Secondaries can be changed manually, increased in increments of +10 microseconds or decreased in increments of -10 microseconds, to test the receiver ability to reacquire and settle.

To manually change the cycle tracking points of the Master and all acquired Secondaries:

1. Press [▶] Key. Set Function indicator to SEL.
2. Press [+/M] key to increase the cycle tracking point +10 microseconds each time the key is pressed, or, Press -/R key to decrease the cycle tracking point -10 microseconds each time the key is pressed.
3. In both conditions, all CS status/alarms illuminates.
4. If Function indicator remains in the SEL position, a properly working receiver will reacquire the correct cycle tracking points and settle. All CS alarms will extinguish.

To manually change the cycle tracking point of S1 secondary:

1. Press [▶] Key. Set Function indicator to S1.
2. Press [+/M] key to increase the cycle tracking point +10 microseconds each time the key is pressed, or, press -/R key to decrease the cycle tracking point -10 microseconds each time the key is pressed.
3. In both conditions, the S1-CS status/alarm illuminates.
4. If Function indicator remains in the S1 position, a properly working receiver will reacquire the correct cycle tracking point and settle. The S1-CS status/alarm will extinguish.

To manually change the cycle tracking point of S2 Secondary:

1. Press [▶] Key. Set Function indicator to S2.
2. Press [+/M] key to increase the cycle tracking point +10 microseconds each time the key is pressed, or, Press -/R key to decrease the cycle tracking point -10 microseconds each time the key is pressed.

3. In both conditions, the S2-CS status/alarm illuminates.
4. If Function Switch 1 remains in the S2 position, a properly working receiver will reacquire the correct cycle tracking point and settle. The S2-CS status/alarm will extinguish.

To manually change the cycle tracking point of the Master Station:

1. Press Mode 1 select key. Set Function indicator to M.
2. Press +/M key to increase the cycle tracking point of the Master Station +10 microseconds each time the key is pressed. The TD's in both displays will decrease -10 microseconds each time the key is pressed.
3. Press -/R key to decrease the cycle tracking point of the Master station -10 microseconds each time the key is pressed. The TD's in both displays will increase +10 microseconds each time the key is pressed.
4. In both conditions, the M-CS status/alarm will illuminate.
5. If Function indicator remains in the M position, a properly working receiver will reacquire the correct cycle tracking point and settle. The M-CS status/alarm will extinguish.

3.7 INTERFERENCE ANALYSIS

Test mode analysis of signal conditions to localize interference from on-board equipment can be performed using the Loran unit.

1. Perform a signal analysis in accordance with the Test Mode Operation, paragraph 3.4.8.
2. Note the average value of the digits, particularly digit 4.
3. Energize the on-board equipment, one item at a time. Operate each item to utilize it's maximum capability.
4. When an item of equipment is generating or radiating noise interference, it will be indicated in digits 3, 4, 5 by displaying lower order numbers and large fluctuations in the average value of digits 3, 4 and 5. Noise interference from on-board equipment can cause the Loran to be completely unusable. In cases such as this the operator must eliminate the interference by isolating the item of equipment causing the interference.

3.7.1 Interference Reduction. In many cases the effects of interference can be reduced or eliminated by relocating the antenna coupler. The following recommendations should be accomplished prior to selecting the final location for mounting the Loran Unit and the Antenna Coupler:

* Follow the recommendations listed in the Installation Section.

* Connect the power cable directly to the battery terminals. Do not connect the power cable to intermediate distribution teminals which carry power for other equipment.

* Perform the Interference Analysis in the Test mode as described in paragraph 3.7.

* In all cases, the ships alternator will require some form of interference surpression. It may require use of a combination of methods. Some recommendations are listed herein.

* Install a 20,000 Microfarad, computer grade, vented electrolytic capacitor from the alternator output terminal to any of three grounds, 1) the engine block, 2) the alternator housing and 3) the ships ground. Testing may be required to determine the best ground. Relocate the system voltage regulator to within 12 inches of the alternator.

* Install shielded wires from the Voltage-regulator to the alternator, grounding the shield to the engine block or the ships ground. Testing may be required to determine the best ground.

* Reduce the length of the main battery cables, both positive and negative cables.

* When alternators cannot be surpressed satisfactorily, it will be necessary to replace or rebuild the alternator to eliminate the source of interference.

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