SATELLITE NAVIGATOR

RS 5000

NAVIGATOR'S MANUAL

NO. 9004a

SPECIAL FUNCTION ENTRY

INITIALIZATION	WAY POINT	D/R CONTROL	SYSTEM CONTROL
01 Day/month/year	30 Great circle	25 Gyro heading	40 Lock keyboard
02	31 Rhumb line	26 Auto heading	41 Unlock keyboard
03	32 Next way point	27 Manual heading	42 Light ON
04	33	28 Auto speed	43 Light OFF
20 Antenna height		29 Manual speed	44 Light Intensity
21 Geoidal height	SATELLITE STATUS	35 Auto set/drift	45 Self test
22 Alarm distance	10 Last fix	36 Manual set/drift	
23 Pulse/mile	11 Next satellite	37	90 Fault code
24 Magnetic error	12 Selection ON	Note: Automatic is	91 Fix count
25	13 Selection OFF	OFF when starting	92 Count reset

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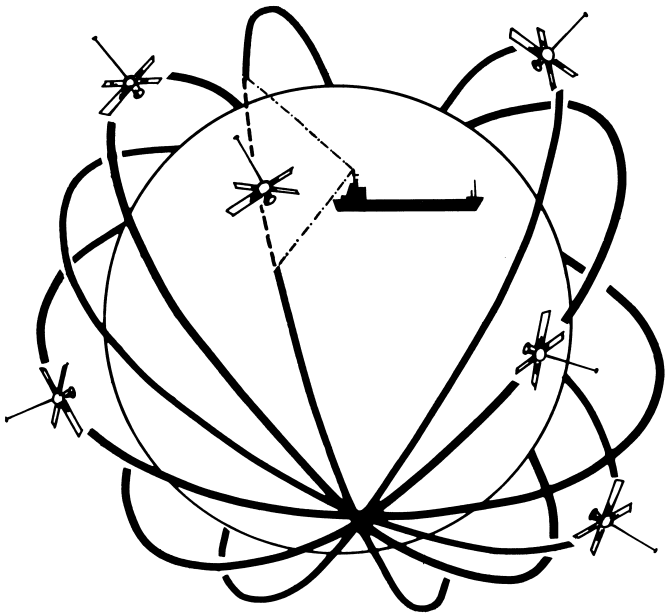
1. PRINCIPLE OF SATELLITE NAVIGATION

Traditional navigation is based on dead reckoning combined with periodic updating from land marks, stars or radio bearings.

Satellite navigation is also based on dead reckoning combined with periodic updating from satellite radio signals.

Speed log and compass inputs can be fed into the satellite navigator automatically or via the keyboard. The system computes the dead reckoned position every 10 seconds, and displays the result in latitude and longitude.

Between 10 and 30 satellites will pass over the horizon every 24 hour, depending on your latitude, and the satellite navigator automatically receives and "tracks" its radio signals, and precisely updates the dead reckoned position.



TRANSIT SATELLITE ORBITS

2. THE TRANSIT SATELLITE SYSTEM

The Navy Navigation Satellite System, NNSS, also called TRANSIT, has been in operation since 1960. The system has reliably provided navigational data of the highest quality to its users almost since its inception. The system is available for commercial applications at no cost to the user, other than the purchase of the receiving equipment. The NNSS was made available to the general public in 1967.

The NNSS consists of 6 satellites in polar orbits circling the earth at a height of 1000 km and a rate of 27,000 km/h, a world-wide network of tracking and injection stations, and a central computational center. Each satellite continuously transmits a message consisting of its own orbital data and predicted orbital motion on two highly stable carrier frequencies (150 MHz and 400 MHz). These frequencies appear to shift slightly as the satellite rapidly passes overhead in exactly the same way the pitch of a train whistle or automobile horn appears to change as it rapidly passes by the stationary observer. This phenomenon is called the "doppler effect" or "doppler shift". The tracking network tracks each pass of each satellite and very accurately measures the doppler shift present on the satellite's two transmitted carrier frequencies. The doppler data is transmitted to the central computing center where it is combined with other data and used to accurately predict the satellite's future orbital motion. Twice daily, the injection stations transmit a corrected orbital message to each satellite prepared from orbital predictions.

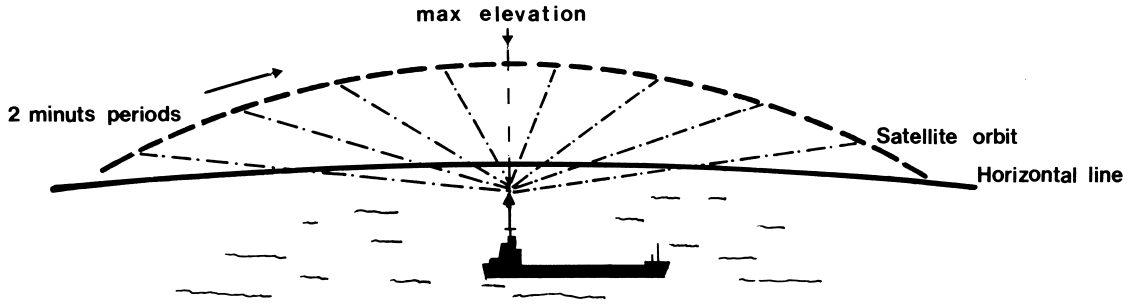
3. POSITION FIX

While the accuracy of the RS 5000 Computer is better than 15 meters, and the satellite orbit is known within 5 meters, there are two external factors which affect accuracy.

Because the doppler shift is a very accurate measurement of MOTION, every knot in SPEED and DRIFT ERROR will cause a fix ERROR of up to 0.2 nm. The satellite fix is a single position related to a given moment, and all the data received during the satellite pass must be converted mathematically to one point. This is possible only when the vessel is stationary, or its motion is precisely known.

The 400 MHz radio signals from the satellites are essentially "line of sight" signals. However, the ionosphere can cause delaying or bending of the radio signals. This effect is strongest during daylight hours and can change from moment to moment contributing a MAXIMUM ERROR OF 0.2 NM but normally less than 0.05 nm.

Good navigation practice recommends against reliance upon any single navigation aid for position fixing. Generally, however, the accuracy of a satellite position fix exceeds the dead reckoning accuracy requirements.



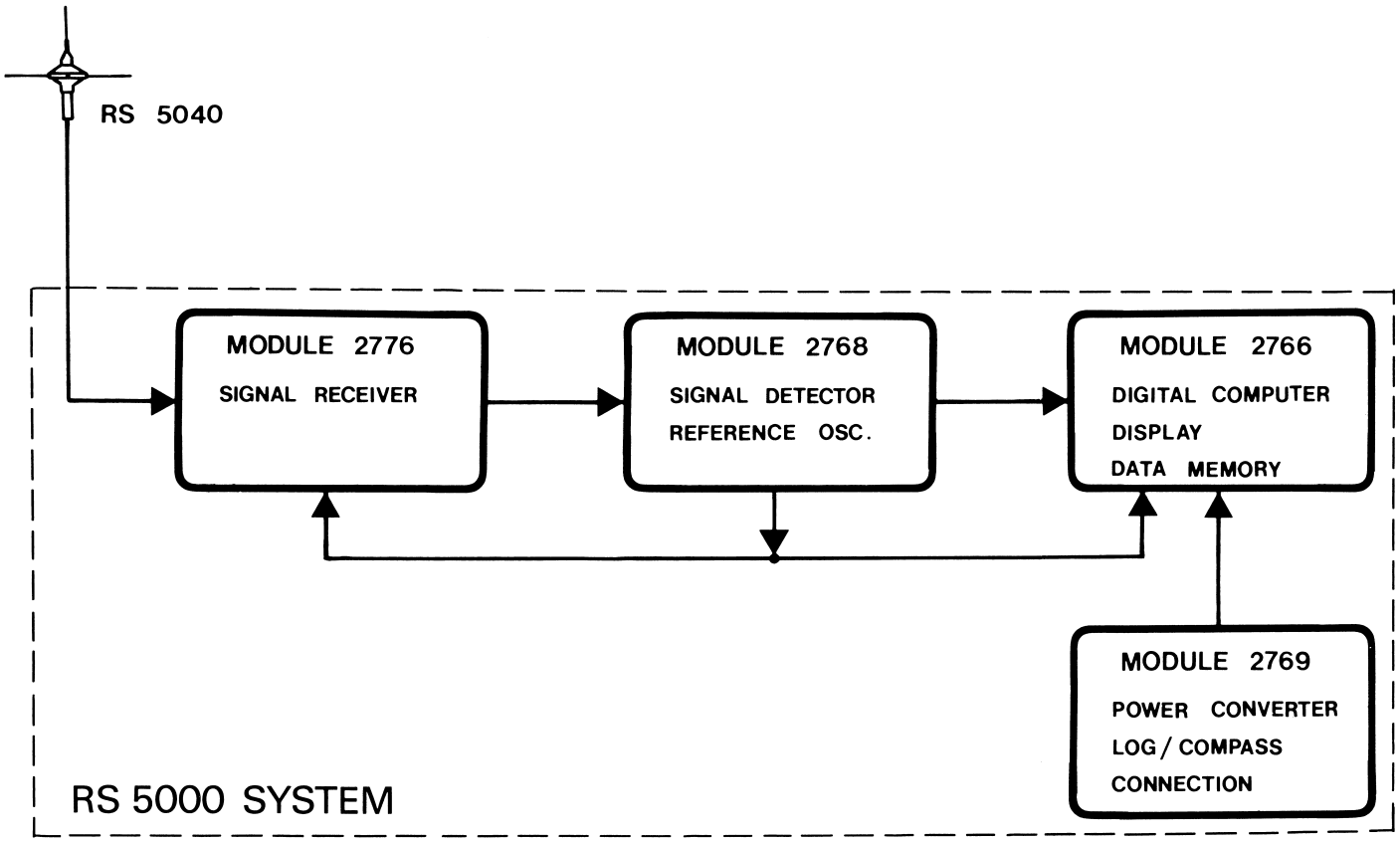
SATELLITE PASS

NUMBER OF FIXES TO EXPECT

Special function 11 makes possible prediction of all future satellites for up to 45 days. However, even when the predicted satellite angle is acceptable, there can be several reasons for not getting a fix. These include:

1. Ionospheric disturbance, by splitting data into several unusable bits, can interrupt transmission.
2. Harbor obstructions such as masts, buildings and high cargo aboard freighters can interrupt reception from certan angles.
3. Pitch and roll in excess of 30 degrees can block the satellite signal from one side.
4. Due slight differences in orbit and speed, two satellites can cross within the same time period. In such cases a jamming effect occurs, and the navigator will fail to lock-up on either signal.
5. Strong interference from a radio transmitter or radar can also jam the signal. This is a common occurance in congested harbors.
6. Due U.S. Navy tracking, testing and alignment procedures the number of active satellites can vary - usually between three and six. When a satellite is switched off from the ground, the RS 5000 will continue to make predictions for the satellite for 45 days before it is cleared from the memory.
7. When initialization data is incorrect, no fix will be obtained. Minimum requirements are GMT accurate within +/– 14 minutes, date (day/month,year), relatet to GMT, and position within +/– 60 miles. **These are the most common operator errors which cause "no fix".**

4. BLOCK DIAGRAM OF SATELLITE NAVIGATOR RS 5000



Radio signals from the satellites are picked up by the antenna and fed via a coaxial cable to the 400 MHz receiver. The receiver amplifies the signal and converts it down to a low frequency. The signal detector then selects the satellite orbit information needed for the digital computer. The information consists of satellite orbit data and doppler data. A very precise temperature controlled reference oscillator is needed for measurement. The digital computer performs dead reckoning, satellite fix calculations, and waypoint calculations.

The switch mode power supply provides correct voltage for the various circuits in the satellite navigator from a supply voltage between 10-32 volts DC.

The log and compass connections direct the electronic pulses from the log and compass interfaces to the digital computer.

5. TECHNICAL SPECIFICATIONS

5.1 RS 5000 Satellite Navigator

Satellite fix accuracy	0.05 NM RMS plus 0.2 NM per knot of speed error.
GMT time accuracy	± 1 second.
Receiver frequency	400 MHz.
Receiver sensitivity	÷149 dBm.
Input power	10 to 32 volt, 15 to 25 watts.
Memory storage	Internal battery stores the following for 30 days, without external power: lat, lon, waypoints, ant height, geo height, mag variation, alarm dist, log pulse, heading, speed, and satellite orbit data for predictions.
Keyboard	Multilayer sealed, tone response.
Display	3 x alpha numeric 16 character vacuum luminisense.
Module construction	Computer module 2766 Receiver module 2776 Oscillator/Detector module 2768 Converter module 2769
Log input	RS 5020/Yacht log, 26,000 pulses/kn. mile. The RS 5000 will accept most electronic logs, with between 100 and 50,000 pulses/kn. mile. Pulse voltage: contact closure, 3,5 to 120 volt, sq. wave.
Heading input	Binary code, 9 bits TTL positive logic. RS 5015 compass system. RS 5030 Gyro interface system.
Dimensions, RS 5000	H:175, W:285, D:110 nm (H 7", W 11-7/32", D 4-5/16")
Weight	2,8 kg (6 lb, 3 oz)
Dimensions, junction box	H:80, W:130, L:170 nm (H 3-5/16", W 5-1/8", L 6-11/16")
Temperature	0-55°.
Humidity	0-95 per cent.
Vibration	0-50 Hz 1 g.
Self test	Automatic function every 60 minuts. Optinal.

5.2 RS 5040 Antenna with preamplifier

Amplifier gain	15 dB/50 ohm.
Input power	through coaxial cable.
Cable length max.	RG 58/u should not be used. RG 8/u 30 meters. RG 8/x 20 meters. RG 8/u 60 meters with extra amplifier.
Humidity	0-100 per cent.
Weight	0.6 kg (1 lb, 4 oz).
Diameter	660 mm (26").
Height	290 mm (11-7/16")
Required supporting tube	38 mm outside diameter (1½", 1/16-3/32" wall thickness).

5.3 Standard system includes:

RS 5000 Satellite Navigator unit

RS 5045 Junction box

RS 5040 Antenna with preamplifier

RS 5046 Multicable with plug, 2 meters

Antenna connectors and fuses

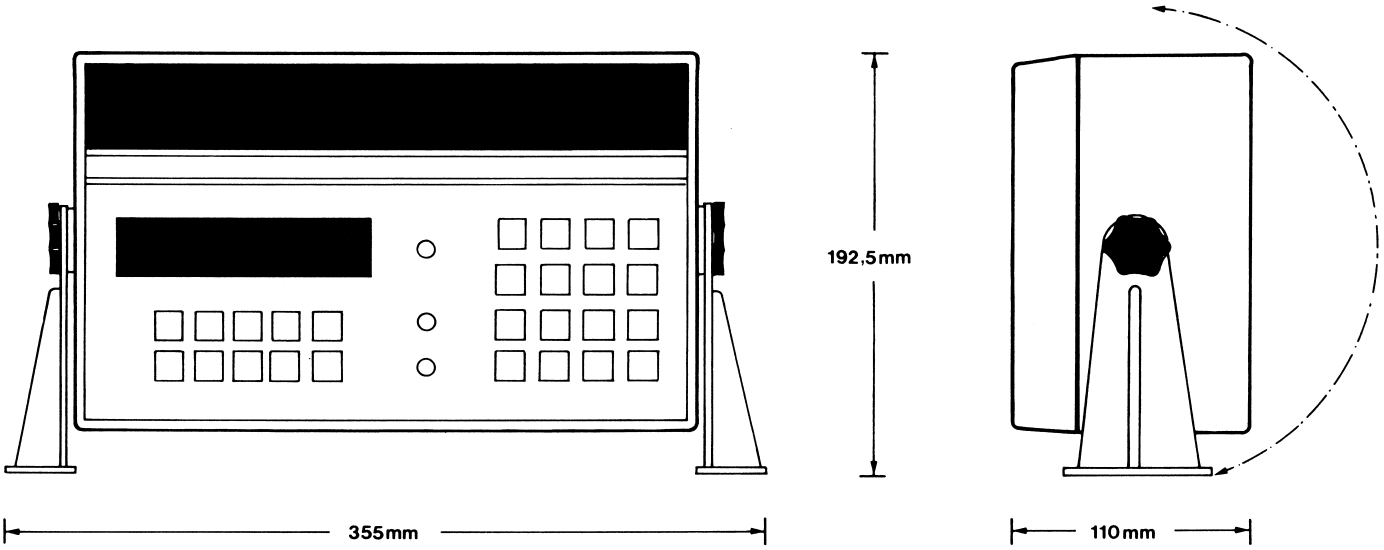
Navigator's Manual

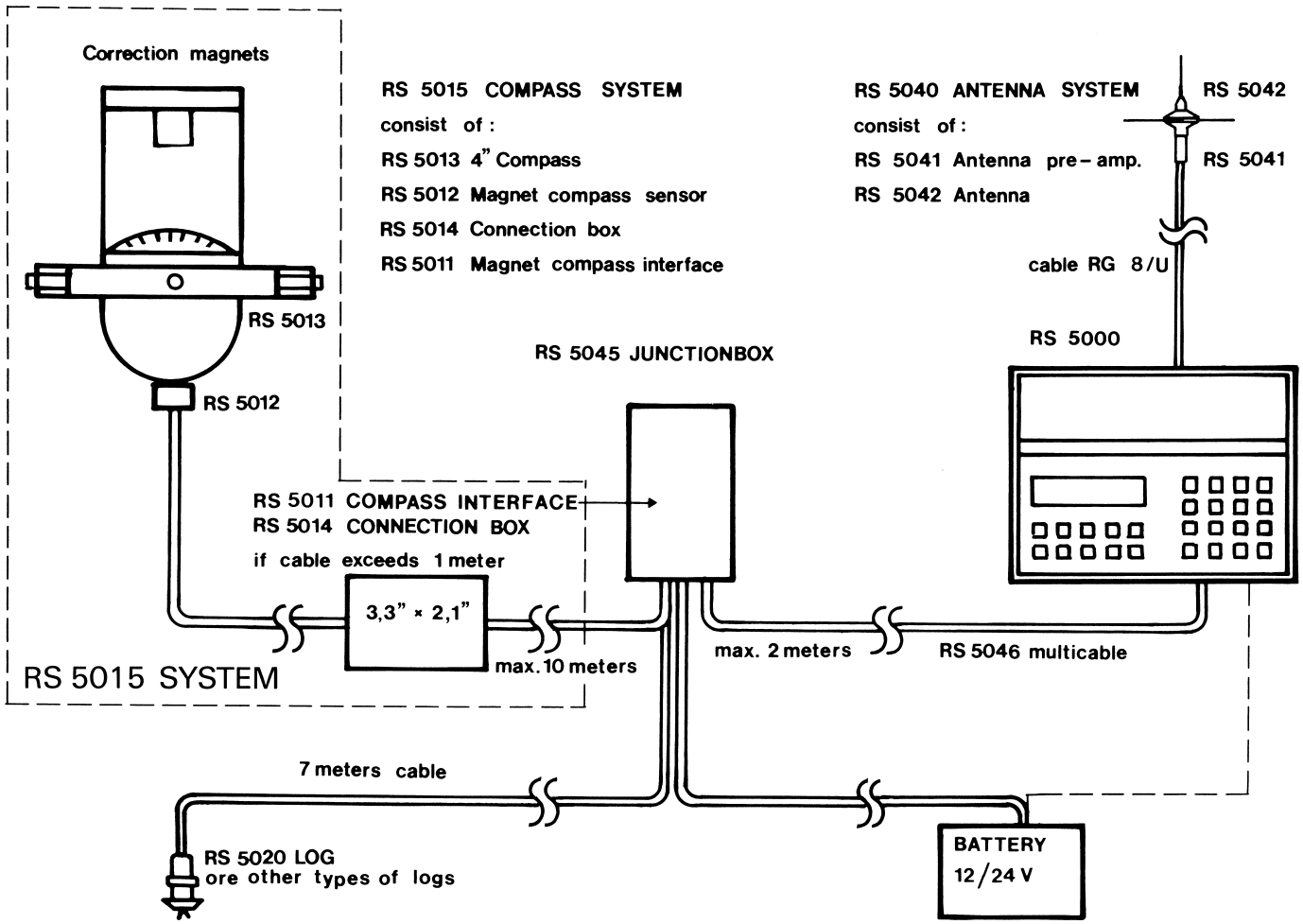
Warranty certificate

Packing size	H:410, W:350, D:160 mm (H 7", W 14½", D 17½")
Packing weight	5 kg (11 lbs)
Packing type	Styrofoam in cardboard box.

6. INSTALLATION OF RS 5000 SYSTEM

6.1 RS 5000 System Interconnect





NOTE: Gyro compass interface can be mounted in RS 5045 junction box instead of RS 5011 magnetic compass interface.

NOTE: Supply voltage should be routed as direct from the battery as possible. Some 12 volt systems where battery capacity is limited, or not separate from enginestarting requirements, may need a line voltage protector.

6.2 Antenna installation

To receive good signals from satellites with low elevation angles it is important to have the antenna mounted as high possible above sea level.

The antenna requires an unobstructed view of the horizon. Single metal objects must not produce more than 2 degrees obstruction.

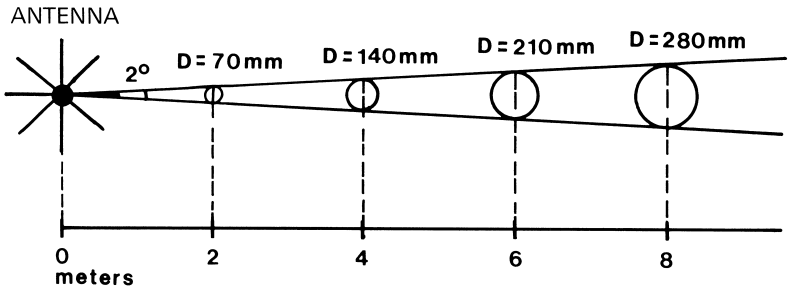
The antenna pre-amplifier is powered through the antenna cable.

The antenna cable must be without interconnections between antenna and navigator unit.

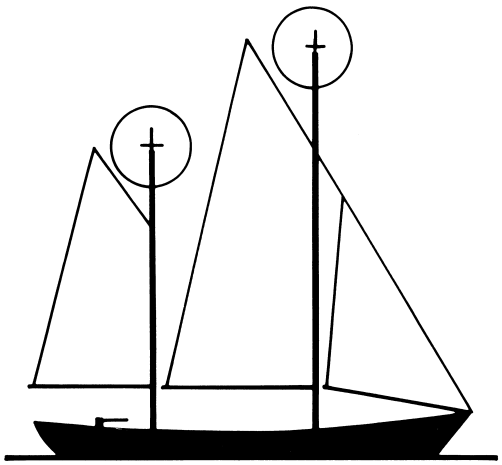
The antenna cable requires a PL 259 plug for both the antenna and for the navigator unit.

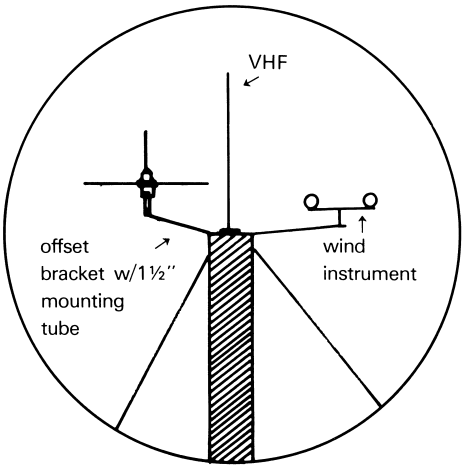
Proper termination of antenna coaxial cable is very important.

Maximum cable length:	RG 8/u, RG 213	30 meters
	RG 8/x	20 meters
	RG 8/u with extra amplifier	60 meters

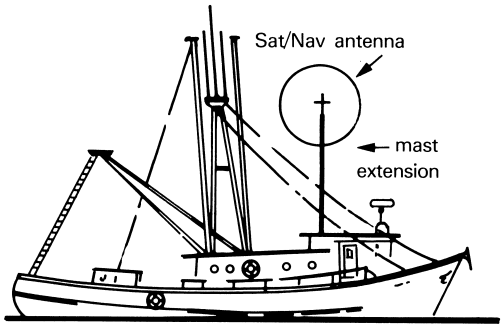


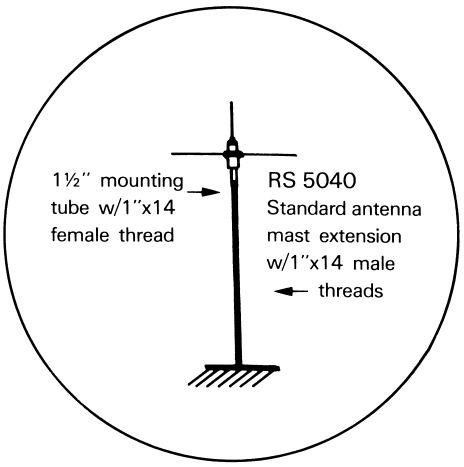
Preformance for the satellite system depends completely on a good antenna installation.





1½" flanged mounting tube, or
1½" tube bolted to side of mast.





TOTAL HEIGHT: 290 mm (11-7/16")
TOTAL WIDTH: 665 mm (26")

Requires 1½" O.D. mounting tube, with wall thickness between 1/16-3/32".

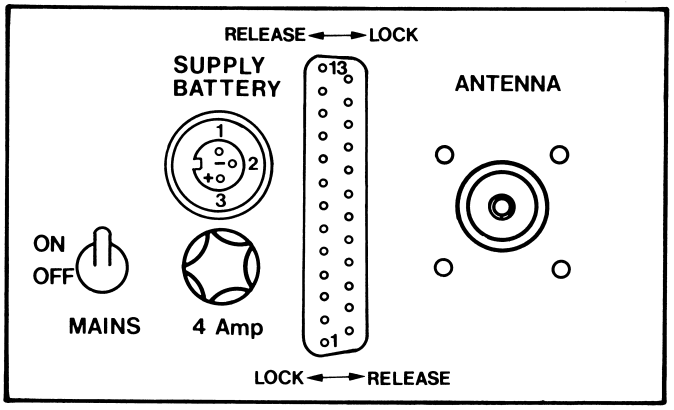
6.3 Installation of navigator unit

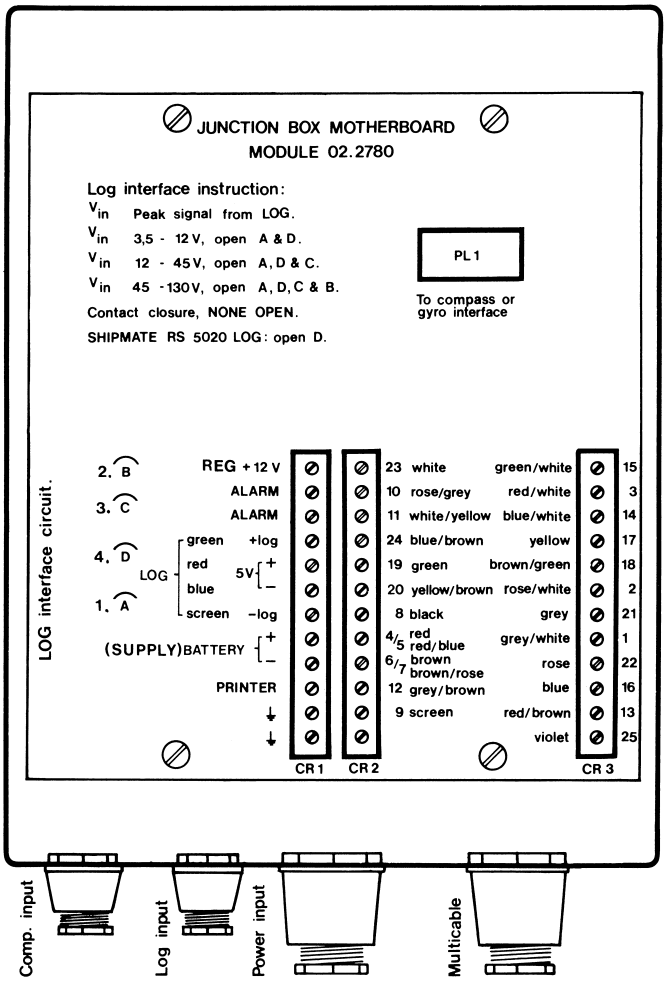
The small dimensions and light weight of the navigator unit allows it to be installed in the most convenient position, on the table, on the bulkhead, or hanging.

Antenna cable plug: PL 259 for antenna and system connections.

Multicable plug: Cannon DB 25S to junction box for: battery, log, compass and alarm. Cable type 24x 0.16 mm² (22 awg), screened, connected by crimping.

Battery plug: The battery plug on the rear side of the navigator unit and the battery connections in the junction box are in parallel.
Which connection to be used depends on the installation.





NOTE: Excess multicable should be cut off before termination.

MULTIPLUG CONNECTIONS:

	PIN:	FUNCTION:	COLOUR:			
	1	DI 2	grey/white	13	COMPASS	red/brown
	2	DI 1	rose/white	14	DI 0	blue/white
	3	DI 3	red/white	15	DI 4	green/white
Mains supply 12, 24 V	4	BATTERY +	red	16	DI 7	blue
	5		red/blue	17	DI 5	yellow
	6	BATTERY –	brown	18	DI 6	brown/green
	7		brown/rose	19	+5V Reg.	green
	8	– LOG	black	20	–5V Reg.	yellow/brown
	9	SCREEN	screen	21	DI 9	grey
	10	ALARM	rose/grey	22	DI 8	rose
	11	ALARM	white/yellow	23	+12V Reg.	white
	12	PRINTER	grey/brown	24	LOG	blue/brown
				25	GYRO	violet

6.4 Junction box

To simplify installation, all connections from compass, log, battery and alarm, are collected in a junction box. Only a single multicable enters the navigator unit.

A two meter multicable and multi plug are provided with the system.

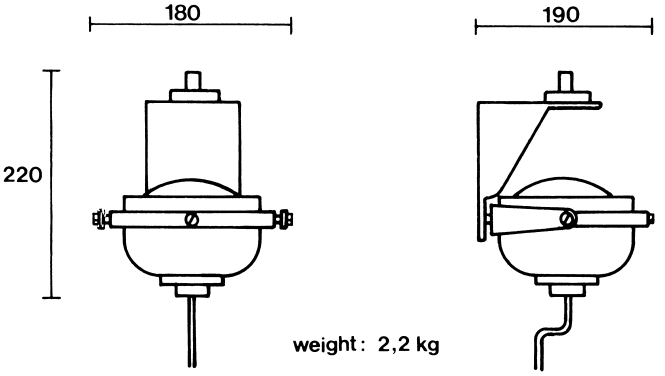
The cables must be mounted in the junction box according to the drawing.

If a magnetic compass sensor is used, the compass interface board is plugged into the junction box, and mounted on stand-offs.

6.5 Compass installation & adjustment

Heading input for dead-reckoning in the RS 5000 can be inserted manually from the keyboard or taken automatically from a compass.

RS 5015 COMPASS SYSTEM consists of a 4" direct-reading steering compass with compass sensor and amplifier. The sensor and amplifier are mechanically and electronically adjusted together with the compass. The amplifier is plugged into the junction box.



The RS 5015 should be mounted where magnetic disturbance is minimal. While it can withstand occasional spray, outside installation is not recommended, but possible in steelboats.

A bracket with correction magnets is supplied with the compass. The correction magnets must be mounted above the compass, and are used to compensate the compass in a steel vessel, using the following procedure:

6.5a Head the vessel to EAST and reduce the observed deviation to zero by placing small magnets in the fore and aft tubes in the bracket.

6.5b Head the vessel to WEST, observe the deviation by pelorus and remove half of the deviation by adding magnets or reduce the strength of the magnets in fore and aft tubes.

6.5c Head the vessel to NORTH, ascertain the deviation and restore the compass to NORTH by placing magnets in the athwartship tubes.

6.5d Head the vessel SOUTH, observe the deviation and remove half of it in the athwartship tubes.

The sensor is mounted on the bottom of the compass bowl and factory adjusted together with the compass.

A 1 meter cable leads to the compass interface in the junction box, where the signals from the sensor are converted to stable digital signals.

The digital signals are transmitted to the RS 5000 through the multicable from the junction box.

The maximum cable length between sensor and junction box is 10 meters. The RS 5014 connection box can be used for cable extension.

6.6 RS 5030 Gyro Compass installation

Please contact your dealer for more information.

6.7 Log installation

Speed inputs to the RS 5000 can be inserted manually from the keyboard or taken automatically from an electronic log.

The RS 5020 Log, for pleasure boats, consists of an ABS thru-hull-fitting with a removeable sensor element with paddle wheel.

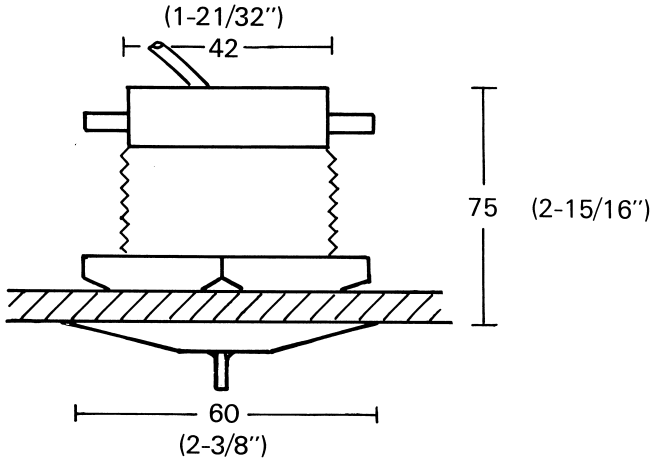
A built-in amplifier in the sensor element gives pulses which can be accepted directly by the RS 5000.

The 7 meter cable on the sensor is connected to the junction box.

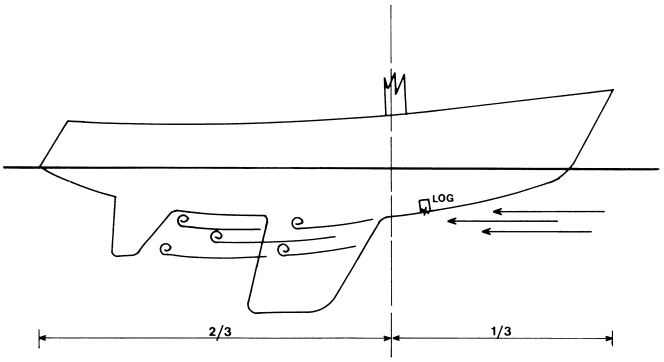
MOST LOGS can be connected through the log interface in the junction box. INSTRUCTIONS ARE PRINTED IN THE JUNCTION BOX.

The number of pulses per mile must be keyed in during initialization of the RS 5000. The acceptable number is between 100 and 50,000.

The log RS 5020 always must be mounted in the front third of the boat in order to avoid disturbing turbulense at high speed.



RS 5020 PLEASURE-BOAT LOG



6.8 Common installation problems

6.8a Prober termination of antenna coaxial cable connectors is the single most important concern. If unsure, it is better to have a qualified technician who is familiar with this type of connection do the job.

The antenna requires an unobstructed view of the horizon.

RG 8/u cable is highly recommended. On short runs RG 8/x or even RG 58/u could be used, but the signal loss at 400 MHz on these smaller cables is much greater than with RG 8/u. The satellite is broadcasting a 1 watt signal for a minimum of 550 miles!

6.8b On 12 volt DC installations, the RS 5000 MUST be isolated from any batteries for engine starting, or powering any other device with high current consumption. Low voltage situations resulting from engine turnover or other reasons, can cause the RS 5000 to lose memory, and may damage the microprocessors if the situation is repeated. On any 12V vessel with limited battery capacity, it is highly recommended to use a line voltage stabilizer with battery back-up. The cable must be 2,5 mm^2.

6.8c The electrical systems on most vessels are not designed to power today's microprocessor-controlled instruments (programmable VHF's, Lorans, Sat/Nav systems). If the installation is approached with this philosophy, most inherent problems can be overcome.

Wiring the system as direct to the battery as possible is recommended. (Avoid common bus connections, where everything is tied together, and line noise levels are highest). Diodes should be used to isolated all batteries. Check for adequate voltage!

6.8d Cut off multicable to shortest length needed, to decrease voltage drops and noise exposure.

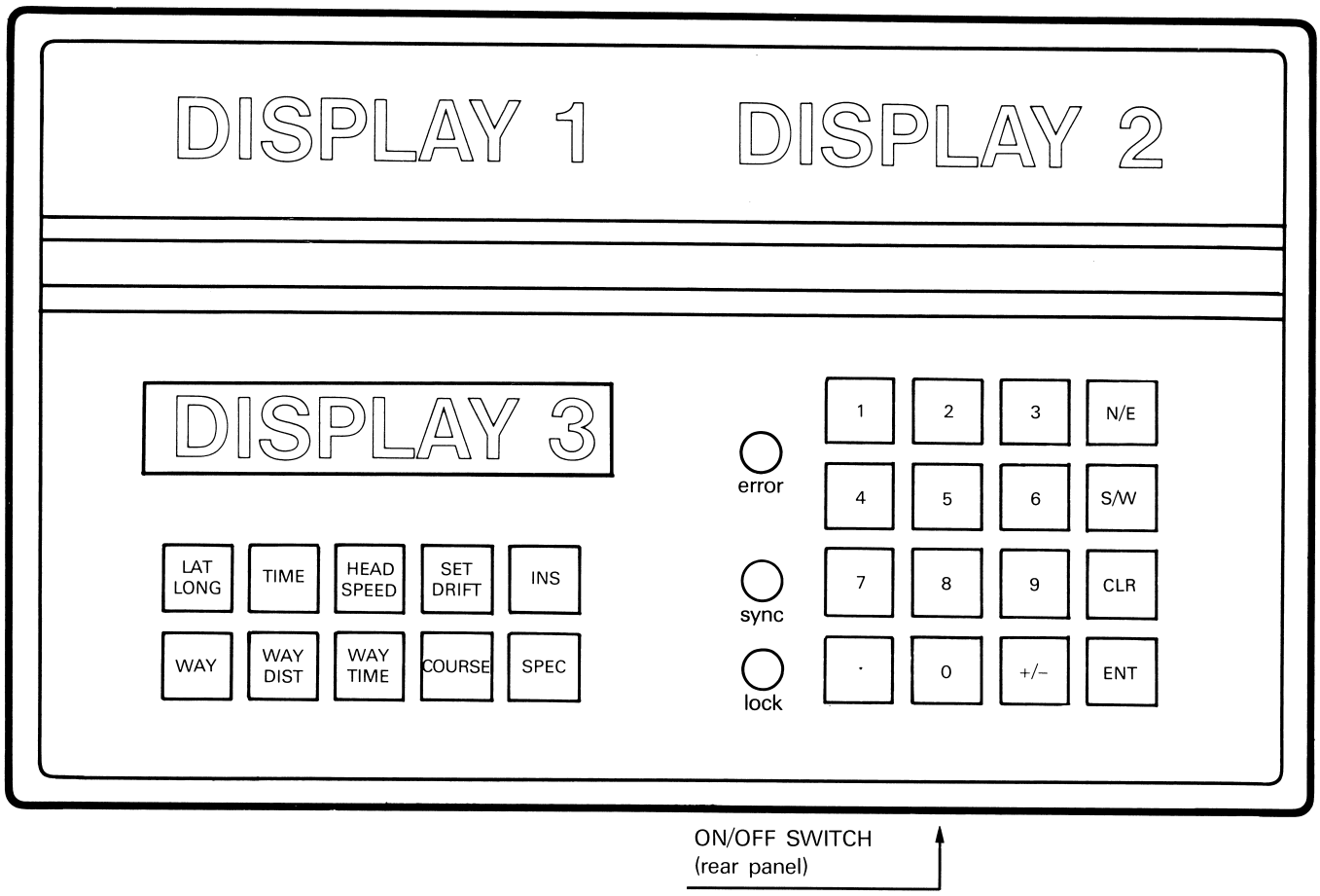
6.8e Read the operating manual throughly before turning the system on.

6.8f Be sure when waiting for fix, that:

1. Time is correct GMT within 14 minutes.
2. Date is correct and relatet to GMT time.
3. Position is correct within 1 degree. Remember N/S and E/W.

NOTES

7. KEYBOARD AND DISPLAY LEGEND



KEY		DISPLAY USED
LAT LONG	Displays current D.R. latitude and longitude, as opposed to waypoint lat/long, last-fix lat/long, etc.	1 & 2
TIME	Displays time (GMT) and dead-reckoning time (time since last fix). O's indicate no fix since start-up.	3
HEAD SPEED	Displays current heading and speed as input to the system, either by keyboard or automatically. Use **INS** (insert), **HEAD SPEED** to change speed/heading.	3
SET DRIFT	Displays set and drift. Display is that value inserted manually, or computed by system.	3
INS	»Insert«. Used with **SPEC** key and special function # to change numerical value, or with direct function key (time, lat/long, hdg/speed, set/drift, way) to insert or change numerical value.	
WAY	Used with **INS** and waypoint # (1-9) to insert or change a waypoint or just **WAY** and way # to display waypoint.	1 & 2
WAY DIST	Displays distance in nautical miles to chosen waypoint (spec 32).	3
WAY TIME	Displays time to chosen waypoint to nearest hour, at present speed.	3
COURSE	Displays course-to-steer (magnetic) and bearing (true) to chosen waypoint.	3

SPEC	"Special". **INS** **SPEC** function #, to change nummerical value. **SPEC** function # , for command function (next sat., last fix, great circle/rhumbline, automatic/manual).
N/E **S/W**	Used with **LAT/LONG** or **WAY** entry to select proper hemisphere, before **ENT** (enter) key is touched.
+/–	Used to select positive or negative entry value before **ENT** is keyed.
CLR	Used to "clear" wrong entry of values, before **ENT** is touched.
ENT	Used to enter selected values.

LIGHTS

Error	Alerts operator to problems with gyrocompass interface or electromagnetic log.
Lock	System receiving 400 MHz signal.
Sync	System is tracking satellite and accepting data.

7.1 Special functions

The RS 5000 has a number of special functions which allow the operator to select particular operating routines, to update previously entered data, and to perform other tasks beyond the basic starting procedure. These features are selected via individually coded special functions, and are listed in the summary chart on the front cover of this manual, and below.

Special functions are accessed via the insert (INS) and special (SPEC) keys, and the code # of the special function. To change a numerical value of a special function: touch INS , SPEC , and the function #. Display 3 will flash the function abbreviation, and the existing value. Key in the new value, and enter (ENT). When a numerical value is NOT to be changed, an automatic/manual selection made, or a system command function wished, simply touch SPEC , and the desired code #.

NOTE: All automatic functions are OFF when starting.

7.2 Battery back-up and memory

When the mains power is interrupted for maximum 1 minute, display 3 will show "POWER FAILURE" after the mains power is normal again. The function of the RS 5000 will continue normaly without starting procedure, but DRT will be 0.00 and the GMT display will be delayed according to the interruption periode.

When the mains power is switched off for up to 45 days, the display will show "RS 5000 WAITING FOR INFO" when the power is switched on, and the short starting procedure (8.1) must be used. After the starting procedure, the RS 5000 need about 10 minutes to update "next satellite" SPEC 11.

The long time memory can be totally cleared by pressing CLR together with switching on the RS 5000. This is the only way to renew the satellite predictions, and can be necessary when the satellite status changes (a satellite is switched on or off).

The external powersupply RS 5024 can supply the RS 5000 for 30 minutes normal function even when 110V/220V AC or 240V DC to the powersupply is missing. When the voltage to the RS 5024 is missing the "ERROR" indicator will be alight.

7.3 List of abbreviations

DRT	Dead reckoning time
HDG	Heading
SPD	Speed
SET	Drift heading
DRIFT	Drift speed
CTS	Course to steer
BRG	Bearing
RL	Rhumb line
GC	Great circle
W	Way point
WAY-D	Distance to way point
WAY-T	Time to way point
NXS	Next satellite
E	Elevation
E	East
N	Satellite number
N	North
ANT	Antenna
MAG	Magnetic
LAT	Latitude
LON	Longitude
LF	Last fix
LFX	Last fix

SPECIAL FUNCTION ENTRY

INITIALIZATION
- 01 Day/month/year
- 02
- 03
- 04
- 20 Antenna height
- 21 Geoidal height
- 22 Alarm distance
- 23 Pulse/mile
- 24 Magnetic error
- 25

WAY POINT
- 30 Great circle
- 31 Rhumb line
- 32 Next way point
- 33

SATELLITE STATUS
- 10 Last fix
- 11 Next satellite
- 12 Selection ON
- 13 Selection OFF

D/R CONTROL
- 25 Gyro heading
- 26 Auto heading
- 27 Manual heading
- 28 Auto speed
- 29 Manual speed
- 35 Auto set/drift
- 36 Manual set/drift
- 37

Note: Automatic is OFF when starting

SYSTEM CONTROL
- 40 Lock keyboard
- 41 Unlock keyboard
- 42 Light ON
- 43 Light OFF
- 44 Light Intensity
- 45 Self test
- 90 Fault code
- 91 Fix count
- 92 Count reset

8. SYSTEM OPERATION AND STARTING PROCEDURE

Operator Action = - - - - - - - - - - - -

System Display Response = ...

8.1 Switch ON the RS 5000 at the main switch on the rear of the cabinet.
Display 1 and 2 will display ..... SAT NAV RS 5000 WAITING FOR INFO

8.2 Display 3 will flash ..... GMT x 0.00.00
Key in GMT to within 14 min.
If GMT time is 14.25 - - - - - - - **14.25** **ENT**

8.3 As soon as **ENT** is pressed, display 3 will flash ..... DATE x1 01 00
Key in date related to GMT.
If date is 26th February 1980– **26.2.80** **ENT**
NOTE: Day, month, year.

8.4 As soon as **ENT** is pressed, display 1 and 2 will show last valid lat & lon; display 3 will show ..... Pos OK YES = 1

If the present position, latitude LAT and longitude LON, is ok, the built-in battery has maintained the memory and the starting procedure can be finished by keying - - - - - - - - - - - - - - - **1**
The display will change to
latitude, longitude ..... LAT... LON...
heading, speed ..... HDG... SPD...
This ends the abbreviated starting procedure.

8.5 Extended starting procedure

If the position LAT, LON is not ok, because the battery is empty or the RS 5000 has been moved over 60 nm., the starting procedure is extended by keying - - - - - - - - - - - - - - - **0**

8.6 Display 1 will flash ..... LAT X0 00 00 N
Key in actual latitude in degress, minutes and hundredths of minutes. NOTE: E/W, N/S.
If latitude is 8°35.80 S - - - - - - **8.35.8** **S/W** **ENT**
(If the exact position is unknown, the key in the approximate position to within 60 nm.)

8.7 As soon as **ENT** is pressed, display 2 will flash ..... LON XX0 00.00 E
Key in actual longitude in degrees, minutes and 1/100 minutes.
If longitude is 70°02.10 E - - - - **70.2.10** **ENT**
NOTE: E/W, N/S.

8.8 As soon as **ENT** is pressed, display 3 will flash ..... ANT HEIGHT XX0
Key in the height of the antenna above sea level in meters.
If the height is 18 meters - - - - **18** **ENT**

8.9 As soon as **ENT** is pressed, display 3 will flash ..... GEO HEIGHT + XX0
The shape of the earth is not a perfect sphere. It differs about 200 meters depending on the location. A map back on the last page shows the value to be inserted. Wrong geoidal height can give up to three times the height error in position error.
If the geoidal height is minus 30 meters - - - - - - - - - - - - - - - **+/-** **30** **ENT**
NOTE: **+/-**
NOTE: In special Deep Sea version Geoidal height is automatic calculated.

8.10 As soon as **ENT** is pressed, display 3 will flash ..... PULSE/MILE XXXX0
If a log is not connected to RS 5000 then key in enter - - - - - - **ENT**
and the starting procedure will continue to step 8.11.

If a log is connected to the RS 5000, then key in the number of pulses per nautical mile. For the RS 5020, the number is 26,000.
For other logs the number can be between 100 and 50,000. It is possible to correct the log when it has a constant error by inserting a slightly higher or lower number. If the log gives 200 pulses per nautical mile - - - - - - **200** **ENT**

8.11 As soon as **ENT** is pressed, display 3 changes to flashing ..... MAG ERROR + X0 00
The RS 5000 performs its dead reckoning computations in degrees true. If a magnetic compass system is connected to the RS 5000 or the heading from a normal compass is keyed in, then the magnetic variation will be corrected automatically in the dead reckoning. If the magnetic north pole error is +3.3 degrees from true north pole - - **3.3** **ENT**
NOTE: East variation is positive value.

9. NAVIGATING WITH RS 5000

9.1 Heading and speed

To obtain an accurate position fix, or dead reckoning update, information about the ship's heading and speed must be fed to the RS 5000. This can be done manually via the keyboard, or automatically via the compass and speed log interface.

9.2 Heading entry on keyboard

An apostrophe after HDG' indicates that heading is in automatic mode (special function 26). Key **SPEC** **27** for manual insertion.

If heading is 15 degrees - - - - - - - - - **INS** **HDG/SPD** **15** **ENT**

If speed is not to be entered, press again - - - - - - - - - - - - - - - - - - **ENT**

Display 3 is then ..... HDG 15 SPD 00

9.3 Heading entry from compass

Press - - - - - - - - - - - - - - - - - - **HDG/SPD**

Enter special function 26 to start auto heading - - - - - - - - - - - - - - - **SPEC** **26**

On display 3 an apostrophe will appear after HDG' indicating that auto heading is ON ..... HDG' 15 SPD 00

9.4 Magnetic variation changes

Local magnetic variation is inserted during the starting procedure, but when moving to other parts of the world the variation changes.

If the magnetic north pole is +3.3 degrees related to true north - - - - **INS** **SPEC** **24** **3.3** **ENT**

East variation is positive value; west is negative.

NOTE: No magnetic variation should be entered when using gyro compass.

9.5 Speed entry on keyboard

An apostrophe after SPD' indicates that speed is in automatic mode (special function 28). For manual insertion, key **SPEC** **29** .

If speed is 12 knots - - - - - - - - - - **INS** **HDG/SPD** **ENT** **12** **ENT**

Display 3 is then ..... HDG' 15 SPD 12

9.6 Speed entry from log

Press heading/speed point - - - - - **HDG/SPD**

Enter special function 28 to start auto speed - - - - - - - - - - - - - - - - **SPEC** **28**

On display 3 an apostrophe will appear after SPD' indicating that auto speed is ON ..... HDG' 15 SPD' 12

NOTE: Correct number of pulses from a particular log must be entered via special function 23.
Inaccuracies can be corrected by slightly varying the number of pulses entered.

9.7 Set/Drift

Known or computed set and drift can be applied to the computed dead reckoned position. Therefore if heading/speed and set/drift are entered precisely, the latitude/longitude display will be more precise.

9.8 Manual set/drift (**SPEC** **36**)

If known set is 90 degrees and drift is 2 knots - - - - - - - - - - - - - **INS** **SET/DRIFT** **90** **ENT** **2** **ENT**

Display is then ..... SET 90 DFT 2

NOTE: These values will remain in the D.R. until changed.

9.9 Auto set/drift (**SPEC** **35**)

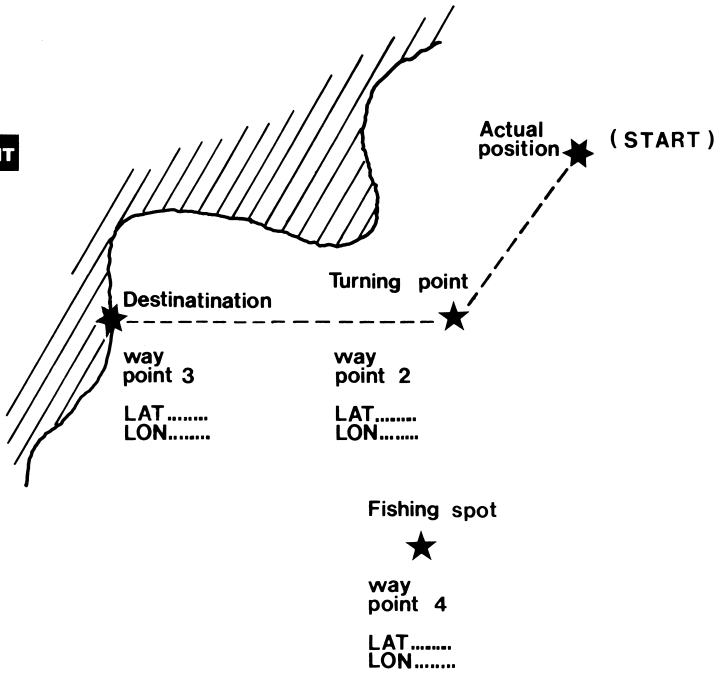
An apostrophe indicates that automatic is ON ..... SET' XX DRIFT' XX

The set/drift can automatically be calculated based on the difference between dead reckoning position and satellite fix position, on each fix.

The set/drift calculated in this way is an average of set/drift in the time between the last two satellites, and will then be applied automatically to the dead reckoning. Automatic set & drift should only be used in conjunction with long passages, and should be checked periodically.

9.10 Geoidal height changes

Local geoidal height is inserted during the starting procedure, but geoidal height may change with position. If it has changed to +10 meters - - - - - - - - - - - - - - - - - - **INS** **SPEC** **21** **10** **+/-** **ENT**



10. WAYPOINTS

A "waypoint" can be either the final destination or an intermediate destination/turning point/event point.

The RS 5000 memory contains 9 waypoints. Any one of the waypoints can be slected as "next waypoint" on the route, for course-to-steer, distance and time computations.

10.1 Inserting waypoint

In the sketch above, a turning point is selected as waypoint 2.

The coordinates are inserted - - - - [INS] [WAY] [2]

flashing latitude - - - - - - - - - - - - [x] [x] [x] [x] [x] [x] [ENT]

flashing longitude - - - - - - - - - - - [x] [x] [x] [x] [x] [x] [ENT]

The destination can be selected as waypoint 3 and inserted as above, and a favorite fishing spot may be selected and inserted as waypoint 4.

10.2 Event mark

Present "D.R." position can be inserted as a waypoint or "event mark". To monitor "distance run" from starting point, or to log a productive fishing spot, use the "event mark" feature.

To enter present DR position as waypoint #1 - - - - - - - - - - - - - - [INS] [WAY] [1] [LAT/LONG] [ENT]

10.3 Next waypoint on route

In the above example, the route is to turning point 2. Select waypoint 2 as "next waypoint" - - - - - [INS] [SPEC] [32] [2] [ENT]

10.4 Rhumb line or Great Circle

The RS 5000 must know if the route chosen is a Rhumb line or Great Circle. Rhumb line is easy to steer, because its course is constant. It is used over short distances. Great Circle is the shortest route (thus fuel efficient), but with changing course.

Rhumb line route, key in - - - - - - - [SPEC] [31]

Great Circle route, key in - - - - - - - [SPEC] [30]

10.5 Course to waypoint

To display course to next waypoint, calculated in Rhumb line or Great Circle, key in - - - - - - - - - - [COURSE]

Display 3 will show ..... 2 CTS 218 BRG 215

The first digit is next waypoint number. CTS is the magnetic course to steer including set/drift to reach the waypoint. BRG is the true bearing to the waypoint, uncompensated for set/drift and compass.

10.6 Distance to waypoint

To display distance to next waypoint, calculated in Rhumb line or Great Circle, key in - - - - - - - - - - [WAY] [DIST]

Display 3 will show ..... 2 RL WAY-D 382.1

The first digit is the next waypoint number. RL means Rhumb line, waypoint distance is 382.1 n mile. The distance is calculated every 10 seconds.

10.7 Alarm distance

As the vessel approaches the waypoint, the built-in alarm can be activated. Special function 22 allows the alarm to be selected between 1 and 9.9 nm.

If the distance is 2.5 nm, key in - - [INS] [SPEC] [22] [2.5] [ENT]

10.8 Waypoint arrival alarm

When the selected alarm distance to waypoint is reached, the built-in alarm will be activated.

Display 3 will indicate ..... WAYPOINT TOUCH

The alarm stops when any key is pressed - - - - - - - - - - - - - - - - - - [ ]

When a new "next waypoint" is keyed in, the alarm is reset to its previous selected alarm distance.

10.9 Time to waypoint

To display the remaining time to next waypoint, at present heading and speed, key in - - - - - - - - - - - - [WAY] [TIME]

Display 3 will show ..... 2 GC WAY-T 21

GC means Great Circle, time to waypoint 21 hours. Time to calculated every 10 seconds, and displayed to the nearest hour.

11. TIME

11.1 GMT

GMT is inserted during the starting procedure, accurate within 14 minutes. If it was entered incorrectly, it is easy to change.

For GMT of 12.03 - - - - - - - - - - - [INS] [TIME] [12.3] [ENT]

11.2 DRT

Dead reckoning time is the time since the last satellite fix. When the satellite has passed, and the position is updated, DRT is time since contact with the satellite was established. The fix position is computed to this point in time. Typically DRT will be 10-15 minutes when a fix is computed.

DRT is a good judge of DR accuracy, as dead reckoning position based on speed and heading inputs will deteriorate over time depending on the accuracy of inputs.

Zero indicates that no fix has been obtained since start-up.

12. SATELLITE STATUS

12.1 Last satellite fix

The RS 5000 stores the position and time of the last satellite fix.

Press special function 10 ------ SPEC 10
Display 1 will be last fix latitude ... LF LAT - - - -
Display 2 will be last fix longitude.. LF LON - - - -
Display 3 will show GMT of last fix, maximum elevation angle, and satellite ID number ..... LFX - - - - E - - - N - - -

12.2 Next satellite

The RS 5000 calculates next pass of every satellite in memory which has a positive elevation angle.

Press special function 11 ------ SPEC 11
Display 3 will show time of next satellite, maximum elevation angle, and satellite ID number ..... NXS - - - - E - - - N - - -

12.3 Future satellites

Keying special function 11 a second time without having pressed any other keys in between will display data for the satellite after next, and so on.

The RS 5000 needs some time to calculate the predictions. In this situation display 3 will show ..... RS 5000 BUSY

Predictions for up to 45 days can be made; also for other locations, by inserting another lat/lon.

12.4 Automatic satellite selection

In order to get an accurate position fix, the satellite must be "tracked" for at least 8 minutes during the pass. When the satellite's maximum elevation angle is less than 10 degrees, the possibility of an 8 minutes contact is remote. As well, the ionospheric disturbance of the satellite's signals increases at low elevation angles.

If the maximum elevation angle is higher than 70 degrees, it can also give inaccurate fixes because east/west estimation becomes difficult.

When the RS 5000 receives a satellite, it automatically checks wether the elevation angle is between 10 and 70 degrees. If it is too low or too high it rejects the satellite and searches for an acceptable one.

The advantage of this "editing" is that the RS 5000 will not be tracking a bad pass while a good satellite may be passing at the same time.

Automatic selection improves the number of good satellite fixes by approximately 10%.

12.5 Selection OFF

When a position fix is essential to make a landfall or for other reasons, and the next satellite is outside of the 10° to 70° editing criteria, it may be possible to get a position fix with some loss of accuracy, mainly in longitude.

Lower angles (less than 10°) may not receive enough data to compute a fix, and will be affected by ionospheric refraction, with longitude errors of up to 1 mile.

Satellite passes above 70° make longitude determination difficult and can result in errors of 1-2 miles on 71°-75° angles.

First, observe the dead reckoning time (DRT). If it is only 1-2 hours, DR position may be more accurate than a satellite fix outside the 10°-70° automatic selection. If DRT is more than 2 hours, and an inaccurate fix is of more value than "no fix", then the automatic satellite selection can be turned off. Key in ---------- SPEC 13
(No display will designate this function).

NOTE: Even if the selection is "off", only fixes which fulfill all data requirements are accepted for updating.

12.6 Selection ON

To enable automatic selection, press special function 12 ------ SPEC 12

NOTE: Turn selection "on" when starting system.

13. SYSTEM CONTROL

13.1 Keyboard lock

To lock the keyboard to prevent unautorized use, key in -------- SPEC 40

13.2 Keyboard release

To release the keyboard-lock, key in ---------- SPEC 41

13.3 Pilot light ON

To illuminate the keyboard at night, key in ---------- SPEC 42

NOTES

14. INITIALIZATION DATA

Port ____________ Latitude ____________ Longitude ____________

Antenna height ____________ Geoidal height ____________ Magnetic variation ____________

Log data ____________ Compass data ____________

Special data ____________

INITIALIZATION DATA

Port ____________ Latitude ____________ Longitude ____________

Antenna height ____________ Geoidal height ____________ Magnetic variation ____________

Log data ____________ Compass data ____________

Special data ____________

INITIALIZATION DATA

Port ____________ Latitude ____________ Longitude ____________

Antenna height ____________ Geoidal height ____________ Magnetic variation ____________

Log data ____________ Compass data ____________

Special data ____________

INITIALIZATION DATA

Port ____________ Latitude ____________ Longitude ____________

Antenna height ____________ Geoidal height ____________ Magnetic variation ____________

Log data ____________ Compass data ____________

Special data ____________

INITIALIZATION DATA

Port ____________ Latitude ____________ Longitude ____________

Antenna height ____________ Geoidal height ____________ Magnetic variation ____________

Log data ____________ Compass data ____________

Special data ____________

INITIALIZATION DATA

Port ____________ Latitude ____________ Longitude ____________

Antenna height ____________ Geoidal height ____________ Magnetic variation ____________

Log data ____________ Compass data ____________

Special data ____________

WAYPOINT DATA

Port ______ Latitude ______ Longitude ______

Antenna height ______ Geoidal height ______ Magnetic variation ______

Log data ______ Compass data ______

Special data ______

WAYPOINT DATA

Port ______ Latitude ______ Longitude ______

Antenna height ______ Geoidal height ______ Magnetic variation ______

Log data ______ Compass data ______

Special data ______

WAYPOINT DATA

Port ______ Latitude ______ Longitude ______

Antenna height ______ Geoidal height ______ Magnetic variation ______

Log data ______ Compass data ______

Special data ______

WAYPOINT DATA

Port ______ Latitude ______ Longitude ______

Antenna height ______ Geoidal height ______ Magnetic variation ______

Log data ______ Compass data ______

Special data ______

WAYPOINT DATA

Port ______ Latitude ______ Longitude ______

Antenna height ______ Geoidal height ______ Magnetic variation ______

Log data ______ Compass data ______

Special data ______

WAYPOINT DATA

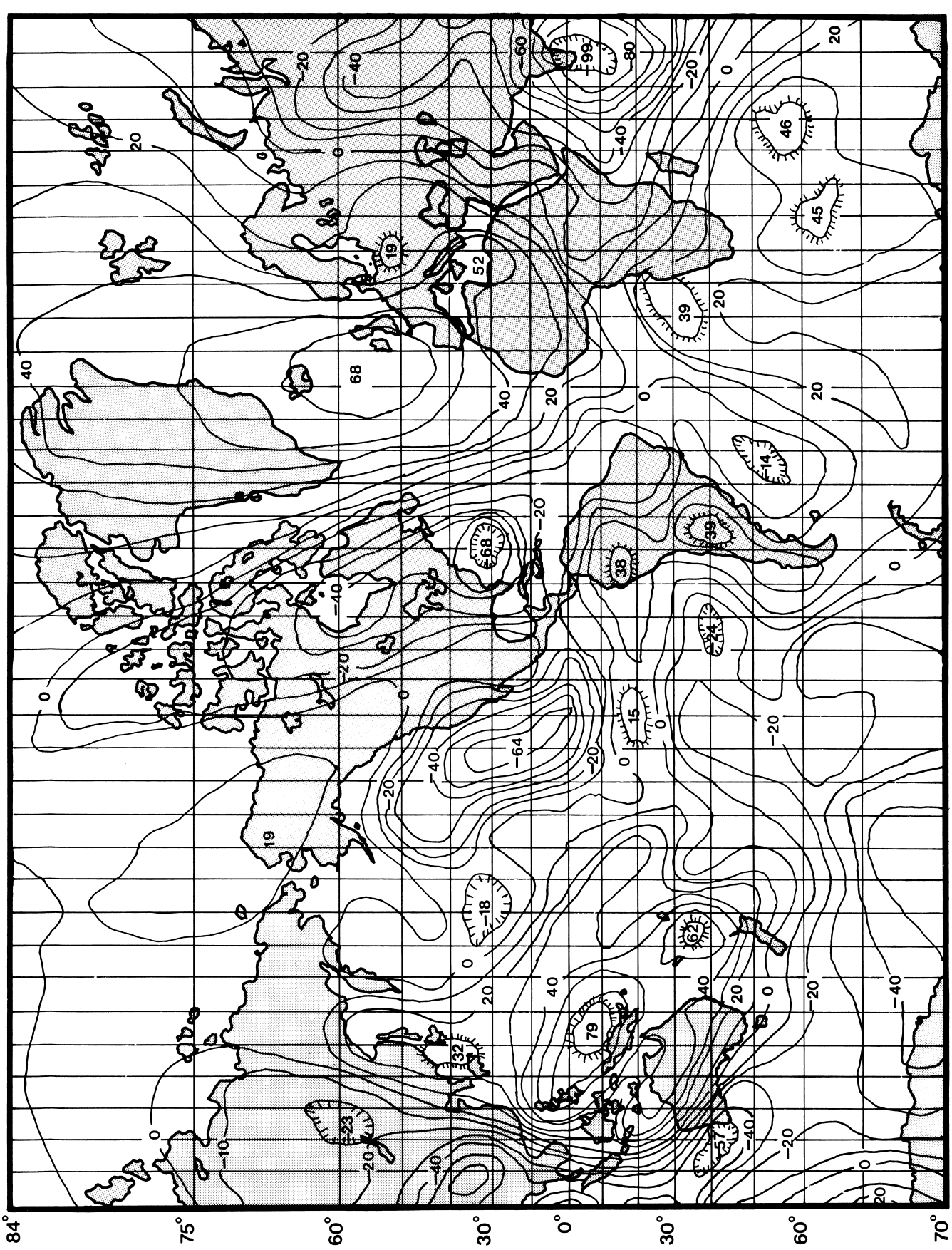
Port ______ Latitude ______ Longitude ______

Antenna height ______ Geoidal height ______ Magnetic variation ______

Log data ______ Compass data ______

Special data ______

15. GEOIDAL HEIGHT MAP



KEY		DISPLAY USED
LAT LONG	Displays current D.R. latitude and longitude, as opposed to waypoint lat/long, last-fix lat/long, etc.	1 & 2
TIME	Displays time (GMT) and dead-reckoning time (time since last fix). O's indicate no fix since start-up.	3
HEAD SPEED	Displays current heading and speed as input to the system, either by keyboard or automatically. Use INS (insert), HEAD SPEED to change speed/heading.	3
SET DRIFT	Displays set and drift. Display is that value inserted manually, or computed by system.	3
INS	»Insert«. Used with SPEC key and special function # to change numerical value, or with direct function key (time, lat/long, hdg/speed, set/drift, way) to insert or change numerical value.	
WAY	Used with INS and waypoint # (1-9) to insert or change a waypoint or just WAY and way # to display waypoint.	1 & 2
WAY DIST	Displays distance in nautical miles to chosen waypoint (spec 32).	3
WAY TIME	Displays time to chosen waypoint to nearest hour, at present speed.	3
COURSE	Displays course-to-steer (magnetic) and bearing (true) to chosen waypoint.	3
SPEC	"Special". INS SPEC function #, to change nummerical value. SPEC function # , for command function (next sat., last fix, great circle/rhumbline, automatic/manual).	
N/E S/W	Used with LAT/LONG or WAY entry to select proper hemisphere, before ENT (enter) key is touched.	
+/-	Used to select positive or negative entry value before ENT is keyed.	
CLR	Used to "clear" wrong entry of values, before ENT is touched.	
ENT	Used to enter selected values.	

LIGHTS

Error	Alerts operator to problems with gyrocompass interface or electromagnetic log.
Lock	System receiving 400 MHz signal.
Sync	System is tracking satellite and accepting data.