OCKAM SYSTEM MANUAL

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Section 1 - System Architecture

The Ockam instrument system provides function-based information helpful to the success and safe operation of sailboats. It takes in data from various sensors (e.g. boatspeed, heading, wind, position), derives further data (e.g. true wind, current, VMG) and displays it all on displays.
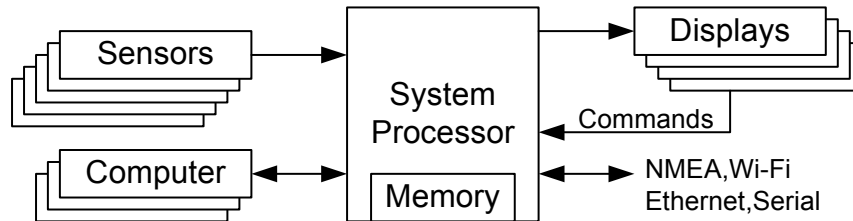
The system is modular with a central processor. Modularity allows the system to adapt to a wide range of needs, while a central processor gives the program access to all data as it goes about calculating its outputs. Systems which use distributed processing (e.g. displays that calculate wind direction from apparent wind data) have two disadvantages; They rely on *display* versions of their inputs, and donot generally have access to secondary but important inputs such as heel.

Available Functions

Apparent wind speed	True wind speed
Boatspeed	Vmg
Heading	Wind Direction
Apparent wind angle	True wind angle
Heel angle	Leeway
Polar speed	Target speed
Time to Stbd layline (1/3)	Time to Port layline (1/3)
Course over ground (1)	Speed over ground (1)
Current Set (1)	Current Drift (1)
Back range	Back bearing
Waypoint Range (1/3)	Waypoint Bearing (1/3)
Depth below Surface	Depth below Keel
Loadcell (2)	Opposite tack
Time	and 76 others...

007 Matryx Display
Up to 18 display pages of
  1 to 4 numeric items
  4 Stripcharts
Tall or Wide orientation
Instant wind calibration &
  7 other calibration controls
Stopwatch controller &
  6 other controller functions
12 Averaging controls

The capability (and cost) of the system is determined by the type and number of modules. The theoretical minimum system would be a CPU module and one display. However, the only functions available would be Time, Stopwatch, and a few diagnostics; not a valuable contribution to winning races. You design your instrument system to fit your needs and budget. You do not have to buy more functionality than you need, and you do not have to be satisfied with less. The same modularity that allows you to put together simpler and less costly instruments, also permits design of complex and more expensive systems.

Systems

There are two choices of processor for the Ockam system. They both do the same job, and are in most ways interchangable. The Unisyn^{tm} system uses the 001 processor, while the **Tryad**^{tm} system uses the T1 processor. The T1 has GPS, NMEA input and output and polar functions built-in, and includes a more powerfull processor. The 001 requires addition of the 041 (for GPS and NMEA I/O), the 037 Polar interface and a dedicated NMEA interface for a NMEA input, if these functions are required.

For simple systems, the 001 processor is the best choice, where the additional inputs and computing power are not required. For more capable systems, the T1 is the better choice. Because both processors are compatible, upgrading to the T1 is an easy replacement.

Displays

Displays are the physical outupt devices which render the system output for use. The information items are called *functions*. The number and type of displays and their location is an important consideration in your instrument design. Consider the various sailing roles and provision displays to fill their needs.

The helmsman should be able to see his displays without having to move from his normal position(s). If possible, they should be mounted forward and close to his line of sight so he does not have to shift his focus. The trimmer, speed king and tactician types usually need one or two displays for VMG, wind or polars, and tend to change functions fairly often. These displays should be accessible; probably on the cabin amidships. They obviously should not be same as the helmsman's. If you have a nav station, you may want a few displays there as well, for depth, waypoint, current set & drift or whatever else you feel you need.

Control

Displays can also control some of the operation of the system – e.g. operating the stopwatch. However, there are other control options.

050 RS232 Interface opens up the instrument system to control via software.

058 Lynx wireless controller provides wireeless 'keyfob' control of instrument functions.

Functions

We use the word **Function** to mean a measured or computed item of data, for example, boatspeed. The instrument system hardware exists to produce these functions. For sailboats, the true wind functions are universally useful, but cruisers might value depth over the grand-prix racer's choice of loadcell. To figure out which interfaces you need, you have to know what each one does for you.

Primary functions	are basic inputs, such as boatspeed or heading upon which all other functions are based.
Performance functions	monitor the level of performance of the boat. This group includes items like VMG.
Tactical functions	help win races. This includes Opposite Tack and Wind Direction.

Navigation functions   are used to aid in safe and quick passage. Depth and Waypoint Range & Bearing are in this group.

Controller functions   lists items like Stopwatch for which the instrument system has built-in controls.

Calibration & troubleshooting functions   help maintain and calibrate the system.

Hardware

Processors

The CPU module is the heart of the Ockam system. It gathers information from all interfaces and controllers, calculates most of the outputs, and sends data to the displays. Ockam has two processor models:

Model 001 CPU (Unisyn system)

The 001 CPU is the original Ockam system processor, now recommended for small-end systems where the built-in hardware and functionality of the T1 is not required.

Model T1 CPU (Tryad system)

The T1 CPU is the next generation processor. In addition to vastly increased computing power, it includes RS232, GPS and NMEA-0183 ports, polar and a 'NMEA tap' output. The T1 is an upgrade from the 001 processor and provides enhanced calculation capability.

Displays & I/O Devices

It is obvious that sticking stuff into the system does no good unless you can get stuff out again. The following modules provide many different ways to read the output of the Ockam system.

005 Display

This small numeric display shows up to four 1-¼ inch digits. Clip-on cards label the function and tell the display which function to show. The 005 is ideal for applications where the functioin will not change often.

007 Matryx

This graphical display is capable of displaying up to 18 user-defined pages, each containing from 1 to 4 instrument readings or a combination of graphical and numeric data for certain instrument functions. It features 128 by 160 pixel high-contrast graphics, adjustable lighting level, and remote control by push-button or the Ockam Bus, or both in addition to 4 front-mounted controls. The 007 may be mounted vertically (Portrait, the default) or horizontally (Landscape) as desired. All display options are available in both orientations.

044 Magnum

This large-format remote-controlled indicator features a 1-3/4" numeric display, 10 character "british-flag" descriptor display, 15 function menus, adjustable lighting level, and remote control by push-button or the Ockam Bus (or both).

050 RS232 Interface

This interfaces links a computer and the Ockam System together. It provides a connection to the system's display and keyboard channels, allowing the computer to read display and polar curve data, control the system's operation and display customized calculated functions on the system's indicators.

058 Lynx wireless controller

Lynx is a programmable wireless 'keyfob' remote controller capable of sending any of the many system command codes. Additionally, the commands can be triggered by hard-wired buttons

042 NMEA Tap

Each NMEA tap module provides a complete NMEA-0183 output stream for use by external hardware such as autopilots or radars. For Unisyn systems (001 CPU), the 041 GPS interface is required.

Interfaces

The capability of the system to provide information depends on what it can sense, which in turn is the responsibility of the interfaces. Following are brief descriptions of each interface module and what it provides for the Ockam system. For more detailed information and specifications on each interface, refer to Section 5.

015 Boatspeed Interface

This interface supplies the Ockam system with boatspeed information from one or two paddle-type sensors. The information is used alone for Boatspeed, Distance-Lost and Log displays. In conjunction with a Wind interface, boatspeed is used for true wind, VMG, and Leeway, and the boatspeed function gains tack-to-tack calibration capability. Adding a Compass interface allows True Wind Direction, and Time to the Laylines.

Note: on new systems, you might want to consider the T2 in place of an 015+022.

022 Wind Interface

This interface supplies the Ockam system with apparent wind angle and speed, and heel angle. The wind information is used for Apparent Wind displays and heel. In conjunction with boatspeed, the system produces true wind, VMG, Leeway, and boatspeed tack-to-tack calibration. Adding a Compass interface allows True Wind Direction, and Time to the Laylines.

Note: on new systems, you might want to consider the T2 in place of an 015+022.

032 Compass Interface

This interface gives the system ship's heading information, allowing calculation of True Wind Direction. In addition, there are switch settings on the interface that tell the system the local magnetic variation when magnetic variation is not available from a GPS.

Note: on new systems, you might want to consider the T2 which includes a NMEA port.

T2 Multiplex Interface

This interface combines the 015 boatspeed and 022 wind with a NMEA port to provide the three most common inputs in one box. A system core can now be configured with just 2 boxes – a 001 or T1 processor and a T2 interface to provide wind, boatspeed and heading.

041 GPS Interface (001 only)

The 041 is not supported on the Tryad system because a GPS interface is built into the T1.

Provide the Unysyn System with range and bearing to waypoint and ships position information, and sources NMEA data on the NMEA channel. With this data, the system repeats waypoint range and bearing, and calculates current set & drift and time to the laylines.

Operation of the interface is automatic; any waypoint displayed by the GPS will be used by the system. If your GPS automatically switches waypoints in a route plan, the Ockam System will use the new waypoints as they come up.

The system compares the GPS's waypoint position against its internal waypoint position. The system tracks the rate and direction of motion between them, and uses this information to calculate current. The calculated current feeds back into the DR position, eventually stopping the relative motion. The process takes several minutes because the error accumulates fairly slowly.

028 Depth Interface

This sounder interface provides surface and keel depth information from a NMEA-0183 depth sounder sensor. If the sensor also outputs it, sea temperature is also provided.

037 Polar (001 only)

The 037 is not supported on the Tryad system because the polar function is built into the T1.

This interface gives the Ockam System POLAR and TARGET boatspeed displays, and access to ship's performance data to calculators and computers. The displays are useful for giving the crew a goal to reach for, since the display shows the theoretical speed that the boat should be making. The combination of a polar module and an RS232 interface allows real-time solution of course-to-steer problems.

The polar requires the addition of a data memory (PROM) containing the performance characteristics of your boat. Ockam does not provide polar curve generation, and therefore can not supply this essential part. There are services which will create this part for you. Please contact us for details.

066 Loadcell Interface

This interface provides the Ockam system with the ability to display the output produced by a loadcell processor such as the Diverse LoadSense.

060 Rudder Interface

The model 060 Rudder interface provides rudder and trimtab output for the Ockam system. These readouts are valuable for tacking analysis. In addition, for those boats with trimtabs,

the readout provides accurate information to the helmsman to help prevent excessive drag by improper settings.

069 Universal Displacement Interface

The model 069 Universal Displacement interface provides general-purpose readout of object position. They can be used for rudder, vang, mast ram or any other object.

099 Custom Interface Series

The 099 modules are custom interfaces ranging from a simple code tweak of a standard item to full custom hardware and software designs. To date Ockam has designed over 100 custom models. Here are some examples:

099AL1   An adaption of an RS232 interface which interfaces a laser rangefinder to onboard software. This in turn provides enemy gain/loss graphing. There have been several variants convering different laser rangefinder models.

099AS1   Sperry gyrocompass interface.

099BE1   Centerboard interface. This interface also interacts with the depthsounder interface settings so Depth below keel changes as the centerboard is adjusted.

099CE1   Engine monitor interface. Provides RPM readout with temperature and oil pressure alarm notification.

099DM1   An 069 Universal Displacement interface which has been modified to control the hydraulically-operated appendage it measures. It responds to Remote Commands entered by the 058 Lynx controller hard buttons. To the already existing Jog buttons, the 099DM1 adds "Zero" and "Tack" buttons, and the ability, if desired, to be controlled by PC software.

Section 2 - Using Your System

This section describes the information displayed by the Ockam System and how to use it. The various functions are grouped by major area of application.

Primary Functions:

Primary functions describe the basic outputs: boatspeed, apparent wind angle and speed, heel, heading and time. These functions form the main inputs to the system from which it calculates all the other functions. They correspond to the readings you would have if the system were a set of discrete instruments, and in the case of boatspeed, is still one of the most important displays from a racing standpoint.

Boatspeed
Interfaces Required:	015 Boatspeed + 022 Wind for Offset cal capability
	or T2 Multiplex
Averaging:	6 sec, adjustable
Update period:	1/4 sec
Format & Range:	0.00 to >30.00 Knots (Unsigned)
Controls:	Averaging, Calibration & Substituting SOG

The bottom line performance measurement is Boatspeed, primarily used by the helmsman and speed king, and sometimes used by the navigator for manual dead-reckoning. Also used in most of the other functions; VMG, true wind, logs, leeway, range & bearings and time to the laylines. Therefore, the importance of this function can not be overstressed.

Because of its importance, a lot of effort goes into making it accurate and useful. Unlike most instrument systems, Ockam has two calibrations for Boatspeed without the masthead unit, and three with the masthead. The third calibration corrects for differences in boatspeed readings from tack to tack. If there are two transducers attached, the system selects the leeward one, and gives a warning if one of them appears to be fouled. Calibration details appear in Section 3.

Resolution is the ability to read extremely small changes in a quantity. In the case of boatspeed, the display gives a resolution of 1/100 knot which allows indication of small boatspeed changes. For example, the slight change caused by moving a crew member to the rail will show up. However, resolution can create problems; the numbers will tend to jump in a meaningless way unless they are updated fast enough to ensure frequent small changes. With an update rate of four or eight times per second the Ockam display tends to flow from one reading to the next, giving an indication of acceleration or deceleration without extraneous arrows and such.

Windspeed Apparent
Wind Angle Apparent
Interfaces Required:	022 Wind or T2
Averaging:	6 sec, adjustable
Update period:	1/4 sec
Format & Range:	0.0 to >100.0 Knots (Unsigned)
	-180 to 180 Degrees (Signed)
Controls:	Averaging, Calibration, Back calculation & AutoCal

The sum of the wind caused by the motion of the boat and the true wind equals the apparent wind. The sails fly in the apparent wind and create the forces that make the boat go, making it the most boat-oriented of the primary functions.

The amount of wind felt aboard the moving boat determines when the useful range of sails is being exceeded, because the sails feel the apparent wind speed. However, many sail lofts specify their sails in terms of true wind speed range.

Apparent wind angle is the angle of attack of the wind on the sail plan, something like the telltales. Apparent wind angle is useful when not close-hauled, i.e. reaching and running. When beating, the geometry of the wind triangle makes apparent wind angle less sensitive to wind and heading changes than other outputs like boatspeed, true wind angle or heading.

If a Mast Rotation Interface is installed, then the displayed Wind Angle Apparent can be either relative to the boat (the normal number), or relative to the mast.

Mast Angle
          Interfaces Required: Mast Rotation
                    Averaging: None
               Update period: 1 sec
           Format & Range: -180 to 180 Degrees (Signed)

Catamarans and other high performance craft sometimes have rotating spars or wingsails. This causes a problem if you want to get the wind data, because the masthead sensor rotates with the mast. The Mast Rotation Interface takes care of this problem by measuring the mast angle and adding it to the measured masthead angle to get apparent wind angle. This output is useful for calibrating the Mast Rotation sensor.

Heel
          Interfaces Required: 022 Wind or T2 or 032 Heading with 3D Compass sensor
                    Averaging: 15 sec, adjustable
               Update period: 1/2 sec
           Format & Range: -45 to 45 Degrees (Signed)
                     Controls: Averaging

Heel angle is not of primary importance by itself, but is a vital datum used in calculations for many other functions. It is used to correct the true wind readings, calculate leeway (used in true wind and dead-reckoning), correct boatspeed tack-to-tack, and select transducers.

Time
          Interfaces Required: None
                                         On T1, GPS sentence ZDA automatically sets time.
                    Averaging: none
               Update period: 1 sec
           Format & Range: hr:min (Option 1=0)
                                         min:sec (Option 1=1)
                                         hr:min:sec (Option 1=2)
                                         UTC (T1 Only, Option 1+=4)
                     Controls: Setting time & Format

Time is maintained by the CPU internal battery. It can be set by the RS232 interface, and displays the time in minutes and seconds, hours and minutes or hours, minutes and seconds. The format is 24 hour military time and can be set to local or UTC (T1 only).

Heading

Interfaces Required: 032 Compass or
                      T1 or T2 with NMEA heading input
Averaging: 1 sec
Update period: 1/4 sec
Format & Range: 0 to 359 Degrees (Unsigned)
Controls: Averaging, Calibration & Substituting COG

Used in True Wind Direction, Opposite Tack Course, Range & Bearings, Current Set & Drift and the Laylines, heading is an important input for the system. Although it is not very handy for piloting, because it is hard to tell where 271 degrees is when you are heading 115 degrees, it is good for sailing upwind, or other course where you want to cleave to a specific course where the high resolution is a great help.

Temperature

Interfaces Required: Sea: 038 Depth
                      Air: T2 with Sonic Masthead
Averaging: none
Update period: 2 sec
Format & Range: Sea: 0.0 to 110.0 °F (option 12=0)
                       -20.0 to 40.0°C (option 12=8)
                 Air: 0 to 110 °F (option 12=0)
                       -20 to 40°C (option 12=1)
Controls: Units

Displays one or two general purpose temperature values. The "Sea temperature" has a resolution of 0.1°C or about 0.2°F. Usually used to detect the gulf stream, and possible wind gradient conditions.

Barometer & Trend

Interfaces Required: T2 with Sonic Masthead
Averaging: 15 sec, adjustable
Update period: 1 sec
Format & Range: Barometer: 27.00 to 32.76 InHg (option 12=0)
                             914 to 1109 millibar (option 12=1)
                 Trend: -2.000 to +2.000 InHg/Hr (option 12=0)
                             -68 to +68 millibar/Hr (option 12=1)
Controls: Units

Displays barometric pressure and pressure trend (the change in barometric pressure over the last hour).
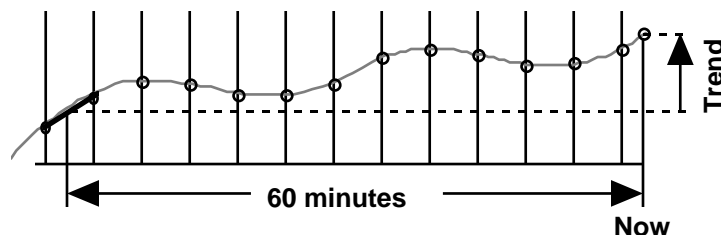
The Ockam system remembers pressure readings each 5 minutes, then determines trend by comparing the present reading versus the interpolated pressure between the remembered readings 60+ and 60- minutes ago.

Performance Functions

This section describes those functions that are useful for monitoring the level of performance of your boat. True wind angle and speed, target boatspeed and VMG are used when sailing upwind and downwind, and polar boatspeed in reaching conditions. The distance lost functions are useful for crew and helmsman training.

<u>Windspeed True</u>
<u>Wind Angle True</u>

Interfaces Required:	(015 Boatspeed & 022 Wind) or T2
Averaging:	8 sec, adjustable
Update period:	1/4 sec
Format & Range:	Windspeed true: 0.0 to >100.0 Knots
	Windangle true: -180 to +180 Degrees
Controls:	Averaging, Offset, QuikCal & AutoCal

The true wind is the wind relative to the water; i.e. as if the boat were not moving. It is the medium in which the boat sails from an overall point of view, and can not be directly sensed by the crew. The difference between apparent and true wind is that apparent wind includes the boatspeed, and true does not, making it independent of how fast or slow the boat is going. True wind angle corresponds to the boat's angle of attack on the wind, which is about half the tacking angle.

<u>VMG (Speed-made-good to weather)</u>

Interfaces Required:	(015 Boatspeed & 022 Wind) or T2
Averaging:	15 sec, adjustable
Update period:	1/4 sec
Format & Range:	<-20.00 to >20.00 Kt
Controls:	Averaging & Tack-to-tack adjustment (via Bt Offset)

VMG measures performance in upwind or downwind sailing as the component of boatspeed in the direction of the true wind (see the figure under Polar & Target boatspeed). In theory, VMG shows where your best progress toward the windward or leeward mark is being made. The maximum VMG should be the proper point of sail. There is a problem with using VMG to steer by though. Because it is the product of boatspeed and true wind angle, steering by VMG can cause you to pinch.

If the helmsman heads up, VMG improves at first because the initially high boatspeed is now pointing closer to the wind. The reading will eventually come down because the boatspeed will fall to the new value concomitant with the higher course. Conversely, heading off has the opposite effect; VMG goes down at first, then comes back up. Since the helmsman's environment is ruled by the next wave and the last puff, it is hard for him to remember a lot of history about VMG. The impression is that he should head up because the numbers go up for pinching and down for footing. The numbers are telling the truth, but the dynamics are lying. VMG should be used by someone with a longer view, like the speed king.

VMC (Speed-made-good on course)

Interfaces Required:	015 or T2 for Boatspeed
	032 or T1 or T2 for Heading
	041 or T1 for Position & Rhumbline
	050 or T1 for control (to set rhumbline)
Averaging:	15 sec, adjustable
Update period:	1/4 sec
Format & Range:	<-20.00 to >20.00 Kt
Controls:	Source & Rhumbline

VMC is the component of boatspeed in the direction of the next mark. When you have a long way to go, and the wind will be from a different direction long before you get there, then you may want to sail as fast as possible in the direction you want to go. VMC is the function you want to maximize.

If the GPS is outputting waypoint range and bearing, VMC is referenced to that. You can override this by setting a rhumb line (see Set VMC Option).

Vmc Sailing
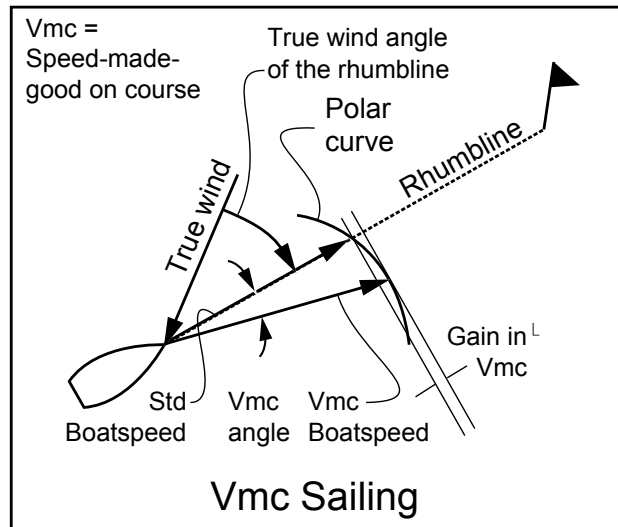
Polar Boatspeed
Target Boatspeed

Interfaces Required:	(015 Boatspeed & 022 Wind) or T2 for True Wind
	037 or T1 for Polar
Averaging:	8 sec, adjustable
Update period:	1/2 sec
Format & Range:	0.00 to >15.00 Knots (Knots, Option 2=0)
	-15.93 to >20.00 Knots (Difference, Option 2=1)
Controls:	Averaging of inputs & output, Format, Polar Selection & Wind weight

Polar curves predict how fast the boat will go in a specified set of true wind conditions. The independent inputs, true wind angle and speed, dictate the output, theoretical boatspeed. A typical polar curve might look like the figure. Boatspeed is plotted radially against true wind angle at a constant true wind speed. It can be used as a check on boat performance by looking up the true wind conditions the boat is experiencing and comparing the value against the actual boatspeed. Polars can also be used to predict boatspeed for an future condition, allowing for strategic planning and predicted apparents.

The Polar module contains one or more of these polar curves, which the system uses to display Polar and Target boatspeeds. The Polar curve result for the present true wind conditions (Wind Angle True and Windspeed True displays) appears as Polar boatspeed. At all points
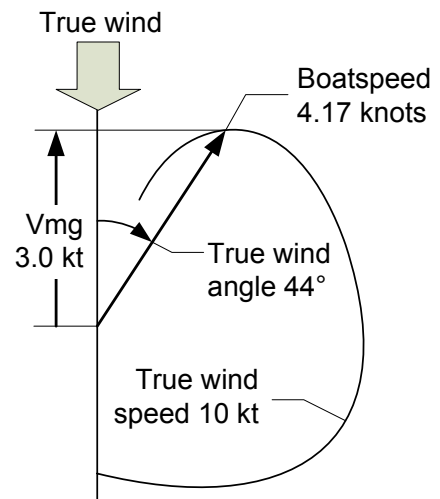
of sail except upwind, this display can be used as a check how well the boat is being sailed, because the yardstick (the polar curve) is always there, and always gives the same results for the same conditions.

Since the Polar value changes with true wind angle, especially upwind, it is an unreliable helming guide for beating. Target Boatspeed is used here instead. Steering to maximum VMG is difficult due to its dynamic characteristics (See the VMG description). To aid in determining where to sail upwind, the system outputs the polar boatspeed at the highest point of the curve (i.e. maximum VMG) for the prevailing true wind speed as Target boatspeed. This display shows the helmsman how fast he should be going while beating; If slower then Target, he should head off and gain speed, and vice versa. Target boatspeed does not change when he tacks, (only when the windspeed changes) so he has a target for actual boatspeed coming out of a tack.

The polar curve information required by the Polar Module is not supplied by Ockam. It may be created by the crew (by taking data and programming the memory chip), or by one of the performance services such as Velocity, which use velocity-prediction models. Most of these models stem from the Pratt Project model (the VPP), the basis of the IMS rating system.

Rudder & Trimtab Angle
        Interfaces Required: 060 Rudder or 069 Universal Displacement
                    Averaging: none
                Update period: 1/2 sec
            Format & Range: -45.0 to +45.0 degrees

Obviously not for the average boat because of the cost, these functions are mainly useful for dynamic analysis of tacking. For those boats with one, a trimtab readout can help reduce drag by providing accurate position feedback to the helmsman.

Tactical Functions

This section covers the tactical functions; opposite tack, true wind direction, time to the laylines and stopwatch. These aid the crew in tactics by informing them about wind shifts, and their position on the course, particularly in relation to the laylines.

Opposite Tack/Track
        Interfaces Required: 015 or T2 for Boatspeed
                                        022 or T2 for Wind
                                        032 or T1 or T2 for Heading
                    Averaging: none
                Update period: 1/2 sec
            Format & Range: 0 to 359 degrees

This function displays the course the boat will take on the opposite tack. It is useful for picking laylines and giving a heading to come to on tacking or gibing.

Wind Direction

Interfaces Required:	(015 Boatspeed + 022 Wind) or T2 for true wind
	032 or T1 or T2 for Heading
Averaging:	8 sec, adjustable
Update period:	1/4 sec
Format & Range:	0 to 359 degrees
Controls:	Averaging, Calibration, Offset, QuikCal, Dynamic compensation

This function displays the direction of the true wind relative to magnetic North. It is calculated from true wind angle, heading and leeway. This is generally considered the most important of the calculated functions, because it displays the true wind in a way that makes it easy to watch for wind shifts. It also is a critical display for the final adjustments to the wind sensors.

Time to Port & Starboard Laylines

Interfaces Required:	(015 Boatspeed + 022 Wind) or T2 for true wind
	032 or T1 or T2 for Heading
	041 or T1 or RS232 for Mark position
	(T1 only) Polar file for tacking angle
Averaging:	15 sec, adjustable
Update period:	1 sec
Format & Range:	-59:59 to +59:59 mm:ss
Controls:	Manual waypoint & Averaging of inputs

Waypoint range and bearing is combined with true wind direction ,tacking angle and boatspeed to give time to the laylines, upwind and downwind. On the 001, tacking angle is determined by maintaining an average of actual up and downwind values. On the T1, tacking angle comes from the polar file if present.

Stopwatch

Interfaces Required:	none
Averaging:	none
Update period:	1 sec
Format & Range:	-55:00 to +59:59 mm:ss
Controls:	Start/Stop (Display or RS232)
	Reset/Sync (Display or RS232)

The Stopwatch display operates like a standard yachting timer. The stopwatch controls allow starting the display from any 5 minute point from 0 to -55 minutes, and also allows re-synchronizing the display to any minute.

Navigation Functions

This section is the navigation group; depth, logs, back and waypoint range & bearing, current set & drift and leeway. These functions help the navigator to locate the boat relative to the course or destination, and give warning of possibly adverse or dangerous current conditions.

Depth below Surface & Keel

        Interfaces Required: 028 Depth or T1 or T2
                  Averaging: none
              Update period: 1/2 sec
            Format & Range: 0 to >300 feet
                      Inputs: Depth reading (from Depth Sounder)
                               Transducer, Keel Depth Settings (from Interface)
                   Controls: Units, Offsets

Shows the water depth. The depth of keel and depth of transducer adjustments on the depth interface affect this function along with the depth transducer input.

Log Trip

        Interfaces Required: 015 Boatspeed or T2
                  Averaging: none
              Update period: 2 sec or as required
            Format & Range: 0.00 to 99.99 miles
                   Controls: Trip log reset (display or RS232)

The log is a calculation of distance traveled through the water. The log is retained when the system is turned off. The trip log may be reset via the Log Reset controller function.

Waypoint Range & Bearing

        Interfaces Required: 041 GPS or T1 or RS-232
                  Averaging: none
              Update period: 1 sec alternating
            Format & Range: 0.00 to 99.99 miles
                               0 to 359 degrees
                   Controls: Manual waypoint

Displays the range and bearing to the waypoint. When the system includes a GPS only, the WAYPOINT repeats the GPS's waypoint data. If Boatspeed and Compass are included, the waypoint information is smoothed by a combination of DR, GPS data, and current calculation. The latter is done to increase the resolution of the output, because most GPSs give waypoint information only to the nearest tenth mile. If no GPS is included, a waypoint may be entered manually via the keyboard interface RS232.

Current Set & Drift

        Interfaces Required: 015 or T2 for Boatspeed
                               032 or T1 or T2 for Heading
                               041 GPS or T1 for COG/SOG
              Update period: 1 sec alternating
            Format & Range: 0.00 to 5.00 Knots, 0 to 359 degrees
                   Controls: Enable, Algorithm settings, Manual Entry

Ockam compares course over ground and speed over ground with Boatspeed, Heading, and Leeway to calculate current (CPU version 16.1 or higher). There are two ways to get a current

reading: you could be sailing in real current, or you could have bad DR inputs (Boatspeed, Leeway or Heading).

Leeway

Interfaces Required:	(015 Boatspeed + 022 Wind) or T2
Averaging:	none
Update period:	1/2 sec
Format & Range:	-6.0 to +6.0 degrees
Controls:	Calibration: Boatspeed interface or K3= Command or AutoCal

The angle between the ship's heading and the boatspeed is called leeway. It results from side pressure by the sails, resisted by the keel. Leeway is used in true wind and dead-reckoning calculations, and is displayed as an aid to proper calibration.

Magnetic Variation

Interfaces Required:	032 Compass for hardware setting
	041 GPS or T1 for automatic input
	050 RS232 or T1 for manual override
Averaging:	none
Update period:	2 sec
Format & Range:	Degrees
Controls:	Manual entry: K7= Command

The angle between the true and magnetic north. If no other source exists, comes from the compass interface, with format X.X. If a GPS is outputting a sentence with magnetic variation, that is output with format X.XX. The K7 command overrides both these inputs until the next boot.

Controller Functions

This section covers the controller functions; stopwatch, log, back range & bearing and distance-lost. It also covers the computer interface (RS232) which provides many useful functions: adjustment of the function averaging, entering waypoints and current, and setting options which control display formats and calculations.

Stopwatch

Command Code:	Ctrl-T (Stop/Start), Ctrl-R (Reset/Sync)
System Requirements:	Display or RS232
Display:	Stopwatch

When the system is first powered up, the stopwatch is stopped at -10:00 minutes. Using the START button causes it to begin counting down (toward zero). A second use will stop it, and a third will restart it from where it stopped. When the reading reaches zero, the stopwatch counts up.

When the stopwatch is stopped, the first use of the RESET button after power-up or after running, will set the stopwatch to 0:00. Repeated use will sets the time to go to -5:00, -10:00, -15:00 and so-on, up to 1 hour (-0:00), and then start over at 0:00. When the stopwatch is running, the RESET button will set time to the closest minute, and counting will continue. For instance, use of the RESET card at -5:08 will cause the stopwatch to continue counting from -5:00.

Log Reset

        Command Code: Ctrl-L
System Requirements: Display or RS232
    Controller Display: Trip Log

Resets the trip log.

User 0 thru 9

  System Requirements: RS232 Interface
        Command Code: U<0..9>=<display-string><cr>
Output Format & Range: Defined by user.
      Update Period: Defined by user.
Default Average (64%): Defined by user.

These tags provide a facility for calculators or computers to display data on indicators. Originally, characters 0 thru 9 were reserved for this, but now any character can be used.

Calibration & Troubleshooting Functions

This section covers the maintenance and diagnostic functions; boatspeed calibrations (absolute and tack-to-tack), wind (speed, angle and upwash) and leeway; and the three diagnostic displays DIAGNOSTIC Configuration, DIAGNOSTIC Errors, and DIAGNOSTIC Card Tester.

TEST Configuration

    Interfaces Required: none
         Averaging: none
     Update period: 2 sec
   Format & Range: 0 to 8191
           Inputs: Interface(s) attached to bus

The system relies on the interfaces to supply data for its calculations. If a particular interface is missing, then any display that depends on that data will not be calculated. For instance, VMG requires both the Boatspeed and Masthead interfaces to calculate true wind angle, from which VMG is derived.

The Configuration display shows which interfaces are known to the CPU. If your installation has interfaces that the system does not know about, then something is wrong. Each interface is assigned a unique number (see Checking Out the Interfaces). The CPU keeps a sum of these numbers for each interface it communicates with as the configuration code. Obviously, if one of the interfaces dies, its number will be omitted from the configuration, and the configuration code will be different than what it should be for that installation. The Configuration display is the first place to look for trouble.

For example, suppose your system has boatspeed, wind and compass interfaces. The Configuration should be 15. If it showed the number 11, it would mean that the masthead interface was missing, and you would not be able to get true wind, VMG or boatspeed cal offsets.

```
            THEORETICAL                              ACTUAL
             CLOCK -> 1                             CLOCK -> 1
         BOATSPEED -> 2                         BOATSPEED -> 2
          MASTHEAD -> 4                           COMPASS -> 8
           COMPASS -> 8                                  ----
                  ----                                     11
                    15  --------------------------------------->  -15
                                                           ----
                                          MASTHEAD ->   -4
```

TEST Errors

Interfaces Required:	none
Averaging:	none
Update period:	2 sec
Format & Range:	0 to 255 (variable length list)
Inputs:	Interface error reports, Error checks by CPU

See List of errors.

The CPU calls attention to errors by flashing its lamp, and via a sequence of numerical codes displayed on the ERRORS function. As the machine does its calculations, it occasionally finds out things that are wrong. For instance, if an interface suddenly stops communicating, that is a cause for reporting an error. Another type of failure would be where the masthead cable shorts out to the spar, causing an error in data.

An error remains displayed until its cause goes away, unless it is a "permanent error", signified by the (!) annunciator. They remain displayed until the system is shut down, because the conditions under which they are detected only happen once, and so they have to hang around until you have a chance to see them.

CAL Boatspeed Master

Interfaces Required:	015 Boatspeed or T2
Averaging:	none
Update period:	2 sec
Format & Range:	0.50 to 1.50
Inputs:	Interface Cal Pot or K1= command and/or AutoCal

CAL Boatspeed Offset

Interfaces Required:	015 Boatspeed or T2 for Boatspeed
	022 Wind or 032 Compass or T2 for heel angle
Averaging:	none
Update period:	2 sec
Format & Range:	-0.125 to +0.124
Inputs:	Interface Cal Pot or K2= command

The overall calibration of Boatspeed is set by the interface signature switch and the CAL Boatspeed Master (control on the interface or the K1 command or AutoCal). If a heel is available, Boatspeed is modulated by heel and CAL Boatspeed Offset.

Taking the simpler case first (no masthead installed, and therefore only one transducer attached), the signature sets the basic calibration to be used, depending on the type of transducer attached.

The fine adjustments are carried out by the MASTER pot, the setting of which is displayed by the function CAL Boatspeed Master. If this function shows '1.00', then the overall calibration used is the same as the transducer manufacturer's nominal value. If the reading is '1.10', then the overall calibration will produce a boatspeed 10 percent higher than nominal.

For instance, Kenyon's paddle transducers normally produce 3.90 cycles/second per knot. If the signature is set to '2' (Kenyon) and the CAL Boatspeed Master function reads '1.00', and the transducer produces 39.00 cycles per second, then the system will display a boatspeed of 10.00 knots. A setting of '1.10' will give a reading of 11.00 knots, and so on.

The situation is modified by attaching a masthead interface, because this enables the CAL Boatspeed Offset function, and for dual transducers, selection of the leeward transducer, under control of the masthead's heel pot. When on PORT tack, the overall calibration used by the system is the SUM of CAL Boatspeed Master and CAL Boatspeed Offset; on STARBOARD tack, it is the DIFFERENCE. Assuming that Master is '1.00', and Offset is '+0.015', then the overall calibration on PORT tack is 1.015. On STARBOARD tack it is 0.985. If the Offset were '-0.015', then the PORT tack cal would be 0.985 and the STARBOARD tack cal would be 1.105.

Assuming you have '1.00' and '+0.015' settings and have a single transducer installed, a calibration factor of 1.015 would be applied to the (single) transducer when the heel is negative (PORT tack), and 0.985 would be applied when the heel is positive (STARBOARD tack).

If two transducers are installed a calibration factor of 1.015 is applied to the STARBOARD transducer when on PORT tack, and 0.985 is applied to the PORT transducer when on STARBOARD tack.

Its a good thing that all this mumbo-jumbo only has to be figured out once, and demonstrates why you should write down all your calibrations somewhere where you can find them!

CAL Wind Angle Offset
        Interfaces Required: 022 or T2 Wind
                  Averaging: none
              Update period: 2 sec
            Format & Range: -16.0 to +15.9 degrees
                      Inputs: Interface Cal Pot or K4= command

Zeros the apparent wind angle. A value of 1.0 makes windangle apparent 1 degree narrower on starboard and 1 degree wider on port. A value of -1.0 does the opposite.

CAL Windspeed
        Interfaces Required: 022 or T2 Wind
                  Averaging: none
              Update period: 2 sec
            Format & Range: 0.50 to 1.50
                      Inputs: Interface Cal Pot or K5= command and/or AutoCal

Changes the apparent wind speed. K1=1.00 is 100% of the nominal calibration of the signature switch calibration. K5=0.99 lowers windspeed apparent 1%, while K5=1.01 raises it 1%.

CAL Leeway

Interfaces Required:	(015 Boatspeed & 022 Wind) or T2
Averaging:	none
Update period:	2 sec
Format & Range:	0.0 to 16.0
Inputs:	Interface Cal Pot or K3= command and/or AutoCal

This calibration is the factor used in calculation of leeway angle (See Leeway function). The leeway calibration is set to zero when shipped from the factory, so the leeway will always be zero until you are ready for it. Since leeway and upwash are compensating errors in true wind angle, you should go about adjusting both of these functions at the same time.

CAL Upwash
CAL Upwash Slope

Interfaces Required:	022 or T2 Wind
Averaging:	none
Update period:	2 sec
Upwash format & range:	-16.0 to +15.9
Slope format & range:	--.500 to +0.500
Inputs:	Interface Cal Pots or K6=, K9= commands and/or AutoCal

The wind is bent by the sails as it approaches them. In fact, the drive created by the sails is caused by this bending. However, if the masthead is inside this disturbed flow, it is not reading the proper angle and speed. This effect is termed upwash and is a complicated concept to understand.

This calibration attempts to correct for upwash by modifying the apparent wind angle only when beating, and and not when running. In heavy air, upwash tends to disappear because the sails are trimmed to spill air aloft, or are reefed. In both cases, the bending in the vicinity of the masthead is eliminated. This effect is controlled by changing the REEF and FLAT parameters.

Upwash broadens (>0) or narrows(<0) the apparent wind angle upwind. Since apparent wind angle has a 3:1 effect on true wind angle (and therefore wind direction) upwind, Upwash is the calibration to use to set upwind wind direction.

Upwash slope is a calibration number that changes Upwash with True Windspeed. The complete Upwash function is

$$Upwash = \left[Kupwash + KupwashSlope \bullet \left(Min(Vt, 35) - 12 \right) \right] \bullet Sign(Ba) \bullet Sin^{2.5}\left(6 * \left(180 - |Ba| \right) \right) \bullet \operatorname{Re} ef^2 \bullet Flat$$

One way to determine the correct slope is to set KupwashSlope to zero and calibrate using Kupwash only, for two True Windspeeds; one at 12 knots and the other at say 18 knots. Calculate the KupwashSlope from the relation

$$KupwashSlope = \frac{Kupwash_{18} - Kupwash_{12}}{18 - 12}$$

Then set Kupwash to the 12 knot value and KupwashSlope to the calculated value. The Upwash Slope can be entered by the spare Cal pot on the 022 Apparent Wind Interface or by the K9=n command. The Cal Upwash can be entered by the Upwash pot or by the K6=n command. The Cal Upwash Function Card will alternate between Upwash (0.0) and Upwash Slope (.00). It is best to set Upwash Slope to 0 until enough data is collected to get a clear plot. Most boats have a slope the falls between +0.200 and +0.350.

System Status (T1 only)

Many useful but slow-changing parameters are output on tag ' ' (space). The format is ID:value, where ID designates the parameter whose value is given; for example, CP:15 indicates that the processor is 85% idle. The list is output one item/second.

This list is current as of T1 Rev 20.03 (11/1/06)

ID:	Description
Axx:	Current value of the Averages.
BU:	Percentage of Ockam Bus being used.
BP:	Available mailboxes (system resource).
BT:	Current CalBt AutoCal value (or 'off').
C1:	Percentage of COM1: being used (system resource).
CP:	Percentage of the processor being used (system resource).
DA:	Local date (see Set Time and Set UTC Offset).
DS:	Option switches (the DIP switches on the panel).
DT:	List of disabled tags (see Disabling Tags).
GP:	GPS flags: 8=Manual Wpt, 32=Manual Current, 256=Have Lat/Lon, 512=Have Waypoint, 1024=Have Cog/Sog.
Kxx:	Current value of the Calibrations.
LE:	Current CalLee AutoCal value (or 'off').
LG:	Current log file (see Built-in logging).
Oxx:	Current value of the Options.
PL:	Name of the polar file in use.
RV:	Software revision, e.g. "20.03".
SY:	Code build: 0=Retail, 1=Debug, 2=AHRS, 4=Quad Serial
TZ:	Offset to local time zone in minutes (see Set UTC Offset).
UM:	Units of measure (See Units of Measure).
UW:	Current CalUW AutoCal value (or 'off').
VA:	Current CalVa AutoCal value (or 'off').
VS:	Current CalVs AutoCal value (or 'off').
VT:	Current CalVt AutoCal value (or 'off').

Maintainance

Maintaining the desicators

All Ockam displays have a blue cartrage containing desicant to prevent internal condensation. On the Matryx and Magnum displays, this cartridge is also the access port for hardware adjustment. Occasionally, it is necessary to rejuvinate the desicant.

1. Remove the cartridge from the display.

2. Place the cartridge in a warm oven (200°F or 95°C) for 2 hours. You may also want to place the display on a window sill so the sun can dry the interior. Do not expose the display to temperatures exceeding 120° F (50°C).

3. Remove the cartridge and set it opening down on the counter to cool. When it cools enough to handle, replace it in the display. Do not leave it uninserted long enough to re-absorb moisture.

Connector maintenance

The most vulnerable components of <u>any</u> instrument system are its points of connection. To promote the highest level of reliability for the instrument system, some attention should be given to these vulnerable items.

- There should be no strain directly on any connection or connector. If there is, some strain relief should be provided to prevent future failure.

- Connectors should be completely electrically isolated from the hull and rig to prevent electrolysis and possible ground faults.

- Silicone grease should be applied to connectors (e.g. BNC connectors) before mating to prevent water ingress and corrosion. This is especially important on mast displays.

- Connectors should be occasionally inspected for oxidation and corrosion. If any is present, it should be gently removed with a wire toothbrush to restore good electrical contact.

Cleaning display lenses

All Ockam displays have an anti-glare coating on the lens surface. If mistreated, this coating will scratch and/or scrub off. Ideally, the coating should be treated as you would treat a pair of mirrored sunglasses. Observe the following precautions:

- Rinse the displays gently with fresh water. Wiping them off when salt is present will abrade the coating.

- If more thorogh cleaning is needed, i.e. to remove fingerprints, use soap and water or alcohol-based lens cleaner and a soft cloth. Be sure to rinse off the lens before wiping.

- Do not use strong solvents such as acetone, which can destroy both the coating and the keypads.

Decommissioning

When decommissioning, remove the displays and sensors and keep them above freezing. LCDs and seals are adversely affected by sub-freezing temperatures. Processors and interfaces are typically unaffected by cold storage.

Section 3 - Installation

This section describes how to install an Ockam System, check it out and calibrate it. The quality of the installation of the Ockam instrument system has a large effect on the reliability and accuracy of the system. In fact, about 90% of the problems people have are installation related. Also, there is no doubt that it is important to calibrate the entire instrument system to get accurate outputs. Since the crew relies on the system to give accurate results, some time and effort should be spent on the details of the installation and calibration.

Isolated power systems

Many modern boats have electrical systems which are designed to be isolated from the hull. This is done to protect the hull from being damaged by electrolysis.

With this type of system, all electrical components and wiring must be designed and installed in such a way that no connection between the electrical system and the hull is made, accidentally or otherwise. Needless to say, in the presence of salt water, this is a cronic challenge requiring constant maintainance and monitoring.
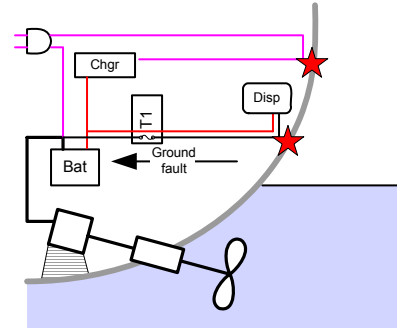
The salient point with isolated supplies is that the hull is not connected to the supply negative, so it is free to float. Any circuit touching it forces it to take on that potential. If another circuit element also touches the hull, ground fault current flows and takes out the weakest link in the 'sneak' path.

These ground faults are very hard to detect, because the damage usually occurs nowhere near where the contact was made and not even in the same piece of gear. And the damaging contact could be momentary, such as when starting the engine.

How to tell if the boat has an isolated supply

Disconnect the power cable from the Ockam CPU – especially the ground lead. Measure the AC and DC voltage and resistance (if the voltages are zero) between the battery negative and the hull (not the engine). If there is voltage or non-zero resistance, the battery is floating.

Check that the Ockam system is isolated from the hull

- With the power leads disconnected from the CPU, but the rest of the system connected, measure the resistance between the Ockam bus shield (connector shell) and the hull. There should be at least 10,000 ohms. If not, go over the bus and isolate all BNC connectors from the hull. Also check for chafing where the cable passes thru bulkheads.

- Sensors attached to interfaces must also isolate their signal and power leads from the case to avoid ground faults. If you get ground indication, disconnect interfaces one at a time to check for this sneak path.

- For the T1, additional ground contacts can also be made thru the NMEA, GPS and RS232 ports. If you get ground indication, remove these connections one at a time to determine where the problem lies.

Installation tips

- Cover all BNC connectors to prevent contact with the hull.

- When running cable thru bulkheads, sleeve the hole to prevent the bulkhead from chafing thru to the Ockam bus shield (or to a 12 volt supply wire).

- Before connecting NMEA output to another device, be sure that the device input is opto-isolated.

- Check that laptop inverters provide isolated power to prevent AC from getting into the RS232 port. With the laptop running on its charger (and inverter), and disconnected from the Ockam system, measure the AC voltage between the laptop metal and battery negative. If necessary, a ground strap connected to battery negative should be fitted.

Indicators

Indicators should be installed where they are easy to read. Try to place them so that crew members do not block their view. The indicators should be far enough away within the users normal field of vision so that he will not have to shift focus too much. Remember that LCD displays are more difficult to read from the side, especially at night.
- Try to keep the indicators away from potential physical harm, like winch handles, and places where they may be kicked or used as steps.
- 005 function cards are magnetic. Be sure to test their effect on any nearby compasses.
- Access to the back side of the mounting bulkhead is desirable for easy access to cabling.
- A storage location on deck for a few function cards is very useful.

Interfaces & Sensors

When planning the installation of the interfaces, try to locate them so that they are near their sensors, easily accessible and well lit. Doing so will simplify installation, cabling, troubleshooting and the calibration procedure. It is helpful to include an extra connector for a temporary indicator near the boatspeed and apparent wind interfaces in order to be able to read the calibration display while adjusting the calibration screws.

```
                   WARNING! Some interfaces are not waterproof.
          They must be protected from being submerged or even splashed with water.
```

The most important aspect of an instrument installation is installing sensors so that the calibration is consistent from season to season. Each sensor has its own peculiar requirements for a good mechanical installation.

Boatspeed

Locating the boatspeed interface near the boatspeed sensor reduces the run of the sensor cable making it easier to replace a transducer should on ever be damaged. In addition, it lessens the possibility of damage or interference and the need for multiple connectors (reducing the possibility of bad connections).

Boatspeed sensors are simple, rugged and reliable devices. However, they sense water flow close to the hull's surface, and are quite sensitive to disturbances in that flow.

- On sailboats, the boatspeed sensors should be placed about one third of the distance from the leading edge of the keel at the hull forward to the waterline bow.

- On powerboats, boatspeed sensors should be placed as far forward as possible (i.e. away from the props) yet still be submerged at high speed. Locate sensors away from the keelson, thru-hulls and cooling devices which could distort the flow past the sensors.
- Do not install a sensor aft of a through-hull or strut which could distort the flow past the sensor.
- The sensors should be placed as close to the centerline as possible. If a sensor must be located off centerline because of constraints of hull construction, consider installing two sensors symmetrically.
- Do not mount sensors aft of maximum beam or close outboard of the keel.
- Be sure there is enough room to remove the transducer from its through-hull (usually 6 inches).
- Avoid installing anything so close to the through-hull (like the boatspeed interface) which could be damaged if it were to be sprayed with water when the sensor is removed.
- The sensor should be aligned in its housing and marked in its proper position so that each time it is removed the sensor can be reinstalled exactly as before for consistency and repeatability in boatspeed reading.
- <u>Be sure that the sensor penetrates to the same depth in its thru-hull</u> each time it is installed. This detail is very important for consistency and repeatability in boatspeed readings. For sensors which do not seat on a solid contact, the gland nut should be marked so that it can be tightened down to exactly the same place each time.
- Port and starboard sensor cables should be marked at the interface end to avoid switching them by mistake.
- If you have one sensor, connect the cable to the left jack of the interface. Set the transducers switch to the correct setting for one transducer.
- If you have two sensors, connect the port side transducer (boat's port side, not port tack) to the left jack, and the starboard transducer to the right jack on the interface. Set the transducers switch to the correct setting for two transducers.

Wind

Locating the wind interface on a transverse bulkhead near the mast generally provides for simpler routing and connection of the mast cable. We suggest a permanent connection (soldered & heat-shrunk) between the mast cable and the interface pigtail in order to make the wire color change permanent (see Section Hookup Diagrams or the specific interface document for proper cable connections). The mast cable should be cut near the mast and the wires reconnected across a terminal strip to allow the mast to be unstepped. The connection at the terminal strip will then be color to color, greatly reducing the possibility of an improper reconnection when the mast is restepped.

Masthead units provide crucial input for calculating true wind information. Unfortunately they are fragile and expensive and must be mounted in an inaccessible place. By far the most common trouble with masthead installations is failure of the mast cable. This vital link between the masthead and the interface has to share space with halyards, screw tips and other sharp edges. If the cable is cut or nicked, the instruments will not work, and the masthead could be burned out. Run the cable in a conduit if possible. The cable is especially vulnerable at entrance and exit points.

The length of the masthead arm should be long enough locate the sensors beyond most of the upwash from the sails. Masthead rigs require longer arms than fractional rigs, and 50 footers require longer arms than 30 footers.

- Run the mast cable in a conduit or protect it in some other way inside the spar.
- The mast cable should be protected from the sharp edges of the entrance and exit holes.
- Do not lead the bottom end of the cable lead through the bilge since water could short it.
- Provision should be made to protect the bottom end of the cable when the mast is unstepped.

- Free-hanging parts of the mast cable below deck should be secured with tie wraps to prevent them from being sucked into machinery or being used as handholds.
- The bracket for the masthead should be aligned as close to the centerline as possible.
- It is vital that the masthead and bracket have no angular play whatever. Even 1° of play will change Wind Direction by 3°.

Compass

It is more important to have the instruments' electronic compass adjusted (compensated) to 0° deviation than for the steering compass. After all, you can not steer accurately within a few degrees. But on the other hand, each degree of error in the electronic compass equals a degree of error in Wind Direction.

- The electronic compass is not waterproof. Locate it so that it will not be submerged or even splashed.
- Locate the electronic compass at least 6 feet away from major sources of magnetic distur-bances, the most obvious of which is the engine.
- Be sure the compass is at least 3 feet away from other magnetic sources like electrical lines, steel-jacketed hydraulic lines, tool boxes, Ockam function cards, anchors, fire extinguishers, speakers, cameras and even some aluminum beer cans (which have a steel ring in the top).
- Within the above constraints, the electronic compass should be located as close as possible to the center of rotation of the boat, both pitch and yaw.
- If you have difficulty in adjusting the compass, consider relocating it further away from magnetic interference.

Cabling & General Tips

- All cable connections should be secured safely out of the way, and protected from water.
- DO NOT RUN CABLES IN THE BILGE. No cable jacket is completely impervious to water, and over time there is a high probability that it will be cut or nicked.
- The connectors themselves should be insulated from metal or carbon fiber to preclude elec-trolysis and possible electrical problems.
- Use pre-made cables if possible (e.g. Ockam 100 series). Making cables on site causes lots of quality control problems.
- If you do make your own cables, use crimp type BNC connectors instead of solder/gland types. The latter are just too difficult to do consistently.
- RG-58C/U cable is greatly preferred over other types because it contains a stranded center conductor, and is generally of better quality. Cable with solid conductors tends to break from vibration fatigue.

"Q" Interfaces

Some interfaces can completely prepare a sensor reading for display; e.g. no othes variables are needed to correct it, and the quantity is not needed elsewhere within the system. The 066 Loadcell and 062 Trim interfaces, along with most custom interfaces (099 types) fall into this category. When first found, these interfaces tell the CPU what tag to use, how much buffer memory to reserve, and how often to call up for data. Subsequently during operation, the CPU calls them up, gets the data (if available), and puts it on the display channel. Because of their address, this type of interface is called a "Q" interface.

There are 16 unique "Q" interface slots numbered 0,1,2…8,9,A,B,C,D,E and F. On any system, no two "Q" interface should be set to the same slot, or neither one will work because of mutual interference. The slot is usually set by a rotary switch on the interface (although some might have fixed slots because of hardware limitations).

Many (but not all) "Q" interfaces also use the slot switch to select their output tag. This allows a system to have more than one of the same interface, each set to its own slot and tag. The 066 Loadcell and 062 Trim interfaces (and several customs) use a standard map from slot to tag (see table).
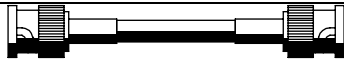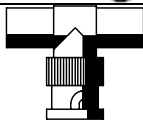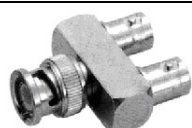
Each Q interface also reserves a certain amount of memory in the CPU for use as a buffer. On the 001, the total amount of memory available is 256 bytes, and this may limit the number of "Q" interfaces you can attach at one time. There is no such limit on the T1.
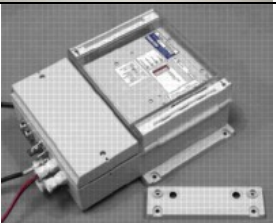
"Q" Interface Table

Use this table to record the "Q" interfaces installed in your system, to ensure that no two interfaces have been set to the same slot, and that the total amount of memory required from the buffer pool does not exceed 256 bytes. Factory settings for the standard "Q" interfaces are;

slot	Interface	Tag	Mem.	Default
0				066 Loadcell,"M", 9
1				
2				062 Trim,"N", 9
3				
4				039 Lat/Lon,"X", 18
5				
6				
7				
8				
9				
A				
B				
C				
D				
E				
F				

Installation accessories

100-xx Coaxial cable connects all Ockam system components together. Standard lengths are 1, 2, 5, 10, 20 and 30 feet.	
110 Barrel connector. Connects 2 100s together.	
114 FFF tee. Connects 3 100s together.	
115 Tee connector. Connects 2 100s and an interface or display together. Do not use conglomerations of tees for multi-drop requirements. Instead, use 106 junction boxes.	
115U Tee connector; like 115 but 100s are parallel. Works well on CPUs	

Junction boxes 106-05 5-position 106-09 9-position	
044CART Waterproof button for remote control of the Matryx and Magnum.	
120 Card organizer, holds 30 cards for the 005 display.	
T1EARS Optional mounting hardware for the T1 processor.	
LGS (little green screwdriver). Standard calibration tool.	

Dual-Lock™ Fasteners

Interfaces are supplied with two Dual-Lock "hook" strips attached to the interface. There is also provision for screw mounting to allow you to choose the appropriate mounting method.

Dual-Lock will adhere to most fiberglas and metal surfaces, as long as they are clean and free of any wax or liquid. If the surface is wood, especially when oiled, or rough finished fiberglass, the loop strip can be attached with small brads or self-tapping screws.

> NOTE! The Masthead interface contains a heel sensor. When mounting this interface with Dual-Lock, mount a batten along an edge of the interface so proper orientation is maintained.

- Clean and dry the mounting surface.
- Mesh the loop strips with the hook strips.
- Peel the backing off the loop strips, and press the interface into place.
- Carefully disengage the interface from the loop strips, and press the loop strips down.
- Allow the adhesive to cure for 6 hours, then remount the interface.

Hookup diagrams

B&G 213 type mastheads

Connecting a B&G-213 type masthead
to an Ockam System T2 Multiplex Interface
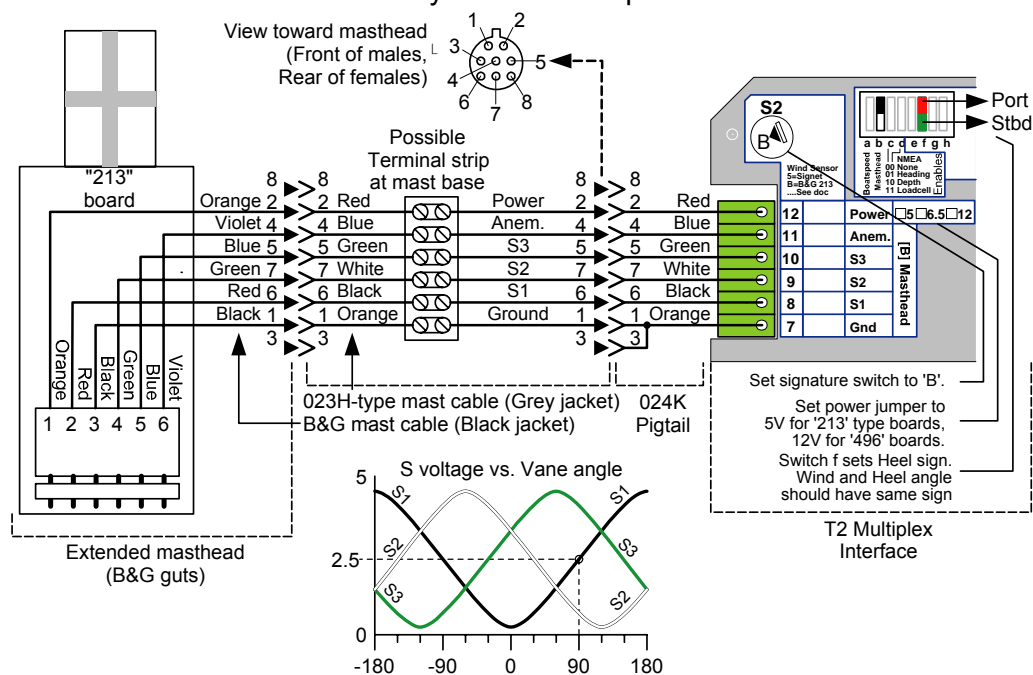
Connecting a B&G-213 type masthead
to an Ockam System 022 Interface

Airmar SmartDepth

NMEA-
NMEA+
NMEA out
NMEA in
Lights
+12..24vdc
+12..24 VDC
Gnd & Shield
Ground
T1 Processor

Smart-
ducer

Note: Works best when:
Smartducer(+) -> Ockam In(-)
Smartducer(-) -> Ockam In(+)

S3

Boatspeed
Masthead
NMEA
00 None
01 Heading
10 Depth
11 Loadcell
Enables

NMEA+
NMEA-
+12..24vdc
Ground
Shield

4
3
2
1

6
5
4
3

[C] NMEA
IN+(A)
IN-(B)
Activity

Strip 3/8"

T2 Multiplex Interface

Smart-
ducer

Ships
Power

Note: Works best when:
Smartducer(+) -> Ockam In(-)
Smartducer(-) -> Ockam In(+)

IN->

+9v 6
5
4
In+(B) -> 3
In-(A) -> 2
Gnd 1

Opto-
Isolated

Strip 3/8"

028B Depth Interface

NMEA+
NMEA-
+12..24vdc
Ground
Shield

4
3
2
1

Smart-
ducer

Ships
Power

Teeter-Todter compass

1&2 bridged (Ground)
5&6 bridged (Data out)

Data out → Pin 2
Data in ← Pin 3
Power
Ground
Pin 5

NMEA out
NMEA in
Lights
+12..24 VDC
Ground

T1 Processor

Teeter-Todter

DB9 for Calibration

1&2 bridged (Ground)
5&6 bridged (Data out)

Data out → Pin 2
Data in ← Pin 3
Power
Ground
Pin 5

S3

Boatspeed
Masthead
a b c d e f g h

NMEA
00 None
01 Heading
10 Depth
11 Loadcell
Enables

IN+(A)
IN-(B)
NMEA
Activity
Strip 3/8"

T2 Multiplex Interface

Teeter-Todter

Ships Power

DB9 for Calibration

1&2 bridged (Ground)
5&6 bridged (Data out)

Data out → Pin 2
Data in ← Pin 3
Power
Ground
Pin 5

IN→

+9v   6
       5
       4
In+(B) → 3
In-(A) → 2
Gnd   1

Opto-Isolated

Strip 3/8"

032B Heading Interface

Teeter-Todter

DB9 for Calibration

Airmar ST650 paddle

T2 Multiplex Interface

Checking Out The System

Basic Power & Communications

Set up so that you can see an indicator set to TEST Configuration. Power up the CPU while watching the indicator. The order in which things happen (or do not happen) helps pinpoint possible troubles.

Power-up for the 001:
1)   The CPU trouble light flashes when power is first applied, showing the 'low battery' voltage condition sensed as the power supply comes on.
2)   The TEST Configuration display is set to the program revision $\boxed{\text{Pxx.x}}$, then the CPU checks RAM and interfaces. This process takes two to three seconds.
3)   The CPU then starts running its main program, and normal TEST Configuration is put up.

Power-up for the T1:
1)   When power is first applied, the indicators light up in a random pattern. The Ockam bus receives power so displays show "all eights" or their splash screen.
2)   The CPU performs self-test which takes about 20 seconds. Near the end of this period, the compact flash card activity light flashes a couple of times.
3)   At the end of self-test, the compact flash activity light flashes once more, and the program executes. The indicator lights get set correctly, and bus activity starts.

Power-up for the 005 and 044 segment-type displays:
1)   Upon receiving power, the display is set to 'all-eights' with punctuation $\boxed{\text{!+8.8:8.8}}$.
2)   For the 005 running off a 001, receipt of the all-indicator message "HI" is displayed a couple of seconds later.
2)   As soon as data is received for the current tag, it is displayed.

Power-up for the 007 Matryx:
1)   Upon receiving power, the splash screen is shown. The Jumbo number is shown here.
2)   After 3 seconds, the splash screen is replaced by the current page.
3)   As data is received, the current page is populated.

Checking Out the Interfaces

The Ockam system assigns a unique numerical value to each active interface and displays the sum on the TEST Configuration function. The values for each of these components are listed below. To use this function you first have to figure out what the configuration should be with all components working properly .

Our example shows a Unisyn system (001 processor) with boatspeed, wind, compass and GPS. In our example, the TEST Configuration number should be 79. Therefore if your TEST Configuration display reads 79 then all the interfaces are present. Refer to Configuration Troubleshooting for more details on how to check out the TEST Configuration.

TEST Configuration Worksheet

Interface	Config. #	Example		Actual
001 Clock or T1 receiving ZDA	1	√	1	
Boatspeed Interface (015 or T2)	2	√	2	
Wind Interface (022 or T2)	4	√	4	
Heading Interface (032 or T1 or T2)	8	√	8	
Depth Sounder Interface (028 or T1 or T2)	16			
Polar Interface (037 or T1 with Polar file)	32			
GPS Interface (001+041 or T1 with GPS input)	64	√	64	
060 Rudder Interface	128			
072 Barometer/Temperature Interface	256			
Any Q interface (see Q interfaces)	512			
Mast Rotation Interface	1024			
AHRS Motion Package	2048			

TEST Configuration **79**   _____

TEST Errors: the CPU's Flashing Light

TEST Errors is the second function for diagnosing problems with the Ockam System. It works in the following manner: If the red light on the CPU flashes, it indicates that the system has detected one or more error codes. When you insert a TEST Errors card in an indicator, it will display a sequence of error codes (numbers). These error codes correspond to specific faults which the system has detected. If no errors have been detected, the display will show '0', and the CPU light will go out. See the TEST Errors troubleshooting section for the list of error codes and what to do about them.

<u>Installation Checklist</u>
System
Indicators checked out .... ____

TEST Configuration OK.. ____

TEST Errors OK .... ____

Boatspeed Interface
Signature set to proper value .... ____

Transducer switch set to 1 or 2 transducers .... ____

Transducer(s) plugged into proper jacks.. ____

CAL Boatspeed Master to 1.06 .... ____

CAL Boatspeed Offset to +0.000 .... ____

CAL Leeway to 7.0 .... ____

Wind Interface
Check that vane is properly oriented... ____

Signature set to proper value .... ____

Heel Sign switch set correctly .... ____

Mast cable properly plugged in .... ____

CAL Wind Angle Offset to +0.0... ____

CAL Windspeed to 1.12.. ____

CAL Upwash to 0.0 .... ____

Heel reads 0° with boat level.. ____

Compass Interface
Magnetic variation set.. ____

Compass swung and compensated .... ____

Depth Interface
Transducer depth set.. ____

Keel depth set.. ____

Loran/Position Interface
Loran checked out & tracking... ____

Loran output enabled.. ____

Polar Curve Module
Calibration set to 00 (100%)... ____

Polar number set .... ____

"Q" Interfaces
All slot switches set differently... ____

Display card magnets set correctly for slot (if applicable)... ____

Troubleshooting

The first part of this section identifies potential system problems. The second part describes procedures for isolating or correcting the problem.

Functional Troubleshooting

No indication on any display.	Indicates lack of power on the Ockam bus • Check system power . See <u>System Power Troubleshooting</u>. • Check the bus. See <u>Ockam Bus Troubleshooting</u>.
Strange display.	See <u>Display Troubleshooting</u>.
LOG or TIME resets on power up or engine start.	Dead backup battery. Return CPU for service when convenient.
Boatspeed not zero when it should be.	• (Several Knots) Usually caused by the AC power to the battery charger. Try disconnecting the boat from shore power. • (Small number or Intermittent) Caused by current or vibration transmitted through the hull to the paddle. NOTE: because they have no bearings to unstuck, ultrasonic boatspeed sensors will typically show a few tenths of a knot at the dock.
Apparent Wind Speed not zero when it should be.	• (Several Knots) Usually caused by the AC power to the battery charger. Try disconnecting the boat from shore power. • Caused by mast vibration. • Apparent wind speed modified by roll rate. See discussion in Section 4, Option 8.
Bad Wind Direction.	• No True Wind Speed. Since true wind is a vector solution, when true wind speed is zero, True Wind Direction has no meaning and is set equal to Heading. • Check True Wind Angle, True Wind Speed and Heading for proper values.
Bad True Wind Angle.	• No True Wind Speed. Since True Wind is a vector solution, when True Wind Speed is zero, True Wind Angle has no meaning, and is set to 0. • Check Apparent Wind Angle, Apparent Wind Speed and Boatspeed for proper values.
Bad Apparent Wind Angle.	• Apparent wind angle modified by roll rate. See <u>Setting Mast Height</u>. • Bad masthead sensoror or connection between masthead and interface. Check for TEST Errors 33, 34 and 35. • Loose masthead bracket.
Bad Heading.	• No power to heading sensor. Most heading sensors require a separate power supply. Check that the heading sensor is receiving power. • Some magnetic item has gotten near the sensor.

- Sensor needs compensation.

System Power Troubleshooting
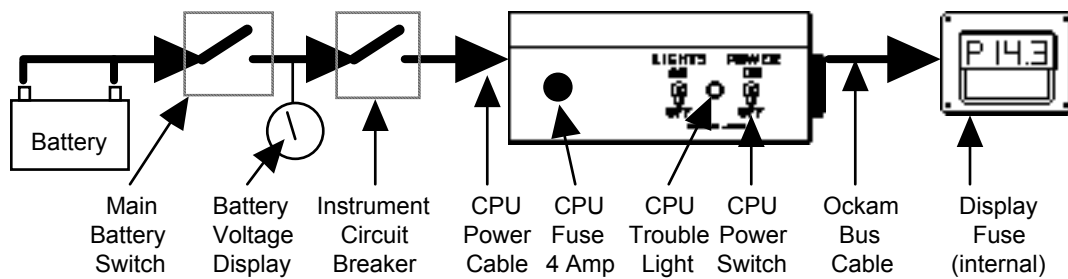
The Ockam system runs on ship's power which typically must pass through 3 switches, two fuses, a voltage regulator, a power limiting circuit and the Ockam Bus before it gets to the display itself. In order to troubleshoot the system power, look at the various power indicators along the path from the ship's battery to the display.

The first place you might be able to verify ship's power is at the power panel. Most have a battery voltage display of some kind. If there is no indication here, the main battery switch or the battery itself is suspect.

001 Unisyn Processor:

The trouble light, located between the two switches on the side of the CPU, provides the next convenient indicator. This light is illuminated by three things; voltage supply greater than 4 volts and less than 10.5 volts, current of more than 3 amperes going to the Ockam Bus, and the existance of TEST Error codes which cause it to flash beginning 2 seconds after power up.

When the CPU is first turned on (both instrument breaker and CPU power switch on), the trouble light should flash as the supply voltage rises above 4 volts, then go out when it rises above 10.5 volts. After two seconds, if there are any TEST Errors, the light will start flashing (See TEST Errors troubleshooting).
- If the trouble light stays on, it indicates either low supply voltage or high Ockam Bus current, either of which will prevent the displays from working. However, it does indicate that power is getting to the CPU.
- To determine which of the above possibilities exist, disconnect the Ockam Bus at the BNC connector on the back side of the CPU. This eliminates the possibility of high current. If the light stays on, then the ship's supply is too low to run the system. If the light goes out, then the Ockam Bus is shorted. See Ockam Bus Troubleshooting.
- If the trouble light stays dark as you turn the CPU on, it means that no power is reaching the CPU. Either the instrument circuit breaker, power cable, CPU fuse or CPU power switch is open.
- If the trouble light flashes and goes out, then power at the CPU is normal, and the Ockam Bus is not shorted (it could be open however; see Ockam Bus Troubleshooting).

If the trouble light reacts properly but nothing happens at the displays, then the probability is that the Ockam Bus is open or disconnected (see Ockam Bus Troubleshooting), or that all the display fuses are blown, which can happen after a lightning strike. If the latter, then you should contact Ockam or an Ockam dealer for help.

T1 Tryad Processor:

If any of the indicator lights are lit, it means that internal 5 volt power is being generated. There is no indication of bus short on the T1.

Ockam Bus Troubleshooting

The Ockam bus supplies power from the CPU to all indicators and interfaces of the system. The bus also carries signals in both directions between the CPU and the indicators and interfaces. In effect, all the boxes of the system are connected together by the bus cable and connectors. There are three general types of problems that can happen to the bus:

Open Bus Troubleshooting

An open bus causes some parts of the system to be disconnected from the other parts. Those components downstream of the open from the CPU will be deprived of both power and signals. If they are indicators, it is evident which ones they are, and therefore approximately where the open may be.

If only interfaces are downstream of the open, the only way you might notice is if some of your functions stop changing. Review your TEST Configuration number to determine which interfaces might be disconnected.

Most opens occur at the connectors at either end of the coaxial cable. Inspect the connector and the cable for frayed wire or evidence of corrosion. A properly installed connector can withstand 2 lb. of pull. If you suspect a connector, try pulling on it.

Vibration can also cause the center conductor to break due to fatigue. If you have a bad cable, you can use an ohm meter to check the continuity between the center contacts and shells of the connectors at both ends.

Tee connectors can fail if they get wet due to plating action from the Ockam supply voltage. Salt water is more of a problem than fresh water. Look for corrosion on or inside the connectors.

Shorted Bus Troubleshooting

A shorted bus grounds the CPU power supply, removing power and signals from all indicators and interfaces. All indicators will be blank, the CPU trouble light will stay on and the CPU box will get warm. The short can be in a cable, a tee connector or one of the boxes of the system.

To find a short, disconnect the bus at the junction nearest the CPU (often a tee connector on the CPU). The CPU trouble light should go out unless the short is in the cable between the CPU and the first junction. Reconnect each part of the junction seperately. When the symptoms reappear, go downstream to the next junction and disconnect the bus there. If the symptoms remain, then the short is in the cable between the junctions. Again reconnect each part seperately until the symptoms reappear. Continue this process until you isolate the problem to a single element.

If the problem is in a cable, inspect the two connectors and the cable itself for a crushed area. If the problem is a tee, it will have to be replaced. If the problem is in one of the boxes, it should be returned for service.

Intermittent Bus Troubleshooting

Intermittents can be either opens or shorts (see above), but can also produce false signals if the shorts or opens are of short duration, or the short is not complete. If the symptoms are the same as open or shorted, diagnose them as described above.

Intermittents which produce false signals give occasional TEST Error code 13, create displays with odd characters or cause outputs to react strangely. These symptoms are usually the result of arcing or conduction through water that has gotten into the Ockam Bus cables and connectors. It indicates that the Ockam bus needs overhauling. You should inspect all cables and replace any that are wet, have corrosion or frayed wires or get warm.

Display Troubleshooting

DISPLAY SHOWS	Possible causes
`blank`	A blank display usually means that the indicator has no power. • System not turned on. • Bad ship's battery voltage. See System Power Troubleshooting. • Blown CPU power fuse. • Cable problem. See Ockam Bus Troubleshooting. • Nonexistant function. Try changing pages. • Blown fuse in the indicator.
`weird`	Weird display means things like imbedded spaces, extra or missing punctuation, etc. • Low battery voltage. See System Power Troubleshooting. • Cable problem. See Ockam Bus Troubleshooting. • Bad function. Try changing pages. • If a weird display persists with one indicator. Try cycling the power, otherwise return for service.
`+8.8:8.8`	This "all-eights" display is generated by the the 005 or 044 segmented indicator as soon as it receives power. When any other information comes along for the indicator to display, it replaces it with that information. During normal power-up, this display is re-placed by the HI display generated during the CPU power-up process. If the "all-eights" display remains, probable causes are: • Nonexistant function. Try the TEST Configuration which is always available. • Bad cable or connector causing low voltage at the indicator. • Bad indicator. • CPU program failed (all indicators would display "all-eights"). Send the CPU back for service.
`8888`	This display is different from the "all-eights" display because it lacks punctuation. If the display only shows this and never behaves normally, it should be sent in for service.
`-HI-`	This display is generated by the 001 CPU and sent to all indicators as part of its power-up procedure. Therefore, you should see this display momentarily just after you turn the system on, and before normal operation commences. If the HI display stays remains displayed; • No card in display.

- Interface for card is missing. See TEST Configuration Troubleshooting.
- (When starting engine) Power drain when starting engine lowers battery supply below 10.5 volts. Try putting the battery selector switch to 1 or 2 instead of BOTH, to separate the service load (ie Ockam) from the engine starter load.

`-E1-`   This display is generated by the indicator when it has lost the timing signal from the CPU. The cable between the CPU and the indicator is still at least partially OK, because the indicator is still receiving power. Connecting or disconnecting modules from the cable sometimes causes this display to appear momentarily.

- (If all displays) CPU is not generating any signals on the cable. (CPU internal fuse F2 may be blown).
- Water in the cable. See Ockam Bus Troubleshooting.
- Bad indicator.

`L000`

`L377`   This type of display is generated by the indicator when it is in card test mode. (See the TEST Card functional description in Section 2). Cycle power to return the display to normal operation.

`----`   This display is generated by the indicator whenever it detects that the function card has been removed. It will be replaced by the first displayable data that comes along after a new function card has been inserted. If a card is installed in the indicator, it means…

- Missing interface. See TEST Configuration Troubleshooting.
- Bad function card. See the TEST Card functional description in Section 2.

`001 CPU light always off`

- If the system seems to be OK, CPU light off is normal.
- No power to CPU. See System Power Troubleshooting.

`001 CPU light always on`

- Low voltage to CPU. See System Power Troubleshooting.
- Ockam bus cable shorted. See Ockam Bus Troubleshooting.

`CPU light blinking`

- One or more error codes is being displayed. Put the TEST Errors function card into a display. See TEST Errors troubleshooting.

TEST Configuration Troubleshooting

The TEST Configuration number tells you which interfaces are communicating with the system. Interfaces provide inputs to the system (e.g. Boatspeed or Heading) as opposed to displays, analog drivers or RS-232's which handle outputs. You need to know what the proper Configuration number is for your system in order to determine if there is a problem. (See the TEST Configuration Worksheet above).

Suppose our system had a Configuration number of 79 (from the example in the worksheet), but the TEST Configuration display reads 71 instead. By subtracting the actual value from the nominal value we find the difference is 8. Therefore the heading interface is not communicating with the CPU.

To check out your system:
1) Put the TEST Configuration card in an indicator, and read the value shown. The sum should agree with the nominal value as shown in the TEST Configuration Worksheet.

2) If the numbers do not agree, subtract the two numbers (nominal - displayed) to get the value of the missing interface(s). If there is more than one interface inoperative, the value would equal the sum of the missing interfaces. Use the TEST Configuration Worksheet to find out which interfaces are missing, and check them out.

3) Check for reasonable numbers on the appropriate displays. For boatspeed, spin a paddle and see if the boatspeed reacts. Look at the apparent wind speed and angle; you should be able to see them change. Place a magnet or steel object near the compass sensor to change its reading.

4) Any interfaces that get this far are basically OK; that is, they can communicate both ways with the CPU. Any gross problems indicated by the above check probably involves the sensors or the wiring associated with the particular interface.

TEST Errors Troubleshooting

As the CPU does its calculations, it occasionally discovers problems or warnings, e.g. an interface suddenly stops communicating. The CPU calls attention to these by flashing its trouble light, and via a sequence of numerical codes on the TEST Errors display.

Error codes are queued when detected, and once displayed, are removed. However, most normal errors repeat themselves often enough for the display to show the error repeatedly until the cause is repaired. Some normal errors (like error 13) will only display once, and then go away because the cause is not repeated.

Some errors are detected only during initialization and are signified by an exclamation point (!). Since these errors will not be repeated, their codes remain displayed so that you will have a chance to read them. They are removed when the CPU is restarted or reset.

TEST Error Codes

0   **No error.** This is the normal display for DIAGNOSTIC Errors.

11   **CPU Program Memory (ROM) Failed.** Return CPU for service.

12   **001: CPU RAM Battery Failed**.
T1: Parameter File corrupted.
For either processor, parameters are reset to factoy defaults. Otherwise, operation will be normal. When convenient, return the processor for maintainance.

13   **Unrecognizable Keyboard Command**. If you are doing Keyboard operations with an RS-232 Interface, this error could mean what it says. You may also get it once when you plug or unplug something from the Ockam bus. However if you get this error all the time, it means that the Ockam bus Cable (the coax and Tees) has deteriorated. The coax may be intermittently shorted, or has water in it.

14   **Bad Evaluation Stack.** This is a programming error. Notify Ockam.

15   **Display output buffer full.** Too much output for the display channel. Disable unused outputs (see Disabling Tags).

16   **Keyboard buffer overflow.** Too many commands. Either a PC is outputting to the system at too high a rate, or the RS232 interface plug is in the bilge.

17   **One or more tags are disabled.** See Disabling Tags.

18   **Calculations falling behind.** Calculation loop full. Disable unused outputs (see Disabling Tags).

19   **Bad Interface response.** An interface is not communicating correctly. If this error persists, contact Ockam.

21   **Boatspeed Interface has dropped out.** The Boatspeed interface used to be there, but is not anymore. All functions involving boatspeed (VMG, true wind, logs, DR etc) will stop. Check Ockam Bus and transducer wiring.

22   **Boatspeed Interface Error**. The A/D chip in the interface is not working correctly. Return the Interface for service.

23   **Starboard sensor input with Transducer Switch set to 1**. The interface is receiving signals from the starboard transducer connector with the selector switch set to one transducer. Possible causes of this error are:
  • You are using only one transducer, but it is connected to the starboard transducer connector. Re-connect the transducer to the port connector.
  • You have two transducers connected, but the selector switch is set to 1 transducer. You should set the selector to 2 transducers (to the right).
  • You are missing the masthead interface which is needed to select between the two boatspeed transducers. See error 24 below.

24   **Two boatspeed transducers without a Masthead Interface**. In order to use two boatspeed transducers, the system needs a heel input, which is a part of the masthead or 3D compass interfaces. If you have no heel input, you can only have one transducer. It should be connected to the port transducer connector, and the selector should be set to 1 transducer (to the left).

25   **Difference between Port & Starboard Boatspeed Excessive**. On two transducer installations, the boatspeed reading of the two transducers differ from each other by an excessive amount. This error can be caused by:
  • The windward transducer coming out of the water. This situation is fairly common in windy conditions, and can cause the windward transducer to read either low, or high, depending on what the wave tips are doing to the impellor. There is no fix for this condition.
  • A fouled impellor on one of the transducers. The boat speed on one tack should be low or zero. On the tack with low boatspeed, the lee transducer is the one needing cleaning.
  • A damaged cable from one of the transducers. Detect which one by the same procedure as (2) and repair it.

26   **Boatspeed & Wind Interface Revisions Incompatible**. On older systems, the leeway calibration was on the wind interface instead of the boatspeed. If you have a combination of new and old interfaces in the same system, you will have either two or zero Leeway calibrations. If you have two Leeway calibrations, the system will use the one on the BOATSPEED. If you have none, the trimmer just above the Upwash cal on the MASTHEAD will be used for Leeway.

27   **Using SOG for boatspeed.** See Option 16.

31   **Wind Interface has dropped out.** The wind interface used to be there, but is not anymore. All functions involving wind and heel (boatspeed tack-to-tack calibration, VMG, True Wind, Laylines etc) will stop. On dual boatspeed transducer installations,

this trouble will also cause error 24.

32 **Wind Interface Error**. The A/D chip in the interface is not working correctly. Return the Interface for service.

33
34
35 The signals from the masthead angle sensor to the interface do not fall within acceptable tolerance. If the mast cable is damaged, these signal lines could be shorted together or shorted to the mast, causing this error. If the cable is damaged, it could cause possible damage to the masthead.

Compare the Windangle Apparent display against the wind vane. If they compare well, then these errors can be ignored. Otherwise, the mast cable or masthead should be checked.

36 **Sign of Heel and Wind Angle do not agree**. The CPU has checked heel angle during a beam-reach condition and found that the heel angle is backwards. Change the heel sense switch on the Wind interface.

37 **Mast Rotation error**. The Mast Rotation Interface reports an error. Refer to the trouble light inside the interface for a more detailed description of the problem.

38 **Mast rotation missing.** The mast rotation interface has dropped out. Wind information will no longer correct for mast rotation.

39 **Sonic masthead with no heel.** Sonic masthead interface without heel sensor requires 3D heading interface.

41 **Compass Interface has dropped out**. The Compass interface used to be there, but is not anymore. Functions involving heading (DR, laylines) will stop.

42 **Compass Interface Error**. The Interface is not getting a signal from the sensor. HEADING display will show a 0 or non-changing value. Check that power is turned on to the sensor (if applicable), and check the wiring between the sensor and the interface. Some sensors send data at less than a 1/4 second rate, so this error may be "normal" for them.

43 **Heading sensor in CALIBRATION mode.** While the heading sensor is calibrating, the Heading output is the "quality of fit" output.

44 **(T1 only) Getting direct NMEA heading with Heading interface attached.** The T1 processor is receiving heading input on its NMEA port, and a Heading interface is also providing heading. The direct input is being ignored.

47 **Using COG for heading+leeway.** See Option 16.

51 **Depth Interface has dropped out**. The Depth interface used to be there, but is not anymore.

52 **Depth Interface Error**. The Interface is not getting a signal from the depth sounder. DEPTH displays will show non-changing values. Check that power is turned on to the depth sounder, and check the wiring between the sounder and the interface.

53 **(T1 only) Direct depth – No Depth Keel.** Older revisions of the T1 have no transducer or keel depth adjustments. Depth Sufrace displays the number being received, and there is no Depth Keel.

Upgrade to the latest T1 software.

54   **(T1 only) Getting direct NMEA depth with Depth interface attached.** The T1 processor is receiving depth input on its NMEA port, and a depth interface is also providing depth. The direct input is being ignored.

61   **Polar Module has dropped out**. The Polar Module used to be there, but is not anymore.

62   **Polar Module reports trouble**. The requested polar ROM has bad header data.

63   **Polar Number is Missing**. The polar number (switch or Option) is set to a polar number which can not be found in any polar ROMs in the Module. If you do not have multiple polars, the polar number will normally have been set to 1. Reset the Polar number switch to 1, and do a Master Reset.

71   **Loran/GPS Interface has dropped out**. Functions involving waypoints (waypoint, laylines and current) will gradually degrade due to accumulation of errors by dead-reckoning.

72   **Loran/GPS Interface reports trouble.** The interface is not receiving properly. Either the GPS is off, the cabling is messed up, or the baud rate or type switches on the interface are incorrectly set.

73   **(T1, 001>A15) No Waypoint from GPS**. The GPS is not outputting Waypoint Range & Bearing. Some GPS's do not output waypoint range & bearing unless they are executing a route.

(001<A16) Loran Waypoint moved more than 1/2 mile. This is normally not an error. You will see this reported when the Loran destination is changed from one waypoint to the next.

74   **(T1, 001>A15) No Current**. Current is out of date because COG/SOG is not being received AND no manual current has been input.

(001<A16) Loran Failed to Update for more than 2 Minutes. The Loran has failed to communicate with the interface for more than 2 minutes. In some Lorans, you may have to instruct the Loran to output data to the output port for the interface to use. This instruction may have to be reissued to the Loran. Communications trouble like error 72 may also cause this error.

75   **(T1, 001>A15) No Lat/Lon**. GPS is not outputting position.

(001<A16) Loran Automatic Current Calculation is Disabled. This error is a reminder, not an indication that something is wrong. Automatic current calculation (CURRENT SET & DRIFT) has been disabled by setting Option 4 to 0.

76   **(T1, 001>A15) No COG/SOG**. GPS is not outputting COG/SOG.

(001<A16) Loran Range & Bearing Frozen. The Loran waypoint position has not changed within the last minute. This may indicate that the Loran has lost track, or that the waypoint range is too far away for adequate resolution of its position (in bearing), or there is no progress toward the waypoint (no boatspeed). Thus, this error will occur if the boat is stopped. The waypoint is maintained by DR (for those systems with boat-

speed and compass) until the Loran changes its range and bearing output. The difference between this error and error 74 is that this one reports on the values as opposed to physical communication.

77 **(T1, 001>A15) Current is Manual**. Current has been manually input (see Manual Current).

(001<A16) Waypoint Update Disabled. This is not an error. It is a reminder that the input from the Loran has been disabled (see Setting Options in Section 4), and the Ockam Waypoint is being updated by Dead Reckoning only.

78 **(T1, 001>A15) Manual Waypoint.** Waypoint Range & Bearing is being input manually, overriding data from the GPS (see Manual Waypoint).

79 **(T1, 001>A15) No Differential GPS.** The GPS is signaling that differential correction has been lost.

80 **(T1, 001>A15) GPS error.** The GPS is signaling an error.

81 **Rudder Interface has dropped out**. The Rudder interface used to be there, but is not anymore.

82 **Rudder Interface Error**. The A/D chip in the interface is not working correctly. Return the interface for service.

91 **Temperature Interface has dropped out**. The Temperature Interface used to be there, but is not anymore.

92 **Temperature Interface reports trouble**. The A/D chip in the interface is not working correctly. Return the Interface for service.

101 **A Q-type Interface has dropped out**. One of the Q interfaces (e.g. Loadcell) used to be there, but is not anymore.

102 **Q-type Interface Slot error**. Two Q interfaces are set to the same slot.

103 **Bad characters from Q-type interface**. One of the Q interfaces has sent bad characters.

104 **Bad Initialization from Q-type Interface**. One of the Q interfaces has a bad header. The interface will not be recognized.

!105 **No room in Buffer Pool for Q-type Interface**. There is no more room in the buffer for more Q interfaces. This is caused by having more Q interfaces than the system can handle. The system allocates space for interfaces as it encounters them, and never deallocates it. Therefore, if you turn the slot switch on an interface, you will allocate buffers for interfaces you do not have. Try turning the power off and back on.

114 **(T1 only) No AutoCal.** An AutoCal control command has been received for a missing or disabled AutoCal table.

115 **(T1 only) Default Settings Saved.** A SAVE DEFAULT command was executed successfully.

116 **(T1 only) Load Polar Requested.** A polar file change has been requested. If unsuccessful, error 117 will be posted.

!117 **(T1 only) Load Polar Failed.** The Load Polar failed.

118 **(T1 only) The RS232 port has changed its settings.** See T1 Command Port.

120 **(T1 only) Changes Saved.** When the T1 saves its settings to the flash card, it throws this advisory.

122 **(T1 only) NMEA port not 4800.** The T1 NMEA port is outputting at 9600 baud.

124 **(T1 only) ZDA disabled.** The T1 clock is not being updated from ZDA (see Calculation Options).

125 **(T1 only) Retro-apparent is enabled.** Apparent wind is being back-calculated from true (see Calculation Options).

126 **(T1 only) Sonic wind interface error.** Message sent by the sonic masthead interface.

130 **(T1 AHRS build only) AHRS missing.**

131 **(T1 AHRS build only) AHRS bad data.**

132 **(T1 AHRS build only) AHRS calibration error.**

!134 **(T1 only) Error reading CF card.**

!135 **(T1 only) Error writing CF card.**

!141 **(T1 only) AutoCommand file loaded.**

142 **(T1 only) AutoCommand issued.**

!150 **(T1 only) Failed to create log file**. Insufficient system resources available to create and open the log file.

!151 **(T1 only) Log file shut down**. Free space on the compact flash fell below 2MB. Logging has been terminated.

152 **(T1 only) Logging disabled**. Logging requires a compact flash size greater than 20 MB.

153 **(T1 only) Logging write error**. There was an error writing the current data block.

154 **(T1 only) Logging updated**. The log was successfully updated.

155 **(T1 only) Next logging file opened**. The previous file was closed and the next in sequence has been opened.

301 **(T1 only) Low buffer pool.** Report this error to Ockam.

302-309   **(T1 only) Full mailbox.** There is too much information being generated as input to one of the processing queues. Error 309 indicates that the GPS is producing so much output that the NMEA tap channel is overflowing. If this error occurs, cut down on the GPS output vie its setup function.

401-466   **(T1 only) Low stack alarm.** One of the tasks is reporting a stack overflow error. Report this error to Ockam.

System Command Troubleshooting

Sometimes, onboard software, PCs, PDAs or Lynx can output commands that lead to perceived trouble because they are either unauthorized, forgotten or wrong. For the T1, Option 27 Set Command Debug Tag allows you to see what commands are being received.

If you use OckamSoft, there is also an applet, SeeCmd.Exe, that will display all commands eminating from the PC it's running on. This application resides in

c:\Program Files\OckamSoft 4\Goodies

When you determine that an issue is being caused by bad commands, disconnect all sources of those commands:

1. Disconnect the PC from the processor. This disables both software on the PC, and commands inbound on WiFi from PDAs.

2. Check that any attached Lynx receivers are not active.

Then re-attach them one at a time until the source is determined.

Calibration Procedure

Instrument Calibration Theory and Practice

Calibration of instrument systems is necessary to make displayed information correct and useful. Instrument systems use sensors to measure primary environmental factors (boatspeed, wind, heading, position, heel and others), possibly combine them, and display the results. Stand-alone systems do not combine inputs, while integrated systems do.

Stand-alone instrument system

Integrated instrument system
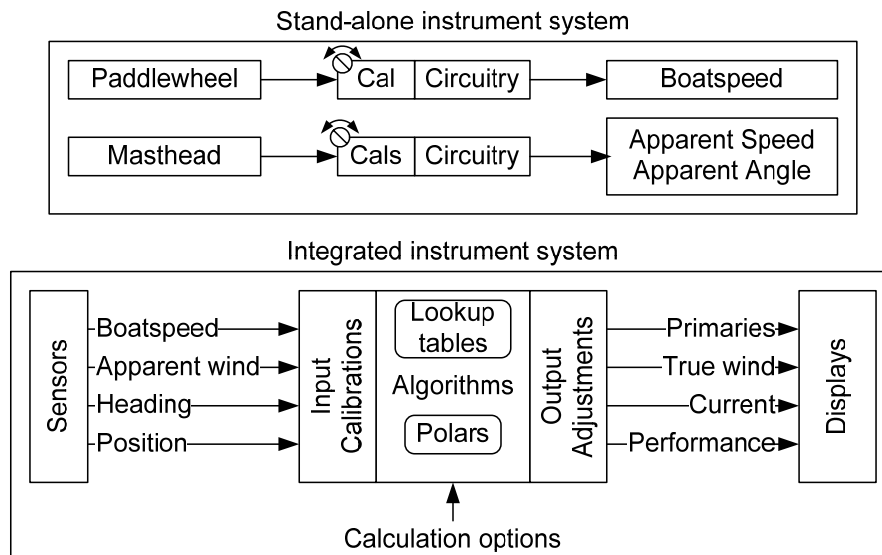
Most instrument systems provide some means of calibration; either through hardware (screw turns) or software commands, or both. Some calibrations tend to be static; once set, they pretty much stay where they are, while other calibrations always seem to need adjustment.

These days, ALL integrated instrument systems (the ones that can output true wind and current) are computerized. They pretty much follow the block diagram, although they might not offer all the adjustments or options shown. A key characteristic of a properly designed integrated system is that all inputs and outputs are available for calibration by all functional channels. For instance, this would allow the effect of heel to change the boatspeed calibration. If the various functions were not available, this could not be done.

Input calibrations correct sensor inputs to make their readings accurate. They adjust for things like boundary layer (paddlewheels), upwash (masthead units), and installation variables such as compass deviation or sensor misalignment. Almost all instrument systems, including stand-alone types, offer some kind of input calibration.

Algorithms are the computer codes that process the inputs to produce outputs. Some outputs (the Primaries) are simply a repeat of the sensor reading, although the digital domain allows better fidelity, modeling and filtering. Other outputs are not directly measurable. For example, true wind angle and speed are a combination of apparent wind and boatspeed, and wind direction is in turn a combination of true wind angle and heading. Instrument algorithms tend to be invariable because they are based on mathematical models, but some systems allow limited control.

Calculation options (when available) change the way the algorithms work. For example, the system might allow switching from paddle to SOG to replace boatspeed, or certain calculations

might be disabled to comply with racing rules. Because these features are limited to high-end systems, they tend to be controlled by computer commands (see Options and Averages).

Output adjustments scale or warp outputs to correct for unmeasured or unknown effects (such as wind shear and gradient), or when input calibrations do not completely correct the sensor inputs.

Look-up tables are a flexible way to specify calibrations or adjustments which depend on other measured parameters, e.g. leeway depending on keel extension. But since they are difficult to create and maintain, they should only be used when needed.

2-Dimensional Look-up Table

Abs(Wind angle)=45	0	10	20
0	0	0.10	0.20
90	0.00	0.13	0.22
120	0.00	0.16	0.24
180	0.00	0.19	0.26

Wind speed=14.6

0.159

Instrument Calibration on the Ockam System

The Ockam Unisyn™ and Tryad™ systems have many types of calibration, options and adjustments providing for all levels of need.

Hardware Cal

A	E Leeway Cal	H Windangle Offset
B Xducr Depth(1st)	F Boatspeed Offset	I Windspeed Cal
C Keel Depth (2nd)	G Boatspeed Master	J Upwash Slope
D Heel Zero		K Upwash Cal

◎ A ◎ B ◎ C ◎ D ◎ E ◎ F ◎ G   H◎ I◎ J◎ K◎

1.06
CAL Boatspeed Master
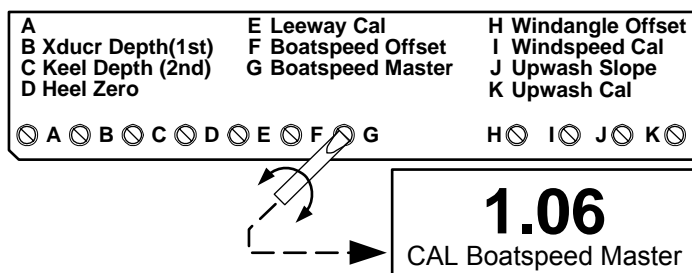
Most Ockam interfaces have Input Cal screws, used for basic instrument calibration. Many deride them as old-fashioned and low-tech. We think so too, and you forgot to mention their inconvenience. The Ockam Instrument system uses them because they are robust, reliable, understandable and do not reset themselves at just the wrong time like RAM-based calibrations can. And they travel with the interface so if you have to replace the processor you do not have to completely re-do your calibration.

Software Calibration is the solution to the inconvenience issue, but we recommend transferring them to the screws once they have been figured out, so your calibrations are locked down forever. It also forces you to write them down so you create a paper backup.

Software Cal

Direct command

Output | K1=1.06

OS4 Driver

Control

Cal Boatspd Master ▼

Val | 1.06   Execute

Matryx

Boatspeed Master

1.06

Inc   Dec   Set   Cancel
⊗   ⊗   ✳   △

Ockam Eye 4.03

CAL Boatspd Master ▼
◎ **1.06**   Execute

Every hardware calibration screw has an equivalent software command. For example, sending the command **K1=1.06** sets CAL Boatspeed Master to 1.06 regardless of the hardware screw setting. Sending the command **K1=D** returns the calibration to the hardware value.

These commands can be entered by means of the ***Eye*** PDA application, ***Matryx*** displays, ***OckamSoft 4***, or even a terminal emulator. They greatly speed the calibration process, but the settings are vulnerable to memory loss or processor replacement. Once the calibration settings have been established, we recommend that the settings be transferred to the hardware screws.

AutoCal

CALUW	TW Speed				
|TW<|	0.0	5.0	10.0	20.0	30.0
0	-2.40	-2.32	-1.10	3.20	3.70
30	-2.25	-2.62	-1.58	2.46	2.75
60	-2.10	-2.47	-1.43	2.61	2.90
100	-1.90	-2.27	-1.23	2.81	3.10
180	-1.50	-1.87	-0.83	3.21	3.50

AutoCal is a PC application which automates the output of Software Cal commands based on user-specified independent variable values. In the table above, CAL Upwash (CALUW) is modified depending on the current value of true wind speed and angle.

In addition to Input Cals, AutoCal can adjust true wind to correct out that last bit of wiggle in wind direction and true wind speed.

If you need this additional capability, download the AutoCal applet http://www.ockam.com/AutoCal.zip which includes a sample spreadsheet and more documentation.

AutoCal in the T1

When your AutoCal table is complete and debugged, you can move the function into the T1, thereby unloading your PC and the comm channel for other work. The AutoCal functionality is then available whether or not the PC is running.

The AutoCal applet includes instructions for preparing AutoCal.dat for the T1.

QuikCal
(T1 only)

Matryx

Unlift/Unhead

-0.5

UnLft   UnHd   Done

⊘ ⊘ ⊛ △
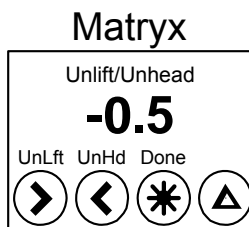
You should not be twirling calibration screws or trying to modify a spreadsheet during a race. In this situation, we recommend using the 'QuikCal'. With this function you can quickly adjust true wind angle for a perfect wind direction.

After the race is over, you should write down the QuikCal value and the conditions under which it was set to aid in figuring out how to modify the system's calibrations in the future.

The Zen of Calibration

You will find the actual process of calibrating your instrument system extremely rewarding and beneficial to your use and understanding of the system. As a result, your confidence and use of this tool on the racecourse will increase dramatically, and you will benefit from many of the additional built-in features of the Ockam instrument system.

The secret to good calibration is an organized, methodical approach that goes one step at a time. In the early stages you will lay the ground work for the overall performance of your system. As in most instances like this, a well done job at this stage will make the calibration of the total system easier and more accurate.

DOCUMENT WHAT YOU DO! You should keep a log on each calibration adjustment. In this way you will know what the current adjustment should be (in case it is inadvertently changed). When you make an adjustment you should enter the date, who made the change, the new value and the reason for making the change. In this way, if you find that you are going adrift after changing a number of different calibrations, you can then go back to the setting that you started with. Calibration worksheets and records are at the end of this section.

Calibrating your instrument system conjures up visions of fine tuning the six dual throat carburetors of your 12 cylinder Ferrari. Our goal in providing this guide is to take the mystery and magic out of calibrating your instruments, by giving you a straightforward, step-by-step system of approach to the procedure of calibration.

You do not need a witch doctor or white-gloved technician to get the instruments straight. Time, attention to detail, and a methodical approach are the only requirements. Time and again we are called to help with this process and when we finish, the owner says "I could have done that myself". This is absolutely correct. There is no inherent difficulty in the calibration process.

Weather Conditions

Picking the right weather and wind conditions will make the calibration process much easier. Ideal conditions are a steady 10 knots of wind, flat water and no current. Calibrating is harder to do as conditions deviate from ideal and should not be attempted in unsteady conditions or in very light air.

Beware of wind shear (a difference in Wind Direction between the bottom and the top of the mast) and wind gradient (a difference in wind speed with distance off the water)! These phenomena are more common then most people realize. They seem to be associated with the arrival

of new breeze, or where the water is colder than the air such as occurs in the spring. They can lead you astray, because the boatspeed will be unequal between tacks, the wind and heel angles will be asymmetrical, and in general, calibration will be made impossible.

There are three sensors which provide the information necessary to compute the Wind Direction solution: the boatspeed paddlewheel, the masthead unit, and the electronic compass. The quality of the installation is vital to ensure that the information the instrument system is receiving is accurate, and that your efforts in calibrating the Wind Direction solution are fruitful. Inaccuracies caused by improper sensor installation cause errors that are hard to identify. Be especially careful that sensors are securely mounted. Loose sensors introduce random errors that come and go, and cause no end of frustration. The correct foundation must be laid to develop maximum accuracy in the Wind Direction solution.

Wind Direction: The Primary Goal

The primary objective of devoting the time to calibrate your instrument system is to develop an accurate Wind Direction solution. The ability to recognize small shifts in Wind Direction on all points of sail is a terrifically powerful enhancement to your tactics and strategy on the race course. This capability is produced by the integration of the information in your Ockam instrument system: boatspeed, apparent wind speed, apparent wind angle, and heading. Because the Wind Direction solution is dependent on the accuracy of these inputs, it follows that if the Wind Direction solution is accurate, the individual inputs (boatspeed, apparent wind speed, apparent wind angle, and heading) will necessarily be accurate.

How do you know if your Wind Direction solution is accurate? The most straightforward way to check the accuracy of the solution is to sail upwind and downwind, tacking (and jibing) from port to starboard tack, looking for a shift in the Wind Direction each time you tack or jibe. In a well calibrated instrument system the Wind Direction will not change through a series of tacks or jibes.

Compensating the Electronic Compass

It is absolutely critical that your electronic compass be compensated. Every degree of error in heading translates into a degree of error in wind direction. Most modern compasses have compensation procedures. Follow them carefully. If you are lucky enough to get your hands on a real compass adjuster, you should use his services. He can compensate the binnacle which does not have an autocompensation procedure, and he can also check the electronic compass with a gyro or sun compass to be sure the compensation is accurate.

Compasses should have a switch to disable autocompensation. There seems to be a law of nature that everywhere a boat circles waiting for a bridge to open, there is a buried steam locomotive below. If autocompensation is on, waiting for the bridge will also destroy your compass compensation.

1. Initial Setup: Heel & CAL Leeway

If this is your initial calibration, you should set up with the following values. Use the screws! You should find out where they are and how to do this anyway. Do not do this if you are doing subsequent runs – this is only for initial settings.

Calibration	Value	Calibration	Value
Cal Boatspeed Master	**1.06**	Cal Windangle Offset	**0.0**
Cal Boatspeed Offset	**0.000**	Cal Windspeed Apparent	**1.09**
Cal Leeway	**8.0**	Cal Upwash	**-3.0**
QuikCal	**0.0**	Cal Upwash Slope	**0.300**

- Visually check the wind vane vs. Windangle Apparent.

- Compare Heading with the binnacle.

- Zero the heel & trim at the dock.

2. Setting CAL Boatspeed Offset & CAL Wind angle Offset

For all the sailing calibration time, you should look for a developed breeze of around 12-14 knots, generally later in the day. Choosing these types of conditions help to reduce the possibility of wind shear (changes in wind speed with altitude) and wind gradient (changes in Wind Direction with altitude) which are often present early in the day, when the breeze is light or the sea breeze is developing. Cold water and warm air (especially in the spring) can also cause wind shear and gradient.

For the calibration of the two above functions, you will want to sail upwind to gather sufficient data to calculate the necessary changes in the calibrations. This normally will require between 30 and 45 minutes of concentrated upwind sailing. The purpose of these two calibrations is to develop symmetry in boatspeed and apparent wind angle readings from one tack to the other. Thus, even with a boatspeed paddlewheel that is off centerline, and a masthead unit which is slightly angled to one side, you will be able to achieve the same boatspeed and apparent wind angle readings on each tack.

1) Sail the boat close hauled with careful attention to the details of trim on one tack. You will want to duplicate the same trim settings on the other tack. You should sail by the telltales or the angle of heel or a method in which you can easily and consistently keep the boat "in the groove". The idea here is to maintain symmetry in the way you are sailing the boat, and to keep the boatspeed and apparent wind angle as stable as possible.
2) Record the boatspeed and apparent wind angle on each tack as often as you can while the boat is in good stable trim. Allow the boatspeed to accelerate and then level off after coming out of a tack. It is important to collect meaningful data from each tack.

CAL Boatspeed Offset Worksheet		Example
Average boatspeed on starboard tack:	a_____	6.40
Average boatspeed on port tack:	b_____	6.80
Average boatspeed:	(a+b)/2 =c_____	6.60
Half difference boatspeed:	(a-b)/2 =d_____	-0.20
Present **Cal Boatspeed Offset** reading:	e_____	0.010
Set new **Cal Boatspeed Offset** reading: (If Stbd tack faster, Cal should increase; If Port tack faster, Cal should decrease) (d/c)+e =f_____		-0.020

CAL Wind Angle Offset Worksheet		Example
Average apparent wind angle on stbd tack	a_____	30
Average apparent wind angle on port tack NOTE: readings on port tack are negative. b–_____		-22
Half difference apparent wind angle	(a+b)/2=c_____	4
Present **Cal Wind angle Offset** reading	d_____	1.5
Set new **Cal Wind angle Offset**: (If Stbd tack wider, Cal should decrease; If Port tack wider, Cal should increase) d-c =e_____		-2.5

3. Setting CAL Boatspeed Master

Boatspeed transducers measure water flow close to the hull, but have to be adjusted to read the boatspeed thru the water. The reason that flow near the hull does not equal boatspeed, is that the hull distorts the flow near itself. Calibrations for boatspeed are therefore required to compensate for hull shape and the position of the transducer.

Boatspeed can be calibrated in many ways: timed runs over a measured distance, comparison with a good standard (i.e. another boat known to be well calibrated, or a towing calibrator), dead-reckoning, or a combination of these. You should use the best standards available and should continue to further improve the calibration as you gain more experience.

If you use calibration by time between marks, make timed runs over an ACCURATELY MEA-SURED distance of at least 1/2 mile, going over the course in both directions to negate current effects. Remember to keep as straight a course as possible, because sinuous courses always make the actual distance traveled longer than measured. Also, if you are powering or being towed over the course, prop wash will make the indicated boatspeed higher than actual. Both of these effects tend to make your calculated boatspeed lower than it actually is. Take the log readings over the course in each direction, trying to interpolate to 1/1000 mile.

Repeat the procedure several times until the applied corrections are less then 2%, which is about as good as running a measured course can do.

CAL Boatspeed Master Worksheet				Example
Find a known course at least 1 mile long. Course distance = a_____				1.05
Run measured mile at slack tide and no wind.	Out run	Back run	Out	Back
Make sure the boatspeed is steady before you begin.				
Record the measured distance from the Trip Log.				
Run #1	_____	_____	0.99	1.03
Run #2	_____	_____	0.97	1.01
Run #3	_____	_____	1.01	1.05
Average of the runs	b_____	c_____	0.99	1.03
Average distance on all runs	(b+c)/2 =d_____			1.01
Boatspeed correction	a/d=e_____			1.04
Present **Cal Boatspeed Master** reading	f_____			1.01
Set new **Cal Boatspeed Master** reading	e•f=g_____			1.05

4. Setting CAL Windspeed & CAL Upwash

Thus far you have set the majority of the calibrations in the system, which provide the "coarse" tuning of the system. The last two, **Cal Windspeed** and **Cal Upwash**, are very powerful calibrations which have substantial effect on the Wind Direction solution. This makes these two calibrations very effective in fine tuning the Wind Direction solution and allows further tweaking for different wind strengths.

- **Check that QuikCal is set to zero!**
- Get warmed up by sailing upwind and rechecking your work on the boatspeed and apparent wind angle offsets. Besides confirming your previous efforts, this exercise will hone your senses for the real excitement.
- Then tack or jibe back and forth at the appropriate apparent wind angle. The important idea here is to steady the course of the boat down once you are close to the required apparent wind angle. The wind angle is not as important as good data achieved by a steady compass heading.
- On you feel that the Wind Direction has settled in, record the data. Then tack or jibe over to the other board, and reestablish a steady course.
- With plenty of Wind Direction data, at least 6 to 8 sets, you can calculate the change in the calibration.
- Finally, sail back upwind using the same care to develop symmetry in sail settings and steering technique. Concentrate on "groove" sailing, not "scalloping", to enhance your data collection.

CAL Windspeed

Downwind, AW speed cal rules

1.When apparent wind-speed calibration is too low:

AW speed

Calc. true wind

Correct true wind

Calc. true wind

AW speed

Port Gybe

Stbd Gybe

Boatspeed

Calc. true wind (port)

Calc. true wind (stbd)

Boatspeed

2.When you jibe to starboard...

3 The calculated true wind lifts (if too high, it heads)
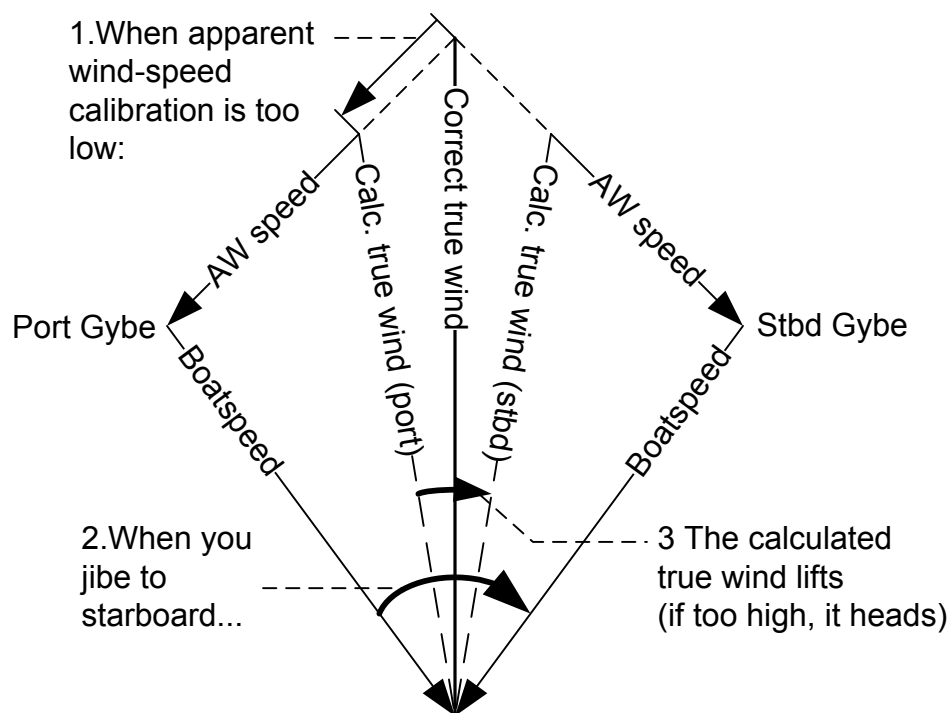
If <u>Headed</u> <u>Down</u>wind, Cal AW Speed <u>Down</u>!

This calibration equates boatspeed to wind speed, so it's done before upwash. Cal Windspeed has the greatest effect on Wind Direction when the **Apparent Wind Angle is 90°**, which means that you should take data while jibing back and forth to a beam reach as shown above.

CAL Windspeed Worksheet				Example
Sail downwind at apparent wind angles of about 90°.	Stbd Jibe	Port Jibe	Stbd	Port
Record **WIND DIRECTION** on both jibes.				
Run #1	_____	_____	<u>230</u>	<u>220</u>
Run #2	_____	_____	<u>231</u>	<u>221</u>
Run #3	_____	_____	<u>230</u>	<u>220</u>
Run #4	_____	_____	<u>232</u>	<u>222</u>
Run #5	_____	_____	<u>231</u>	<u>221</u>
Average **WIND DIRECTION** on each jibe	a_____	b_____	231	221
WIND DIRECTION Difference	a-b=c_____			10
Figure change to Cal Windspeed				
If Direction **HEADS** you when you jibe, **DECREASE** Cal Windspeed				
If Direction **LIFTS** you when you jibe(example), **INCREASE** Cal Windspeed				
Change Cal approximately 1.25% per degree of change in Wind Direction.				
(0.0125•c)+1=d_____				1.125
Present **Cal Windspeed**	e_____			1.02
Set new **Cal Windspeed**	d•e=f_____			1.15

CAL Upwash

Upwind, AW angle rules

1.When apparent wind angle is too wide:

Calc. true wind (port)

Correct true wind

Calc. true wind (stbd)

3 The true wind lifts (and vice versa)

2.When you tack to port...

Boatspeed

Boatspeed

Port Tack

Stbd Tack
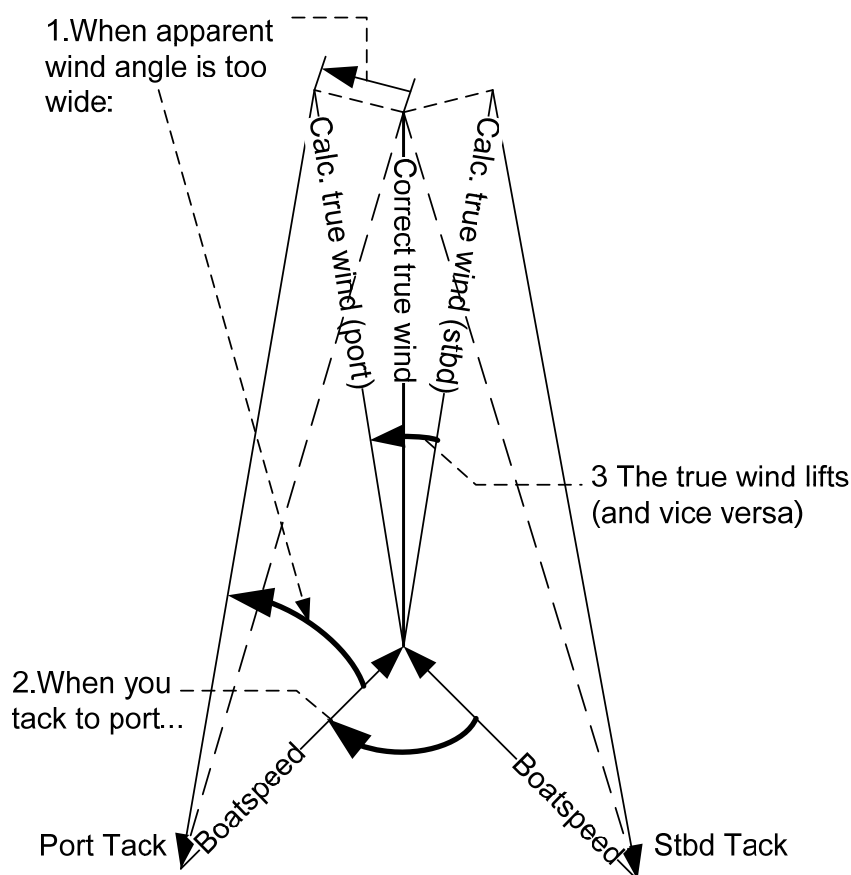
If <u>Headed</u> <u>Up</u>wind, Cal <u>Upwash</u> <u>Up</u>

Cal Upwash has its greatest effect on Wind Direction when the apparent wind angle is approximately **30°**, which means that you should take data while tacking back and forth upwind.

CAL Upwash Worksheet				Example
Sail upwind and record **WIND DIRECTION** on both tacks.	Stbd tack	Port tack	Stbd	Port
Run #1	_____	_____	230	220
Run #2	_____	_____	231	221
Run #3	_____	_____	230	220
Run #4	_____	_____	232	222
Run #5	_____	_____	231	221
Average **WIND DIRECTION** on each tack	a_____	b_____	231	221
WIND DIRECTION Difference		a-b=c_____		10
Figure change to Cal Upwash				
If Direction **HEADS** you when you tack, **INCREASE** Cal Upwash				
If Direction **LIFTS** you when you tack (example), **DECREASE** Cal Upwash				
Change Cal approximately 0.3° per degree of change in Wind Direction				
Note sign of (d) is opposite to (c)		-0.3•c=d_____		-3.0
Present **Cal Upwash**		e_____		+0.5
Set new **Cal Upwash**		d+e=f_____		-2.5

5. Calibration qualification

What degree of accuracy should you expect? The degree of accuracy obtainable is a function of time: the more time spent working on the calibration procedure, the closer to a perfect solution you will come. However, the bulk of the calibration accuracy is gained in your first sessions tuning your instruments be able to achieve a 5° to 7° solution, that is a 5° to 7° shift in Wind Direction when you tack or jibe, during your first calibration session. With only a reasonable amount more effort spent calibrating, you should be able to fine tune your Wind Direction solution to around 3°. Each additional degree of accuracy from this point on requires some dedicated efforts in sailing and data recording to accomplish additional gains.

Once you have reached a 3° solution, you should spend your time confirming your Wind Direction solution for different wind velocities. Use the same approach as above for heavier and lighter conditions, and this will further fine tune the Wind Direction solution. Once you are confident of a 3° solution throughout a wide range of wind velocities, you will be well on your way to a perfect solution. Collect your data every time you race or tune, as this will help increase the data base to further finesse your calibration accuracy.

Fine Tuning

Anemometers are not generally subject to the same variation in calibration as boatspeed transducers, because they are above most of the distortion caused by the sails.

You can use your calibrated boatspeed to check the windspeed, but not to a high degree of accuracy. This is done by recording an average windspeed with the boat at rest, and then motoring directly into the wind. The windspeed should increase by your boatspeed. If Windspeed goes up by more than your boatspeed, then the CAL WINDSPEED is too high, and vice versa. You should not do this type of calibration in winds over a few knots because your resolution is poor, several tenths of windspeed against boatspeed of 5 to 8 knots. Wind speed can be better calibrated using Wind Direction.

Leeway is hard to set rationally, because it is almost impossible to measure. The usual way is to dial in a calibration that gives a "comfortable" leeway under normal conditions, ie between 2° and 4° in strong upwind conditions. You can figure out what the leeway factor is from

$$\text{LEEWAY FACTOR} = \frac{\text{LEEWAY*BOATSPEED}^2}{\text{HEEL}}$$

where BOATSPEED, LEEWAY and HEEL are for "standard" upwind conditions. You may also use Back Range & Bearing to calculate leeway by sailing out and back to a floating marker with a sea anchor on it. Sail by the mark on a beam reach, and reset the Back Range & Bearing. Continue out for a mile or so, and then reach back to the mark. As you pass it, note the Back Range & Bearing which is the residual error. Three things can contribute to a non-zero residual: compass error, boatspeed asymmetry, and leeway. Assuming no compass error (a dangerous assumption), residuals which say that you are short or long, are due to boatspeed asymmetry. Residuals which position you at right angles are due to leeway. If the leeway calibration is too small, the Dead Reckoning puts you to weather of the mark, and vice versa.

This works because the boat points slightly toward the wind relative to its course through the water. If the CPU makes the proper amount of correction for this, your Dead Reckoning ends up where you are. Otherwise, the Dead Reckoning moves to windward (or leeward) on both the outbound and inbound legs, giving an error which accumulates in the same direction for both legs.

For systems with a compass interface, there is a way to check the accuracy of the wind, heading and boatspeed calibrations. Wind Direction and true wind speed should not correlate with the boat's maneuvers. If variations in Wind Direction consistently follow the boat, it indicates that the true wind solution is incorrect. The calibrations can be adjusted to minimize the variation in Wind Direction.

In these discussions we speak of Wind Direction as moving with or against the boat during maneuvers. "Moving with" means that the Wind Direction veers when the boat turns clockwise (Heading and Wind Direction both go to higher or lower readings). It also means that the wind appears to take a header when you tack. "Moving against" means that the Wind Direction backs when the boat turns clockwise (Heading and Wind Direction go in opposite directions). The wind appears to lift on tacking.

It is helpful to know what effect each calibration has on Wind Direction and speed. Wind Direction is composed of true wind angle and heading. True wind angle is in turn composed of boatspeed, apparent wind angle and speed, and leeway. Each of these inputs have one or more calibrations, adjustment of which will affect the solution to the true wind. Here are some rules which may help in deciding what to adjust.
- Do your fine tuning AFTER your coarse tuning.
- Put in some leeway (even a guess) before doing fine tuning.
- Every calibration changes the solution. Adjust the one calibration you think is least "good" first, then review things.
- Pick the calibration that has the most effect for the type of error you have.
- Fine tuning means FINE. Do not adjust anything too much.
- The closer you are to perfect, the less you should mess with things.

Boatspeed Master & Offset Calibration

The solution to the wind triangle is made from two magnitudes (boatspeed and apparent wind speed) and an angle (apparent wind angle) with garnishes of heel, leeway and upwash. The correct solution (in terms of wiggles) only requires that the ratio of boatspeed to apparent wind speed be correct. Both could be wrong in absolute terms, but by the same percentage. Given that we could tweak either boatspeed or wind speed to get a wiggle-free solution, it is better to do wind speed, because boatspeed has an absolute relationship to the navigation triangle (see the next section). In fact, the ability to get absolute boatspeed from conventional or GPS-based calibration is what establishes wind speed in absolute terms via the calibration procedure described in this section. Also, although boatspeed offset affects the wind triangle, people are very sensitive to imbalance in boatspeed from tack to tack, so this calibration is better done in the conventional way. Thus the effect of boatspeed calibrations are left out of this discussion, except for rules of thumb.

Heading Calibration (Compass Compensation)

Since Wind Direction is based directly on heading, the effect of any error in the compass reading is directly translated into that output. Analysis of a compass installation, swinging and compensation (to exact reading if possible) should be done by a qualified compass adjuster if good Wind Direction is to be expected.

Compass location also affects the quality of the output. Besides the unheeled effects of engine and wiring compensated for by the adjuster when he swings the compass, errors are often introduced when the boat is heeled, particularly if the compass is mounted asymmetrically (like outboard of the engine). Compasses almost never get swung heeled, so heeling errors do not get recognized.

Apparent Wind Angle Offset

This calibration moves the apparent wind angle to the right or left (an unsymmetrical adjustment) and therefore moves Wind Direction to the right or left. In upwind conditions, there is a large corresponding offset on Wind Direction , and downwind there is a lesser offset. Since the offset is left or right, and not in and out (like wind speed, leeway and upwash produce), there is little visible wiggle effect on Wind Direction for either tacking or jibing. The number is merely offset right or left by a greater or lesser amount.

Wind Direction wiggle caused by wind angle offset is evident only when going from upwind to downwind rather than from tack to tack, because of the decrease in the effect of apparent wind angle under the latter conditions. Apparent wind angle offset creates true wind speed wiggle fairly strongly in reach-to-reach maneuvers, and moderately in tacking.

Apparent Wind Speed

Increasing this calibration causes Wind Direction to move with the boat and also causes the up-wind true wind speed to be higher than the downwind. Decreasing the calibration causes the opposite effects. Since real wind speed varies a lot, comparing upwind against downwind speeds tends to be imprecise, but over a long period, you may gradually gain the feeling that wind speed always drops [or increases] when turning downwind, which can be used as corroborative evidence of the need to change calibrations.

Upwash

Upwash calibration symmetrically increases or decreases apparent wind angle upwind but not downwind. Increasing the magnitude of apparent wind angle (positive upwash calibration) causes the Wind Direction to move against the boat upwind, and has no effect downwind. It has no significant effect on true wind speed. In terms of calibration (as opposed to aerodynamic theory), upwash should be used to trim out residual errors which remain after other calibrations are set as well as they can be.

$$\text{UPWASH} = (\text{CAL.UPWASH}) \cdot \text{REEF}^2 \cdot \text{FLAT} \cdot \text{SIN}^{2.5}(.6 \cdot (180 - Ba))$$

Where
    Ba is the measured apparent wind angle
    REEF is the reefing parameter (0..1)
    FLAT is the flattening parameter (0..1)
    (REEF and FLAT are set by HPIL/RS232 interfaces)

Leeway

Leeway tends to be a navigation department function, set by the DR tuning. However, it does have an effect on the wind triangle. Leeway symmetrically increases true wind angle upwind but not downwind (like upwash). Therefore, increasing the leeway calibration causes the Wind Direction to move against the boat in tacking, has no effect jibing, and has a lesser effect when going from upwind to downwind. It has no effect on true wind speed wiggle.

$$\text{LEEWAY} = \frac{(\text{CAL LEEWAY}) \cdot \text{HEEL}}{\text{BOATSPEED}^2}$$

Qualitative Rules of Thumb

All the above boils down to the following rules of thumb. These rules give the direction to turn the screws, but not how much. In general, the less you turn them, the better. Also, you should concentrate on WINDSPEED, WIND ANGLE OFFSET and UPWASH for tuning the wind triangle. Al-

though BOATSPEED and LEEWAY have effects, they need to be used to tune the navigation triangle. However, in order to aid in determining their effect on the wind solution, in case DR tuning is also needed, the effects are shown in brackets.

If Wind Direction moves WITH you when tacking or reaching;
    Increase UPWASH about 0.3° per degree of wiggle, or
    Decrease WINDSPEED about 1.5% per degree of wiggle
    [Increase boatspeed about 2% per degree of wiggle]
    [Increase leeway about 1° per degree of wiggle]

If Wind Direction moves WITH you from port beat to port run;
    Decrease WIND ANGLE OFFSET about 1° per degree of wiggle, or
    Decrease UPWASH about 0.67° per degree of wiggle
    [Increase LEEWAY about 2° per degree of wiggle]

If true wind speed is higher downwind;
    Increase WINDSPEED about 8% per knot of wiggle

Quantitative Effects

Listed below are the perturbations (i.e. wiggle effect) each calibration has on Wind Direction and speed for tacking, reaching and beat-to-run for a boat that does 6.8 knots upwind. The effects are calculated by describing the effect of a small change of each calibration in a POSITIVE direction from a perfect state, and then performing the described maneuver. These conditions therefore describe the effect of calibrations that are too HIGH. Positive Wind Direction changes imply WITH type wiggle.

Maneuver; Tacking Starboard to Port
    True wind angle +40 to -40, Boatspeed 6.8 at 20° heel
    True wind speed 12 kts

CAL	CHANGE	WIND DIRECTION	TRUE WIND SPEED
Ba OFFSET	+1 °	+0.02°	+0.20 Knots
Va CAL	+1 %	+0.44°	no change
UPWASH	+1 °	-2.88°	no change
Vs MASTER	+1 %	-0.42°	no change
Vs OFFSET	+1 %	no change	-0.10 Knots
LEEWAY	(see note)	-0.86°	no change

Maneuver: Reach Starboard to Port
    True wind angle +90 to -90, Boatspeed 8.6 at 15° heel
    True wind speed 12 kts

CAL	CHANGE	WIND DIRECTION	TRUE WIND SPEED
Ba OFFSET	+1 °	+0.01°	-0.31 Knots
Va CAL	+1 %	+0.81°	no change
UPWASH	+1 °	-1.75°	no change
Vs MASTER	+1.01	-0.82°	no change
Vs OFFSET	+0.010	no change	no change
LEEWAY	(see note)	no change	no change

Maneuver: Port Beat to Port Run
    True wind angle -40 to -165, Boatspeed 6.8 at 20° heel to 7.2 at 0° heel.
    True wind speed 12 kts

CAL	CHANGE	WIND DIRECTION	TRUE WIND SPEED
Ba OFFSET	+1 °	+1.03°	+0.07 Knots
Va CAL	+1 %	-0.13°	-0.12 Knots
UPWASH	+1 °	+1.41°	-0.10 Knots
Vs MASTER	+1 %	+0.12°	+0.12 Knots
Vs OFFSET	+1 %	+0.12°	+0.12 Knots
LEEWAY	(see note)	-0.43°	-0.08 Knots

Cal change for LEEWAY is such that Leeway increases 1° in the upwind case. For our hypothetical boat, CAL LEEWAY goes from 7.5 (3.2° upwind) to 9.8 (4.2° upwind).

Calibration Worksheets

CAL Boatspeed Offset Worksheet		Example
Average boatspeed on starboard tack:	a_____	6.40
Average boatspeed on port tack:	b_____	6.80
Average boatspeed:	(a+b)/2 =c_____	6.60
Half difference boatspeed:	(a-b)/2 =d_____	-0.20
Present **Cal Boatspeed Offset** reading:	e_____	0.010
Set new **Cal Boatspeed Offset** reading: (If Stbd tack faster, Cal should increase; If Port tack faster, Cal should decrease)	(d/c)+e =f_____	-0.020

CAL Wind Angle Offset Worksheet		Example
Average apparent wind angle on stbd tack	a_____	30
Average apparent wind angle on port tack NOTE: readings on port tack are negative.	b–_____	-22
Half difference apparent wind angle	(a+b)/2=c_____	4
Present **Cal Wind angle Offset** reading	d_____	1.5
Set new **Cal Wind angle Offset**: (If Stbd tack wider, Cal should decrease; If Port tack wider, Cal should increase)	d-c =e_____	-2.5

CAL Boatspeed Master Worksheet				Example	
Find a known course at least 1 mile long.	Course distance = a_____			1.05	
Run measured mile at slack tide and no wind.	Out run	Back run		Out	Back
Make sure the boatspeed is steady before you begin. Record the measured distance from the Trip Log.					
Run #1	_____	_____		0.99	1.03
Run #2	_____	_____		0.97	1.01
Run #3	_____	_____		1.01	1.05
Average of the runs	b_____	c_____		0.99	1.03
Average distance on all runs	(b+c)/2 =d_____			1.01	
Boatspeed correction	a/d=e_____			1.04	
Present **Cal Boatspeed Master** reading	f_____			1.01	
Set new **Cal Boatspeed Master** reading	e•f=g_____			1.05	

CAL Windspeed Worksheet				Example	
Sail downwind at apparent wind angles of about 90°.	Stbd Jibe	Port Jibe		Stbd	Port
Record **WIND DIRECTION** on both jibes.					
Run #1	_____	_____		230	220
Run #2	_____	_____		231	221
Run #3	_____	_____		230	220
Run #4	_____	_____		232	222
Run #5	_____	_____		231	221
Average **WIND DIRECTION** on each jibe	a_____	b_____		231	221
WIND DIRECTION Difference	a-b=c_____			10	
Figure change to Cal Windspeed If Direction **HEADS** you when you jibe, **DECREASE** Cal Windspeed If Direction **LIFTS** you when you jibe(example), **INCREASE** Cal Windspeed Change Cal approximately 1.25% per degree of change in Wind Direction.	(0.0125•c)+1=d_____			1.125	
Present **Cal Windspeed**	e_____			1.02	
Set new **Cal Windspeed**	d•e=f_____			1.15	

CAL Upwash Worksheet   Example

Sail upwind and record **WIND DIRECTION** on both tacks.	Stbd tack	Port tack	Stbd	Port
Run #1	_____	_____	230	220
Run #2	_____	_____	231	221
Run #3	_____	_____	230	220
Run #4	_____	_____	232	222
Run #5	_____	_____	231	221
Average **WIND DIRECTION** on each tack	a_____	b_____	231	221
WIND DIRECTION Difference		a-b=c_____		10

Figure change to Cal Upwash
  If Direction **HEADS** you when you tack, **INCREASE** Cal Upwash
  If Direction **LIFTS** you when you tack (example), **DECREASE** Cal Upwash
  Change Cal approximately 0.3° per degree of change in Wind Direction
  Note sign of (d) is opposite to (c)
		-0.3•c=d_____		-3.0

Present **Cal Upwash**		e_____		+0.5
Set new **Cal Upwash**		d+e=f_____		-2.5

Section 4 - Technical Information

This section contains information on some of the technical aspects of the OCKAM system including all the syntax of the command language.

Reading Data

The RS232 interface has access to all data available to the displays. Each display item is identified by a <tag>, a unique ASCII character associated with a particular display. The display cards magnetically encode this character to tell the display which data item to show.

Certain data items alternate between two quantities, like BACK range & bearing. Both range and bearing are sent out under the same tag (r). The system identifies one of the items by following the <tag> with an apostrophe; i.e. r'17.4. Displays ignore this character and therefore display the data alternately. Computer programs must check for this character to distinguish between the two data items.

See the [Full List of Tags](#) for details.

Accessing The Polars

P=<anlgle>,<speed>,<polar>

To access the polar curve module, you need to tell it what conditions you want a boatspeed for (the true wind speed and angle). You tell the system the conditions you want a polar speed for by issuing one of the following commands;
a. "P=<true wind angle>,<true wind speed>,<polar-number>"
b. "P=<true wind angle>,<true wind speed>"
c. "P=<true wind angle>"

After you set the conditions, the system will send the boatspeed result on User 0 (tag "0"). You must request this tag within 1/2 second of the output of the "P=" command, or you will miss it. The system takes the conditions specified in the P= command, looks up the polar speed for those conditions, and outputs the result to USER 0. If you specify a full set of conditions as in (a), you can select different versions of your polars if your module is equipped with them. If you specify angle and speed as in (b), you get the polar for the currently selected polar (the last (a) type request sent, or if none has been sent, then the polar selected by the interface polar switch). If you use form (c), the current value of true wind speed (tag a) is used, along with your specified angle.

Sending Control Information

Control codes

Control code commands are issued by controllers or by sending the appropriate control character to the system from the RS232 interface.

Ctrl-B	Reset Back Range/Bearing	Ctrl-L	Reset trip log.
Ctrl-E	Bt narrower (-) 0.5 degree (UnHead).	Ctrl-F	Bt wider (+) 0.5 degree (UnLift).
Ctrl-R	Reset stopwatch.	Ctrl-T	Start or stop stopwatch.

Adjusting Averages

"A<var>=<seconds>"

This function allows you to increase or decrease the damping constant the system uses on many of the displays. The damping only affects the displays, and not the calculations. The argument <seconds> is the number of seconds it takes for the display <var> to go from an old value, 64% of the way to a new value. For example, if you set the boatspeed average to 10 seconds, and suddenly start traveling at 10 knots from rest, the boatspeed indicator would take 10 seconds to go from 0.00 knots to 6.40 knots. The table below gives the variables associated with each value of <var>, and the associated default value of <seconds>; the values the system uses unless you change them. Once you change a value, it will remain changed as long as the battery backup keeps the variable memory alive. For example, to change Boatspeed averaging to 6 seconds, send "A0=6".

var	DISPLAY	DEFAULT	var	DISPLAY	DEFAULT
0	Boatspeed	6	16	Port LL Course Avg	5
1	Windspeed Apparent	6	17	Layline Vs Avg	25
2	Wind Angle Apparent	4	18	Upwind Bt Avg	15
3	Heel	10	19	Downwind Bt Avg	15
4	Windspeed True	8	20	Stbd LL Avg	5
5	Wind Angle True	8	21	Port LL Avg	5
6	VMG	10	22	Opposite Tack	10
7	Shift basis average	600	23	Heading	1
8	Puff basis average	600	24	VMC	10
9	Time to Laylines wind direction	25	25	Barometric pressure	25
10	Polar/Target true wind speed	5	26	Windspeed Axial (3D sonic)	2
11	Polar/Target true wind angle	5	27	Trim	10
12	Polar Boatspeed	5	28	Seastate	0
13	Target Boatspeed	5	29	Pitch rate	1
14	Wind Direction	8	30	Current Speed	0
15	Stbd LL Course Avg	5	31	Target Angle	0

On Tryad systems, all averages are enumerated on the System Status output.

On the T1, A<n>=0 sets averaging to none. Sending A<n>=-<seconds> (negative) switches the averaging function to butterworth filter with 3db point at <seconds>. Butterworth filters have a faster rolloff than conventional averaging (i.e. you get faster response and less delay, but there may be overshoot).

On the 001, the value of A can not be less than 1, and is an integer (i.e. A1=1.5 is A1=1).

Manual Current

"C=<drift>,<set>" or "C=<drift>"

To set a manual current vector for use with the dead reckoning functions WAYPOINT Range & Bearing and BACK Range & Bearing, send one of the commands "C=<drift>,<set>" or "C=<drift>" where <drift> is the current velocity in KNOTS, and <set> is the current direction (magnetic direction the current is SETTING you towards). If you use the second type, the old value of <set> will be used.

If you have a GPS attached to the system, entering a manual current overrides automatic calculation of current by the system. This capability allows you to override the current if your calibrations are not good enough for current calculation.

Disabling Unwanted Output

D<tag>=0 or 1

Controls output of functions. D<tag>=1 disables <tag> while D<tag>=0 enables it. Tag can be entered literally (e.g. DB=1 for boatspeed) or numerically (e.g. D\65=1 for apparent wind speed). If any tags other than Synopsis (tag ':') are disabled, Error 17 will be displayed as a reminder. To enable all tags, enter D\0=0.

On Tryad systems, disabled tags are enumerated on the System Status output DT:.

E<tag>=<mask> (T1 only)

Tag can be either a character or an escape sequence, \xxx. The escape sequence allows specification of non-printable characters. Using \0 specifies ALL TAGS, i.e. E\0=0 turns off everything.

    Mask and 1 enables output on the Ockam Bus.

    Mask and 2 enables output on the Serial port.

Changing Calibrations

"Kn=<cal>"

The K command allows you to temporarily change the calibrations that normally have to be set with a screwdriver on the interfaces. The purpose of this command is to allow you to try out a change in calibration without having to actually physically go do it. Since it would be bad to rely on the CPU memory to forever remember a calibration,

<u>Do not rely on K calibrations for other than temporary changes. Set the calibrations with the screw adjustments for greater reliability.</u>

To change a calibration, send "K<n>=<cal>" where <n> defines which calibration you want to change (see table), and <cal> is the new calibration. When you change a calibration with the K command, the display for that calibration will show the exclamation point to remind you that it is a temporary value. You can also return the calibration to the interface value by sending "K<n>=D".

Command	Range	Adjusts
K1=	0.5 to 1.5	Cal Boatspeed Master
K2=	-0.05 to +0.05	Cal Boatspeed Offset
K3=	0 to 16	Cal Leeway
K4=	-16 to 16	CAL Windangle Offset
K5=	0.5 to 1.5	CAL Windspeed
K6=	-16 to 16	Cal Upwash
K7=	-50 to 50	Magnetic Variation
K8=	0.5 to 1.5	Calibrates Polar & Target Boatspeed out of the polar.
K9=	0 to 0.35	Cal Upwash Slope
K10=	0 to 1.0	**(T1 only)** Windspeed Apparent Offset. This calibration sets an offset different than the default. This number represents the amount of wind needed to start the cups moving. It is added to the speed reported by the windspeed sensor. It can only be entered by the K10=n command; no calibration screw exists for this.

K11=	-10 to 10	Upwind QuikCal (Angle)	**(T1 only)** See QuikCal
K12=	-10 to 10	Downwind QuikCal (Angle)	
K13=	±Knots	Upwind QuikCal (Speed)	
K14=	±Knots	Downwind QuikCal (Speed)	
K15=	±Feet	**(T1 only)** Sets the transducer depth for depth coming in via the T1 NMEA channel.	
K16=	±Feet	**(T1 only)** Sets the keel depth for depth coming in via the T1 NMEA channel.	

Not all calibrations have a dedicated tag (e.g. CAL Boatspeed Master on tag "I"). However, on Tryad systems, all cals are enumerated on the System Status output.

QuikCal® correction

This is a calibration that adds or subtracts from the *magnitude* of the true wind angle. If the true wind angle is too narrow (too small in magnigude), wind direction will head when you tack. If it's too wide (too large in magnitude), you will be lifted when you tack. QuikCal adds or subtracts an adjustable number of degrees from the magnitude of the true wind angle; for a positive 2.0 QuikCal, 21 degrees becomes 23, and –21 degrees becomes -23.

QuikCal uses the "Controller card" model; the operator presses an "UnLift" or "UnHead" button on a controller card (or Matryx cal page) to change a variable that directly widens or narrows true wind angle. So if you find yourself being headed, press the "UnHead" button and vice versa.

There are separate upwind and downwind corrections, and the relevant one is displayed on tag 'e' and changed by the control codes. Ctrl-E makes the number more negative (UnLift) and Ctrl-F more positive (UnHead), by ½ degree (i.e. 1 degree of Head/Lift) per hit. The correction value can also be directly set by K11 (upwind) and K12 (downwind).

Master Reset

If the system behaves strangely, it may be necessary to reset the CPU. This process clears out all information in the variable memory (RAM), and resets all parameters to their initial values. The logs, waypoint, options and averaging times are reset to standard values. Both processors can be reset using the RS232 command MASTER RESET (all upper case, terminated by carriage return). Success is indicated when error 12 is displayed after the boot process.

Hardware Reset of the 001:

Turn the light switch on, and the power off. Then turn the power on and the light switch off. If the CPU sees lights turn off in the first second of life, the master reset is performed.

Hardware Reset of the T1:

Turn the T1 off. Then turn on DIP switch #8 on and power up. After boot-up is successful, turn DIP switch #8 back off.

Setting Options

"O<n>=<value>"

The options function provides certain information for the system which can be useful in certain conditions. The argument <n> identifies the option you want to change, and <value> is the new value for that option.

On Tryad systems, options are enumerated on the System Status output.

Set Time Format

O1=0 (HH:MM)   Option 1 sets the TIME display to hours and minutes, minutes and
O1=1 (MM:SS)   seconds or hours, minutes and seconds.
O1=2 (HH:MM:SS)
+4 displays UTC (T1)

Select Polar & Target Format

O2=0 or 1 or 2   Option 2 sets POLAR & TARGET Boatspeed display formats. The default value (0) is knots, i.e. the value stored in the polar module. A value of 1 sets the displays to differential knots, i.e., [Boatspeed minus Polar] and [Boatspeed minus Target]. A value of 2 gives Polar and Target as percentage, ie [100 times Boatspeed divided by Polar speed] and [100 times Boatspeed divided by Target speed].

Select Polar

O3=<polar#>   Option 3 overrides the polar selector switch in the polar module, and forces use of a particular polar number for the functions POLAR and TARGET Boatspeed. The setting of this option does not affect the polar number used for "P=" commands (below). Your module has to have more than one polar installed before you can use this function. The default value for option 3 is 0, and causes the system to use whichever polar is selected by the switch on the polar module. A setting of '1' forces use of polar 1 and so on, regardless of the switch setting. If this option and the selector switch are both '0', then the first physically addressed polar is selected. Note that selecting a polar that is not there can cause some strange results.

                        For the T1, Option 3 selects the polar file (see Polar File Set). The filename is displayed on System Status, "PL".

Adjust True Wind angle

O4=<offset>   Option 4 adjusts the TRUE wind angle offset. The <degrees> value is added to the true wind angle just after it is calculated, and before it is used. The purpose of this function is to compensate for wind shear by twisting the measured true wind into "effective" true wind (i.e. the wind at the center of effort). Option 4 affects True wind angle, Wind Direction, VMG, Time to the Laylines, Distance Lost VMG, Opposite Tack and Polar and Target Boatspeeds.

                        This is now generally deprecated because it masks wind shear.

Adjust Reef & Flat

O5=<REEF>
O6=<FLAT>

Options 5 and 6 control the UPWASH function. The default Upwash correction is $Upwash = \operatorname{Re} ef^2 \bullet Flat \bullet Sin^{2.5}\left[.6 \bullet (180 - Ba)\right]$. Both options default to 1 (i.e. full effect). Reducing Reef or Flat lowers the upwash correction. The reduction is linear with FLAT, and as the square of REEF.

These are now generally deprecated in favor of Upwash slope and AutoCal functions.

Enable Current Calculation

O7=0 or 1

Option 7 controls calculation of CURRENT SET & DRIFT. A setting of 0 inhibits automatic current calculation (and gives Error 75 when the GPS makes an output). A setting of 1 (default) enables automatic current.

Set Mast Height

O8=<mast height>

Option 8 is used for correcting the apparent wind angle and speed for roll rate. The athwartships disturbance is calculated from roll rate and mast height, and removed from the apparent wind. Setting a value of 0 feet eliminates the correction.

Set Light Level

O9=0 to 9

Option 9 controls the lighting level number sent with the lights frame. Matryx and Magnum indicators use this number to control their default lighting level.

Set VMC Option

O10=0 or 1 or 2

Option 10 sets the mode for the VMC output. The default (0) causes VMC to be calculated with a rhumbline the same as the waypoint bearing (from a Position device or the W= command). Setting 1 causes the VMC to be calculated from a rhumbline input under Option 11. Setting 2 causes tag "f" to display COG/SOG based on boatspeed/track and current set & drift.

O10=	VMC rhumbline	Opposite Tack
0	Waypoint bearing	With current
1	Option 11 value	With current
2	Waypoint bearing	Without current
3	Option 11 value	Without current

Set VMC Course

O11=< VMC Rhumb> Sets the rhumbline course to be used for VMC when Option 10 is 1.

Set Units of Measure

O12=0 to 11   Sets the units-of-measure for Temperature, Barometric pressure, Depth and Distance-Lost outputs. This option is a mask (like Configuration). The "1" bit controls the temperature units in degrees Fahrenheit (O12=0) or Centigrade (O12=1). The "2" bit controls the depth/DL units in Feet (O12=0) or Meters (O12=2). The "8" bit controls the barometric pressure units in Inches of Mercury (O12=0) or Millibars (O12=8). You can combine them by addition (see the table). The default is Fahrenheit and Feet. Also note that the Option Switch in the 001 CPU will set the Master Reset value of O12 to 0 or 3 (see below). The settings are in saved RAM, and remain in effect until the next Master Reset.

This value is displayed on System Status, "UM".

O12	Temperature	Depth	Barometer
0	°F	Feet	In. Mercury
1	°C	Feet	In. Mercury
2	°F	Meters	In. Mercury
3	°C	Meters	In. Mercury
8	°F	Feet	Millibars
9	°C	Feet	Millibars
10	°F	Meters	Millibars
11	°C	Meters	Millibars

Set Stopwatch Format

O13=0 or 1   O13=0 sets the stopwatch to mm:ss format; O13=1 sets the stopwatch to sss format (e.g. -10:00 would be displayed as -600).

Set Current Update Limit

O14=<knots>   Sets the limit that current magnitude updates. Default is 0.1 knot per GPS update.

Set Current Update Percentage

O15=<0 to 1>   Sets the percentage of new measured current to be applied (i.e. smoothing). Default is 0.25 (25%); maximum is 0.999, minimum is 0. To increase response, increase the number.

Substitute COG/SOG for Speed/Hdg

O16=0 to 3   Enable GPS COG and SOG as replacements for paddle and compass + leeway. O16=0 sets paddle & compass; O16=1 sets SOG & compass; O16=2 sets paddle & COG; O16=3 sets SOG & COG.

O16=	Boatspeed source	Track source
0	Paddle	Compass+leeway
1	SOG	Compass+leeway
2	Paddle	COG
3	SOG	COG

Set Compass Lubber

O17=<lubber>   Set the compass offset (lubber line). Input is degrees.

Set Compass Deviation Parameters

O18=<dev.amp>   Allows B-type adjustment of compass deviation.
O19=<dev.phase> $Hdg = HdgMeasured + O18 * SIN(HdgMeasured + O19)$

Set Wind Weight

O20=<k>   Changes in wind gradient and density can sometimes prevent boats from making (and sometimes too easily exceed) their target speeds. Option 20 may help correct this by adjusting the true wind speed input to the polar function. The wind value used to access the polar curves is the product of Option 20 and measured true wind speed.

Set Calculation Options (T1 only)

O21=<option>   Sets a bit field which controls calculation:

1	Set prohibits ZDA from setting the CPU clock.
2	Set turns on retro-apparent (see below).
4	Set disables roll rate in true wind calculation
8	Set disables pitch rate in true wind calculation
16	Set disables yaw rate in true wind calculation
32	Set disables Hazen upwash rolloff function. 1.00 is used for all Bt.
64	Set causes Lat/Lon to output in CookPos form.
128	Set disables the frogeye filter.
256	Set disables pitch rate in apparent.
512	Set disables roll rate in apparent.
1024	Debug: Reverse roll correction to true wind
2048	Debug: Reverse pitch correction to true wind
4096	Debug: Reverse yaw correction to true wind

Set AHRS Flags (T1 with AHRS option only)

O22=<AHRS flags>.

1	Set disables heel output.
2	Set disables pitch output.
4	Set disables heading output.
8	Set disables roll rate output.
16	Set disables pitch rate output.
32	Set disables yaw rate output.

Set Update Rate (T1 only)

O23=1 or 2   Sets the T1 processing loop rate.

1	4 Hz. (Standard Ockam Rate)
2	8 Hz.

Set boxcar average (T1 only)

O25=<**N**>   Sets the boxcar length to **N** for boatspeed and apparent wind speed. Default is 7.

Set UTC Offset (T1 only)

O26=<minutes>   Sets the local offset from UTC (in minutes). If time is set to local (see Set Time Format), Option 26 is subtracted from the internal clock, and time is displayed as HH:MM[:SS]. If time is set to UTC, the internal clock is displayed as HH:MM[:SS]z. Eastern time is +300 minutes. This value is also displayed on System Status, "TZ".

Set Command Debug Tag (T1 only)

O27=<**tag-decimal**> When set to non-zero, all commands are echoed on the specified tag. Useful for troubleshooting mysterious command-related issues. Set to 0 on power-up. See System Command Troubleshooting.

ROT correction for Wind Direction (T1 only)

O28=<**factor**>   Rate-of-turn * **factor** is added to the true wind solution to counteract tacking disturbance (experimental).

Control NMEA -> NMEA channel (T1 only)

O29=<**0 or 1**>   Enable (1) or disable (0, default) transferring NMEA input transfer to the high channel.

Querying System Information

Q<**tag**>=n[,m]   Queries for undisplayed items. Output is to <tag>, which is not restricted to the traditional user channels.

N	Returned value (on specified tag)
1	Program revision
2	System flags
3	Average value for Am (see Averages)
4	Option value for Om (see Options)
5	Disabled tags as a string (see Disabling Tags)
6	Current AutoCal(m) value (see AutoCal)

For example: sending Q9=3,4 returns the average for Windspeed True on tag 9. On the Tryad system, these items are output on System Status.

Setting Time

T=**<hour>:<minute>:<second>**

Sending the command 'T=hh:mm:ss' where hh is hours, mm is minutes, and ss is seconds will set the CPU clock. The ':' characters may be anything except spaces. If you do not enter the seconds (T=hh:mm), then seconds will be set to 0. Likewise, entering (T=hh) sets minutes and seconds to 0. The hours argument (hh) is in 24-hour format (0 to 23 hours).

On the T1, the clock runs on UTC time. When you enter a T= command, the Time Format is checked to determine whether or not to correct your entry by the UTC offset.

Setting a Manual Waypoint

W=**<bearing>,<range>**

A waypoint can be entered manually via the RS232 interface, and will enable two of the functions normally available via the GPS interface; WAYPOINT range & bearing, and TIME to the Laylines. CURRENT set & drift is not automatically calculated, but may be manually entered (see the C command above). This function is not as accurate as the GPS version, because it is based solely on the dead-reckoning of the CPU.

To set a waypoint, issue the string 'W=<bearing>,<range>' where <bearing> is the magnetic bearing from your present position to the waypoint, and <range> is the range from present position to the waypoint. For example, sending 'W=225,1.5' sets a waypoint 1.5 miles southwest of your present position.

A second version of this command lets you update the waypoint as you sail toward it. If you issue 'W=<bearing>', the waypoint will be slewed around to the new bearing, using the existing range. This form can be used when going upwind and at the outer edges of the upwind diamond, to make a partial correction for DR errors that may have accumulated.

Remote commands

Remote commands are actually user output commands to tag @. Most displays and interfaces s monitor for this frame, and if programmed appropriately, respond. The original use was to allow remote control of the Magnum display, originally called the 'Jumbo'. The Matryx display also responds to this command set.

Most of the remote commands include an address field to allow multiple devices of the same type to be differentiated. For the Magnum, the address is set by a rotary switch, while the Matryx is set by the setup menu. In the case of the Lynx, the address is changed by remote command.

Theory of operation

Jumbos (actually Matryx, Magnum and the 005B) listen for frames beginning with '@J' followed by an address to designate a particular jumbo, and ending with a specific command to change pages, menus, lighting and display comments.	**Example**: the frame @J1S+<0> tells jumbo #1 to advance to the next page or menu item.
To put such a frame on the bus, wrap it in the user output syntax.	**Example**: U@=J1S+<cr>

Remote Display Commands

U@=**Jn…**

Matryx and Magnum can be controlled by this remote command as well as by hardware buttons. The address range (*n*) is 1 to 15, or '*' to address all Jumbos. The address is set by a rotary switch or setup menu.

Cmd	Description	Example
C*tags*	(Magnum rev. B2B or later) Create a custom menu consisting of *tags* (the magnum does not differentiate prime tags).	U@=J1CBcad
D*text*	Display *text*. Magnum displays on the text line, Matryx displays on a drop-down.	U@=J1DTACK!
I*ticks*	Identify. The display flashes for *ticks* seconds.	U@=J1I1
L*m*	Set local light level to *m* (0 thru 9). Lighting is the product of the local light level and the system light level as set by Option 9.	U@=J4L6
M*m*	(Magnum only) Set to Menu *m*.	U@=J1M3
S*m*	Set to menu item *m* (Magnum) or page (Matryx).	U@=J1S3
S+|-	Next|Previous page/menu item	U@=J2S+
T*tags*	Display *tags* (Magnum can only have 1 tag; Matryx can have 1-4 tags)	U@=J1TB (set J#1 to Boatspeed)

Lynx Remote Controller Commands

"U@=L*n…*"

Lynx is a device for issuing system commands under control of a key fob or hard buttons or both. The primary use of remote commands is to reprogram what each fob button should say. The address range (*n*) is 1 to 16, and there is no '*' address. All Lynx addresses are shipped set to 1, and can be changed with the A command (refer to the Lynx manual).

Cmd	Description	Example
A*m*	Change Lynx *n* address to *m* (1 to 16); must be sent twice in succession. Used to add more Lynx to the same system. After the second command is received, the Lynx address becomes *m*.	U@=L1A2 U@=L1A2 Lynx1 becomes Lynx2
B*mc*Tag	Send button m command c on Tag. Used to read out current settings.	U@=L1B11x Sends Lynx 1, button 1, command 1 to tag 'x'
C*nCmd*	Program button *n* with *Cmd*. Erases all other commands on that button.	U@=L1C1^T Lynx 1 button 1 now starts the stopwatch.
C*n+Cmd*	Append *Cmd* to button *n*. Previous command(s) are not erased. Allows setting multiple commands per button.	U@=L1C1+U@=J1Tt Lynx 1 button 1 now also sets Jumbo 1 to display stopwatch.
D*tag*	For troubleshooting. When a command is triggered, it is additionally sent as a frame on *tag*, so you can see what the Lynx is doing. This diagnostic is disabled on power up.	U@=L1Dx
V*tag*	Send Lynx version on *tag*. This is a handy way to see if the Lynx exists.	U@=L1Vx Tag x displays "Lynx 1.00"
Z*dur*	Quick-flash the LED (and buzzer, if attached) for *dur* ATUs; (an ATU is about 0.01 seconds).	U@=L1Z10 Lynx 1 light flickers for 1 second.

Software Remote Control Commands

"U@=Os…"

Beginning with OckamSoft 4.07, the driver includes an API to allow remote control of software via the Ockam bus. There are 16 'slots' *s*, each with its own API. Racecourse uses slot #1 and Logging uses slot #2. There are 14 other slots available for 3rd party use. The API traps Ockam frames like "@O*s*…" and stores the command for access by OS4-friendly applications. See the driver header file for details.

These software commands have been implemented for OS4 Racecourse and Logging functions, and respond to the following commands.

Logging

Cmd	Description	Example
L0 (off) L1 (on)	Turn logging off or on.	U@=O2L1 Turns on logging.
C*text*	Insert comment *text* into log file. Turns log on.	U@=O2CJack helming Turns on the log and enters 'Jack helming' as a comment.

Racecourse

Cmd	Description	Example
N	Switch to next leg.	U@=O1N
P0 (closest) P1 (origin) P2 (pin)	Ping mark	U@=O1P0

Custom Interface Commands

"U@=Qn…"

Custom interfaces (or 'Q' interfaces as they are sometimes called) provide ad-hoc inputs for the system. There can be up to 16 Q interfaces on the system, each assigned to a unique slot. The slot number is usually assigned by a rotary switch on the interface, but sometimes can be hard-coded (as is the case of the hi-res rudder interfaces). New interfaces written after 8/06 may have the capability of additionally responding to this new set of remote commands.

The address used for @Q commands is the slot number. All future Q interfaces will support this basic command.

Serial Interface Commands

"U@=Sn..."

Serial interfaces e.g. GPS, NMEA depth etc. (Serial n (1..15); '*' addresses all Serial. S0 addresses the serial port of the T1.

Cmd	Description	Example
D*text*	Send *text* to sensor.	U@=S1D<waypoint setting> Enters a waypoint (if the attached device is a GPS).
E*m*	Enable function (see particular interface).	U@=S0E3 Enable both NMEA and Ockam data on the T1.

Redefining Tag Descriptors

U@=Vn,LongName,ShortName

Displays other than the 005 have an internal database which equates tag with description (e.g. tag 'B' is defined as 'Boatspeed'). When tags not in the database are displayed, they show up as "Tag #". You can assign meaningful descriptions to these functions (or override the default descriptions) by sending a command of the form "@V*n,descr,symbol*" where *n* is the decimal tag value.

   Example: U@=V77,Forestay,Fst   Re-defines Aux 1 (tag 'M') as the forestay loadcell

There is a limit to the number of substitutions allowed (the Matryx has room for 21), and EEPROMs have a limit on the number of times they can be written (about 10,000 times).

SAVE DEFAULT (T1 only)

Saves the current settings (averages, options, etc.) as the default values on master reset. Throws error 115 if successful.

Displaying Data

"U<tag>=<string>"

The display function provides a facility for your computer to display data on the Ockam indicators, or to enter comments into the data stream when recording data. There are ten display cards re-served for this facility (User 0 thru User 9, tags '0' thru '9') although any letter can be used for <*tag*>. The User cards are supplied with the RS232 interface and have a blank area for you to write in the name of your function(s). When a User label is inserted into an indicator, and your computer is running a program to output to that label, the indicator will display the results of your calculations in just the same way as standard functions.

The format for accomplishing this is to send the string: 'Un=<string>'. The argument n (a digit be-tween 0 and nine) indicates which label (User 0 thru User 9) to send the <string> to. The <string> is any characters following the '=' up to a maximum of 21 characters. The CPU will send your <string> to the appropriate display. The <string> may contain any character except null, but if it is to be displayed, it should conform to the formats that Ockam displays understand. Any display with function label User <n> will try to display the <string>. For example, sending 'U1=-15:42' will cause the CPU to display -15:42 on indicators with the User 1 label.

Indicators display data right justified with unused left digits blanked. 005's can display the digits and characters '0' thru '9', 'EHILOPS' and <space>. The 044 numeric line can do the alphabet except for '@KMNQVWXZ'. Lower case characters are mapped into their upper case equivalents. The period (.) is supported between each of the four digits (X.X.X.X). The colon (:) can only be displayed between the second and third digits (XX:XX), and will appear there regardless of where the colon is positioned in the <string>. A sign (+ or -) and exclamation (!) can be shown at the left of the display, and will appear only if sent. The exclamation point is turned on by the <bell> control- code (^G).

Also see the Full List of Tags.

AutoCal

AutoCal is a way to automatically change system calibration based on conditions. It was originally used in the America's Cup where very careful calibration was needed. Nowadays, with unorthodox design, scary rigs and canting keels, AutoCal provides that extra flexibility needed where static calibration is not enough.

Warning!
Because AutoCal adds a layer of complexity, you should only implement it if you need to.

In Unisyn systems (001 processor), AutoCal is external to the processor, implemented on a PC, sending K commands generated from a spreadsheet table.

In Tryad systems (T1 processor), the external AutoCal can be used until the table is stable, then moved to the T1. AutoCal is implemented for 4 inputs and 2 outputs as 6 structs (binary) in file AUTOCAL.DAT. Each table is f(x,y), and can contain a maximum of 15 rows and columns. The user specifies Row and column independent variable values and tags.

NOTE
The contents of Tryad AutoCal tables are ADDED TO the relevant calibration screw (or Kn=) value. This is different behavior from OckamSoft 3 AutoCal operation where the AutoCal REPLACED the screw value by actually issuing Kn= commands.

This means that for the Tryad, you should modify your OS3 AutoCal table values by subtracting your "standard" screw cal value (if relevant) from each element of the table.

Cal Leeway Leeway=-(CalLeeway+**AcalAdjLeeCal()**)*Heel/Vs^2
RangeName=CALLEE

Cal Upwash Ba=BaMeasured+
(CalUpwash+**AcalAdjUpwCal()**+CalUpSlope*(Vt-12))*
sign(Ba)*Hazen(Ba)*Reef^2*Flat;
RangeName=CALUW

Cal Va Va=CalVa*(1+**AcalAdjVaCal()**)*(counts/dT+offset).
RangeName=CALVA

Cal Vs Vs=CalVsMaster*(1+**AcalAdjVsCal()**)*(counts/dT+offset)
RangeName=CALVS

The 2 following are "output cals" which are applied during the calculation of true wind. They can be used to remove any errors remaining after the other Cal functions have been applied.

Bt Bt'=Bt+sign(Bt)*(**AcalAdjBt()** + QuikCal)
RangeName=CALBT

Vt Vt'=Bt+sign(Bt)***AcalAdjVt()**
RangeName=CALVT

The file is created by app CVTACAL.EXE. Remember that the tables are all "zero-based"; that is, default output (e.g. when a table is disabled) will be zero.

The AutoCal valuess are enumerated on the [System Status](#) output.

Enabling and Disabling AutoCals (T1 only)

Ln=m   Enable (m=1) or disable (m=0) AutoCal function n.

n	AutoCal function
1	CalVa
2	CalUW
3	CalLee
4	CalVs
5	CalBt
6	CalVt

Communications on the Ockam Bus

The OCKAM system uses a single wire to supply power and communication to all devices connected to it. This wire is in the form of a coaxial cable supplying a nominal 9 volts at a maximum of 3 amperes. The data is communicated on the same wire by placing negative-going pulses (to within 1 volt of ground) of 3.2 microseconds duration and in the first quarter of a particular 13.02 microsecond window (See Figure 1). Each channel is identified with a particular

BUS CHANNEL TIMING
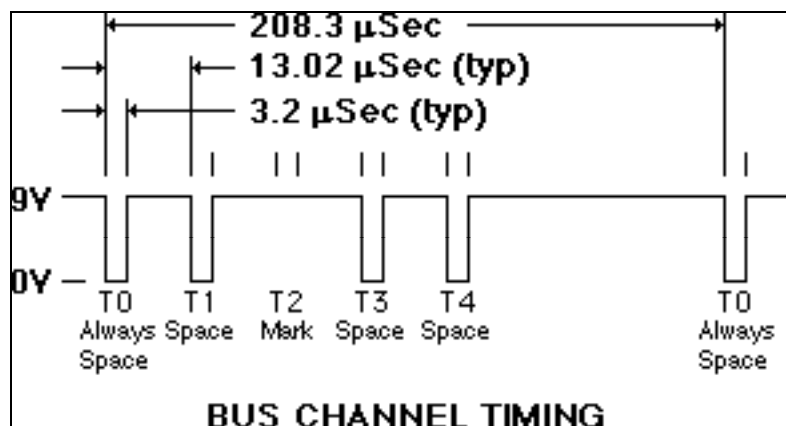
window, and each occurrence of a channel's window represents the state of the current bit for that channel for the next 208.3 microseconds, (i.e. 4800 baud).

The first (of 16) windows is called T0. The CPU always places T0 pulses on the bus, and all devices phase-lock onto this pulse to regenerate timing for their particular channel. 13.02 microseconds after the start of the T0 pulse, the (optional) pulse for channel 1 occurs, 13.02 microseconds later channel 2's pulse occurs, and so on. There are 14 time periods following the T0 pulse available for use. The 15th period is never used, to help devices to lock onto the T0 pulse properly.

If a pulse is to be inserted into its time slot, it is placed in the first 25% of its time window. The other 75% of the window is used to allow the bus to settle down after the pulse propagates throughout the system. The 14 time periods following T0 where a pulse may be placed are referred to as T1, T2, and so on. The presence of a pulse in a particular T time will be interpreted as a "space" or 0 bit for that channel for that particular bit-time. The absence of a pulse is interpreted as a "mark" or 1 bit.

The Ockam system uses channels 1 thru 6. Channels 7 thru 14 are unused at the present time, and may be used for independent communications, except that expansion of the Ockam system may use some more channels at a future time.

At the next level above multiplexed bits, the system transmits all data as asynchronous ASCII characters, that is, start bit, 7 data bits, odd parity bit, and one stop bit. Detection of data is done by phase-locking onto the T0 pulse, and then looking for any low level on the bus during the channel's T time. The result of this is demultiplexed asynchronous ASCII as described above.

Transmission of data is accomplished by shorting the bus during a channel's T time when sending a "space", and doing nothing during a "mark". Note that this scheme allows a "wire-OR" arrangement of transmitters on the bus, so a multiplicity of interfaces and controllers can talk to the CPU (and each other) provided they wait their turn.

The CPU controls the bus communications on channels 1-4 and uses each channel for a specific purpose; Channel 1 is used as the main data output channel. All indicators and controllers listen on this channel for data to be displayed. Channel 2 is used by the controllers and keyboard interfaces to control the CPU. Channel 3 is used by the CPU when requesting data from an interface. Channel 4 is used by the interface to return data to the CPU. Interfaces never talk on this channel unless they have been ordered to via channel 3.

Channel 1 data is organized into FRAMES. Each frame consists of asynchronous ASCII characters with odd parity, and one stop bit, organized as **null**, <tag>, and a variable length string carrying the actual value, and ending with the **null** that begins the next frame.

The <tag> is a unique ASCII character associated with a particular display. The display cards encode this character magnetically. Table 4.1.1 summarizes the <tag>s presently defined.

An example of a part of channel 1's output might look like this;

      ...A6375**null**,<0DH><0AH>4**null**T16:45**null**H-21**null**B7.31**null**D...

where ...A6375 is the end of the SYNOPSIS string ending time slot 3. **null**,<0DH><0AH>4 is the frame which identifies the beginning of TIME SLOT 4, one of eight tables of operations being executed by the CPU. Note that the frame is comma, carriage return, line feed, <number>. **null**T16:45 is the TIME frame. This could be minutes and seconds, or hours and minutes depending on the output option chosen. **null**H-21 is the HEEL frame, and data says heel is 21 degrees to port. **null**B7.31 is the BOATSPEED frame, and shows a boatspeed of 7.31 knots.

List of functions and Tags

This table lists the functions and tags output by the Ockam System. The interfaces required to produce them are also listed. Notes are marked with [] and detailed at the end of the table.

Function	Char	Hex	Dec	005 Card	Interfaces[1]	Notes
	nul	00	0			Separator; cannot be tag
	soh	01	1			non-printing character
	stx	02	2			non-printing character
	etx	03	3			non-printing character
	eot	04	4			non-printing character
	enq	05	5			non-printing character
	ack	06	6			non-printing character
Error flag	*bel*	07	7			005 displays "!"
	bs	08	8			non-printing character
	ht	09	9			non-printing character
	lf	0A	10			non-printing character
	vt	0B	11			non-printing character
	ff	0C	12			non-printing character
	cr	0D	13			non-printing character
	so	0E	14			non-printing character
	si	0F	15			non-printing character
	dle	10	16			non-printing character

	dc1	11	17			non-printing character
	dc2	12	18			non-printing character
	dc3	13	19			non-printing character
	dc4	14	20			non-printing character
	nak	15	21			non-printing character
	syn	16	22			non-printing character
	etb	17	23			non-printing character
	can	18	24			non-printing character
	em	19	25			non-printing character
	sub	1A	26			non-printing character
	esc	1B	27			non-printing character
	fs	1C	28			non-printing character
	gs	1D	29			non-printing character
	rs	1E	30			non-printing character
	us	1F	31			non-printing character
System Status	space	20	32	00100000	T1	T1 only. System Status
	!	21	33	00100001		"All indicator" on the 005
	"	22	34	00100010		
	#	23	35	00100011		Many Q intf use this tag
NMEA data	$	24	36	00100100	T1 or 001>16.2	
	%	25	37	00100101		address "E" on most Q
	&	26	38	00100110		address "F" on most Q
	'	27	39	00100111		
	(	28	40	00101000		
	)	29	41	00101001		
Lights	*	2A	42	00101010	none	See O9=
Axial windspeed	+	2B	43	00101011	3D MHU	vertical wind component
Time ticker	,	2C	44	00101100	none	count of display channel time slices from CPU
	-	2D	45	00101101		
	.	2E	46	00101110		
	/	2F	47	00101111		
User 0	0	30	48	00110000	RS-232	[3] Also see Polars
User 1	1	31	49	00110001	RS-232	[3]
User 2	2	32	50	00110010	RS-232	[3]
User 3	3	33	51	00110011	RS-232	[3]
User 4	4	34	52	00110100	RS-232	[3]
User 5	5	35	53	00110101	RS-232	[3]
User 6	6	36	54	00110110	RS-232	[3]
User 7	7	37	55	00110111	RS-232	[3]
User 8	8	38	56	00111000	RS-232	[3]
User 9	9	39	57	00111001	RS-232	[3]
Synopsis	:	3A	58	00111010	1,2,3	Raw data (normally disabled)
	;	3B	59	00111011		
Target angle	<	3C	60	00111100	T1 + Polar	
	=	3D	61	00111101		
	>	3E	62	00111110		

	?	3F	63	00111111		
Remote commands	@	40	64	01000000	RS-232 or Lynx	See Controlling Ind.
Windspeed Apparent	A	41	65	01000001	2	
Windspeed True	a	61	97	01100001	1,2	
Boatspeed	B	42	66	01000010	1	
VMG	b	62	98	01100010	1,2	
Heading	C	43	67	01000011	3	See O17= and O18=
Wind Direction	c	63	99	01100011	1,2,3	
Wind Angle Apparent	D	44	68	01000100	2	
Wind Angle True	d	64	100	01100100	1,2	
Mast Angle	E	45	69	01000101	mast rotation	
Bt/Vt correction	e	65	101	01100101	T1 + 1,2	T1 only See QuikCal
Current Set	F	46	70	01000110	1,3,4	[2] See O14= O15=
Current Drift	F'					
VMC	f	66	102	01100110	1,4,5	See O10= O11=
Air Temp.	G	47	71	01000111	Sonic MH	[2] See O12=
Sea Temp	G'				Smart Depth	
Barom. Trend	g	67	103	01100111	Sonic MH	[1] See O12=
Barom Pressure	g'					
Heel	H	48	72	01001000	2 or 3a	port is -, stbd is +
Leeway	h	68	104	01101000	1,2	Calculated. See formula
CAL Boatspeed Master	I	49	73	01001001	1	default is 1.00
CAL Boatspeed Offset	i	69	105	01101001	1	default is 0.000
CAL Wind Angle Offset	J	4A	74	01001010	2	default is 0.0
CAL Windspeed	j	6A	106	01101010	2	default is 1.00
CAL Leeway	K	4B	75	01001011	1	usually 7.0
CAL Upwash	k	6B	107	01101011	2	[2] Default is 0.00
CAL Upwash Slope	k'					[2] Default is +0.395
LOG Permanent	L	4C	76	01001100	1	Not in 001 rev A16
Log Trip	l	6C	108	01101100	1	See Ctrl Codes
Aux. 1	M	4D	77	01001101	Q intf	usually Loadcell 1
Aux. 2	m	6D	109	01101101	Q intf	
Aux. 3	N	4E	78	01001110	Q intf	usually Trim
Aux. 4	n	6E	110	01101110	Q intf	
Opposite Tack	O	4F	79	01001111	1,2,3	For 001>16.2 & all T1, opposite track (i.e., includes current).
Magnetic Var.	o	6F	111	01101111	4 or RS-232	See Magnetic Variation
Polar Boatspd	P	50	80	01010000	1,2,5	See O20=
Target Boatspd	p	70	112	01110000	1,2,5	See O20=
Stbd Layline	Q	51	81	01010001	1,2,3,4	MM:SS format
Port Layline	q	71	113	01110001	1,2,3,4	MM:SS format
Waypoint Brg	R	52	82	01010010	1,3	[2] See W=
Waypoint Range	R'					

|						
Back Bearing	r	72	114	01110010	1,3	[2] See Ctrl Codes
Back Range	r'					
Status Output	S	53	83	01010011	T1 > 20.03	Messages from sensors
	s	73	115	01110011		
Time (of day)	T	54	84	01010100	None	Format: See O1= Setting: See T=
Stopwatch	t	74	116	01110100	None	Format: See O13= Control: See Ctrl Codes
COG	U	55	85	01010101	4	[2] See O16=
SOG	U'					
	u	75	117	01110101		
Dist Lost Vs	V	56	86	01010110	1	on 001
Lift/Head					1,2,3	on T1
Dist Lost VMG	v	76	118	01110110	1,2	on 001
Puff/Lull					1,2,3	on T1
Depth Surface	W	57	87	01010111	Depth	See O12=
Depth Keel	w	77	119	01110111	Depth	See O12=
Latitude	X	58	88	01011000	4	[2] units are degrees.
Longitude	X'					
Cross-track error	x	78	120	01111000	4	T1 > 20.02
Rudder Angle	Y	59	89	01011001	Rudder	
Trimtab Angle	y	79	121	01111001	Rudder	
Configuration	Z	5A	90	01011010	None	Active interfaces. See Configuration.
Version	Z'					001: once at startup T1: alternates w/config.
Test Errors	z	7A	122	01111010	None	See Test Errors
	[	5B	91	01011011		
	\	5C	92	01011100		
	]	5D	93	01011101		
Trim (avg.pitch)	^	5E	94	01011110	Trim or 3A	
	_	5F	95	01011111		
	`	60	96	01100000		
	{	7B	123	01111011		
	|	7C	124	01111100		
	}	7D	125	01111101		
Sea State	~	7E	126	01111110	Trim or 3A	
	del	7F	127	01111111		
		FF	255	11111111		See 005 Diagnostics.

Notes:

1. Interfaces: 1=Boatspeed 2=App. Wind 3=Heading 3A=3D Hdg 4=GPS 5=Polar
2. Separate display items on 007, alternating on 005 & 044
3. '0' thru '9' are traditional User Output tags. Now any tag can be a User Output.

Section 5.1 - System Processors

T1 System Processor

Document current with CPU.RTB dated 11/1/06
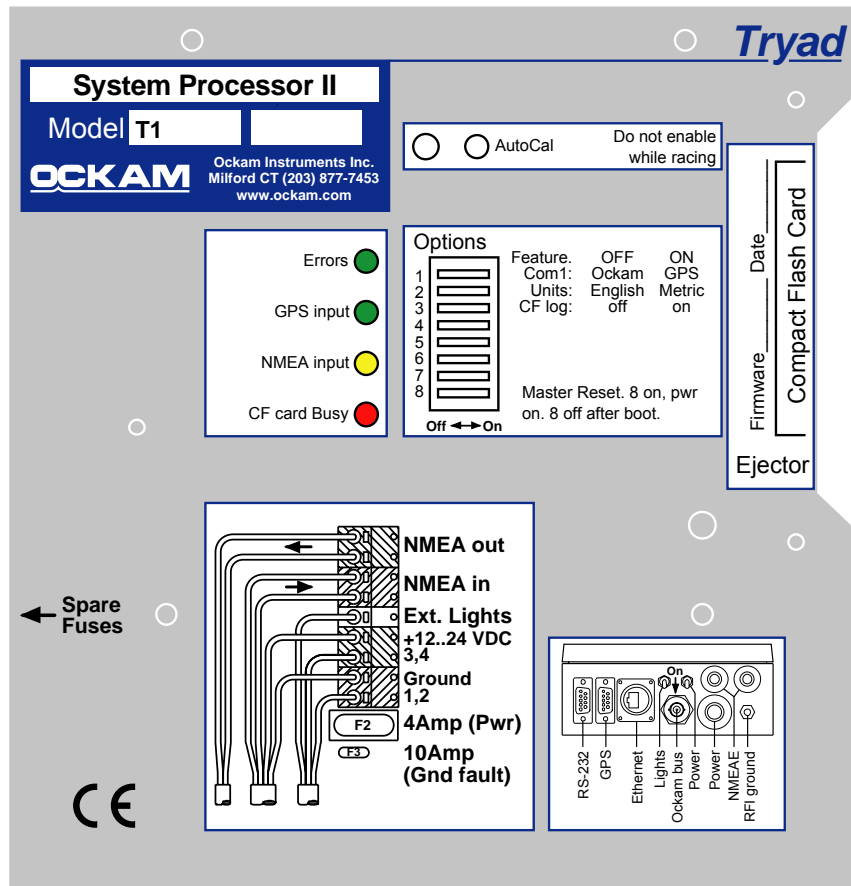
The Tryad T1 CPU is the brain of the Ockam system. It gathers information from various interface components, controllers and serial ports, calculates outputs, and sends data to displays and other data targets. The CPU also includes a clock and calendar which provides various timing functions to the system.

Specifications

Dimensions:	12-1/2" W x 9" H x 4" D
Mounting:	#10-24 x 2" Bolts on 9-1/2" x 4-5/8" Ctrs.
Weight:	4 Lb.
Orientation:	Any
Accessories:	System Manual
	Mounting hardware
Power Requirements:	10.5-28 VDC at 7 watts plus requirements of all other modules.
Fuses:	Power: 4 AMP Miniblade automotive fuse
	Ground: 10 Amp Picofuse
	Signal: 250ma Picofuse

Mating Connectors:	Power, Lights:	Pigtail (Terminal strip)
	Ockam Bus:	BNC Male (UG-88/U)
	Ethernet Bus:	Weatherproof RJ-45
	RS232:	DB9 female (DCE)
	GPS:	DB9 male (DTE)
	NMEA:	Pigtail (Terminal strip)

Features:　Two switches control power and lights, or may alternatively be controlled through the power cable wiring. Trouble lights aid in diagnosing signal and error problems.

CE　The Tryad T1 CPU complies with relevant sections of EU EN60945:1997 and EMC Directive 89/336/EEC.

Hardware

The Tryad T1 CPU is a PC running on ships 12 to 24 VDC supply and coupled to hardware for driving the Ockam Bus. Program and data is stored on a removable CompactFlash card, which lets the owner easily upgrade software via a PC.

External Connections

RS-232: provides instrument data and control to PCs, and is the equivalent of an 050 RS232 interface - default output is Ockam data, and input is keyboard commands. The data stream for this port is independent of the Ockam Bus, so keyboard commands to an 050 RS232 interface will not interfere. The data rate of this port is not limited to 480 (Ockam stream) or 960 (Ockam+NMEA streams) characters per second as they are with an RS232. Default setting is 9600 baud, 8 data bits, no parity and 1 stop bit.
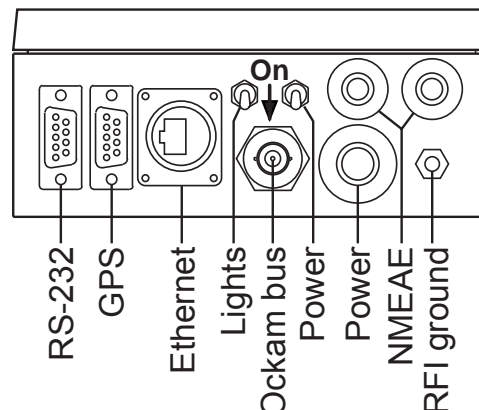
Setting DIP switch #1 at power up will temporarily set the RS-232 port to 4800,N,8,1, and source GPS data only. In other words, RS-232 output would look like a GPS.

GPS: is an RS-232 port that accepts an NMEA data stream (4800,N,8,1). This port is a superset of an 041 GPS interface (which is no longer supported on the T1). Wire the GPS with a DB9F, Signal (out-) on pin 2, and Ground on pin 5. The GPS out+ signal (if any) is not used.

The version of T1 code that runs the AHRS gyro receives AHRS data on the GPS: port, and GPS is expected on the internal NMEA port.

NOTE
The GPS: port is NOT opto-isolated. Ensure that the attached GPS shares the same ground as the Tryad processor.

Ethernet: This connector will provide Ethernet connection when activated.

Ockam bus This connector is a standard Ockam bus, supporting all Ockam hardware except:

　　041 GPS Interface. Replaced by the T1 GPS connector.
　　037 Polar interface. Replaced by polar file(s) in the T1 Flash card.

See Installation. When powered up, the Ockam cable has +9.6 volts DC on the center conductor, and **BATTERY GROUND** on the shield. Be careful to insulate all Ockam Bus connectors from contact with hull or rigging.

RFI ground This contact is capacitively connected to the Ockam ground and provides an AC ground to reduce radio frequency interference. It should be directly connected to the closest major conducting part of the hull or keel with a substantial wire (#0 or larger). Flat braid copper is recommended.

Some boats have Isolated power systems. In these cases, the engine may not be grounded. Check before using the engine for RFI ground.

To minimize radio frequency interference (RFI), the Ockam Bus should be RF-grounded (i.e. shield connected thru a capacitor to the hull) at every available junction.

Internal Connections

NMEA out Terminals 8 & 9 of the T1 terminal strip output a consolidated NMEA data stream (a **NMEA tap**®). Since GPS data is included in this stream, you probably do not want to route this to the GPS.

NMEA in Terminals 6 & 7 of the T1 terminal strip accept NMEA-0183 data for Heading or Depth. Spare power terminals (2 and 4) are provided for use by the NMEA device. If the AHRS build of CPU software is used, GPS connects here.
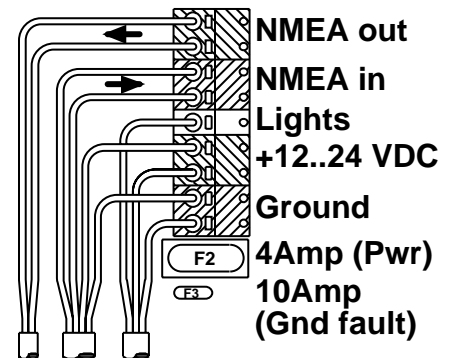
Lights(5), Power(4,3), Ground(2,1) These connections go to the ship's power panel and provide power to the Ockam system. Voltage supply should be between 10.5 and 26 volts DC. The CPU draws about ½ amp at 12.6 volts. You can control the lights by connecting the "Lights" wire to a circuit breaker. Otherwise leave it disconnected, and control the lights with the external switch. If both are used, lights are on if either control is active.

Inputs accepted by the GPS port

Waypoint range & bearing:	BWR, BWC, BER, BEC, RMB
Position	GGA, GLL, RMC
COG/SOG	RMC(True only!), VTG
Cross-Track Error	XTE
Magnetic Variation	HVM, HVD, RMC)
Time & Date	ZDA

Inputs accepted by the NMEA-In port

Heading	HDG, HDM, PTNTHPR
Depth	DBS, DBT, DBK, DPT
Sea temperature	MTW (Celcius only!)

Outputs from the NMEA-Out port

All input from GPS port plus, if the data is available, the following Ockam data cast as NMEA sentences:

Depth	"$IIDBT, $IIDPT
Heading	$IIHDG
True wind direction & speed	$IIMWD
Apparent wind	$IIMWV
True wind angle & speed	$IIMWV
Rudder & tab	$IIRSA
Current set & drift	$IIVDR
Heading & boatspeed	$IIVHW
Logs	$IIVLW
VMG	$IIVPW
Apparent wind angle & speed	$IIVWR
True wind angle & speed	$IIVWT

Program & data storage

The T1 processor runs code stored on its CompactFlash card. This device is a solid state disk with a DOS file system containing the T1 processor code as well as other data. You can buy Compact Flash Readers at camera and computer stores that will allow you to read and write to the card. See Contents of the disk for more information.

AutoCal If a file named AUTOCAL.DAT is present on the drive, it will provide up to 4 input calibration and 2 output adjustment tables. See AutoCal.

Polar The T1 supports polar functions by using the standard Ockam ESP polar file format which replaces the 037 Polar interface. If an appropriately formatted file set exists in the root directory of the drive, the system will configure as an 037 would have. See below for details on how the polar file set works.
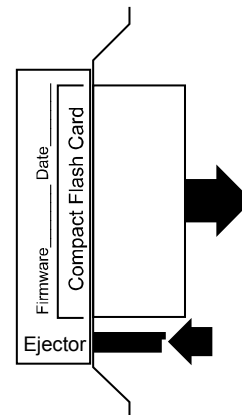
DIP switches

DIP #1   Controls how the RS232 works. (see T1 RS232 port).

DIP #2   Read on master reset only. Sets initial units of measure.

DIP #3   Enables the built-in logging function.

DIP #8   On power-up: performs a master reset (all paremeters reset to factory values).
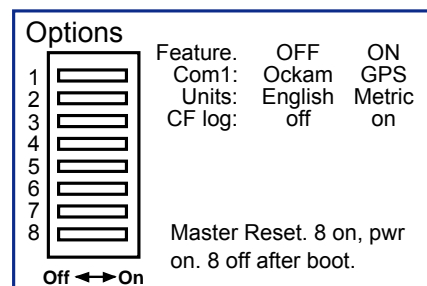
The current value of the DIP switches is output on System Status, "DS".

Connecting NMEA output to a PC

You can view the NMEA output by connecting pin 8 of the terminal block to pin 2 of a DB9 female, and ground (pin 1) to pin 5. Output is 4800 baud 8 data bits 1 stop bit.

Connecting a PC
to the NMEA output

Rear of
DB9 Female
(To PC)

NMEA in →
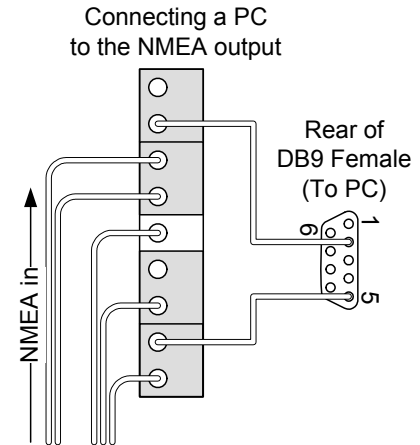
Operation

Providing power to the CPU is all that is needed to start the Ockam system.

> **The Tryad is a PC.**
> **After power on, it takes 45 seconds before**
> **anything appears to happen.**

Polar file set (T1 code dated 9/17/02 or later)

The 037 Polar interface hardware is no longer supported on the T1. Instead, the Tryad system uses polar "**.TPO**" files, which contain static speed and angle data predicting boat performance. For example, the file would supply the answer to "In 12 knots, what should my upwind boatspeed and angle be?" e.g. "7.65 knots at 46.5 degrees true".

These files are derived from the Velocity Prediction Program ("VPP") which is part of the IMS rating system. A VPP service will supply the polar data as a worksheet (WKS or WK1 file), which allows you to view, plot and modify the data. You can then use the CVTPO utility to convert between the worksheet and TPO formats.

If the Compact Flash card contains (only) a file named **POLAR.TPO**, it will be loaded, and the system will use the data in 6 outputs. See below for a detailed description of these outputs.

Multiple polar files are also supported. If a file named **POLAR.IDX** containing a list of TPO file names is found in the root directory, Option 3 (Polar number) indexes the list to specify the file. If the index is out of range, or the file does not exist or is corrupted, the Tryad will try for POLAR.TPO.

Example:

Suppose file POLAR.IDX looks like this.	``polar1.tpo``

If the default polar number (=0) is in effect, the Tryad will attempt to load "``polar1.tpo``" (in the root of the Compact flash). Issuing the command "O3=2" will switch the polar to file "``polar2.tpo``" (in subdirectory "Polars"), and throw a single error 116 (LoadPolar request). If the load fails, permanent error 117 will be posted, and Tryad will try for default "POLAR.TPO". Success will cancel error 117 and set bit 16 of the Configuration.	``;Blank lines do not count``
	 ``;and lines beginning with ';' are``
	 ``;comments and do not count either``
	
	 ``c:\polars\polar2.tpo``
	 ``c:\polar3.tpo``

Tryad outputs the polar filename (less path) as item PL: of the System Status.

Resetting the system

To MASTER RESET the system to factory defaults (or to your saved defaults, see below);

1. Turn the system power off.
2. Turn DIP switch #8 on (to the right).
3. Turn the system power on and wait for booting to complete.
4. Confirm that error 12 is up (proof of master reset).
5. Turn DIP switch #8 off (to the left).

System parameters

The T1 maintains a set of parameters that control the details of operation of the system, for example, averaging times for all the outputs. These numbers are initially set to factory settings and saved to file CPU.OID on the Compact Flash card.

The parameters can be changed by sending various commands to the system via an RS-232 connection. When any parameter is changed, a timer starts running, and after a certain period, the CPU.OID file is updated. (Flash memory can be written only a certain number of times. The timer limits the number of writes to the flash card.)

You can also customize the initialized values by creating a DEFAULT.OID file which contains the various parameters set the way you want (as opposed to the factory setting). To do this, set the parameters the way you want them and then;

- Turn the system off, put the Compact Flash card in a PC and copy CPU.OID to DEFAULT.OID, then return the card to the Tryad. Or...

- Issue the command SET DEFAULT<cr>. The system will create a DEFAULT.OID based on the current settings and throw a single error 115 as proof.

When the system is MASTER RESET (as described above), if a DEFAULT.OID file exists, it is used instead of the factory settings. If you want to return to factory settings, delete the file DEFAULT.OID on the flash card and MASTER RESET.

T1 Command port (RS232 port)

The factory default setting for the T1 RS232 port is 9600 baud, no parity, 1 stop bit, and it outputs Ockam data and receives commands (see below). The port can also be set up in other ways to accommodate different situations.

NMEA mode   Turning Option Switch 1 on before powering up forces the port settings
                         to 4800 baud, 8 data bits, and NMEA data.

                         This mode provides a clean way to port the GPS into a PC without the
                         necessity of changing any wiring. In other words, if you want to run a
                         charting program and need GPS input, you do not need to disconnect
                         the GPS from the T1 and reconnect it to the PC. Instead, turn Option
                         Switch 1 on and power up. The RS232 port will then look like a GPS.

!Sn<cr>   This command controls what data format comes out of the RS232 port.

                         `n=0: No output       n=1: Ockam output (default);`
                         `n=2: NMEA output     n=3: Both Ockam and NMEA`

                         Some programs expect Ockam data format (`!S1<cr>`), while others
                         require NMEA-0183 (`!S2<cr>`).
                         OckamSoft drivers can accept both (`!S3<cr>`).

                         • See the troubleshooting guide for an example.

                         • See the note below regarding saving changes.

!B<baud><cr>   This command changes the baud rate of the RS232 port.

                         `<baud>=4800, 9600(default), 19200 or 38400`

                         • A single error 118 is thrown to acknowlege the change.

                         • See the note below regarding saving changes.

                         • Use this command carefully; after changing the port baud rate, you
                           must then set the PC baud rate to the same value before
                           communications can be reestablished.

!Wn<cr>   This command changes the word length of the RS232 port.

                         `n=0: 8 databits (default)  n=1: 7 databits`

                         • A single error 118 is thrown to acknowledge the change.

                         • See the note below regarding saving changes.

                         • Use this command carefully; after changing the port word length, you
                           must then set the PC word length to the same value before
                           communications can be reestablished.

Saving changes   The port settings (!S, !B and !W) change the behavior of the port
                         immediately. However, it may be many seconds before the changes are
                         written permanently (see the note above concerning writing to flash
                         memory). You will know when they have been saved when you see a
                         single instance of error 120.

                         The Option Switch 1 trick to force 4800,N,8,1/NMEA does not change
                         the saved settings for the port. If you turn the T1 on with S1 off, the port
                         reverts to the saved settings.

Commands

Commands may be entered thru the RS232 port on the T1 and/or via an RS232 interface
attached to the Ockam Bus. See Sending Control Information for details.

Variables

Most variables are the same as the old system, except that, in order to conserve bus bandwidth, a "frog eye" filter is used. Each variable is calculated at its appointed rate and only output if it changes, or 4 seconds have elapsed since the last output. This filter can be disabled if desired (see Set Calculation Options).

See Primary Functions.

Retro-Apparent

Normally, apparent wind functions (Va and Ba) are displayed as the masthead sensor is read. However, if (CalcOptions & 0x2), then they are back calculated from wind direction and true wind speed.

Built-in Logging

T1 firmware Rev 20.03 (dated 11/1/06) can maintain a series of log files on its compact flash card. These logs are automatically produced; no software commands need to be issued to start or otherwise control them. Logging will only occur if the compact flash card has a capacity greater than 20 MB and the free space exceeds 2 MB.

Logging is enabled by T1 DIP switch #3. If this switch is on (and the resource constraints are met), then logging automatically takes place The current log filename is displayed on System Status, "LG".

On startup the T1 begins logging all displayed data to file "LOGx.TXT" (where x is 0 thru 7). In order to protect against issues with powering off, data is buffered in RAM and written to the file on the minute. If there are any LOGx.TXT files on the CF card, the logger determines the date of the newest one, and opens the next log in sequence.

After 1 hour elapses, LOGx.TXT is closed and LOGx+1.TXT (n is modulo 8, so LOG8.txt becomes LOG0.txt) is started. This process continues, until after 8 hours, LOGx is reopened and overwritten.

The log files are plain text. Everything which goes out on the display channel is logged, including commands. This means that disabled tags do not get logged, and if NMEA data is enabled (!S2) then that is too.

The application DumpLog.exe understands this type of file, and can be used to produce Excel spreadsheets from the log files. Download http://www.ockam.com/dumplog.zip and read the included ReadMe.txt.

240-25F
(5,7,8 jumpered)
IRQ5

3.6v backup
battery

NMEA in
invert A
Signal
250ma pico
Power 4amp
miniblade
Gnd fault
10amp pico

Jumper settings & Fuses

There are 3 jumper sets on the main board. The top right two (240-25F and IRQ5) should not be changed without specific instructions.

Normally reversing the NMEA wires is all that is needed
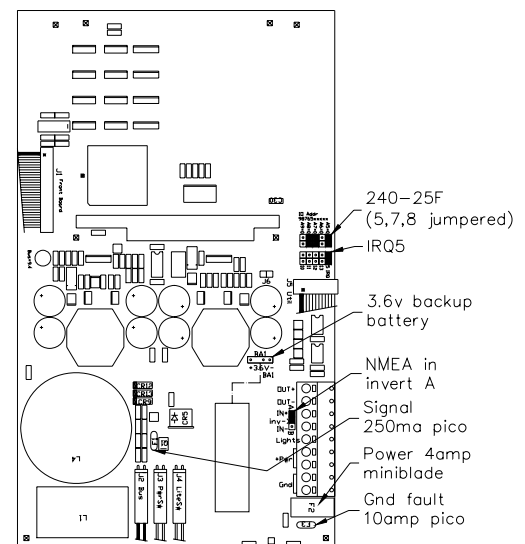
to get the correct polarity on this signal. The NMEA in jumper set allows inversion of the NMEA signal for the case where reversing the wires does not work.

The 3.6volt backup battery connects to the jumper indicated and maintains the internal clock.

There are 3 fuses that might have to be replaced.

Power　　　　a 4 amp miniblade, available at car parts stores.

Gnd fault　　　a 10 amp picofuse that protects the circuit board in situations where an Ockam bus cable accidentally touches a live voltage.

Signal　　　　a 250ma picofuse that protects the circuit board from a stuck signal transistor.

Spare fuses are located to the left of the DIP switches on the T1.

Contents of the Compact-Flash disk

The compact flash card contains the T1 operating program and data files. The file system type is bootable DOS FAT and can be read and written by most PCs. You might want to copy the contents of the compact flash card to your PC as a backup.

Because it boots DOS, creating your own compact flash for the T1 is now an arcane skill. If you must (or want) to do this, download the utility from http://www.ockam.com/CFformat.zip. Further instructions are included. Compact flash card sizes of 16MB, 64MB and 256MB are currently supported.

Dos & Utilities

C:\DOS\	(80 files, 2.8MB) DOS 6.22 lives here.
DRVSPACE.BIN	(ReadOnly,Hidden) DOS file.
IO.SYS	(ReadOnly,Hidden) DOS file.
MSDOS.SYS	(ReadOnly,Hidden) DOS file.
<path>	C:\UTILS;C:\DOS;
AUTOEXEC.BAT	Runs CPU.EXE or CTTY AUX for manual file maintenance.
BOOT.COM	Programmatically reboots the PC104.
COMMAND.COM	DOS file.
CONFIG.SYS	Configuration file (virtually unused)
RTTBOOT.COM	Loader program for protected mode files (like CPU.RTB).
SETUP.COM	Allows changing BIOS settings from the DOS prompt. Settings do not take effect until reboot.
XTCLK.COM	DOS clock <--> battery-backed clock

CPU files

CPU.OID	This is CPU.EXE's "remembered variables", similar to the battery-backed RAM on the old processor.
DEFAULT.OID	If available, this file will be used during Master Reset. You might want to save a copy of CPU.OID as DEFAULT.OID after setting averages and flags as you like them.
AUTOCAL.DAT	(User supplied) This is the 6 AutoCal tables used by CPU to adjust inputs to get a good wind triangle solution.
BOOTS.TXT	(Created by CPU.RTB) Log of startups and other debugging information.
CPU.BAT	Runs CPU.RTB
CPU.RTB	This is the instrument program. There will be frequent updates for this one.

POLAR.TPO	(User supplied) default Polar file.
POLAR.IDX	(User supplied) Polar index file, specifying multiple polars.
TESTOPT.EXE	Senses option switches into return code to allow branching within a batch file based on CPU option switch settings. Also sets COM1:19200,N,8,1.

AUTOEXEC.BAT

```
set path=C:\utils;C:\dos;
rem If Option 1 on, go directly to DOS
testopt 1
rem if errorlevel 1 goto :talk
rem Otherwise, run main program
:run
cpu
BOOT
:talk
ctty aux
```

CONFIG.SYS

```
stacks=0,0
rem NOT FOR RTOS32 device=c:\dos\himem.sys /verbose
rem NOT FOR RTOS32 device=c:\dos\emm386.exe 64 /verbose
```

CPU.BAT

```
rttboot cpu.rtb
```

Model T1 Cpu Revision History

Rev	Date	Change
A2	3/18/02	1st production release of T1 software rev 20.00 (6/21/02)
A2	9/16/02	rev 20.00 Only shown by date CPU.RTB 9/16/02, added Master reset to switch 8
B1		Rev OKA1016A2, Fixed NMEA input, CPU.RTB 2/21/03
B2	5/20/03	Rev OKA1015A3, OKA1016A2 fix corupting AMPRO'S
B3	4/27/04	Rev 20.01 Flick gps $p<anything>, fix depth intf protocol
B4	?	20.01, changed to Kontron PC104
B5	?	20.01, unknown change
	11/1/06	rev 20.03 limited devel release with logging, etc.

001 System Processor
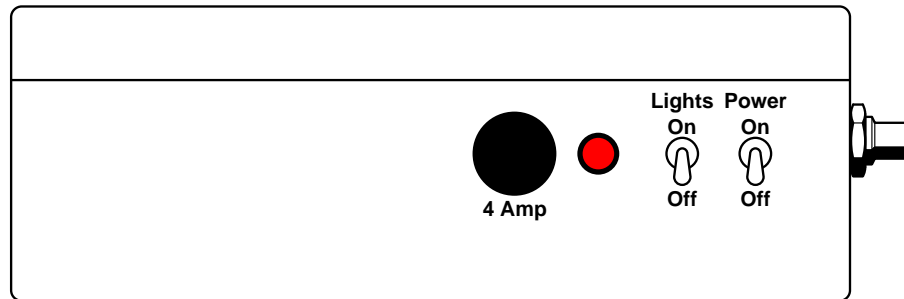
The CPU is the central processor for the Unisyn system. It gathers information from all interfaces and controllers, calculates the outputs, and sends data to the displays. Included in the CPU is a clock running on an internal battery which provides various timing functions to the system.

Specifications

Dimensions:	12-1/2" W x 9" H x 4" D
Mounting:	#10-24 x 2" Bolts on 9-1/2" x 4-5/8" Ctrs.
Weight:	4 Lb.
Orientation:	Any
Accessories:	System Manual
	001C Power cord
	Mounting hardware
	(2) 3AG-4A Fuses
	5 System Cards
Power Requirements:	10.5 to 35 VDC at 150ma plus current requirements of all other modules.
Fuses:	Power: 3AG-4 AMP
	Ground: 10 Amp Picofuse
	Signal: 125ma Picofuse
Mating Connectors:	POWER: AMP CPC 206060-1, Cable seal 54010-1
	BUS: BNC Male (UG-88/U)
Features:	Two switches control power and lights, or may alternatively be controlled through the power cable wiring. A trouble light aids in diagnosing power and error problems.

Operation

System power starts at the ship's lighting battery and flows through a battery disconnect switch, a circuit breaker on the power panel, the POWER switch and a 4 ampere fuse on the CPU. (Ground faults are protected by an internal 10 amp fuse soldered into the circuit board.) To turn the system on, the various ships switches should be turned on, along with the POWER switch on the CPU. When proper power is applied, the system begins operation. The power-up sequence takes about 5 seconds;

1 Power is supplied to the BUS, causing indicators to display all eights with punctuation !+8.8:8.8 .

2 The CPU sends HI to all indicators, which shows the program revision P14.3 or whatever the current revision is.

3 Normal operational data is sent to the indicators.

The POWER switch may be left in the ON position, allowing the system to be controlled by the ship's circuit breaker.

Also see Resetting the CPU.

Installation

The CPU module requires a supply of 12 to 32 volts DC, at up to 3 amperes (depending on the number of modules attached). Power connection is made via a three conductor cable; BLACK to ground, WHITE to (+) power, and optionally, GREEN to switched (+) power for lighting control. Lighting may be controlled by the LIGHTS switch on the CPU, or by the GREEN wire on the power cable. If the switch is used, then the green wire should be taped up out of the way; if the green wire is used, then the LIGHTS switch should be set to the OFF position, and the green wire should be connected to a SWITCHED supply. It is important to have control of the lights, because the light switch is used to reset the CPU.
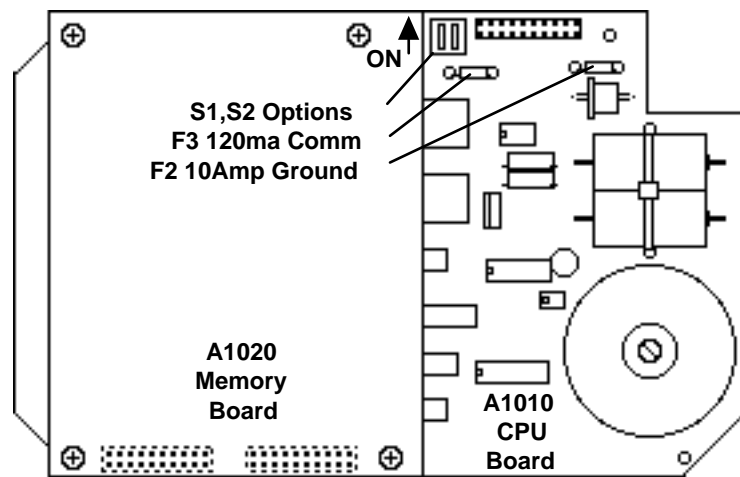
Location of Options Switches inside 001 CPU

Normally, the units-of-measure for the Ockam System are in Feet & °F. You can set the them to Meters & °C by setting the internal Options switch 1 ON & switch 2 OFF, then performing a Master Reset. Any other switch setting sets defaults to °F and Feet. This switch only has an effect when a Master Reset is performed. You can change the output units individually or collectively with Option 12, and they will stay at the new setting until another Master Reset is performed.

Release Notice for Unisyn 16.3 software dated 1/19/99

Unisyn is a new release of the Ockam System firmware for the 001 (rev A16.3) that supports three new interface types. The software continues to support all standard interfaces, but some new features will not be activated unless the new interface/sensors are installed. The changes described are relative to CPU software A14.4.

New Heading: The 032B Compass Interface supports many 3-axis compasses, providing pitch and roll in addition to heading. When available, the roll input replaces the heel sensor input of the 022 or T2 Masthead interface, and the pitch input provides two new functions; Trim and Sea State.

The Trim (average pitch angle) function is the same as that provided by the 062 Trim Interface. Sea State is the mean value (RMS) of the pitch angle

changes, and reflects the amount of "undulation" the boat is experiencing. This function has been used by several America's Cup syndicates, and the IMS technical committee to quantify the sea state.

New Masthead: Unisyn supports the T2 Multiplex Interface which supports the new Sonic Wind sensors. These sensors have no moving parts, and so have no lag or friction. Disturbances caused by tacking are not spread out in time, and therefore do not degrade the wind direction solution beyond the evolution itself. In addition, pitch and roll rate correction can be more effectively applied to the fully responsive measured apparent wind, which reduces errors produced by these disturbances. The much greater sensitivity of the sonic sensor also improves downwind wind direction solutions.

Enhanced GPS: Unisyn supports the enhanced 041 GPS interface. In addition to waypoint range and bearing and Lat/Lon, the extended interface provides COG/SOG, Time, Magnetic Variation and a Differential GPS flag. The enhanced GPS interface is backward compatible with earlier versions of CPU software.

Note
Older systems upgrading to Unisyn with 041 may notice a change in system configuration. This is because with Unisyn, the 041 does not need to also configure as a "Q" interface (config=512) in order to send Lat/Lon. If the system does not have any other "Q" interfaces, the configuration will drop by 512 when switching to Unisyn.

New Current: Unisyn now uses GPS Cog/Sog to produce a much more responsive current calculation. Changes in current are visible in seconds rather than the minutes of the old CPU software. *It is no longer necessary to have an active waypoint within 10 miles for an accurate current calculation.*

Log Functions: Since Unisyn uses a new method to calculate current, the Trip Log now extends to 1000 miles. We regret the elimination of the following log functions, Back Range and Bearing, Permanent Log, Distance Lost Boatspeed, and Distance Lost VMG.

Alternative track: Unisyn can now use COG and SOG to replace boatspeed and heading. This capability allows system operation at high latitudes where compasses are unreliable, and where boatspeed is broken.

Wind trend   Two new functions have been added to help monitor true wind. They display the shift (angle) and puff (speed) of the current wind relative to average. These functions replace the DLVS (shift) and DLVMG (puff) functions.

Windweight   A new Option has been added to adjust the displayed true wind speed to allow for changes in wind gradient. This adjustment only applies to the Windspeed True display and the windspeed input to the Polar and Target funcitons.

Light control   The back range & bearing controller card now controls lighting level for Magnum displays.

Friction Offset: The signature setting "B" on the 022 Apparent Wind Interface now uses a default offset of 0.6 Knots (CPU 14.4 was 2 Knots). The Cal. Windspeed will need to be increased 0.05 to 0.10 to compensate for the 1.4 Knots difference. This change is made to better match the new bearings in the 213 B&G MHU. A user-defined offset can be entered with the K10=n command.

New and Changed Functions:

1. DLVS has been replaced by Wind Direction Trend. The tag remains 'V', but the function is now angle (Mt minus a long-term average Mt). The averaging time defaults to 3 minutes, and is adjustable with A7= command. The average can be reset to current value by sending ctrl-U (i.e. the old DLVS display card and controls should be relabeled "Mt Trend").

   VARDAT="V",4,5,6,1,dMt,"Mt Trend"

. DLVMG has been replaced by True Windspeed Trend. The tag remains 'v', but the function is now signed knots (Vt minus a long-term average Vt). The averaging time defaults to 3 minutes, and is adjustable with A8= command. The average can be reset to current value by sending ctrl-V (i.e. the old DLVMG display card and controls should be relabeled "Vt Trend").

   VARDAT="v",1,1,5,1,dVt,"Vt Trend"

2. The Back Range & Bearing function has been removed. The controller card (ctrl-B) now cycles the lighting level for Magnum displays. 005 displays will show "----".

3. When one of the sonic interfaces is used, the following functions are enabled.

   • Axial Windspeed Apparent (tag "+", 00101011) is the component of apparent wind along the mast (positive is up). Outputs 4/sec, average number 26, default is 2 seconds. To acquaint OckamSoft with this function, you should include the following line in your OK.DAT file.

      VARDAT="+",1,1,5,1,"Vax","Wndspd App Axial"

   • Synopsis (tag ":") (normally disabled) becomes 21 chars long. The sonic data substitutes for windspeed counter and S1 to S3 voltages. The new synopsis looks like

      ppssaaaaxxxxbbbbhhmmm

      where **pp** and **ss** retain their old meaning (port and stbd boatspeed counters)

      aaaa is horizontal app wind speed in mtr/sec*100 Hex; e.g. "031D" indicates 15.5 knots horizontal apparent wind speed

      xxxx is axial app wind speed in mtr/sec*100 Hex; e.g. "FFAC" (-100 decimal) would be output when Vax is blowing down at 1 mtr/sec

      bbbb is horizontal app wind angle in tenth degrees Hex; e.g. "072F" indicates an apparent wind angle of -22.5 degrees

      hh and **mmm** retain their old meanings (heel and heading).

4. When a 3D Compass sensor is attached, Pitch (trim) is output on tag "^" (magnet pattern 01011110, wildcard code 24567) and Seastate is output on tag "~" (magnet pattern 01111110, wildcard code 234567). The old Trim interface Pitch output was on tag "N" (and still will be if it's attached).

      VARDAT="^",1,0.1,5,1,Bp,"Pitch"
      VARDAT="~",2,0.1,5,1,Ss,"Undulation"

5. When the extended 041 GPS is installed, several new functions are enabled;

   • GPS Cog/Sog is transferred into the instrument system and output on tag "U" (magnet pattern 01010101). It is also used to calculate current, resulting in a more responsive output than previously. This also eliminates the requirement that the waypoint be within 10 miles. Enable Cog/Sog output from the GPS (sentence VTG).
      VARDAT="U", 3,10,5,0,Cog,"Grnd Course"
      VARDAT="U'",2,1,5,2,Sog,"Grnd Speed"

   • GPS time resets the instrument system clock on power-up. To enable this function, enable sentence ZDA on the GPS.

- GPS magnetic variation is output in place of the value entered in the compass interface. OckamSoft will use this value in preference to the chart Magnetic Variation. To enable this function, enable sentence HVD or HVM on the GPS.

- Latitude and Longitude will output consecutively rather than Lon following Lat by 1/4 second.

6. Current (tag 'F') is now calculated from COG/SOG rather than Waypoint, and requires the 041C interface for automatic calculation (see #3 above). Older style interfaces (040 and 041B will not produce current output anymore. The C= command still allows manual entry.

7. Opposite Tack (tag 'O') now takes into account current by default; i.e. Opposite <u>Track</u> (see Option 10).

8. VMC (tag "f") can no longer be switched to COG/SOG (see Option 10 above).

9. Synopsis (tag ":") is now disabled by default. To enable synopsis, enter D:=0. Also see changes in format with sonic masthead above.

Model 001 Cpu Revision History

Rev	Date	Change
A2	6/1/82	Board E1020A1, U11-6 TO +5, U9-1 TO GND. Software S001A6
A3	6/19/82	Board E1010A2, Remove C13, U5-13 TO +5. Board E1020A2, U12-6 TO GND. SOFTWARE S001A6
A4	7/14/82	SOFTWARE S001A8B
A5	10/1/82	SOFTWARE S001A9A
A6	3/9/83	Board E1010A2, C10 from 4.7 to 68 uf. SOFTWARE S001A10
A6A	5/20/83	SOFTWARE S001A10A
A7	6/14/83	SOFTWARE S001A10B
A8	7/6/83	SOFTWARE S001A10D
A9	2/1/84	Major change to RAMEN circuit and 5V supply to help eliminate RAM lost (error 12). SOFTWARE S001A12
A10	3/1/84	Board E1010A4, E1020A3
A11	1/2/86	Software S001A14
A12	10/1/87	Add DF255 fuse to protect Q111 FET in case clock stops w/FET on.
A13	2/15/89	Software S001A14.2. Adds depth in meters/ft to Option 12.
A14	5/1/89	Board E1010B1. Add switch for Euro mode, Ground fuse.
A15	6/14/89	Software S001A14.3. Mast rotation, Euro switch code, A15 wind triangle.
A16	1/19/99	Software S001A16.3 Unisyn upgrade.

Section 5.2 - Displays & I/O

005 Display
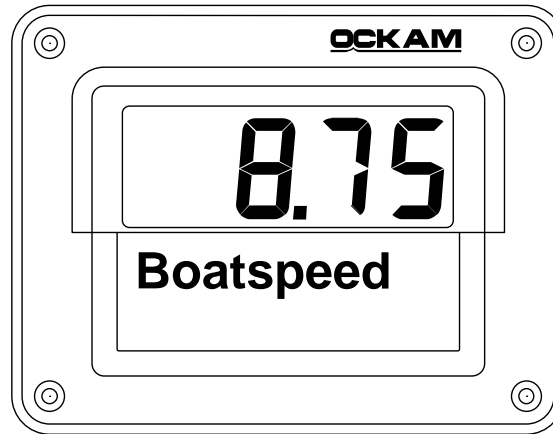
This module is the basic output device of the Ockam system. The module can display up to four digits plus sign, and various decimal points and colon. The digits are one inch high and can be backlit for night viewing.

Specifications

Bezel:	5.5 W x 4.25 H x 0.5 above mounting surface.
Cutout:	4.75 W x 3.5 H with .38 x 45° corners.
Clearance:	1.75 behind mounting surface, except 3.25 for connector.
Mounting:	#6 Screws on 4.75 x 3.5 Centers.
Weight:	1 Lb.
Orientation:	Any
Accessories:	Mounting screws with O-rings & bezel gasket.
Power:	5ma (lights off); 65ma (lights on)
Fuse:	250ma Picofuse (internal)
Mating Connector:	BNC Male (UG-88/U)

C€   The 005 Display complies with relevant sections of EU EN60945:1997 and EMC Directive 89/336/EEC.

Operation

Each display module is told what type of information to show by means of a selector "card". Each card consists of a legend area with the name of the function prominently displayed, and a set of magnets which are sensed by the display. The card thus tells the user what it is he is seeing, and tells the display what to show. Changing functions is as simple as removing one card, and clicking in another.

There are five special selector cards supplied with various interfaces that have buttons on them; Stopwatch, Distance Lost Vs, Distance Lost VMG, Trip Log and Back Range & Bearing. These cards allow the 005 display to send control commands to the CPU that control these functions. Simply insert the card into the indicator; when the button is depressed, the display sends the correct code to the CPU to control that function.

Diagnostics

The self-test function occurs when power is first applied. Successful completion causes the "all eights and punctuation" display. (The '**HI**' display normally seen after the self-test display when the system is turned on is primarily a CPU test.) If the controller's CPU or memory fails, the display will not show all eights and punctuation; it usually only shows all eights without punctuation.

The phase-lock error display occurs if the circuit that receives data from the system is having a problem. Normally, this display will appear temporarily when the bus is disturbed by plugging or unplugging modules, or when the lights are turned on or off. The **E1** is displayed when the fault occurs, and is replaced by the next display update. If the error happens when the display is frozen (no card inserted, or a card for a non-existent function), the **E1** will remain displayed, even if the cause goes away.

The card tester function is enabled by inserting the TEST CARD. Its function is to test the ability of the display to correctly read the magnetic card codes, and to test the cards themselves to see if they are properly coded. The card test function is performed as follows;

1. Insert the TEST CARD into the controller. The display should immediately show '**L377**' which is the magnet code of the TEST CARD. If it does not, it means that one or more of the magnet sensors can not read a magnet, or that the TEST CARD is defective (check the magnets; there should be 8 of them in the card).
2. Remove the TEST CARD. The display should show '**L000**', which indicates that no magnets are being sensed. This indicates that none of the sensors are stuck "on", completing the test of the controller's magnet sensors.
3. To test other cards, insert the card into the display and note the "L" reading. The value given should match the list of readings tabulated in Section 4. For instance, the Boatspeed card should give a reading of '**L102**'.
4. To return the display to normal operation, turn the system off, or unplug the display.
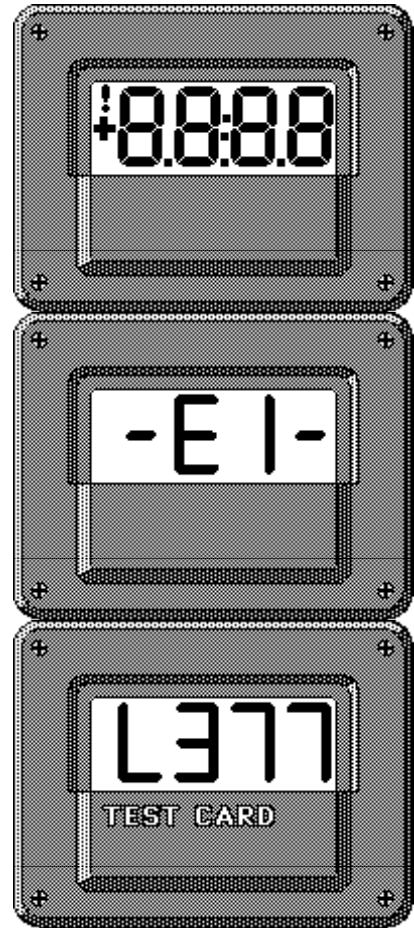
Installation

1. Select a proper location for the indicator. There must be at least 1.25" clearance behind the mounting surface for the box, and 3.25" behind the mounting surface at the bottom middle for the connector. Be sure that the surface is even so as not to torque the box too much.
2. Mark the mounting holes on 4.75" by 3.5" centers. Draw lines between these marks. Mark 45° by .38" corners on the rectangle by measuring .38" from each corner on each line, and connecting the adjacent marks.
3. Cut out the octagonal hole for the indicator body, and drill 4 #35 pilot holes for the mounting screws.
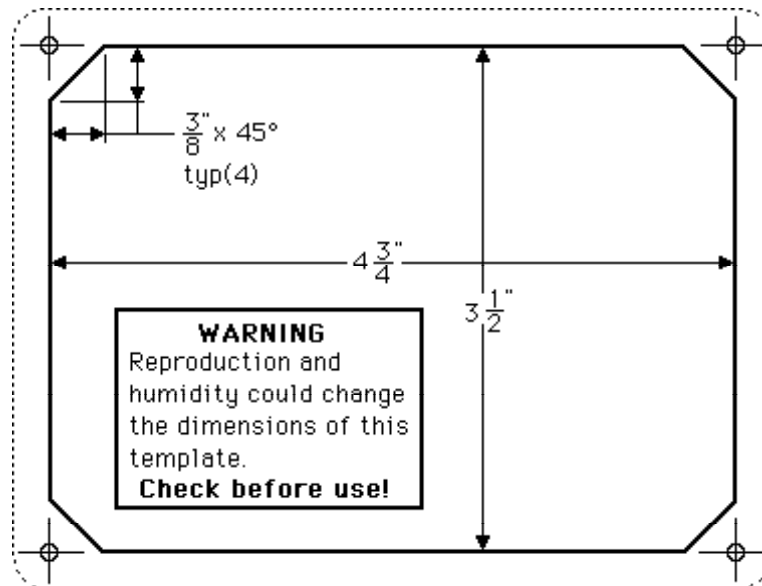
4. Run the coaxial cable through the hole, connect a MODEL 115 FMF tee, and attach the tee the indicator.
5. Put the indicator into the hole. Put the 4 O-rings onto the #6 sheet-metal screws, and screw the indicator down onto the bulkhead.

Troubleshooting

If the display fails to show anything, check other displays to be sure that the system is working. Try re-connecting the indicator to the CPU to check that the coax bus is OK. If the indicator seems to be at fault, the internal fuse should be replaced.

If the display fails to respond to a card, make sure the function is active by trying the card in another display or by using the Diagnostic cards to confirm that the required interfaces are functioning properly.

005 Display Card Magnet Positions

Magnet 8 is the right-most one when the card is inserted in an indicator in the normal orientation. In the following tables, 'rdg' is the value shown on the indicator after the indicator has been activated by the 'TEST Card' Function Card. The position of the magnet switches on the 'Controller Cards' is shown by the value of the 'rdg' shown on the indicator when the switch is activated. These switches always reside in positions 3 and 6.
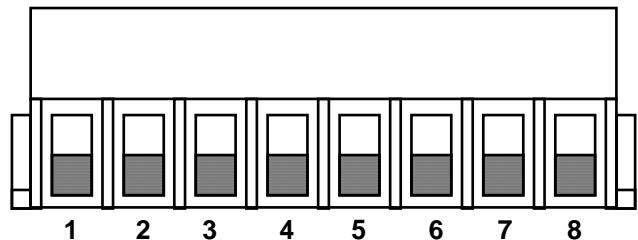
MODEL 001 CPU

rdg	Tag	P/N	Description	1	2	3	4	5	6	7	8
124	T	005TD	TIME		X		X		X		
330		005XTS	STOPWATCH	X	X	370	X	X	334		
132	Z	005ST	TEST Configuration		X		X	X		X	
172	z	005ER	TEST Errors		X	X	X	X		X	
377		005CT	TEST Cards	X	X	X	X	X	X	X	X

MODEL 015 BOATSPEED

rdg	Tag	P/N	Description	1	2	3	4	5	6	7	8
102	B	005VS	BOATSPEED		X					X	
114	L	005PL	PERMANENT LOG		X			X	X		
221		005XTL	TRIP LOG	X			X		225		X
211		005XDLS	DIST LOST VS	X				X	215		X
111	I	005CVS	CAL Boatspeed Master		X			X			X
151	i	005DVS	CAL Boatspeed Offset		X	X		X			X
113	K	005CLW	CAL LEEWAY		X			X		X	X

MODEL 022 MASTHEAD

rdg	Tag	P/N	Description	1	2	3	4	5	6	7	8
101	A	005VA	WINDSPEED Apparent		X						X
141	a	005VT	WINDSPEED True		X	X					X
142	b	005VM	VMG		X	X				X	
104	D	005BA	WIND ANGLE Apparent		X				X		
144	d	005BT	WIND ANGLE True		X	X			X		
110	H	005PH	HEEL		X			X			
150	h	005LW	LEEWAY		X	X		X			
112	J	005CBA	CAL WindAngle Offset		X			X		X	
152	j	005CVA	CAL Windspeed		X	X		X		X	
153	k	005CUP	CAL Upwash		X	X		X		X	X
311		005XDLV	DIST LOST VMG	X	X			X	315		X

MODEL 028 DEPTHSOUNDER

rdg	Tag	P/N	Description	1	2	3	4	5	6	7	8
127	W	005DWS	DEPTH Below Surface		X		X		X	X	X
167	w	005DWK	DEPTH Below Keel		X	X	X		X	X	X

MODEL 032 COMPASS

rdg	Tag	P/N	Description	1	2	3	4	5	6	7	8
103	C	005MS	HEADING		X					X	X
143	c	005MT	WIND DIRECTION		X	X				X	X
117	O	005OT	OPPOSITE TACK		X			X	X	X	X
321		005XBR	BACK Rng/Brg	X	X		X		325		X

MODEL 037 POLAR

rdg	Tag	P/N	Description	1	2	3	4	5	6	7	8
120	P	005PS	POLAR Boatspeed		X		X				
160	p	005PB	TARGET Boatspeed		X	X	X				

MODEL 040 LORAN/040C POSITION/041 GPS

rdg	Tag	P/N	Description	1	2	3	4	5	6	7	8
106	F	005CS	CURRENT Spd/Dir		X				X	X	
121	Q	005LS	STBD LAYLINE		X		X				X
161	q	005LP	PORT LAYLINE		X	X	X				X
122	R	005WR	WAYPOINT Rng/Brg		X		X			X	
146	f	005VMC	VMC		X	X			X	X	

MODEL 050 RS232

rdg	Tag	P/N	Description	1	2	3	4	5	6	7	8
060	0	005U0	USER 0			X	X				
061	1	005U1	USER 1			X	X				X
062	2	005U2	USER 2			X	X			X	
063	3	005U3	USER 3			X	X			X	X
064	4	005U4	USER 4			X	X		X		
065	5	005U5	USER 5			X	X		X		X
066	6	005U6	USER 6			X	X		X	X	
067	7	005U7	USER 7			X	X		X	X	X
070	8	005U8	USER 8			X	X	X			
071	9	005U9	USER 9			X	X	X			X

MODEL 060 RUDDER

rdg	Tag	P/N	Description	1	2	3	4	5	6	7	8
131	Y	005RA	RUDDER ANGLE		X		X	X			X
171	y	005TA	TRIM TAB ANGLE		X	X	X	X			X

MODEL 062 TRIM

rdg	Tag	P/N	Description	1	2	3	4	5	6	7	8
116	N	005TRIM	TRIM		X			X	X	X	

MODEL 066 STRAIN GAUGE

rdg	Tag	P/N	Description	1	2	3	4	5	6	7	8
115	M	005SG	LOAD CELL		X			X	X		X

MODEL 068 MAST ROTATION

rdg	Tag	P/N	Description	1	2	3	4	5	6	7	8
105	E	005MA	Mast Angle		X				X		X

MODEL 005B REMOTE CONTROL CARD SET

| rdg	Tag	P/N	Description	1	2	3	4	5	6	7	8
200		005R1	REMOTE #1	X							
204		005R2	REMOTE #2	X					X		
240		005R3	REMOTE #3	X		X					
244		005R4	REMOTE #4	X		X			X		

Test Card

This diagnostic card is to check the magnetic sensors and magnets in the 005 Display units and Cards respectively. When the test card is inserted, the indicator goes into card test mode, and display the value of any label inserted (see 'rdg' in the table above). Since the test card has a value of 377, the first indication of entry into this mode is a display of L377. Once this mode is entered, the indicator will not return to normal until the system is powered down.

Model 005 Indicator Revision History

Rev	Date	Change
A1	8/1/85	First release. SOFTWARE S005A1
A2	9/15/85	Boards E3010A2, E3020A2 (Mechanical only

007 Matryx Display

The Ockam 007 Matryx is a graphical indicator capable of displaying up to 18 user-defined pages, each containing from 1 to 4 instrument readings or a combination of graphical and numeric data for certain instrument functions. It features 128 by 160 pixel high-contrast graphics, adjustable lighting level, and remote control by push-button or the Ockam Bus, or both in addition to 4 front-mounted controls. The 007 may be mounted vertically (Portrait, as shown to the right, the default) or horizontally (Landscape) as desired. All display options are available in both orientations.
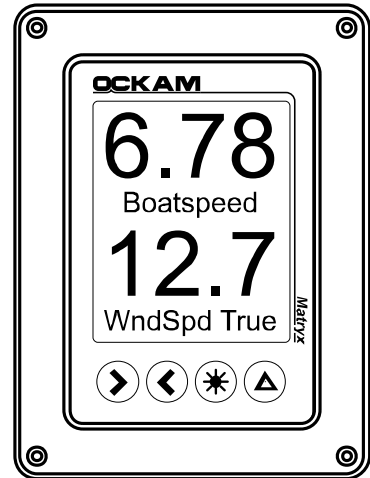
Specifications

Bezel:	8" x 6" x 1/4" above mounting surface.
Cutout:	7-1/4" x 5-1/4" with 3/4" corner radii.
Clearance:	2-1/8" behind mounting surface, except 3-1/8" for connector.
Mounting:	#6 Screws on 7-1/4" x 5-1/4" Centers.
Weight:	28 oz.
Orientation:	Portrait (tall; default) or Landscape (wide)
Accessories:	Mounting screws with O-rings & bezel gasket.
Power:	160ma (lights off); 200ma (lights on)
Fuse:	500ma Picofuse (internal)
Mating Connector:	BNC Female (UG-89/U)
Compatibility:	Any revision of system software, except remote control via Ockam Bus requires CPU software A14.3 or later.

CE   The Matryx Display complies with relevant sections of EU EN60945:1997 and EMC Directive 89/336/EEC.

Operation

Orientation & Polarity
The Matryx display can be mounted and used in either Landscape mode (wide) or Portrait mode (tall). To switch between Portrait and Landscape, press the Setup button (△), then **>>** twice to select the Display Setup page. Press **Next** to select Change Orientation, then **Sel**.

Similarly, the display will operate black-on-white (default) or white-on-black. Repeat the procedure above to the Display Setup page, then select Invert Display and **Sel**.

Display pages
The Ockam Matryx displays one of up to 18 pages of information. Each page consists of from one to four numeric items (e.g. Boatspeed, True Wind Speed, etc.) along with its description, or one of 6 stripcharts (plots of instrument functions versus time) with its associated numeric and average values.

Pages can be added (up to 18), deleted (minimum of 1) and modified as required using the front buttons. The current page is selected using the front or remote buttons (if attached), or via commands from an onboard computer.

Instrument items available for display consist of about 79 items (see item list below). Availability of these items depends on the configuration of your instrument system (see Section 4).

Controls

The Ockam Matryx has four front-mounted control buttons and rear terminals for connecting two remote momentary push-buttons. These provide the means for manually controlling what page the indicator displays.

(▶)(◀)   These two buttons (and the remote buttons, if connected) step forward and backward through the defined pages.

(✱)   This button controls the display's light level in 4 steps. In addition, the overall brightness of Matryx and Magnum displays in the system may be set using the Instrument Setup/Set system Options/Sys light level function (see below).

(△) **Display Setup**

This button brings up the setup pages, used to modify the pages list for the display. In addition, instrument control items can be set from here. When in setup, the 4 buttons are redefined as needed for the particular page, and their function labels become visible.

Page Setup
Modify current page
Add new page
Delete current page

This is the first setup page, and allows you to add, delete or modify the display page list. If you want to do one of these, use the **Next** button to highlight the desired action, then press **Sel**.

Add and Modify bring up another page (see **Adding or Modifying Pages** below) where you will be asked about which instrument functions to include on the new or current page. Delete simply removes the current page and exits setup.

To leave setup, press **Abort**. To move on to the instrument setup page, press **>>**.

Instrument Setup
Stopwatch & Resets
Set calibrations
Set system averages
Set system options

This setup page allows you to:
1. Control the instrument stopwatch, log and delta wind displays;
2. Adjust the instrument calibrations;
3. Change the instrument averages;
4. Set certain instrument options.

If you want to do one of these, use the **Next** button to highlight the desired action, then press **Sel**.
To leave setup, press **Abort**. To move on to the display setup page, press **>>**.

Display Setup
Set display address
Invert display
Change orientation
Reset display

This setup page allows you to:
1. Set the display address (computer remote control: see below);
2. Switch between black-on-white and white-on-black display;
3. Change display orientation between landscape and portrait;
4. Reset the display to factory settings.

If you want to do one of these, use the **Next** button to highlight the desired action, then press **Sel**.
To leave setup, press **Abort**. To return to page setup, press **>>**.

Adding or Modifying Pages

```
   Page 1 item 1/2
User 9
VMC
VMG
Wind Dir.
Wind< App
Wind< True
Windspd App
WindspdTrue
```

From Page Setup/Add Page or Page Setup/Modify Page, you get a list of available functions to add or change. The title shows the Page and item numbers, and, for Modify, the selection will be placed on the present item.

Press **>>** to move down 1 screen or **Next** to move down 1 item until you have reached the desired item, then press **Sel**. The screen repeats until all items have been selected (up to 4/4). When modifying, pressing **Abort** before all items are selected leaves the remaining items at their existing values. Pressing **Abort** while Adding a page prevents its creation.

This is the complete list of items available

ApWnd Axial (Tag +)	Course Gnd (Tag U)	Longitude (Tag X)	User 1 (Tag 1)
AirTemp (Tag G)	Curr Set (Tag F)	Mag Var. (Tag o)	User 2 (Tag 2)
Aux 1 (Tag M)	Curr Drift (Tag F')	Mast Angle (Tag E)	User 3 (Tag 3)
Aux 2 (Tag m)	Delta Wdr (Tag V)	NMEA stuff (Tag $)	User 4 (Tag 4)
Aux 3 (Tag N)	Delta Wsp (Tag v)	Opp track (Tag O)	User 5 (Tag 5)
Aux 4 (Tag n)	Depth Surf (Tag W)	Polar 037 (Tag P)	User 6 (Tag 6)
Back Brg (Tag r)	DepthKeel (Tag w)	Pitch (Tag ^)	User 7 (Tag 7)
Back Range (Tag r')	Enemy Brg (Tag >)	Rudder < (Tag Y)	User 8 (Tag 8)
BaroTrend (Tag g)	Enemy Rng (Tag >')	Sea State (Tag ~)	User 9 (Tag 9)
Barometr (Tag g')	Errors (Tag z)	SeaTemp (Tag G')	VMC (Tag f)
Boatspeed (Tag B)	Heading (Tag C)	Setup Cmds (Tag @)	VMG (Tag b)
CAL Vs Mstr (Tag I)	Heel (Tag H)	Speed Gnd (Tag U')	Windspd App (Tag A)
CALVsOffst (Tag I)	Latitude (Tag X')	Stopwatch (Tag t)	WindspdTrue (Tag a)
CAL W<Offst (Tag J)	Layln Stbd (Tag Q)	Synopsis (Tag :)	Wind Dir. (Tag c)
CAL Wndspd (Tag j)	Layln Port (Tag q)	Target 037 (Tag p)	Wind< App (Tag D)
CAL Leeway (Tag K)	Leeway (Tag h)	Ticker (Tag ,)	Wind< True (Tag d)
CAL Upwash (Tag k)	Lights (Tag *)	Time (Tag T)	Wpt Brg (Tag R)
CAL UpSlope (Tag k')	Log Perm (Tag L)	Trimtab < (Tag y)	Wpt Range (Tag R')
Config (Tag Z)	Log Trip (Tag l)	User 0 (Tag 0)	

It is possible that instrument functions are being generated which are not in this list, for instance by a custom interface. These custom functions will be identified by the word "Tag " and the tag letter. If you know you have an output and it is not shown, scroll down to the T's and select the appropriate "Tag" entry. If you have an onboard computer attached to the Ockam System, you can rename these functions to a more meaningful description (see Redefining tag descriptors).

Stopwatch & Resets

```
      Resets
Sw Start/Stop
Sw Reset/Sync
Trip Log
Delta Mt
Delta Vt
```

(△) then **>>** to Instrument Setup, then **Sel** Stopwatch & Resets. This is a "sticky" page in that it stays up until you press **Abort**. Press **Next** to select the desired function, then press **Sel**. to execute the function.

See Stopwatch controller functions.

Alternatively, by ptessing the (△) key, and selecting "Add a new page", then "Controller" provides stopwatch, log and wind delta control with the selected function displayed on screen (this is the recommended method when a second Ockam display is not available to view the function). Note: In this mode, the Matryx buttons function according to the on-screen prompts, consequently Stopwatch control temporarily eliminates the ability to "page back".

EEPROM

Page and display configuration is stored in an EEPROM, which has a limited number of write cycles. In order to reduce wear and tear, changes in page and display configuration are written to

the EEPROM 1 minute after the last change to these items. After you change the display, if the changes are important, wait at least 1 minute before powering down the display.

If the Flag Message "**EEPROM Failed**" occurs consistently on power-up, the display should be returned for service.

Installation

1. Select a proper location for the indicator. There must be at least 2-1/8" clearance behind the mounting surface for the box, and 3-1/8" behind the mounting surface on the top (portrait mount) or left side (landscape mount) for the connector. Be sure that the surface is even so as not to torque the box. Mark the mounting holes on 7-1/4" by 5-1/4" centers. Draw lines between these marks with 3/4" radii at the corners of the rectangle. Cut out the hole for the indicator body, kerf outside the lines, and drill 4 #35 pilot holes for the mounting screws.

2. Pull the bus cable(s) through the hole, connect a 115 FMF tee, and attach the tee to the bus. Attach button wires to the button terminals if desired. Wire tie the cables to the strain-relief, and mount the indicator and mounting pad in the hole with the 4 O-rings under the screws.

3. Power the system and set the correct orientation (see **Orientation & Polarity** above).

4. If computer remote control is going to be used, set the display number (see above) so that all Matryx and Magnum displays have unique numbers. If you set the display number to 0, the display can not be accessed by commands on the Ockam Bus.

5. Changes in page and display configuration are written to the EEPROM 1 minute after the last change to these items. After you set up the display, wait at least 1 minute before powering down the system.

Troubleshooting

If the display fails to show anything, check other displays to be sure that the system is working. Try re-connecting the indicator to the CPU to check that the coax bus is OK. If the indicator seems to be at fault, the internal fuse should be replaced.

If the display fails to respond to the buttons or Ockam Bus commands, check that the display number is not set to zero, and that CPU software revision is A14.3 or later.

Pressing all 4 buttons at once "reboots" the display.

Adjusting Buttons

If the front panel buttons do not respond as expected, they may require adjustment as follows:

1. Remove the dessicator plug (the blue thing on the back) from the box.

2. Determine the button to be adjusted. Note the position of the corresponding adjustment potentiometer as shown on the back label of the Matryx display. Use the LGS to adjust the potentiometer inside the unit until the button is constantly on (fully counter-clockwise). This sets button sensitivity to its maximum.
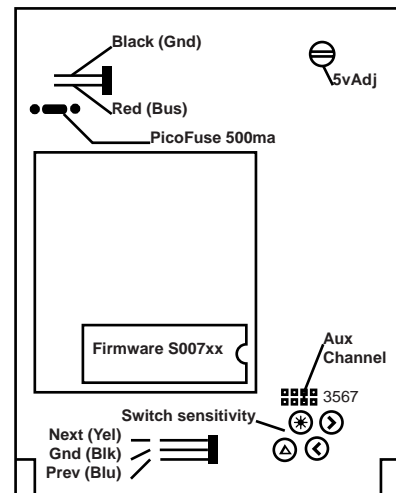
3. Adjust the potentiometer until the button just turns off. Note: the potentiometer may be fully counter-clockwise without triggering the button. Note the position of the potentiometer; Counter-clockwise from this point will cause the button to be in the triggered condition.

4. Turn the potentiometer all the way clockwise. This adjusts the button sensitivity to its minimum.

5. Press and hold the button under adjustment. Move the potentiometer in the counter-clockwise direction to increase sensitivity until the button is triggered.

6. Press the button to check its operation. If it does not operate easily, adjust the potentiometer counter-clockwise slightly, being careful not to move the potentiometer too far.

7. Repeat steps 2 through 5 for each button (previous, next, lights, and setup).

Model 007 Indicator Revision History

Rev	Date	Change
A1	9/27/99	First release. Software 1.01.
A2	3/3/00	S007A2. Fix reset to display default screen.
A3	4/4/00	S007A3. Fix FET and reset diode.
A4	4/10/00	Added controller pages.
B1	4/25/00	Ver 1.10. More controller pages.
B2	7/27/01	Ver 1.20. Fix controller page resets, add QuikCal. This rev works on both boards
B3	5/24/02	Rev 1.21. Increase tag storage to 100, create storage for custom descriptors.
B4	11/4/02	Rev 1.22. Fix issue with remote command creating page but not switching to it.
B5	7/8/03	Rev 1.30. New RDC processor.
B6	9/24/04	Change LCD to DMF5001NYJLY-AQE-AZ.
B7	7/18/06	Change LCD to Vishay LCD-160G128B-TFK-VZ and eliminate negative supply.

044 Magnum Large Format Display
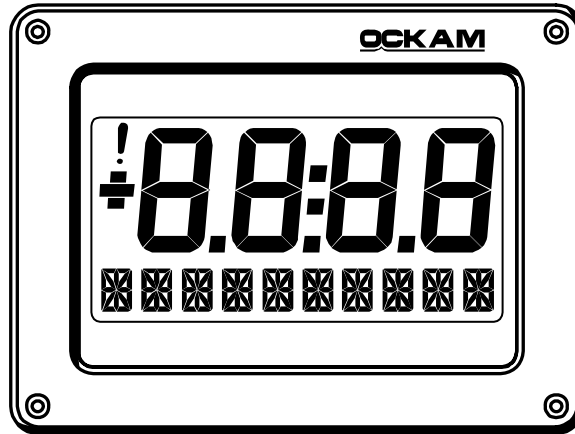
The Ockam 044 Magnum is a large format remote-controlled indicator featuring a 1-3/4" numeric display, 10 character british-flag descriptor display, 15 function menus, adjustable lighting level, and remote control by push-button or the Ockam Bus, or both.

Specifications

Bezel:	8" W x 6" H x 1/4" above mounting surface.
Cutout:	7-1/4" W x 5-1/4" H with 3/4" corner radii.
Clearance:	2-1/8" behind mounting surface, except 3-1/8" for connector.
Mounting:	#6 Screws on 7-1/4" x 5-1/4" Centers.
Weight:	28 oz.
Orientation:	Any
Power:	25ma (lights off); 50ma (lights on)
Fuse:	250ma Picofuse (internal)
Mating Connector:	BNC Female (UG-89/U)
Compatibility:	T1 or 001 CPU software A14.3 or later.

Operation

Controls
The Ockam Magnum is controlled by two external pushbuttons or by Remote Commands. Three internal rotary switches accessible through the desicator hole set the menu that the buttons or command steps through.

Normally, the internal switches are set to specify one of 15 (*16 for rev B2B or later*) function menus (S1) and the default item in that menu (S2). The external buttons and commands step up and down through this menu. An indicator number is set by S3 which sets the address for the remote commands. The wwitches are numbered 0 thru 9 and "A" thru "F" to represent 10 thru 15.
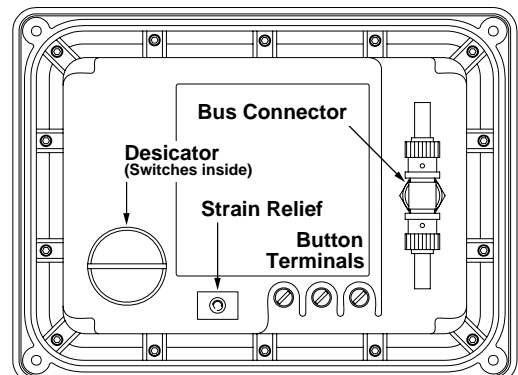
For example, if all three internal switches are set to 1, (Indicator 1, Menu 1, Selection 1), Boatspeed will be displayed when the indicator powers up. The UP button will switch the display to Stopwatch, then Target Boatspeed and so on. The DOWN button will step the display back to Stopwatch, then Boatspeed, then Wind direction and so on. The indicator will also respond to Ockam Bus commands addressed to J1 (see Remote Display Commands).

MENU #1	
Item	Function
1	Boatspeed
2	Stopwatch
3	Target Boatspeed
4	Windspeed True
5	Windangle True
6	Wind Direction

Setting the Display to a fixed function
Setting the indicator number (S3) to 0 will cause the indicator to interpret S1 and S2 as a tag in "hex" (e.g. Boatspeed is 42 hex, see Tags). This allows the indicator to be set to any function. In this mode, the external buttons have no effect, and remote control via the Ockam Bus is not possible.

Remote control via the Ockam Bus
Magnum displays with non-zero indicator numbers (S3) can be controlled via Remote Display Commands.

Redefining descriptors (Magnum Rev B2B or later)
Items not included in the internal database will be labeled "Tag x". You can 'rename' these descriptors with a remote command (see Redefining tag descriptors).

User-Defined Menu (Magnum Rev B2B or later)
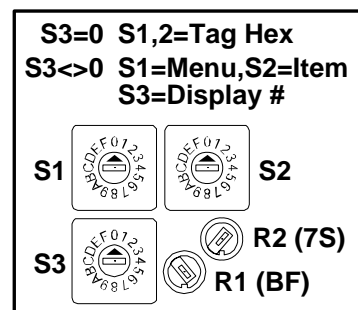You can define your own menu (Menu #0) via Remote Display Commands.

Menus

Menu 0 (B2B or later)	Menu #1	Menu #2	Menu #3
Software defined (see Remote Display Commands).	Boatspeed	Boatspeed	Boatspeed
	Stopwatch	Stopwatch	Stopwatch
	Target Boatspeed	Target Boatspeed	Target Boatspeed
	Windspeed True	Polar Boatspeed	Windangle Apparent
	Windangle True	Heading	Heading
	Wind Direction	Windspeed True	Windspeed True
		Windangle True	Wind Direction
		Windangle Apparent	
		Wind Direction	

Menu #4	Menu #5	Menu #6	Menu #7
Boatspeed	Boatspeed	Windangle Apparent	Heading
Heading	Heading	Windangle True	Waypoint
Wind Direction	Depth Keel	Windspeed Apparent	Range/Bearing
Windspeed True	Wind Direction	Windspeed True	Opposite Tack
Windangle Apparent	Windspeed True	Wind Direction	Trip Log
Depth Keel		Heel Angle	Back Range/Bearing
		Trim Angle	Depth Keel

Menu #8	Menu #9	Menu #10 ("A")	Menu #11 ("B")
Heading	Boatspeed	Boatspeed	Boatspeed
Opposite Tack	Target Boatspeed	Stopwatch	Stopwatch
Layline Starboard	Windangle Apparent	User 1	User 1
Layline Port	Windangle True	User 2	User 2
Current Set/Drift	Loadcell #1	User 3	User 3
Depth Keel	Heel Angle	Windspeed True	Heading
		Windangle True	Windspeed True
		Wind Direction	Windangle True
			Windangle Apparent
			Wind Direction

Menu #12 ("C")	Menu #13 ("D")	Menu #14 ("E")	Menu #15 ("F")
Loadcell 2	User 0 thru 9	CAL Boatspeed	*Everything!*
Loadcell 4	(10 items)	Master	
Rudder		CAL Windangle Offset	
Trimtab		CAL Leeway	
		CAL Boatspeed Offset	
		CAL Windspeed	
		CAL Upwash	
		TEST Configuration	
		TEST Errors	

Installation

1 Determine the required menu and selection settings for the installation. For mast displays, you might set all S1 to 1 (Menu 1), S2 to 1, 2… to select successive default items in the menu, and set S3 to 1, 2… so the indicator numbers correspond to their order on the mast. Unscrew the desiccator and set the proper values into S1-3.

There are also two pots which set the drive voltage to the LCD. R1 sets the voltage for the british-flag display, and R2 sets the numeric display. Verify that these pots are set correctly for the normal viewing angle (R1 is normally set to 10 o'clock, and R2 full CCW).

```
S3=0   S1,2=Tag Hex
S3<>0  S1=Menu,S2=Item
       S3=Display #

S1          S2

S3          R2 (7S)
            R1 (BF)
```

2 Select a proper location for the indicator. There must be at least 2-1/8" clearance behind the mounting surface for the box, and 3-1/8" behind the mounting surface on the left side for the connector. Be sure that the surface is even so as not to torque the box. Mark the mounting holes on 7-1/4" by 5-1/4" centers. Draw lines between these marks with 3/4" radii at the corners of the rectangle. Cut out the hole for the indicator body, kerf outside the lines, and drill 4 #35 pilot holes for the mounting screws.

3 Pull the cables through the hole, connect a 115 FMF tee, and attach the tee the bus. Attach the button wires to the button terminals. Wire tie the cables to the strain-relief, and mount the indicator in the hole with the 4 O-rings under the #6 screws.
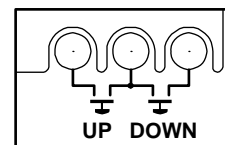
```
UP   DOWN
```

Troubleshooting

If the display fails to show anything, check other displays to be sure that the system is working. Try re-connecting the indicator to the CPU to check that the coax bus is OK. If the indicator seems to be at fault, the internal fuse should be replaced.

If the display fails to respond to the buttons or Ockam Bus commands, check that the indicator number switch (S3) is not set to zero, and that CPU software revision is A14.3 or later.

Model 044 Indicator Revision History

Rev	Date	Change
A1	2/21/94	First release.
A2		Change Polarization axsis to zero
A3	12/30/96	Remove tape from fiber-optic back light
A4	11/96	Switch to anti-glare glass (S/N 16530)
A5	6/23/98	Make backboard work with 89C52 40-pin dip pkg
A6	8/17/99	Use magdelta.hex cs:A583 for Delta WD (made active 02/27/02)
B2B	6/23/06	Single-board A3400B2 using HC12. Major rewrite of code.

058 Lynx wireless controller
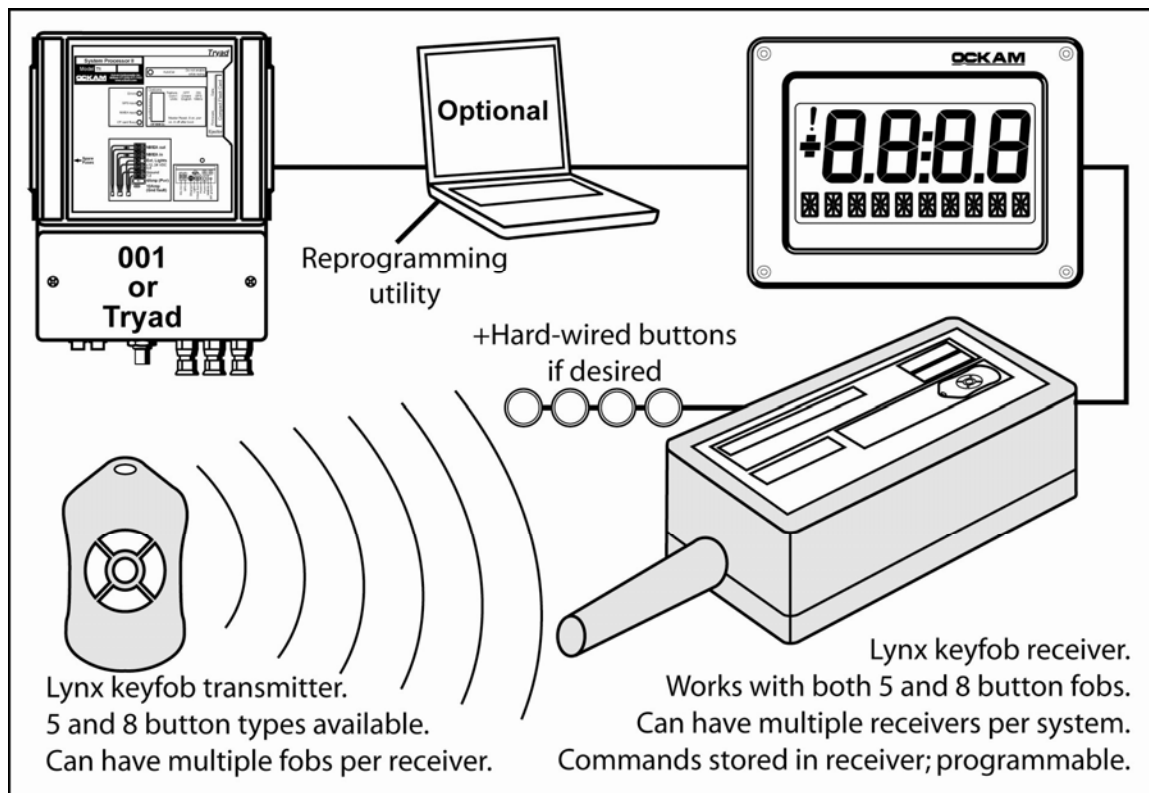
Lynx is an affordable wireless <u>programmable</u> remote controller for the Ockam system. It responds to 'key fob' controllers or wired buttons (or both). In addition to the convenience, it replaces the heavy hard wiring traditionally installed for controlling mast displays, by sending control commands over the Ockam bus.

The Lynx receiver stores 8 sets of commands which are triggered by the associated transmitter (or transmitters; a Lynx receiver can be triggered by any number of properly keyed wireless controllers). The receiver also has the ability to be triggered by up to 4 hard-wired buttons.

Lynx is capable of outputting any of the Ockam system command set. As supplied, key fob buttons 1 and 3 step mast display pages, buttons 2 and 4 control the stopwatch and button 5 does a 'man overboard' function[1]. Hard-wired buttons perform functions 5 thru 8, #5 being common with button 5 of the key fob.

The OckamSoft 4 driver (rev. 4.07 or later) provides an easy way to reassign the button commands to suit your needs.

If needed, up to 16 Lynx receivers can be attached to the system, each with its own set of keyed controllers and buttons. Of course, each receiver would be programmed with its own set of commands.

---

[1]Note: Some Ockam systems do not output back range & bearing.
Test the man-overboard feature before relying on it.


Specifications

Receiver component:

Dimensions:	4" W x 2" H x 1-3/4" D (less antenna and BNC)
Mounting:	3M DualLock
Weight:	¼ Lb.
Power Requirements:	55ma
Fuse:	250ma Picofuse
Mating Connections:	Ockam Bus: BNC Female
	Buttons & beeper: 6 position terminal strip
Operating frequency:	418 Mhz.

Transmitter component: (multiple transmitters may be used)

Standard:	5-button key fob
Optional:	8-button controller

One 5-Button key fob is supplied with the 058. Additional fobs may be purchased to trigger the same receiver. Receiver serial number must be supplied at time of order.
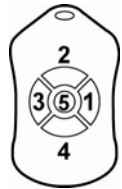
The 8-Button controller may be purchased separately. It provides access to all 8 functions of the receiver. Receiver serial number must be supplied at time of order.

Installation
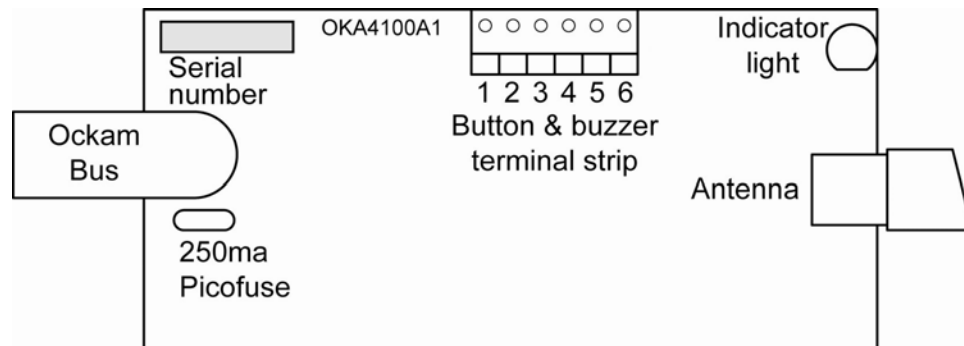
Connect the Lynx receiver to the Ockam bus. On power-up the LED should quick-flash. Pick a protected location (the receiver is not waterproof). You may need to experiment to find the correct location and antenna orientation for proper operation with the key fob. Try the key fob to confirm proper operation. Each button push should blink the LED.

If connecting hardware buttons, use normally-open momentary types, and connect as shown. The buttons trigger receiver functions 5 thru 8, allowing 3 independent actions, plus 1 common with the 5-button fob.

A buzzer may also be attached. It provides an audible sound in parallel with the LED. Pin 6 of the receiver terminal strip is an open-collector transistor capable of 50ma drive current.

Ensure the key fob serial numbers match the serial number of the receiver.
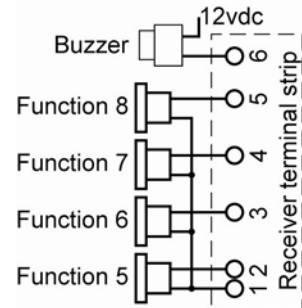
Replacing the transmitter battery

If the Lynx stops working or the operating range becomes too short, the transmitter battery probably needs replacement. Both the 5-button and 8-button transmitters use coin cells type **CR2032**, available in camera stores or over the internet. To replace the battery;

5-button fob

- Pry open the case using a dime.

- Remove the circuit board.

- Pull out the battery and replace with a fresh one. Observe polarity; the wider diameter goes UP.

- Reverse the disassembly.
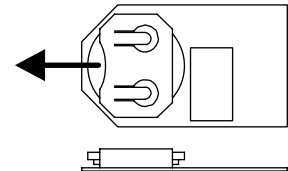
8-button controller

- Slide the battery compartment cover off.

- Pull out the battery and replace with a fresh one. Observe polarity; the wider diameter goes UP.

- Reverse the disassembly.
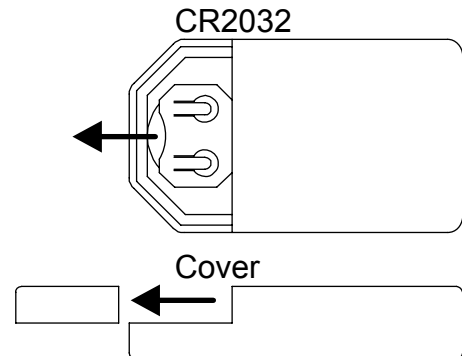
Programming the receiver

The Lynx is programmed through the Ockam bus using '@' frames. This method is tedious but totally flexible. To use this method, refer to the Communications protocol section below. For most people, the OS4 driver (rev. 4.07 or later) is much handier.

Using the OS4 Driver

1. Open the OckamSoft 4 driver and select the Lynx Remotes tab.

2. If it says "There are no Lynx attached", check that the lynx receiver is attached to the Ockam bus. Then press the ReScan button and wait for the receiver to be detected.
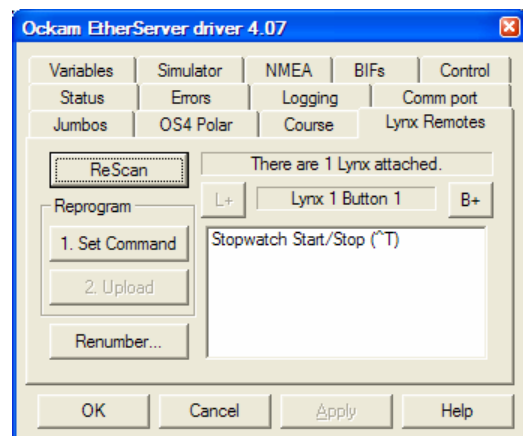
3. Use the B+ button to review the button assignments. If more than one Lynx is attached, use the L+ button to select the Lynx.

4. To reprogram a button, press Set Command. Pick the desired command from the droplist, and press OK.

5. If you do not find what you want, fill in the Ockam command and a description. Press Test to confirm the command does what you expect, then Add to the droplist. Select your newly minted command from the droplist and press OK.

6. The Lynx dialog shows your new definition, and the Upload button becomes active, indicating that the Lynx button definitions have changed.

7. If you want to stack more than one command on a button, check Append before pressing OK.

8. After re-defining your buttons, press the Upload button to reprogram the Lynx receiver(s).
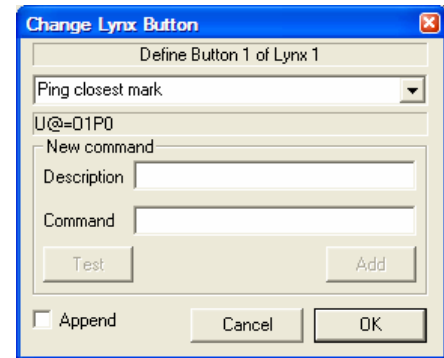
Adding a Second Lynx

To add another Lynx receiver to your system (which adds another set of 8 commands), you must renumber Lynx #1 to some other number, so you can then attach another Lynx (all Lynx are shipped set to #1). To renumber a Lynx;

1. Select Lynx #1 and press Renumber.

2. Enter the new number and press OK. The Lynx will be renumbered, and a new scan is initiated.

3. Connect the new lynx (new #1) and press ReScan.

Communications protocol

The Lynx listens to the display channel for frames beginning with "@Ln" where n (1 thru 16) is its current address. To send this type of frame, send a direct command using the User command syntax "U@=Ln..."

Example:

Let's say you wanted to assign "Jumbo 1 Up" to button 1 of the receiver.

Description	Command
When Jumbo 1 hears "@J1S+", it advances to the next page.	@J1S+
To place this command on the bus, one would enter a user command (User output to tag '@').	U@=J1S+
When Lynx receiver n hears a frame like this, it reprograms button m to <command>.	@LnCm<command>

Therefore, to reprogram Button 1 on Lynx 1 to advance Jumbo 1, enter this user command.	U@=L1C1U@=J1S+
This command adds "Jumbo 2 Up" to the same button, so the button 1 advances both Jumbos at the same time. Note the 'C1+' which appends rather than replaces and the 'J2' which specifies Jumbo #2.	U@=L1C1+U@=J2S+

Each command received by the receiver is signaled by a quick-flashing of the LED.

Lynx commands

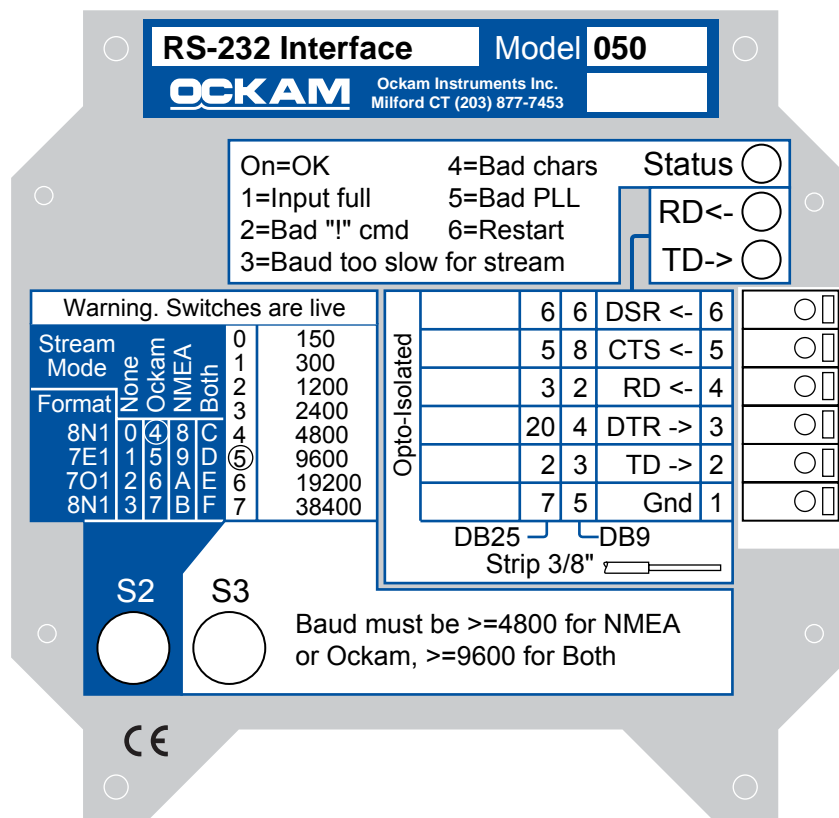|	
U@=LnAm U@=LnAm	Change address of Lynx n to address m (1 thru 16). Allows multiple receivers to be configured on the same system. Lynx ignores commands where n=m. NOTE: in order to prevent accidental address change, this command must be received twice in succession by the Lynx before the address is changed.
U@=LnB$mcTag$	Output Lynx n button m (1 to 8) command c (1 to 8) on tag Tag. This command is used to read out the contents of the receiver key buffers (e.g. by the OS4 driver).
U@=LnC$mCmd$ U@=LnC$m+Cmd$	Set Lynx n button m to Cmd. If the command starts with '+', the command is appended, allowing for multiple commands to be assigned to the same button.
U@=LnDtag	Used for troubleshooting. After this command is issued, Lynx output is additionally sent as $TagCmd$. This assignment is cleared on power-up. To clear the debug feature without removing power, send "U@=LnD".
U@=LnVtag	Output Lynx receiver version information on tag tag.
U@= LnZdur	Quick-flash the LED (and buzzer, if attached) for dur ATUs; (an ATU is about 0.01 seconds).

Lynx command set files

The Lynx receiver does not store a description. The translation is provided to the OS4 driver by the file LynxCmds.txt, located in the OckamSoft 4 directory. When you define a new command, it is appended to the file. If this file becomes corrupted, you can download a fresh copy from http://www.ockam.com/Lynx

A second file is provided, Lynx Presets.txt, which describes the default settings for the Lynx receiver.

Revision History

Rev	Date	Change
1.00	5/24/06	1st Revision.

050 RS-232 Interface 050

RS-232 Interface   Model **050**

OCKAM Ockam Instruments Inc.
Milford CT (203) 877-7453

On=OK	4=Bad chars
1=Input full	5=Bad PLL
2=Bad "!" cmd	6=Restart
3=Baud too slow for stream	

Status ◯
RD<- ◯
TD-> ◯

Warning. Switches are live

Stream Mode	None	Ockam	NMEA	Both	0	150
Format					1	300
					2	1200
					3	2400
8N1	0	④	8	C	4	4800
7E1	1	⑤	9	D	⑤	9600
7O1	2	6	A	E	6	19200
8N1	3	7	B	F	7	38400

Opto-Isolated

	6	6	DSR <-	6	◯▯
	5	8	CTS <-	5	◯▯
	3	2	RD <-	4	◯▯
	20	4	DTR ->	3	◯▯
	2	3	TD ->	2	◯▯
	7	5	Gnd	1	◯▯

DB25 ⌐   ⌐ DB9
Strip 3/8"

S2   S3

Baud must be >=4800 for NMEA
or Ockam, >=9600 for Both

C E

The 050D RS232 interface links the Ockam System to a computer. This link provides access to the system's display and keyboard channels, allowing the computer to read display and polar curve data, control certain aspects of the CPU's operation, control operation of the 044 Magnum indicators and certain other devices, and display calculated functions on the system's indicators. The 050D can also connect to Ockam's NMEA channel, which in conjunction with the 041 GPS interface, provides complete bidirectional access to the GPS by the computer.

Specifications

Dimensions:	4-3/4" W x 4-3/4" H x 2" D
Mounting:	Velcro™ or 10-24 x 5/8" on 4-5/16" x 3-1/2" Ctrs
Weight:	1 Lb.
Orientation:	Any
Accessories:	10 Display Cards
Power Requirements:	45ma
Fuse:	250ma Picofuse (back board)
Mating Connector:	BUS: BNC Female (UG-89/U)
	RS232: Terminal strip (DB9 & DB25 pigtails available)
Compatible Devices:	Any Computer with RS232 I/O

C E   The 050 RS-232 Interface complies with relevant sections of EU EN60945:1997 and EMC Directive 89/336/EEC.

A computer coupled to an Ockam System is a very powerful tool, because it allows you do things with your instruments that simply can not be done any other way. The most important use for the RS232 interface is as a source of data for OckamSoft™ or other graphical display and control programs. These programs provide information in graphic form such as racecourses, maps,

stripcharts, polars, sail selection etc. They also derive important variables using data which the instrument system does not have, such as time to the starting line and waypoint data from data stored in the computer.

All systems designers make assumptions about what type of boat their equipment is going to be used on. The way the system responds to the environment is based on these assumptions. Your requirements may be entirely different, and the RS232 interface allows you to adjust averaging, enter waypoints and current, to make the system behave the way that is best for you.

Theory of Operation
The RS232 interface connects your computer to the Ockam system. Its job is to supply your computer with instrument information (e.g. Boatspeed, True wind Direction, etc.), and send your instructions to the OCK-AM system (for changing averages, controlling functions, etc.).
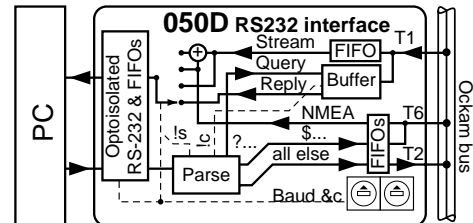
Input to your computer

The interface sends information to your computer in one of four ways as specified by interface switch S2 on power-up or by subsequent "!" command lines from the computer;

- Protocol mode causes the interface to output data only when asked. The interface waits for your computer to ask for specific data, then returns the value(s). The 050D interface buffers data internally, minimizing response time.

  The advantage of this type of output is that your computer does not have to weed through a bunch of (at the moment) irrelevant data to find what it wants. The disadvantage is that there is a turn-around time involved, and the requesting software can sometimes hang because the interface and computer can both think it is the other's turn to say something.

- Ockam stream output causes all Ockam display data to continuously flow to the computer. It sends your computer EVERYTHING that comes out of the OCKAM system (about 400 characters per second). This type of output is generally input to an Ockam driver that separates the data and stores it in an array inside the computer, so it is instantly available to any program.

  The advantage of this type of output is that the data arriving at your computer is as up-to-date as it can be, and if an Ockam driver is installed, is available without any communication delay. Its disadvantage is that your computer has to handle information at up to 480 characters per second (about 10% of an 8086, much less on an 80X86).

- NMEA stream output causes NMEA data to continuously flow to the computer.

- Interleaved output causes both NMEA and Ockam data to flow to the computer. NMEA sentences are sent imbedded in Ockam tag "$". Because two streams are melded together within the interface, the data rate can be as high as 960 characters per second.

Output from your computer

Output to the interface is generally in the form of lines, that is, a string of characters terminated with carriage return. The exception is control characters, which are stripped out and sent directly to the Ockam system. Output lines can be;

- ?<tag>[<tag>...]<cr> is the form for requesting data when the interface is in protocol mode. The interface responds with the value for the specified tag(s), separated by commas and ending with <cr><lf> (tags are enumerated in section 4). Tags can be followed by apostrophe ("'" meaning the "prime" or alternate value, e.g. the range value for tag R, waypoint range and bearing) or accent grave ("`" meaning both values).

Example:	To interface	Response
Request boatspeed	?B<cr>	6.57<cr><lf>
Request Waypoint range and bearing	?R'R<cr>	14.56,314<cr><lf>
Same thing	?R`<cr>	14.56,314<cr><lf>

- !...<cr> are commands to the interface itself. !S0 switches the interface to Protocol, !S1 to Ockam streamer, !S2 to NMEA streamer and !S3 to Interleaved output. !C<tag> erases the Ockam data buffer associated with Protocol input for <tag>.

- $...<cr> outputs data to the NMEA channel. This sentence allows the computer to source data for any NMEA devices receiving data from the Ockam bus. Since the 041 GPS interface can also source data on the NMEA channel, you should first disable it before using the $ command (see Operation with the 041 below).

All other lines and most control characters are treated as output to the Ockam keyboard channel. These lines are detailed in section 4 of the manual, and include;

- <Control-char> all control characters except <cr>, <lf>, <null> and <esc> pass to Ockam which uses them to control stopwatch, back range & bearing, trip log and distance lost.

- A<n>=<sec><cr> sets averaging time for Ockam data output.

- C=<speed>[,<direction>]<cr> specifies current set & drift.

- K<n>=<cal><cr> temporarily changes the Ockam calibrations.

- O<n>=<m><cr> controls various options of the instruments including time, stopwatch and polar display format, wind twist, reef and flat, current control, mast height, lighting level for Magnums, VMC and units of measure.

- P=<Bt>[,<Vt>[,<polar#>]]<cr> requests a polar data point.

- T=<time><cr> sets the Ockam clock.

- U<tag>=...<cr> sends data to Ockam displays and control data to Magnum displays and certain interfaces.

- W=<bearing>[,<range>]<cr> specifies the Ockam waypoint.

Installation

The computer connects to the interface by a 6 position terminal strip and pigtail with 9-pin female D connector (25-pin pigtails are available on special order). The diagram shows the connection to a PC.

To PC (Data terminal equipment (DTE))   050 RS232 interface (Data comm. equip. (DCE))

DB9F	DB25F		
1	8	<-Data carrier detect (DCD)	
6	6	<-Data set ready (DSR)	↑True
8	5	<-Clear to send (CTS)	↑True
2	3	<-Receive data (RD)	↓Mark
4	20	Data terminal ready (DTR)->	↑True
3	2	Transmit data (TD)->	↓Mark
5	7	<-Ground (SG)->	

DTR false stops RD   DSR,DCD
CTS false stops TD   passive true

You need to decide which mode, how many data bits, type of parity and at what baud rate to run. Then set interface switches S1(left) and S2 (right) to the appropriate values.
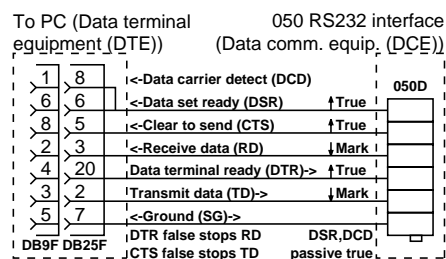
Settings by application

Application	Settings	S1	S2
OckamSoft 2/MapTech	9600,N,7,1 Ockam Streamer	4	5
Compusail	9600,N,8,1 Ockam Streamer	4	D
NMEA applications	4800,N,8,1 NMEA Streamer	8	C

S2 (Parity & default operating mode)

Mode	No parity	Even parity	Odd parity	High parity
Protocol (No streamer)	**0**	**1**	**2**	**3**
Ockam Streamer	**4**	**5**	**6**	**7**
NMEA streamer	**8**	**9**	**A**	**B**
Interleaved	**C**	**D**	**E**	**F**

Note: Mode can be changed with the "!S" command, but parity can not.

S3 (Baud rate)

S3	Baud	S3	Baud	S3	Baud	S3	Baud
0	150	**2**	1200	**4**	4800	**6**	19200
1	300	**3**	2400	**5**	9600	**7**	38400

Operation

Use with the 041 GPS interface

The 041 GPS interface can interact with the 050D interface in two ways: when enabled, it can copy the GPS output to the NMEA channel which can be read by the 050D and sent to the computer in either NMEA streamer (NMEA data only) or Interleaved (both NMEA and Ockam data). The 041 can also receive data from the RS-232 interface and pass it on to the GPS.

When the 041 interface is enabled to copy to the NMEA channel, the 050D should not use its "$" output mode, because there is no flow control on the NMEA channel, and both sets of data would become mixed together. When contemplating use of "$" output from the 050D, you should disable the 041 with the GPS interface through its switches or send the "@Sn0" command (see the 041 section).

Sending data to the 041 GPS interface requires it have a non-zero address. The 041 monitors the Ockam display channel for data frames of the form "@SnD...<0>"; "@" is the tag reserved ro device control (note that creating tag "@" can be accomplished by sending "U@=..."). "Sn" specifies Serial interface n where n equals the 041 address switch setting, and D specifies that output data follows. All characters following "D" are copied to the GPS with <cr><lf> appended. For example, suppose your GPS accepts remote entry of waypoints with a sentence like

$IIWPL,llll.ll,N,yyyyy.yy,W,n<cr><lf>

and is attached to GPS interface addressed at 1. You can enter waypoint 98 into your GPS at N41°14.156, W72°1.954 with

U@=S1D$IIWPL,4114.156,N,07201.954,W,98<cr>

Technical Data

The 050 RS-232D interface uses the A3240 back board and requires 4 jumpers to be set to the correct locations as shown to the left. Also shown is the location for the interface fuse (spares are located inside the CPU box) and the correct polarity for the bus connector.
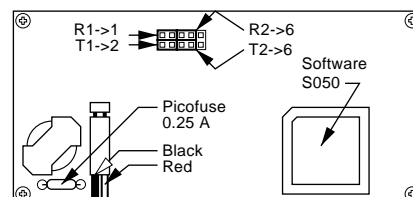
Settings for old (black) RS-232

The left switch (A) controls the number of data bits (7 or 8), parity (even, odd or none) and number of stop bits (1 or 2). To set this switch, look up the desired options for number of data bits, parity and stop bits, and set switch A appropriately.

Bits	Parity	Stop	Sw A	Bits	Parity	Stop	Sw A
7	None	1	1	8	None	1	9
7	None	2	5	8	None	2	D
7	Even	1	2	8	Even	1	A
7	Even	2	6	8	Even	2	E
7	Odd	1	0	8	Odd	1	8
7	Odd	2	4	8	Odd	2	C

The right switch (B) controls the MODE of the interface (STREAMER or PROTOCOL), and the baud rate. (The mode of operation is described above.) Find the desired combination and set switch B appropriately.

	Switch B				Switch B	
Baud rate	Protocol	Streamer		Baud rate	Protocol	Streamer
9600	0	8		1200	3	B•
4800	1	9		300	5	D•
2400	4	C•		150	6	E•
1800	2	A•		110	7	F•

• Settings A thru F are illegal (STREAMER at less than 4800 baud)

Revision History

REV	DATE	CHANGE
A1		SOFTWARE S050A1 (Streamer only)
A2		SOFTWARE S050A2
B1		SOFTWARE S050B1 (Protocol only)
C1		Board E1610B1, S050C1 (Streamer/Protocol)
C2	11/5/84	SOFTWARE S050C2
C3	9/5/85	SOFTWARE S050C3
D1	5/22/95	Board A3850B1, A3240A2, software S050D1. Add NMEA channel functions, buffering, interface control via software.

042 NMEAtap
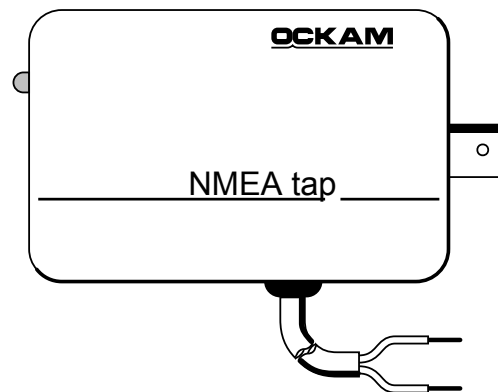
The 042 NMEA tap connects NMEA-0183 listeners to the NMEA data channel of the Ockam system bus. This channel provides switched connection with the GPS through the 041 GPS interface and with the onboard computer through the 050D enhanced RS-232 interface.

The advantages of using the 042 NMEA tap over hard-wiring are: lower labor cost, more flexible and neater routing and three types of troubleshooting capability.

The first troubleshooting tool is an LED which shows that output is actually coming out of the box. The second tool is an onboard computer using the 050D RS-232 interface to view the NMEA data to determine if the required sentences are present. The third troubleshooting tool uses the computer to disable the GPS interface NMEA output and substitute NMEA data of its own to drive the device. Untold hours of grief can be spared, and a cleaner and more professional installation can thus be achieved by using the 041 NMEA tap.

Specifications

|	
Dimensions:	3-3/4" L x 2-1/4" W x 1-1/2" H
Mounting:	Velcro™
Weight:	1 Lb.
Orientation:	Any
System Power Requirements:	45ma
Fuse:	250ma Picofuse
Mating Connector:	BUS: BNC Female (UG-89/U)
	NMEA device: Terminal block
Compatible Devices:	Any device supporting NMEA-0183 input

Theory Of Operation
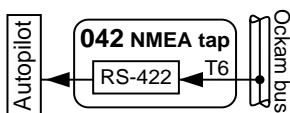
The 042 NMEA tap converts the data on Ockam's T6 data channel to **RS-422** format on the device's output wires. Since there is no processor, no data processing is possible in this box. The T6 data channel is sourced by either the 041 GPS interface or the 050D RS-232 interface. The source can be switched by the RS-232 interface.

Installation

[A1 tap connections shown in brackets]

The 041 should be connected to the NMEA listener's input connector, TX- [BLUE] to IN-(A) and TX+ [ORANGE] to IN+(B). If connecting to an RS-232 device, connect TX- [BLUE] to the device input (DB9 pin 2 or DB25 3) and Gnd [BLACK] to the device ground (DB9 pin 5 or DB25 7). <u>Do NOT connect TX+ [ORANGE] to the RS-232 ground.</u> Set the baud rate to 4800,N,8,1. If desired, you can output display information by moving the jumper in the upper left [right] to (1) instead of (6).
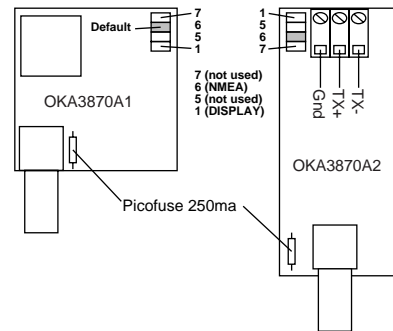
Model 042 NMEA tap interface revision history

Rev	Date	Change
A1	5/22/95	First release
A2	9/27/00	Redesigned – replace obsolete components.

Section 5.3 - Interfaces

T2 Multiplex Interface
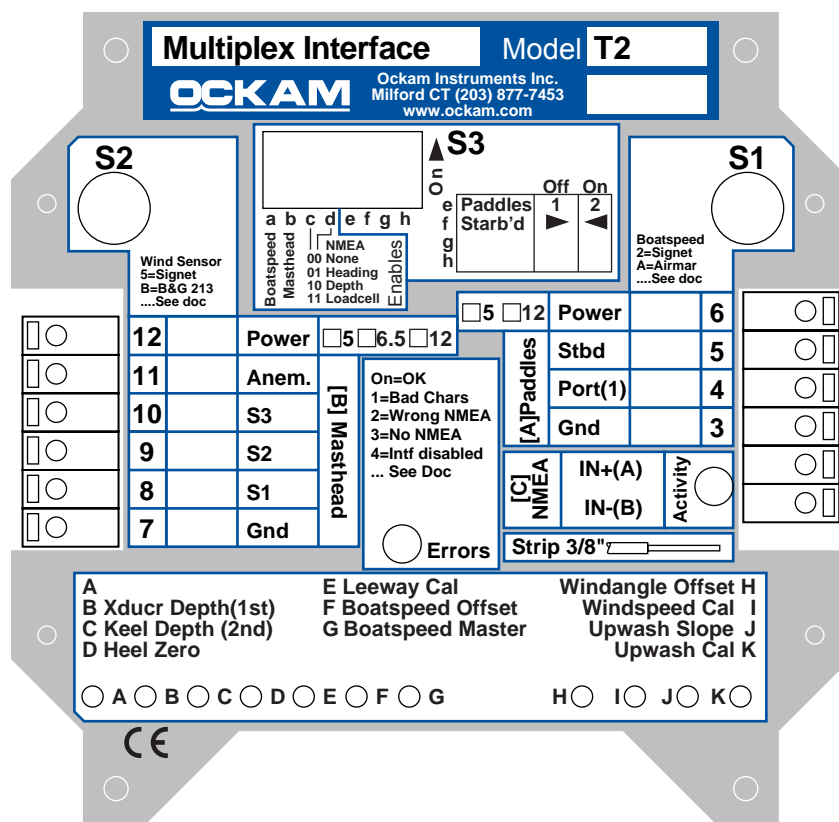
The T2 Multiplex interface is 3 interfaces in one:

1. A Boatspeed interface accepting one or 2 paddle transducers. It can completely replace the 015 Boatspeed interface, and has a separate power connection for powered sensors.

2. A Masthead interface accepting analog masthead types from many manufacturers. A MEMS heel sensor is included. It can completely replace the 022 Masthead interface, and has an improved masthead power supply.

3. A NMEA interface accepting one of Heading, Depth or Loadcell inputs. It can be used in place of one of 032 Compass, 028 Depth or 066 Loadcell interfaces, although at reduced functionality.

Each of these interfaces can be enabled or disabled as needed. For example, if it were desired to use a sonic masthead, the T2 Masthead interface could be disabled in favor of the separate sonic interface.

The T2 interface is compatible with all Ockam processors. It reduces the number of interface boxes of a minimum system from 4 to 2.

The Tryad T2 Interface complies with relevant sections of EU EN60945:1997 and EMC Directive 89/336/EEC.

Specifications

Dimensions:	4-3/4" W x 4-3/4" H x 2" D
Mounting:	Velcro™ or 10-24 x 5/8" on 4-5/16" x 3-1/2" Ctrs
Weight:	1 Lb.
Orientation:	Must be right side up, 90° to centerline. May face forward or aft.
Power Requirements:	145ma
Fuse:	500ma, 2 250ma Picofuses
Mating Connections:	BUS: BNC Female
	Sensors: Terminal strips

Installation

1. If the interface requires modification for sensor power, do the appropriate modification before installing the interface (see NOTE column below). After re-assembly check that the interface works properly as described in (3) below.
2. Mount the interface in a protected location. To simplify calibration, mount the interface so that the adjustments can be gotten at, preferably while an indicator is visible.
3. Connect the interface to the system via the coaxial bus, and power the system up. Check the enable switches (S3a through f). For each enabled interface, TEST Configuration divided by "Config" should be odd.

Interface	Config	Interface	Config	Interface	Config
Boatspeed	2	Heading	8	Loadcell	512
Wind	4	Depth	16		

4. Set the Signature and DIP switches to their appropriate values.
5. Connect the transducer(s) to the correct terminals on the interface. Spin and twiddle the sensors to determine that they are operating correctly.
   For systems with 2 boatspeed transducers, the port transducer is selected when heel angle is positive, and the starboard transducer is selected when heel angle is negative. For debugging purposes, the sign of heel can be changed by tilting the interface to the appropriate angle.

Theory and setup will be discussed for each section separately.

[A] Boatspeed Interface

All paddle-wheel boatspeed sensors make pulses at a rate proportional to the speed of the water flowing past the sensor. The T2 Boatspeed interface component passes pulse counts from the transducer(s) to the CPU where they are used to determine the boatspeed. Additional information from the Signature and Transducer switches, and three calibration controls are sent to allow accurate calibration.

Enable Boatspeed Interface (S3a)

This switch enables (On) or disables (Off) the Boatspeed Interface component of the T2.

Signature (S1)

The signature switch determines the nominal calibration number (i.e. pulses per mile) to be used in calculating boatspeed, and whether power is to be supplied to the paddles. This control could be considered the "Coarse Adjust" for boatspeed. Signature switch settings are given in the table below.

Transducers (S3e)

The transducer switch tells the CPU whether to expect one or two paddle inputs. This information is used to change the behavior of the CPU;

- If two transducers are selected, the system will switch from one plug to the other when the boat tacks, and flash a warning if their speed differs too much.

Note
If you select two transducers, Heel input (from Masthead or 3D Heading interface) is required to provide the switching information.

- If the switch is set to 1 transducer, then input comes only from the Port(1) connector.

Cal Boatspeed Master (Cal 'G') See CAL Boatspeed Master.

Cal Boatspeed Offset (Cal 'F')   See CAL Boatspeed Offset.

Cal Leeway (Cal 'E')   See CAL Leeway.

Additional Setup
1. If the paddles require power, check that the Paddle Power jumper on the back side of the board (see Jumpers settings & Fuses below) is set to the proper voltage (it is set to 5 volts by default). If you change the jumper, you should check the appropriate box on the facia.
2. Connect the T2 to the system via the coaxial bus, and power the system up. Check the **Test Configuration** display. The number should reflect the existence of the Boatspeed interface: [**Test Configuration** divided by 2] should be odd.
3. Check for proper operation by spinning the proper paddle(s) and checking the **Boatspeed** display. For systems without a masthead interface, or with 1 transducer, the port transducer always provides the input. For systems with Masthead interface and 2 transducers, the port transducer is selected when the heel angle is positive, and the starboard transducer is selected when the heel angle is negative. For debugging purposes, the sign of heel can be changed by tilting the interface to the appropriate angle.

Boatspeed Signature & default calibation settings

			Connections				
Sw	Hz/Kt	Transducer	Pwr	Sig	Gnd	Cal	Remarks
0	20.1						
1	11.9						
2	7.00	SIGNET MK 33.1		Red	Blk,Sh	1.00	
3	5.57	B&G original turbine				0.90	
4	3.90	Airmar ST650	Red	Grn	Blk,Sh	1.20	Set power to 5V
5	2.35						
6	1.54						
7	1.00						
8	20.1						
9	13.1						
A	8.53	Airmar (B&G paddle A)		Red	Shield	1.28	51Ω pullup,5V
B	5.56	Airmar Sonic CS4500		'Grn'	'Bare'	1.00	Externally powered No pullup resistors
B	5.56	Airmar ST650 (when in lieu of CS4500)	Red	Grn	Blk,Sh	0.84	Set power to 5V No pullup resistors
C	3.62						

D	2.35					
E	1.54					
F	1.00					

[B] Masthead Interface

The interface can use any of several synchro-pot (360 degree) mastheads for input. These sensors produce three triangle wave DC voltage outputs carrying the angular information, and a pulse rate for speed. The interface measures the three voltages and pulse rate, and passes them to the CPU where they are used to determine the apparent wind angle and speed. The interface also measures the heel angle using a MEMS sensor, and sends it, the settings of the Signature and Heel Sign switches, and the four calibrations to the CPU.

Enable Masthead Interface (S3b)

This switch enables (On) or disables (Off) the Masthead Interface component of the T2.

Signature (S2)

The signature switch determines the basic calibration of (i.e. the "coarse" calibration), and whether power is to be supplied (for hall effect sensors) the anemometer. This switch should be set to the number (or letter) given in the table below depending on the type of transducer you have installed.

Heel Sign (S3f)

This switch determines the sign of the heel sensor. This information is important, because the system determines which boatspeed transducer to use, and the direction of the leeway from the sign of heel. The sign of heel and apparent wind angle should be the same, that is, Positive Heel and wind angle on Starboard tack (heeling to port). If the interface is mounted facing forward, switch S3f should be in the Off (down) position; if facing aft, it should be On.

Heel zero (Cal 'D')

This control allows the heel angle reading to be corrected for misalignment of the masthead interface. There is no readout of this adjustment other than Heel angle itself.

Cal Wind Angle (Cal 'K')   See CAL Windangle Offset.

Cal Wind Speed (Cal 'J')   See CAL Windspeed.

Cal Upwash (Cal 'H')   See CAL Upwash.

Cal Upwash Slope (Cal 'I')   See CAL Upwash Slope.

Additional Setup
1. Check that the Masthead Power jumper on the back side of the board (see Jumpers settings & Fuses below) is set to the proper voltage for your masthead sensor (it is set to 5 volts by default). If you change the jumper, you should check the appropriate box on the facia.

2. Since the interface contains a heel sensor, it is important that the interface be securely mounted to an athwartships bulkhead (i.e. when looking at the interface, you are looking either forward or aft) and properly leveled.

3. Connect the interface to the system via the coaxial bus, and power the system up. Check the **Test Configuration** display. The number should reflect the existence of the Masthead interface; [**Test Configuration** divided by 4] should be odd.

4. Connect the masthead to the interface and check for proper operation by spinning the cups and checking the **Windspeed Apparent** display.

5. Rotate the wind vane and check the **Wind Angle Apparent** display. Check for proper angle readings ahead and 90° to both sides. The reading should be negative for port wind angles, and positive for starboard wind angles. If necessary and possible, adjust the vane for proper zero degree reading.

6. Mount the masthead, and connect it via the mast cable to the interface. Run another quick check of wind angle while aloft.

7. With the boat upright, zero the Heel angle via the Heel Zero adjustment. Note that there is a fair amount of averaging in the heel reading and you should wait about 30 seconds before deciding that the control is set correctly. Heel the boat to port and check that the sign of heel angle is positive.

Masthead Signature & default calibation settings

Sw	Hz/Kt	Zero	Tri	Transducer Type	Cal	Notes
0	8.000	0	Y			
1	4.516	0	Y			
2	2.549	0	Y			
3	1.432	0	Y	Kenyon C50050	1.12	
4	1.104	0	Y			
5	0.670	0	Y	Signet Mk 24.31	1.07	Reposition vane
6	0.410	0	Y			
7	0.250	0	Y			
8	8.000	0	Y			
9	4.516	0	Y			
A	2.549	0	Y			
B	1.096	180	N	B & G 213 Electronic	1.13	560 ohm pullup
C	1.096	180	Y	B & G Older Pot types	1.13	560 ohm pullup
D	0.670	0	Y			
E	0.410	0	Y			
F	0.250	0	Y			

Masthead Wiring

Function	Ockam		Kenyon		Signet		B&G		Standard	
	Pin	Wire	Pin	Wire	Pin	Wire	Pin	Wire	Pin	Wire
Ground	1,3	Orn	E	Orn	1,3	Blk,Yel	A	Blk		Blk
+Power	2	Red	B	Red	2	Orn	D	Orn		Red
Anem.	4	Blu	F	Blu	4	Blu	H	Pur		Blu
S3	5	Grn	C	Grn	5	Red	G	Blu		Grn
S1	6	Blk	A	Blk	6	Wht	C	Red		Wht
S2	7	Wht	D	Wht	7	Grn	F	Grn		Yel

Pins

① ②
③ ④ ⑤
⑥ ⑦ ⑧

[C] NMEA Interface

The T2 accepts NMEA data (at 4800 baud, No parity, 8 data bits) for one of four possible sensors:

Enable NMEA interfaces (S3c,d)

S3c	S3d	Sensor	Remarks
Off	Off	Airmar PB100	Provides sonic wind input replacing analog data on terminals 7-12.
Off	On	Compass	Provides 2D heading from HDM or HDG sentences, 3D from HPR sensors.
On	Off	Depth	Provides depth from DBK, DBS or DBT sentences. Adjust Transducer Depth (B) until Depth Surface is OK then adjust Keel Depth (C) until Depth Keel is OK. If temperature data is included (MTW), temperature will output on Aux 1 (tag 'M'). NMEA temperature is centigrade only.
On	On	Loadcell	Accepts Navtec protocol ("Axxx") or NMEA XDR sentence, outputting on Aux 1 (tag 'M').

Additional Setup

Set S3c & S3d to the proper settings, connect the sensor to the T2 and power up. The 'Activity' light should flash, indicating data arriving. Proper polarity is indicated by 'flashing' (mostly off) rather than 'occulting' (mostly on).

The T2 interface will search for valid data, including inverting the signal after several seconds. While searching, the T2 Error light flashes '1' (searching) and possibly '3' (bad characters). When it has good data, the Error light remains on.

Wait a reasonable time for the interface to lock on. If it fails, try swapping the wires (IN+ <-> IN-). If it still fails to lock with the wires in either configuration, you may have to reverse hardware polarity by moving the NMEA jumper (see below) and try again.

Status Light

| Blinks	Meaning
On	No errors
1	Bad NMEA characters (e.g. inverted signal)
2	No valid data for specified (S3c,d) NMEA sentence. In other words, NMEA data may be coming in, but not for the selected type.
3	No valid NMEA data is being received.
4	One of (Boatspeed or Masthead) interfaces is disabled.

Jumper settings & Fuses
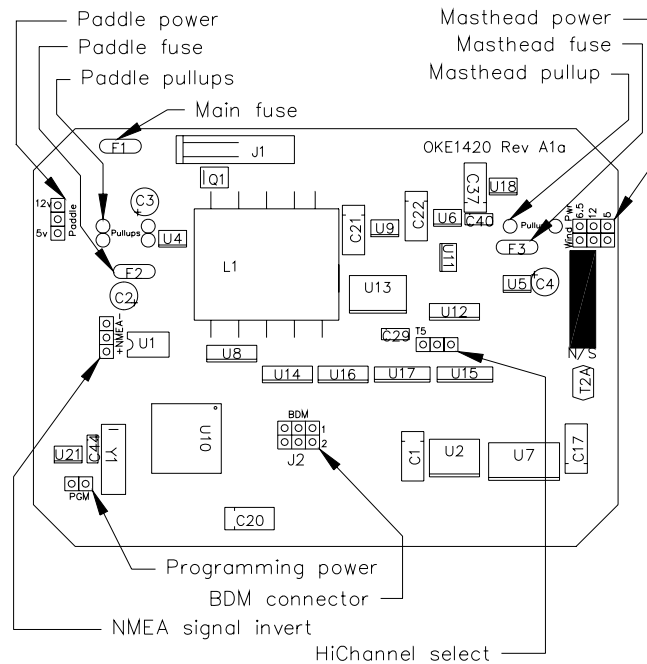
Revision History

Rev	Date	Change
T2A1	3/18/02	1st production release of T2 software rev T2A2.s19, OKA1421A2 3/7/02
T2A2	7/25/02	T2A2X.s19 Decrease heel average by ½. Add A<rdg> input for loadcell.
T2A3	1/ /04	T2A3.s19 Add xducer & Keel offset's. Parse HPR heading input.
T2A4	4/21/04	T2A4.s19 Allow loadcell to configure (problem w/ "Q" protocall)
T2A5	9/13/06	T2A5.s19 Fix heel response with "stiction" algorithm

015 Boatspeed Interface
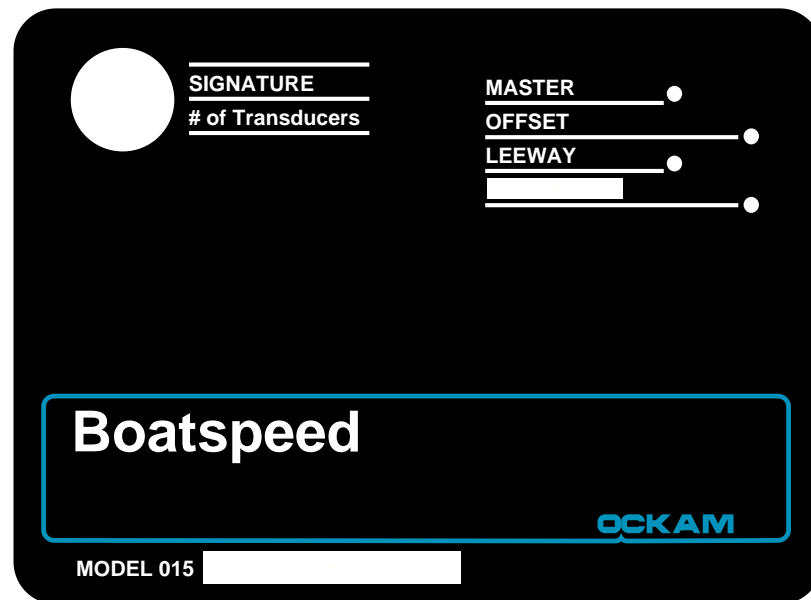
The Model 015 interface supplies the OCKAM system with boatspeed information from one or two paddle-type sensors. The information is used alone for Boatspeed, Distance-Lost and Log displays. In conjunction with a Wind interface, boatspeed is used for true wind, VMG, Leeway and Distance-Lost VMG functions, and the boatspeed function gains tack-to-tack calibration capability. Adding a Compass interface allows dead-reckoning functions, True Wind Direction, and Time to the Laylines.

Specifications

Dimensions:	4-3/4" W x 3-1/2" H x 1-1/2" D
Mounting:	#10-24 x 5/8" Bolts on 4-1/4" x 3" Ctrs.
Weight:	1 Lb.
Orientation:	Any
Power Requirements:	25ma
Fuses:	Bus: 250ma Picofuse (back board)
	Transducer: 125ma Picofuse (front board)
Mating Connectors:	BUS: BNC Female (UG-89/U)
	TRANSDUCERS: TNC Male (Amphenol 77175)
Compatible sensors:	Kenyon, Signet, B&G, Datamarine, Airmar

Theory Of Operation

All paddle-wheel boatspeed sensors make pulses at a rate proportional to the speed of the water flowing past the sensor. The 015 Boatspeed interface passes pulse counts from the transducer(s) to the CPU where they are used to determine the boatspeed. Additional information from the Signature and Transducer switches, and three calibration controls are sent to allow accurate calibration.

The interface can use any of several paddle-type sensors for input. Kenyon, Signet and Brookes & Gatehouse sensors have been interfaced successfully, and others will be published as they are checked out.

SIGNATURE   The signature switch determines the nominal calibration number (ie pulses per mile) to be used in calculating boatspeed, and whether power is to be supplied to the paddles. This control could be considered the "Coarse Adjust" for boatspeed. Signature switch settings are given in the table below.

TRANSDUCERS   The transducer switch tells the CPU whether to expect one or two paddle inputs. This information is used to change the behavior of the CPU; If two transducers are selected, the system will switch from one plug to the other when the boat tacks, and give an alarm if their speed differs too much. If the switch is set to 1 transducer, then input comes only from the left connector.

MASTER   See CAL Boatspeed Master.

OFFSET   See CAL Boatspeed Offset.

LEEWAY   See CAL Leeway.

Installation
1. If the interface requires modification for hall power, do the appropriate modification before installing the interface (see NOTE column below). After re-assembly, check that the interface still works properly as described in (3) below.
2. Mount the interface in a protected location. The interface is not waterproof, and must be protected from water and mechanical damage. To simplify calibration, mount the interface so that the adjustments can be gotten at, preferably while an indicator is visible.
3. Connect the interface to the system via the coaxial bus, and power the system up. Check the CONFIGURATION display. The number should reflect the existence of the BOATSPEED interface (See Section 3. The integer part of [CONFIGURATION divided by 2] should be an odd value).
4. Set the SIGNATURE (yellow rotary switch at top left corner) to the appropriate value as shown below.
5. Set the Number of Transducers (green or red switch under the signature switch) to the left if one transducer is to be connected. Set it to the right if two transducers are to be connected. This switch tells the CPU whether all signals are to come from the left transducer jack, or from both.
6. Connect the transducer(s) to the transducer jack(s) on the interface. The required plug is a TNC male connector (Amphenol #77175). Make connection to the center contact as shown below under CTR, and the outer contact as shown under SHLD.
7. Check the operation of the BOATSPEED by spinning the proper paddle(s) and checking the BOATSPEED display. For systems without a masthead interface, or with 1 transducer, the PORT transducer always provides the input.

For systems with MASTHEAD interface and 2 transducers, the PORT transducer is selected when the HEEL angle is positive, and the STARBOARD transducer is selected when the HEEL angle is negative. For debugging purposes, the sign of HEEL can be changed by dismounting the MASTHEAD interface and tilting it to the appropriate angle.

Boatspeed Signature & default calibation settings

			Connections				
Sw	Hz/Kt	Transducer	Pwr	Sig	Gnd	Cal	Remarks
0	20.1						
1	11.9						
2	7.00	SIGNET MK 33.1		Red	Blk,Sh	1.00	
3	5.57	B&G original turbine				0.90	
4	3.90	Airmar ST650	Red	Grn	Blk,Sh	1.20	Set power to 5V
5	2.35						
6	1.54						
7	1.00						
8	20.1						
9	13.1						
A	8.53	Airmar (B&G paddle A)		Red	Shield	1.28	51Ω pullup,5V
B	5.56	Airmar Sonic CS4500		'Grn'	'Bare'	1.00	Externally powered No pullup resistors
B	5.56	Airmar ST650 (when in lieu of CS4500)	Red	Grn	Blk,Sh	0.84	Set power to 5V No pullup resistors
C	3.62						
D	2.35						
E	1.54						
F	1.00						

Table shows calibrations as of CPU firmware Rev A14

Notes:

1) Turn platform on front board so that the alternate 30K (Orange Black Orange) pullup resistors are located toward the bottom edge instead of the standard 510Ω (Green Brown Brown).

2) Airmar transducer requires 51 ohm resistors on platform. Turn platform over (as described in note 1) and replace 30K resistors with 51 ohm (Green Brown Black).

MODEL 015 BOATSPEED REVISION HISTORY

REV	DATE	CHANGE
A6	5/30/82	SOFTWARE S015A4
A7	10/1/82	SOFTWARE S015A7
A8	11/19/82	ADD LEEWAY POT. SOFTWARE S015A8
A9		Board E1410A2, JB12F2 jumper selection. Cut trace to '244p8, add jumper to JS16p4
A10	4/25/83	SOFTWARE S015A9

022 Wind Interface
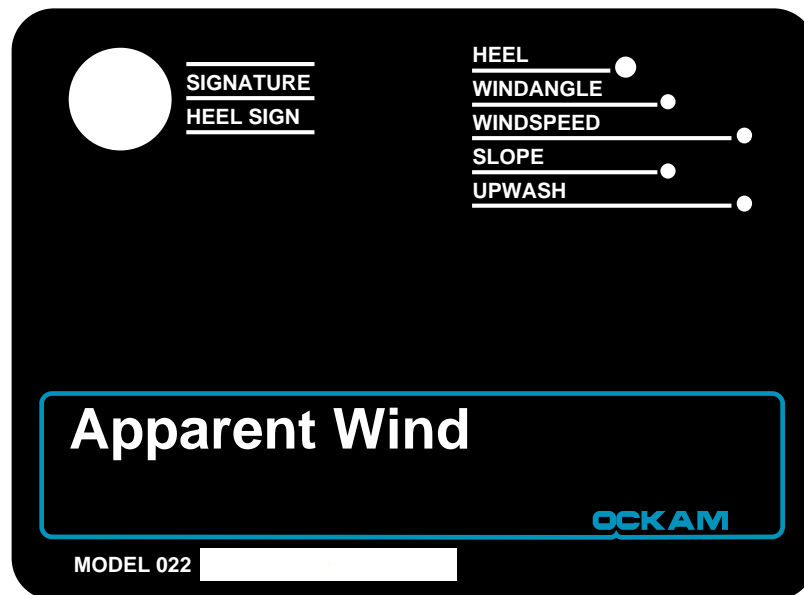
The Model 022 interface supplies the OCKAM system with apparent wind angle and speed, and heel angle. In conjunction with boatspeed, the system produces true wind, VMG, Leeway, Distance-Lost VMG, and boatspeed tack-to-tack calibration. Adding a Compass interface allows dead-reckoning functions, True Wind Direction, and Time to the Laylines.

Specifications

Dimensions:	4-3/4" W x 3-1/2" H x 1-1/2" D
Mounting:	10-24 x 5/8" on 4-1/4 x 3" Ctrs
Weight:	1 Lb.
Orientation:	Vertically mounted on Athwartships bulkhead
Power Requirements:	45ma.
Fuses:	Bus: 250ma Picofuse (back board)
	Transducer: 125ma Picofuse (front board)
Mating Connector:	BUS: BNC Female (UG-89/U)
	TRANSDUCER: AMP CPC 205841-1, 54010-1
Compatible sensors:	Kenyon, Signet and B&G paddlewheels.

Theory Of Operation

Calculating true wind requires very accurate knowledge of the apparent wind. The readings must be properly corrected for heel, leeway and upwash in order to get accurate true wind angle and direction. There are six controls on the interface to aid in calibration.

The interface can use any of several synchro-pot (360 degree) mastheads for input. These sensors produce three triangle wave DC voltage outputs carrying the angular information, and a pulse rate for the speed. The interface measures the three voltages and pulse rate, and passes them to the CPU where they are used to determine the apparent wind angle and speed. The interface also measures the heel angle (another voltage generated inside the interface), and

sends it and the settings of the Signature and HEEL SIGN switches, and the three calibrations to the CPU.

SIGNATURE   The signature switch determines the basic calibration of (i. e. the "coarse" calibration), and whether power is to be supplied (for hall effect sensors) the anemometer. This switch should be set to the number (or letter) given in the table below depending on the type of transducer you have installed.

Heel Sign   This switch determines the sign of the heel sensor. This information is important, because the system determines which boatspeed transducer to use, and the direction of the leeway from the sign of heel.

HEEL   This control allows the heel angle reading to be corrected for misalignment of the masthead interface. There is no readout of this adjustment.

ANGLE   See CAL Windangle Offset.

SPEED   See CAL Windspeed.

SLOPE   See CAL Upwash Slope.

UPWASH   See CAL Upwash.

Installation
1. If the interface requires modification for sensor power, do the appropriate modification before installing the interface (see NOTE column below). After re-assembly, check that the interface still works properly as described in (3) below.
2. Mount the interface in a protected location and on an athwartships bulkhead. The interface is not waterproof, and must be protected from water and mechanical damage. To simplify calibration, mount the interface so that the adjustments can be accessed, preferably while an indicator is visible.
3. Connect the interface to the system via the coaxial bus, and power the system up. Check the CONFIGURATION display. The number should reflect the existence of the MASTHEAD interface (See Section 3). For those familiar with this function, the whole part of {CONFIGURATION divided by 4} should be odd.
4. Set the SIGNATURE (yellow rotary switch at top left corner) to the appropriate value as shown below.
5. Set the HEEL SIGN (green or red switch under the signature switch) to STARBOARD (to the left if the interface is mounted on the forward face of a bulkhead, or to the right if on an after face). This switch tells the CPU which sign the heel voltage should have. (HEEL and WIND ANGLE APPARENT should have the same sign).
6. Connect the masthead cable to the pigtail supplied according to the chart on page 4. The required plug is an AMP #205841-1 CPC connector.
7. To insure calibration (within the plus or minus 16 degrees of wind angle offset adjustment) you may have to rotate the vane on the masthead unit.
8. Check the operation of the masthead by rotating the wind vane and checking the WIND ANGLE Apparent display. The reading should be negative for port wind angles, and positive for starboard wind angles. Adjust the vane for proper zero degree reading. Check the operation of the anemometer by spinning the wind cups and checking the WINDSPEED Apparent display.
9. Mount the masthead, and connect it via the mast cable to the interface. Run another quick check of wind angle while aloft.

10. With the boat not heeled, zero the Heel angle via the Heel Offset adjustment. Note that there is a fair amount of averaging in the heel reading and you should wait about 30 seconds before deciding that the control is set correctly. Heel the boat to port and check that the sign of heel angle is positive.
11. Set the WIND ANGLE Offset adjustment to +0.0, the CAL Upwash to +0.0 and the CAL WINDSPEED to the value shown under CAL below. This cal represents the latest consensus on windspeed.

Transducer Type	Type	Sig.	Zero	Hz/Kt	Cal	Notes			
(Unassigned)	COIL	0	0	8.000					
(Unassigned)	COIL	1	0	4.516					
(Unassigned)	COIL	2	0	2.549					
Kenyon C50050	COIL	3	0	1.432	1.12				
(Unassigned)	COIL	4	0	1.104					
Signet Mk 24.31	COIL	5	0	0.670	1.07	See fig. below			
(Unassigned)	COIL	6	0	0.410					
(Unassigned)	COIL	7	0	0.250					
(Unassigned)	HALL	8	0	8.000					
(Unassigned)	HALL	9	0	4.516					
(Unassigned)	HALL	A	0	2.549					
B & G Model 213 Electronic	HALL	B	180	1.096	1.13	560Ω Platform			
B & G Older Pot types	HALL	C	180	1.096	1.13	560Ω Platform			
(Unassigned)	HALL	D	0	0.670					
STANDARD HORIZON	HALL	E	0	0.410		560Ω, Reverse Vane			
(Unassigned)	HALL	F	0	0.250					

Table shows calibrations as of CPU firmware Rev A14.3
560Ω Platform is standard.

Masthead Wiring

Function	Ockam		Kenyon		Signet		B&G		Standard	
	Pin	Wire	Pin	Wire	Pin	Wire	Pin	Wire	Pin	Wire
Ground	1,3	Orn	E	Orn	1,3	Blk,Yel	A	Blk		Blk
+Power	2	Red	B	Red	2	Orn	D	Orn		Red
Anem.	4	Blu	F	Blu	4	Blu	H	Pur		Blu
S3	5	Grn	C	Grn	5	Red	G	Blu		Grn
S1	6	Blk	A	Blk	6	Wht	C	Red		Wht
S2	7	Wht	D	Wht	7	Grn	F	Grn		Yel
	① ② ③ ④ ⑤ ⑥ ⑦ ⑧ Pins									

MODEL 022 WIND REVISION HISTORY

REV	DATE	CHANGE
A6	5/30/82	SOFTWARE S015A4
A7	10/1/82	SOFTWARE S015A7
A8	11/19/82	Remove LEEWAY pot. SOFTWARE S015A8
A9		Board E1410A2, JB12F2 jumper selection Cut trace to '244p8, add jumper to JS16p4
A10	4/25/83	SOFTWARE S015A9

028 Depth/Temperature Interface
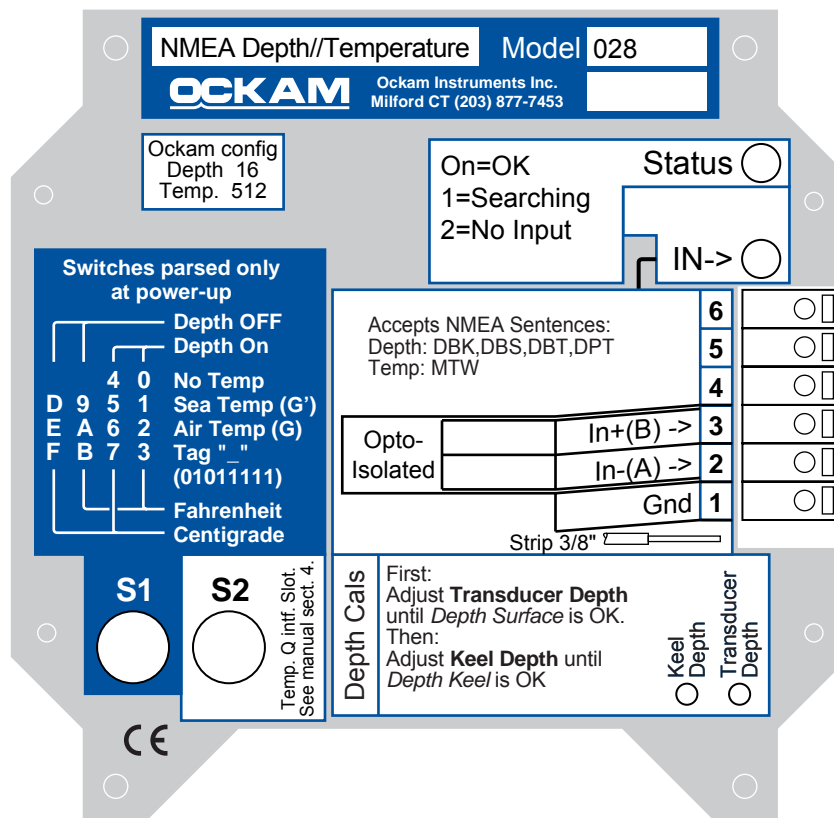
The Model 028B interface supplies the Ockam system with depth information from any depth sounder which outputs the NMEA-0183 DBS, DBT or DBK sentences. The system calculates depth below surface (for navigation) and depth below keel (for piloting) and distributes it to the Ockam displays and connected software. The primary purpose of this distribution is to get the information to those who want it, when they want it, without having to spend bulkhead space on specialized depth repeaters.

If the depth transducer outputs temperature, that data can be displayed as well.

Specifications

Dimensions:	4-3/4" W x 3-1/2" H x 1-1/2" D
Mounting:	#10-24 x 5/8" Bolts on 4-1/4" x 3" Ctrs.
Weight:	1 Lb.
Orientation:	Any
Power Requirements:	15ma
Fuse:	250ma Picofuse (back board)
Mating Connector:	BUS: BNC Male (UG-88/U)
	028B: Terminal strip

The Tryad T1 CPU complies with relevant sections of EU EN60945:1997 and EMC Directive 89/336/EEC.

Theory Of Operation

The 028B interface accepts one of the following NMEA-0183 depth sentence types:

```
$xxDBS,xxx,f…           (Depth from Surface)
$xxDBT,xxx,f…           (Depth from Transducer)
$xxDBT,A,xxx,f,…        (Depth from Transducer, Robertson Proprietary)
$xxDBK,xxx,f…           (Depth from Keel)
```

and/or the following NMEA-0183 temperature sentence:

```
$xxMTW,                 (Water temperature)
```

The interface also sends transducer and keel switch settings to allow Depth from Surface and Depth below Keel to be calculated.

The Ockam system always displays depth in FEET or METERS regardless of the depth sounder units setting. Ockam converts the reading to the precision allowed by the resolution of the depthsounder output.

Installation

1. Set the adjustments on the interface to the appropriate values. The right pot should be set for the depth (in feet) of the transducer below the surface. This switch increases the Surface depth and reduces the Keel depth displays. It is normally shipped set to 0.0 feet, so that the Surface reading is the same as the depthsounder's "transducer depth" reading. The left pot should be set to the depth of the keel in feet from the waterline. This setting reduces the Keel display and has no effect on the Surface display. It is normally shipped set to 0 feet.
2. Connect the interface to the depth sounder. Connect the depthsounder OUT+ lead to the interface IN+ terminal, and the OUT- lead to the IN- terminal. If there is only one signal wire, connect it to the IN- terminal, and connect ground to the IN+ terminal.
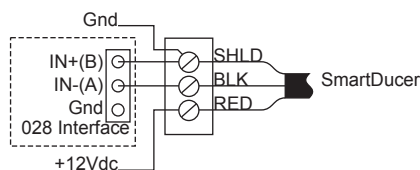
Connecting SmartDucer to 028B
Interface (prior to 2002)
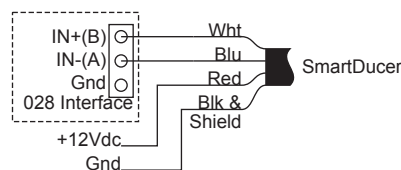
Connecting SmartDucer to 028B
Interface (after 2002)

3. Switch S1 controls the output of Depth and temperature information; ie whether or not to display temperature as well as depth, and the units for temperature. Set S1 as follows:

	Depth ON		Depth OFF	
	Fahrenheit	Centigrade	Fahrenheit	Centigrade
No temperature	0	4		
Sea temperature "G'"	1	5	9	D
Air temperature "G"	2	6	A	E
Custom temperature "_"	3	7	B	F

If temperature is enabled, set S2 to an available slot (see Q interface list in section 4). The default value is 1.
4. Connect the interface to the system via the coaxial bus, and power the system up. Check the CONFIGURATION display. The number should reflect the existence of the DEPTH interface (See Section 3. INT(CONFIGURATION/16) should be odd). If temperature is enabled (see 3 above), add 512 to the CONFIGURATION.

MODEL 028B DEPTH REVISION HISTORY

REV	DATE	CHANGE
B1	4/2/97	Switch to gray box; OKA3904, S028B1
B2	9/14/00	Remove search input polarity, S028B2(NMEADP3X(cs F98B))
C1	8/24/01	T3 Use OKA3821 w/NMEADPC1.s19
D1	5/10/02	Allows NMEA temp to come thru (NMEADPD1.s19) Tag "_",temp
D2	3/18/03	Fix S1 setting 0,4 to work as depth only (NEMADPD2.s19)

032C Heading Interface

3D Compass Model **032**

OCKAM Ockam Instruments Inc.
Milford CT (203) 877-7453

Ockam config
8

On=OK
1=Searching
2=No Input

Status ◯

IN-> ◯

	6
	5
	4
In+(B) ->	**3**
In-(A) ->	**2**
Gnd	**1**

Opto-Isolated

Magnetic
Variation
West +, dial number
East -, dial 100-number.
Example:
12 West Var. is 12
12 East Var. is 88

S1   **S2**

Strip 3/8"
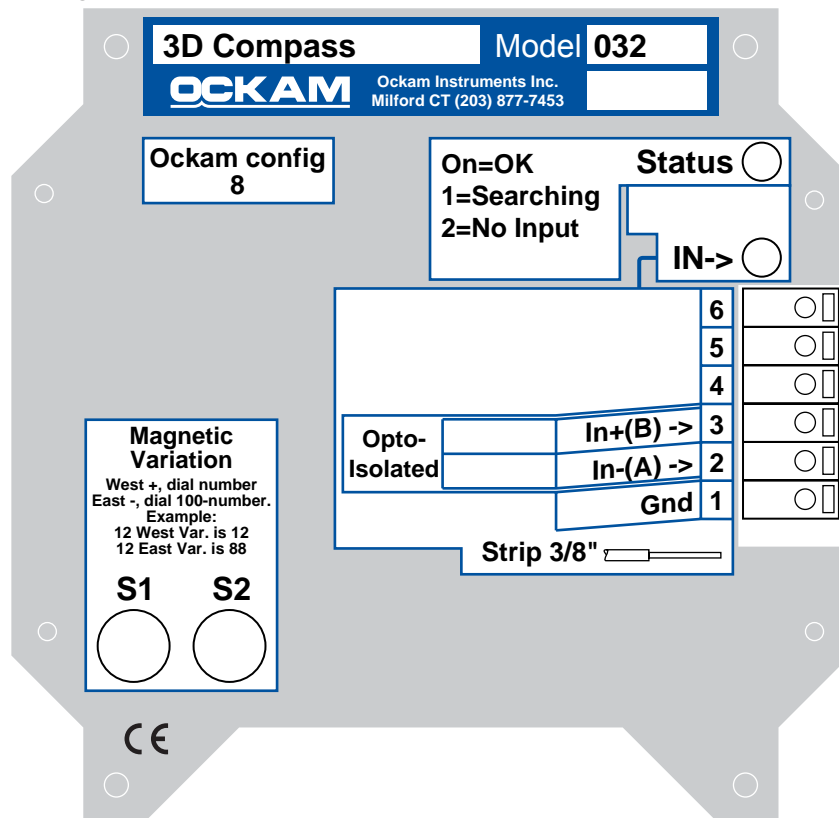
The 032C Heading interface gives the Ockam system ship's heading information, allowing calculation of Wind Direction and other earth-oriented information. In addition, if a suitable transducer is attached, heel and pitch information will also be gathered. There are two rotary switches to set the system's default local magnetic variation.

The 032C interface is designed to accept the following inputs:

NMEA-0183 (HCC, HDM, HDT, HSC, or VHW)	(Heading only)
Honeywell HMR-3000 or Teeter-Todter	(Heading, Pitch, Heel & Cal status)
SailComp DGS3	(Heading, Pitch and Heel)
Maretron PMAROUT,ATT	(Heading, Pitch and Heel)

Specifications

Dimensions:	4-3/4" W x 4-3/4" H x 2" D
Mounting:	Velcro™ or 10-24 x 5/8" on 4-5/16" x 3-1/2" Ctrs
Weight:	1 Lb.
Orientation:	Any
Power Requirements:	45ma
Fuse:	250ma Picofuse (on back board; spares inside 001 CPU)
Mating Connections:	Bus: BNC Male
	Sensor: Terminal strip
Compatible Devices:	Any sensor with NMEA heading output or certain '3D' compasses (see details below).

CE The Tryad 032C Interface complies with relevant sections of EU EN60945:1997 and EMC Directive 89/336/EEC.

Theory Of Operation

If the input is NMEA-0183 OR the processor is an 001 with old software, the unit will operate in 'classic' mode, providing only heading and magnetic variation. The NMEA input can be one of these 5 possible heading sentences. Check the sensor documentation and pick the one with the highest resolution (the heading protocol has 0.1° resolution).

```
$xxHCC,hhh              (Unknown heading, assumed True)
$xxHDM,hhh,M            (Magnetic heading)
$xxHDT,hhh,T            (True heading)
$xxHSC,hhh,T,hhh,M      (True & Mag. heading; Magnetic used)
$xxVHW,hhh,T,hhh,M,...  (True & Mag. heading; Magnetic used)
```

If the input is one of the types listed below, AND the processor is a T1 or 001 with Unisyn software, the 032C will switch to '3D' mode where it can supply heading, pitch, heel angle, magnetic variation and possibly calibration quality.

```
$PTNTCCD,…              (Honeywell calibration data)
$PTNTHPR,…              (Honeywell heading, pitch, roll data)
%…                      (SailComp DGS3 pitch, roll, heading data)
$PMAROUT,ATT,…          (Maretron pitch & roll data; hdg on HDM)
```

Sometimes, the Ockam system and navigation software needs magnetic variation to convert to/from true bearing. The switches on the 032C interface provide the default value for this. If the system has Unisyn (A16) software and includes the 041C GPS interface, and the GPS outputs the correct sentence, the magnetic variation will come from that interface instead.

Installation

1. Mount and wire the compass sensor according to the manufacturer's instructions. Connect the compass OUT+ lead to the interface IN+ terminal, and the OUT- lead to the IN- terminal. If there is only one signal wire, connect it to the IN- terminal, and connect ground to the IN+ terminal.

2. Set the interface rotary switches for the local magnetic variation. Numbers less than 50 are East, and numbers between 50 and 99 are West: 99 is 1° West; 90 is 10° West; 80 is 20° West, etc. Changing the magnetic variation will not change the heading display unless only true bearing is being received from the compass.

3. Connect the interface to the system via the coaxial bus, and power the system up. Check the Configuration display. The number should reflect the existence of the Heading interface. (Divide Configuration by 8; the whole number should be odd.)

4. Check the operation of the compass by turning the compass and checking the Heading display.

5. Mount the compass sensor in its bracket, and adjust it so that the Heading display agrees with the binnacle. **Ensure that there are no magnetic materials, motors or current-carrying conductors within 4 feet of the compass.**

6. Get the compass swung and compensated by a certified compass adjuster, or for auto-compensating sensors, follow the manufacturer's compensation instructions

Revision History

Rev	Date	Change
B1	4/2/97	Switch to gray box; OKA3804, S032B1
B2	9/11/98	Software S032B2 "HDG 032B2" (3DHDG.hex), Finds KVH 3DHdg sentence, input wires either way and activates Error 42 w/ no input
B3	4/20/99	Add HDG sentence to input. HDG 032B3 (3DHDG4.hex, cs 019D, 6:07pm)
B4	7/24/99	Allows for fast compasses to not overwrite output. HDG 032B4 (3DHDG5.hex, cs F799, 3:24pm)
B5	9/14/00	Remove search input polarity, S032B5(3DHDG5X(cs=4D63)) "Does not always find input on turn on!" 11/9/00
B6	11/9/00	Reapply search, added HPR and CCD cal. Mode, can also do NMEA and either sentence at 4800 or 9600 baud S032B6 (3DHDG6.HEX (cs=FFAF)
C1	8/2/01	1st Release w/OKA3821 board software 3DHDGC1.s19
C2	2/14/05	Add Maretron PMAROUT,ATT input

037 Polar Curve Module (001 only)
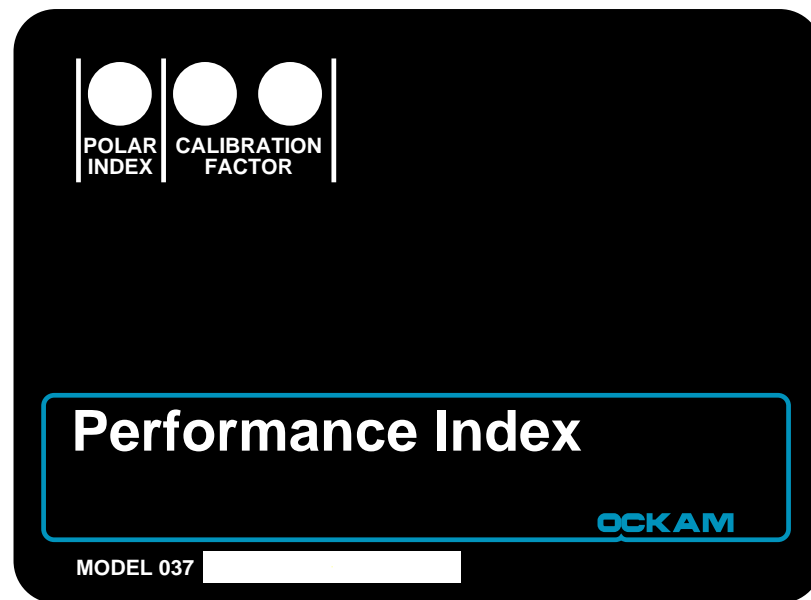
The purpose of the Polar Module is to give the Ockam System optimum Polar Boatspeed and Target Boatspeed displays, and access to ship's performance data to calculators and computers. The displays are useful for giving the crew a goal to strive for, since the display shows the theoretical speed the boat should be making. The combination of a polar module and one of the computer or calculator interfaces allows real-time solution of course-to-steer problems.

Specifications

Dimensions:	4-3/4" W x 3-1/2" H x 1-1/2" D
Mounting:	#10-24 x 5/8" Bolts on 4-1/4" x 3" Ctrs.
Weight:	1 Lb.
Orientation:	Any
Accessories:	Mounting Hardware
	2 Display Cards
Power Requirements:	25ma
Fuse:	250ma Picofuse (back board)
Mating Connector:	BUS: BNC Female (UG-89/U)

Operation

The model 037 polar module can hold up to four polar curves. The system determines which one to use from the polar selector switch in the module, or from commands sent from keyboard devices (HPIL or RS232).

The module requires the addition of data memory chips (EPROMs) containing the performance characteristics of your boat. Ockam does not do polar curve generation, and therefore can not supply this essential part. There are services which will create this part for you. Please contact us for details. Or, if you are into computers and such, you can do your own (see below).

Installation

1. Your polar curve information has to be loaded into CMOS EPROM memory chips (27C16's which hold 1 polar or 27C32's which hold 2) either by you or by one of the performance prediction services. Each polar has to have a unique POLAR Number programmed into it at location 0008. This is the number that the module looks for depending on the setting of the POLAR Number switch or command.
2. Open the polar module by unscrewing the 4 screws at the bottom of the mounting holes, and pulling the lid straight off.
3. The chips containing your data are inserted into the sockets on the circuit board attached to the lid (see below). If you have 1 chip, put it in the socket marked U1. If you have two, either one can be installed in either socket. The chip has a semicircular notch on one of the narrow sides, which MUST be positioned to the left as shown. Failure to properly install the EPROM will destroy it.
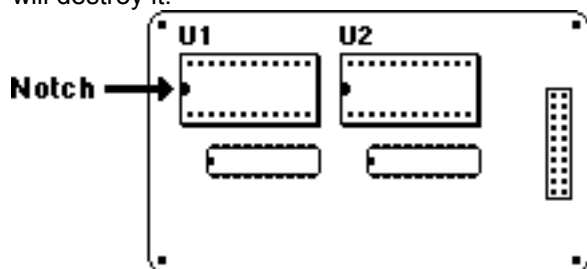
4. Set the POLAR Number switch to the polar desired (the first polar is usually #1), and set the calibration adjustment to 00 (100 percent). These switches are located on the front of the board.
5. Carefully center the lid on the box and push it home. Do not cock the lid or the board connector will not mate properly. Test proper operation of the module by plugging it into the CPU and checking CONFIGURATION (divided by 16 gives odd result), POLAR boatspeed comes up on an indicator (you must have boatspeed and wind interfaces hooked up too), and that ERRORS 61, 62 or 63 do not appear. If nothing happens, the board connector probably is mismated. When it is properly checked out, screw the lid back down.

ACCESSING POLAR DATA FROM A CALCULATOR

Calculators and computers can access the polar curves in the following way.

1 Set the desired conditions by entering the command string

   P=<true wind angle>[,<true wind speed>[,<rom number>]]<cr>

   Note that the speed and rom number entries are optional. The angle and speed entries can be in floating point (e.g. 13.1) form.
2 Immediately request tag '0' (User 0). The polar curve value for the specified conditions will be output between 1/2 and 2 seconds after the conditions are set.

HOW THE POLAR DATA PROM IS ORGANIZED

The polar data PROM is a 2048 byte by 8 bit CMOS EPROM organized as follows:

```
ADDRESS         CONTENTS
0000-002F       HEADER INFORMATION
0030-007F       BOATSPEED VECTOR AT TRUE WIND SPEED OF 1 KNOT
0080-00CF       BOATSPEED VECTOR AT TRUE WIND SPEED OF 2 KNOTS
00D0-011F       BOATSPEED VECTOR AT TRUE WIND SPEED OF 3 KNOTS
.........       .................
0760-07AF       BOATSPEED VECTOR AT TRUE WIND SPEED OF 24 KNOTS
07B0-07FF       BOATSPEED VECTOR AT TRUE WIND SPEED OF 25 KNOTS
```

The header information contains data on the type of polar curve, when it was made, etc. It is organized as follows:

```
ADDRESS         CONTENTS
0000            ORGANIZATION TYPE (CURRENTLY MUST BE 1)
0001            ROM SIZE IN 256-BYTE PAGES (CURRENTLY MUST BE 8)
0002-0004       WIND ANGLE VECTOR DESCRIPTOR. (MUST BE 22,180,2)
0005-0007       WINDSPEED VECTOR DESCRIPTOR. (MUST BE 1,25,1)
0008            POLAR NUMBER. (The number selected by the switch)
0009            REVISION NUMBER.
000A-000F       RESERVED (SHOULD BE 0)
0010-002F       POLAR  IDENTIFICATION  STRING.  32  PRINTABLE  CHARACTERS
                IDENTIFYING THE POLAR'S CONTENTS
```

BOATSPEED VECTORS

Each boatspeed vector describes the boatspeed at a constant true wind speed, and for true wind angles of 22 degrees thru 180 degrees in 2 degree increments. For example, the first boatspeed vector begins at location 0030 and contains the following boatspeeds:

$$Vs(22),Vs(24),Vs(26),...,Vs(176),Vs(178),Vs(180).$$

The Vs(180) value is stored at location 007F. Each boatspeed occupies one byte and is in fixed-point binary format as xxxx.xxxx, or 0 to 16 knots by 1/16 knot increments. The vectors at 22 and 180 degrees are special. They contain the TARGET boatspeed values; the boatspeed you should make when going upwind (the 22 degree vector) and downwind (the 180 degree vector).

MODEL 037 POLAR MODULE REVISION HISTORY

REV	DATE	CHANGE
A1	5/26/83	SOFTWARE 'POLAR 1.73'
A2	5/22/84	SOFTWARE S037A2

041 GPS Interface (001 only)

GPS Interface   Model **041**

OCKAM **Ockam Instruments Inc.**
Milford CT (203) 877-7453

Ockam config 64	On=OK 4=Bad chars	Status ◯
	1=Searching 5=Bad PLL	**OUT<-** ◯
	2=No Lat/Lon 6=Restart	**IN->** ◯
	3=No Rng/Brg	

"S" addr
None

```
0  8   1
1  9   2
2  A   3
3  B   4
4  C   5
5  D   6
6  E   7
7  F
```
NMEA chan.
Enabled
Disabled

S1   **S2**

	6
Out+(B) <-	5
Out-(A) <-	4
In+(B) ->	3
In-(A) ->	2
Gnd	1

Opto-Isolated

Strip 3/8"

For CPU software A16+, switch inop.
For CPU software <A16, Q slot number.
Default=4, Tag="X", Config bit 512 on.
See manual section 4 & 5.09 for details

CE

The 041C interface connects to the GPS and provides position, waypoint, magnetic variation and time information to the Ockam system. In addition, it can source a copy of GPS data on the NMEA channel of the Ockam bus cable. It can also output data to the GPS from two sources; NMEA sentences created from Ockam data, and text sent by an RS-232 interface. Ockam data outputs include VHW (speed and heading), DBT (depth), VDR (current) and VPW (VMG), HDG (heading), MWD (wind direction & true wind speed), RSA (rudder and tab), MWV (apparent and true wind angle & speed), VWL (logs), VWR (alt. apparent wind) and VWT (alt. true wind). These Ockam NMEA strings can be enabled to the NMEA channel as well. For GPS units which have the capability, NMEA strings sent from the RS-232 interface allow up and downloading waypoints and controlling GPS functions from the on-board PC.

Specifications

Dimensions:	4-3/4" W x 4-3/4" H x 2" D
Mounting:	Velcro™ or 10-24 x 5/8" on 4-5/16" x 3-1/2" Ctrs
Weight:	1 Lb.
Accessories:	10 Display Cards
Power Requirements:	45ma
Fuse:	250ma Picofuse (back board)
Mating Connections:	BUS: BNC Female GPS: Terminal strip
Compatible Devices:	Any Position sensor with NMEA output of position (GLL, GGA or RMC) and waypoint range and bearing (BWR, BWC, BER, BEC or RMB). Will also use time (ZDA), Cog/Sog (VTG or RMC) and magnetic variation (HDG, HVD, HVM or RMC) with system software revision 16.

The 041 GPS Interface complies with relevant sections of EU EN60945:1997 and EMC Directive 89/336/EEC.

Theory Of Operation

The 041C GPS interface provides the Ockam system with ship's position and waypoint range & bearing. When connected to a rev 16 system, it also provides time, Cog/Sog and magnetic variation. It replaces the functions of the 040 interface (configuration 64) and the 039 Lat/Lon interface (configuration 512). It also eliminates the need for the 045 NMEA driver by outputting NMEA sentences derived from Ockam data.
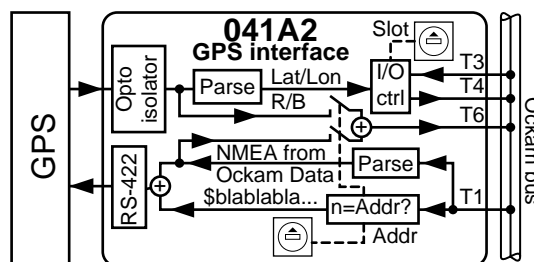
SLOT SWITCH

When the 041C interface is connected to older systems (with system software revision less than 16), the "Slot" switch of the 041 sets the address for the "Q" protocol whereby Lat/Lon is transferred. Each slot switch attached to an Ockam system must be set to a unique number (see Section 3 "Q interfaces"). When connected to system rev. 16 or later, the slot switch is inactive; Ship's position is transferred via the extended GPS protocol, new with system rev. 16.

INPUT (Ship's position)

Ship's position data input can be one of the following NMEA sentences (parsed data shown underlined). The interface will send data from any of these that come in, so the GPS should be set to output only one of them. Check the documentation and pick the one with the highest resolution (the 041 will interpret to 5 decimal places in minutes).

```
$xxGGA,hhmmss,lllll.ll,N,yyyyy.yy,W,dgpsflag,...
$xxGLL,llll.ll,N,yyyyy.yy,W[,hhmmss.ss]
$xxRMC,hhmmss,valid,llll.ll,N,yyyyy.yy,W,...  (See also CogSog & MagVar)
```

Ship's position is output using the Ockam "Q" protocol, wherein the 041 interface formats the data for end use, and the Ockam system passes it through to the display channel for use by on-board computers. This output is not intended for display, although output can be checked by setting an Ockam display to tag X (0X0XX000, only the right 4 digits will be displayed). Output is on tag "X" in signed degrees to 5 decimal places, no leading zeros, latitude on the prime tag and positive North and East.

X'41.24275	(Latitude output equivalent to 41°14.565'N)
X-73.03315	(Longitude output equivalent to 73°1.989'W)

Output occurs each time the GPS outputs a Lat/Lon sentence. When the sentence is received, Latitude is output, followed by Longitude. In older CPU revs, Longitude follows Latitude by one second, placing an upper limit on input of once every two seconds.

For CPU rev 16 and above, Latitude and longitude are output consecutively, allowing a higher thruput rate. However, having too high an output rate can prevent the other GPS data from being output at all. In addition, the differential flag of the GGA sentence is monitored, producing Error 79 if differential GPS drops out.

INPUT (Waypoint range & bearing)

Waypoint range and bearing can be from any one of the following (the Lat/Lons are waypoint position, not ship's position). Again, select the one with the best waypoint range and bearing resolution.

```
$xxBWR,hhmmss,llll.ll,N,yyyyy.yy,W,b.b,T,b.b,M,d.d,N,nnn
$xxBWC,hhmmss,llll.ll,N,yyyyy.yy,W,b.b,T,b.b,M,d.d,N,nnn
$xxBER,hhmmss,llll.ll,N,yyyyy.yy,W,b.b,T,b.b,M,d.d,N,nnn
$xxBEC,hhmmss,llll.ll,N,yyyyy.yy,W,b.b,T,b.b,M,d.d,N,nnn
$xxRMB,A,x.x,a,o..o,d..d,llll.ll,N,yyyyy.yy,W,d.d,b.b,v.v,X*nn
```

When the interface finds one of the waypoint range and bearing message, it sends it to the CPU. The system compares the reported waypoint position against its DR waypoint position. A large range difference (greater than 1/2 mile) causes the DR waypoint to be moved into agreement with the GPS waypoint. This is what happens when the GPS first reports a (new) waypoint, and results in error code 73.

Once the DR and GPS waypoints agree closely, the system tracks the rate and direction of motion between them, and uses this information to calculate current. The calculated current feeds back into the DR position, eventually stopping the relative motion. The process takes several minutes because the error accumulates fairly slowly.

Some GPS outputs bearing only in true while all OCKAM system functions are with respect to magnetic north, including WAYPOINT Range & Bearing. The system converts the GPS bearing output to magnetic by adding in the magnetic variation, which is a switch setting in the COMPASS interface. If your GPS reports its bearing in magnetic degrees, the variation is not used. If the bearing is true, you should set the compass switches (or calibration K7 on RS232 interfaces) to the local magnetic variation, or the system will not be able to do its current calculations correctly.

OTHER INPUT

With 001 revision A16 and above, other inputs are also transferred. In older 001 revisions (<A16), these inputs are not used.

COG/SOG

```
$xxVTG,ccc,T,ccc,M,sss,M,sss,K
$xxRMC,...,sss,ccc,...        (See also Lat/Lon & MagVar)
```

If VTG or RMC is output, the Ockam system will output COG/SOG on tag 'f', and calculate and display current on tag 'F'.

Magnetic Variation

```
$xxHDG,hhh,ddd,E,vvv,E
$xxHVD,vvv,E
$xxHVM,vvv,E
$xxHVD,vvv,D,E          (Trimble proprietary)
$xxHVM,vvv,D,E          (Trimble proprietary)
$xxRMC,...,vvv,...   (See also Lat/Lon & CogSog)
```

If one of the above sentences is output, the Ockam system outputs this magnetic variation (on tag 'o') in place of the compass interface switch setting. The format will have two decimal places instead of the one place output from the compass interface.

TIME

```
$xxZDA,hhmmss.ss,ddd,mmm,yyyy,lzh,lzm
```

On startup, if ZDA is output, the Ockam system will resync it's clock to the mm:ss portion of the GPS clock (maintaining local time offset).

OUTPUT to GPS (and NMEA channel) from Ockam data
The 041 also outputs Ockam data in NMEA format, eliminating the need to attach an 045 NMEA driver. Since this function is output only, it does not have a configuration value or slot switch setting.

```
$IIDBT,<depth_keel>,f,,M,,F
$IIHDG,<heading>,,,,
$IIMWD,,T,<wind direction>,M,<true wind speed>,N,,M
$IIMWV,<app wind angle 0-359>,R,<app wind speed>,N,A
$IIMWV,<true wind angle 0-359>,T,<true wind speed>,N,A
$IIRSA,<rudder angle>,A,<trimtab angle>,A
$IIVDR,,T,<current set>,M,<current drift>,N
$IIVHW,,T,<heading>,M,<boatspeed>,N,,K
$IIVLW,<perm.log>,N,<trip log>,N
$IIVPW,<VMG>,N,,M
$IIVWR,<app wind angle 0-180>,L/R,<app wind speed>,N,,M,,K
$IIVWT,<true wind angle 0-180>,L/R,<true wind speed>,N,,M,,K
```

Output of each sentence will occur if the required data is available on the Ockam bus, e.g. the DBT sentence will output only if an 028 Depth interface is attached. The format for the data is the same as that on the Ockam displays (see section 2). The "POCKAM" sentence is a so-called proprietary sentence, and is included so there will always be something going out regardless of which interfaces are attached to the system. These sentences will also appear on the NMEA channel if enabled (see "Data on the NMEA channel" below).

OUTPUT to GPS from computer
In addition to the above, the 050 RS-232 interface can also send data to the GPS (if wiring is provided between the 041 output and the GPS input and the GPS understands what's being said). The 041 monitors the Ockam data channel for frames of the form

@S*n*D<anything_but_null>

where "@S*n*" specifies a command to serial interface *n* and "D" specifies data to be sent to the GPS (S and D can be upper or lower case). Everything following "D" will be sent to the GPS. The value of *n* is specified switch S1 of the interface which also controls the initial state of NMEA channel output.

S1 setting	Address for @S commands	Initial NMEA channel state
0	**Not addressable**	**Disabled**
1-7	**1-7 (and 0)**	**Disabled**
8	**Not addressable**	**GPS & Ockam Enabled**
9-F	**1-7 (and 0)**	**GPS & Ockam Enabled**

Note: sending "@S0..." specifies all addressable "S" interfaces (i.e. 1-7 and 9-F).

GPS data on the NMEA channel
The 041 interface can source data onto the Ockam NMEA channel (T6), which is a channel unused by the Ockam system per se. If enabled, all NMEA sentences coming from the GPS (and NMEA sentences created from Ockam data) are copied onto this channel. Initial control of this function is by switch S1 (see table above), with subsequent control (to addressable interfaces) by

@SnE0	Disable all data -> NMEA channel
@SnE1	Enable GPS data -> NMEA channel
@SnE2	Enable Ockam data -> NMEA channel
@SnE3	Enable GPS and Ockam data -> NMEA channel

Note

Setting S1 to 0 <u>permanently disables</u> GPS data on the NMEA channel because the interface will not respond to @S commands. Setting S1 to 8 <u>permanently enables</u> GPS and Ockam data on the NMEA channel, preventing other interfaces (including the 050D RS-232 interface) from using the channel because the 041 can not be disabled except by resetting S1 and re-powering the system.

Installation
1. Check the unit documentation and procure any necessary plug or hardware which might be required to attach the interface to the GPS. Also check to see if input <u>to</u> the GPS can be used to advantage (e,g, speed & heading data can sometimes help GPS performance). Determine which pins or terminals will connect to the 041 interface: two GPS->interface wires (and two interface->GPS wires, if needed) will be required.
2. Connect the GPS and the interface as shown below. If the designation is not clear, check the voltage between the "+" and "-" pair of wires with the GPS running (the "+" wire should be positive with respect to the "-" wire).

Signal	NMEA designation	Voltage	041 Interface
Shield			**Ground (1)**
GPS out -	**OUT "A"**	**-**	**In- (2)**
GPS out +	**OUT "B"**	**+**	**In+ (3)**
GPS in -	**IN "A"**	**-**	**Out- (4)**
GPS in +	**IN "B"**	**+**	**Out+ (5)**

3. Connect the interface and power up both the GPS and the system. Follow the checkout instructions below to prove that the interface is performing OK.
4. Mount the interface.

Checkout
1. Be sure the onboard computer is not sending waypoint data. If unsure, turn it off.
2. Reset the Ockam system (see section 3) to ensure no tags are disabled, and that GPS waypoint data is enabled.
3. Put a route into the GPS.
4. Check that the Waypoint range & bearing display is alternating and giving the same data as the GPS (within .1 mile). Switch to another waypoint (more than 1/2 mile from the first) and check again.
5. Check that ship's position is being delivered. Set an Ockam display to tag X (0X0XX000). Since only the right 4 digits are displayed, and the number is degrees, not minutes, you can not compare values. However, if the display flips between numbers, the Lat/Lon is probably OK.

Troubleshooting
1. Check the <u>OUT</u> and <u>IN</u> LED's in the upper right corner of the interface. Both should be flashing, indicating that data is going in both directions (output from the interface will happen even if it is not connected to the GPS).
2. Check the <u>Status</u> LED in the upper right corner of the interface. It is normally on.

   If the Error LED is off, there is no power to the interface. Check the Ockam bus wiring between the interface and the system CPU.

    a. blink indicates that the interface has not heard valid data from the GPS since power-up. During this phase the interface periodically swaps the input wires looking for valid NMEA data. Once it has decided that the input wires are OK, it will no longer give this error. Check the wiring between the interface and the GPS, and any GPS setup that might have to be done before output happens.

    b. blinks indicate no matches with data. The GPS is not sending any recognizable data to the interface.

    c. blinks indicate bad characters (framing, parity or overrun errors). Swap the GPS->interface wires and restart the Ockam system.

3, If you have access to an onboard computer and an 050D RS232 interface, you can view the GPS data directly. Set the 041 interface S1 to 8 (always enabled) and the 050D interface S2 to NMEA streamer. Connect the 050D to the computer running a terminal emulator at 4800 baud, No parity, 8 data bits and 1 stop bit. You should then see NMEA data coming from the 041 interface. Check that the data looks OK, and that the required sentences are there and showing data.

Technical Data
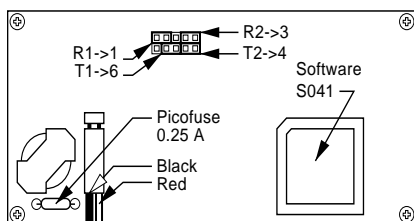
The 041 GPS interface uses the A3240 back board and requires 4 jumpers to be set to the correct locations as shown to the left. Also shown is the location for the interface fuse (spares are located inside the CPU box) and the correct polarity for the bus connector.

Model 041 GPS Interface Revision History

Rev	Date	Change
A1	5/23/95	First release
A2	4/4/96	S041A2. Add Ockam NMEA data to NMEA channel output. Fix input selection for Trimble Ntxxx
B1	7/30/96	Software 041B1
C1	9/19/97	Unisyn compatible software S041C1
C2	2/13/98	S041C2 fix Lat/Lon X' tag when used with old CPU software.
C3	11/16/98	Handle 5 or more decimal digits of L/L input (hires surveying GPS's)
D1	1/13/99	Add handling of RMC (for Valid, L/L,CogSog & MagVar)

060 Rudder/Trimtab Interface
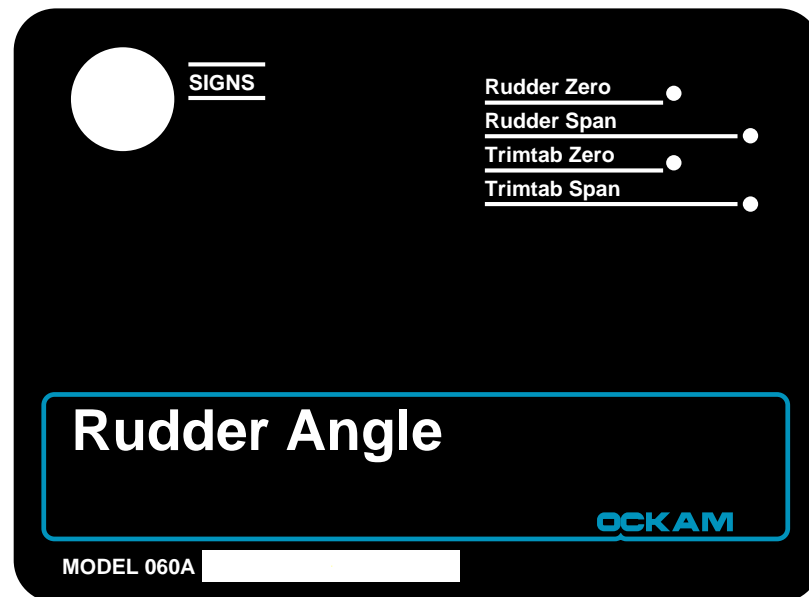
The model 060 Rudder interface provides rudder and trimtab output for the OCKAM system. These readouts are valuable for tacking analysis. In addition, for those boats with trimtabs, the readout provides accurate information to the helmsman to help prevent excessive drag by improper settings.

Specifications

Dimensions:	4-3/4" W x 3-1/2" H x 1-1/2" D
Mounting:	#10-24 x 5/8" Bolts on 4-1/4" x 3" Ctrs.
Weight:	1 Lb.
Orientation:	Any
Accessories:	Mounting Hardware
	Manual Section 5.9
	2 Display Cards
	Little Green Screwdriver
Power Requirements:	35ma
Fuses:	Bus: 250ma Picofuse (back board)
	Transducer: 125ma Picofuse (front board)
Mating Connector: BUS:	BNC Male
	Sensors: 4-Wire Pigtail
Compatible Sensors:	Any Potentiometer(s) between 500 ohm and
	10Kohm. Must Travel at least 50%.

Theory Of Operation

The interface can use any linear potentiometer sensor value between 500 and 10,000 ohms. The interface provides 5.12 volts drive, measures the voltage at the wipers, and passes them to the CPU where they are used to determine the rudder and trimtab angles. The interface also sends the settings of the SIGNS and the four calibrations to the CPU.

SIGNS   - Sets the sign(s) of the readings
RUDDER SPAN - Calibrates the maximum rudder angle
RUDDER ZERO - Sets the rudder zero
TRIM SPAN   - Calibrates the maximum trimtab angle
TRIM ZERO   - Sets the trimtab zero

Installation

1. Mount the interface in a protected location. The interface is not waterproof, and must be protected from water and mechanical damage. To simplify calibration, mount the interface so that the adjustments can be gotten at, preferably while an indicator is visible.
2. Mount the potentiometers, and connect them to the pigtail on the interface. The two ends of the potentiometer(s) should be connected to the BLACK and RED wires, the rudder wiper should be connected to the GREEN wire, and the trimtab wiper should be connected to the BLUE wire.
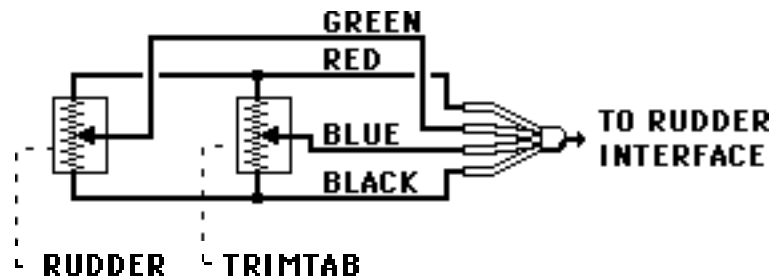
2. Connect the interface to the system via the coaxial bus, and power the system up. Check the CONFIGURATION display. The number should reflect the existence of the RUDDER interface (See Section 3. The CONFIGURATION should be include 128.)
3. Check the operation of the rudder by moving the sensors and checking the RUDDER and TRIMTAB displays.
4. With the helm(s) zeroed, set the ZERO adjustments. Set the helms to known values and set the SPAN adjustments, ignoring the sign(s). Repeat zero and span adjustments until you are satisfied with the readings.
5. Select the signature switch setting (positions 0 thru 3) which gives the correct sign(s) for the (two) readings.

Revision History

REV	DATE	CHANGE
A6	5/30/82	SOFTWARE S015A4
A7	10/1/82	SOFTWARE S015A7
A8	11/19/82	Remove LEEWAY pot. SOFTWARE S015A8
A9	4/25/83	Board E1410A2, JB12F2 jumper selection. Cut trace to '244p8, add jumper to JS16p4. SOFTWARE S015A9
A10	8/19/87	Simplify wiring harness. now common ground,pwr

066 Loadcell Interface
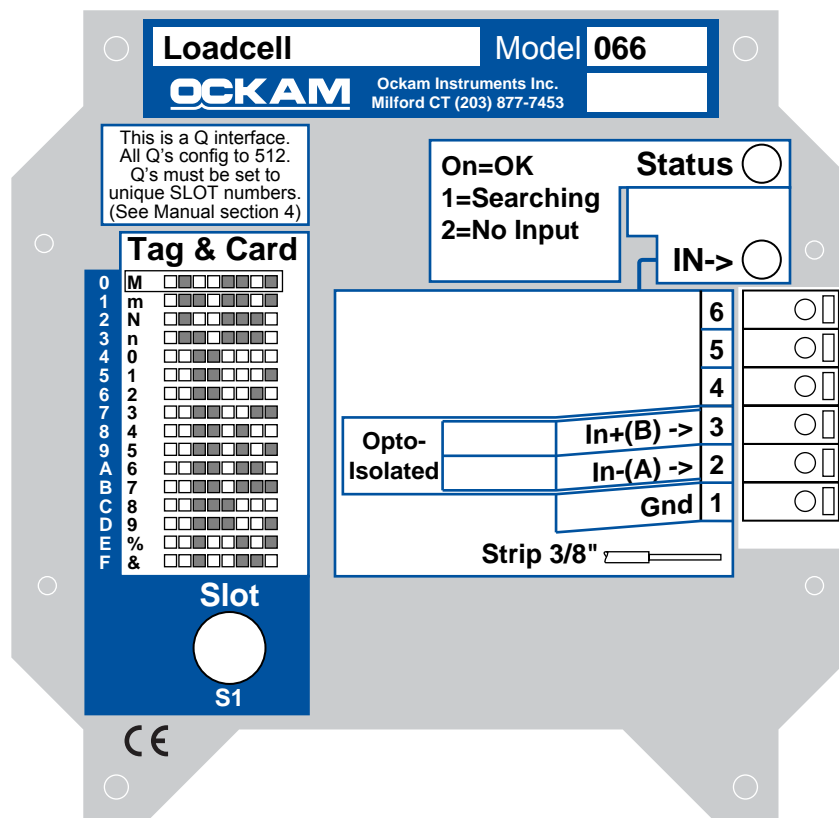
The Model 066 Load Cell interface provides the OCKAM system with the ability to display the output from a compatible load cell system, thereby eliminating the need for specialized indicators, and allowing the values to be logged.

Specifications

Dimensions:	4-3/4" W x 3-1/2" H x 1-1/2" D
Mounting:	VELCRO pads (or 4 #10-24 x 5/8" screws)
Weight:	1 Lb.
Orientation:	Any
Accessories:	"Load" Display Card
Power Requirements:	85 ma
Fuse:	250ma Picofuse
"Q" interface:	Variable tag, any slot (default is slot 0, Tag "M"), 9 bytes buffer space
Mating Connectors:	Ockam Bus: BNC Male (UG-88/U)
	Loadcell: NMEA-0183 2-wire terminal strip
Compatibility:	NAVTEC 1700 Load Cell System
	DIVERSE LoadSense with RS-232 amplifier

C E   The 066 Loadcell Interface complies with relevant sections of EU EN60945:1997 and EMC Directive 89/336/EEC.

Installation

1. A compatible load cell system must be installed in addition to the 066 Load Cell interface. The load cell system senses the force, and converts the strain-gauge signal into a digital output for use by the Load Cell interface. There are two such systems available.

   - The NAVTEC 1720 series load cell and 1730 converter. The 1735 digital display may be included as part of the load meter system but is not necessary for use of the 066 Load Cell interface.

   - The DIVERSE load cell and RS-232 amplifier.

2. The **Slot/Tag** switch on the interface is normally supplied set to "0". This tells the Interface, to send its data on tag "M", the display card normally supplied with the interface. You should leave this switch alone unless you are installing multiple Load Cells or other Q interfaces (see Multiple Q Interfaces section).

3. Check that your Ockam CPU has the correct (Revision A14 or higher) of software. Put the TEST CONFIGURATION card into a display and turn the Ockam system on. The display will show "HI", then "P14.x" and finally the system configuration. The "P" number must be 14 or larger in order to use the Load Cell interface. If the number is less, contact Ockam instruments and arrange for a CPU software update.

4. Install the load cell system in accordance with the instructions provided by the manufacturer.

5. Mount the Load Cell interface near the load cell system and connect the processor to the interface per manufacturer's instructions.

6. Connect the interface to the OCKAM system and turn the power on. Insert the TEST CONFIGURATION card into a display and verify that the number is correct. The configuration value for the Load Cell interface is 512. See CONFIGURATION function for details on use.

7. Insert the LOAD CELL card into a display and power up the load cell. The display should show "E" until the load cell begins working.

Troubleshooting

1. If the display does not change when you put the LOAD CELL card in, check the following;
   - Recheck the installation.
   - Be sure that the load cell system is powered up and operating correctly (See the load cell system instructions).
   - Check the CONFIGURATION (step 7 above).
   - Check that the LOAD card and **Slot/Tag** switch setting are compatible (See step 2 above, and the next section).

2. If the CONFIGURATION number from step 3 above is incorrect, check the following;
   - CPU revision A14 or higher (step 4 above).
   - The connection between the Ockam CPU and the interface.
   - The interface fuse (System Manual Section 4).

Installing Multiple Load Cell Or Other Q Interfaces

The Load Cell interface is a Q interface. The Ockam System can accommodate up to 16 (depending on how many resources they require) of these interfaces at the same time. The slot designation allows the CPU to differentiate amongst the Q interfaces by giving each a different "address". Each interface is required to occupy a different "slot"; it does not matter which (to the CPU at least), as long as they are all different.

Naturally enough, the slot designation **is** important. It determines which display card "tag" (i.e. magnet pattern) the data is to be sent on. The tag information is carried inside the Q interface itself, and in some interfaces, can be changed by selecting a different slot. Some interfaces have a fixed tag value, and some (like the Load Cell interface) have a choice of tags.

If you have multiple Q interfaces (including Load Cells), you need to select a Slot switch setting so that all are different, and also designate different tags. You also need to check that the tags

you select are matched by the magnet patterns of the display cards you expect the readings to appear on.
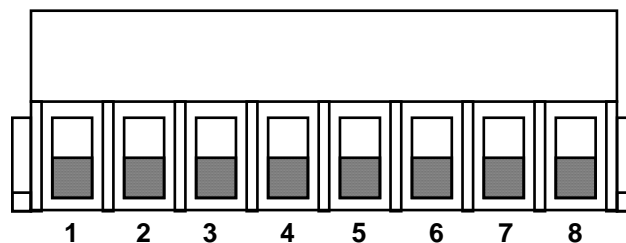
MODEL 066 LOAD CELL

rdg	Slot	Tag	Normal Use	1	2	3	4	5	6	7	8
115	**0**	**M**	**Load Cell #1 (Supplied)**		•			•	•		•
155	1	m	Load Cell #2		•	•		•	•		•
116	2	N	Trim Q interface		•			•	•	•	
156	3	n	Load Cell #4		•	•		•	•	•	
060	4	0	User 0, Polar output			•	•				
061	5	1	User 1			•	•				•
062	6	2	User 2			•	•			•	
063	7	3	User 3			•	•			•	•
064	8	4	User 4			•	•		•		
065	9	5	User 5			•	•		•		•
066	A	6	User 6			•	•		•	•	
067	B	7	User 7			•	•		•	•	•
070	C	8	User 8			•	•	•			
071	D	9	User 9			•	•	•			•
044	E	$	None			•			•		
043	F	#	None			•				•	•

Revision History

REV	DATE	CHANGE
A1	11/15/85	Software S066A1
A2	4/15/86	Software S066A2 Fix overrun error
B1	7/10/92	Software S066B1. Accept Navtec Conv II, Diverse 4800 baud.
B2	5/25/93	Change input resistors to accept Conv II RS-422 input.

069 Universal Displacement Interface
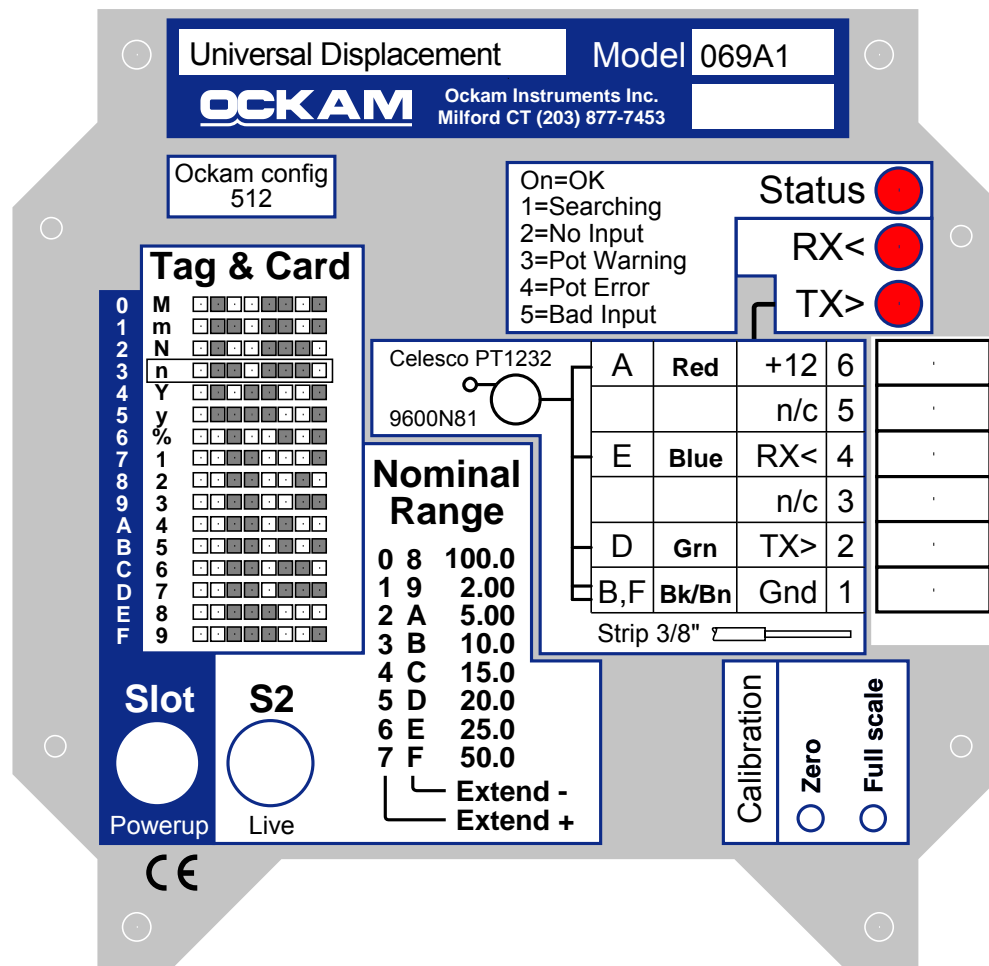
The Model 069 Load Cell interface provides the OCKAM system with the ability to display the position of just about anything.

Specifications

Dimensions:	4-3/4" W x 3-1/2" H x 1-1/2" D
Mounting:	VELCRO pads (or 4 #10-24 x 5/8" screws)
Weight:	1 Lb.
Orientation:	Any
Power Requirements:	85 ma
Fuse:	250ma Picofuse
"Q" interface:	Variable tag, any slot (default is slot 3, Tag "n"), 9 bytes buffer space
Mating Connectors:	Ockam Bus: BNC Male (UG-88/U)
	Sensor: RS-232 terminal strip with power.
Compatibility:	Celesco PT1232 string pot sensor, not supplied

CE The 069 Loadcell Interface complies with relevant sections of EU EN60945:1997 and EMC Directive 89/336/EEC.

Installation

1. Determine the maximum length the string pot will travel, including overrun, then pick the next longer model (see http://www.celesco.com/_datasheets/pt1232.pdf).

<div style="border:1px solid black">

WARNING

NEVER let the string get pulled out beyond the stop or the sensor will break.

NEVER let the string fly back unchecked. The sudden stop will also break the sensor.

</div>

2. Install the string pot in accordance with the instructions provided.

3. Connect the string pot to the interface as shown on the facia.

4. Decide which slot to set the interface to. S1 must be set to a unique number amongst the Q interfaces. S1 also determines which tag the output goes to.

5. If you are using a 001 processor, check that it has the correct (Revision A14 or higher). Put up TEST Configuration and turn the system on. The display will show "HI", then "P14.x" and finally the system configuration. The "P" number must be 14 or larger in order to use this interface. If the number is less, contact Ockam instruments and arrange for a CPU software update.

6. Put up the tag defined in step 4 and check for proper operation. Set S2 to an appropriate nominal range for the sensor and application. Note that this switch also designates whether extending the string makes the reading go positive or negative.

7. Set the sensor to the "zero" or home position (actual "0" is not necessary – it might make sense for the output to go from 4 to 7). Adjust the Zero calibration for correct output.

8. Move the sensor to "full scale" position and adjust the Full Scale calibration. Repeat steps 7 and 8 until satisfactory output is achieved.

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