![Livorsi Marine, Inc. · livorsi.com logo]

DataTach™

PropSlip Multi-Gauge

Actual Size

Owner s Manual

Thank you for purchasing the

Livorsi *™* **DataTach** *™ PropSlip Multi-Gauge.*

We know you probably won't read the entire manual before using your new gauge, but you should. We stayed up many long nights trying to make it easy to use, but it has a computer inside, only two switches on the dashboard to control it and does some really cool things.

So we stayed up even more long nights writing this manual to help you navigate the inevitable complexities of such a capable product. The least you could do is stay up a little late, just one night, and Read This Fabulous Manual, or some of it.

It'll make your first day on the water with your new **Livorsi** **DataTach** *™ PropSlip Multi-Gauge* so much more pleasant, really.

Enjoy!

Note: The DataTach web analysis service is currently under construction. If you have the optional recording module, contact Livorsi Marine for instructions on how to have your recorded data converted to chart form.

Program and owner's manual updates will also be available when the automated analysis service is online.

We'll notify you when these online services become available.
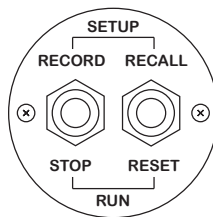
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System Pieces

Your DataTach is a unique, multi-function, recording gauge that captures information about the performance of your boat that can help you maximize its performance.
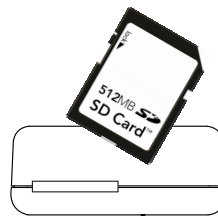
The DataTach system consists of...

...a DataTach

...a Switch-Panel

... an (optional) Recording Module (w/card)

... a GPS Receiver

... your boat!

How it Works

Inside the DataTach is a computer that receives GPS speed and engine RPM information. Five times every second, the computer calculates the slip of your boat's propeller from that information and displays it for you.

With the optional recording module, you can record speed, slip, RPM and GPS information on an SD memory card for eventual transfer to the DataTach website (www.datatach.com) where it can be analyzed and graphed.

What's Slip?
Your boat's propeller acts like a screw in the water and, like screws, has a "pitch". Pitch is the distance a screw progresses through a material in one complete turn. With a 6-32 machine screw turning into a nut, you get exactly 1/32" of travel for each turn of the screwdriver. But for a propeller in water, it's another story. In theory, for each turn of the propeller, your boat should move forward by an amount equal to the prop's pitch, but in reality it doesn't. Every bit of your boat that's in the water induces drag, and the water is not solid. This results in the propeller slipping behind the theoretical distance it should travel with each rotation. The difference between the theory and the reality is called "**propeller slip**".

Propeller slip is a key indicator of overall boat performance. Under many conditions, a decrease in propeller slip corresponds with improved performance and fuel economy. Modern powerboats have various engine, drive, and adjustable trim systems designed to increase performance, and thus, decrease propeller slip.

Calculating Propeller Slip

Slip is calculated from Speed, Drive Ratio, RPM and Propeller Pitch as follows:

$$Slip = \left(1 - \frac{Speed(mph) \times 1056 \times DriveRatio}{RPM \times Pitch(in)}\right) \times 100\%$$

Example: your boat runs 61.3mph at 4300mph with a 24 inch pitch prop and 1.36:1 drive ratio. What's the slip?

$$\left(1 - \frac{61.3mph \times 1056 \times 1.36}{4300rpm \times 24(in)}\right) \times 100\% = 14.7\%$$

Or, if you use KPH as your speed unit:

$$Slip = \left(1 - \frac{Speed(kph) \times 656 \times DriveRatio}{RPM \times Pitch(in)}\right) \times 100\%$$

Example: your boat runs 105kph at 4700mph with a 22 inch pitch prop and 1.33:1 drive ratio. What's the slip?

$$\left(1 - \frac{105.0(kph) \times 656 \times 1.33}{4700rpm \times 22(in)}\right) \times 100\% = 11.4\%$$

The DataTach makes this calculation five times per second so you don't have to.

The Right Amount of Slip

If your goal is maximum speed on plane with wide open throttle, you'll want the lowest slip possible. If your goal is maximum acceleration "out of the hole", there is an optimum slip at which your motor's transfer of power to the water is maximized. You can determine this optimum setup by examining acceleration plots.

Typical slip values depend on hull type and speed:

• Sailboats, barges, displacement craft	< 9 MPH	45%
• Heavy powerboats and workboats	9 - 15 MPH	26%
• Powerboats and Lightweight Cruisers	15 - 30 MPH	24%
• High speed planing boats	30 - 60 MPH	20-25%
• V bottom race boats	60 - 90 MPH	10-20%
• Hydroplanes and catamarans	> 90 MPH	7-12%

Factors That Affect Propeller Slip

|	
• Hull Design (Stepped vs V-Bottom)	• Actual (measured) Pitch of Propeller
• Condition of boat bottom	• Condition of propeller
• Engine mounting height	• Engine/Drive trim angle
• Jack plate mounting	• Engine/Drive setback
• Weight distribution	• Fuel / passenger / cargo load

Design vs. Measured Pitch

While all propellers are designed to have a specific pitch (often stamped on the hub), the complexity of their design and inconsistencies in manufacturing often result in the true, measured pitch being different. In effect, no two propellers are exactly the same, and they may not have the pitch you see stamped on the hub. As a result, calculating slip from the design pitch of your propeller(s) may not yield absolutely accurate results. The DataTach's usefulness in improving the performance of your boat <u>does not depend on knowing your propeller's true pitch</u>. The DataTach will accurately reflect performance improvements (or degradation) that results from changes you make to your boat. So, even if you don't know your propeller's true pitch, the DataTach will help you optimize performance.
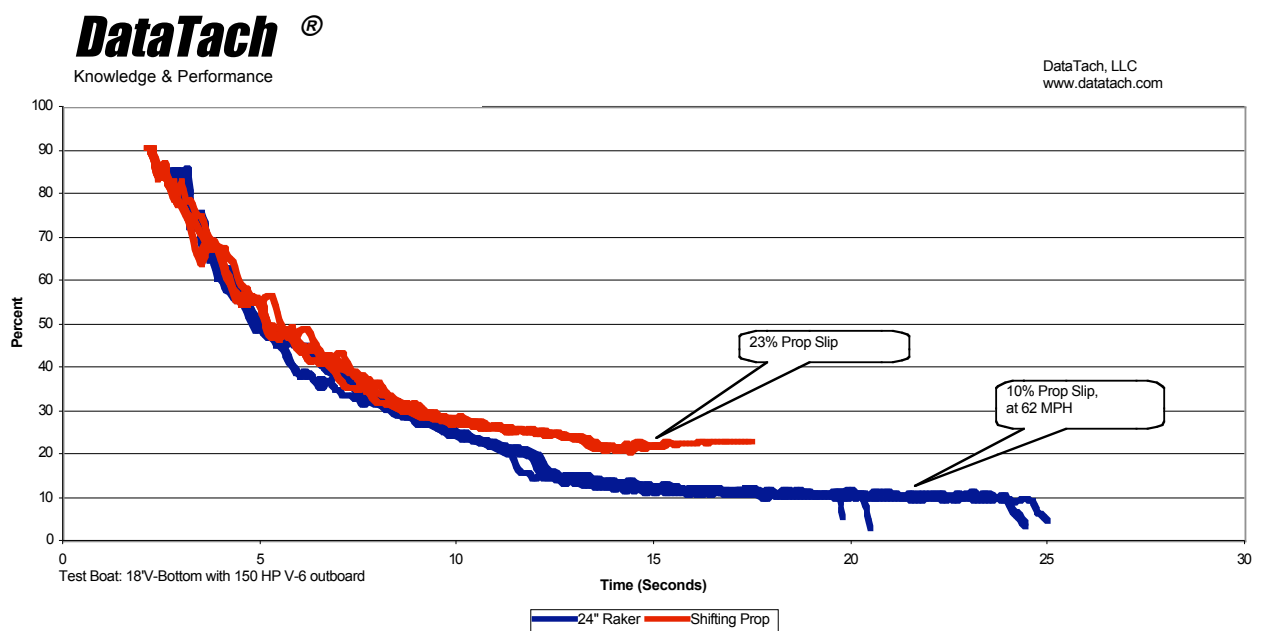
If you desire the ultimate in slip measurement accuracy, you can have the true pitch of your propeller measured at many propeller service centers.

Slip vs. Speed

Planing hulls rise out of the water as speed increases. As a result, drag and slip both decrease with increasing speed as shown in this theoretical curve:

Slip vs. Speed for Planing Hulls
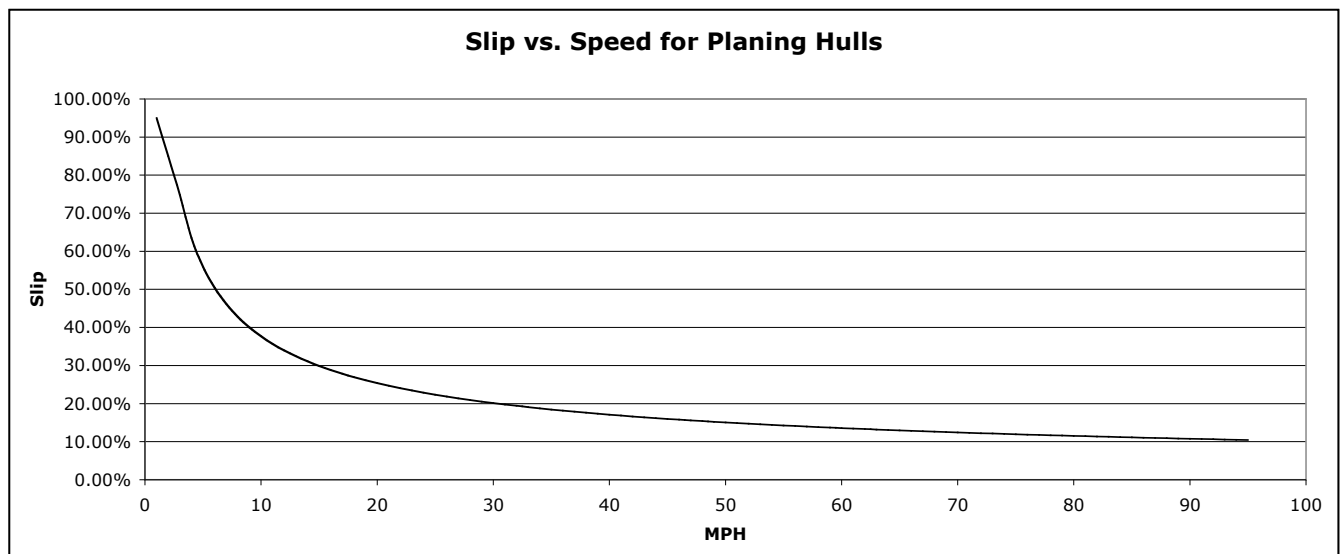
Here's an example of slip data obtained by a DataTach from a 18' V-bottom boat. Two propellers were tested on the same hull. The DataTach caught the reduction in slip offered by the shifting prop 12 seconds into the run. For more insight into analyzing such graphs, visit www.datatach.com.

DataTach ®
Knowledge & Performance

DataTach, LLC
www.datatach.com

23% Prop Slip

10% Prop Slip,
at 62 MPH

Test Boat: 18'V-Bottom with 150 HP V-6 outboard

24" Raker   Shifting Prop

6

The DataTach Display

SETUP Mode Indicator

GPS Status Indicator

Course over Ground

Engine RPMs
(single or twin)

Prop Slip
(single or twin)

Recording
Indicator

MAX Speed
Recall Indicator

Speed
(in MPH or KPH,
as desired)

Speed Unit Indicators
(MPH or KPH,
as desired)

GPS Status and Course Over Ground (COG)
Course over ground is rounded to the nearest 10°
The GPS status indicator (compass rose) reflects the state of your GPS receiver:

Off	No GPS receiver detected
Blinking	GPS is detected but the receiver does not have satellite lock
On	GPS data is valid

During loss of GPS lock, the displayed speed will freeze for up to five seconds, ignoring short losses of signal as you pass under obstructions. If lock is not regained within five seconds, the GPS status indicator will blink, the COG display will turn off, and speed will go to zero.

Single or Twin Engine RPM and Slip readings
Unused tach inputs will result in blank displays of RPM and Slip on the corresponding side of the gauge. You may connect a single engine to both tach inputs if you wish. The resolution of RPM and slip calculations is determined by "**Display Resolution**" in **SETUP** mode.

GPS Speed with Recall
Boat speed, as obtained from the GPS receiver, in the units of your choice (MPH or KPH as determined by the **SETUP** parameter "**Speed Units**")

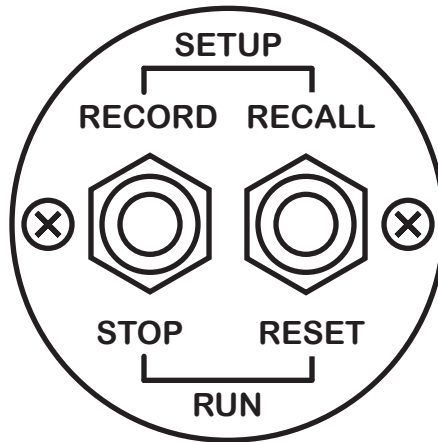**MAX Recall Indicator -** Active when MAX speed is recalled
SETUP Indicator - Active when the gauge is in SETUP mode
RECORDING Indicator - Active when recording data using the optional recording module

The Switch-Panel and Operating Modes

The Switch Panel

The DataTach's functions and modes are controlled from a Switch-Panel with two dual-throw spring-return toggle switches. There are two operating modes, RUN and SETUP. RUN is the normal operating mode. The gauge powers up in RUN mode and you should seldom need to leave it for SETUP mode. SETUP mode allows you to alter gauge operating parameters. When you need it, SETUP mode is entered by flipping both switches up. You exit SETUP mode by flipping both switches down.

The functions of the switches are different in RUN and SETUP modes.

In RUN mode: The left switch starts and stops data recording. The right switch recalls or re-sets the maximum speed monitor.

In SETUP mode: The left switch moves you forward or backward through a list of alterable parameters. The right switch alters the selected parameter. If you hold the right switch up/down for more than one second, the selected parameter will automatically increment/decrement. This is helpful when the desired parameter value is a long way from where you are. Hold the switch until you get near your desired number, then "home-in" with individual flips of the switch.

NOTE: If you do not have the optional recording module, the left switch is only used, in combination with the right switch, to flip between RUN and SETUP modes.

Enter SETUP

Flip both switches up simultaneously, then release.
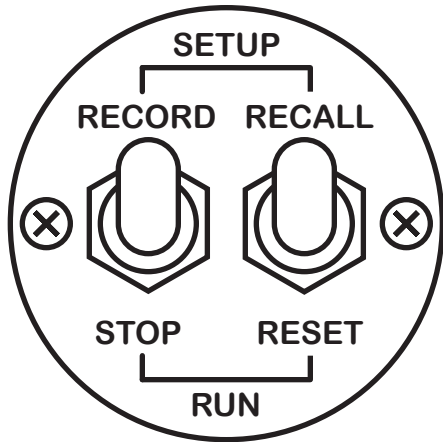
Enter SETUP only if you wish to change an operating parameter or preference.

In SETUP mode...
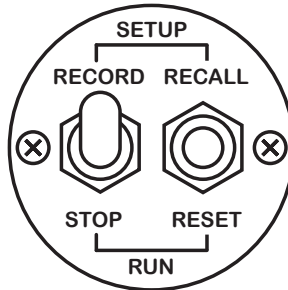
Next Parameter

Increment Parameter
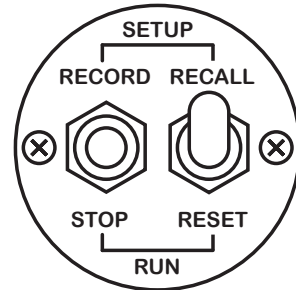
Previous Parameter
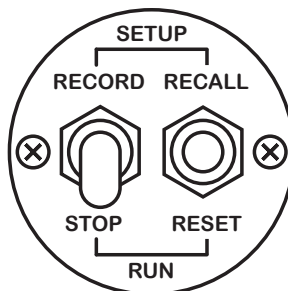
Decrement Parameter

Return to RUN

Flip both switches down simultaneously, then release.

The gauge powers up in RUN mode.

In RUN mode...

Start Recording

Recall MAX Speed

Stop Recording

Reset MAX Speed

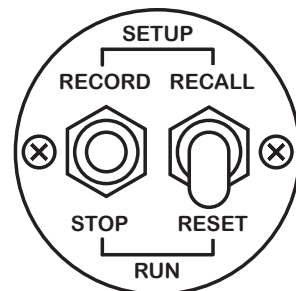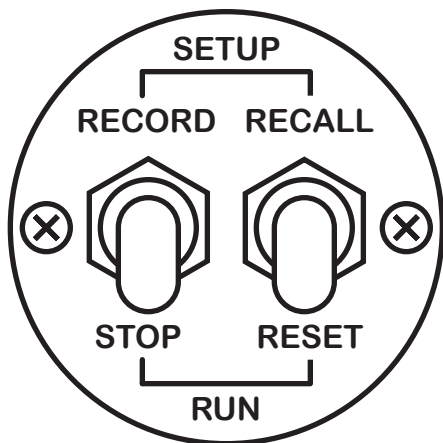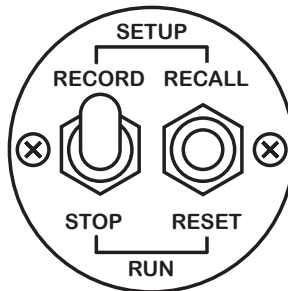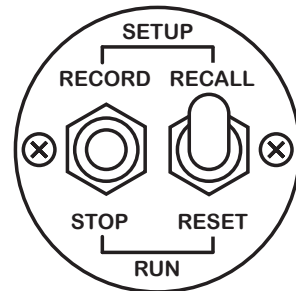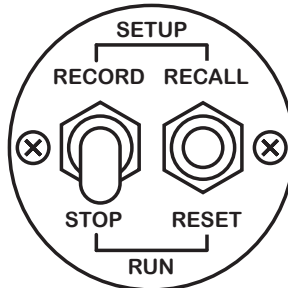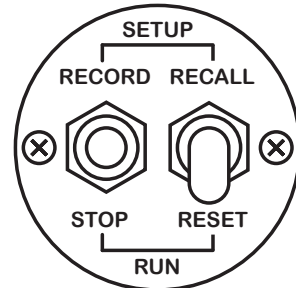# Recalling and Resetting Maximum Speed

To see the highest speed your boat has achieved since the last reset, hold the right switch up. The MAX indicator turns on and the display shows maximum speed, the engine RPMs that produced it, and the heading and slip at that time. When you release the switch, the display returns to "live" information and the MAX indicator turns off.

Maximum speed is remembered indefinitely, even if the DataTach is turned off.

To reset to your boat's current speed, toggle the right switch down momentarily.

NOTE: GPS receivers introduce a small delay in reported speed as they perform complex calculations on the satellite data they receive. As a result, when you cut back the throttle quickly after a high speed run, engine RPMs will fall before the reported GPS speed does. When this happens, calculated slip will be artificially low, perhaps even zero, for a second or two.

Whenever a new maximum speed is reached, the DataTach saves the RPM measurement from 2.5 seconds earlier to avoid this problem, but under some circumstances GPS data may be delayed by more than that. If, during a run, you cut the throttle immediately after reaching maximum speed, MAX recall may show abnormally low slip. The maximum speed reading will always be correct.

Recording, Uploading and Graphing Data

With the optional recording module, your DataTach will record boat speed, engine RPMs, propeller slip, position and heading, 5 times per second on a properly prepared SD memory card. You may then upload the recorded data to the DataTach website for analysis.

At any time during a boating session, you may start recording data by toggling the left switch up. Recording begins and continues until you toggle the left switch down. The Recording indicator is on while recording. When you start recording, any previously recorded information is overwritten. If you do not have the recording module, the left switch is used only to enter and exit Setup.

The included SD Memory card is capable of holding hours of data, more than enough to record your boat's performance over time under varying conditions (upwind/up current, downwind/down current). Simply record everything of interest. When you are done, remove the SD memory card and transfer it to your PC. Visit the DataTach website (www.datatach.com) for instructions on uploading your recorded data for analysis.

Setting Up Your DataTach

Before you first use your DataTach, you must tell it a little about your boat's setup and your personal preferences for using the gauge. This information is entered in **Setup Mode**. Once set up, the DataTach remembers all settings indefinitely, and you may change settings again at any time. The various parameters are arranged in a circular list. When you've advanced through the last parameter, you are returned to the first. You may navigate this circular list in either direction by toggling the left switch up or down.

To exit Setup and return to normal **RUN** mode, press both toggle switches down.

Note: changing parameters while recording may result in storing incorrect data.

Propeller Pitch (PP)
(You may find this stamped on the prop hub)
In normal resolution mode, the DataTach accepts propeller pitch in one inch increments from 5 to 40 inches. In high resolution mode, propeller pitch is accepted in increments of one tenth inch. Most propellers are specified in increments of one inch, but may not actually be of the stated "design pitch". Use high resolution mode if you've had your propeller's true pitch measured by a capable prop shop. If you have multiple propellers with different measured pitches, enter the average of the measured pitches. (If you have propellers with different design pitches, what were you thinking?)

Propeller Diameter (Pd)
(You should find this stamped on the prop hub)
Propeller diameter is entered in increments of 0.25 inch from 5 to 20 inches, and in increments of 0.5 inch from 20 to 50 inches. If your propeller is larger than 50 inches in diameter, call us. We'd like to visit.

Drive Ratio (dr)
(Consult your drive manual)
The DataTach interprets drive ratio as crankshaft speed/prop speed. Drive ratios from 0.50 (propeller turns twice as fast as the crankshaft) to 3.00 (propeller turns three times slower than the crankshaft) are accepted in increments of 0.01.

Pulses Per Revolution (ppr)

The DataTach must know how many electrical pulses your engine's tachometer output produces per revolution of the crankshaft. Locate this value in your engine/drive documentation, or select the PPR value from this table of common settings:

Drive Type	# of Cylinders	PPR
Inboard/Outboard	4	2
Inboard/Outboard	6	3
Inboard/Outboard	8	4
Inboard/Outboard	10	5
Outboard	6	6

If you have a diesel engine, you must consult your documentation for the proper PPR. If none of the listed settings produce proper tachometer readings, consult the troubleshooting section at the end of the manual.

The DataTach accepts PPR values from 0.5 to 20 in increments of 0.5.

Speed Units (SPd)

You may display speed in either MPH or KPH. Toggling the right switch up or down will flip the gauge back and forth between the two measurement systems as indicated by the **MPH** / **KPH** icons at the bottom of the display.

Tachometer Signal Sensitivity (SEn)

Tachometer signals vary in amplitude from engine to engine. To ensure compatibility with the widest range of engines, the DataTach provides two levels of sensitivity for its tachometer inputs. If you do not get stable, accurate tachometer readings using the default Low sensitivity setting, toggle the right switch up to select Hi sensitivity. Toggle it down to return to low sensitivity.

bri

Backlight Brightness (bri)
The DataTach display backlight is adjustable in intensity from 1% (too dim) to 100% (too bright) in increments of 1%. Something in between should suit you.

rES

Display Resolution (rES)
The DataTach provides two display resolutions:

High and **normal**

For casual use, the display may appear too busy. When you don't want all that fine detail on the display, select **nor**mal display mode. RPMs are rounded to the nearest 50, and slip is rounded to full percent.

If you want more precision, select **Hi**gh resolution mode. Engine RPMs are indicated down to the RPM and slip is indicated to the nearest 0.1%

NOTE: In high resolution mode, prop pitch is entered to the nearest 0.1", just as you might get if your prop is measured by a performance propeller shop. In normal mode, pitch is limited to industry standard 1 inch increments. You may enter propeller pitch in high resolution mode to capture the precise measured pitch of your propeller, then switch to normal resolution for daily operation. Your propeller pitch entry is retained at 0.1" resolution.

Program Updates

From time to time, we may introduce software updates for your DataTach. The optional Recording Module enables your DataTach to receive program updates downloaded from the Livorsi (www.livorsi.com) or DataTach (www.datatach.com) websites.

Your DataTach's current program version number is displayed briefly (where you usually see speed readings) when the gauge turns on. If there is a newer version of the program available online, the website will explain what it offers, and provide instructions for updating.

The memory card provided with the DataTach contains the latest version of the program available at the time of purchase, and an initialized data recording file. You may wish to copy both of these files to a safe place on your computer, in case you lose the card or wish to reload your original version of software after an update. The latest program updates, all previous versions, and a copy of the initialized data recording file will always be available online.

The DataTach looks for two files on any memory card you plug into the Recording Module:

"FILENAME".GPU   This file contains the Gauge Program Update. "FILENAME" generally reflects the version of the update. For example, the gauge was first released with PROGV10.GPU which was version 1.0 of the gauge program.

PROPSLIP.DAT   This file holds any data you record. When you first receive your recording module, this file will be very large to ensure a large unbroken space on the card for the gauge to record data. Every time you record, this file will change size in proportion to the length of the recording session, and will generally be much smaller than the file's initial size.

There must be no files other than these on the memory card. Do not remove or modify them, or add any other files to the card. The easiest way to prevent accidental alteration of the card by your computer is to keep the SD card "Lock" switch in the locked position. The DataTach ignores this switch, but your computer does not. The included memory card is already locked. There is no reason to unlock it unless you wish to copy a new program update file to the card. Keeping the card locked is particularly important if you use a Macintosh computer, as the Mac will place housekeeping files on any memory card it sees, potentially requiring you to prepare the card again.

If you only wish to update the gauge software, you do not need propslip.dat on the card.

If you only wish to record, you do not need a .gpu file on the card.

When a new program update is available, you must prepare the memory card for the update as described in the next section.

Preparing/Updating Memory Cards

If you wish to update your gauge's operating program, or accidentally alter the memory card (it happens!), or wish to use another SD card, you can prepare it using a PC (with SD card reader) by following this procedure:

1) Unlock and insert the card in your reader.
2) Locate the card's icon using Windows Explorer.
3) Right click the card's icon and select "Format" from the pull down menu.
4) Select FAT (not FAT32) and "Quick Format", then format the card.
5) Copy the appropriate "FILENAME.GPU" for the desired update to the card.
6) Copy the file "PROPSLIP.DAT" to the card.
7) Right click on the card's icon and select "Eject" from the pull down menu.
8) Remove the card from your card reader and lock it.

The card is now ready for use with the DataTach. If you do not have copies of the two files, you may obtain the latest versions from the DataTach or Livori websites. Note that the supplied PROPSLIP.DAT file is quite large and takes some time to write to the card.

Installation
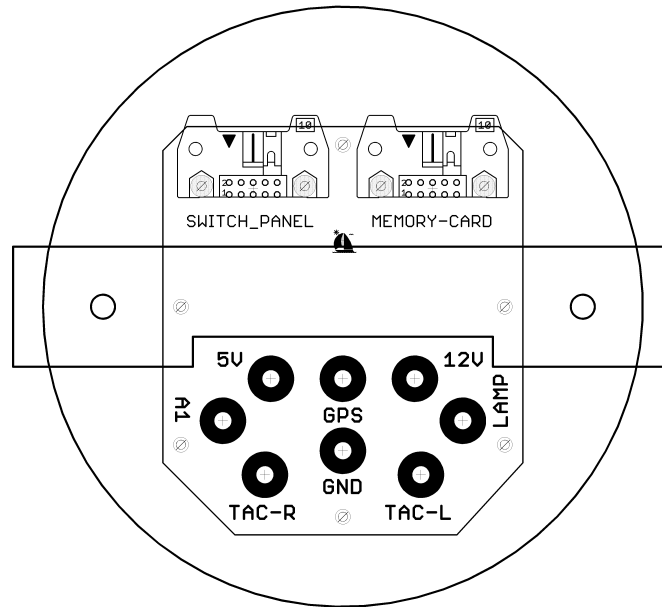
Mechanical Installation

The DataTach is five inches in diameter. It mounts in a 4-5/8 inch circular dashboard cutout and is held from behind by a metal bracket. The switch panel mounts through a 2 inch cutout, and is fastened from the front with the included screws.

The optional Recording (Memory-Card) Module attaches to any flat surface (shielded from spray) with the included double-sided tape. **Do not** install the module with the memory card slot facing up, as water spray or condensation may fall into the module.

Electrical Installation

The switch panel and recording module (memory-card) cables snap into the latching connectors on the back of the DataTach. The connectors are keyed to prevent reverse insertion. Each cable connector has a small "key" on one face that slips into a slot on the circuit board connector. It is not possible to insert the connectors backwards. Make sure you plug the cables into their corresponding connectors. If you accidently swap the cables, the gauge will not operate properly, but no damage will be done.

The switch-panel and recording module cables are long enough to allow you to wire the gauge before mounting it through the dashboard cutout. Wrap any excess ribbon cable into a small loop and fasten in place with tape, tie wraps or twist ties. If your boat produces high voltage tachometer signals from the ignition coil (see the section on "Tachometer Sensitivity"), make sure you do not route the ribbon cables (especially the recording module cable) near the tachometer wires.

The remaining connections are made to terminal posts on the gauge back as follows:

GND   Boat ground. Also connect GPS receiver ground here.

12V   Boat main power, attach GPS receiver power here if it requires 12VDC.

LAMP   Instrument lamp power. If you want the backlight on at all times, or do not have an instrument lamp power switch, connect this to 12V.

TAC-L   Left tachometer. If you provide no signal here, the left tachometer and slip displays will remain blank.

TAC-R   Right tachometer. If you provide no signal here, the right tachometer and slip displays will remain blank.

      Note: in single engine applications, you can connect both tachometer inputs together. The DataTach will display the same RPM and slip information on both sides of the display.

5V   If your GPS receiver requires 5VDC, connect its power wire here.

GPS   Signal output from your compatible GPS (Livorsi or other) receiver (NMEA-0183, 4800 bps).

A1   Not used.

Note: We've done our best to protect the DataTach from improper installation, but it is still possible to damage the gauge by wiring it incorrectly and we can't take responsibility for that. Install the gauge and re-check all the wiring before turning on your boat's electrical system. Be very careful to avoid shorting signals with tools during the installation process.

We recommend the use of crimped ring terminals on the ends of your wires. They insure a good connection and help prevent accidental shorting from loose wire ends. If your wiring harness doesn't have enough slack for you to wire the gauge while it's pulled out of the instrument panel, and you don't have enough room to work from the back of the panel, make a short "extension harness" and connect it to your existing harness with wire nuts or crimp splices.

Specifications

Operating Temperature Range:	15 to 140°F (-10 to 60°C)
Storage Temperature Range:	-5 to 185°F (-20 to 85°C)
Operating voltage:	12 to 16VDC (reverse battery protected)
Speed Range:	0-199.9 M/KPH with 0.1 M/KPH resolution
	0-999 M/KPH with 1 M/KPH resolution
Speed Accuracy:	Determined by GPS receiver
Tachometer range:	0-9,999* RPM
Tachometer accuracy:	±0.5%*
Slip Range:	0-100%
Course Over Ground accuracy:	Determined by GPS receiver
Course Over Ground resolution:	10 degrees

TroubleShooting

Here's a list of common symptoms and their potential cures. As new troubleshooting information becomes available, we'll update the online version of this manual at www.livorsi.com or www.datatach.com.

Symptom	Potential Cure
Speed is always zero	If the compass rose is not visible, the DataTach is not receiving data from your GPS receiver. Check the wiring. If the compass rose is flashing, the GPS receiver is operating, but has not achieved satellite lock. Check that your GPS receiver has an unobstructed view of the sky and is not near any source of electrical interference.
I can't record	Make sure you have a properly initialized SD card in the Recording Module socket and that the recording module is plugged into the back of the DataTach. The card must be inserted with the label side facing the label side of the module. If the "Recording" icon does not show when you flip the left toggle switch to "Record", make sure you have a memory card in the module and check the memory module wiring. If the "Recording" icon flashes, the memory card is present but the gauge cannot find the "PROPSLIP.DAT" file. See " **Preparing memory cards for use with the DataTach"** to re-initialize the card.
Tach is erratic	See "**Tachometer Signal Sensitivity".** If changing sensitivity does not help, check the tachometer wiring. The DataTach is compatible with most tachometer signals, but some ignition systems may provide a high voltage tachometer signal directly from the ignition coil. If this is the case in your boat, you may need to reduce the signal amplitude using a resistor. Placing a 33K or 100K ohm resistor between your boat's tachometer signal and the DataTach's tachometer inputs may solve the problem. Start with the tachometer signal sensitivity set to 'Hi". If you still get erratic readings, try "Lo".
Tach does not come on	See "**Tachometer Signal Sensitivity"** and set the sensitivity to "Hi". Check the tachometer wiring.

Symptom	Potential Cure
Tach seems to follow engine speed, but reading is wrong	Check **Pulses Per Revolution**. If you are pulling your tachometer signal from an inductive pickup around a spark plug or coil wire, and you have an ignition system with "Multiple Spark Discharge", you may not be able to get an accurate tach reading at low RPMs. Such engines are likely to have dedicated tachometer outputs. You must connect the DataTach to that dedicated output. If you are pulling RPMs from a sensor located on the crankshaft or propshaft (as in diesel installations), consult your drivetrain documentation for the correct "PPr" setting.
Recalled slip at MAX RPM is too low or zero	All GPS receivers introduce a small delay in reported speed as they perform complex calculations on the satellite data they receive. As a result, when you cut back the throttle after a high speed run, engine RPMs will fall before the reported GPS speed does. When this happens, calculated slip will be artificially low, perhaps even zero, for a second or two. Whenever a new maximum speed is reached, the DataTach saves the slip measurement from 2.5 seconds earlier to avoid this problem. Under some circumstances, GPS data may be delayed by more than 2.5 seconds. If, during your test run, you cut the throttle immediately after reaching maximum speed, the MAX recall may show abnormally low slip. The indicated maximum speed will always be correct.
Recalled MAX speed is impossibly high	Some GPS receivers can be confused by nearby sources of radio interference and produce wild speed readings on occasion. The DataTach attempts to filter out such wild readings, but it is possible that one will get through and create an erroneous maximum speed reading. If you regularly recall unexpectedly high maximum speeds, check that your GPS receiver is not located near any source of radio interference. If you are having this problem you will probably also notice blips in the real time speed display, but unlike the DataTach's MAX recall function, you are likely to ignore them.

Symptom	Potential Cure
I can't read the SD card in my computer	If your PC cannot read the contents of the memory card, it may have been corrupted. This can happen if you turn off your boat's electrical system while the gauge is recording data, or if severe electrical noise in your boat's electrical system couples into the recording module wiring (see the installation instructions on suggestions for avoiding electrical noise from ignition systems). If this happens, the memory card can be made to work again by re-initializing it. See "**Preparing memory cards for use with the DataTach**"

From all of us at:

and

Thanks again!

We believe you'll find the **Prop Slip Multi-Gauge** a productive and enjoyable addition to your boat. We know there are people in this world who don't understand how anyone could enjoy a dashboard gauge. But the DataTach is different. With it, you'll know more about your boat than most.

The rest of them?

They don't know what they're missing.

Toll Free: 877-548-5900
Fax: 847-548-5903

Livorsi Marine Inc.
10 Livorsi Drive
Grayslake, Illinois 60030

Sales – sales@livorsi.com
Tech Support – fredo@livorsi.com

Customer Service – bettys@livorsi.com
General information – info@livorsi.com

Did you read the entire manual? No? Then *you* don't know what *you re* missing