Interfacing Marine Electronics

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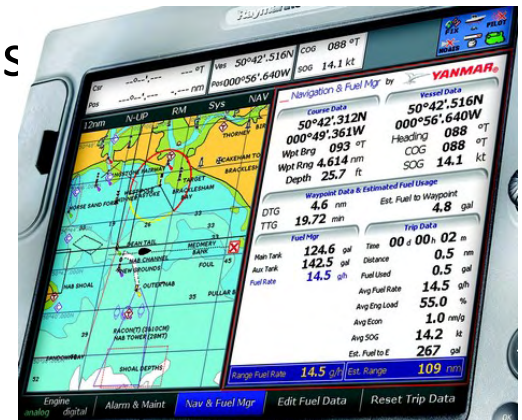
Agenda

- Trends
- Generations
- Interfaces
- Sensors
- Implementation
  - Mfg. network
  - Dealer network
  - Do it yourself

Sailboat Instrument Trends

- Manufacturer – sailboats are the smallest market
  - we get what is leftover
  - R&D very expensive –
  - Tough for specialty firms to survive

- Micro-electronics – sailboat instruments use chipset from others – think changes in cell phones
  - Components are cheap
- Networks – open versus closed – think PC versus Apple
- Sensors – the emergence of smart sensors
  - Think game changer for sailboat instruments

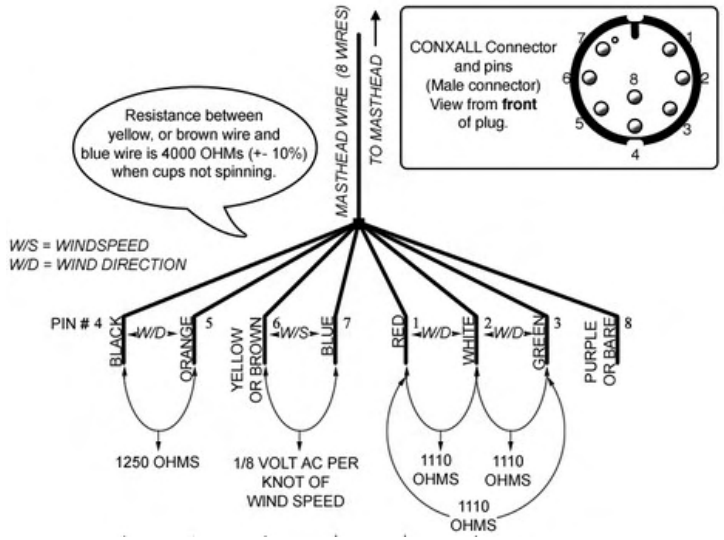


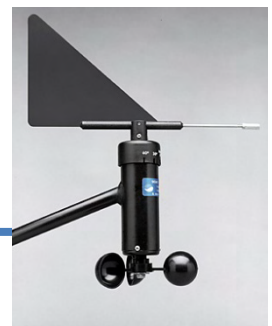
Sailboat Instrument Trends

- Speciality Sailboat Instrument Firms
  - Technology and R&D Advances
    - Frozen with old technology – Signet,EMS,
    - Closed – Datamarine,Kenyon
    - Bought by big guys
    - Innovate, adapt and survive - Ockam
- The big two –Raymarine and Navico (B&G, Eagle, Lowrance, Northstar and Simrad)
  - Spin-offs from Defense Contractors
  - Buying little guys
  - Raymarine near bankrupt trying to sell itself
- The wolf at the door – Garmin
- The revolution – Smart Sensor NMEA 2000
  - Airmar/Maretron
- Technology merge of cell, computer, marine, auto, aviation systems
    - Intellectual property lawsuits
    - Honeywell sued Raymarine, Furuno, and Navico
- www.panbo.com for the latest Marine Electronics Blog

Mayo's Generations

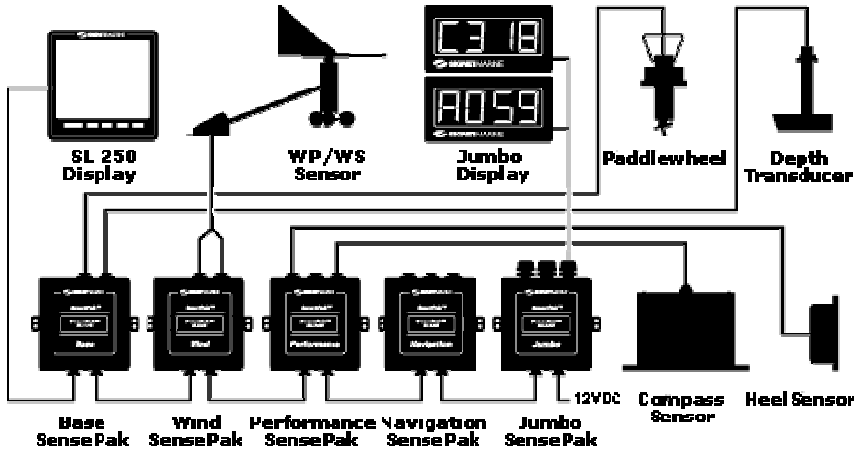
- Gen 1
  - Mechanical sensor
  - Analog voltage signal
  - Dedicated converter/display
  - No communication





Mayo's Generations

- Gen 2
  - Mechanical sensor
  - Analog voltage signal
  - Dedicated converter/display
  - Proprietary Communication

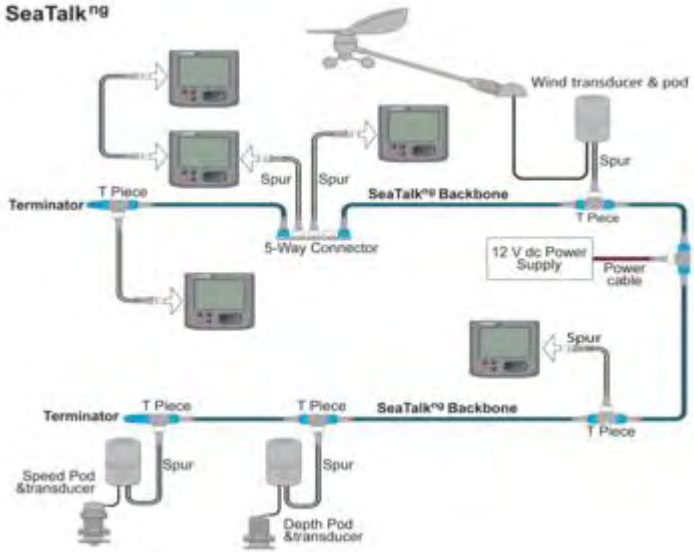


Mayo's Generations

- Gen 3
  - Mechanical sensor
  - Analog voltage signal
  - Display
    - Dedicated converter/display
    - Multi-function converter display
    - Separate converter and monitor/display
  - NMEA 0183

Mayo's Generations

- Gen 4
  - Mechanical/digital sensor
  - Analog/digital voltage signal
  - Display
    - Dedicated converter/display
    - Multi-function converter display
    - Separate converter and monitor/display
  - NMEA 2000 over semi-proprietary network



Mayo's Generations

- Gen 5
  - Smart mechanical NMEA 2000 sensor
  - Smart digital NMEA 2000 sensor
  - Display
    - Multi-function display
    - Multi-function monitor
  - NMEA 2000 over open network
    - Mix and match and create your own system
    - The Airmar/Maretron revolution

Interfacing

- Stay with the same manufacturer private networks
  - Raymarine - SeaTalk
  - Simrad - SimNet

- Have your dealer assemble NMEA 0183 or NMEA 2000 network
- Do your own NMEA 0183 or NMEA 2000 network

What are NMEA 0183 and NMEA 2000

- They are open communication protocols
  - Cannot convert from one to the other
- Both are in wide use today
- Cannot be mixed on same port
  - Some instrument can use both on separate ports
- NMEA 2000 is more capable than MNEA 083
  - Instruments before 2000 have only NMEA 083
  - NMEA 083 tends to be paired communication
  - NMEA 2000 is mult-user communication

NMEA 0183

- **NMEA 0183 (Ver. 3.01) Standard**
- **–Single talker multi-listener**
- **–Universal method for data exchange between two devices**
- **–Complicated installation and setup**
- **–Open to miss-interpretation**

- It is not possible to simply wire multiple data sources to a single input port as doing so will result in data collisions between the various sources, none of the data would be read.
- To get all of the sources in through a single port you must use a device called a multiplexer which takes the NMEA data signals from multiple instruments and combine them into a single data stream

NMEA 0183

- Many application require two way communication so one input and one output port is consumed connecting the two instruments
  - Remember an input (listener) can be connected to only one output (talker)
    - This is the major limitation of 083
  - Hard wired using twisted shielded pair wiring

Sample NMEA 0183 Messages

- AAM - Waypoint Arrival Alarm
- ALM - Almanac data
- APA - Auto Pilot A sentence
- APB - Auto Pilot B sentence
- BOD - Bearing Origin to Destination
- BWC - Bearing using Great Circle route
- DTM - Datum being used.
- GGA - Fix information
- GLL - Lat/Lon data
- GRS - GPS Range Residuals
- GSA - Overall Satellite data
- GST - GPS Pseudorange Noise Statistics
- GSV - Detailed Satellite data
- MSK - send control for a beacon receiver MSS - Beacon receiver status information. RMA - recommended Loran data RMB - recommended navigation data for gps RMC - recommended minimum data for gps RTE - route message TRF - Transit Fix Data STN - Multiple Data ID VBW - dual Ground / Water Spped VTG - Vector track an Speed over the Ground WCV - Waypoint closure velocity (Velocity Made Good) WPL - Waypoint Location information XTC - cross track error XTE - measured cross track error ZTG - Zulu (UTC) time and time to go (to destination) ZDA - Date and Time Some gps receivers with special capabilities output these special messages.
- HCHDG - Compass output
- PSLIB - Remote Control for a DGPS receiver
-

You need to turn on/off the messages you need

Raymarine E80

- NMEA 0183 Input - GLL, GGA, GLC, GTD, VTG, BWC, BWR, RMA, RMB, RMC, XTE, VHW, HDG, HDM, HDT, DBT, DPT, APB, VLW, MWV, WPL, RTE, DSC and ZDA.
- NMEA 0183 Output - User selectable APB, BWC, BWR, DBT, DPT, GGA, GLL, MTW, RMA, RMB, RMC, RSD, TTM, VLW, VHW, VTG, WPL, VHF/DSC and ZDA
- SeaTalk Input - Depth,SOG,COG, Position, Waypoint number, range/ bearing, TTG, Boat speed, Time, XTE, Heading, Wind, data, Log/Trip, Pilot status, Temperature, MOB and cursor position

Be watchful of Data Conflicts!!!!

Compatability

- **ZDA** - Data and Time
- $GPZDA,hhmmss.ss,dd,mm,yyyy,xx,yy*CC
  $GPZDA,201530.00,04,07,2002,00,00*60
  where: hhmmss HrMinSec(UTC) dd,mm,yyy
  Day,Month,Year

Custom MNEA 0183

- **Garmin g12** sentences for version 4.57
- $GPRMC,183729,A,3907.356,N,12102.482,W,000.0,360.0,080301,015.5,E*6F
- $GPRMB,A,,,,,,,,,,,V*71
  $GPGGA,183730,3907.356,N,12102.482,W,1,05,1.6,646.4,M,-24.1,M,,*75
  $GPGSA,A,3,02,,,07,,09,24,26,,,,,1.6,1.6,1.0*3D
  $GPGSV,2,1,08,02,43,088,38,04,42,145,00,05,11,291,00,07,60,043,35*71
  $GPGSV,2,2,08,08,02,145,00,09,46,303,47,24,16,178,32,26,18,231,43*77
  $PGRME,22.0,M,52.9,M,51.0,M*14
  $GPGLL,3907.360,N,12102.481,W,183730,A*33 $PGRMZ,2062,f,3*2D
  $PGRMM,WGS 84*06 $GPBOD,,T,,M,,*47 $GPRTE,1,1,c,0*07
  $GPRMC,183731,A,3907.482,N,12102.436,W,000.0,360.0,080301,015.5,E*67 $GPRMB,A,,,,,,,,,,,V*71

Only Garmin speaks Garmin !!!!

MNEA 2000

- •**NMEA 2000®Standard - network protocol**
- **“Open” standard for electronics, electrical and engine data all on the same network**
- **Marine manufacturers collaborating and creating an “open” network enviornment**
- **Exchange of data between multiple manufacturers equipment simultaneously**
- **Entrepreneurs developing NMEA 2000 diagnostic tools**
- **Special pre-made twist connect cables**

NMEA 2000

- **•NMEA 2000®Standard**
- **–Multi-Talker + Multi-Listener**
- **–Multi-Master, No Single Controller**
- **–Single Channel Parallel Bus**
- **•250 Kbits/sec(50times faster than 0183)**
- **•200 Meter Length**
- **–50 Physical Nodes**
- Open two way multi-user bus
  - Data goes on (sensors)-data comes off (displays)

NMEA 2000

- **NMEA 2000®–CAN (Controller Area Network)**
- **Developed by Intel and Bosch**
- **Used in control processes for industrial use**
- **Used in automotive**
- **Very reliable low cost sensors/interfaces**

NMEA 2000

- **NMEA 2000®Standard–Why CAN?**
- **Proven robust error free protocol**
- **Automatically determines repeated errors**
  - **Will take node off line to protect network**
- **Priority messaging embedded**
  - **Collision avoidance**
- **Critical messaging always gets thru**

NMEA 2000

- With the advantages of NMEA 2000 why would anybody use NMEA 0183?

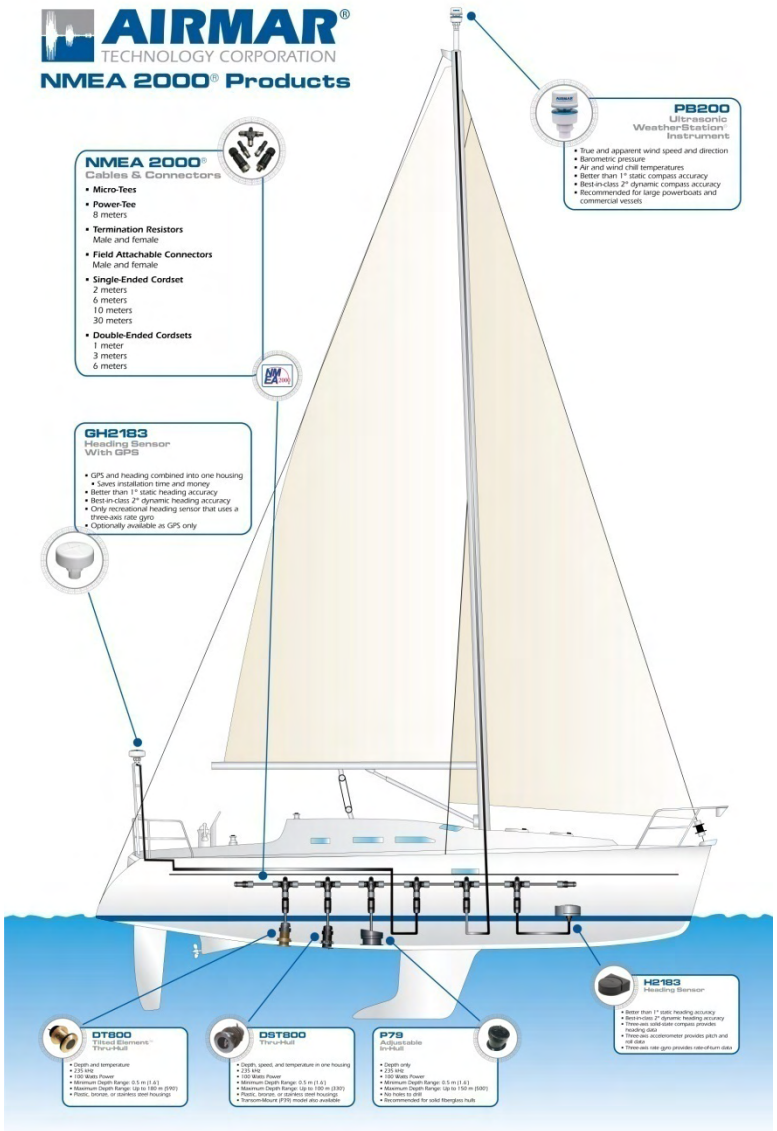
- Many older instruments only have MNEA 0183 interfaces.

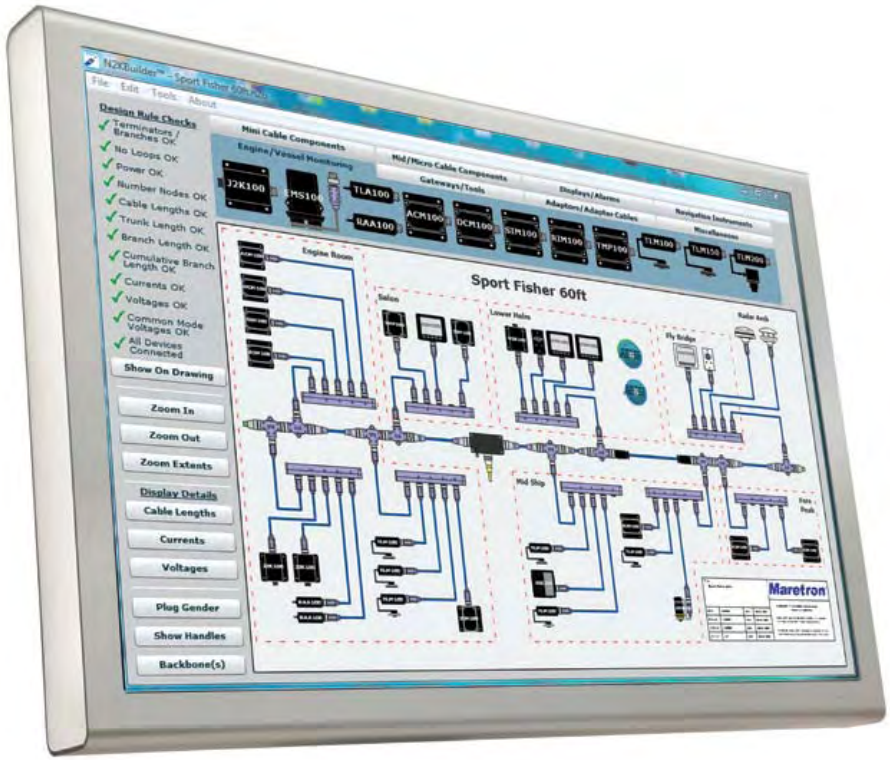
Simrad Communication

- Input (NMEA 0183) : GLL, GGA, RMC, RMB, GSA, GSV, APB, BWC, DBT, DPT, MTW, VLW, VHW, HDG
- Output (NMEA 0183) : GGA, GLL, GSA, GSV, VTG, ZDA, AAM, APB, BOD, BWC, BWR, RMC, RMB, XTE, DBT, DPT,MTW, VLW,VHW, HDG, MWV,TLL, TTM
- Input (NMEA 2000®) PGN's: 59904, 60928, 65285, 65292, 65293, 65303, 65305, 65323, 65325, 65480, 126208, 126992,126996, 127237, 127237, 127245, 127250, 127251, 127257, 127258, 127488, 127489, 127493, 127505,127508, 128259, 128267, 128275, 129025, 129026, 129029, 129033, 129038, 129039, 129040, 129285,129539, 129540, 129794, 129801, 129802, 130306, 130310, 130310, 130311, 130312, 130313, 130314,130576, 130577, 130817, 130820, 130821, 130831, 130832, 130834, 130835, 130838, 130839, 130840,130842, 130844, 130845, 130850, 130851, 130860
- Output (NMEA 2000®) PGN's: 59904, 60928, 61184, 65292, 65287, 65289, 65290, 65293, 65303, 65305, 65323, 126208,126996, 127237, 128259, 128267, 129285, 130577, 130818, 130819, 130831, 130835, 130836, 130837,130839, 130840, 130844, 130845, 130850, 130851

Video input port

NMEA 2000 systems get very big





The Sensor revolution
Smart sensors with direct NMEA output

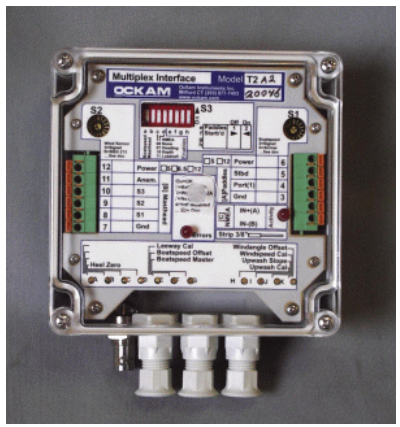
- Allows you to mix sensors and displays from different manufacturers

Depth, speed and temperature with NMEA output

Raystar GPS send out data on 0183,2000 or SeaTalk

Sensors without NMEA need interface

Converts analog sensor input
to NMEA 0183 or 2000



Compass Revolution

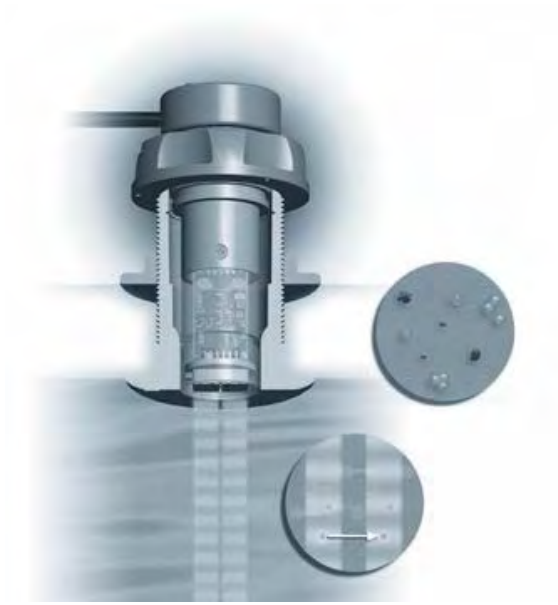
- Sailings benefit from Smart Bombs

Magnetic compass as the primary means of determining heading. The heading data is used to calculate wind direction, current data, and VMC performance data. A 3D compass also provides data to calculate precise pitch, heel, and turn rate.

Compass Revolution

Maretron's SSC200 is a solid state, rate gyro electronic compass that provides better than 1° heading accuracy through ±45° of roll and pitch angle, and better than 1° roll and pitch accuracy

Speed sensor revolution



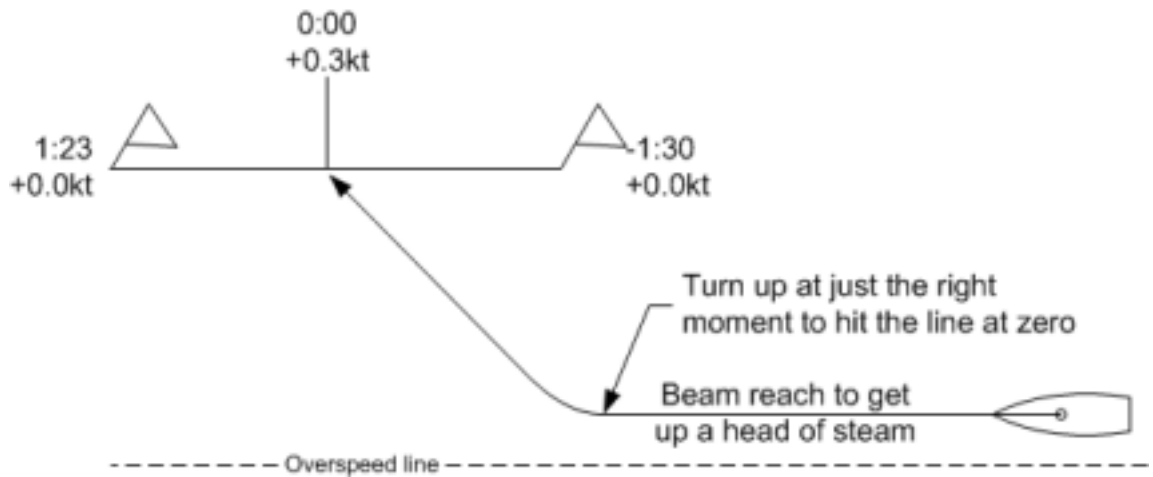
Unparalleled accuracy as low as 0.1 knots (0.1 MPH)

- No moving parts
- Makes retrofitting a breeze—the retractable insert fits most Airmar 51 mm (2”) housings
- Low-profile, plastic, or bronze housings available
- Built-in temperature sensor
- Optional Data Converter charges analog signal to NMEA 0183 data stream

Advanced displays

NEW!

Starting line display



Calibration

- All high-tech instrument systems require calibration to deliver the accurate outputs

- You will adjust boatspeed, heading and apparent wind to deliver a steady and reliable wind direction and current.

Update your GPS first

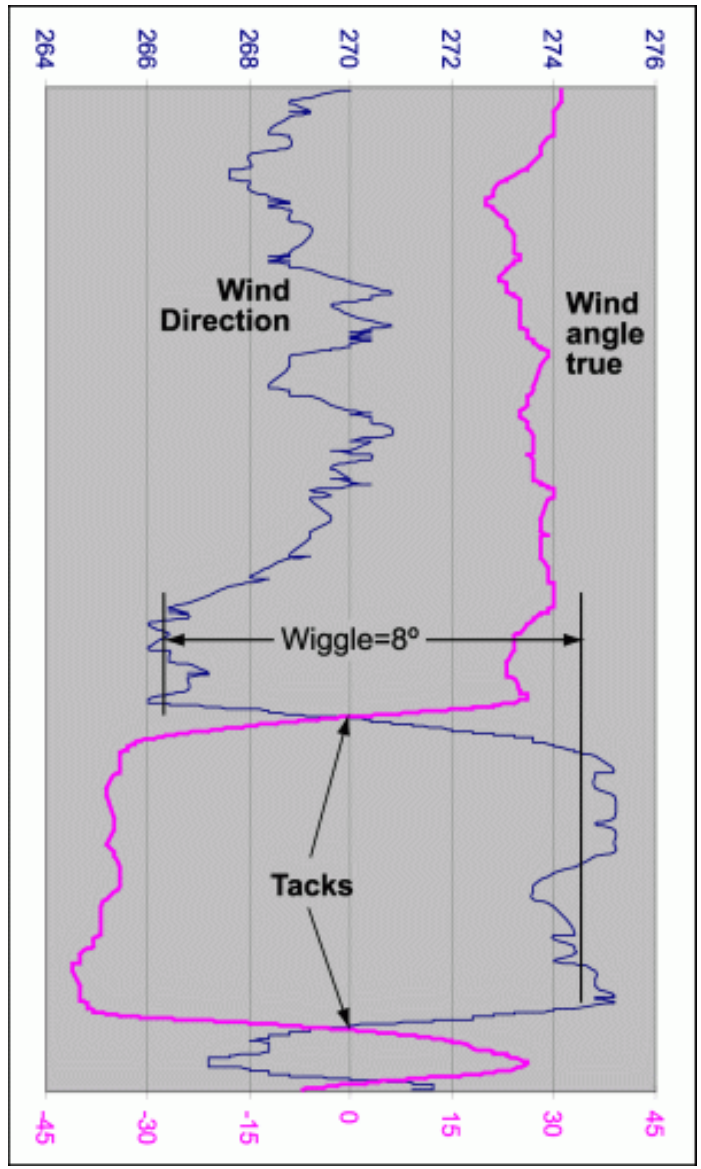
- Chartplotters are basically special purpose computers – Heart of any system
- Driven by software
- Manufacturers constantly upgrade software.
- Most offer free downloads
- Upgrade is easy
  - Download onto PC and expand
  - Copy to CF, UBS stick etc
  - Put Plotter into upgrade mode, insert chip, run program

Steps for Calibration

- Do your turns to calibrate compass
- Calibrate boatpeed versus GPS at slack tide
- Calibrate windspeed on calm day versus GPS
  - Check versus weather buoy or sea state at higher speeds
- Adjust wind angle on each tack to match close hauled IMS polars/design wind angle
  - Same of both tacks
- Verify by checking "Holy Grail of Calibration"

Holy Grail of Calibration

- Ground Wind Direction remain constant on either tack
  - Adjust each wind angle by 4°



Upgrading an old system

- Should you upgrade an old system with newer technology
- Should you keep using a 10 year old,computer, cell phone or TV?
  - Technology is changing so fast it is not cost effective
  - Moores Law – Number of transistors in a chip doubles every 24 months and sells for half
  - Only if you can interface with new

The PB200

Wind Speed and Direction are measured using four ultrasonic transducers, internal temperature and barometric pressure sensors and internal WAAS GPS engine and three-axis, solid-state compass to provide both Apparent and True Wind Speed and Direction

The PB200 is unique in its ability to provide 2° heading accuracy under dynamic conditions do to the temperature compensated 3D accelerometer and rate gyro providing precise tilt and rate of turn data which allows accurate measurement of True Wind Speed and Direction even when tilted up to 30°.

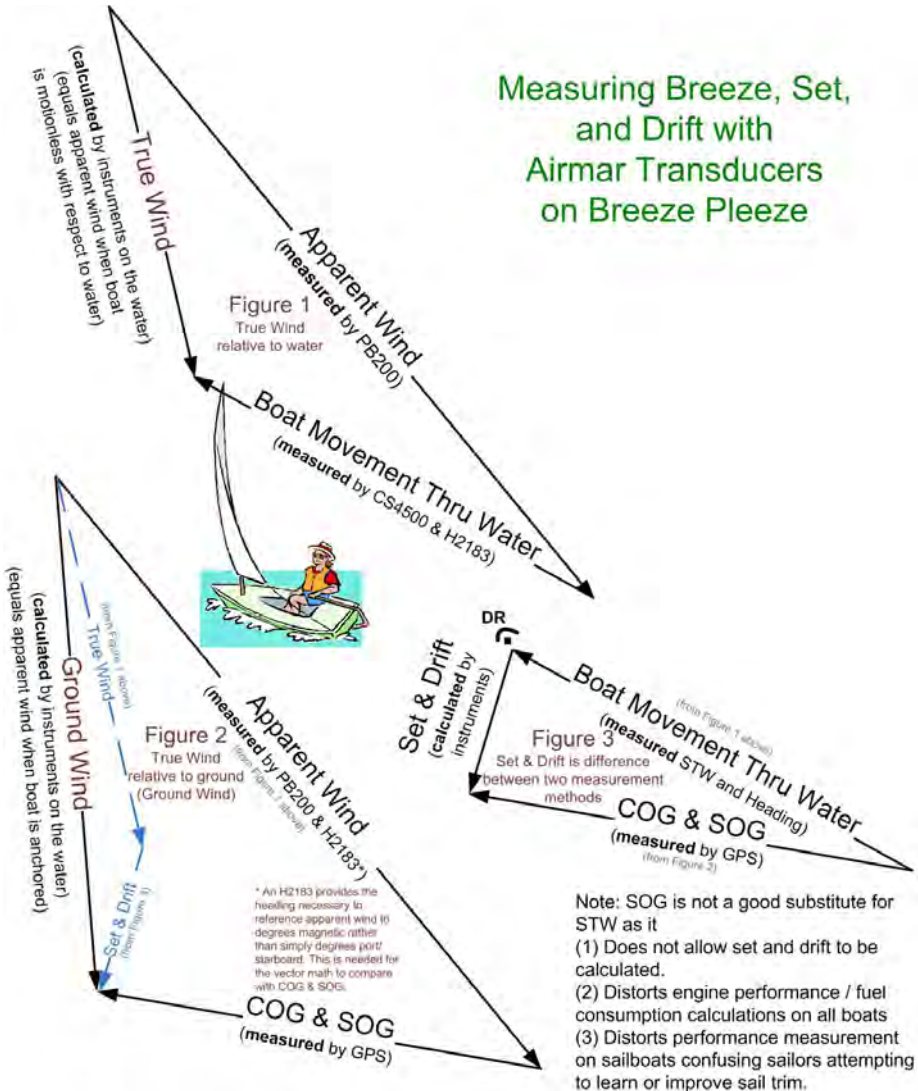
NMEA 0183 and NMEA 2000 output computable
with Raymarine E80

The PB 200 is sold as a powerboat not a sailboat instrument

What it sends out

- *Data Output Protocol - NMEA0183:*
- $GPDTM..... Datum Reference
- $GPGGA..... GPS Fix Data
- $GPGLL..... Geographic Position—Latitude and Longitude
- $GPGSA..... GNSS DOP and Active Satellite
- $GPGSV..... Satellites in View
- $GPRMC..... Recommended Minimum GNSS
- $GPVTG..... COG and SOG
- $GPZDA..... Time and Date
- $HCHDG..... Heading, Deviation, and Variation
- $$WIMDA..... Meteorological Composite
- $WIMWD..... Wind Direction and Speed
- $WIMWV..... Wind Speed and Angle
- $WIMWR..... Relative Wind Direction and Speed
- $WIMWT..... True Wind Direction and Speed
- $YXXDR..... Transducer Measurements

Add a boat speed sensor and you get the Holy Grail of Data.



Does it work

- The PB200 differentiates itself from past versions and competing mast head sensors by incorporating a 3-axis accelerometer and internal motion correction software able to measure and correct for the motion of the boat bouncing underneath it. *The resulting wind angle measurement stayed constant as the boat heeled and rolled underneath the sensor, even when amplified by my 50 foot high mast!*

How does it compare?

- PB200 showed variations of no more than 1 degree from my chosen AWA of 45 degrees as the autopilot aggressively followed the wind. Meanwhile, the mechanical driven display showed AWA variations as much as 12 degrees
- While the PB200 showed AWA variations of 3 degrees as my boats autopilot responded well to staying 130 degrees off the wind, the mechanically driven display showed variations of as much as 35 degrees,

The Micro-electronics Revolution

- Airmar PB200 - $1000
  - Windspeed, wind angle, ground wind direction, compass, GPS, rate gyro, barometer, temperature, NMEA 0183 and NMEA 2000
- Signet Wind plus display - $1235
  - Apparent wind speed and angle with NMEA 0183

Thank You

Excitation – Technology from 1980 to 2011

E80 w 0183,SeaTalk,video

GPS to VHF on NMEA

Dedicated plotting depth

Volvo Hourmeter

Battery voltmeter – hundredths

AC controller

Handheld Charger station

Ockam multi-display

Digital handbearing compass