

# ***Maretron***

**Leading the Way in NMEA 2000® Technology**

## **NMEA 2000® Importance to Boat Builders**

***By***

***Larry Anderson – Maretron VP of Sales & Marketing  
(Chairman NMEA Standards 1999-2004)***

# Industry Expert Comment

- *“NMEA 2000 really works, and it’s going to make boating better. Simplicity, redundancy, multi manufacturer flexibility—my first hands-on experience with NMEA 2000 was, as we say up here in Maine, a corker! This relatively simple setup was pleasantly similar to working with Tinkertoys. The wires are made up in various lengths with keyed male and female ends—virtually foolproof. So all I had to do was screw together the cables and wire the one power feed; everything came on, and the display recognized all sensors and was ready to show me screens of info. If I were fitting out a new boat or refitting an old one, there’d be a NMEA 2000 trunk running through her, and I’d be looking at electronics, engines, and whatever other systems could take good advantage of it.”* **Used with permission. Ben Ellison, Power and Motor Yacht**

# Presenter's Qualifications

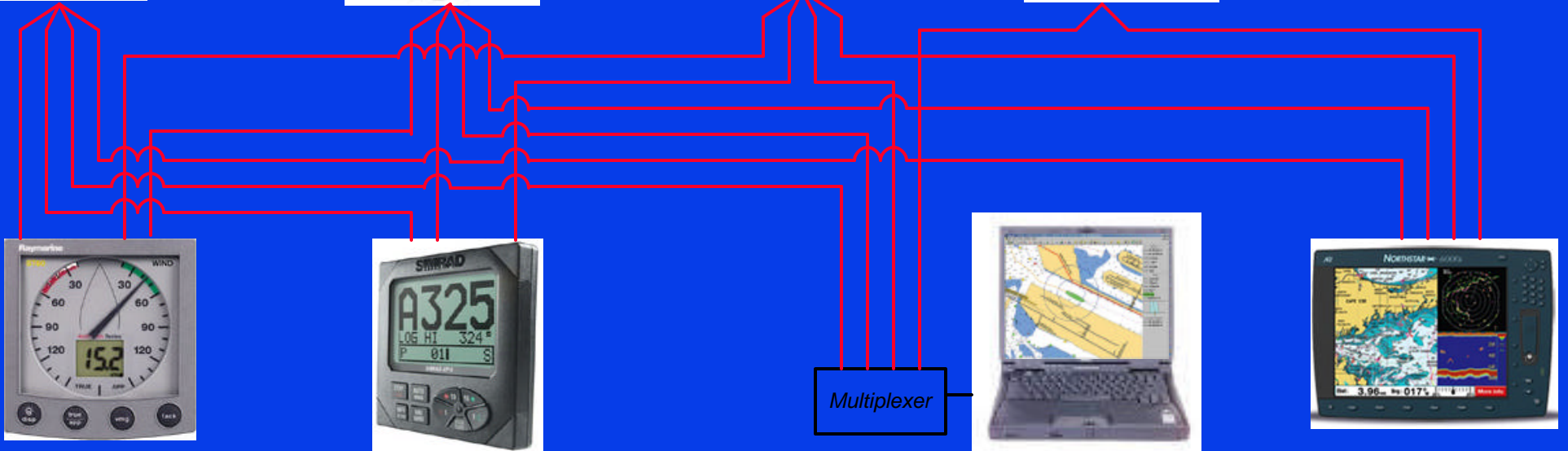
- **42 years in marine electronics industry**
- **Grew up on the ocean in a commercial fishing family**
- **Boating enthusiast – many holidays spent sailing**
- **Led new product development at Raytheon Marine, Standard Communications, Robertson-Shipmate, and SEA-Datamarine**
- **NMEA Standards Committee chairman 1999-2004**
  - **Maintained and updated NMEA 0183 standard**
  - **Managed beta development to first official release NMEA 2000®**
- **Have been active in NMEA, ABYC, SAE, and IEC**

# **NMEA (National Marine Electronics Association)**

- **Association of Marine Electronics: manufacturers, dealers, sales reps, distributors, mass-merchants**
- **Has provided electronics interface standards since 1970's**
- **Best known for NMEA 0183**
- **Publisher of Marine Electronics Journal**
- **NMEA programs raising level of marine electronics industry:**
  - **Installation Standards, CMET (Certified Marine Electronics Technician), and installer certification programs**
- **Cooperates with ABYC and NMMA**
- **Works closely with IEC**
  - **Global standards**

# NMEA 0183 Communications

- NMEA 0183 introduced in 1983
- NMEA 0183 single talker, multi-listener
- NMEA 0183 not a network (point to point communication)
- Results in very complex wiring systems



# NMEA 0183 is Outdated

- **Communication Speed - 4800 baud** or bits per second
  - *(A Seldom used version high-speed 0183 is 38,400 baud)*
- **Typical 0183 message is 400 bits in size**
  - Result – NMEA 0183 is limited to **12 messages per second**
- **Compass: (requires 15 messages per second)**
  - » Heading **10** messages per second,
  - » rate of turn **4** messages per second,
  - » vessel attitude **1** per second
- **Now consider Compass, GPS, Wind, Depth, Speed, Temp, AIS, etc.**
- **Message requirement climbs to more than 100/second**
- **Very simply NMEA 0183 can't handle this volume of traffic**

# Other NMEA 0183 Short Comings

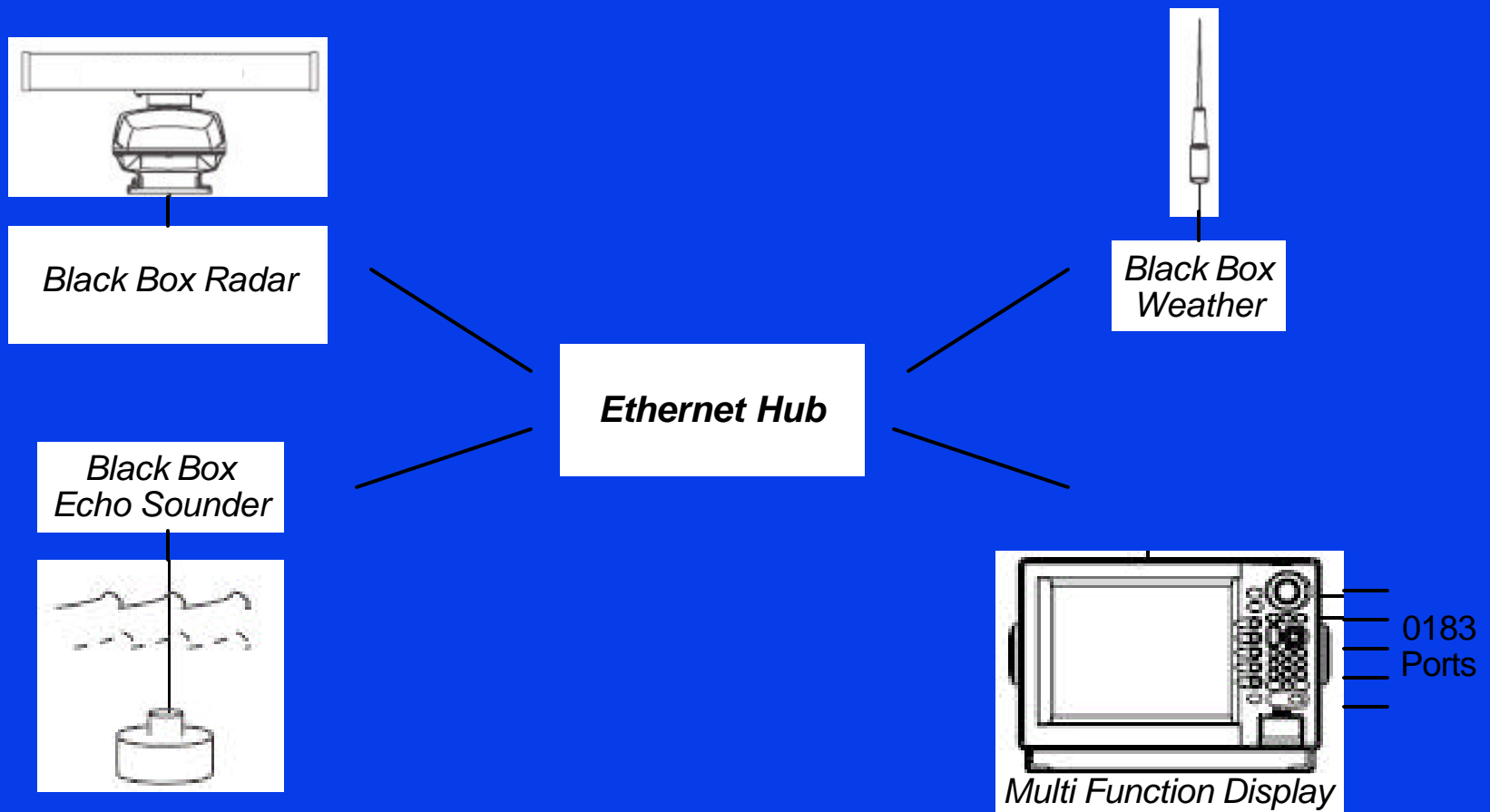
- **Cable and connectors aren't specified**
  - Therefore Plug-n-play impossible
    - » (each manufacturer uses different connectors)
- **No standardization of wire color coding**
  - Reliability compromised as connection methods not specified, corrosion due to poor wiring practices are common place
- **Although NMEA 0183 is a standard, no certification process**
  - Standard is implemented differently by various engineers
    - » Leads to many interoperability issues (manufacturer A wont talk to manufacturer B equipment)
- **Ambiguities within NMEA 0183 Standard**
  - Messages can be transmitted in one of several different sentences leading to interoperability problems between different manufacturers'

# Why CAN not Ethernet?

- Frequently asked question
- Ethernet has band width for video
  - CAN doesn't

# Ethernet Protocols

- Ethernet protocols typically used for large data transfers
  - Examples of shipboard applications include radar images, chart maps, weather overlay information, and echo sounder images



# Ethernet Protocols (Cont.)

- **Marine examples include:**
  - » Furuno NavNet, Raymarine HSB2, Nobeltec black box radar and sounder
- **These type standards are proprietary by manufacturer**
  - » data can not be exchanged across various manufacturer's products
- **Ethernet not typically used in industry for real time control**
  - » (i.e., industrial, automotive, and aerospace industries CAN)
- **CAN is more cost effective than Ethernet**
- **CAN is time determinate ensuring critical messages pass**
  - » (Steering, throttle, and other safety critical data will get through in time)

# NMEA 2000<sup>®</sup> Because:

- **NMEA 0183 Short-Comings**
  - Point-to-point - complex wiring
  - No physical layer specified - plug-n-play impossible
  - No real-time data sharing between multiple equipment
  - Lack of bandwidth for today's digital world
  - No certification process - interoperability issues
  - Interpretation ambiguities leads to interoperability
- **Ethernet protocols Short-Comings**
  - **Not suitable real time control applications**
  - **Costly** for simple sensors (i.e., temperature, voltage, etc.)
  - More power consumption than CAN

# NMEA 2000® Beginnings

- NMEA 2000® has been in process of development since 1994
- Industry developed by 40 marine companies & organizations
- Development aided and guided by US Coast Guard, Oklahoma State University, Sun Microsystems
- Developed in cooperation with:
  - Society of Automotive Engineers (Truck and Bus J1939)
  - Agriculture and Forestry organizations (Off-road Vehicles)
  - IEC and ISO (Global Organizations)

# NMEA 2000<sup>®</sup> Original Objectives

- **Network standard –**
  - » data streaming around boat being shared amongst various components
- **Facilitate real time control and command status information**
  - » Navigation Information (time, position, speed, heading, variation, rate of turn, set/drift, depth, waypoint, ETA, distance log, etc.)
  - » Autopilot control and status (rudder command, rudder angle, cross track error, radius turn order, etc.)
  - » Drive-by-Wire Functions (electronic steering, throttle, shifting)
  - » Engine/Transmission Monitoring (RPM, temperatures, pressures, voltages, fuel rates, trim, etc.)
  - » Vessel Monitoring System (pitch, roll, tank levels, batteries)
  - » Electrical system control and status (DC/AC load switching and status)
  - » Automatic Identification System (vessel data transmission and status reporting)
  - » Environmental Information (wind speed and direction, temperature, humidity, barometric pressure, sea temp, tide, current, salinity, etc.)

# NMEA 2000 Objectives (Cont.)

- **Bandwidth to accommodate future needs**
- **Specify physical layer (cable/connectors)**
  - » To ensure plug-n-play compatibility
- **Product certification**
  - » To reduce/eliminate out-of-box interoperability
  - » Auto-addressing eliminating specialist to install
- **Cost effective to implement**
  - » Limiting price increases
- **Time determinate**
  - » Protect mission-critical data delivery
- **Fail Safe and/or Redundant Capability**

# NMEA 2000<sup>®</sup> Based on CAN

- **Controller Area Network (CAN)** platform for NMEA 2000<sup>®</sup>
  - **CAN**: high-integrity serial data communications bus for real-time applications
  - **CAN** has excellent error detection and confinement capabilities
  - **CAN** operates at data rates of up to 1 Megabits per second
  - **CAN** originally developed for automotive
    - » now used by aerospace, industrial automation, and other industries for real time control and status applications
  - **CAN** is an international standard: ISO 11898

# NMEA 2000<sup>®</sup> Messaging

- Many industry groups use CAN platform and create their own messaging
  - Bus, truck, and agricultural industries created messaging standard called J1939 (Used by **marine engines**)
  - Industrial automation industry created messaging called DeviceNet
  - NMEA (**marine electronics industry**) created messaging called NMEA 2000<sup>®</sup>
- NMEA 2000 currently has over 100 message types for exchanging information (And is growing)
  - Position, heading, AIS, radar tracked targets, waypoints, cross track error, engine and transmission status, environmental, tanks, etc.

# Physical Interface (Cable and Connectors)

- **NMEA 2000<sup>®</sup> specifies cable/connectors ensuring plug-n-play**
- **Standardized Waterproof cable**
  - » 5 conductor (2 wires for data, 2-wires for power and ground, 1 shield)
  - » Data pair independently shielded, power pair independently shielded, plus overall shield encompassing data and power pairs
  - » Color coded wires reducing wiring errors
- **Standardized waterproof connectors**
  - » Can be submerged in the bilge and still operate
  - » Keyed contact insuring correct wiring
  - » Gold plated terminals for reliable connections
  - » Threaded connectors prevent inadvertent disconnects
  - » No expertise or training required
- **Engineered for Serviceability**
  - » Device can be plugged or unplugged without powering down network
  - » Device failure or removal of product does not effect rest of network

# NMEA 2000<sup>®</sup> Cable and Accessories



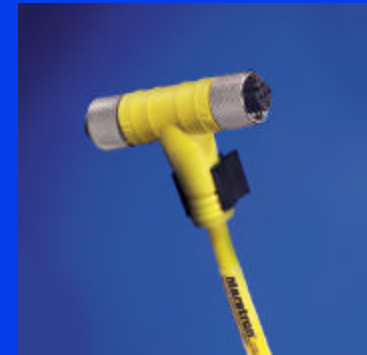
**Bulk Cable**



**Double Ended Cordset**



**Terminators**



**Powertaps**



**Field Attachable  
Connector**



**Multi Port Box**



**Bulkhead Feed thru**

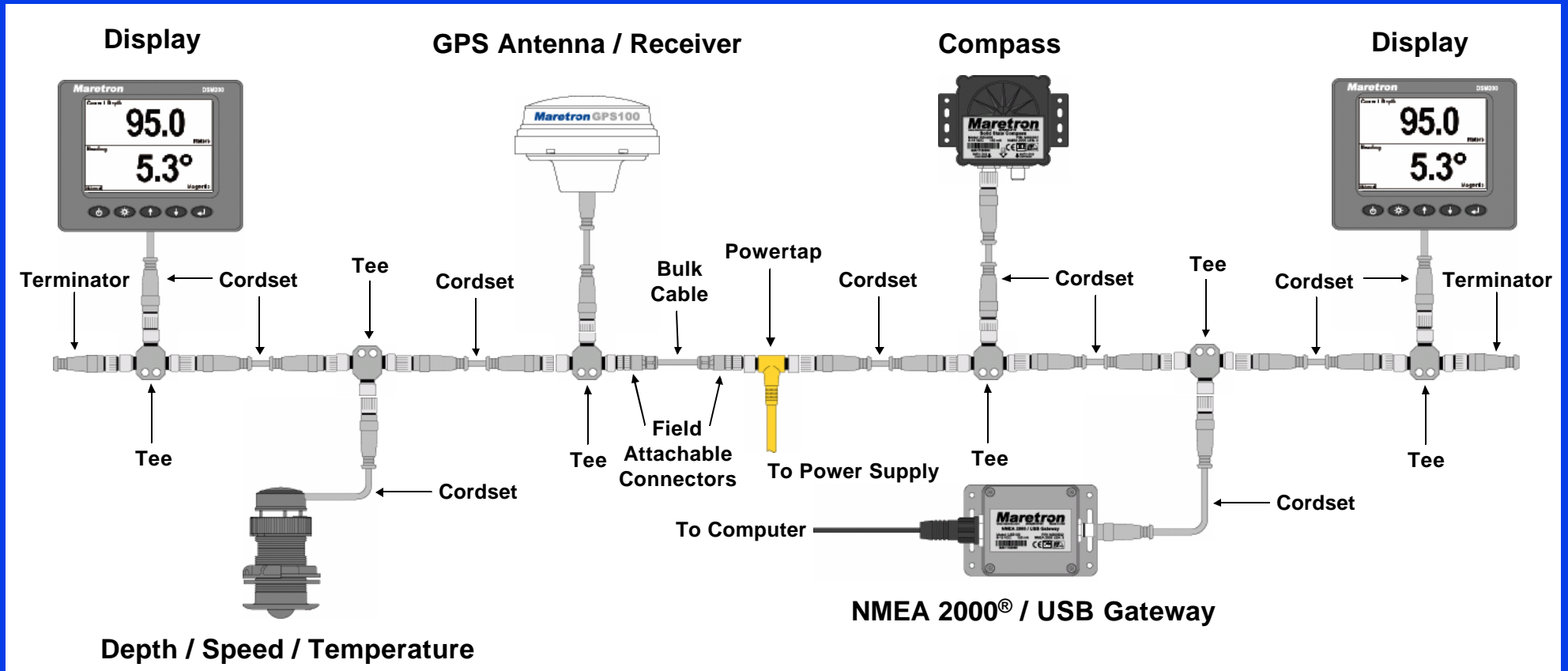


**Tee Connector**

# Cable and Connector **System Types**

- **Micro C** cable and connectors (**thin**)
  - Device power directly from cable up to 1 amp
  - Supports up to 4 amps of current in any given branch
  - Micro trunk line up to 100 meters or 328 feet
  - Maximum drop line length of 6 meters or 19 feet
  
- **Mini** cable and connectors (**thick**)
  - Device power up to 1 amp
  - Supports up to 8 amps of current in any given branch
  - Mini trunk line lengths up to 200 meters or 656 feet
  - Maximum drop line length 6 meters or 19 feet

# NMEA 2000<sup>®</sup> Network Connection Example



# **NMEA 2000<sup>®</sup> Certification Process**

- **A device claiming NMEA 2000<sup>®</sup> must be certified**
  - Copyrighted term illegal to claim without certification
  - Each certified product has submitted an electronic file
    - » Proves product behavior and other parameters are correct
- **Certification facilitates plug-n-play**
  - Interpretation ambiguities removed
  - Auto-addressing like printer connection to computer
- **NMEA 2000<sup>®</sup> guarantees backward compatibility**
  - Older product will not be made obsolete

# **NMEA 2000<sup>®</sup> Open Standard vs. Proprietary**

- **Universally open standard means**
  - Any manufacturer can participate
  - End user of products can make choices between brands
  - Free Enterprise philosophy
- **Proprietary standard means**
  - A company decides which of its competitors may or may not participate and under what terms
  - End user has only the options that the manufacturer decides
  - Dictatorial philosophy

# Certified Products as of 9/22/05

- **Airmar Smart Depth NMEA 2000® Depth, Speed and Temperature**
- **Volvo Penta Engine Gateway EVC system.**
- **Outboard Engine Controller Evinrude's V4 and V6 ETEC outboards**
- **Faria NMEA Info Center RPM, boost pressure, oil pressure, coolant temperature, battery voltage etc.**
- **Faria Mini-gateway RPM, Boost pressure, Oil pressure, Coolant Temperature, Battery Voltage etc.**
- **Kvaser Neptune Gateway between NMEA 0183 and NMEA 2000®.**
- **Lowrance EP 15 fluid level sensor**
- **Lowrance EP 20 Suzuki engine interface**
- **Lowrance EP 10 fuel flow sensor**
- **Lowrance EP 25 paddle wheel speed sensor**
- **Lowrance EP 35 temperature sensor**

# Cont'd Certified Products

- Maretron DST100 Depth/speed/temperature
- Maretron N2KMeter Diagnostic tool of NMEA 2000®
- Maretron GPS100 12 channel with automatic WAAS
- Maretron DSM200 displays all data numerically or graphically.
- Maretron USB100 Gateway for USB using NMEA0183
- Maretron SSC200 Solid-state rate-gyro compass
- Maretron NMEA 2000® Cables/Connector approved for NMEA 2000®.
- Offshore Systems ( UK) Ltd. Capacitive Fuel Level Sender
- Offshore Systems ( UK) Ltd. Tank Sender Adaptor levels from Fuel, Freshwater, Wastewater, Blackwater, Oil and Live Well senders

# Cont'd Certified Products

- Raymarine *ST 290 Data processing unit* of the new ST290 range
- Raymarine *E80/E02011-Colour Radar/Chart Plotter*
- Raymarine *E120/E2013- Colour Radar/ Chart Plotter*
- Simrad *RFC35R-2000 Ratesensor stabilized fluxgate compass.*
- Simrad *AP25 Autopilot.*
- Simrad *AP26 Autopilot.*
- Simrad *AP16 Autopilot.*
- Simrad *AT44 Converter*
- Simrad *CP31/CX33 Combi*
- Simrad *CX34 Combi Nav system*
- Simrad *EQ33 Echo Sounder*
- Simrad *IS12 Combi.*
- Simrad *IS12 Compass.*

# Cont'd Certified Products

- **Teleflex *i6000 Shift and Throttle Control System for Boat Engine***
- **Yamaha Marine *6Y883688 Triducer***
- **Yamaha Marine *6Y88350T10 Tachometer Square***
- **Yamaha Marine *6Y88350S00 Speedometer/Fuel Management Square***
- **Yamaha Marine *6Y88350010 Speedometer/Fuel Management Round***
- **Yamaha Marine *6Y88350T00 Tachometer Square***
- **Yamaha Marine *6Y88350F00 Fuel Management Square***
- **Yamaha Marine *6Y88350000 Speedometer Square***

# NMEA 2000<sup>®</sup> Summary

- **Network standard**
  - » Engineered for onboard vessel real time control and status communication
- **Designed for today and future vessel networking**
- **Robust cable system**
  - » With plug-n-play compatibility across different manufacturers' products
- **Simplicity in connect-ability**
- **Product certification**
  - » Reduces interoperability issues between different manufacturers' products
- **Cost effective and proven CAN technology**
  - » Used in many different industries for real time control and status
- **Time determinate system**
  - » Ensures critical messages always get through in time
- **Accommodates fail safe or redundant systems**
  - » Concerns for safety

# Industry Expert Opinion on NMEA 2000®

*"I am convinced that networked electronics and, to an even greater extent, the application of the same technology to whole-boat power distribution systems, will result in the greatest revolution in boat systems that we have seen in at least three decades. The NMEA, with its NMEA 2000® protocol and corresponding 'physical layer', is in the forefront of this revolution, and playing a powerful leadership role."* **Used with permission. Nigel Calder**

# THE END

