Can-Bus Instruments for Boats

Back in the 1980’s, Robert Bosch developed a new wiring system for cars, called Can-Bus. Their incentive was to reduce the wiring complexity and cost that modern cars had grown in the previous 20 years. Where cars of the 1960’s had under 100m of wire in the electrical system, by the 80’s some cars had 4000m. An early 1970’s car had about $110 worth of electrical system, at production costs, but today that is closer to $2000.

The name comes from CAN for Controller Area Network and Bus for a common group of wires (or circuits) that distribute data to various devices. A network means a group of devices that can communicate because they share the same data paths. Controller comes from microcontroller, the small integrated circuit inside each Can-bus device that allows it to have a unique identity and be able to send and/or receive messages over the network. Now if that word Network leaves you cold at the thought of some unfathomable computerized complication, bear with me it’s really not that bad, and there’s some terrific benefits for marine use.

The basic idea is that instead of each electronic device having its own separate power wires and sensor or output wires, a whole bunch of devices could share the same wires if only each device was electrically unique and the signals on the wires were “addressed” to each device. That’s what Can-Bus does. Instead of a signal like “rpm is 3400” being a fixed voltage or “oil pressure is above 50 kpa” being just a closed or open circuit, all signals in a Can-Bus system are digital messages of a fixed size. Each one contains enough info to identify it so that only the correct devices take any notice of the message, the others just ignore it.

Most of us driving a car with a Can-Bus system are probably not even aware it’s even there because the electrical system and instruments are installed by the car maker and rarely changed after purchase, but that’s not the case with boats. Generally you get to choose what goes inside your boat from the products of several manufacturers. In addition, recent advances in
instruments, especially LCD type displays, makes it simple for the user to change the instrument faces and information displayed, at the touch of a button. That means a marine Can-Bus system not only uses less wires, but can show a lot more information now on just one gauge than we could a whole dash full before.

For a system that relies on each device having a unique identity and being able to understand messages from many other devices, probably made by different manufacturers, you’d expect there must be some sort of common standard “language” in use. There is and it’s called NMEA 2000. NMEA 2000 (National Marine Electronics Association standard 2000) defines how each device’s unique identity is determined, the language and size of the messages, the voltages used and so on. In this way NMEA 2000 devices from different manufacturers can all communicate happily together. Now your fish finder, GPS unit, dash gauges, fuel tank level sender and your engine’s ECU (for example) can all communicate to determine boat speed and range, fuel economy, position on the globe, a whole host of info we did not have before.

All NMEA 2000 devices are digital, so the “language” used is a string of “0”s and “1”s, or in electrical terms, low and high voltages. A typical NMEA 2000 message looks like this –

<table>
<thead>
<tr>
<th>Start</th>
<th>Identity &amp; Priority</th>
<th>Data</th>
<th>Reliability Check</th>
<th>Acknowledge</th>
<th>End</th>
</tr>
</thead>
</table>

Each box represents a fixed number of groups of “0”s and “1”s where –

- Start denotes the message starts here, to separate messages.
- Identity & Priority determines which devices will take any notice of the message, and how important it is. For example engine RPM is often changing rapidly, but fuel level changes very slowly (we hope) so we need to give RPM messages priority over fuel level messages to ensure a smooth display of info on the gauges.
- Data represents the actual info we want to display, like 3400 rpm, or 10.6 LPH fuel flow.
- Reliability Check is the built in tolerance to cope with outside interference, bad connections and the like that are always possible around electrical systems in cars and boats. If the reliability check fails, it means part of the message was corrupted or missing, so it is ignored and the next message (from the same sender) is used instead.
- The Acknowledge part lets the sender know it is being received, so communication is two way. In this way a problem in communication can be displayed as an error code, by one of the senders in the system.
- End shows this message is over and the Bus is now available for another messages to be sent.

The two extra harness plugs on an Evinrude E-TEC V6 for Can-Bus. The 3 pin plug connects a cooling water pressure sender into the system, while the 4 pin plug provides EMM data (fuel flow, rpm, load etc.) to the Can-Bus system.
The NMEA 2000 standard sets the communication speed at 250Kb/sec (250,000 bits per second) which means the Bus length can be up to 100 metres, and it can handle up to about 4000 messages per second. Up to 50 devices can be attached to a single system.

A Typical Can-Bus backbone harness has 4 or 5 wires inside a single outer cover. Two are for power+ and power-, two are for digital signals Can Hi (“1”) or Can Low (“0”), and some systems also have a shield or ground for the fifth wire. While cables and devices from various manufacturers have different plugs and sockets, the NMEA 2000 standard means they can all communicate so all it takes is a few adaptors to make a system.

Two different NMEA 2000 Can Bus dash wiring systems set up for training. On the left a system using Hubs, the large coiled harness in the centre is the backbone. On the right a system using “T” junctions. The circular white device connected to the far right T is a GPS antenna.

Can-Bus instruments come is a variety of shapes and sizes. On the left is the I-Command Classic series from Evinrude for users who like traditional, dedicated gauges with analogue dials. The larger dials also have an LCD panel that users can set to display several functions. On the right is a Raymarine display where the chart plotter/fish finder display can also show the engine data, at the touch of a button.
Can-Bus instruments offer a real revolution to boat dashboard displays. Because many senders and displays are now networked together getting info like your speed over the ground compared with your speed over the water, or your position on the globe and how far you’ve traveled, or your fuel economy and how far you can go on what remains in the tank, can all be displayed simply. You can even set up your displays to match your mission, for example a day’s fishing might see water depth, GPS position and water temperature as main displays so you can find your favourite fishing spot. Or, for a day’s cruising you may prefer to show instant fuel economy, so you can find the most economical speed, and see how far you can proceed at a given speed. Can-Bus offers lots of possibilities to make your boating more informed and fun.

Evinrude’s I-Command Digital system uses LCD dials that can be easily set to show many different displays. Above are 2 large and 2 small gauges. Below is a sample of the various faces each large gauge can display. You can have analogue or digital and up to 16 displays set-up and just switch between them at the touch of a button!
Can-Bus wiring is simplicity itself.

Here is an example of the I-Command Digital layout. One cable, called the “backbone” runs from end to end of the bus system.

Each device is attached via “T” fitting. As long as the Backbone is the “straight through” side on each “T”, and there is an end terminator at each end of the bus, up to 50 devices can all happily share the network.

Need to add a new gauge or sender? No problem, just unplug any joint along the Backbone and insert a new “T” junction. Connect your new device and you’re ready to go.