NMEA 2000 Design

Provided by

Maretron®
Technical Support
NMEA2000 System Designs

- Generally there are two types of NMEA2000 systems:
  - A Factory Designed NMEA2000 System
    - Limited data capability outside of the original factory design.
  - A Custom Designed NMEA2000 System
    - Many data capabilities

Both systems work using the NMEA2000 Physical Standards.
Custom NMEA2000 Networks
OK, where do we Start?

- **Customer Needs**
  - What must be monitored?

- **Device Selection**
  - What Devices do we need to monitor those values?

- **Design**
  - How do we connect them together?

- **Configuration**
  - How do we configure the devices?

- **Installation**
What must be Monitored?

- Thousands of data values to choose from
  - Choose what is important.
  - Work systematically from a list.

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**My Boat's Monitoring needs list**

- [x] Engine Oil Pressure
- [x] Transmission Oil Pressure
- [x] Tank Level Fuel, Water, Oil
- [x] Security Four Doors
What must be Monitored?

- For each System Type
  - Identify what Parameters you want to monitor
  - Identify quantities.

My customer wants:

```
Engine-----------------Oil----------Pressure------
0 PSI to 80 PSI
```

[Image of a gauge showing Engine Oil Pressure with the reading 39.8 psi]
What Can Be Monitored?

- Visit [NMEA.org](http://www.nmea.org) list of NMEA2000 certified products.
- Visit each NMEA2000 manufacturer website for a list of capable NMEA2000 parameters.
- Maretron website provides a System Capability Matrix list that can help you identify what parameters can be monitored. Go to: [http://www.maretron.com/company/presskit.php](http://www.maretron.com/company/presskit.php)
What Next?

- Customer Needs
  - What must be monitored?
- Device Selection
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  - How do we configure the devices?
- Installation
Device Selection

- NMEA2000® lets you mix and match between vendors
  - Research what different vendors offer.
  - Research if the Device will transmit or receive the exact parameter you wish to see.
- NMEA makes it mandatory for a manufacturer to publish Transmitted PGNs and Received PGNS from a device.
- You may still need to call the manufacturer to determine exactly if the device will transmit/display the specific PGN value.
## Device Data Selection

<table>
<thead>
<tr>
<th>Description</th>
<th>PGN #</th>
<th>PGN Name</th>
<th>Default Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Periodic Data PGNs</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>DC Detailed Status</td>
<td>127506</td>
<td></td>
<td>0.67 times/second</td>
</tr>
<tr>
<td>Battery Status</td>
<td>127508</td>
<td></td>
<td>0.67 times/second</td>
</tr>
<tr>
<td>Battery Configuration Status</td>
<td>127513</td>
<td></td>
<td>N/A</td>
</tr>
<tr>
<td><strong>Response to Requested PGNs</strong></td>
<td></td>
<td></td>
<td>N/A</td>
</tr>
<tr>
<td>PGN List (Transmit and Receive)</td>
<td>126464</td>
<td></td>
<td>N/A</td>
</tr>
<tr>
<td>Product Information</td>
<td>126996</td>
<td></td>
<td>N/A</td>
</tr>
<tr>
<td>Configuration Information</td>
<td>126998</td>
<td></td>
<td>N/A</td>
</tr>
<tr>
<td><strong>Protocol PGNs</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ISO Acknowledge</td>
<td>059392</td>
<td></td>
<td>N/A</td>
</tr>
<tr>
<td>ISO Request</td>
<td>059904</td>
<td></td>
<td>N/A</td>
</tr>
<tr>
<td>ISO Address Claim</td>
<td>060928</td>
<td></td>
<td>N/A</td>
</tr>
<tr>
<td>ISO Address Command</td>
<td>065240</td>
<td></td>
<td>N/A</td>
</tr>
<tr>
<td>NMEA</td>
<td>126208</td>
<td></td>
<td>N/A</td>
</tr>
<tr>
<td><strong>Maretron Proprietary PGNs</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Configuration</td>
<td>128720</td>
<td></td>
<td>N/A</td>
</tr>
</tbody>
</table>

The following DC Types are selectable:
- Battery (See Section 2.5.3 for options that are enabled when this type is selected)
- Alternator
- Converter
- Solar Cell
- Wind Generator
What Next?

- Customer Needs
  - What must be monitored?
- Device Selection
  - What Devices do we need to monitor those values?
- Design
  - How do we connect them together?
- Configuration
  - How do we configure the devices?
- Installation
NMEA 2000® Wiring

- NMEA2000® does three things
  - Supplies Power.
  - Supplies Data.
  - Protects against Electrical Noise

- These are INDEPENDENT of each other
- These are COMBINED in the same cable
Data Problems?

- Noise from Outside
- Echoes from the network itself
  - From the ends
  - From each connector
  - From each device
- NMEA has strict rules to keep the echoes in limits
  - Not more than 50 devices
  - One backbone, correctly terminated, < 100 or 200 m
  - No loops
  - Cumulative Branch Length < 78m
Basic NMEA2000 Physical Layer

A single CAN network consists of the following core components in order to work properly:

- Two Terminators
- Two or more physical nodes
- Power insertion
NMEA2000 Power

- Know the power limitation per leg.
- Try to insert the Powertap for an equal current distribution point.
- Build into your system power upgradability.
- Avoid ground loops and noise inducing connections.
Power

- Each device on the network must receive sufficient Voltage and Current
  - Long cables have large Voltage Drops
  - Thin cables have large Voltage Drops
  - More devices mean more Current means large Voltage Drops
  - Batteries don’t always supply 12V.
- NMEA has strict rules to keep the voltages in limits
  - Devices must be able to work at 9V to 16V
  - Common Mode Voltage < 2.5V
Power

9-16VDC Requirement!

35 meters of power wire
Not Enough Voltage

- If there is not enough Voltage at some Devices
  - Move the Power Source - recalculate
  - Use thicker wires - recalculate
  - Feed Power at more than one Point – recalculate.
Cumulative Drop Length (CDL)

Determine effective implementation practices with the use of newer cabling components.

Create cleaner transmission lines to reduce possible failure points.
Too Many Devices

- If there are more than 50 devices
  - Split the network into 2 (or more)
  - Each network has its own power
  - Add a Network Bus Extender to bridge the data between the networks.
Network infrastructure & expansion rules

- Networks must not exceed 50 physical nodes per network.

- Shield connections grounded at a single power tap.

- Extended network must not exceed 250 total devices.
Layout the Design
Specify Cable Lengths
Calculate the Voltages
Check NMEA 2000® Rules

- Backbone
  - Is it correctly terminated?
  - Are there no loops?
  - Is there more than 50 nodes?
  - Is it less than 200m long? (100m if Micro Cabling is used)
- Is the Cumulative Branch Length < 78m?
- Can the Power Pair handle the current?
- Does each Device get at least 9V on the Power Pair?
  - Repeat when battery is at 10.5 Volts.
Getting Vessel Data to Users

- Use a USB Gateway to get it to a Computer
- Use an Ethernet Gateway to get it on to the Vessel’s Ethernet Network
What Next?

- Customer Needs
  - What must be monitored?
- Device Selection
  - What Devices do we need to monitor those values?
- Design
  - How do we connect them together?
- Configuration
  - How do we configure the devices?
- Installation
Configuring Instance Numbers

- Each Device has an address
  - Automatically assigned
- Each Data Type has an Instance Number
  - May be allocated to the Device.
  - May require an instance number for each data value
    - (e.g. A device monitoring 3 temperatures will require 3 instance numbers)
  - Cannot have more than one device transmitting the same instance number for one Data Type.
Configuring

- Use information captured in the Design Phase
  - Keep good records
  - Textual descriptions help you remember what you planned to do.
  - Label diagrams
    - Cables
    - Devices
- Create Configuration Tables that match the Tool that you will use to do the Configuring.
  - No standard to Configure Devices – each manufacturer has their own tool.
### Network Configuration Table Example

**Network 1**

<table>
<thead>
<tr>
<th>Manuf.</th>
<th>Model ID</th>
<th>Serial No.</th>
<th>Unique Instance</th>
<th>Source</th>
<th>Label</th>
<th>Installation Descr. #1</th>
<th>Installation Descr. #2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maretron</td>
<td>DSM250</td>
<td>S16653GH</td>
<td>4</td>
<td>Helm</td>
<td>Cockpit</td>
<td>At the helm</td>
<td></td>
</tr>
<tr>
<td>Maretron</td>
<td>SSC200</td>
<td>SN215656</td>
<td>0</td>
<td>Compass</td>
<td>Cockpit</td>
<td>Behind the Wheel</td>
<td></td>
</tr>
<tr>
<td>Maretron</td>
<td>GPS100</td>
<td>SN7654321DF</td>
<td>0</td>
<td>GPS</td>
<td>Cabin</td>
<td>On the roof</td>
<td></td>
</tr>
<tr>
<td>Maretron</td>
<td>WSO100</td>
<td>SN87678652</td>
<td>0</td>
<td>Weather Station</td>
<td>Masthead</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Channel Details

<table>
<thead>
<tr>
<th>Channel</th>
<th>Source</th>
<th>Instance</th>
<th>Label</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pressure</td>
<td>Atmospheric</td>
<td>0</td>
<td>Masthead Pressure</td>
</tr>
<tr>
<td>Temperature</td>
<td>Outside</td>
<td>0</td>
<td>Masthead Temperature</td>
</tr>
<tr>
<td>Humidity</td>
<td>Outside</td>
<td>0</td>
<td>Masthead Humidity</td>
</tr>
<tr>
<td>Wind</td>
<td></td>
<td>0</td>
<td>Masthead Wind</td>
</tr>
</tbody>
</table>

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**Close**
Configure Before Installing

- Create a small Network in your Office
- Connect One Device at a Time.
- Record Serial Number
- Configure
  - Labels
  - Instance Numbers
  - Installation Descriptions
- Label Device
  - physically
What Next?

- Customer Needs
  - What must be monitored?
- Device Selection
  - What Devices do we need to monitor those values?
- Design
  - How do we connect them together?
- Configuration
  - How do we configure the devices?
- Installation
Installation

- Cables
  - Use pre-made cables wherever possible.
  - Except where small holes make it impossible to pass the connectors through.
  - Use different colors (Blue & Gray) for different networks.
  - Label the cables on the drawings, and then physically on each end.
Understanding long-term scalability

- Easy infrastructure adjustments or device count increase.
- Designate cable expansion areas illustrate exposed termination at particular locations.
- Document unused NMEA2000 drop ports onto your design.
Bend Radius for Service Loops
Installation

- Devices
  - Use the Installation Descriptions that can be stored electronically in the Device.
  - Have a company standard on how these fields are used.
  - Match this with a physical label.
Workflow

- Customer Needs
  - What must be monitored?
- Device Selection
  - What Devices do we need to monitor those values?
- Design
  - How do we connect them together?
- Configuration
  - How do we configure the devices?
- Installation
  - Tips
Conclusion

- NMEA2000® is a stable networking standard for vessels, that is becoming more used every year.
- The learning curve is significant, but worth getting trained for.
- There are free tools available to do all the complicated calculations.
- You want to know what is happening on your Vessel – with NMEA2000®, you can get whatever information you need.
Questions or Comments

- Support@Maretron.com

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