Secrets to DeviceNet Uptime

This document lists the 5 secrets to DeviceNet Uptime. More detailed information can be found in the white papers ***"DeviceNet Physical Layer, an Insider's View"*** *and* ***"Three Hidden Demons in your Network"***

The Secrets…

…are not really secrets, but you might think they are because so few people seem to be aware of how easy it can be to have reliable, low maintenance networks.

Ready for the big secrets?

- Careful Design
- Proper Installation
- Validation
- Baseline performance
- Periodic comparison with baseline

Careful Design

The design step that can save you so much time and frustration later on. Design and installation guidelines are published in the DeviceNet Specification, and are available from most of the major controls vendors. These guidelines exist to make your DeviceNet experience fast and easy, and following them completely and carefully will help you avoid the majority of network problems.

- Selecting appropriate media
- Determining network layout
- Determining the required number and position of power supplies
  - Controlling maximum load current in each segment
  - Limiting DC common mode voltage to <5V
  - Guaranteeing sufficient voltage at each node

During the design phase you may want to consider including 24/7 monitoring devices such as the PowerMonitor tee connector to detect power faults rapidly and accelerate fault diagnosis.

Proper Installation

Installation is usually out of your hands, but it is essential that all personnel are familiar with proper network cable installation practices.

- Avoid excessive pulling pressure on network cables – even a few broken strands in the cable can have an effect. The maximum pull tension is 160lbs for thick cable, 65lbs for thin and 90lbs for flat media.
- Avoid small radius bends – see the table for the minimum bend radius of different cable types:

Cable Type	Min Radius *(diameter)* During Installation *(i.e. in conduit)*	Min Radius *(diameter)* in a Fixed, Non-moving Installation.
Thick	9" *(18")*	3.15" *(6.3")*
Thin	5.2" *(10.4")*	1.82" *(3.64")*
Flat Media	2.1" *(4.2")*	2.1" *(4.2")*

- Avoid pulling directly on pre-molded connectors; they are not designed to withstand the tension required to pull cable through a conduit.
- When installing connectors, ensure that all wire strands are inside the screw clamp. It is quite common for a stray strand to cause a permanent or hard-to-find intermittent short. Also make sure the screw clamps are tightened per the installation instructions for the connector. Over tightening can result in stripped threads and loose or intermittent connections.
- Both trunk length and drop length are critical. You should always try to minimize cable lengths. Avoid coiling excess wire behind cabinets or wrapping it around equipment where it can pick up noise and makes the network much longer than it was intended.
- Validate the wiring before you connect the nodes or power supply to the network. *You cannot do media validation with nodes connected!*

Validation

Installation problems occur for a variety of reasons, and it is prudent to validate media installation before connecting nodes or applying power. Complete validation checks the media, basic network function, electrical performance and communication performance.

Media Validation

You can eliminate many of the annoying and time consuming start-up problems simply by checking the media before nodes and power supplies are connected. Tools are available from a few vendors that send signals down the cable and evaluate the reflections. These tools can detect shorts, opens, incorrect connections *(i.e. crossed wires)*, incorrect wire type, excessive trunk length and excessive drop length. Some tools can also test the terminating resistors. Some of these problems are difficult to diagnose and locate in an operating network so the small investment in time is well worth it.

Basic Functional Validation

After media validation, the next step is to connect all nodes and turn on the power. A basic functional validation can be performed by simply making sure that all network status LEDs are flashing green. At this point any red LEDs are most likely caused by incorrect MAC Ids or baud rate settings *(after all you* *did just check the media, didn't you?).* A configuration tool *(typically software on a laptop)* can be used to test communication with all nodes on the network, this is commonly called a "Who's Online" or "Network Who"; the tool communicates with each node and reads its identity information. After verifying all nodes are communicating the next step is to configure the scanner *(master, or client).*

Simply checking that all nodes are capable of communicating does not guarantee that the network is installed and operating as it should – it only indicates that any faults that exist are not sufficient to cause fatal problems.

Electrical Performance Validation

All nodes on the network must be actively communicating during electrical parameter validation.

Electrical performance is validated using a tool that independently measures the dominant/recessive signal and differential voltages and compares them to the limits in the specification. Accurately measuring the voltages representing ones and zeros on the wire is critical to determining noise margins and validating correct physical layer installation.

In addition to checking the data signal levels, it is important to check common mode voltage. The DC common mode voltage can be performed using a multimeter *(measure DC common to shield at several points and determine the maximum spread)*, but it is faster and more effective to use a tool that is capable of measuring total common mode voltage *(which includes common mode noise).*

You should also verify power supply voltage and check for power supply ripple at a number of points in the network. Power supply testing can be done using a basic voltmeter or a tool with complete physical layer diagnostics capability. Shield voltage is an important indicator of proper shield connection and should also be checked.

- Avoid using tools that measure mean signal voltages (DeviceNet Detective, multimeter) because these types of measurements do not provide assurance of correct operation – they are only useful to diagnose serious physical layer problems.
- The NetMeter is the only tool for DeviceNet that measures the dominant/recessive signal and differential signal voltages, total common mode voltage, shield voltage, power supply voltage and power supply ripple.

Communication Performance Validation

Bus errors are the ultimate indicator of physical layer problems. In most networks it is quite reasonable to expect zero bus errors, and any indication of errors should be investigated.

Bus traffic measurements are useful to 'tune' the scanner for maximum performance. They can also help avoid scan cycle overrun. Overrun when the scanner is configured to run faster than the network can support and begins the next cycle before the previous one is complete. High bus traffic (>90%) and occasional node timeouts with zero bus errors is a very strong indication of scan timing problems.

In addition to verifying bus traffic, the I/O update rate should be checked for systems that have specific performance goals. Measuring the message rate for each node and verifying the I/O update rate per node can avoid determinism related problems later.

- The NetMeter is the only tool for DeviceNet that accurately measures bus error rates down to the node level as well as bandwidth usage and message rates down to the node level which are essential to determine I/O update rate.

Baseline performance

Now that your network is validated, you need to record a baseline. The easiest way is to record all validation measurements for later comparison. If problems are encountered later on, comparing current conditions against the baseline can accelerate the troubleshooting process immensely.

You can download a free baseline measurement worksheet from http://www.mysst.com/download*. This worksheet helps you to record all critical baseline information.*

Periodic comparison with baseline

Most networks are installed, and then forgotten until they cause trouble. In contrast, periodically checking network operation against the baseline avoids unscheduled downtime by detecting faults before they cause trouble.

The recorded baseline is a snapshot of your network as it was installed. Over time power supplies can drift, flexing and vibration can degrade cable and connectors, corrosion can affect connectors, minor damage *(crushing & abrasions)* can degrade media characteristics and accidental changes can be made to network topology during maintenance and repairs. A periodic check-up can detect early signs of degraded performance and damage before is causes problems, and while preventative maintenance is usually performed during scheduled downtime, *NetMeter allows you to do a baseline comparison during normal operation!*

Scheduled maintenance with baseline comparison prevents panic repairs!