

MET 382 Spring '08


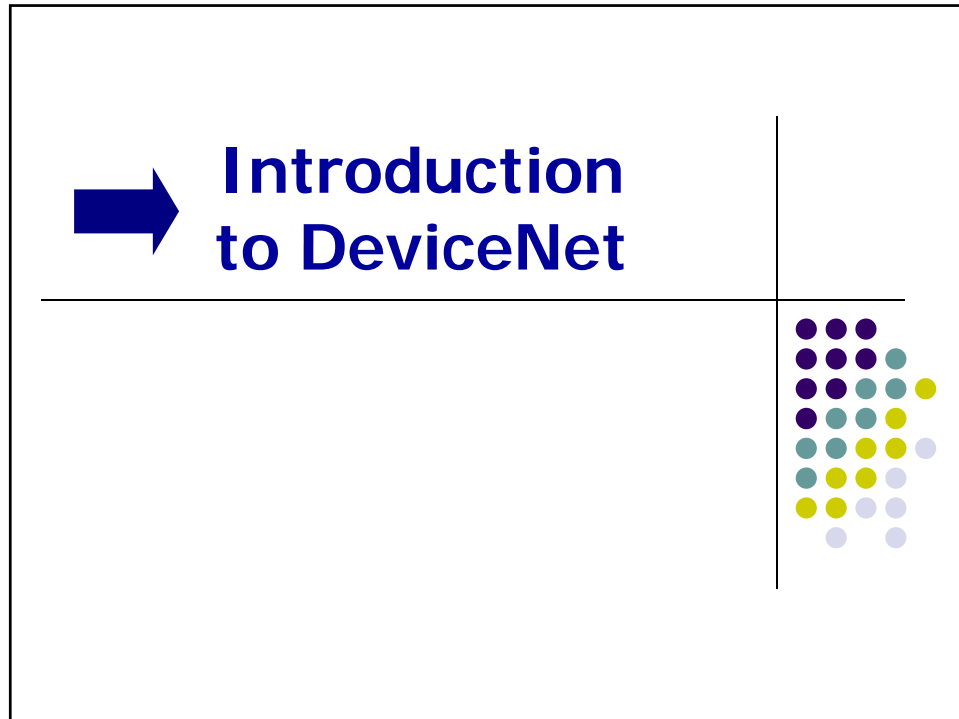
Introduction to DeviceNet



Topics

- Introduction to DeviceNet
- DeviceNet Components
- DeviceNet Fundamentals
- Introduction to The 1756-DNB Scanner
- Configuring the Scanner Module
- DeviceNet Overhead Rungs

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What is DeviceNet?

- DeviceNet is an example of a device-level local area network (LAN).
- DeviceNet brings LAN technology down to the lowest level of the manufacturing enterprise – the shop floor.
- Just like a computer can function as a node on an Ethernet network, a field device (such as a photoelectric sensor) can function as a node on a DeviceNet network.

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Input Field Devices



- An input field device that provides on/off type information (such as a photo-eye) can be purchased with a *discrete (switched)* output or a *DeviceNet* output.
 - An input field device that has a *discrete (switched)* output is wired to a PLC discrete input module (24 volts DC or 120 volts AC).
 - An input field device that has a *DeviceNet* output is wired to a DeviceNet network.
 - The DeviceNet capable input device transmits on/off data as well as diagnostic information to the PLC.

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Output Field Devices

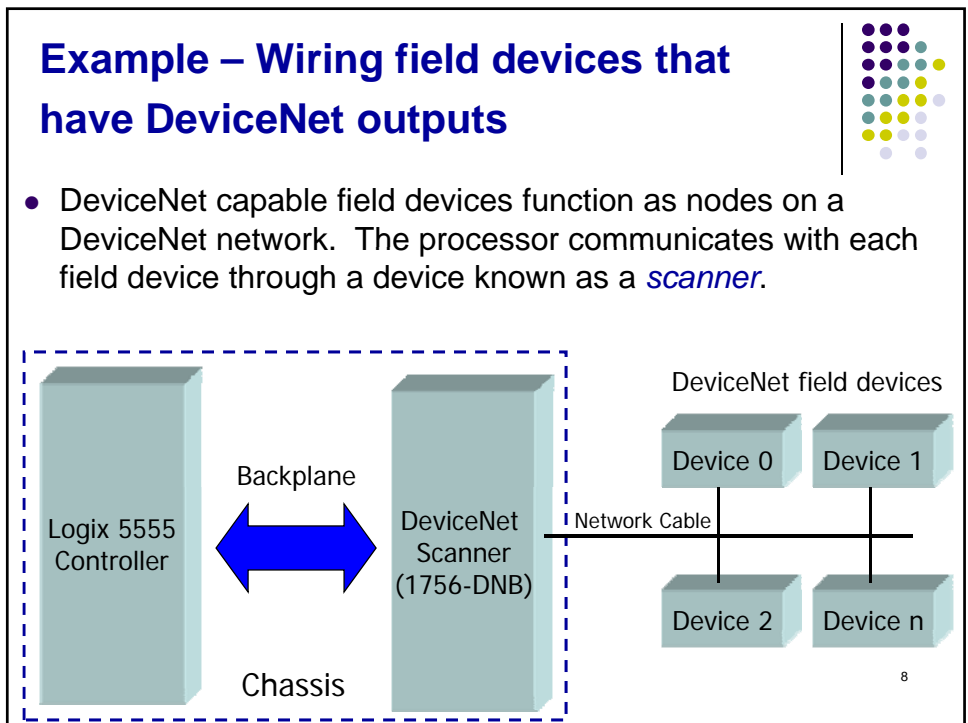
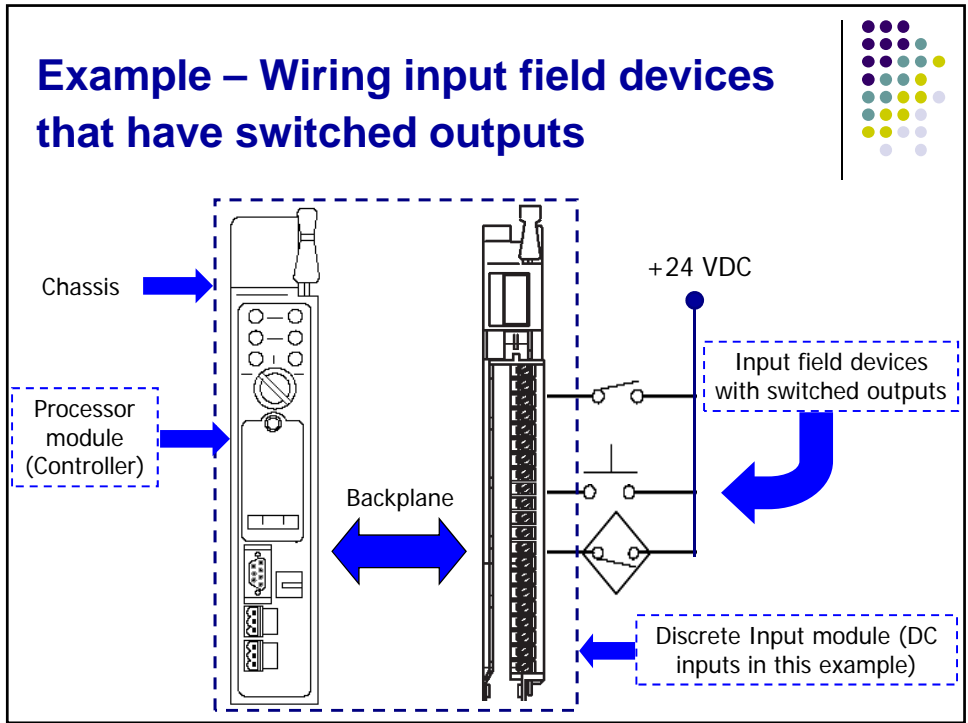


- An output field device that is switched on and off (such as a solenoid valve) by a PLC program can be:
 - Wired to a *discrete output module* (24 volts DC or 120 volts AC),

OR

- Wired as a node on *DeviceNet* and then controlled by the PLC over the network.

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DeviceNet Options when Implementing a New System



- Today, a manufacturing company that implements a PLC-based control system has essentially three options with respect to DeviceNet:
 - Option 1 – The company does not use DeviceNet!
 - Option 2 – The company uses DeviceNet and ALL of the field devices are DeviceNet capable.
 - Option 3 – The company implements a hybrid system.

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The ODVA



- DeviceNet is an open (non-proprietary) network.
- DeviceNet is supported by the Open DeviceNet Vendors Association (ODVA).
- “The ODVA is an organization that manages DeviceNet technology and promotes the worldwide adoption of DeviceNet in industrial automation.”
- Check out: www.odva.org

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Typical DeviceNet Nodes



Typical field devices that are placed on DeviceNet:

- Photoelectric sensors
- Proximity sensors (inductive & capacitive)
- Mechanical limit switches
- Pneumatic and hydraulic valves
- Motor starters
- Motor drives
- Operator interfaces (panel views, etc.)
- PLCs
- PCs
- Electric Robots
- And much more...

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DeviceNet Advantages



- Faster installation times
 - Wiring is simpler (often reduced to quick disconnect type connectors)
 - Fewer connections compared to traditional point-to-point wiring
 - Nodes can be easily added, removed, and relocated – even with power on!

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DeviceNet Advantages (cont'd)



- **Less expensive** compared to traditional point-to-point wiring
 - The required number of conduit, junction boxes, and terminal strips are reduced
 - Labor costs are reduced since wiring is easier and faster

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DeviceNet Advantages (cont'd)



- Most devices provide useful *diagnostic information* which can make systems easier to troubleshoot and minimize downtime
- DeviceNet devices can sometimes offer *more control features* compared to traditional/switched devices.
 - For example, an inductive proximity sensor that has a DeviceNet output can produce on/off data (indicating that an object is present or absent) as well as analog data (indicating how far away the object is).

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DeviceNet Advantages (cont'd)



- DeviceNet technology can be used with either PLC or PC-based control systems.

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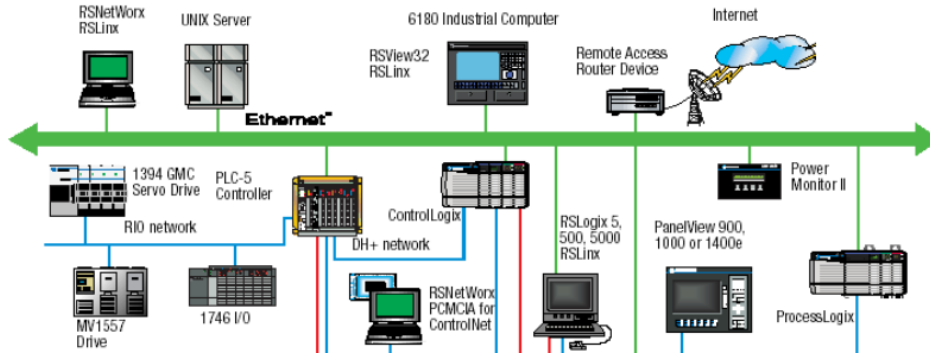
Networking in Today's Manufacturing Enterprise



- Spanning the entire manufacturing enterprise, local area networks play a vital role in today's automated manufacturing environment.
- One network, however, does not do it all. Different levels of the manufacturing enterprise have different needs and require different types of networks.
- Many manufacturers are using DeviceNet to network devices commonly found on the factory floor.

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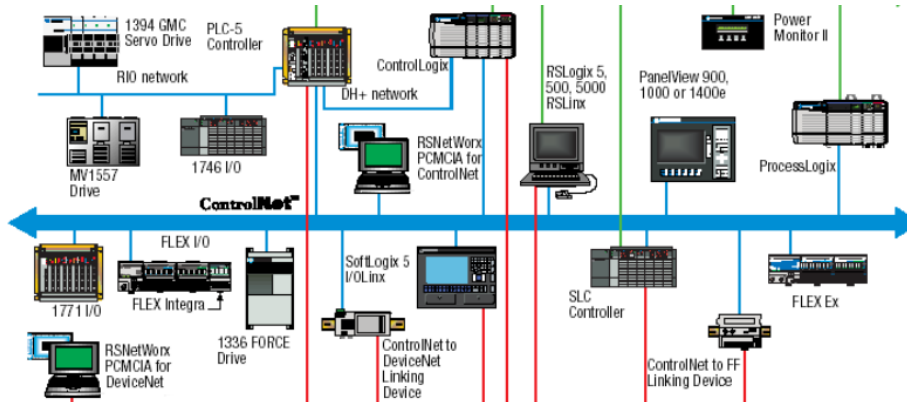
Networking The Manufacturing Enterprise - Ethernet for Business, Research, and General Office Applications



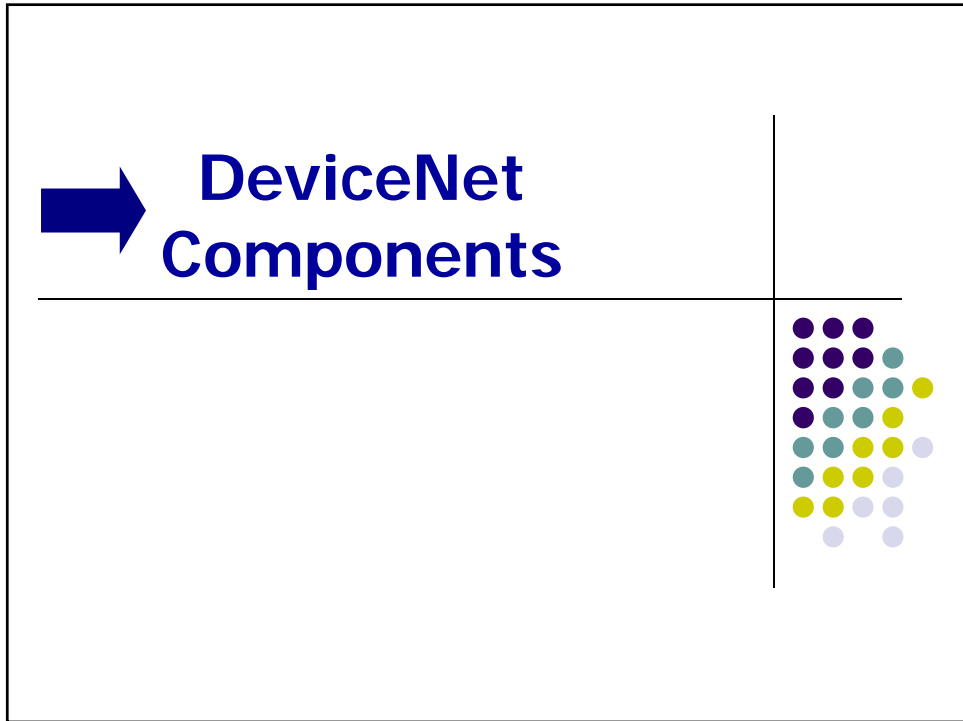
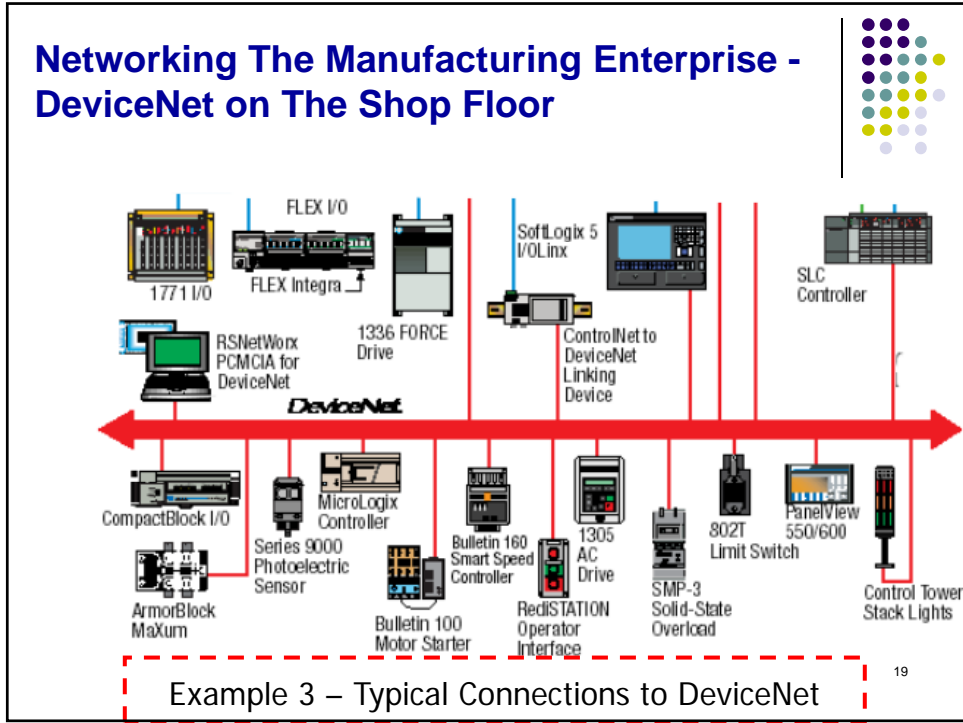
Example 1 – Typical Connections to Ethernet

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Networking The Manufacturing Enterprise - ControlNet at the Workcell Level



Example 2 – Typical Connections to ControlNet



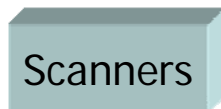
Introduction



- The devices commonly attached to a DeviceNet network can generally be classified as follows:
 - Scanners
 - DC Power Supply
 - Field Devices
 - User Interface

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DeviceNet Scanners



- The scanner is usually a PLC module (when using PLC control) or an adapter card in a personal computer (when using PC control)
- There is usually one scanner on each DeviceNet network
- Allen-Bradley Scanners: 1756-DNB (ControlLogix),
1771-SDN (PLC-5), 1747-SDN (SLC-500)

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DeviceNet Scanners (Cont'd)



Scanners

- A “*scan list*” is generated and then downloaded to the DeviceNet scanner.
- The scan list includes:
 - A list of the active devices on the network
 - How to communicate with each device (polled, strobed, COS, or cyclic)
 - How to map the DeviceNet I/O into the ControlLogix tag database

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DeviceNet Scanners (Cont'd)




Scanners

- The scanner is always in one of the following modes:
 - Idle mode
 - In this mode the scanner does not communicate with the devices on the network
 - Run mode
 - In the run mode the scanner communicates with the field devices (nodes) on the DeviceNet and passes data to and from the Logix5555 controller

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DeviceNet Scanners (Cont'd)




Scanners

- On each dropline of the CIMT conveyor system the DeviceNet scanner module is located in slot 3.

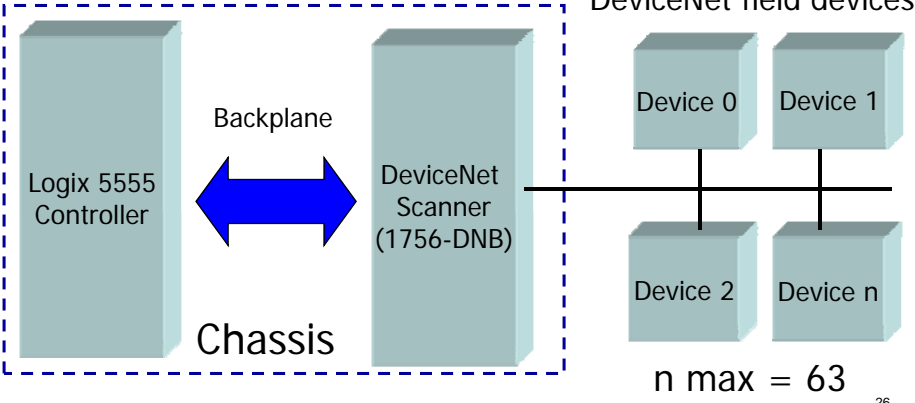
The 1756-DNB
ControlLogix
Scanner Module





DeviceNet Scanners (Cont'd)

Basic Block Diagram:



n max = 63

DeviceNet Power Supply

24 volt DC
Power Supply



- The DeviceNet cable carries both data and power (24v DC).
- Some devices are totally powered from the DeviceNet cable.
- Other devices (e.g., a panel view) require additional power from a second 24 volt DC power supply

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DeviceNet Field Devices

Field Devices

- Allen-Bradley DeviceNet field devices are classified as follows:
 - **Single point devices**
 - Photoelectric sensors, proximity sensors, etc.
 - **I/O platforms**
 - Compact block I/O, Armor block I/O, or Flex I/O
 - Enables traditional/switched devices to be connected to DeviceNet
 - **DeviceLink**
 - Enables traditional/switched devices to be connected to DeviceNet

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DeviceNet Field Devices

Field Devices

- Allen-Bradley DeviceNet field devices are classified as follows (Continued):
 - **User Interface**
 - Configures a DeviceNet network
 - Usually a computer running DeviceNet configuration software
 - **Motor drives**
 - **Electronic operator interfaces (EOI)**
 - Examples include: PanelViews, message displays, etc.

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DeviceNet Components - Field Devices → Single Point Devices



← Photoelectric Sensor

871TM Inductive Proximity Switch



These devices have true DeviceNet outputs and will function as a node on DeviceNet

DeviceNet Components - Field Devices → I/O Platforms, Compact Block I/O



Switched field devices are connected here

Incoming DeviceNet cable

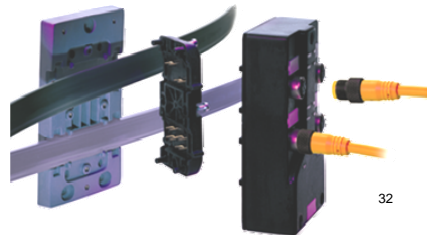
Compact Block I/O devices include a built-in network adapter, inputs/outputs, and a power supply in one small package

DeviceNet Components - Field Devices → I/O Platforms, Armor Block I/O



- Multiple traditional/switched field devices can be wired to an Armor block.
- Each block supports multiple inputs or outputs.
- The entire block functions as one node on DeviceNet.
- A wide variety of I/O combinations (inputs/outputs, AC/DC) are available.

- Armor blocks are factory hardened units that can be mounted directly on a conveyor or machine – no enclosure is necessary.



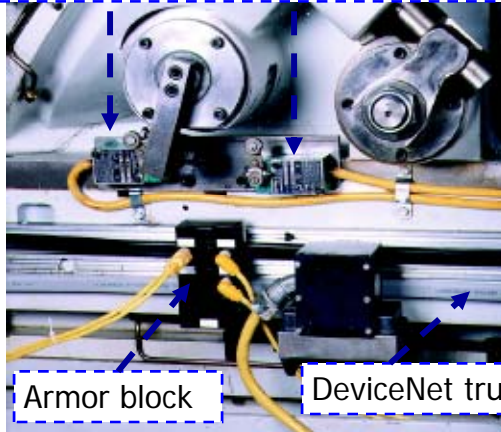
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DeviceNet Components - Field Devices

→ Armor Block I/O Example



These two mechanical limit switches are connected to the Armor Block shown below



Armor block

DeviceNet trunkline

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DeviceNet Components - Field Devices

→ I/O Platforms, Flex I/O



- Flex I/O can be used to connect traditional/switched field devices to DeviceNet.
- Flex I/O can be used with multiple networks. To use Flex I/O with DeviceNet use the 1794-ADN Adapter.
- Flex I/O modules mount on a DIN Rail – There is no chassis.
- One Flex I/O system supports up to 8 I/O modules.
- A wide variety of I/O is available.



DeviceNet Components - Field Devices

→ DeviceLink



A **DeviceLink** is used to connect traditional/switched field devices to DeviceNet.

Typical field devices include:

- Photoelectric sensors
- Proximity sensors
- Mechanical limit switches
- and many more...

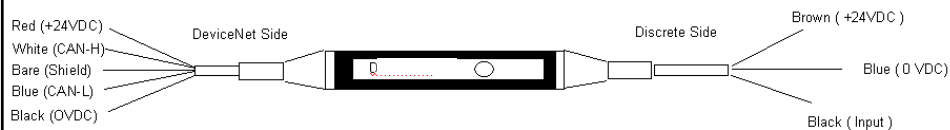


Traditional/switched devices have switched (discrete) outputs (AC or DC) that are either fully on or fully off.

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DeviceNet Components - Field Devices

→ DeviceLink (Cont'd)



DeviceLink wire colors and definitions

↑
This end connects to DeviceNet

↑
This end is connected to the traditional/switched field device

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DeviceNet Components - User Interface



User Interface

- The user interface is usually a computer.
- The user interface is used for:
 - Node commissioning** (assigning a device a node number)
 - Monitoring or changing **device parameters**
 - Monitoring or changing the **scanners scan list**

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DeviceNet Components - User Interface (Cont'd)



User Interface

- The User Interface runs the **DeviceNet configuration software**. The configuration software is used to setup a new DeviceNet, troubleshoot problems associated with an existing DeviceNet, or making changes to an existing DeviceNet.
- The user interface is typically assigned a high node number (such as 62, where node numbers range from 0 to 63)
- DeviceNet configuration software example: Rockwell Software's **RSNetworkx for DeviceNet**

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DeviceNet Components - User Interface (Cont'd)

User Interface



➤ Available Allen-Bradley PC Adapter Cards:

- 1784-PCID (desktop, PCI card)
- 1784-PCIDS (desktop, PCI card)
 - The 1784-PCIDS allows the PC to function as a **user interface** or a DeviceNet **scanner** if using PC-based control. [This card is installed in each dropline PC](#)
- 1784-PCD (notebook, PCMCIA card)
- 1784-PCDS (notebook, PCMCIA card, same function as 1784-PCIDS)

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DeviceNet Fundamentals



DeviceNet Fundamentals



- Topics:
 - Topology
 - Assigning Node numbers
 - Available Baud Rates
 - DeviceNet Media
 - I/O Message Types

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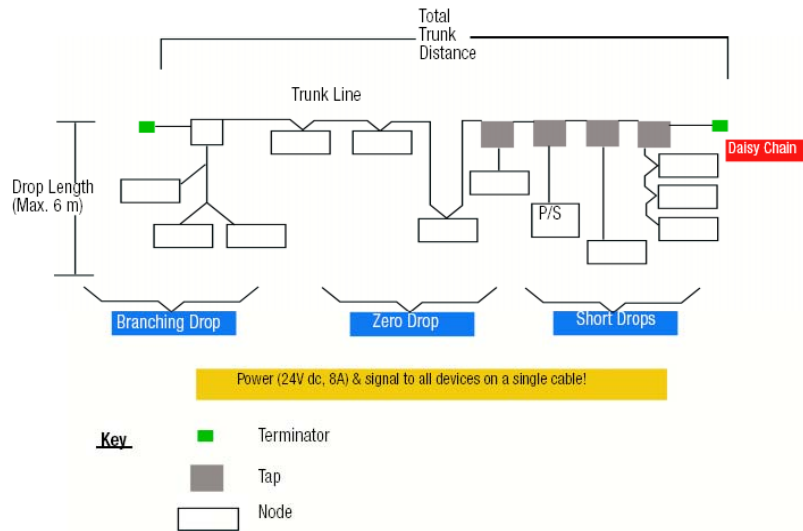
DeviceNet Fundamentals - Topology



- DeviceNet is based on a **bus topology** (also called trunkline/dropline)
- A DeviceNet LAN has a main trunkline with multiple droplines

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DeviceNet Fundamentals - Topology



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DeviceNet Fundamentals - Assigning Node Numbers

- Each device must have a unique node number ranging from 0 to 63
- All devices “out of the box” default to node 63
 - New devices must be reassigned a different node number

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DeviceNet Fundamentals - Available Baud Rates



- DeviceNet supports the following baud rates:
 - 125k bps (this is the default)
 - 250k bps
 - 500k bps
- Many devices support **autobaud**
 - These devices automatically sense and then set their data rate to the correct value when they are connected into an existing network

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DeviceNet Fundamentals - Available Baud Rates (Cont'd)



- The baud rate and node numbers for Allen-Bradley **scanners** are set as follows:
 - **ControlLogix** – Use the pushbutton on the front of the 1756-DNB module
 - DeviceNet cable disconnected – The pushbutton is used to set the *baud rate*
 - DeviceNet cable connected – The pushbutton is used to set *node number*
 - **PLC-5** – DIP switches on the scanner module
 - **SLC-500** – Software (RSLogix500)

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DeviceNet Fundamentals - DeviceNet Media



- There are three media types:
 - Round – Thick
 - Typically used for trunkline
 - Round – Thin
 - Typically used for drop lines
 - Flat



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DeviceNet Media, Flat Cable



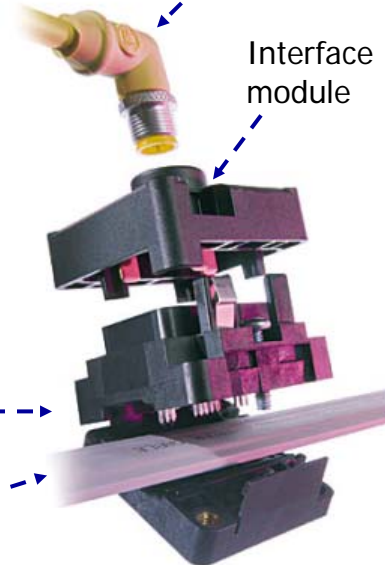
- KwikLink™ Flat Media System
 - “50% savings in installior costs”
 - Modular connector system
 - “Vampire teeth” pierce cab

Hinged tap

Flat cable

Quick disconnect connector

Interface module



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DeviceNet Media – Comparing Different Media



Data Rates	Max. Trunk Length (thick)	Max. Trunk Length (thin)	Max. Trunk Length (flat)	Drop Line Budgets
500 Kbps	100 meters (328 ft)	100 meters (328 ft)	75 meters (246 ft)	39 meters (128 ft.)
250 Kbps	250 meters (820 ft)	100 meters (328 ft)	200 meters (656 ft)	78 meters (256 ft.)
125 Kbps	500 meters (1640 ft)	100 meters (328 ft)	420 meters (1,378 ft)	156 meters (512 ft.)

Each dropline can span up to 20 feet (6 meters)

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DeviceNet Media – Wire Color Codes



- A DeviceNet cable carries both data and power

	Wire Color	Wire Identity	Usage Round	Usage Flat
Data	white	CAN_H	signal	signal
	blue	CAN_L	signal	signal
Drain wire connected to shield	bare	drain	shield	n/a
Ground	black	V-	power	power
+24 VDC	red	V+	power	power

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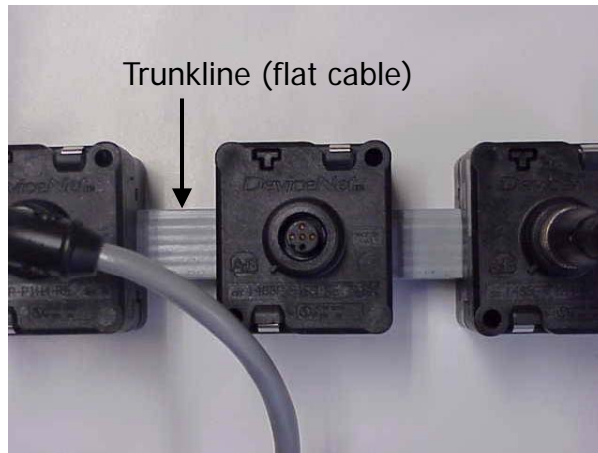
DeviceNet Media – Open Style Connector



Terminating
Resistor

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DeviceNet Media – Sealed Style Connectors



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DeviceNet Fundamentals - I/O Message Types



- Methods for gathering device data include:
 - Polled
 - Strobed
 - Change-of-State (COS)
 - Cyclic

The actual method used depends on your specific application and which method(s) are actually supported by the field device.

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Introduction to The 1756-DNB Scanner



The 1756-DNB Scanner



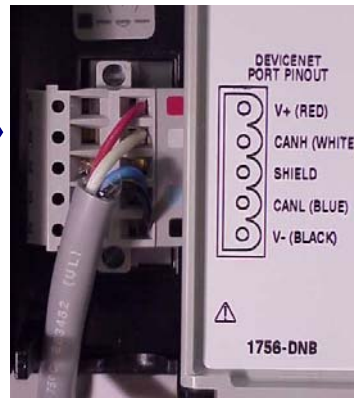
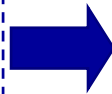
- Topics:
 - 1756-DNB Scanner – Wiring Details
 - 1756-DNB Scanner – Using The Message Display
 - Scanner Error Codes

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1756-DNB Scanner – Wiring Details



The DeviceNet cable connected to the 1756-DNB scanner



Wire Color	Wire Identity	Usage Round	Usage Flat
white	CAN_H	signal	signal
blue	CAN_L	signal	signal
bare	drain	shield	n/a
black	V-	power	power
red	V+	power	power

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1756-DNB Scanner – Using The Message Display

The **scanners message display** is located on the front of the 1756-DNB module. It displays:

- The scanners DeviceNet node address
- The scanners current mode (idle or run)
- Error Codes (if any) {See next slide for error codes}

LEDs show important status information


Use this button to manually set the scanners baud rate and node address

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Scanner Error Codes

Error Code	Details
70	SDN failed Duplicate Node Check. Another node on network has same node.
72	The slave node is no longer responding on the network. The node number blinks after the error code.
73	The electronic keys in the scan list do not match the vendor, type or code of the slave at this node number. The node number blinks after the error code. Note: The assign keys can be disabled for a node in the SDN scan list editor.
75 or 76	No scan list is Active in SDN.
77	The Transmit or Receive size in the scan list never matched what slave device expects. The node number blinks after the error code.
78	The slave whose node number blinks after this error code, has never responded to communications from the SDN.
79	Scanners duplicate node check transmission was not <u>acked</u> . Could be a network wiring problem or no other device on network.
80	The PLC or SLC is in program mode or SDN is in IDLE mode from the command register.
81	The PLC or SLC is in program mode or SDN is in FAULT mode from the command register.
82	
83	Slave device is returning an error response. Normally happens if the device does not support the kind of connection being requested by SDN (COS, etc.). Device owned by another master.

<h2>Scanner Error Codes</h2>	
Error Code	Details
84	SDN is initializing the network communication. Happens after powerup and clears automatically after SDN communicates to each slave device.
85	The Transmit or Receive size in the scan list not what slave device expects. Scanner was communicating OK to device, but the devices I/O assembly size(s) changed. The node number blinks after the error code.
86	Idle data being produced in RUN mode. The SDN has received data from a slave in the past, but now is getting 0 bytes from the slave.
89	Error occurred in scanner while executing ADR commands. Probably caused by an ADR file stored in the scanner that doesn't match the device. Reload valid ADR file to scanner to cure this problem.
90	SDN is in DISABLE mode from the command register.
91	The SDN is Bus-off meaning that there were significant communication errors on the network. Cycle network power to recover.
92	No +24VDC network power to Phoenix connector on SDN
95	Flash update of SDN firmware, scan list or module configuration in progress
97	SDN is in HALT mode from the command register.
E8	Firmware incompatibility exists in the 1747-SDN scanner. Download init, boot and main firmware code segments as separate operations using Flash Update Tool.
E9	The 1747-SDN scanner has been flushed from the command register. Cycle Power to SDN to recover.



Configuring The Scanner Module



Configuring The Scanner Module

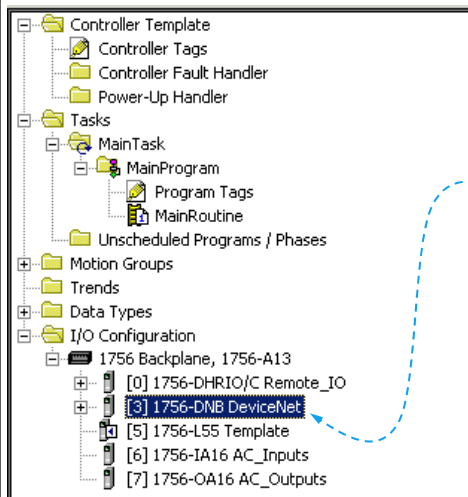


- Basic Procedure:
 - Add the 1756-DNB DeviceNet scanner module to the ***I/O Configuration Folder*** of the CIMT 243 template program.
 - Configure the scanner module as shown on the following slides.

Continued on next slide ...

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Configuring the Scanner Module



Add the scanner module (1756-DNB) to the I/O Configuration folder

Configure the module by selecting the desired properties

Continued on next slide ...

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Configuring the Scanner Module



DroplinePLCs\192.168.1.35\Backplane\3

Device Name: 1756-DNB DeviceNet Scanner
Vendor: Allen-Bradley Company
Product Type: 12
Product Code: 14
Revision: 7.1
Serial Number: 000D6ECB

Faults:

Close Help

Note: Use revision 7.1 when configuring the 1756-DNB DeviceNet scanner

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Configuring the Scanner - Configuration Results



The Results -- The General Tab ...

Module Properties: Local:3 (1756-DNB 7.1)

General* | Connection | RSNetWorx | Module Info | Scan List | Backplane

Type: 1756-DNB 1756 DeviceNet Scanner
Vendor: Allen-Bradley
Name: DeviceNet Input Size: 124 (32-bit)
Description: DeviceNet Scanner Output Size: 123 (32-bit)
Status Size: 32 (32-bit)
Node: 2 Slot: 3
Revision: 7 Electronic Keying: Compatible Keying
Comm Format and Major Revision cannot be changed while pending edits exist.

Status: Offline OK Cancel Apply Help

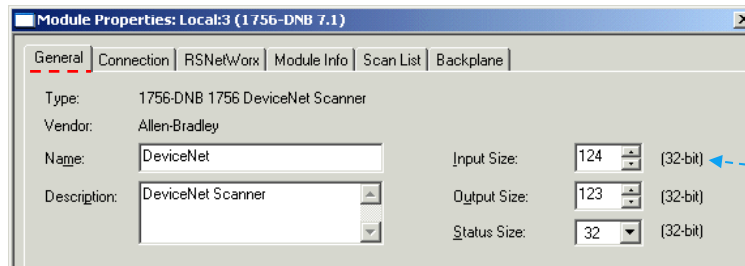
Continued on next slide ...

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Configuring the Scanner - Configuration Results



The Results -- The General Tab (cont'd) ...



By default RSLogix5000 will allocate a maximum of 124 DINTs for input data, 123 DINTs for output data, and 32 DINTs for status.

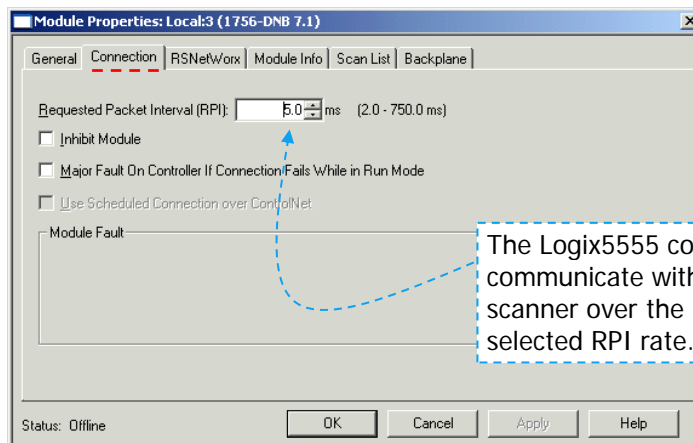
If memory is limited the input and output data sizes can be adjusted for your application, otherwise use the maximum values as shown above.

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Configuring the Scanner - Configuration Results



The Results -- The Connection Tab ...



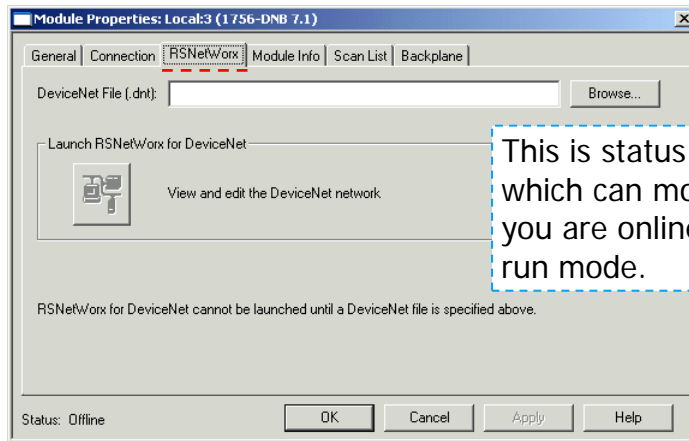
The Logix5555 controller will communicate with the 1756-DNB scanner over the backplane at the selected RPI rate.

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Configuring the Scanner - Configuration Results



The Results -- The Module Info Tab ...

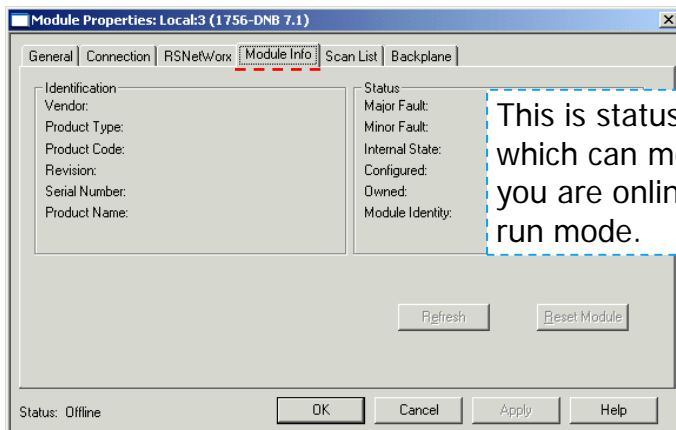


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Configuring the Scanner - Configuration Results



The Results -- The Backplane Tab ...

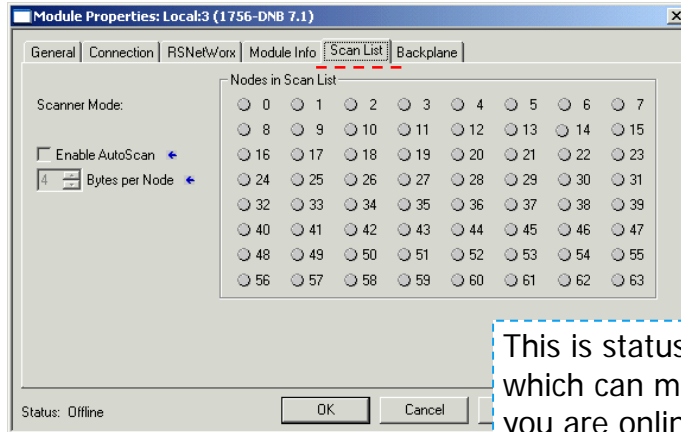


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Configuring the Scanner - Configuration Results



The Results -- The Backplane Tab ...

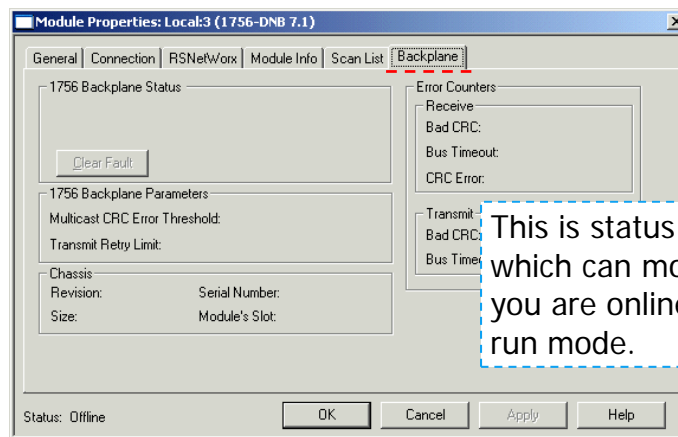


This is status information which can monitored when you are online and in the run mode.

Configuring the Scanner - Configuration Results



The Results -- The Backplane Tab ...



This is status information which can monitored when you are online and in the run mode.

Configuring the Scanner - Configuration Results



The Results – I/O Controller Scoped Tags

[-] Local:3:I		AB:1756_DNB_500Bytes:I:0
[-] Local:3:I.StatusRegister		AB:1756_DNB_StatusRegister:I:0
[-] Local:3:I.Data	← Inputs	DINT[124]
[-] Local:3:O		AB:1756_DNB_496Bytes:O:0
[-] Local:3:O.CommandRegister		AB:1756_DNB_CommandRegister:O:0
[-] Local:3:O.Data	← Outputs	DINT[123]
[-] Local:3:S	← Status	AB:1756_DNB_Status_128Bytes:S:0
[-] Local:3:S.ScanCounter		DINT
[-] Local:3:S.DeviceFailureRegister		SINT[8]
[-] Local:3:S.AutoverifyFailureRegister		SINT[8]
[-] Local:3:S.DeviceIdleRegister		SINT[8]
[-] Local:3:S.ActiveNodeRegister		SINT[8]
[-] Local:3:S.StatusDisplay		SINT[4]
[-] Local:3:S.ScannerAddress		SINT
[-] Local:3:S.ScannerStatus		SINT
[-] Local:3:S.ScrollingDeviceAddress		SINT
[-] Local:3:S.ScrollingDeviceStatus		SINT
[-] Local:3:S.DeviceStatus		SINT[64]

Configuring the Scanner - Configuration Results



The Results – Output Tags

[-] Local:3:O		
[-] Local:3:O.CommandRegister		
[-] Local:3:O.CommandRegister.Run	←	
[-] Local:3:O.CommandRegister.Fault		
[-] Local:3:O.CommandRegister.DisableNetwork		
[-] Local:3:O.CommandRegister.HaltScanner		
[-] Local:3:O.CommandRegister.Reset		
[-] Local:3:O.Data		
[-] Local:3:O.Data[0]		DINT
[-] Local:3:O.Data[1]		DINT
[-] Local:3:O.Data[2]		DINT
[-] Local:3:O.Data[3]		DINT
[-] Local:3:O.Data[4]		DINT
[-] Local:3:O.Data[5]		DINT
[-] Local:3:O.Data[6]		DINT
[-] Local:3:O.Data[7]		DINT
[-] Local:3:O.Data[8]		DINT
[-] Local:3:O.Data[9]		DINT
[-] Local:3:O.Data[10]		DINT
[-] Local:3:O.Data[11]		DINT

When this bit is set to a 1 the scanner is placed into the RUN mode. When this bit is reset to a 0 the scanner is placed into the IDLE mode. See *DeviceNet Overhead Rungs*

Continued on next slide ...

Configuring the Scanner - Configuration Results



The Results – Output Tags (cont'd)

[-] Local:3:0		
[-] Local:3:0.CommandRegister		
[-] Local:3:0.CommandRegister.Run		
[-] Local:3:0.CommandRegister.Fault		
[-] Local:3:0.CommandRegister.DisableNetwork		
[-] Local:3:0.CommandRegister.HaltScanner		
[-] Local:3:0.CommandRegister.Reset		BOOL
[-] Local:3:0.Data		DINT[123]
[+] Local:3:0.Data[0]		DINT
[+] Local:3:0.Data[1]		DINT
[+] Local:3:0.Data[2]		DINT
[+] Local:3:0.Data[3]		DINT
[+] Local:3:0.Data[4]		DINT
[+] Local:3:0.Data[5]		DINT
[+] Local:3:0.Data[6]		DINT
[+] Local:3:0.Data[7]		DINT
[+] Local:3:0.Data[8]		DINT
[+] Local:3:0.Data[9]		DINT
[+] Local:3:0.Data[10]		DINT
[+] Local:3:0.Data[11]		DINT

This is an array of DINTs corresponding to the scanner's outputs. To understand this array you must first understand how the outputs are mapped into the scanner's scan list using RSNetworkx for DeviceNet!



Configuring the Scanner - Configuration Results



The Results – Input Tags

[-] Local:3:1		
[-] Local:3:1.StatusRegister		
[-] Local:3:1.StatusRegister.Run		
[-] Local:3:1.StatusRegister.Fault		
[-] Local:3:1.StatusRegister.DisableNetwork		
[-] Local:3:1.StatusRegister.DeviceFailure		
[-] Local:3:1.StatusRegister.AutoVerity		
[-] Local:3:1.StatusRegister.CommFailure		
[-] Local:3:1.StatusRegister.DupNodeFail		BOOL
[-] Local:3:1.StatusRegister.DnetPowerDetect		BOOL
[-] Local:3:1.Data		DINT[124]
[+] Local:3:1.Data[0]		DINT
[+] Local:3:1.Data[1]		DINT
[+] Local:3:1.Data[2]		DINT
[+] Local:3:1.Data[3]		DINT
[+] Local:3:1.Data[4]		DINT
[+] Local:3:1.Data[5]		DINT
[+] Local:3:1.Data[6]		DINT
[+] Local:3:1.Data[7]		DINT
[+] Local:3:1.Data[8]		DINT
[+] Local:3:1.Data[9]		DINT
[+] Local:3:1.Data[10]		DINT
[+] Local:3:1.Data[11]		DINT

This is an array of DINTs corresponding to the scanner's inputs. To understand this array you must first understand how the inputs are mapped into the scanner's scan list using RSNetworkx for DeviceNet!



