Smart3G – pn5732P
Ethernet PLC

User Guide

(Document Revision 1.6)

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Buford, GA USA

For more information please visit the product web page:
www.vitalsystem.com/smart3g

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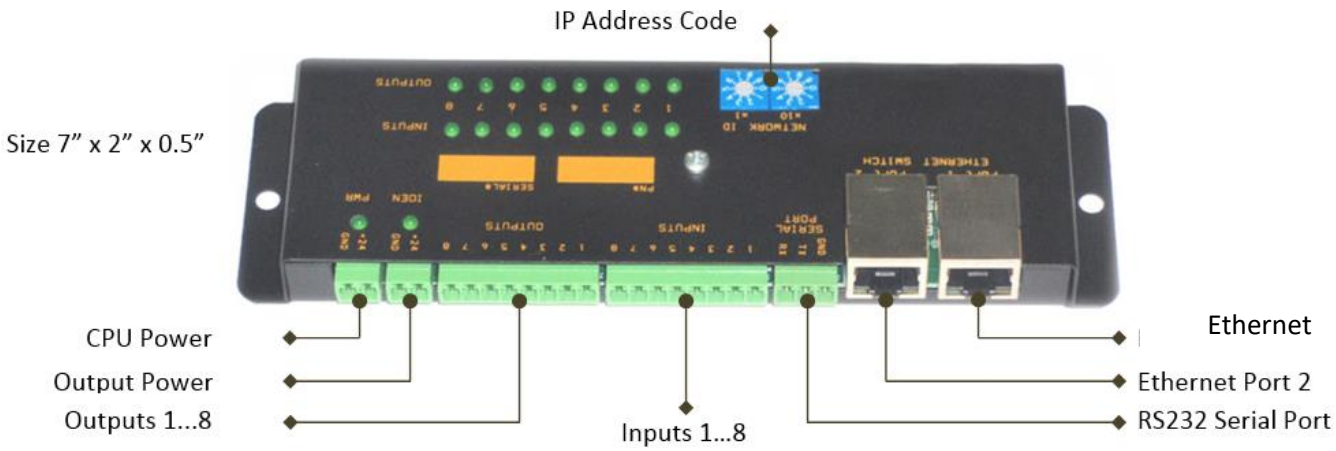
Smart-3G - Ethernet Programmable Controller

The ***Smart-3G - Ethernet Programmable Controller*** provides networked 24volts Digital I/O for MDR Powered Roller Conveyor systems, as well as general purpose Fast Local/Remote Machine I/O. These Devices are fully programmable via Ladder Logic for any type of control application, and can act as a programmable master device, or a slaved Remote I/O device. The modules communicate over Ethernet to master or peer devices using ***Ethernet/IP***, ***Modbus/TCP*** and ***S3G-Master/Slave*** protocols. For ***MDR*** systems, interlocking messaging bits e.g., upstream, downstream, merge, divert, etc are handled by the firmware for simplified Ladder Logic Programming.

Custom PC Application can also be developed using free sample source code for C and .Net applications.

1. Module Description



2. Electrical Specs

CPU Input Power	18-30Volt DC, 500mA
I/O Voltage	18-30Volt DC
Total Max I/O Current	3 Amps
I/O Type	PNP (Sourcing)
Output Current	500 mA Per Output
Input Voltage Range	0…30Volts
Input Threshold Voltage	4 Volts. (Logic Low: 0...4v, Logic High: 4.1v...30v)
Network	Ethernet 100MB/S
Ethernet Switch	2 Ports. (Always use Port 1 when single port is required)

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3. Operating Modes

The ***Smart-3G*** controller has two main operating modes:

- Remote I/O controller
- Programmable Logic Controller

3.1 Remote I/O controller Mode

Using the ***SuperLogic*** configuration window, if the **Remote I/O** check box is **ON**, the device allows an external master to control the I/O directly over Ethernet. Any of the three protocols can be used to control the I/O this way. This mode is active be default from factory. The controller does not execute any user downloaded ladder logic program.

The CPU Led blinks in the following two patterns:

- When a Master **Is** Online: One second On/Off cycle with 2% duty cycle. (very short blips)
- When Master **Is Not** Online: One second On/Off cycle with 50% duty cycle

3.2 Programmable Logic controller Mode

If the **Remote I/O** check box is **OFF**, the device executes the downloaded user ladder logic program to control the I/O. In this mode, any Master device can still connect to the device, but the outputs will remain in the Ladder Logic program control. The master can write to Control Word file which the device can pick up and take appropriate actions as defined by the user ladder logic program.

In this mode, the CPU Led blinks in the following patterns:

- Ladder Logic Run Mode: Heart-beat blink mode (blip-blip, blip-blip, blip-blip…)
- Ladder Logic Stopped: One second On/Off cycle with 50% duty cycle.

The ladder logic program controls the local I/O as well as access and control the I/O on remote ***Smart-3G*** devices using the ***S3G-Master/Slave*** protocol. The remote I/O appears as local I/O and is accessed the same way as the local I/O. You can control up to eight remote ***Smart-3G*** devices from a single master ***Smart-3G*** device, providing a total of 72 inputs and 72 outputs.

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4. Network Configuration and Protocols

4.1 IP Address

The Device IP address is configured partly by the rotary switches and partly by the ***SuperLogic*** software configuration window. The default IP address is set to 192.168.0.1. With the rotary switches, the address range for the device is 192.168.0.1 thru 192.168.0.99. The first three digits of IP address can be changed using the software configuration tool. In addition to the IP address, the default Gateway and Address Mask can also be changed by the configuration software.

4.2 Ethernet/IP Protocol

Configuration Parameters	
Device Type	Generic
Name	Any user defined name
Data Format	SINT (byte)
IP Addr	Device IP Address
Input	112, Size 12 Bytes (Produce Data)
Output	111, Size 8 Bytes (4 Bytes in case of RSLogix)
Config	113, Size 0

Input/Produce Message Format

Size: 12 Bytes (4 byte header and 8 byte data); **Type**: SINT(8bit)
Byte 0 = 1 Header 4 Bytes (always set to 1)
Byte 1 = 0
Byte 2 = 0
Byte 3 = 0
Byte 4 = Input States, 8 bits
Byte 5 = Output Enable Bit, 1 bit
Byte 6 = Output States, 8 bits
Byte 7 = 0
Byte 8, 9 = Contents of Control Word 1 (CW:1)
Byte 10, 11 = Contents of Control Word 2 (CW:2)

Data to Ethernet/IP Master is read from ***Smart-3G*** Internal control words file CW:1 and CW:2, 16bit integers.

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Output/Consume Message Format

Using Allen Bradley RSLogix:

Size: 4 Data Bytes
Type: SINT(8bit)

> **NOTE**: ***Allen Bradley RSLogix*** *does not use Header bits when mapping outputs, so output size should be set to 4.*

Byte 0, 1 → Control Word 9 (or directly to the Output pins)
Byte 2, 3 → Control Word 10

Data from Ethernet/IP Master controller is saved in **CW:9** and **CW:10** in ***Smart-3G*** internal control words file.

If **Remote I/O** check-box is checked in ***SuperLogic*** configuration window, Byte 0 is mapped to outputs for direct master PLC control:

Byte 0 → Outputs 1…8 (bits 0...7 are mapped to Outputs 1…8).

Using 3GScan Software Library for Windows and Linux:

The output size is set to 8 bytes.

Byte 0 = 1 Header 4 Bytes (Always set to 1)
Byte 1 = 0
Byte 2 = 0
Byte 3 = 0
Byte 4, 5 → Control Word 9 (or directly to Outputs)
Byte 6, 7 → Control Word 10

If **Remote I/O** check-box is checked in ***SuperLogic*** configuration window, Byte 4 is mapped to outputs for direct PC software control:

Byte 4 → Outputs 1…8 (bits 0...7 are mapped to Outputs 1…8).

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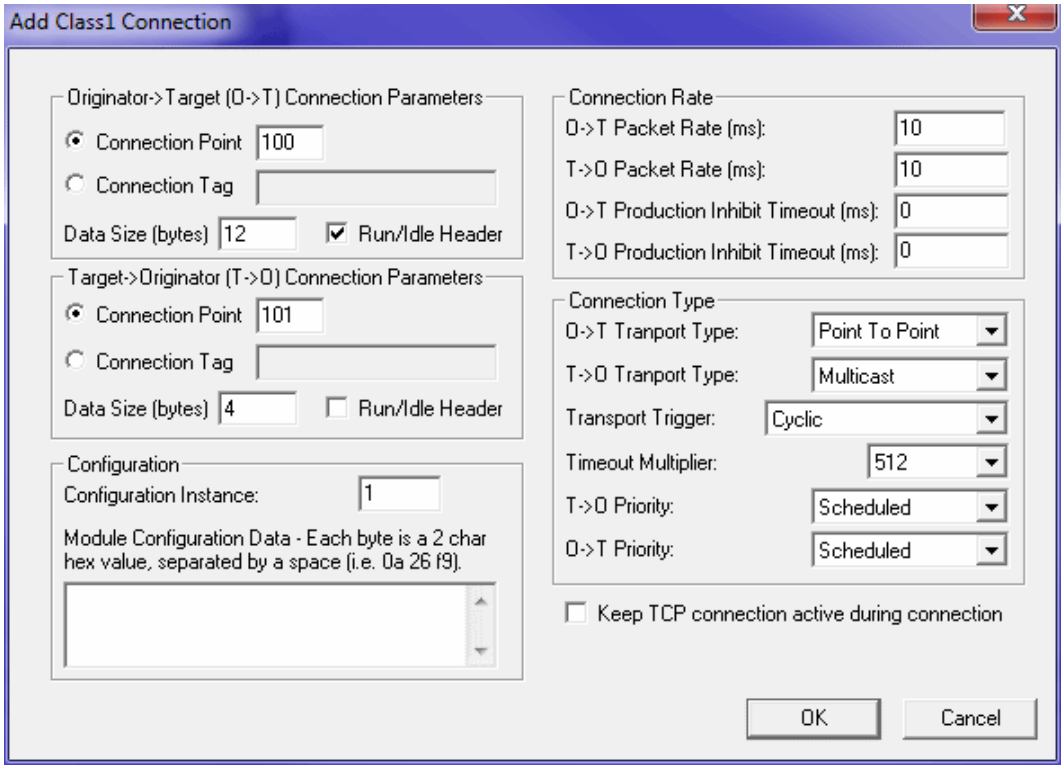
Ethernet/IP Configuration Example

Below is an example of a typical Ethernet/IP Master configuration using a 10ms polling interval and a 5 second connection timeout.



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4.3 Modbus / TCP Protocol

Inputs and Outputs are access via Modbus Discrete Inputs (1..8) and Coils (11-18), as well as via holding registers.

Modbus/TCP protocol can read the entire Control Words file CW: 1…54 via ***Modbus Holding Registers***. Writes (or Output-Holding) are only allowed to Registers 9, 10, 23 and 24.

Modbus Slave address is ignored.

Reading Modbus Holding Register 1 through 54 will read Control Words 1 thru 54 in the card.

Writing to Modbus Holding Register 9 and 10 will write to Control Words 9 and 10 in the card. Can be used for any general purpose.

The following special condition applies to Register 23 and 24:

Read Holding Reg 23 = Read 8 Inputs (bits 0…7) and new barcode bit (bit 15)
Read Holding Reg 24 = Read 8 Outputs (bits 0…7) and I/O Power State (bit 15)

Write Holding Reg 23 = Write to CW:23
Write Holding Reg 24 = Write to CW:24, or Write to output pins if Remote I/O Checkbox is on.

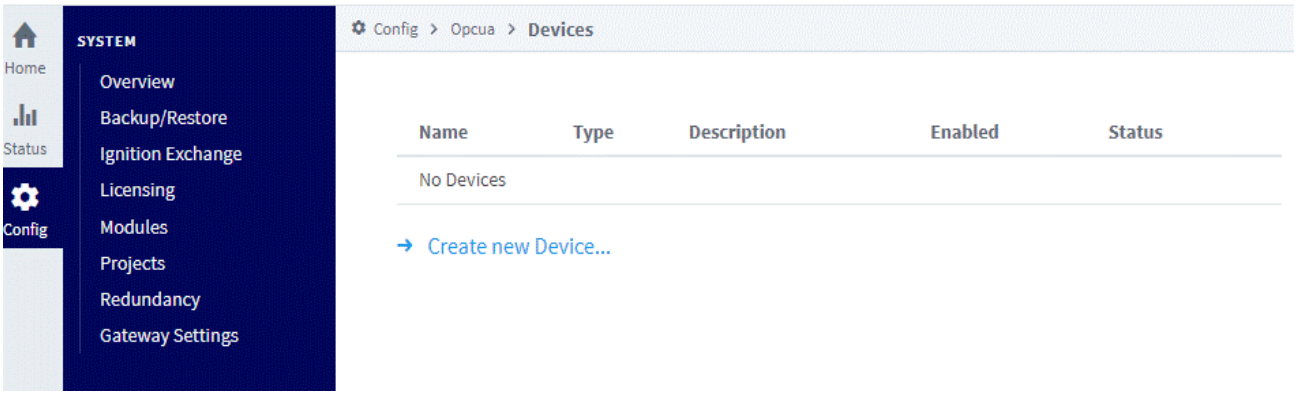
The following Discrete Inputs and Coils will also read/write to the device's IO.

Discrete Inputs 1-8 = Reads Inputs 1-8
Coils 11-18 = Read/Write to Outputs 1-8 (Write only available in Remote I/O mode)

Ignition SCADA/HMI Setup via Modbus/TCP

The following example setup will let you read/write inputs and outputs on the Smart3G card. You can also use Modbus registers to read/write control words in case you are running the card in Ladder Logic mode.

Navigate to the OPC UA->Device Connections page on the Ignition Config tab, and select Create new Device:



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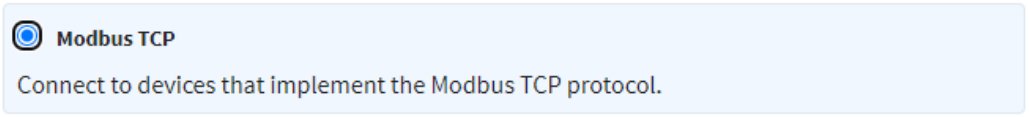
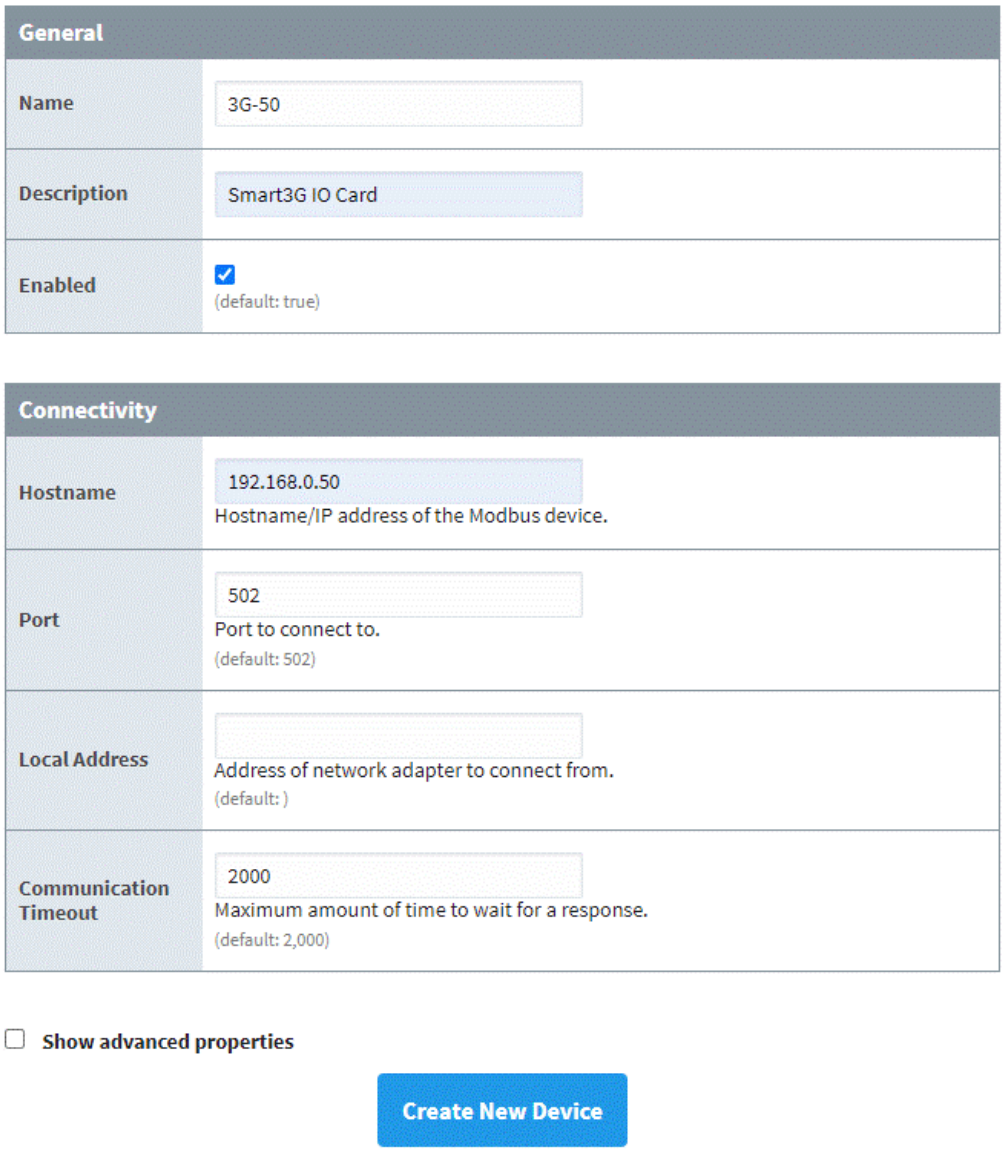
Select Modbus TCP:



Enter a name and IP Address for the 3G card, and select Create New Device:



Select More->Address on the new device, and import the configuration at the following link:

https://vitalsystem.com/portal/plc/Ignition-3G-config.csv

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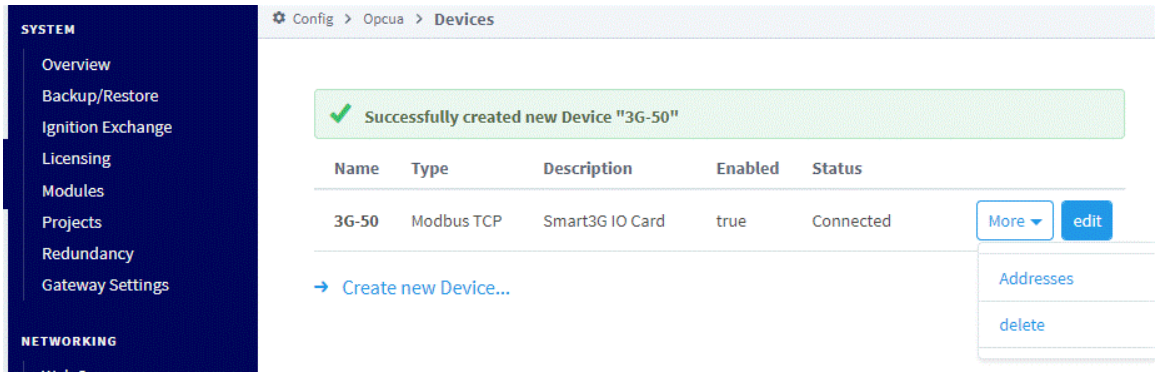
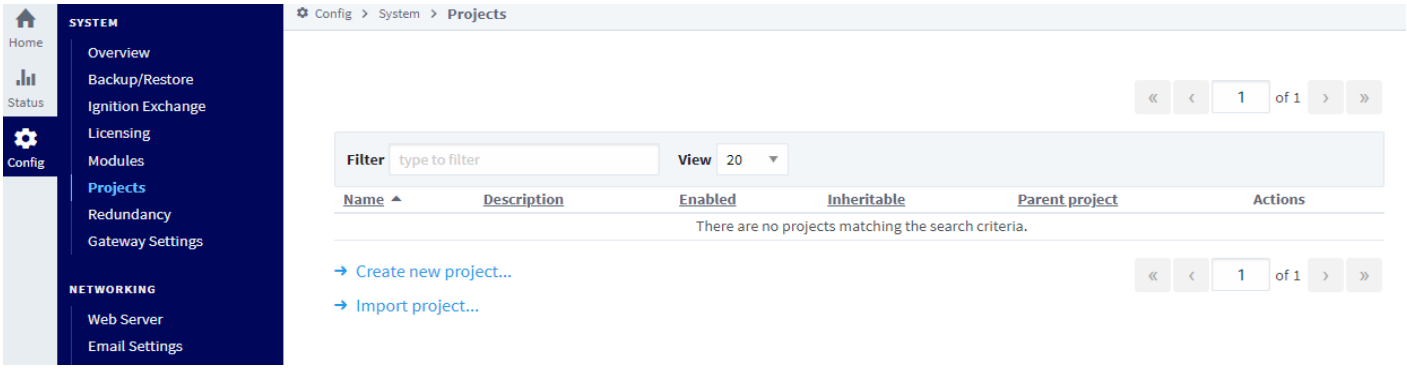
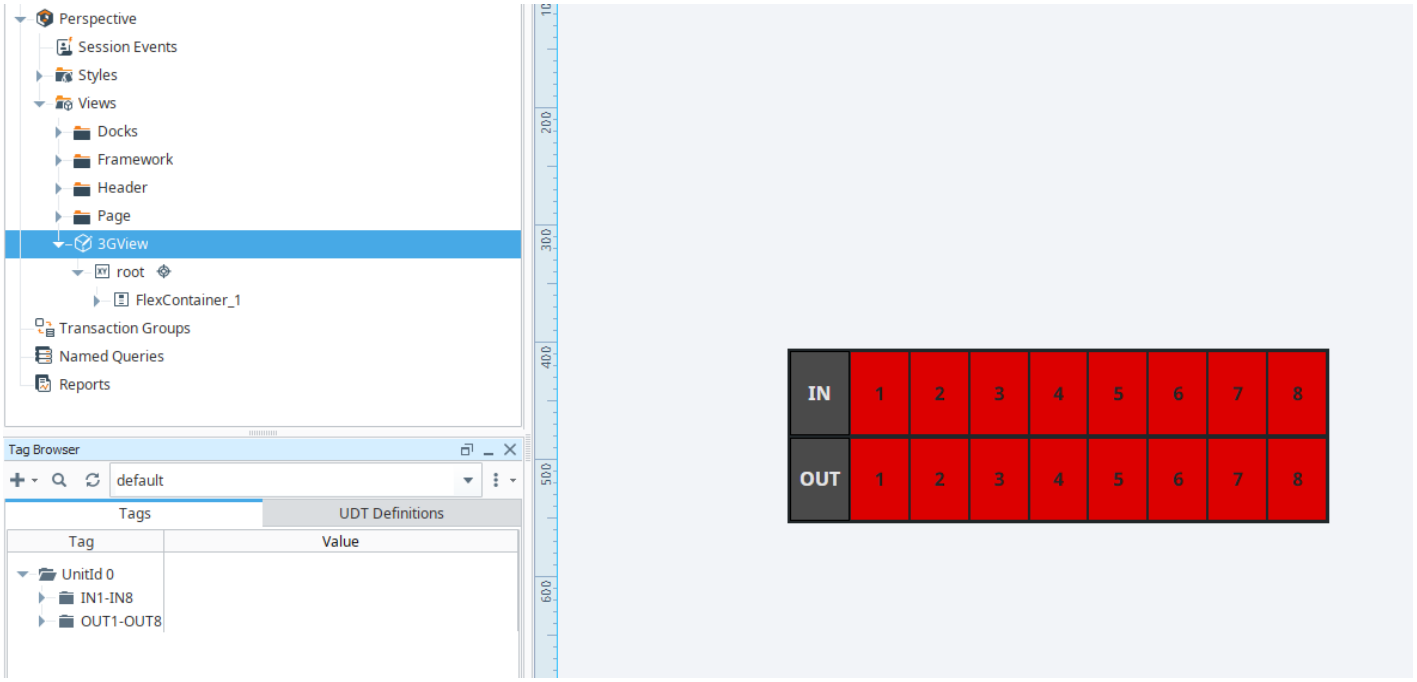


The 3G device is now set up and the tags are available for use in your ignition projects. We have made a basic example view to monitor the IO states in the following project:
https://vitalsystem.com/portal/plc/Ignition_Smart3G_Project.zip

You can import the project from the System->Projects page in the Ignition Config Window:



You can then open the project in the Ignition Designer and find the Smart3G example view at this location:



4.4 S3G-Master/Slave Protocol

The ***Smart-3G*** controller allows expanding the local I/O on the ***Smart-3G*** device by using remote ***Smart-3G*** devices (configured as **Remote I/O**). Up to eight slave ***Smart-3G*** cards can be scanned by the master, providing a total of 72 inputs and 72 outputs. The ladder logic program controls the local I/O as well as access and control remote I/O of ***Smart-3G*** devices using the ***S3G-Master/Slave*** protocol.

The remote ***Smart-3G*** devices must have their **Remote I/O** check box turned **ON**, so they do not run their own ladder program. To enable scanning of remote ***Smart-3G*** device(s), enter the device id (last digit of the IP address) in Control Words 41 thru 48 inside the ladder logic program. The default value is 0, which disables the particular slot of the slave scanner.

The remote I/O is accessed as follows:

Remote Device	Address Control Word	Input File	Output File
#1	41	IN: 9..16	OUT: 9..16
#2	42	IN:17..24	OUT:17..24
#3	43	IN:25..32	OUT:25..32
#4	44	IN:33..40	OUT:33..40
#5	45	IN:41..48	OUT:41..48
#6	46	IN:49..56	OUT:49..56
#7	47	IN:57..64	OUT:57..64
#8	48	IN:65..72	OUT:65..72

For example, to scan device at 192.168.0.88, copy 88 to CW:41. The I/O of device 88 will appear in files IN:9..16 and OUT:9..16.

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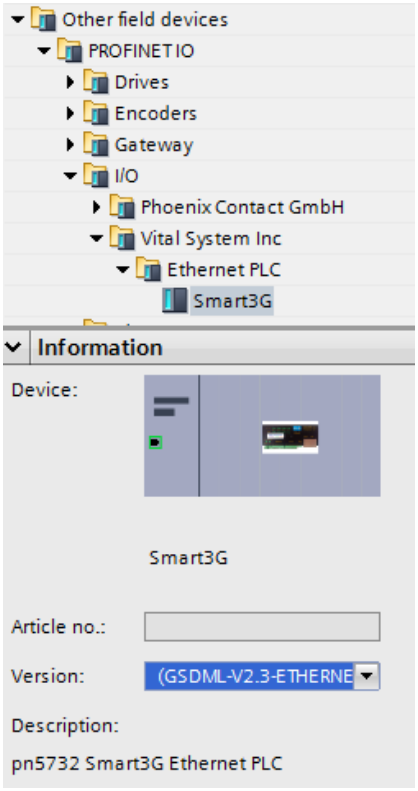
4.5 ProfiNET

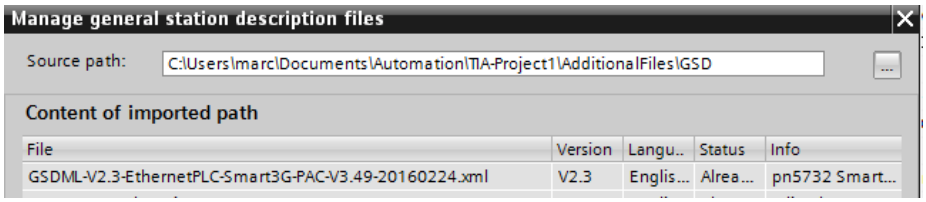
Simatic TIA Setup for Siemens

Import XML Device Profile

The Smart3G ProfiNET Device Profile can be imported into a ProfiNET project by selecting the XML device profile from Vital System Inc.

After successfully importing the Smart3G device profile, it should then be available in the project's Hardware Catalog.



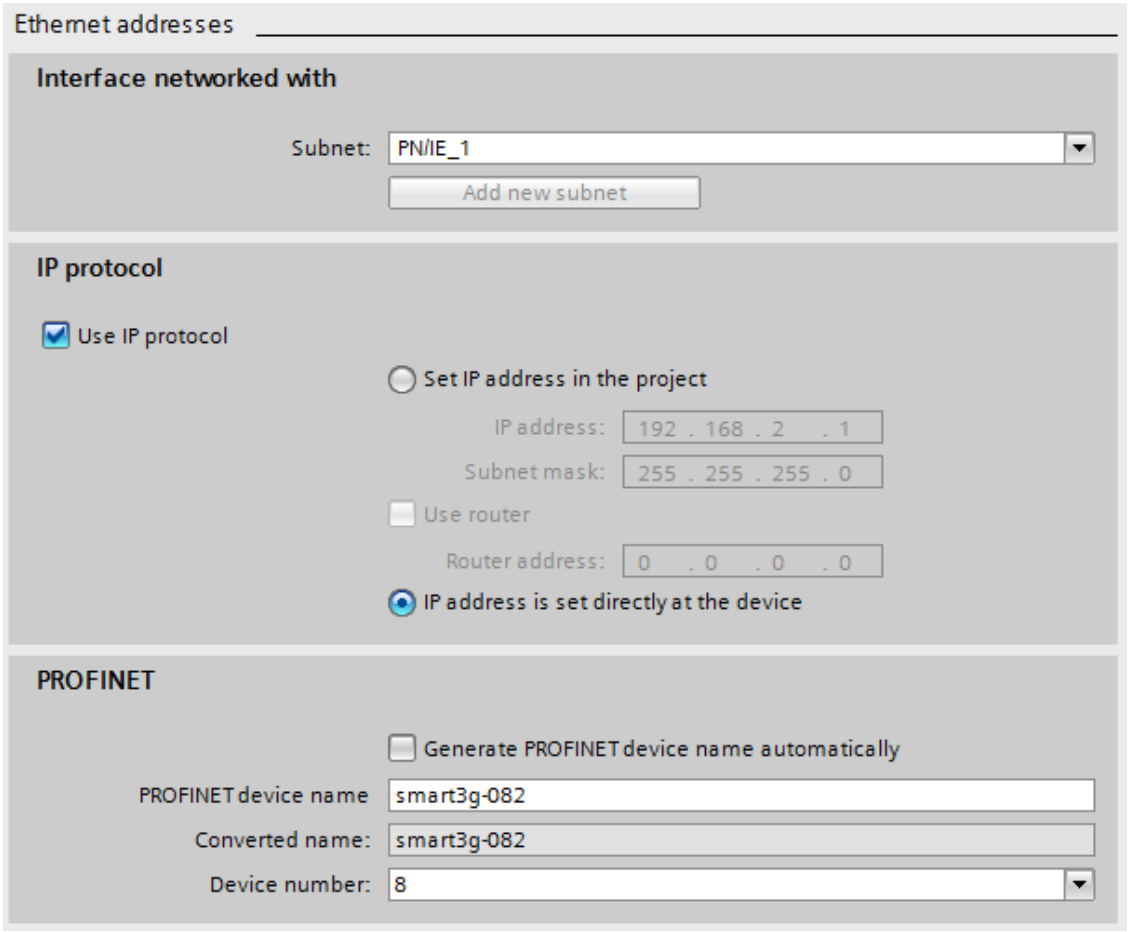


Ethernet Configuration for Profinet

The Smart3G IP address is always specified on the device itself depending on the rotary switch selection.

> **NOTE**: *The IP Address of the Smart3G device cannot be configured via ProfiNET. It can, however, be configured from the Deploy3G or SuperLogic applications.*

The Profinet device name must be set to the text "**smart3g-xxx**", where "**xxx**" is the last octet of the IP Address written in a 3-digit notation. This is also specified by the rotary switch selection.



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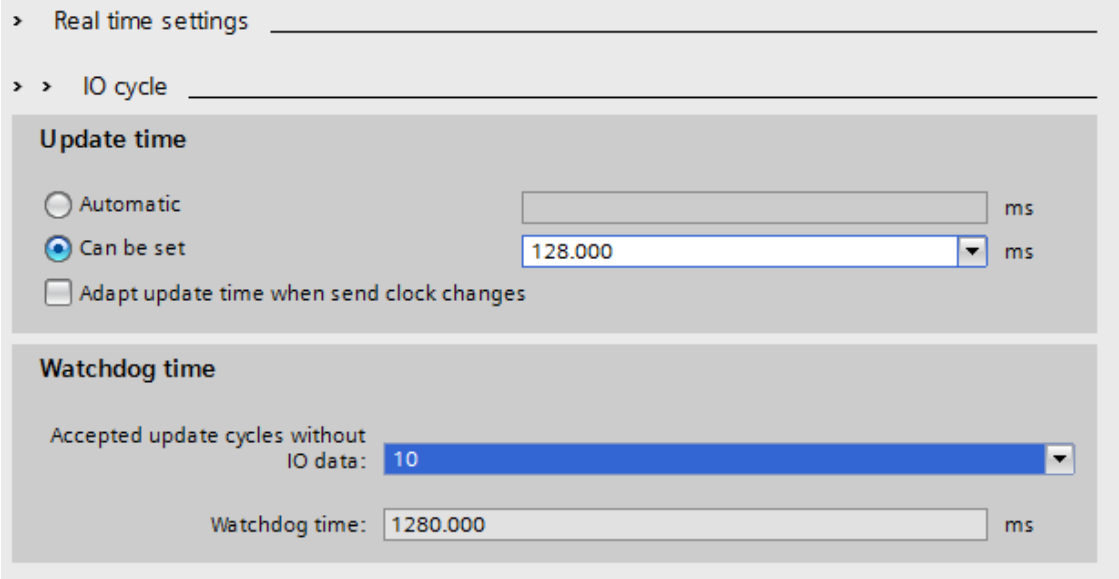
Real Time Settings

These settings control the Smart3G I/O polling rate, and the timeout duration. The polling rate can be set as low as 4 millisecond.



Modules and I/O Data

Slot#	Subslot#	Module	Description
1	1001	Digital I/O	Digital Inputs (1-byte or 8-bits) Digital Outputs (1-byte or 8-bits)
	1002	Status Bits	(16-bits); **Bit0** = *IO Power*; **Bit1** = *RemoteIO*; **Bit2** = *Run Mode*;
	1003	Control Bits	(16-bits); CB:*1 – 6; 9 – 12; 14 – 15; 18 – 19;*
2	1001	CW:01	Read-only Control Word (2-bytes or 16-bits)
	1002	CW:02	Read-only Control Word (2-bytes or 16-bits)
	1003	CW:03	Read-only Control Word (2-bytes or 16-bits)
	1004	CW:04	Read-only Control Word (2-bytes or 16-bits)
	1005	CW:25	Read-only Control Word (2-bytes or 16-bits)
	1006	CW:26	Read-only Control Word (2-bytes or 16-bits)
	1007	CW:27	Read-only Control Word (2-bytes or 16-bits)
3	1001	CW:09	Writable Control Word (2-bytes or 16-bits)
	1002	CW:10	Writable Control Word (2-bytes or 16-bits)
	1003	CW:28	Writable Control Word (2-bytes or 16-bits)
	1004	CW:29	Writable Control Word (2-bytes or 16-bits)
	1005	CW:30	Writable Control Word (2-bytes or 16-bits)

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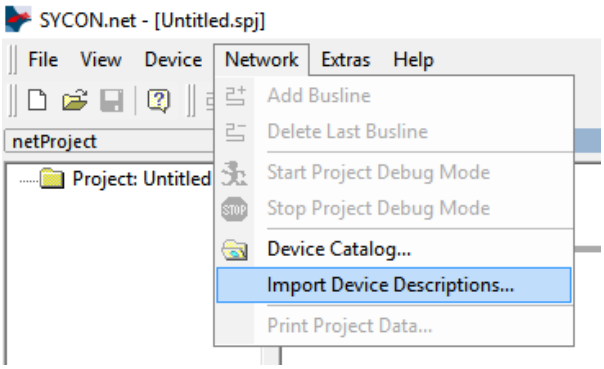
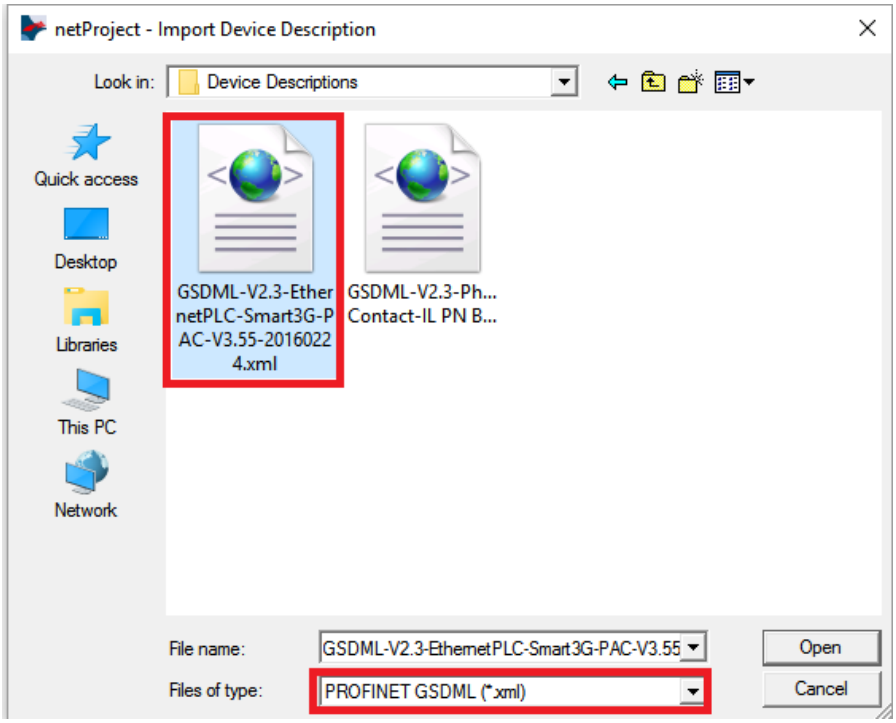
SYCON Setup for Hilscher Profinet I/O Controller

1. Import the Smart3G XML Device Description.





2. Add the Hilscher Profinet I/O Controller on the main bus line. This can be found in the Device Catalog under the "Master" section of "Profinet I/O".

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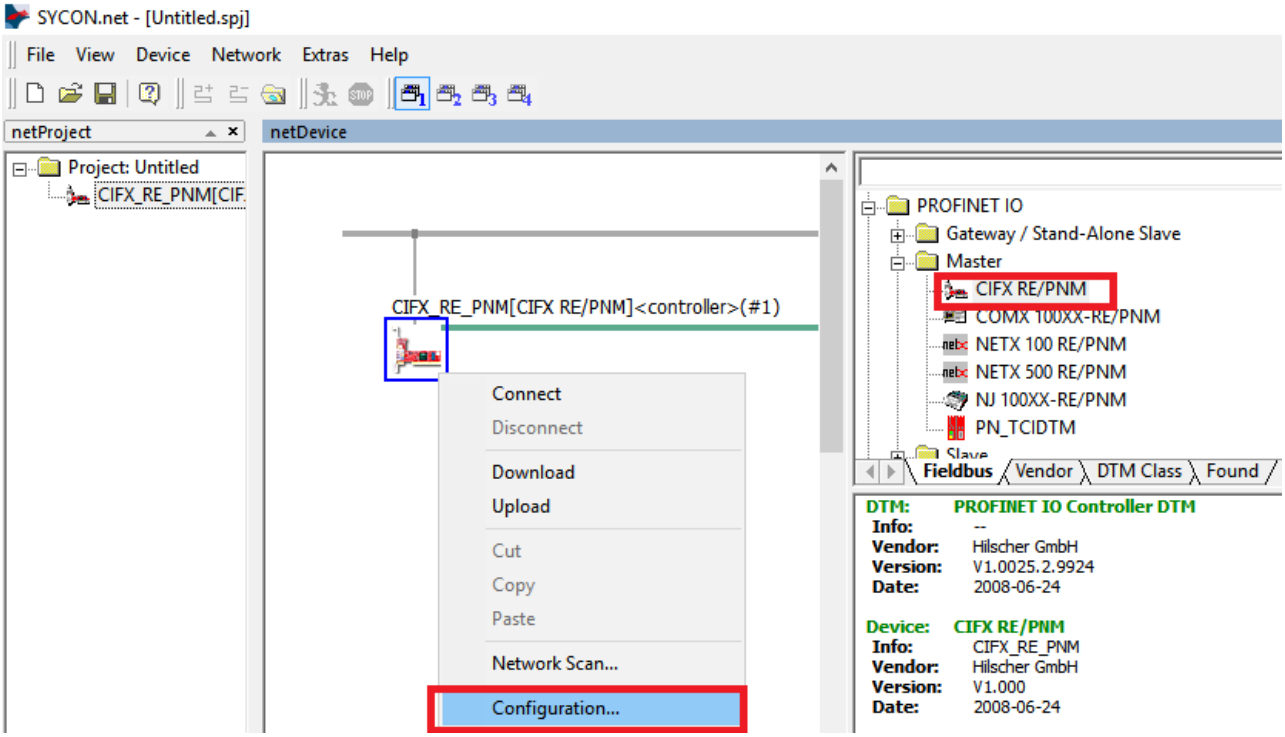
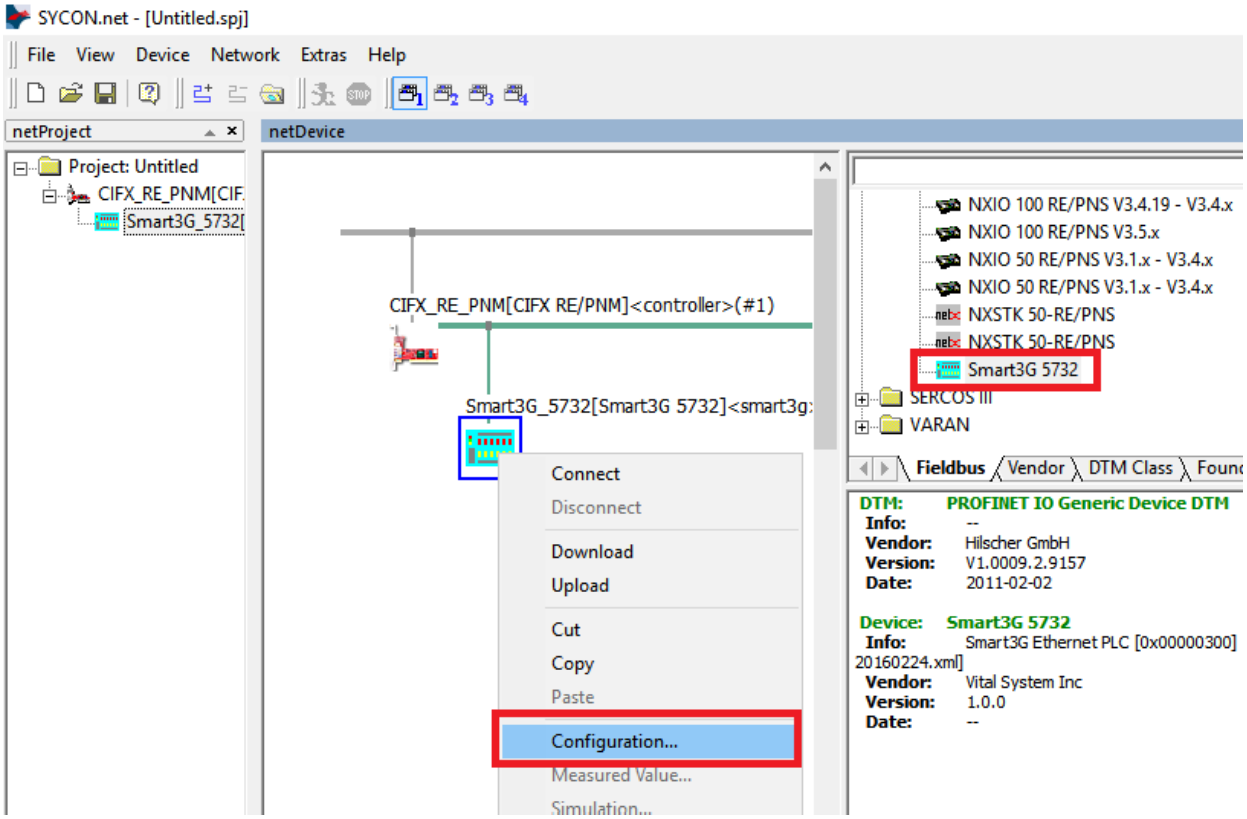


3. Add the Smart3G as a Profinet I/O Device on the Hilscher Controller's bus line. This can be found under the "Slave" section of "Profinet I/O". The Smart3G device can then be configured.



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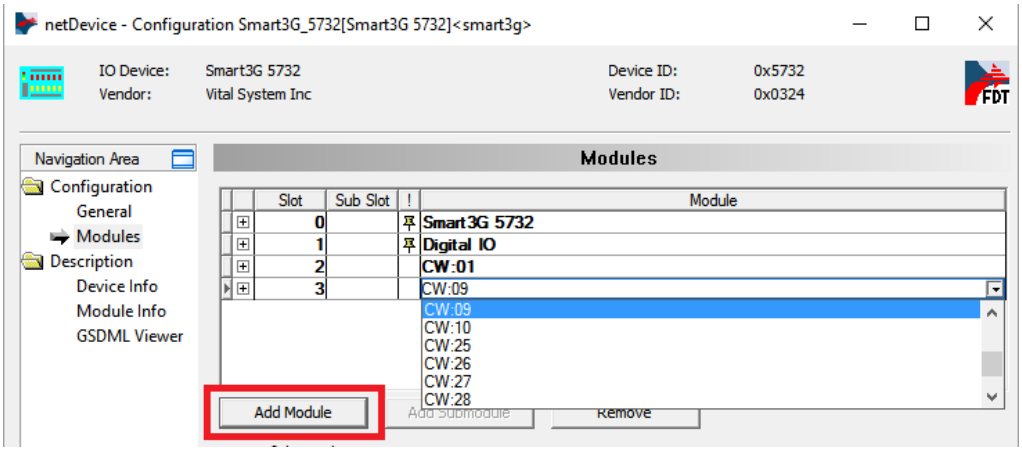
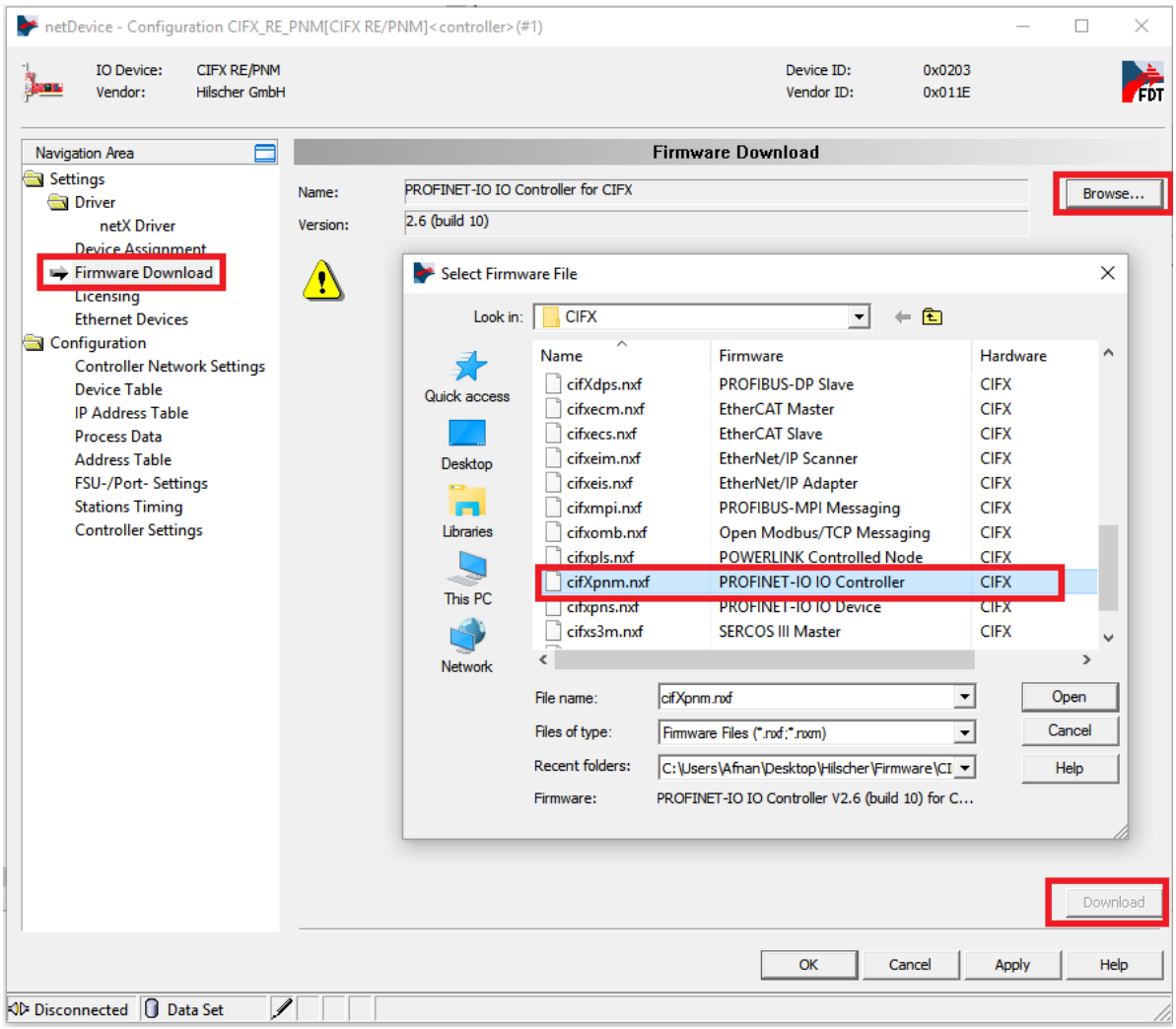
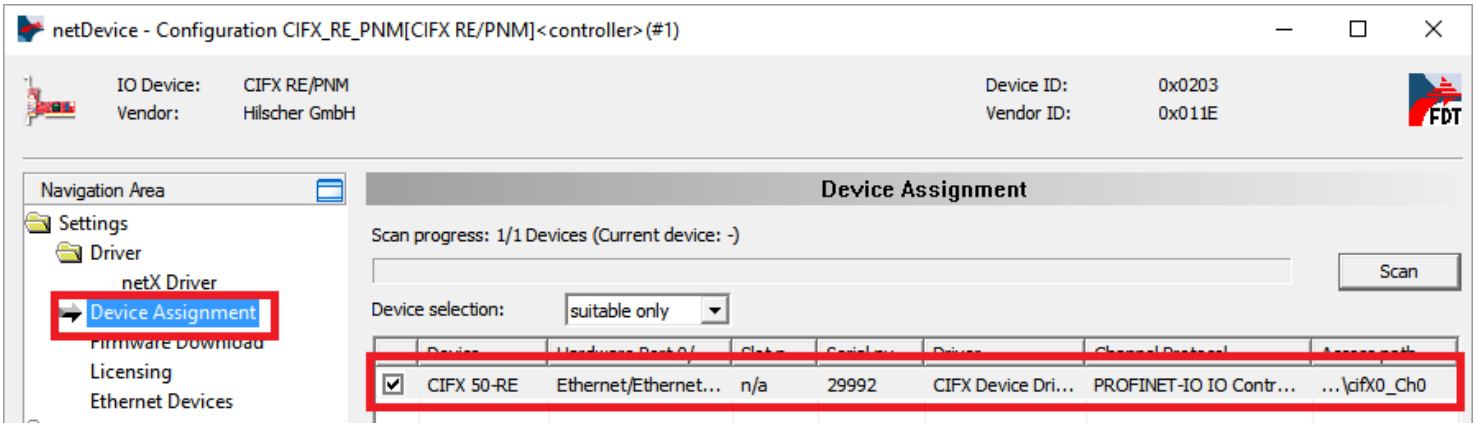
4. In the Smart3G configuration, modules can be added or removed as necessary. Refer to the Profinet Modules section for more information.



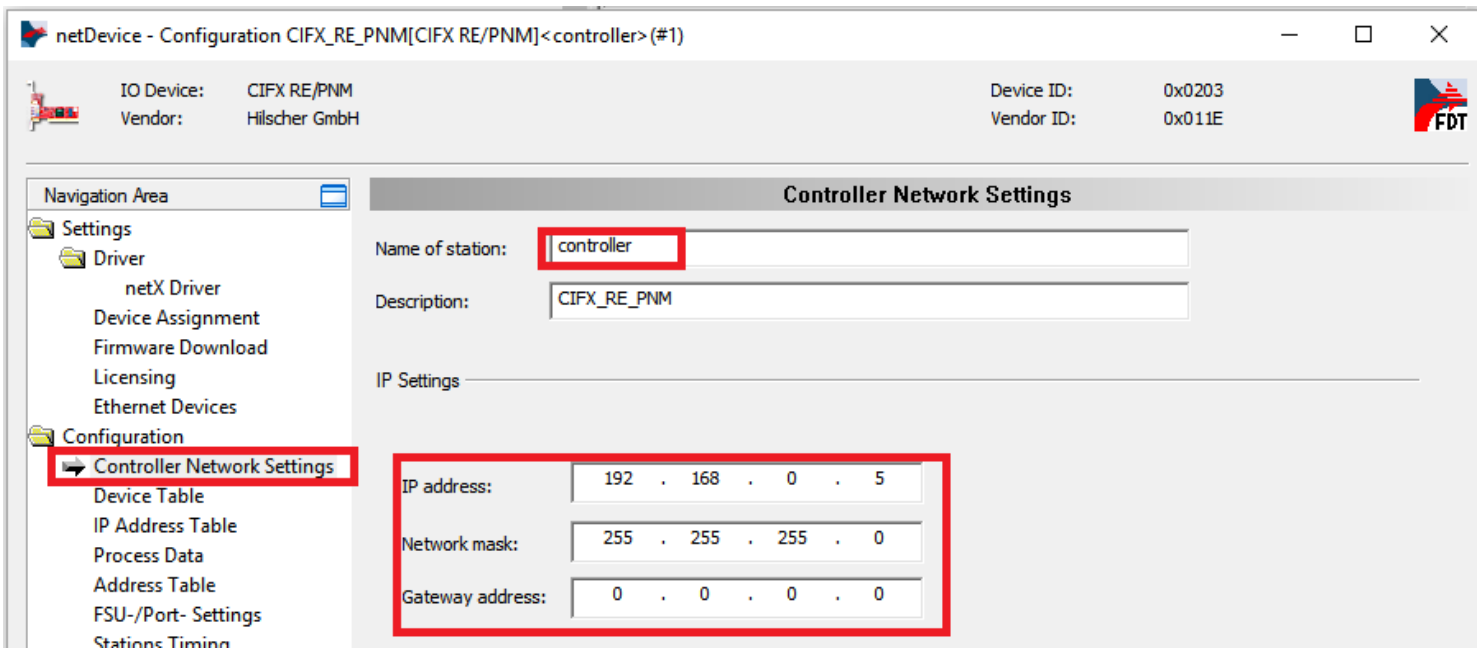
5. In the Hilscher Device Configuration, the firmware for "Profinet I/O Controller" will need to be downloaded to the device. Click on "Download" to set the active firmware.



6. After the successfully downloading the firmware, the Hilscher device will need to be set as the active device from the "Device Assignment" section.



7. Configure the Network settings of the Hilscher Device. Ensure that the Profinet slaves and master are all on the same network.



8. Set Process image storage format to Little Endian for compatibility with other applications. Also Watchdog time can be set to a high value (~2000 millisec) to avoid false disconnects when scanning very high number of devices.

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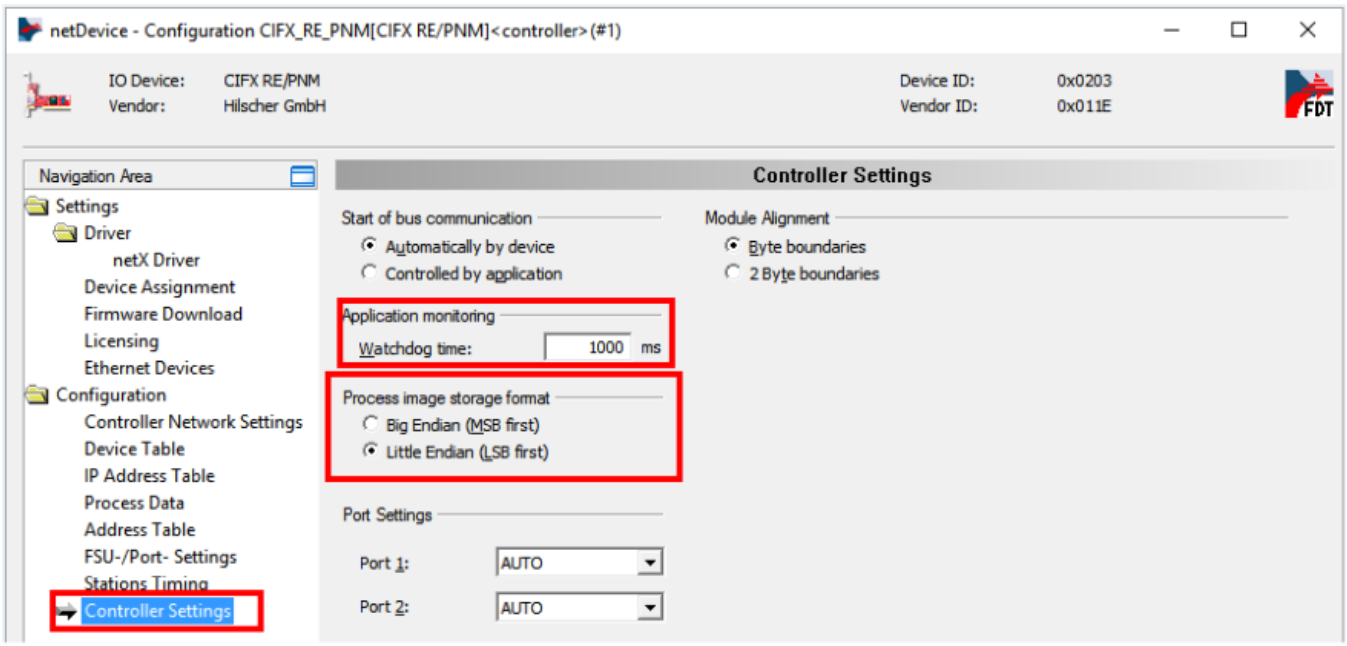
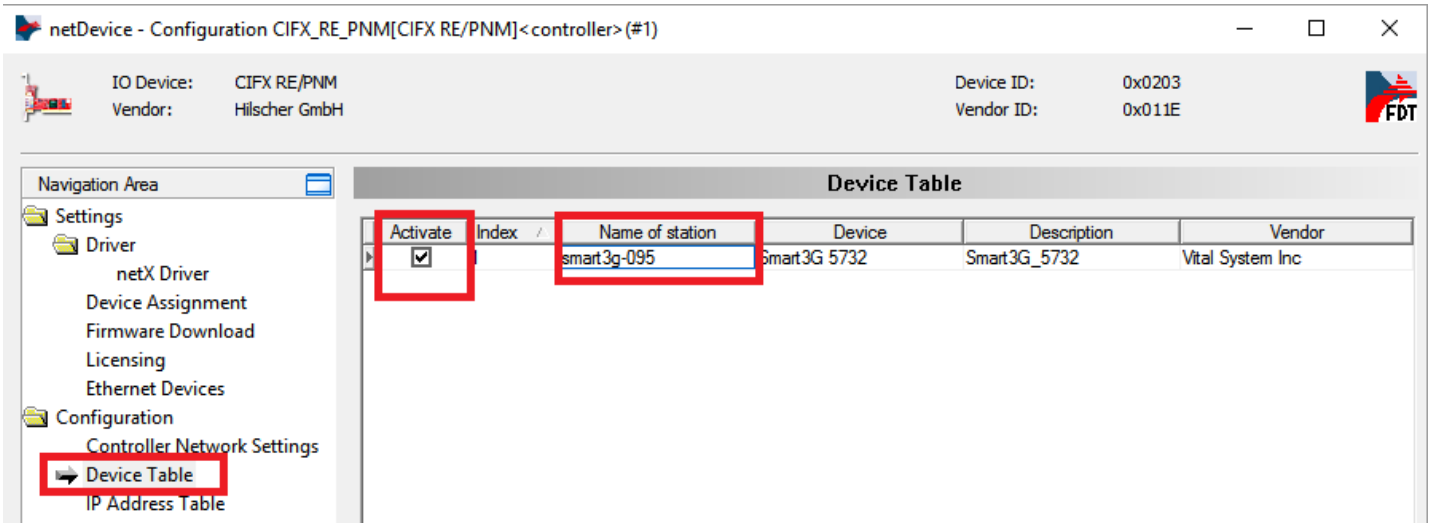
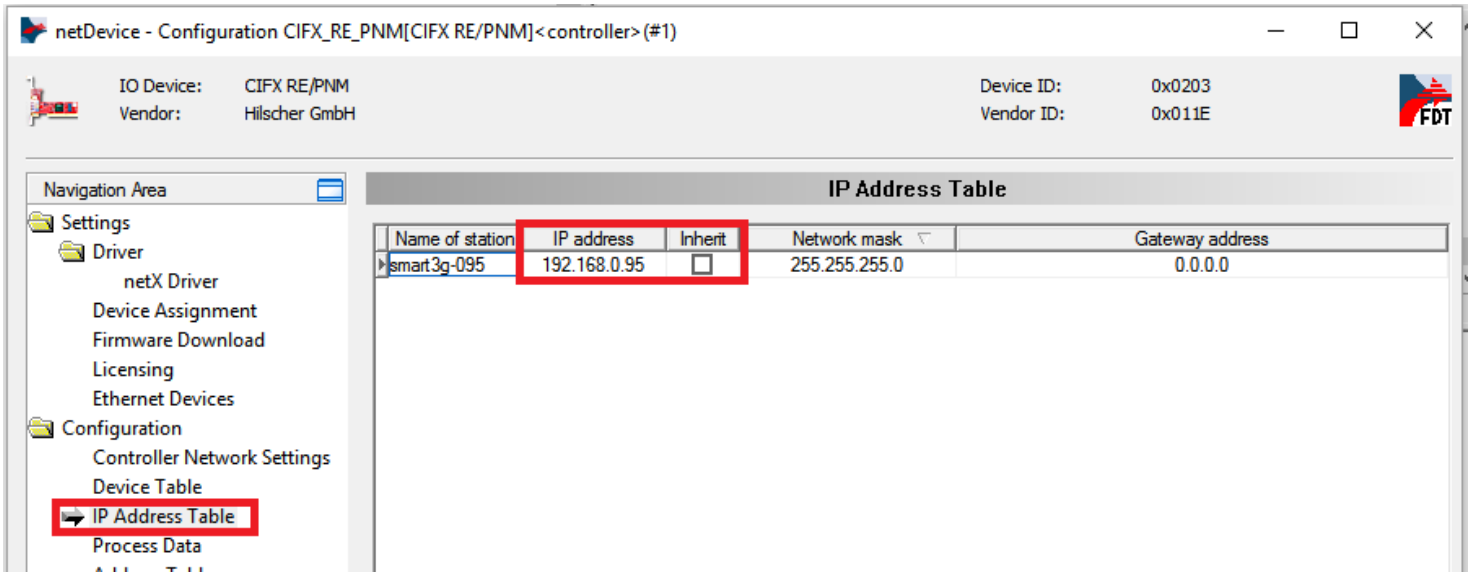


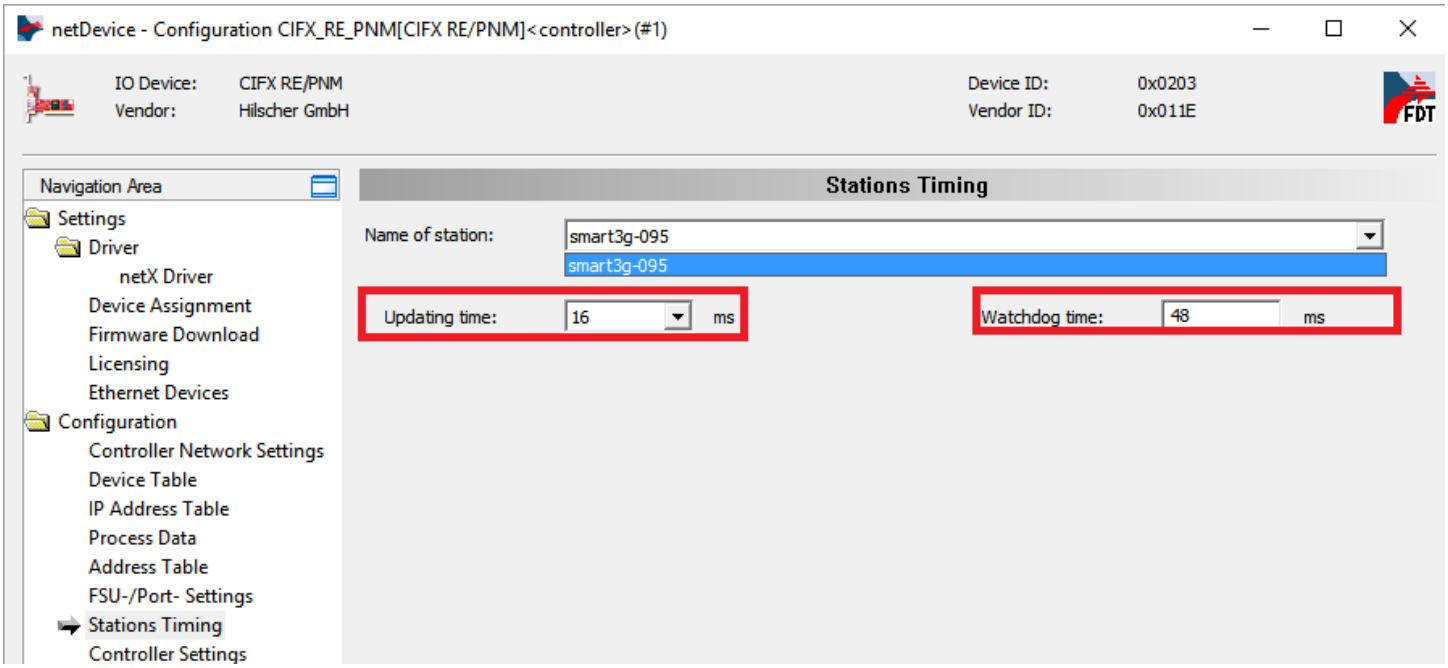
9. Set the Station Name for all Smart3G devices according to their set IP Address. See this section on how to set the proper station name.



10. Set the IP Address for each Smart3G device to its set IP Address. Uncheck the "Inherit" setting to prevent the Hilscher device from setting the Smart3G IP Address.



11. Configure the "Update Time" which controls the data exchange interval, and the "Watchdog Time" which controls the connection timeout.



12. After hitting "OK", the configuration can then be downloaded to the Hilscher Device in order to initiate the Profinet Network operation.

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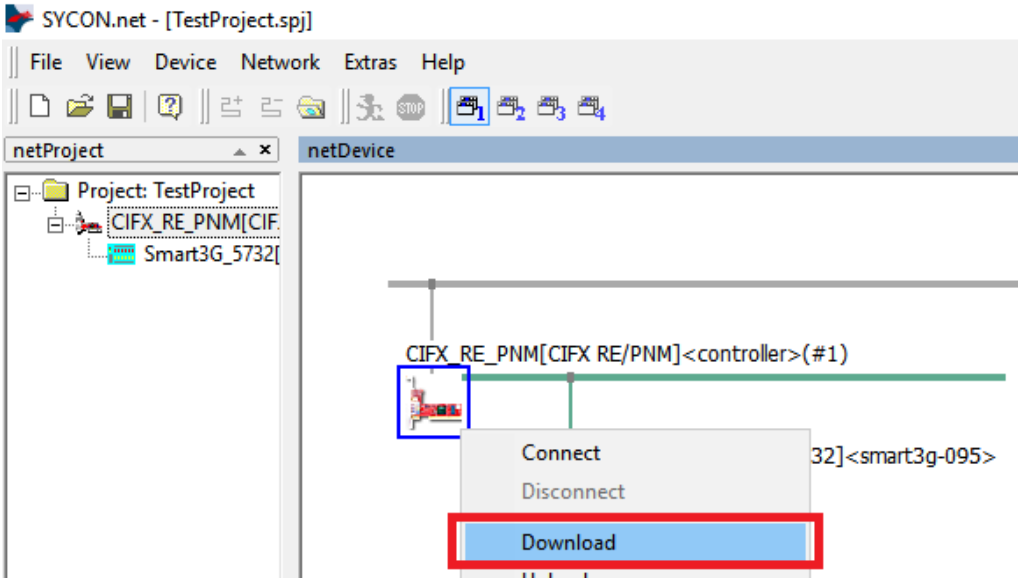

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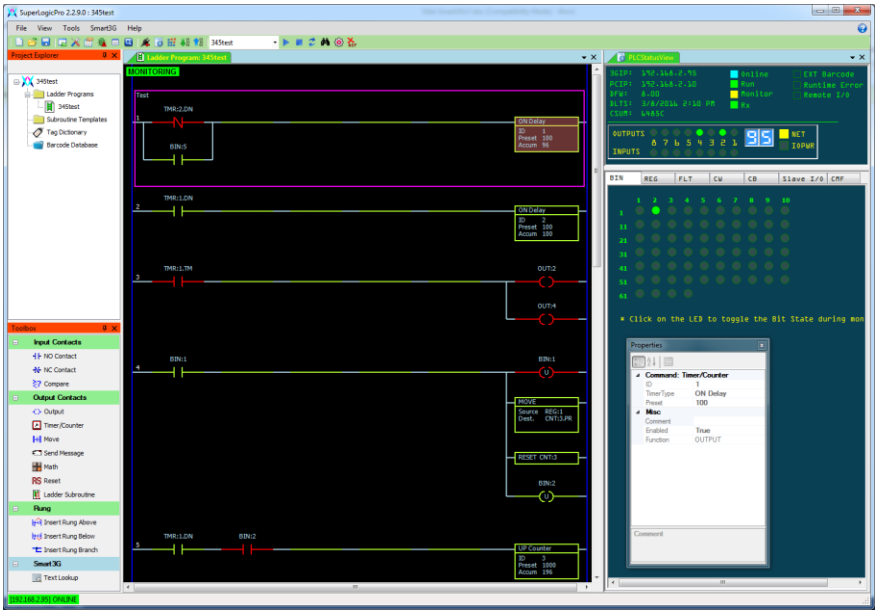
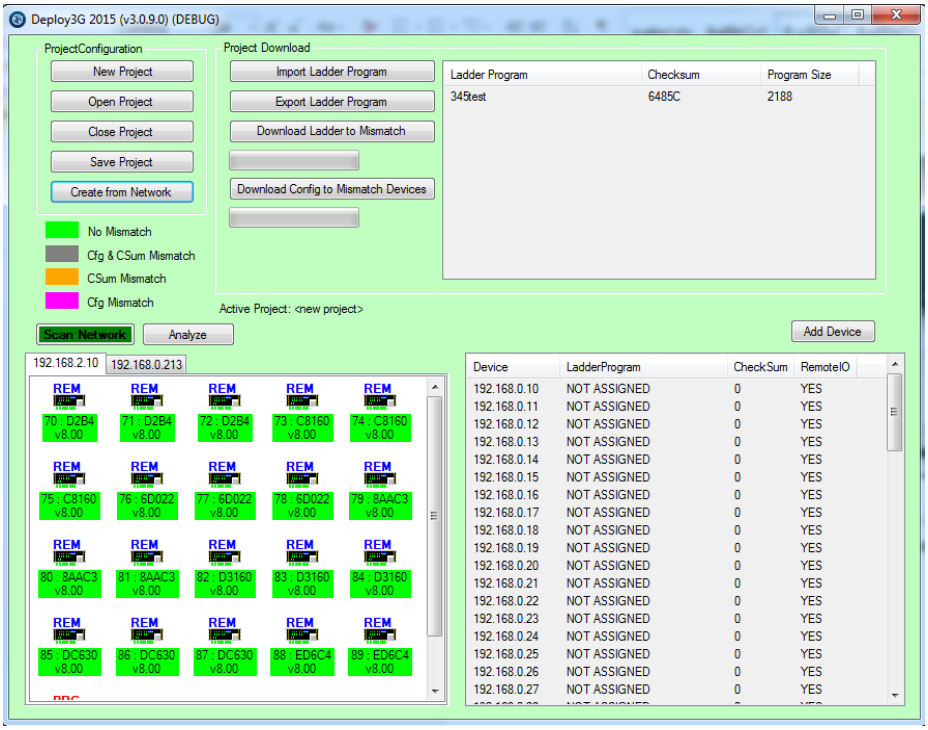
5. Programming and Configuring Smart-3G Devices

The Programming and configuration of Smart-3G devices is accomplished by the SuperLogic and Deploy3G PC software. SuperLogic software allows editing, downloading, monitoring/debugging of the ladder logic program. The configuration window in this program allows editing the IP address and other parameters of the device. Please refer to the SuperLogic Software manual for more detail.



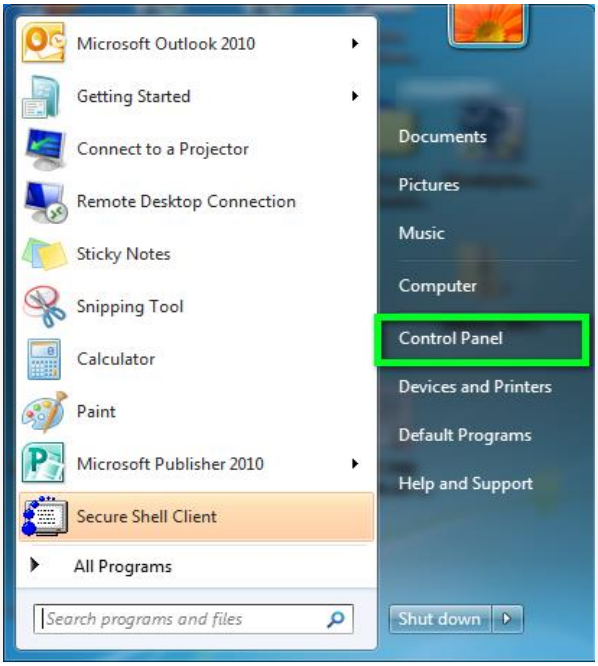
Deploy3G PC software is used to program and configure systems with multiple Smart3G cards. It maintains a database of ladder programs and device configurations for the entire project.



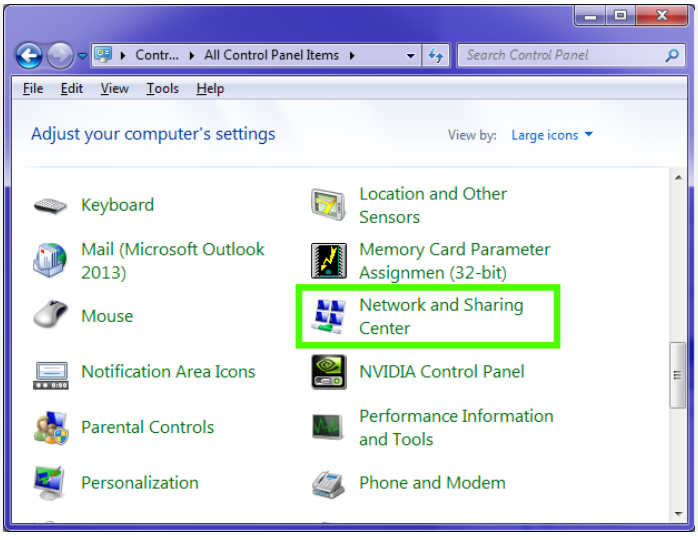
Deploy/Superlogic Required Setup Steps

In order to connect a Smart3G card to either Deploy3G or Superlogic, you must set the IP address of the computer's Ethernet Adapter to match the target network for the 3G cards. Here are step-by-step instructions on how to do this:

Click the **Start** menu. Next, click on the **Control Panel** option.



Click on the **Network and Sharing Center** option.



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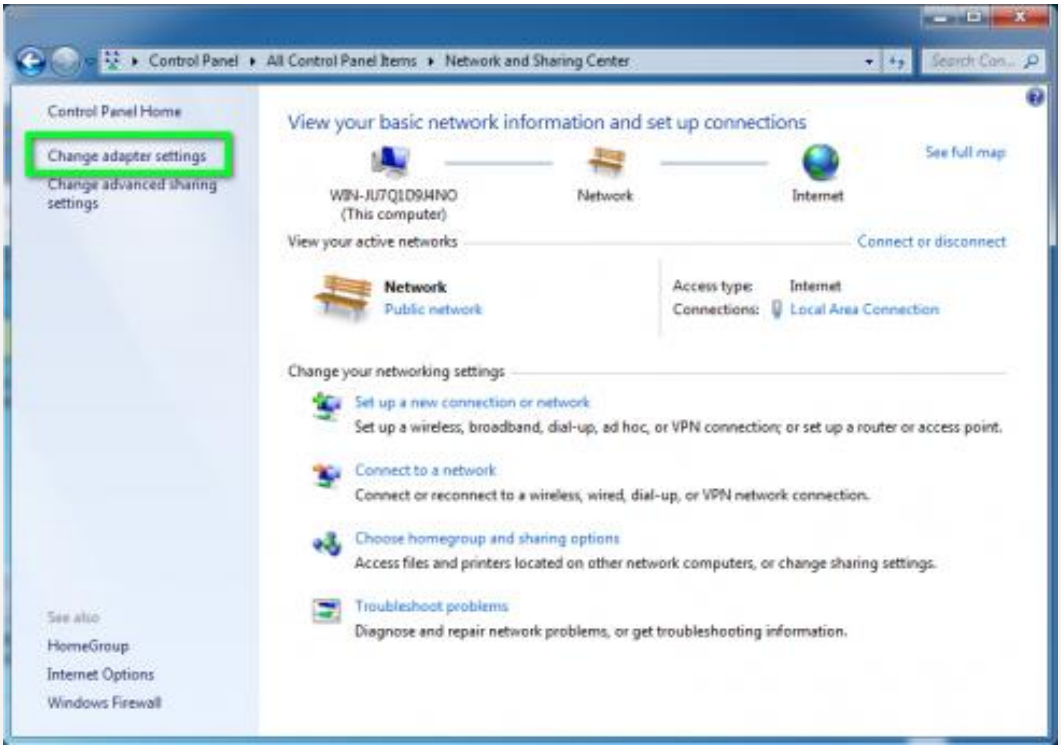
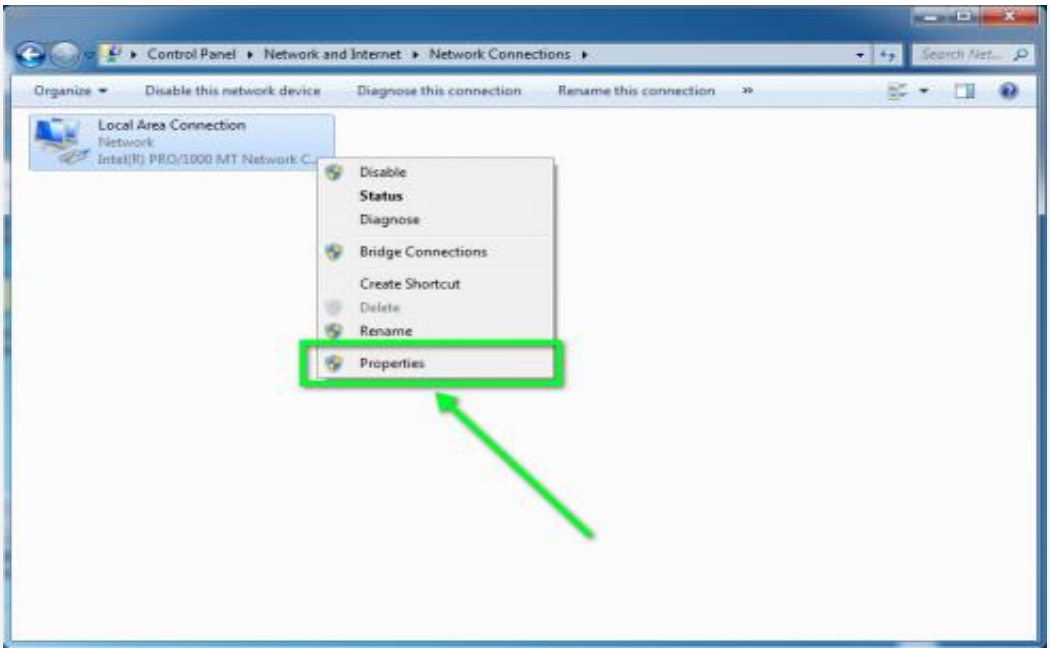
Click on **Change adapter settings** from the left side menu.



Right-click on the **Local Area Connection** icon, then select **Properties** (there may be multiple. Select the one that corresponds to your Smart3G device).



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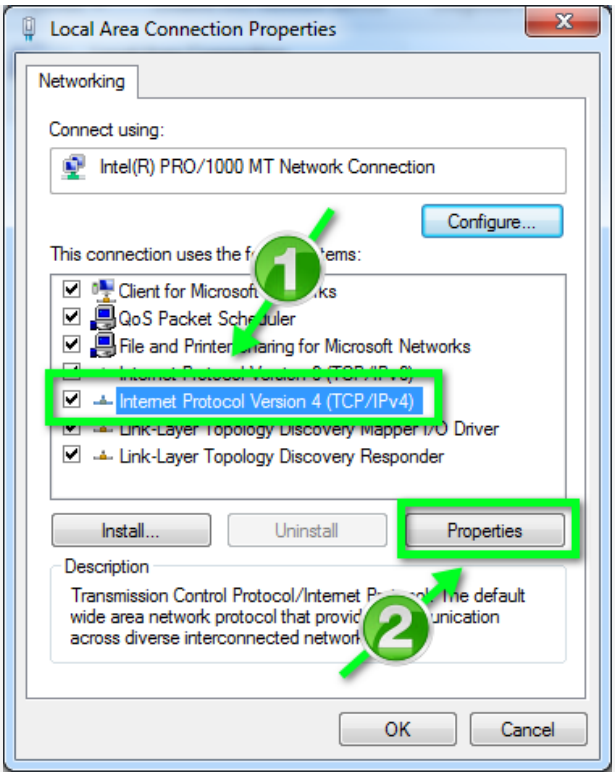
In the window that opens, click on **Internet Protocol Version 4 (TCP/IPv4)** (you may need to scroll down to find it). Next, click on the **Properties** button.



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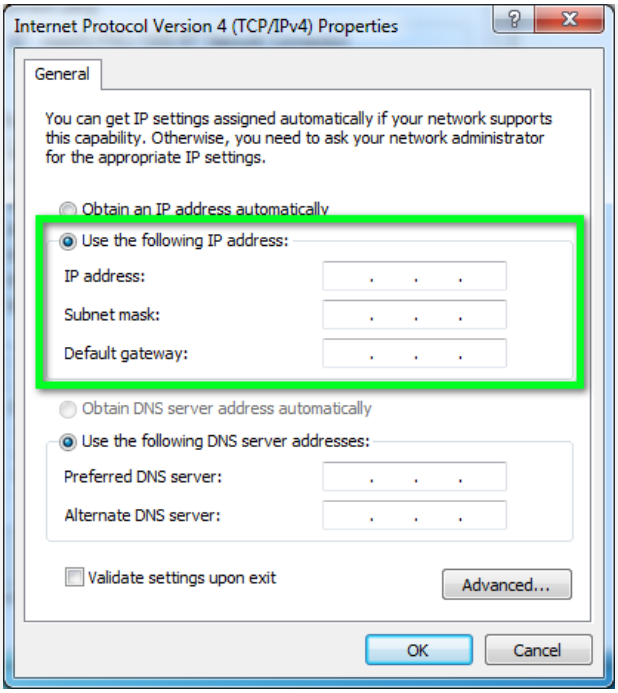
In the window that opens, click the 'Use the following IP address' radio button. In the IP address and Subnet Mask boxes, enter your target network IP and subnet mask (Smart3G Default is 192.168.0.xxx and 255.255.0.0). Leave both the Gateway and DNS server settings blank.



Click OK to save the setting. After a few seconds, click scan in Deploy3G. Your Smart3G device should appear. If it does not appear, the Smart3G device may have an incorrect IP address. To fix this:

1. Confirm that there is only 1 Smart3G device on the network (these steps will affect the whole network)
2. Confirm that you have the above Adapter IP and Subnet settings set correctly.
3. In Deploy3G, right click the white area of the Network Devices box, and select Auto-Configure.
4. The Smart3G device should now be on the correct network, and should appear when you click scan.

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6. Control Word File

The Control Word file is a 16-bit integer file. The ladder logic program can read and write any Control Word using the CW:n syntax, although some Control Words are read only as mentioned in the following table. ***Device ID is the last digit of the IP address***. Modbus/TCP can read any control word and write is allowed to only certain control words. Ethernet/IP can read/write certain locations only.

File Index	Description
CW:1,2	Data is transmitted to master in Ethernet/IP or Profinet poll. Can be used to transmit status info to master.
CW:3,4,5	Reserved
CW:6	Merge Device ID (Read Only)
CW:7	Divert 1 Device ID (Read Only)
CW:8	Divert 2 Device ID (Read Only)
CW:9, 10	Profinet, Ethernet/IP or Modbus/TCP – Data Write from Master
CW:11	Local Device ID
CW:12	Downstream Device ID
CW:13	Upstream Device ID
CW:14	Master/Slave Protocol Scan List Status. Bits 0…7 indicate online status for each device. Bits 8…15 indicate Output Power Status.
CW:15	User Defined. This value is read from the SuperLogic Zone Count configuration parameter. (Read Only).
CW:16	Ladder Logic Transmit Message Destination Device ID
CW:17…22	Ladder Logic Transmit Message Data. Each control word can have value of 0 thru 255.
CW:23, 24	Special Definition for ***Modbus/TCP Holding Register*** Read CW:23 = Read 8 Inputs (Bit 0..7) and new serial port data bit (Bit 15) Read CW:24 = Read 8 Outputs (Bit 0..7) and Output Enable Bit (Bit 15) Write CW:23 = Write to CW:23 Write CW:24 = Write to CW:24, or Write directly to output pins if Remote I/O Checkbox is checked.
CW:25…30	Ladder Logic Receive Message Data. Each control word can have value of 0 thru 255.
CW:31…40	Serial Data Received from Serial Port. Must be terminated by carriage return or Line feed.
CW:41…48	Device IDs for remote (slave) ***Smart-3G*** controllers. Used to enable slave device scanning for the S3G Master/Slave protocol. Value of 0 disables scanning.
CW:49..56	Input / Output data for slave devices for S3G protocol. Bit 0…7 are inputs and bits 8…15 are outputs. This data is also accessible using the IN/OUT file, eg IN:55, OUT:71 etc.

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7. Control Bit File

The Control bit file is a binary file. This file is used to pass status and control data between the user ladder logic program and the firmware. Some locations of this file are read only.

File Index	Description
CB:1	Package Arriving from Merge Branch. (Input, Read Only)
CB:2	Merge Ready Status to Branch (Output, Read / Write)
CB:3	Package Available for Divert Branch 1. (Output, Read / Write)
CB:4	Divert Branch 1 is Ready (Input, Read Only)
CB:5	Package Available for Divert Branch 2. (Output, Read / Write)
CB:6	Divert Branch 2 is Ready (Input, Read Only)
CB:7	FIFO is Empty (Read Only)
CB:8	FIFO is FULL (Read Only)
CB:9	Output Power On (Read Only)
CB:10	New Barcode Received (Read / Write)
CB:11	Package Available Status to Downstream main line (Output, Read / Write)
CB:12	Ready to Take Packages from Upstream main line (Output, Read / Write)
CB:13	Reserved
CB:14	Slug(0) or Singulation(1). Set in the SuperLogic PC Software Configuration screen. (Read Only for Ladder program). This bit indicates how the packages are released. Implementation of release mode is done by the user ladder program. If release mode selection is not supported by the ladder program, this bit can be used for any other configuration selection.
CB:15	Barcode Overrun. This control bit activates when a new barcode is received while CB:10 is still in the active state. In this case, the newly scanned barcode is ignored. CB:10 must be deactivated in order to indicate that the current barcode scan may be overwritten with a newer scan.
CB:16	Reserved
CB:17	Reserved
CB:18	Package Available from Upstream main line. (Input, Read Only)
CB:19	Downstream main line is ready to take packages. (Input, Read Only)
CB:20	ProfiNET Active. This control bit is activated when a ProfiNET connection is currently online and actively transmitting I/O data.

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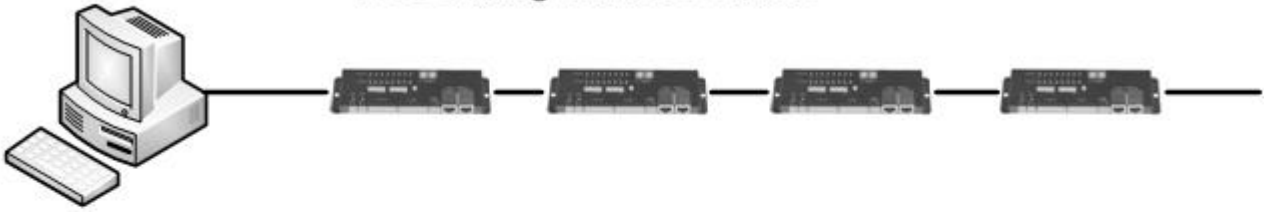
8. Smart-3G Network Topology Examples

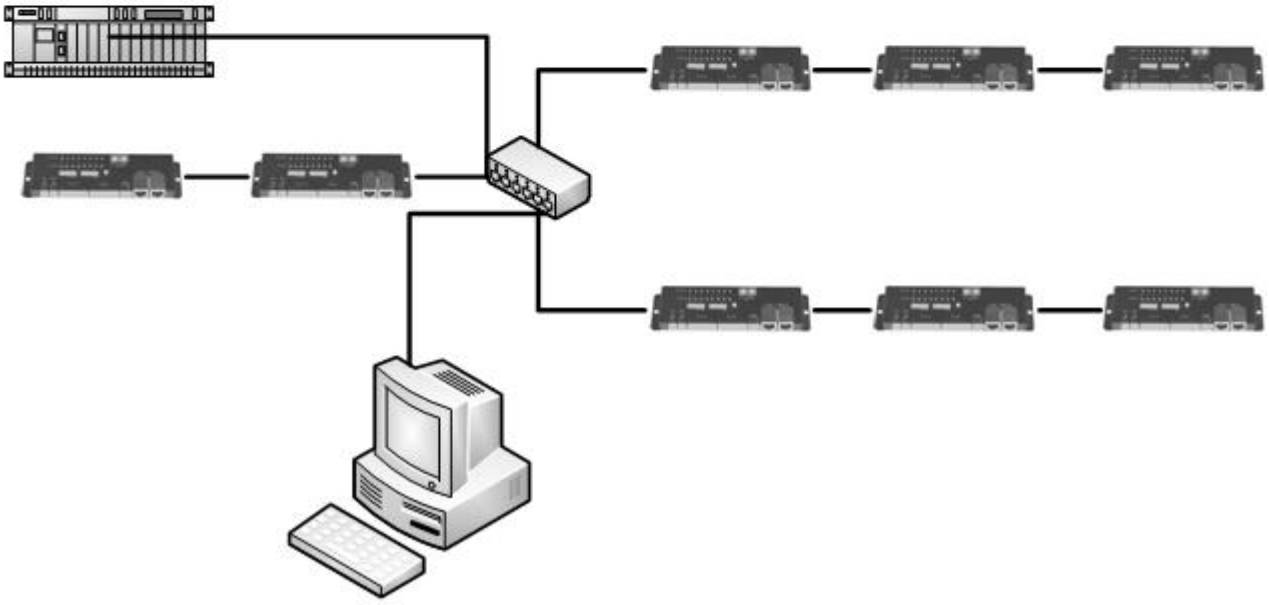
Master PLC Scanning eNetPLC Devices

PC Scanning eNetPLC Devices



Master eNetPLC Scanning Slaved eNetPLC Devices

Multi-Master Scanning eNetPLC Sub Systems



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