



Machine Ethernet Network Specification

Global Common

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Table of Contents

1. Scope.....	4
2. Purpose	4
3. Ethernet Network Media	4
4. Ethernet Cable Installation.....	6
5. Network Topology	7
6. Ethernet Switch Hardware	10
7. Ethernet Switch Configuration	11
8. Programmable Controller Configuration	13
A. Annex A - Definitions	15
B. Annex B - Electromagnetic Compatibility Table	17
C. Annex C - Example Machine Networks.....	18
D. Annex D - References.....	26

List of Figures

Figure 1: Stranded vs Solid Core Ethernet Cable..... 4

Figure 2: Bulkhead Connector..... 5

Figure 3: VELCRO Cable Ties 7

Figure 4: Maximum of Two Switches Between PLC and Device..... 8

Figure 5: Linear (Embedded Switch) Topology 8

Figure 6: Linear (Embedded Switch) Topology - NOT ALLOWED 8

Figure 7: Kinetix Drive Connection to CompactLogix A2 Port..... 9

Figure 8: Example Manufacturing IT Network and PLC Connections..... 10

Figure 9: Switch Express Setup 11

Figure 10: PTP Traffic Disabled on Port Gi1/1 12

Figure 11: Switch Configuration in Drawings..... 13

Figure 12: Time Synchronization..... 13

Figure 13: EtherNet/IP Mode..... 13

Figure 14: Basic Non-CIP Sync Network 18

Figure 16: CompactLogix CIP Sync Application..... 19

Figure 17: ControlLogix CIP Sync Application..... 20

Figure 18: ControlLogix CIP Application with Multiple Stations 21

Figure 19: ControlLogix Remote CIP Sync Application with Multiple Stations 22

Figure 20: ControlLogix Segmented Network..... 23

Figure 21: LabVIEW Test Machine – Standalone 24

Figure 22: LabVIEW Test Machine Integrated with Assembly Line 25

1. Scope

- 1.1 This specification addresses the use of networking media, devices, and design as applied to machine Ethernet networks of Industrial Equipment and systems used in processing or manufacturing at Nexteer Automotive.
- 1.2 This specification is intended to document and illustrate basic principles of well-designed machine Ethernet networks. It should not be considered as the sole source of network media and design information for all applications. Additional information on network media and design is available from device suppliers, seminars, and standards.

2. Purpose

- 2.1 This specification applies to the purchase of new equipment and control system rebuilds. It should not be implied that any existing equipment be required to be retrofitted in order to comply with this specification, however, this specification does apply to network performance issues driven by evaluations performed on existing equipment.
- 2.2 Each application is unique, and in all cases good engineering practices should be used. For network device applications and designs not explicitly covered in this specification the principles established in this specification should be followed. The supplier must work closely with the device manufacturers and consult with the Nexteer Controls Engineer as needed for each application.
- 2.3 The use of the word “shall” indicate requirements and the use of the word “should” indicates recommendations. The use of the word “may” indicate permission or allowance and the use of the word “can” indicates a possibility.
- 2.4 The supplier has the responsibility to ensure that all local and national regulations, as well as, manufacturer’s recommendations relating to the use of this specification in any application are satisfied.

3. Ethernet Network Media

3.1 Data Rate Requirements

- 3.1.1 The machine Ethernet network communication data rate shall be a minimum of 100Mb/s.
- 3.1.2 The programmable controller and manufacturing IT network connection communication data rate shall be capable of a minimum of 1Gb/s.

3.2 Cable Requirements

- 3.2.1 Stranded copper conductor Ethernet patch cables are required for connecting all devices on the machine network. Solid core Ethernet cabling shall not be used.



Figure 1: Stranded vs Solid Core Ethernet Cable

3.2.2 Ethernet patch cables shall be purchased from cable manufacturers, ensuring the cable and its molded connectors have been tested and meet required standards.

Note: Due to the unpredictability of connector performance degradation as a result of an improperly terminated cable, crimp-on modular connectors are not allowed.

3.2.3 Ethernet cable shall have a minimum performance rating of Category 5e.

3.2.4 Ethernet cabling shall be shielded twisted pair (STP).

3.2.5 Ethernet cable insulation shall be rated for a minimum of 75°C.

3.2.6 Ethernet cable insulation shall be rated for a minimum of 600VAC.

3.2.7 The following Ethernet cable jacket types are allowed and preferred. The jacket type selected shall be suitable for the operating conditions.

- PVC – Stationary applications
- TPE, PUR – Flexible applications

3.2.8 Ethernet cabling installed on open cable tray shall be type CMP, CMR, CMG or CM tray rated communication cable or equivalent.

3.2.9 Ethernet cabling shall be rated for high flex applications where the cable will flex or move during the operation of the machine.

Note: Cable track or robot installations are common applications requiring high flex rated cabling.

3.2.10 Ethernet cable lengths shall not exceed 100m (328ft).

3.3 Connector Requirements

3.3.1 Ethernet connectors shall have a minimum performance rating of Category 5e.

3.3.2 Ethernet connections for In-Cabinet environments should utilize RJ45 connectors.

3.3.3 Ethernet connections for On-Machine environments shall utilize M12 pre-molded connectors rated a minimum of IP65.

Exception: RJ45 connectors rated a minimum of IP65, with a latching mechanism, are allowed.

3.3.4 Transitions between In-Cabinet and On-Machine environments shall be made using cable entry solutions or Ethernet bulkhead connectors. The transition solution shall maintain the IP rating of the enclosure.

Note: Cable entry solutions are preferred to limit the number of Ethernet connectors in the cabling between two devices.



Figure 2: Bulkhead Connector

3.3.5 Shielded twisted pair (STP) Ethernet cable grounding shall be maintained through the cable and connectors. This includes bulkhead connectors, when used.

3.3.6 Single channel of Ethernet cabling between two devices shall not exceed four connectors, in order to maintain the Category 5e performance rating.

Note: A plug to port bulkhead may be counted as one connector and a back to back port bulkhead may be counted as one connector.

4. Ethernet Cable Installation

4.1 Ethernet cable shall be routed and grouped based on the EMC2 category in the Electromagnetic Compatibility table in Annex B. This includes routing inside an enclosure, raceway, wire duct, cable tray, conduit, or physically on the machine.

4.2 Cable Routing

4.2.1 Ethernet cables routed **INSIDE** of an enclosure shall be separated from Category EMC1 conductors and shall have the following minimum distance of separation:

- 80 mm (3 in) – EMC1 conductors (AC power lines, high power digital AC I/O, high power digital I/O and power connections (connectors) from motion drives of less than 20 amps)
- 150 mm (6 in.) – AC power lines of 20 amps or more

Exception: Termination points (for conductors of different EMC categories) on a device are closer together than the specified spacing.

4.2.2 Ethernet cables routed **OUTSIDE** of an enclosure shall be separated from Category EMC1 conductors with the following minimum distance of separation:

- 150 mm (6 in) – EMC1 conductors (AC power lines, high power digital AC I/O, high power digital I/O and power connections (connectors) from motion drives of less than 20 amps)
- 300 mm (12 in.) – AC power lines of 20 amps or more

Exception: Termination points (for conductors of different EMC categories) on a device are closer together than the specified spacing.

Exception: Suitable metal barriers may be used to reduce the minimum separation requirements listed above. The barrier shall be electrically bonded to protective earth.

4.2.3 Ethernet cables may be routed with Category EMC2 and EMC3 conductors with no separation requirements.

4.2.4 If an Ethernet cable must cross Category EMC1 conductors, it shall be at a 90-degree angle.

4.2.5 Ethernet cable bend radius shall follow manufacturer's specifications. The cable bend radius for stationary applications shall not be less than 25 mm (1 in), and flexing applications shall not be less than 75 mm (3 in).

4.2.6 Excess Ethernet cable lengths should be limited to less than 3 m (10 ft).

4.2.7 Excess Ethernet cable routed **INSIDE** of an enclosure shall be coiled at the bottom or side of the enclosure and not inside of wire ducts.

Note: All excess Ethernet cable should be pulled into an enclosure when not using bulkhead connections to enter the enclosure.

4.2.8 Excess Ethernet cable routed **OUTSIDE** of an enclosure shall be coiled near the enclosure or device to avoid damage. Excess cable shall be coiled and secured to the machine structure and not resting on the factory floor or walkway.

4.3 Cable Support

- 4.3.1 Ethernet Cable shall be appropriately supported every 450 mm (18 in) when suspended in a non-vertical run.
- 4.3.2 Ethernet cable restraints shall be secured in a manner that does not deform or damage the cable. Cable management systems, such as VELCRO cable ties or straps, are recommended for securing Ethernet cable. Rigid plastic cable ties, such as Ty Wraps, shall not be used.



Figure 3: VELCRO Cable Ties

- 4.3.3 Ethernet cabling should be installed to allow fast cable replacement. Ethernet cabling inside of cable trays or wire ducts shall not be constrained with other cables.
- 4.3.4 Ethernet cable shall be secured within 300mm (12 in) of end device connector on flexing applications, to provide strain relief for the connection with the device.

4.4 Cable Identification

- 4.4.1 Ethernet cables shall be labeled at each connector in accordance with the electrical drawings. Identification shall include device designation, switch, and port. For example:
- 5905PLC_P1- 5102ESW_Gi1/2
 - 6100HMI-5102ESW_Fa1/3

5. Network Topology

The machine Ethernet network topology is critical to the function of the machine. The network topology shall be developed based on the following sections to achieve a reliable, efficient and scalable machine network. See Annex C for examples machine networks.

5.1 Star Topology

- 5.1.1 Star topology shall be used for all Nexteer machine Ethernet networks.
- 5.1.2 All end devices shall connect directly to an Ethernet switch, including remote programming ports.

Exception: Devices that support embedded switch technology, such as Kinetix drives and Balluff Network Interface modules, may be connected in series with each other. The requirements in the Linear (Embedded Switch) Topology section below shall be followed.

5.1.3 A maximum of two Ethernet switches in series are allowed between the programmable controller and the end device.

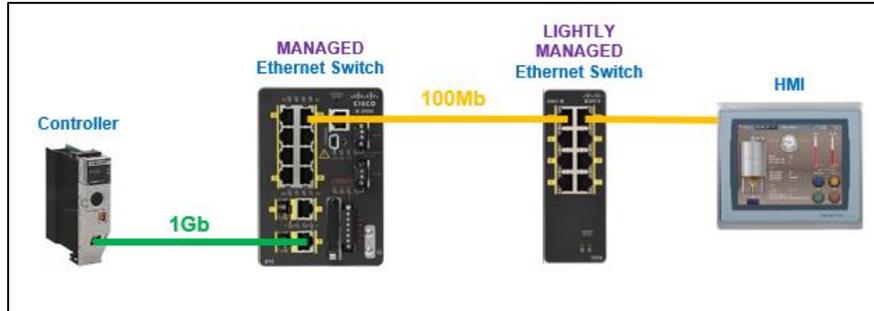


Figure 4: Maximum of Two Switches Between PLC and Device

5.2 Linear (Embedded Switch) Topology

5.2.1 Linear (Embedded Switch) topology shall be used to connect devices with embedded switch technology in series with each other. This reduces the number of Ethernet switch ports required on a machine.

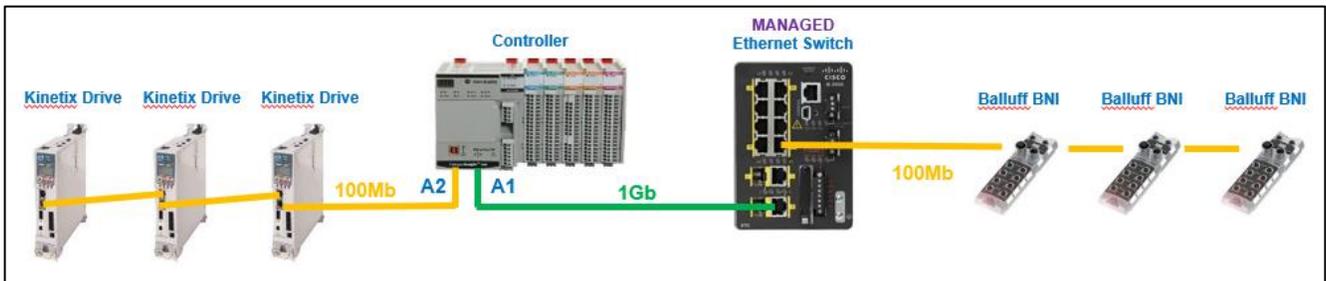


Figure 5: Linear (Embedded Switch) Topology

5.2.2 Linear (Embedded Switch) topology shall only connect devices of the same type and brand. This topology shall not be used to connect different device types in series even when the devices are adjacent to each other, support this technology and have available ports.

Exception: Kinetix servo drives should connect directly to the CompactLogix A2 port due to CIP Sync communications.

Example: Connecting a code reader directly to an open programmable controller port, or an HMI to an open BNI module port is not allowed.

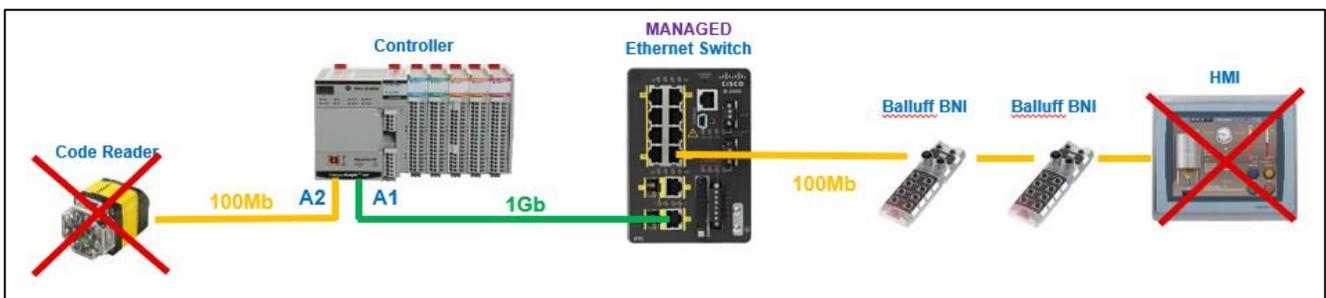


Figure 6: Linear (Embedded Switch) Topology - NOT ALLOWED

5.3 CIP Sync Motion Applications

- 5.3.1 Devices with CIP Sync communication shall be connected directly to a CompactLogix controller port or to a Managed Ethernet switch with CIP Sync support.
- 5.3.2 Kinetix drives located within the same enclosure as a CompactLogix controller shall connect directly to the CompactLogix controller using the A2 port (minimizing cable length, devices, and connectors, between the CIP Sync time aware devices as close to the controller as possible and promoting the use of both ports on the controller).

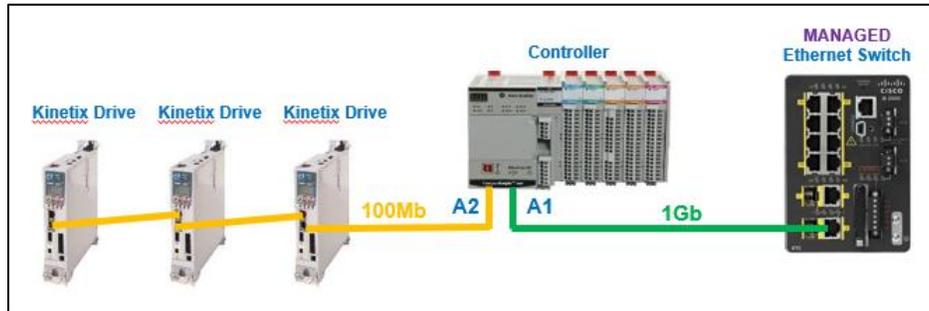


Figure 7: Kinetix Drive Connection to CompactLogix A2 Port

5.4 Process Data File Transfer Applications

- 5.4.1 Machine networks with applications that need to transfer process data files, such as camera images, press curve data files, torque and angle data files, may require an additional network connection to the manufacturing IT network. Transfer of these files may reduce machine network performance.
- 5.4.2 Review with the purchasing Manufacturing Engineer, Controls Engineer and the destination plants Manufacturing IT group to determine the appropriate solution for the application.

6. Ethernet Switch Hardware

6.1 The Ethernet switch hardware used on machine networks shall be selected from Nexteer’s Approved Components List SD-007, which is available at www.nexteerdatabase.com.

6.2 Managed Ethernet Switch

6.2.1 A managed Ethernet switch is required on all machines and shall provide the connection between the programmable controller and the manufacturing IT network.

- Gigabit Port 1 (Gi1/1) shall be reserved for the manufacturing IT network connection.
- Gigabit Port 2 (Gi1/2) shall be connected to the programmable controller.

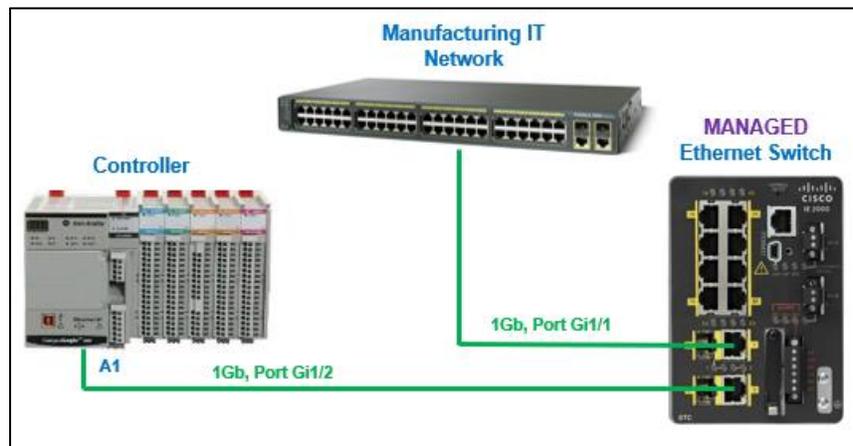


Figure 8: Example Manufacturing IT Network and PLC Connections

6.2.2 The managed Ethernet switch providing the connection between the programmable controller and the manufacturing IT network shall be provided with CIP Sync support on machines with CIP Sync communications (IEEE 1588).

6.2.3 Managed Ethernet switches are required to provide the connection between the machine network and additional controller communication modules for ControlLogix applications.

Note: Additional Controller communication modules do not apply to CompactLogix applications. See Annex C.6 for example network.

6.2.4 Managed Ethernet switches connected directly to the programmable controller or controller communication modules shall be provided with a minimum of 2 spare ports.

Note: The manufacturing IT network connection at Gi1/1 is not considered a spare port.

6.2.5 All other managed Ethernet switches shall have a minimum of 1 spare port.

6.3 Lightly Managed Ethernet Switch

6.3.1 Lightly managed Ethernet switches may be used to provide additional connections to a managed switch.

6.3.2 All lightly managed Ethernet switches shall have a minimum of 1 spare port.

6.4 Power Over Ethernet (PoE) Injector

6.4.1 A dedicated PoE Injector shall be provided for each Ethernet communicating device requiring PoE communication.

Note: PoE Injectors that support multiple Ethernet devices are not allowed.

7. Ethernet Switch Configuration

- 7.1 Express Setup shall be configured on all machine network Ethernet switches as detailed in this section. All parameters not covered in this section shall remain at their default setting, unless approved by Manufacturing IT or Controls Engineer.



Figure 9: Switch Express Setup

7.2 Basic Ethernet Switch Configuration

- 7.2.1 The switch **Hostname** shall include the SD number of the machine, a dash and device ID. For example: SD123456-200ESW.
- 7.2.2 The switch **VLAN** shall be set to "1".
- 7.2.3 The switch **IP Address Mode** shall be set to "Static".
- 7.2.4 The switch **IP Address** shall be configured based on the address provided by Nexteer Manufacturing IT department.
- 7.2.5 The switch **Subnet Mask** shall be configured as "255.255.255.0".
- 7.2.6 The switch **Default Gateway** shall be configured based on the address provided by Nexteer Manufacturing IT department.
- 7.2.7 The switch **Admin Username** shall be set to "admin".
- 7.2.8 The switch **Password** shall be set to the prefix "Sd_" and the asset number of the machine, with no spaces. For example: Sd_123456.
- 7.2.9 The switch shall have **Spanning Tree Protocol (STP)** DISABLED globally.

7.3 CIP Sync Applications (PTP Setup)

7.3.1 The switch shall be configured for **End-to-End Transparent Mode**.

7.3.2 The switch shall have **PTP Traffic Disabled** on manufacturing IT network port (Gi1/1).

The screenshot shows a configuration interface for PTP. At the top, the 'Mode' is set to 'End to End Transparent' in a dropdown menu. Below this is a 'Submit' button. The configuration details are as follows:

- PTP Device Type: End to End transparent clock
- Number of PTP ports: 10
- Local clock time: 01:41:58 UTC May 23 1993
- Device Time Source: No time source
- Device Clock Time: 11:27:11.180 UTC Sun Feb 17 2019

Below the configuration details is a table with two columns: 'Port Name' and 'Enable'. The table lists ports from Fa1/1 to Gi1/2. The 'Enable' column contains checkboxes, with the checkbox for Gi1/1 being unchecked and circled in red. At the bottom right of the table area, there are 'Save' and 'Cancel' buttons, with the 'Save' button also circled in red.

Port Name	Enable
Fa1/1	<input checked="" type="checkbox"/>
Fa1/2	<input checked="" type="checkbox"/>
Fa1/3	<input checked="" type="checkbox"/>
Fa1/4	<input checked="" type="checkbox"/>
Fa1/5	<input checked="" type="checkbox"/>
Fa1/6	<input checked="" type="checkbox"/>
Fa1/7	<input checked="" type="checkbox"/>
Fa1/8	<input checked="" type="checkbox"/>
Gi1/1	<input type="checkbox"/>
Gi1/2	<input checked="" type="checkbox"/>

Figure 10: PTP Traffic Disabled on Port Gi1/1

7.4 Ethernet Switch Configuration Documentation

7.4.1 The switch configuration shall be documented in the electrical drawing package for all machine network Ethernet switches.

Note: This should be done on the communication layout sheets, adjacent to each switch.

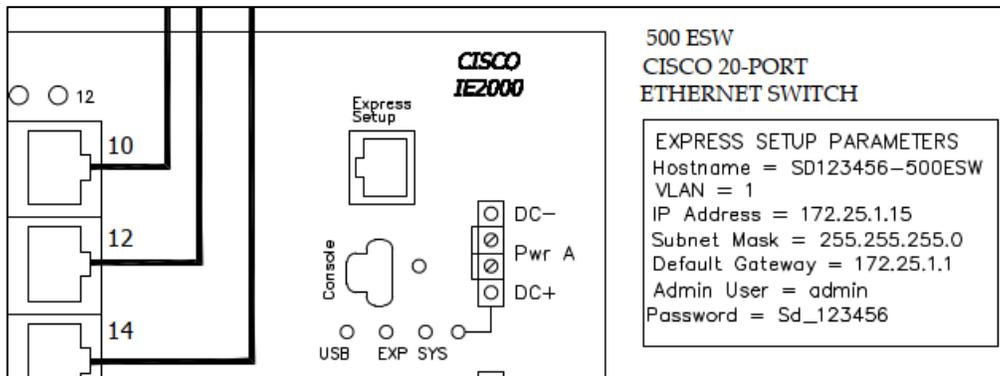


Figure 11: Switch Configuration in Drawings

7.4.2 Ethernet switch configuration backups shall be provided.

8. Programmable Controller Configuration

8.1 Programmable controller Ethernet communication configurations are a critical part of the machine Ethernet network performance. The controller shall be configured following the requirements and recommendations detailed in this section.

8.2 Controller Properties

8.2.1 Controller Ethernet ports shall be configured for Auto-Negotiate.

8.2.2 Time Synchronization shall be disabled on all projects that do not use CIP Sync communications.

Note: This should only be enabled for motion applications with Kinetix servo drives.

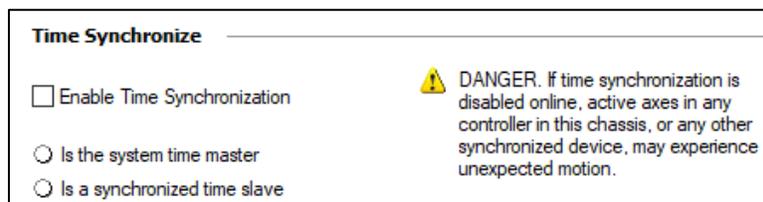


Figure 12: Time Synchronization

8.2.3 CompactLogix controllers EtherNet/IP Mode shall be configured to use Linear/DLR.



Figure 13: EtherNet/IP Mode

8.3 Class 1 Connections (Ethernet I/O Modules)

8.3.1 Class 1 (Implicit) connections shall be used to communicate with devices whenever possible. These connections are used for configured Ethernet I/O modules and Produced/Consumed communications.

Note: Approved programmable controllers and communication modules support many more Class 1 connections and packets per second, compared to Class 3 connections.

8.3.2 Controller Class 1 utilization shall not exceed 80%.

8.3.3 Ethernet I/O modules shall be configured to communicate using the Unicast transmission packet type.

8.3.4 Ethernet I/O module default RPI settings are recommended. Module RPI settings may be adjusted to meet application requirements.

8.4 Class 3 Connections (HMI/MSG)

8.4.1 Class 3 (Explicit) connections shall only be used on a limited basis and only when required to meet the application requirements. These connections are used for HMI communications, MSG instructions, and Nexteer Traceability Application communications.

Note: Approved programmable controllers and communications modules support a limited amount of Class 3 connections and packets per second, compared to Class 1 connections.

8.4.2 Controller Class 3 utilization shall not exceed 80%.

8.4.3 As the number of Class 3 connections on a machine network increases, network segmentation should be considered. Network segmentation may be accomplished using additional controller communication modules when using ControlLogix controllers. See Annex C.6 for example network.

A. Annex A - Definitions

- A.1 **Electrically Bonded:** This is the practice of electrically connecting all exposed metal as protection from electric shock and electromagnetic interference (EMI).
- A.2 **Broadcast Traffic:** A transmission method where a packet delivery system delivers a given packet to all hosts on the local area network.
- A.3 **Cable Tray Rated (Type TC):** Cable appropriately rated to be installed in or on cable tray.
- A.4 **Channel:** The end-to-end transmission path between two points at which application-specific equipment is connected.
- A.5 **CIP Sync:** A CIP implementation of IEEE 1588 PTP (Precision Time Protocol) and provides accurate real-time synchronization of controllers and devices on the network.
- A.6 **Class 1 Connection:** Any connection that uses an RPI (Requested Packet Interval). These include I/O and Produce/Consume connections. Another name for a class 1 message is "Implicit". Implicit refers to the information (source address, data type, destination address, etc.) which is implied in the message but not contained in the message.
- A.7 **Class 3 Connection:** Any connection that does not use an RPI (Requested Packet Interval). Class 3 connections are not time critical. Example: MSG Instruction, RSLink Classic communications (program upload/download), HMI communications. Another name for a class 3 message is "Explicit". Explicit messages include basic information (source address, data type, destination address, etc.) in every message, hence they are explicit.
- A.8 **Common Industrial Protocol (CIP):** Industrial protocol for industrial automation applications including control, safety, synchronization, motion, configuration and information.
- A.9 **Connector:** A connector is defined as a mated port (jack) and plug for connecting two cables or devices. An electrically conductive communications path.
- A.10 **Device Level Ring (DLR) Topology:** A method of connecting Ethernet communicating devices such that they are in series, providing media redundancy in a ring topology.
- A.11 **Electromagnetic Compatibility (EMC):** A term used to describe how well a device or system can function in an electromagnetic environment without introducing disturbances that interfere with the operation of other electrical products in the environment.
- A.12 **EtherNet/IP:** Industrial network protocol for industrial automation applications that adapts the CIP protocol to standard Ethernet.
- A.13 **Manufacturing IT Network:** Collection of cabling and equipment located within Nexteer facilities. Used for interfacing between machinery control systems and central database/traceability systems.
- A.14 **In Cabinet:** The area inside of a main enclosure, operator panel, or junction box, where protection from the environment is provided.
- A.15 **IP Rating:** Ingress protection, rating the degree of protection by mechanical casings.
- A.16 **IP Address:** Internet protocol address, which is a numerical label assigned to each device connected to an industrial network.
- A.17 **Linear (Switch Based) Topology:** A method of connecting Ethernet switches such that they are in series.
- A.18 **Linear (Embedded Switch) Topology:** A method of connecting devices with embedded Ethernet switch technology such that they are in series.

-
- A.19 **Multicast Traffic:** A transmission method of sending packets to a group of interested receivers in a single transmission. It uses specially reserved multicast address blocks.
 - A.20 **On Machine:** The area outside of a main enclosure, operator panels, or junction boxes, on the machine structure with exposure to the environment.
 - A.21 **Patch Cable:** An Ethernet cable consisting of stranded conductors and molded connector ends used to connect Ethernet communicating devices.
 - A.22 **Power Over Ethernet (PoE):** A method of providing power to devices using the same Ethernet cable that is used for communicating.
 - A.23 **Punch-Down Block:** An insulation displacement connection (IDC) for the termination of solid core Ethernet cables.
 - A.24 **Request Packet Interval (RPI):** The RPI specifies the period at which data updates over a connection. For example, the input module sends data to a controller at the RPI that you assign to the module.
 - A.25 **Shielded Twisted Pair (STP):** Ethernet cable consisting of twisted pairs of copper wire surrounded by an insulated coating.
 - A.26 **Star Topology:** A method of connecting Ethernet devices directly to an Ethernet switch.
 - A.27 **Unicast Traffic:** A transmission method by which a communication packet is sent to a single destination.
 - A.28 **Unshielded Twisted Pair (UTP):** Ethernet cable consisting of unshielded twisted pairs of copper wire surrounded by an outer jacket.

B. Annex B - Electromagnetic Compatibility Table

Conductor Electromagnetic Compatibility is grouped into three categories with respect to noise.

B.1 ODVA Conductor Electromagnetic Compatibility Table

Group conductor cables fitting this description	Into this category	Examples:
<p>Control & AC Power: high-power conductors that are more tolerant of electrical noise than Category 2 conductors and may also cause more noise to be picked up by adjacent conductors.</p> <ul style="list-style-type: none"> Corresponds to IEEE levels 3 (low susceptibility) & 4 (power) 	<p>EMC1</p>	<ul style="list-style-type: none"> AC power lines and I/O circuits High-power digital I/O High-power digital DC I/O Power connections (connectors) from motion drives to motors
<p>Signal & Communications - low-power conductors that are less tolerant of electrical noise than category-1 conductors and should also cause less noise to be picked up by adjacent conductors. (They connect to sensors and actuators relatively close to the I/O modules).</p> <ul style="list-style-type: none"> Corresponds to IEEE levels 1 (high susceptibility) & 2 (medium susceptibility) 	<p>EMC2</p>	<ul style="list-style-type: none"> Analog I/O lines and DC power lines for analog circuits Low-power digital AC/DC I/O lines Low-power digital I/O lines Communications cable (EtherNet/IP, DeviceNet™ and ControlNet™) to connect between processors or I/O adapters modules, programming terminals, computers and data terminals
<p>Intra-enclosure: interconnect the system components within an enclosure</p> <ul style="list-style-type: none"> Corresponds to IEEE levels 1 (high susceptibility) & 2 (medium susceptibility) 	<p>EMC3</p>	<ul style="list-style-type: none"> Low-voltage DC power lines Communications cables to connect between system components within the same enclosure

C. Annex C - Example Machine Networks

The following sample network diagrams are intended to provide clarification of our requirements detailed above. All machine networks are application specific and therefore these are only to be used for reference only.

C.1 CompactLogix Basic Application

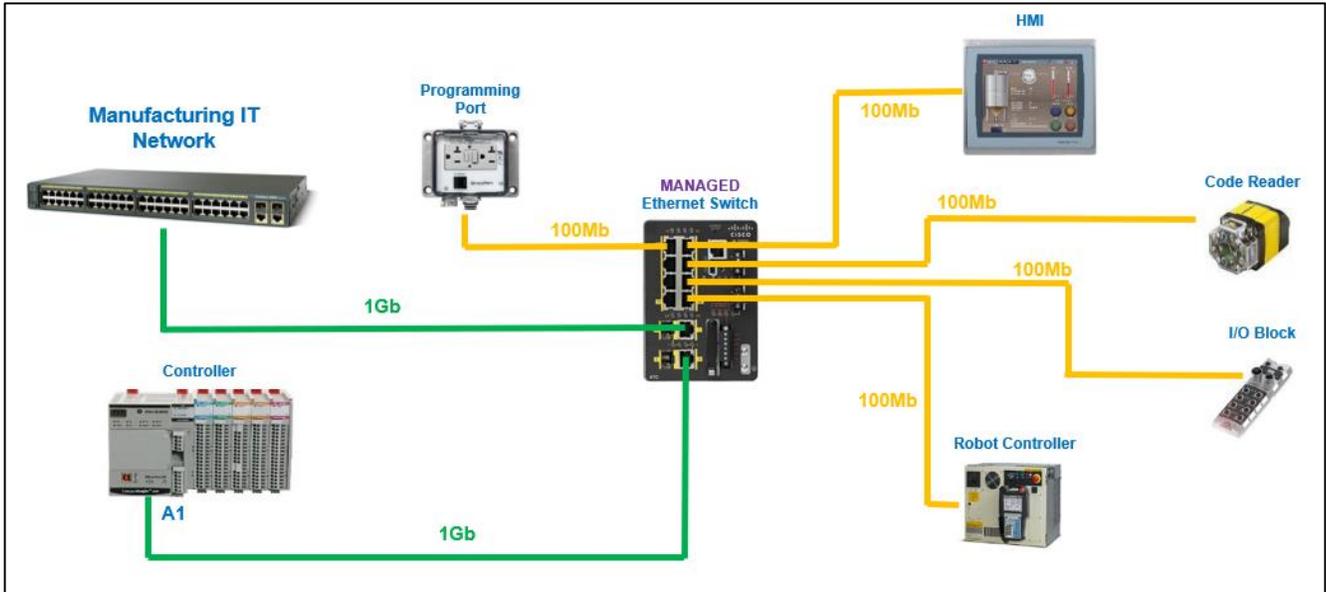


Figure 14: Basic Non-CIP Sync Network

The example network layout demonstrates the following:

- Star topology
- Manufacturing IT network connects to Ethernet switch Port Gi1/1
- Controller Port A1 connects to Ethernet switch Port Gi1/2
- Managed Ethernet switch with "LITE" firmware used without CIP Sync support
- Minimum of two spare ports provided

C.2 CompactLogix CIP Sync Application

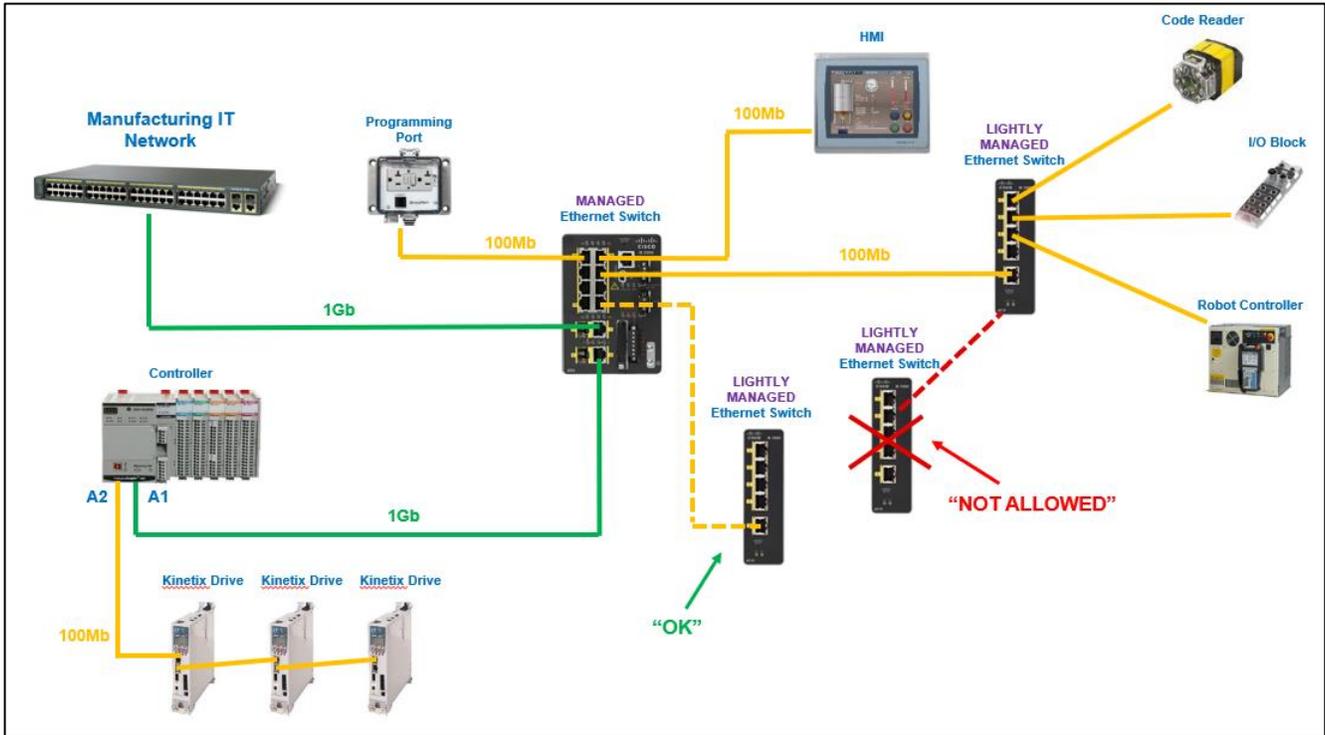


Figure 16: CompactLogix CIP Sync Application

The example network layout demonstrates the following:

- Star topology
- Manufacturing IT network connects to Ethernet switch Port Gi1/1
- Controller Port A1 connects to Ethernet switch Port Gi1/2
- Managed Ethernet switch used with CIP Sync support
- PTP traffic disabled on manufacturing IT network Port Gi1/1
- Kinetix motion drives connect directly to CompactLogix port A2
- Controller EtherNet/IP Mode set to Linear / DLR
- Time Synchronization Enabled in Controller
- Kinetix motion drives use embedded Ethernet switch technology for linear topology
- Lightly Managed Ethernet switch used to provide additional ports for non-CIP Sync devices
- Maximum of two Ethernet switches between controller and end device

C.3 ControlLogix CIP Sync Application

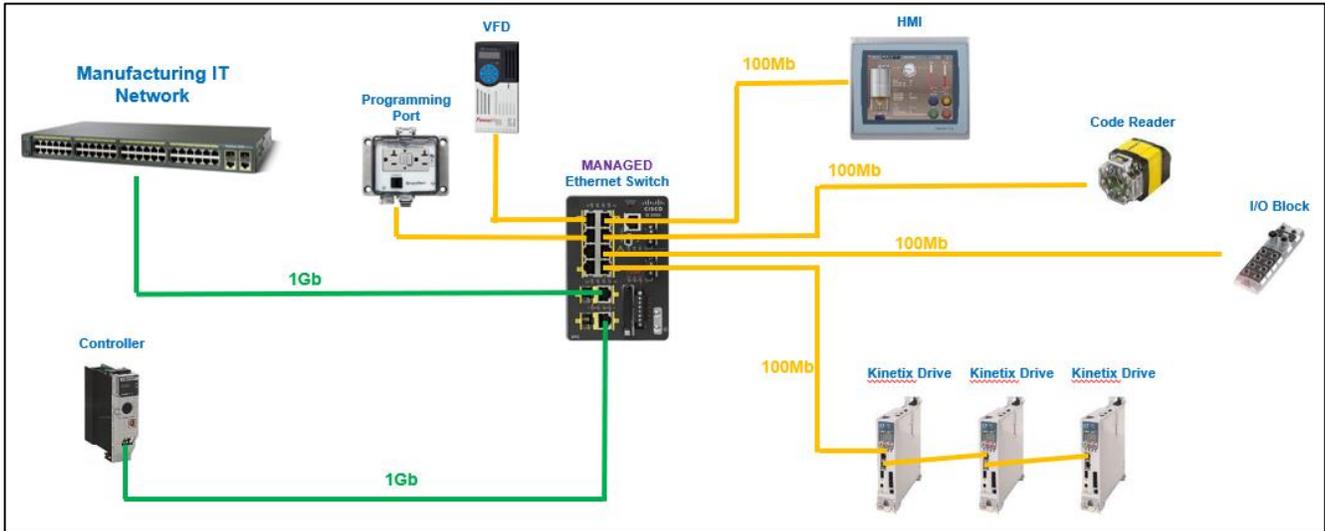


Figure 17: ControlLogix CIP Sync Application

The example network layout demonstrates the following:

- Star topology
- Manufacturing IT network connects to Ethernet switch Port Gi1/1
- Controller port connects to Ethernet switch port Gi1/2
- Managed Ethernet switch used with CIP Sync support
- PTP traffic disabled on manufacturing IT network Port Gi1/1
- Time Synchronization Enabled in Controller
- Kinex drives connect directly to managed Ethernet switch with CIP Sync support
- Kinex motion drives use embedded Ethernet switch technology for linear topology

C.4 ControlLogix CIP Sync Application with Multiple Stations

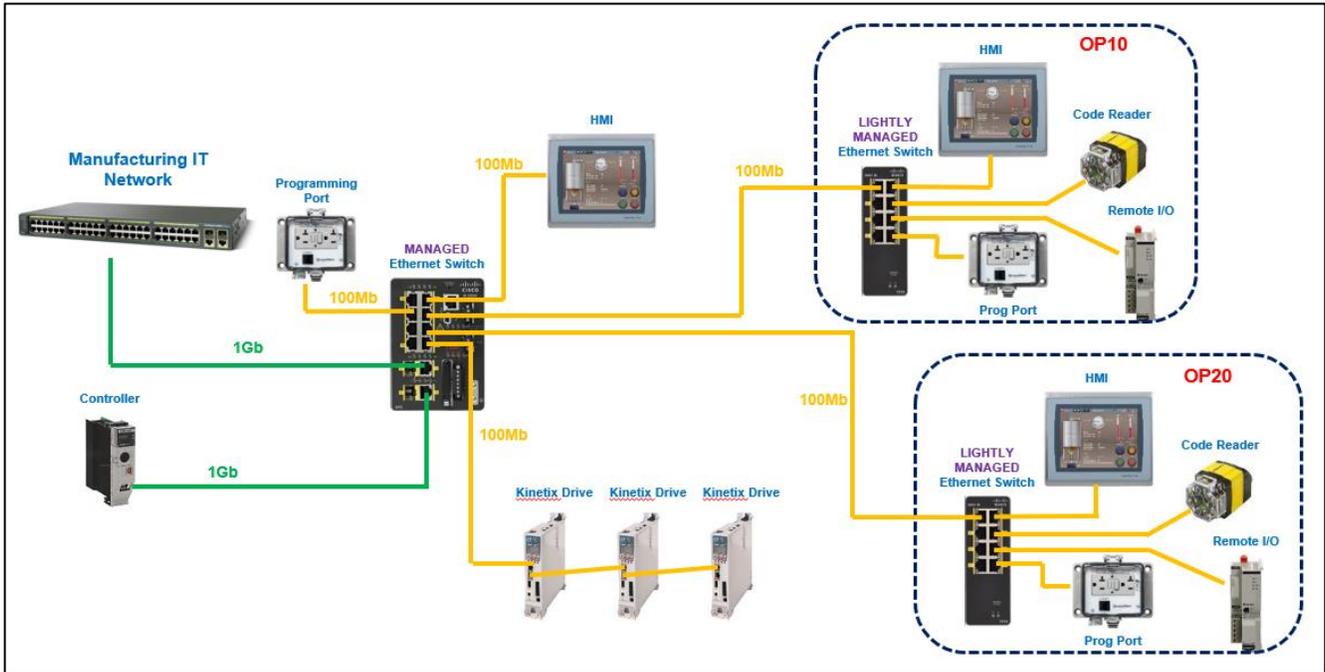


Figure 18: ControlLogix CIP Application with Multiple Stations

The example network layout demonstrates the following:

- Star topology
- Manufacturing IT network connects to Ethernet switch Port Gi1/1
- Controller port connects to Ethernet switch port Gi1/2
- Managed Ethernet switch used with CIP Sync support
- PTP traffic disabled on manufacturing IT network Port Gi1/1
- Time Synchronization Enabled in Controller
- Lightly Managed Ethernet switch provides additional ports for non-CIP Sync devices at OP10 and 20
- Kinetix drives connected directly to managed Ethernet switch with CIP Sync support
- Kinetix motion drives utilize embedded Ethernet switch technology for linear topology

C.5 ControlLogix Remote CIP Sync Application with Multiple Stations

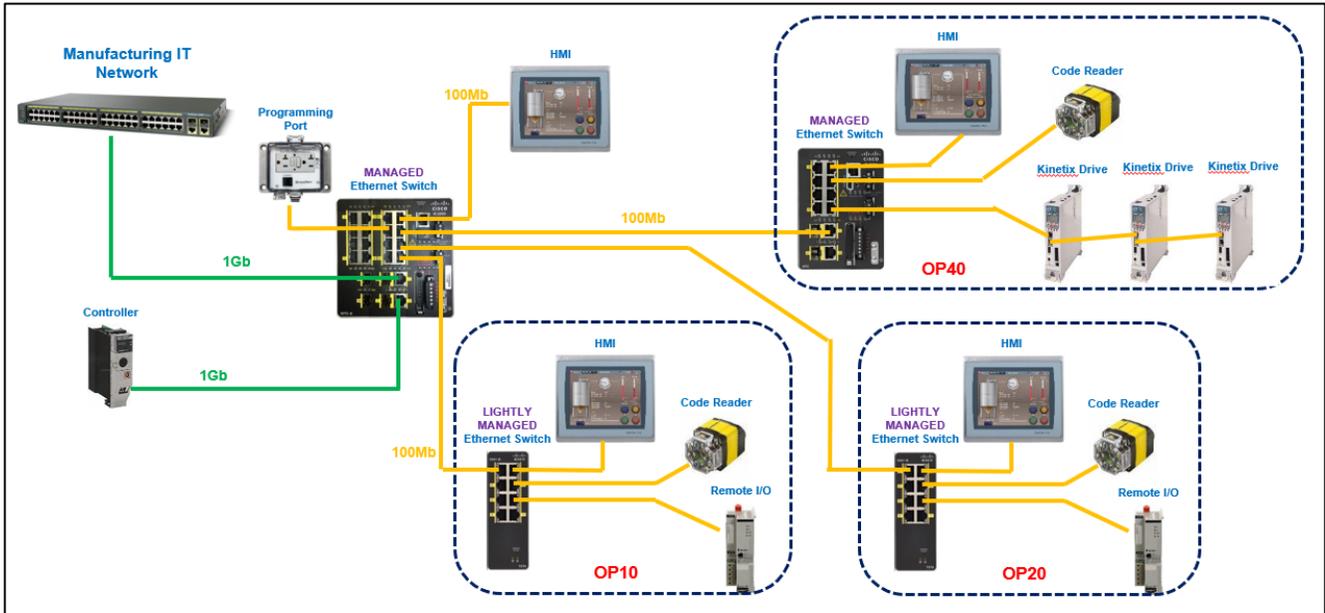


Figure 19: ControlLogix Remote CIP Sync Application with Multiple Stations

The example network layout demonstrates the following:

- Star topology
- Manufacturing IT network connects to Ethernet switch Port Gi1/1
- Controller port connects to Ethernet switch port Gi1/2
- Managed Ethernet switch used with CIP Sync support
- PTP traffic disabled on manufacturing IT network Port Gi1/1
- Time Synchronization Enabled in Controller
- Lightly Managed Ethernet switch provides additional ports for non-CIP Sync devices at OP10 and 20
- Managed Ethernet switch provides additional ports for CIP Sync devices at OP40
- Kinetix drives use embedded Ethernet switch technology for linear topology at OP40

C.6 ControlLogix Segmented Network Application

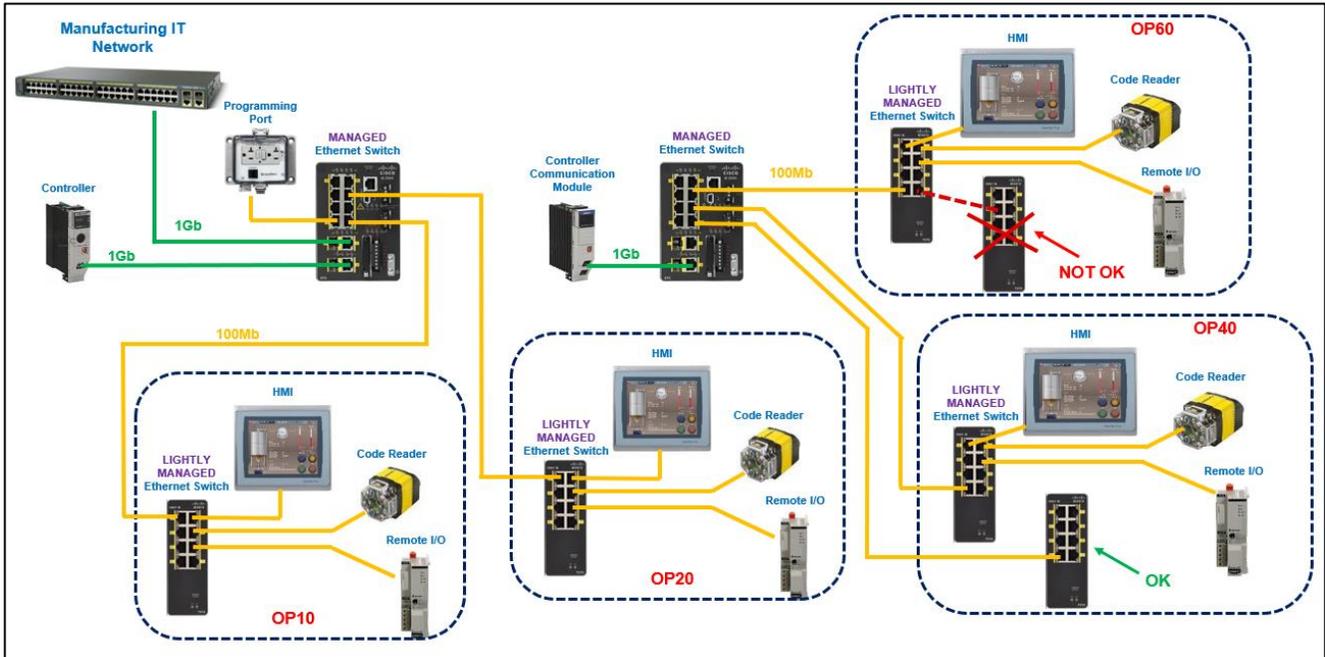


Figure 20: ControlLogix Segmented Network

The example network layout demonstrates the following:

- Star topology
- Manufacturing IT network connects to Ethernet switch Port Gi1/1 on switch connected to PLC
- Controller connects to Ethernet switch port Gi1/2 on switch connected to manufacturing IT network
- Network segmentation provided using controller communication module
- Lightly Managed Ethernet switches provide additional ports for non-CIP Sync devices
- Maximum of two Ethernet switches between controller and end device

C.7 LabVIEW Test Machine Application

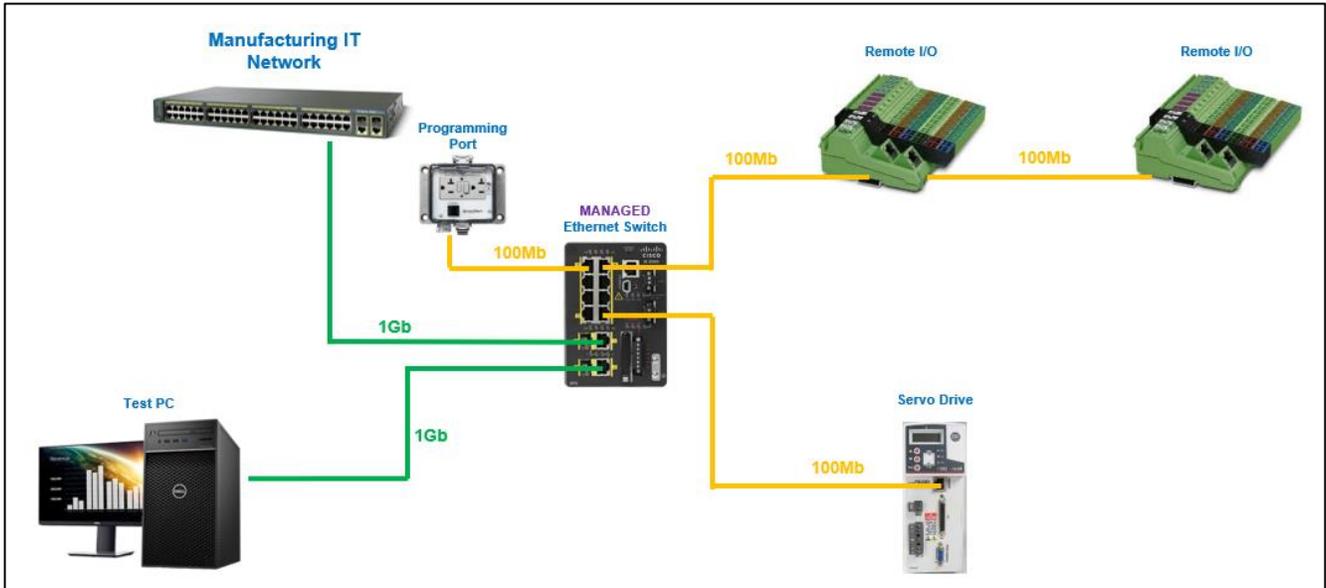


Figure 21: LabVIEW Test Machine – Standalone

The example network layout demonstrates the following:

- Star topology
- Manufacturing IT network connects to Ethernet switch Port Gi1/1
- Test PC connects directly to Ethernet switch on Port Gi1/2
- Remote I/O modules utilize embedded Ethernet switch technology for linear topology

C.8 LabVIEW Test Machine Application Integrated with Assembly Line

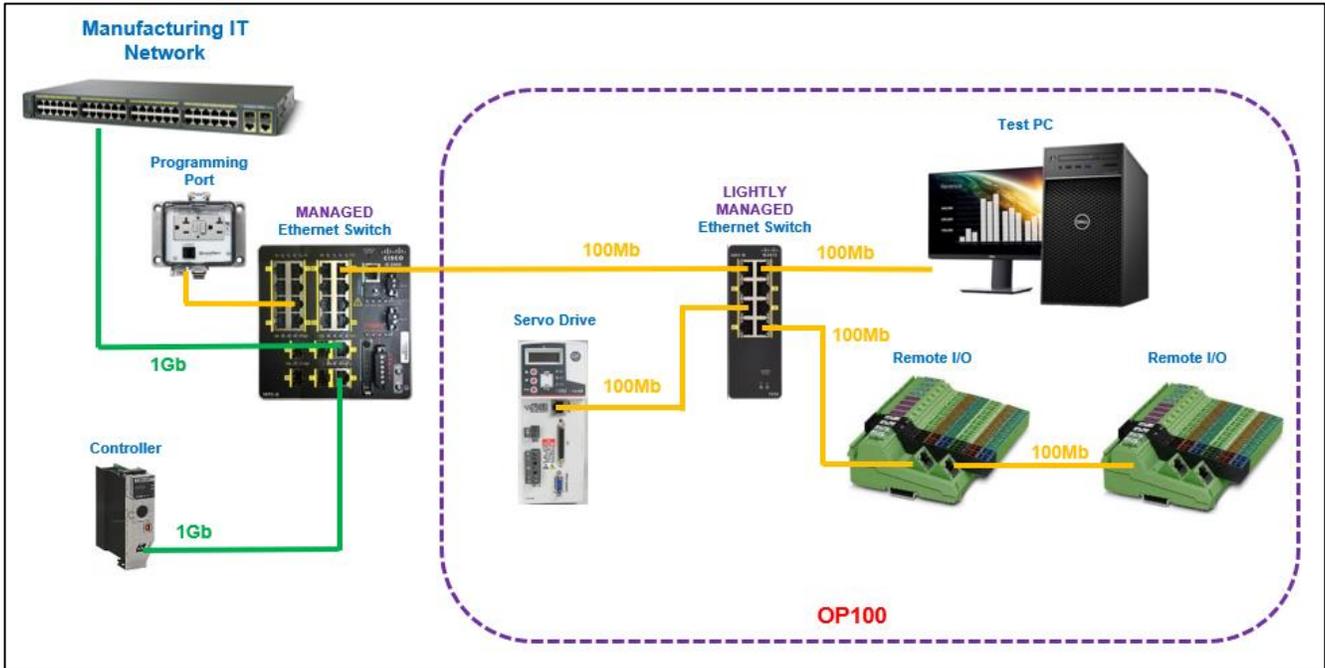


Figure 22: LabVIEW Test Machine Integrated with Assembly Line

The example network layout demonstrates the following:

- Star topology
- Lightly managed switch used at Test Machine
- Test Machine connects directly to Assembly Line managed Ethernet switch

D. Annex D - References

The references used in the development of this specification are listed below.

- D.1 **ODVA:** EtherNet/IP - Media Planning and Installation Manual
- D.2 **IEC 60204-1:** Safety of Machinery - Electrical Equipment of Machines – General Requirements
- D.3 **Nexteer Specification SD-004:** Electrical Specification for Industrial Machinery – Addendum to IEC 60204-1
- D.4 **NFPA 79:** Electrical Standard for Industrial Equipment

Note: Users of this specification shall consult applicable Federal, State, Country, and Local laws, regulations and standards in addition to those listed. Reference the most current versions of the specifications / standards listed.

Record of Revisions

Revision No	Date	Section	Description
001	04JN20	ALL	Initial Release
002			
003			
004			
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