

# Modicon M580

## Open Ethernet Network System Planning Guide

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All pertinent state, regional, and local safety regulations must be observed when installing and using this product. For reasons of safety and to help ensure compliance with documented system data, only the manufacturer should perform repairs to components.

When devices are used for applications with technical safety requirements, the relevant instructions must be followed.

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# Safety Information

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## Important Information

### NOTICE

Read these instructions carefully, and look at the equipment to become familiar with the device before trying to install, operate, service, or maintain it. The following special messages may appear throughout this documentation or on the equipment to warn of potential hazards or to call attention to information that clarifies or simplifies a procedure.



The addition of this symbol to a “Danger” or “Warning” safety label indicates that an electrical hazard exists which will result in personal injury if the instructions are not followed.



This is the safety alert symbol. It is used to alert you to potential personal injury hazards. Obey all safety messages that follow this symbol to avoid possible injury or death.

## **DANGER**

**DANGER** indicates a hazardous situation which, if not avoided, **will result in** death or serious injury.

## **WARNING**

**WARNING** indicates a hazardous situation which, if not avoided, **could result in** death or serious injury.

## **CAUTION**

**CAUTION** indicates a hazardous situation which, if not avoided, **could result in** minor or moderate injury.

## **NOTICE**

**NOTICE** is used to address practices not related to physical injury.

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## PLEASE NOTE

Electrical equipment should be installed, operated, serviced, and maintained only by qualified personnel. No responsibility is assumed by Schneider Electric for any consequences arising out of the use of this material.

A qualified person is one who has skills and knowledge related to the construction and operation of electrical equipment and its installation, and has received safety training to recognize and avoid the hazards involved.

## BEFORE YOU BEGIN

Do not use this product on machinery lacking effective point-of-operation guarding. Lack of effective point-of-operation guarding on a machine can result in serious injury to the operator of that machine.

 <b>WARNING</b>
<b>UNGUARDED EQUIPMENT</b>
<ul style="list-style-type: none"><li>• Do not use this software and related automation equipment on equipment which does not have point-of-operation protection.</li><li>• Do not reach into machinery during operation.</li></ul>
<b>Failure to follow these instructions can result in death, serious injury, or equipment damage.</b>



This automation equipment and related software is used to control a variety of industrial processes. The type or model of automation equipment suitable for each application will vary depending on factors such as the control function required, degree of protection required, production methods, unusual conditions, government regulations, etc. In some applications, more than one processor may be required, as when backup redundancy is needed.

Only you, the user, machine builder or system integrator can be aware of all the conditions and factors present during setup, operation, and maintenance of the machine and, therefore, can determine the automation equipment and the related safeties and interlocks which can be properly used. When selecting automation and control equipment and related software for a particular application, you should refer to the applicable local and national standards and regulations. The National Safety Council's Accident Prevention Manual (nationally recognized in the United States of America) also provides much useful information.

In some applications, such as packaging machinery, additional operator protection such as point-of-operation guarding must be provided. This is necessary if the operator's hands and other parts of the body are free to enter the pinch points or other hazardous areas and serious injury can occur. Software products alone cannot protect an operator from injury. For this reason the software cannot be substituted for or take the place of point-of-operation protection.

Ensure that appropriate safeties and mechanical/electrical interlocks related to point-of-operation protection have been installed and are operational before placing the equipment into service. All interlocks and safeties related to point-of-operation protection must be coordinated with the related automation equipment and software programming.

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**NOTE:** Coordination of safeties and mechanical/electrical interlocks for point-of-operation protection is outside the scope of the Function Block Library, System User Guide, or other implementation referenced in this documentation.

## START-UP AND TEST

Before using electrical control and automation equipment for regular operation after installation, the system should be given a start-up test by qualified personnel to verify correct operation of the equipment. It is important that arrangements for such a check be made and that enough time is allowed to perform complete and satisfactory testing.

### **WARNING**

#### **EQUIPMENT OPERATION HAZARD**

- Verify that all installation and set up procedures have been completed.
- Before operational tests are performed, remove all blocks or other temporary holding means used for shipment from all component devices.
- Remove tools, meters, and debris from equipment.

**Failure to follow these instructions can result in death, serious injury, or equipment damage.**

Follow all start-up tests recommended in the equipment documentation. Store all equipment documentation for future references.

**Software testing must be done in both simulated and real environments.**

Verify that the completed system is free from all short circuits and temporary grounds that are not installed according to local regulations (according to the National Electrical Code in the U.S.A, for instance). If high-potential voltage testing is necessary, follow recommendations in equipment documentation to prevent accidental equipment damage.

Before energizing equipment:

- Remove tools, meters, and debris from equipment.
- Close the equipment enclosure door.
- Remove all temporary grounds from incoming power lines.
- Perform all start-up tests recommended by the manufacturer.

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## OPERATION AND ADJUSTMENTS

The following precautions are from the NEMA Standards Publication ICS 7.1-1995 (English version prevails):

- Regardless of the care exercised in the design and manufacture of equipment or in the selection and ratings of components, there are hazards that can be encountered if such equipment is improperly operated.
- It is sometimes possible to misadjust the equipment and thus produce unsatisfactory or unsafe operation. Always use the manufacturer's instructions as a guide for functional adjustments. Personnel who have access to these adjustments should be familiar with the equipment manufacturer's instructions and the machinery used with the electrical equipment.
- Only those operational adjustments actually required by the operator should be accessible to the operator. Access to other controls should be restricted to prevent unauthorized changes in operating characteristics.



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# About the Book

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## At a Glance

### Document Scope

EcoStruxure Plant is Schneider Electric IIoT platform (Industrial Internet of Things) designed to address the key challenges of many different types of users, including plant managers, operations managers, engineers, maintenance teams, and operators, by delivering a system that is scalable, flexible, integrated, and collaborative.

This document presents usage of industrial Ethernet managed switches with the Modicon M580 offer. A switch centric architecture provides flexibility and openness on system network design.

This guide provides detailed information about planning such M580 open architecture, including the following:

- topology rules and recommendations for designing an open network architecture
- implementation of industrial managed Ethernet Switches
- system commissioning and maintenance
- system performance and limitations
- system diagnostics

### Validity Note

This documentation is valid for Standalone Modicon M580 and M580 safety systems.

The technical characteristics of the devices described in the present document also appear online. To access the information online:

Step	Action
1	Go to the Schneider Electric home page <a href="http://www.schneider-electric.com">www.schneider-electric.com</a> .
2	In the <b>Search</b> box type the reference of a product or the name of a product range. <ul style="list-style-type: none"><li>● Do not include blank spaces in the reference or product range.</li><li>● To get information on grouping similar modules, use asterisks (*).</li></ul>
3	If you entered a reference, go to the <b>Product Datasheets</b> search results and click on the reference that interests you. If you entered the name of a product range, go to the <b>Product Ranges</b> search results and click on the product range that interests you.
4	If more than one reference appears in the <b>Products</b> search results, click on the reference that interests you.
5	Depending on the size of your screen, you may need to scroll down to see the datasheet.
6	To save or print a datasheet as a .pdf file, click <b>Download XXX product datasheet</b> .

The characteristics that are described in the present document should be the same as those characteristics that appear online. In line with our policy of constant improvement, we may revise content over time to improve clarity and accuracy. If you see a difference between the document and online information, use the online information as your reference.

## Related Documents

Title of documentation	Reference number
Modicon M580, Hardware, Reference Manual	EIO0000001578 (English), EIO0000001579 (French), EIO0000001580 (German), EIO0000001582 (Italian), EIO0000001581 (Spanish), EIO0000001583 (Chinese)
Modicon M580 BMENOC0301/11, Ethernet Communication Module, Installation and Configuration Guide	HRB62665 (English), HRB65311 (French), HRB65313 (German), HRB65314 (Italian), HRB65315 (Spanish), HRB65316 (Chinese)
Modicon M580 BMENOC0321, Control Network Module, Installation and Configuration Guide	NVE24232 (English), NVE24233 (French), NVE24237 (German), NVE24240 (Italian), NVE24239 (Spanish), NVE24242 (Chinese)
M580 BMENOS0300, Network Option Switch, Installation and Configuration Guide	NHA89117 (English), NHA89119 (French), NHA89120 (German), NHA89121 (Italian), NHA89122 (Spanish), NHA89123 (Chinese)
Modicon M580 Standalone, System Planning Guide for Frequently Used Architectures	HRB62666 (English), HRB65318 (French), HRB65319 (German), HRB65320 (Italian), HRB65321 (Spanish), HRB65322 (Chinese)
Modicon M580, System Planning Guide for Complex Topologies	NHA58892 (English), NHA58893 (French), NHA58894 (German), NHA58895 (Italian), NHA58896 (Spanish), NHA58897 (Chinese)
Modicon M580, RIO Modules, Installation and Configuration Guide	EIO0000001584 (English), EIO0000001585 (French), EIO0000001586 (German), EIO0000001587 (Italian), EIO0000001588 (Spanish), EIO0000001589 (Chinese),
Modicon M580, Safety System Planning Guide	QGH60283 (English), QGH60284 (French), QGH60285 (German), QGH60286 (Spanish), QGH60287 (Italian), QGH60288 (Chinese)
EcoStruxure™ Control Expert, System Bits and Words, Reference Manual	EIO0000002135 (English), EIO0000002136 (French), EIO0000002137 (German), EIO0000002138 (Italian), EIO0000002139 (Spanish), EIO0000002140 (Chinese)

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You can download these technical publications and other technical information from our website at [www.schneider-electric.com/en/download](http://www.schneider-electric.com/en/download).



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# Chapter 1

## Designing an Open Ethernet Network

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### What Is in This Chapter?

This chapter contains the following topics:

Topic	Page
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Design Principles	16
Compatibility and Limitations	21

## Introduction

### M580 Architecture - Modicon M580 Typical System Introduction

A typical Modicon M580 system is designed and tested for simultaneous use of:

- an Ethernet main local rack and the ability to extend to other local racks
- RIO drops that support Ethernet and X-Bus communications across the backplane
- Ethernet distributed equipment
- BMENOS0300 network option switch modules that attach RIO drops and distributed equipment to the M580 system
- BMENOC0321 control network module that creates transparency between the device network and the control network
- RIO and distributed equipment integrated on the same physical network
- RIO and DIO sub-rings that communicate with the RIO main ring
- third-party modules and devices
- daisy-chain ring architectures provided by communication modules with dual device Ethernet network ports

A typical Modicon M580 system provides automatic network recovery and deterministic RIO performance.

Complex Modicon M580 system incorporate recommended Connexium managed switches and their corresponding predefined configuration files.

These architectures are described in the following documentations:

- *Modicon M580 Standalone, System Planning Guide for Frequently Used Architectures*
- *Modicon M580, System Planning Guide for Complex Topologies*
- *Modicon M580, Safety System Planning Guide*

### Using M580 in an Open Ethernet Network

An alternative to typical Modicon M580 system is to design your M580 device network by connecting devices directly to an existing open Ethernet network.

This is possible by using industrial Ethernet managed switches and using the service ports instead of the device network ports for the CPU and RIO adapter modules.

Integrating Modicon M580 system in an open Ethernet network has significant impact in the operation and performance of the connected Ethernet devices. For example, performance metrics such as recovery time is not maintained by design.

This document details the steps needed to ensure M580 system operating in an open Ethernet network.

## ***NOTICE***

### **LOSS OF I/O DATA AND POSSIBLE DISCONNECTION OF RIO DROPS**

The precautions and recommendations given in this documentation are provided only to integrate an M580 system in an open Ethernet network.

Do not apply them to a typical M580 system.

**Failure to follow these instructions can result in equipment damage.**

**NOTE:** The architectures described in this document have been tested and validated in various scenarios. If you intend to use architectures different than the ones described in this document please contact your local technical support.

## Design Principles

### Overview

Modicon M580 system and the traffic managed in its network is strictly regulated by switch configuration parameters like VLAN Identifier (VLAN-ID), QoS, and DSCP. This along with RSTP protocol helps to ensure deterministic RIO performance.

Hence, to integrate Modicon M580 system in an open Ethernet network, it is imperative that the industrial Ethernet managed switches incorporate management of these features in its configuration.

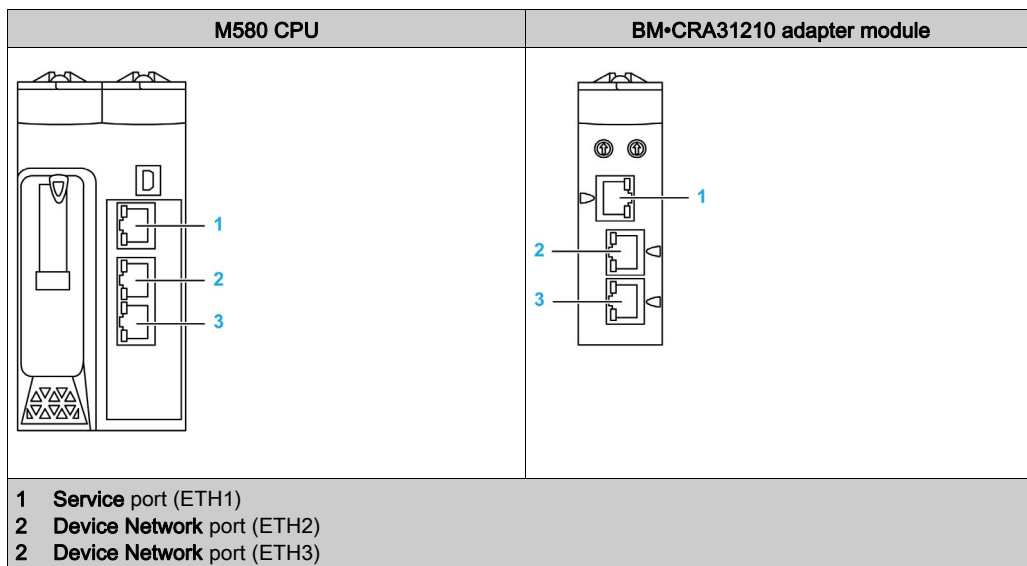
Then design your architecture following the principles described in:

- Point-to-point connection
- VLAN isolation

### Point-to-Point Connection

The first principle is a point-to-point connection only using the service port of the M580 CPU and BM•CRA31210 adapter modules to connect to the industrial Ethernet managed switches.

The following figures show the location of the service port of the modules:



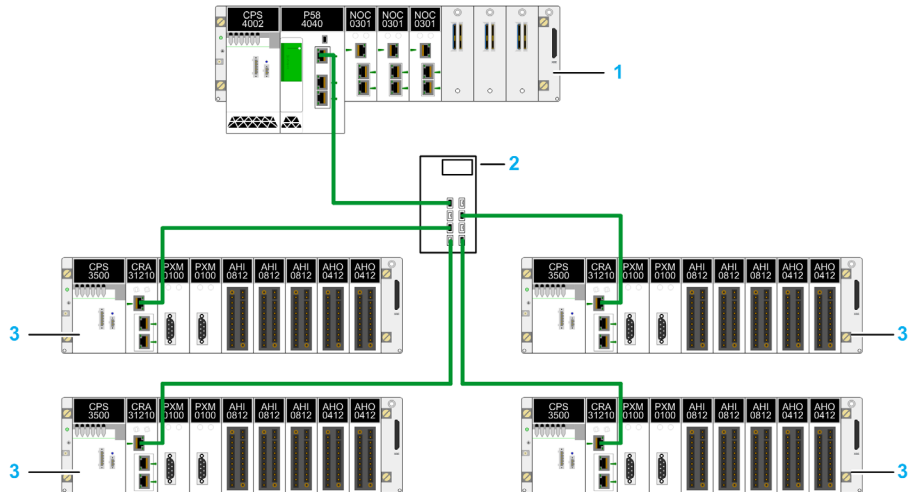
The device network ports have VLAN tagging as well as RSTP enabled whereas the service ports are configured to strip existing VLAN tags and do not support RSTP.

By using the service port only, you eliminate the possibility of device modification of packets with VLAN tagging and RSTP-based network recovery.



The service port of each module in the open Ethernet network (M580 CPU and BM•CRA31210 adapter modules) is connected to its dedicated port of the industrial Ethernet managed switch.

The following figure illustrates the point-to-point connection principle using only the service port of the modules in the network:



- 1 Modicon M580 CPU
- 2 Industrial Ethernet managed switch
- 3 X80 RIO drop

To prevent from interference with pre-existing device network port parameter configuration, make sure that only the service ports of the M580 CPU and BM•CRA31210 adapter modules are connected to the industrial Ethernet managed switching. If this verification is not done you can have a bandwidth overload of service port of the switch.

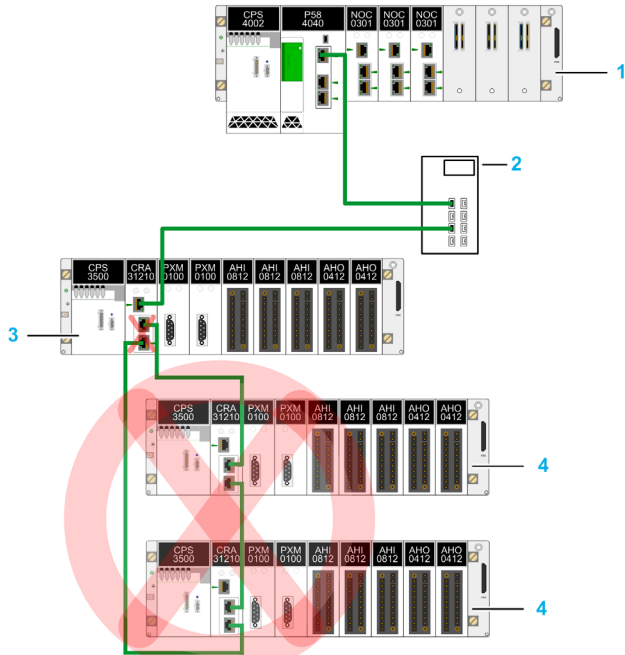
## ***NOTICE***

### **LOSS OF DETERMINISM AND CONNECTIVITY WITH THE RIO DROPS**

Do not create daisy chain loop of X80 RIO drops to the same port of the industrial Ethernet managed switch.

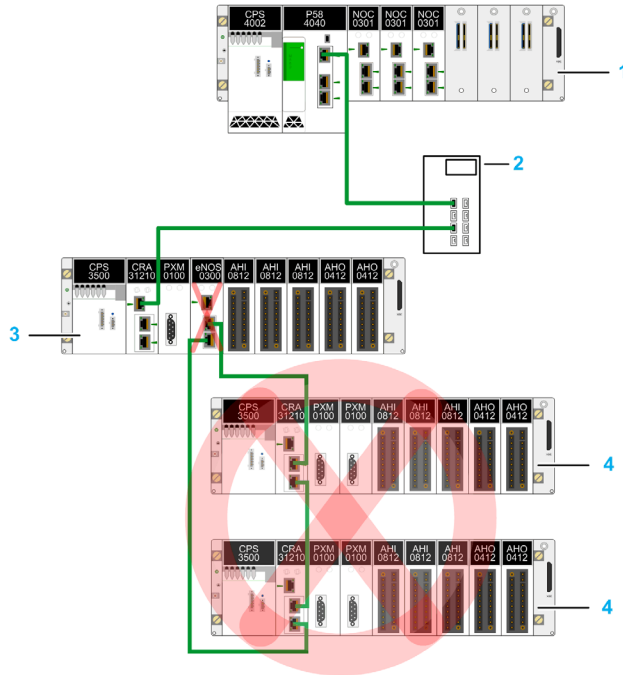
**Failure to follow these instructions can result in equipment damage.**

You cannot create a daisy chain loop from an RIO drop connected to the industrial Ethernet managed switch:



- 1 Modicon M580 CPU
- 2 Industrial Ethernet managed switch
- 3 X80 RIO drop connected to the open Ethernet network
- 4 X80 RIO drops in a daisy chain loop using the device network ports of the X80 adapter module.

When M580 system is integrated in an open Ethernet network, Schneider Electric recommends not to use BMENOS0300 modules to connect RIO/DIO devices and/or RIO/DIO sub-ring:



- 1 Modicon M580 CPU
- 2 Industrial Ethernet managed switch
- 3 X80 RIO drop connected to the open Ethernet network
- 4 X80 RIO drop in a sub-ring connected to the BMENOS0300 module.

## VLAN Isolation

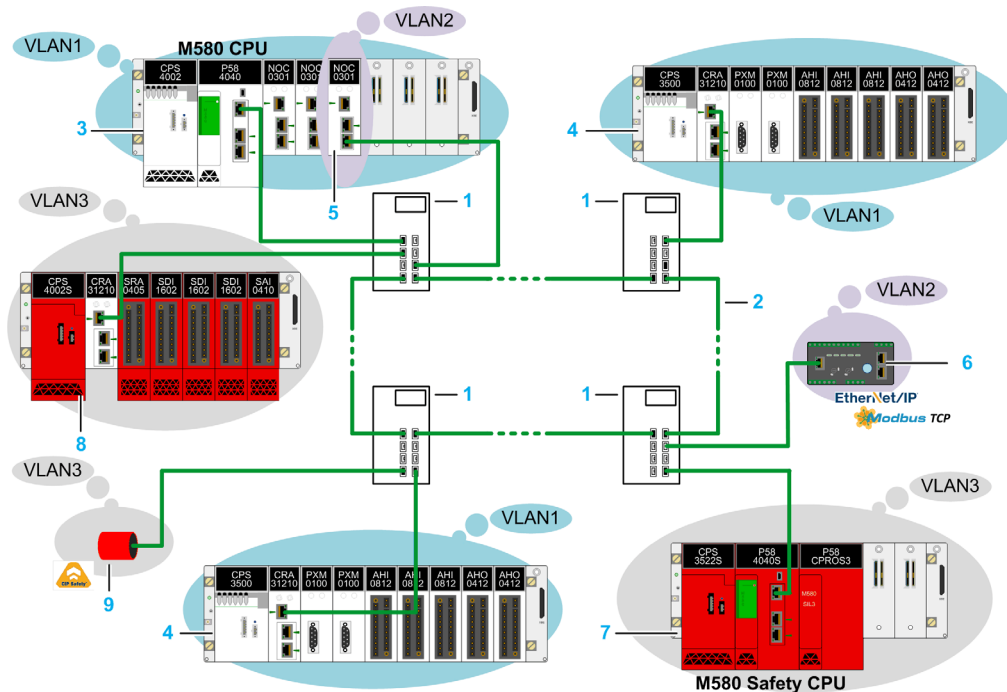
The second principle is to assign dedicated and unique VLAN-IDs to separate the traffic generated by the M580 system in the open Ethernet network.

For example, if the network has a process M580 CPU that scans several X80 RIO drops, assign the same VLAN-ID to the ports of the switch to which the adapter modules of the RIO drops are connected. This assignment creates a VLAN isolation for the process M580 CPU and its scanned modules.

Create as many as necessary group of participants by assigning a dedicated and unique VLAN-ID to:

- Process CPU and its scanned RIO drops (VLAN-x)
- Safety CPU and its scanned safety RIO drops and CIP safety devices (VLAN-y)
- BMENOC\*\*\* module and its connected DIO devices (VLAN-z)
- And so on

The following figure illustrates the VLAN isolation for three groups of network participants:



- 1 Industrial Ethernet managed switch
- 2 Ring configuration and operation configured as per the switch manufacturer recommendations
- 3 Modicon M580 CPU with Ethernet I/O scanner assigned to VLAN1
- 4 X80 RIO drop scanned by the Modicon M580 CPU
- 5 Modicon BMENOC.... module assigned to VLAN2
- 6 DIO device (for example, EtherNet/IP or Modbus TCP) scanned by the BMENOC.... module
- 7 Modicon M580 safety CPU with Ethernet I/O scanner assigned to VLAN3
- 8 Safety X80 RIO drop scanned by the Modicon M580 safety CPU
- 9 CIP Safety device

## Compatibility and Limitations

### Hardware Compatibility

The following standalone CPUs with Ethernet I/O scanner service (both RIO and DIO scanner service) can be used in an open Ethernet network:

- BMEP582040(H), BMEP582040S
- BMEP583040
- BMEP584040, BMEP584040S
- BMEP585040(C)
- BMEP586040(C)

For detailed information on the limit and performance of the compatible M580 CPU refer to chapter *Performance Characteristics (see Modicon M580, Hardware, Reference Manual)*.

Each RIO drop contains one of the following adapter modules to be connected in an open Ethernet network:

- BMXCRA31210(C)
- BMECRA31210(C)

### Network Limitations

The service port bandwidth of an M580 CPU is limited to 100 Mbit/s whereas the service port bandwidth of a BM•CRA31210 module is capped to 5 Mbit/s.

## ***NOTICE***

### **LOSS OF CONNECTIVITY WITH THE RIO DROPS**

When designing the open Ethernet network, make sure that the total traffic managed by the service port of the BM•CRA31210 module does not exceed 5 Mbits/s.

**Failure to follow these instructions can result in equipment damage.**

Factors typically affecting network bandwidth at the service ports of the modules are:

- Type of I/O, expert or communication modules installed in the RIO drops
- Number of RIO drops scanned
- Scan rate of the RIO drops

The processing capability without packet loss, including unicast, multicast, and broadcast frames management is limited for M580 CPU and BM•CRA31210.

Design the open Ethernet network architecture by taking into account that the overall traffic does not exceed the following limits:

**M580 CPU:** 15000 packets per second (pps)

**BM•CRA31210:** 8000 packets per second (pps)



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# Chapter 2

## Open Ethernet Network Configuration

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### What Is in This Chapter?

This chapter contains the following topics:

Topic	Page
Module Configuration	24
Industrial Ethernet Managed Switches Configuration	25

## Module Configuration

### Service Port Configuration

The service port provides access to the open Ethernet network.

When enabled, the service port supports these modes:

- **Access** (default): This mode supports Ethernet communications.
- **Mirroring**: In this mode, the port acts like a read-only port. The data traffic from one of the other 2 device network Ethernet ports is copied to this port. That is, you cannot access devices through the service port.

To access devices connected to the industrial Ethernet managed switches, the service port of the M580 CPU and BM•CRA31210 adapter modules has to be set to **Access**.

### ***NOTICE***

#### **LOSS OF CONNECTIVITY WITH THE RIO DROPS**

For the M580 CPU and BM•CRA31210 adapter modules connected to industrial Ethernet managed switches:

- Do not disable the service port.
- Do not configure the service port mode to mirroring.

**Failure to follow these instructions can result in equipment damage.**

For more detailed information on service port configuration, refer to chapter:

- Configuring the CPU with Control Expert (*see Modicon M580, Hardware, Reference Manual*) for the M580 CPU, or
- Control Expert Configuration for Ethernet RIO Modules (*see Modicon M580, RIO Modules, Installation and Configuration Guide*) for the BM•CRA31210 adapter modules.



## Industrial Ethernet Managed Switches Configuration

### Open Network Convergence Configuration

A typical M580 system provides deterministic services to RIO drops by using, among others, the RSTP protocol for network convergence in case of link loss. Usage of service port only in an open Ethernet network eliminates RSTP capability.

As the Ethernet link loss is the main trigger for network convergence, configure the industrial Ethernet managed switches for optimal network availability.

In this context, the detection time is defined as the maximum time by which the open Ethernet network should detect communication loss and appropriately converge to avoid operational impact.

The maximum recovery time supported by the industrial Ethernet switch network has to be taken as reference to configure the parameters that define the detection time of the communication between the M580 CPU and the BM•CRA31210 adapter modules.

Improper configuration of network convergence (network convergence period is greater than scan rate) leads to an indeterministic network and loss of communication.

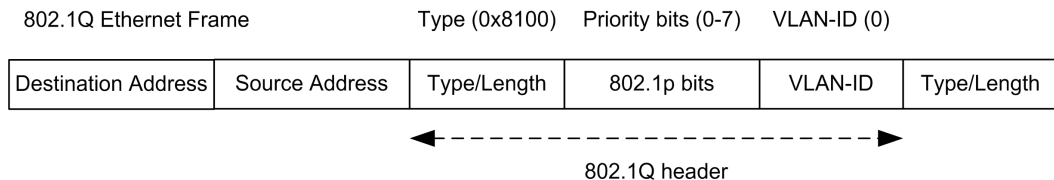
Refer to chapter *Communication Loss Detection Times (see Modicon M580 Standalone, System Planning Guide for, Frequently Used Architectures)* to determine the detection time value of communication loss.

### Setting Traffic Priority

Traffic priority is managed in 802.1Q Ethernet frame header of the packets by setting:

- VLAN-ID field with a unique ID value for every port dedicated to a Modicon M580 CPU and its corresponding X80 RIO drops in the network.  
VLAN-ID field with a unique ID value for every port dedicated to a Modicon BMENOC0301/11 module and its corresponding DIOs in the network.
- 802.1p priority value for every unique DSCP value (refer to the Quality of Service Configuration table ([see page 26](#))).

The following figure represents a typical 802.1Q Ethernet frame header:



### VLAN Identifier (VLAN-ID)

VLAN is used to provide virtual isolation of traffic on the network.

Network traffic with a unique VLAN-ID is produced/consumed by only the devices configured for this VLAN.

## ***NOTICE***

### **LOSS OF CONNECTIVITY WITH THE RIO DROPS**

Do not assign the same VLAN-ID to X80 RIO drops managed by different M580 CPUs.

**Failure to follow these instructions can result in equipment damage.**

Assign as many as necessary VLAN-IDs to create traffic isolation (*see page 19*) between the Modicon M580 CPU and its scanned X80 RIO drops and other modules.

To achieve this isolation, ensure that for every such M580 system being configured in the network, a single unique VLAN-ID is attributed to the switch ports to which the service ports of the modules are connected.

### **VLAN Priority Scheduling**

VLAN priority scheduling is Layer 2 Ethernet switch functionality that prioritizes packet management in buffer overflow situations. For this open M580 architecture, we prescribe that, the lowest priority packets should be dropped from processing in the scenario of a buffer overflow at the industrial Ethernet managed switch level.

### **Quality of Service Configuration**

In the industrial Ethernet managed switch, along with assigning unique VLAN-IDs, care should also be taken in assigning traffic priority to each type of Ethernet packets between the M580 CPU and the respective X80 RIO drops.

Configure the industrial Ethernet managed switches to assign appropriate 802.1p priority to every packet based on the DSCP value embedded in the packet. For example, RIO and CIP safety traffic have high 802.1p priority (that is 5) when traffic with DSCP value of 47 is received at the industrial Ethernet managed switch.

The following table gives the traffic priority to be set in 802.1Q header of the Ethernet packets in the industrial Ethernet managed switch, corresponding to the respective DSCP value:

QoS Level	DSCP Value	Traffic priority bit (802.1p)	Traffic usage	Network usage
Urgent	59 (111011 bin)	7	Network time protocol (NTP) messaging	Time synchronization between CPU and Remote I/O (X80 RIO drops, X80 RIO Safety drops)
Scheduled	47 (101111 bin)	5	Implicit (I/O and safety)	Remote I/O (X80 RIO drops, X80 RIO Safety drops) and CIP Safety devices)

QoS Level	DSCP Value	Traffic priority bit (802.1p)	Traffic usage	Network usage
High	43 (101011 bin)	5	Implicit (I/O)	Distributed I/O (DIO) (EtherNet/IP or Modbus TCP) or CPU to CPU communication
Explicit	27 (011011 bin)	3	Explicit messaging	All equipments (application based)
Other	0 (000000 bin) and other DSCP values	1	Other traffic	Other Messages (for example, DHCP, SNMP, FTP, TFTP, IGMP, SMTP, ICMP, and so on.)

When the switch is configured for VLAN priority scheduling, the least priority packets are dropped. In consequence if Scheduled QoS level traffic such as RIO and CIP safety is not configured to the correct traffic priority (Priority 5), this can lead to a loss of data during buffer overflow scenario.

## ***NOTICE***

### **LOSS OF DETERMINISM AND DISCONNECTION OF THE RIO DROPS**

Verify that the industrial Ethernet switch configuration strictly adheres to the traffic priorities given in the above table.

**Failure to follow these instructions can result in equipment damage.**



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# Chapter 3

## System Performance

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### System Performance

#### Overview

The formulas that apply to typical M580 system for computing the minimum cycle time of tasks and the application response time can be used when you integrate an M580 system to an open Ethernet network.

#### Calculating a Minimum MAST Cycle

If only the MAST task is configured, the minimum MAST cycle time (in ms) can be calculated as follows:

- (number of drops using MAST task) / 1.5

The minimum cycle time for other tasks can similarly be estimated:

- *FAST task*: (number of drops using FAST task) / 1.5
- *AUX0 task*: (number of drops using AUX0 task) / 1.5
- *AUX1 task*: (number of drops using AUX1 task) / 1.5

If multiple tasks need to be configured, satisfy the following conditions (where all cycle times are measured in ms):

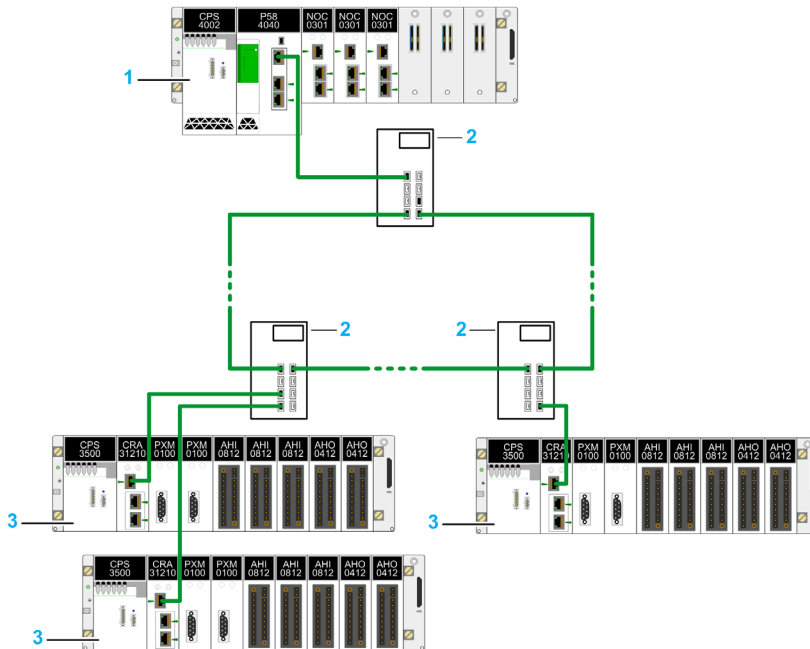
$$\frac{(\text{number of drops using MAST task})}{(\text{MAST cycle time})} + \frac{(\text{number of drops using FAST task})}{(\text{FAST cycle time})} + \frac{(\text{number of drops using AUX0 task})}{(\text{AUX0 cycle time})} + \frac{(\text{number of drops using AUX1 task})}{(\text{AUX1 cycle time})} < 1.5$$

If DIO devices are configured, the minimum cycle time needs to be increased.

#### Application Response Time Example

Application response time (ART) is the time a CPU application takes to react to an input, starting when the input signal triggers a write command from the CPU and ending when the corresponding output module changes state.

The ART example values (provided in the table below) are calculated from the below open M580 system associated with the MAST task:



- 1 M580 CPU with RIO scanner service in the local rack
- 2 Industrial Ethernet managed switch
- 3 X80 RIO drop with BM•CRA312•0 X80 EIO adapter module.

Recall that the ART formula is:

$$ART = (2 * CRA\_Drop\_Process) + (RPI) + (Network\_In\_Time) + (Network\_In\_Jitter) + (CPU\_In\_Jitter) + (2 * CPU\_Scan) + (CPU\_Out\_Jitter) + (Network\_Out\_Time) + Network\_Out\_Jitter$$

For a detailed explanation of each parameter, refer to the ART Computation Parameters topic (see *Modicon M580 Standalone, System Planning Guide for, Frequently Used Architectures*).

The maximum values calculated for the ART computation example with CPU scan time of 50 ms and RPI of 25 ms are:

Parameter	Description and formula	Maximum value (ms) for the M580 open architecture example
<b>CRA_Drop_Process</b>	BM•CRA312•0 processing time <b>CRA_Drop_Process</b> = The sum of BM•CRA312•0 input scan time and queue delay.	<b>CRA_Drop_Process</b> = 4.4
<b>RPI</b>	BM•CRA312•0 input RPI value is depending to the defined CPU task Default values are: <ul style="list-style-type: none"> <li>● 0.5 * CPU period if the MAST task is in periodic mode.</li> <li>● watchdog/4 if the MAST task is in cyclic mode.</li> </ul>	<b>RPI</b> = 0.5 * 50 = 25
<b>Network_In_Time</b>	Network input time <b>Network_In_Time</b> = (network delay based on I/O packet size) * (the number of hops <sup>(1)</sup> the packet travels)	<b>Network_In_Time</b> = (0.078 * 4) = 0.312 <ul style="list-style-type: none"> <li>● 0.078 s is the estimated network delay based on I/O packet size of 800 bytes. The network delay values are estimated and given in the table below.</li> <li>● 4 is the number of hops the packet travels</li> </ul>
		I/O packet size (bytes):      Estimated network delay (µs):
		128                                      26
		256                                      35
		400                                      46
		800                                      78
		1200                                    110
1400                                    127		
<b>Network_In_Jitter</b>	Network input jitter is the delay occasioned by devices <b>Network_In_Jitter</b> = [(network delay) * (number of RIO drops)] + [(network delay) * (number of distributed equipment hops <sup>(1)</sup> )]	<b>Network_In_Jitter</b> = (0.078 * 3) = 0.234 <ul style="list-style-type: none"> <li>● 0.078 s is the estimated network delay based on I/O packet size of 800 bytes.</li> <li>● 3 is the number of RIO drops</li> <li>● There is no distributed equipment</li> </ul>
<b>(1)</b> The maximum potential hop count, which represents the maximum number of switches a packet might pass through from the adapter module BM•CRA312•0 to the CPU. This count includes the switches in both the BM•CRA312•0 X80 EIO adapter module and the CPU with Ethernet I/O scanner service.		

Parameter	Description and formula	Maximum value (ms) for the M580 open architecture example
<b>CPU_In_Jitter</b>	CPU Ethernet I/O scanner service input jitter: CPU input queue delay (owing to RIO drops and DIO traffic) to read packet. <b>CPU_In_Jitter</b> = (1 + (0.07 * (number of RIO drops)))	<b>CPU_In_Jitter</b> = (1 + (0.07 * 3)) = 1.21 ● 3 is the number of RIO drops.
<b>CPU_Scan</b>	CPU scan time User defined, based on application.	<b>CPU_Scan</b> = 50
<b>CPU_Out_Jitter</b>	CPU Ethernet I/O scanner service output jitter: CPU output queue delay (owing to RIO drops). <b>CPU_Out_Jitter</b> = (1 + (0.07 * (number of RIO drops)))	<b>CPU_Out_Jitter</b> = (1 + (0.07 * 3)) = 1.21 ● 3 is the number of RIO drops.
<b>Network_Out_Time</b>	Same formula as network input time <b>Network_Out_Time</b> = (network delay) * (the number of hops <sup>(1)</sup> the packet travels)	<b>Network_OUT_Time</b> = (0.078 * 4) = 0.312 ● 0.078 s is the estimated network delay based on I/O packet size of 800 bytes. ● 4 is the number of hops the packet travels
<b>Network_Out_Jitter</b>	Same formula as Network input jitter without I/O frames from RIO drops <b>Network_Out_Jitter</b> = (network delay) * (number of distributed equipment hops <sup>(1)</sup> )	<b>Network_Out_Jitter</b> = 0 Does not apply. No distributed equipment is connected to the RIO network.
<b>CRA_Drop_Process</b>	BM•CRA312•0 process time <b>CRA_Drop_Process</b> = The sum of the BM•CRA312•0 X80 EIO adapter module output scan time and queue delay	<b>CRA_Drop_Process</b> = 4.4
<b>(1)</b> The maximum potential hop count, which represents the maximum number of switches a packet might pass through from the adapter module BM•CRA312•0 to the CPU. This count includes the switches in both the BM•CRA312•0 X80 EIO adapter module and the CPU with Ethernet I/O scanner service.		

Thus for the M580 open network architecture example, the max ART = (2\*4.4) + 25 + 0.312 + 0.234 + 1.21 + (2\*50) + 1.21 + 0.312 + 0 = 137.078 ms



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# Chapter 4

## System Commissioning and Diagnostics

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### System Commissioning and Diagnostics

#### System Commissioning

The commissioning (see *Modicon M580 Standalone, System Planning Guide for, Frequently Used Architectures*) process described for a typical M580 architecture can be used as reference for the open Ethernet network.

#### System Diagnostic

For detailed module diagnostic data, refer to the respective module user guide:

- For the CPU with Ethernet I/O scanner service, refer to the *Modicon M580, Hardware, Reference Manual*.
- For the BM•CRA312•0 X80 EIO adapter modules, refer to the *Modicon M580, RIO Modules, Installation and Configuration Guide*.
- For the BMENOC0301 or BMENOC0311 Ethernet communication modules, refer to the *Modicon M580 BMENOC0301/11, Ethernet Communication Module, Installation and Configuration Guide*.

**NOTE:** Refer to the *EcoStruxure™ Control Expert, System Bits and Words, Reference Manual* for a detailed explanation of system bits and words.





## I

### 802.1Q

The IEEE protocol designator for Virtual Local Area Network (VLAN). This standard provides VLAN identification and quality of service (QoS) levels.

## D

### DSCP

(*differentiated service code points*) This 6-bit field is in the header of an IP packet to classify and prioritize traffic.

## N

### network convergence

Activity of re-configuring the network in situation of network loss to ensure system availability.

### NTP

(*network time protocol*) Protocol for synchronizing computer system clocks. The protocol uses a jitter buffer to resist the effects of variable latency.

## Q

### QoS

(*quality of service*) The practice of assigning different priorities to traffic types for the purpose of regulating data flow on the network. In an industrial network, QoS is used to provide a predictable level of network performance.

## R

### RSTP

(*rapid spanning tree protocol*) Allows a network design to include spare (redundant) links to provide automatic backup paths if an active link stops working, without the need for loops or manual enabling/disabling of backup links.

## V

### VLAN

*(virtual local area network)* A local area network (LAN) that extends beyond a single LAN to a group of LAN segments. A VLAN is a logical entity that is created and configured uniquely using applicable software.