YASKAWA

YASKAWA AC Drive Products

Ethernet Network Configuration Recommendations

Application Note

Applicable Products: CM090, CM091, CM092, CM093,
SI-EM3, SI-EM3/V, SI-EN3, SI-EN3/V, SI-EP3, SI-EP3/V

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1 Preface

Yaskawa manufactures products used as components in a wide variety of industrial systems and equipment. The selection and application of Yaskawa products remain the responsibility of the equipment manufacturer or end user. Yaskawa accepts no responsibility for the way its products are incorporated into the final system design. Under no circumstances should any Yaskawa product be incorporated into any product or design as the exclusive or sole safety control. Without exception, all controls should be designed to detect faults dynamically and fail safely under all circumstances. All systems or equipment designed to incorporate a product manufactured by Yaskawa must be supplied to the end user with appropriate warnings and instructions as to the safe use and operation of that part. Any warnings provided by Yaskawa must be promptly provided to the end user. Yaskawa offers an express warranty only as to the quality of its products in conforming to standards and specifications published in the Yaskawa manual. NO OTHER WARRANTY, EXPRESS OR IMPLIED, IS OFFERED. Yaskawa assumes no liability for any personal injury, property damage, losses, or claims arising from misapplication of its products.

2 Product Overview

◆ Introduction

Yaskawa AC drives can be placed on Ethernet networks and support various protocols including EtherNet/IP and Modbus/TCP. There are many good resources for Ethernet network configuration recommendations, which this document does not address.

This document describes certain recommended methods for setup of Ethernet networks to achieve the best performance from Yaskawa products.

◆ Intended Audience

This document assumes that the reader is familiar with Ethernet network configurations. *Refer to References on page 10* for a list of resources about these recommendations.

◆ Applicable Products

This document is applicable to the Yaskawa products listed in *Table 1*.

Table 1 Applicable Products

Option Number	Description
CM090	Modbus TCP/IP 7-Series Option Kit
CM091	Modbus TCP/IP V7 Drive Option Kit
CM092	EtherNet/IP 7-Series Option Kit
CM093	EtherNet/IP V7 Drive Option Kit
SI-EM3 SI-EM3/V	Modbus TCP/IP 1000-Series Drive Option Modbus TCP/IP V1000 Drive Option
SI-EN3 SI-EN3/V	EtherNet/IP 1000-Series Drive Option EtherNet/IP V1000 Drive Option
SI-EP3 SI-EP3/V	PROFINET 1000-Series Drive Option PROFINET V1000 Drive Option

3 Yaskawa Recommended Best Practices

◆ Electrical Noise Overview

Electrical noise can cause abnormal operation of Yaskawa AC drives and equipment if proper installation practices are not followed. In the worst cases, it can cause false inputs, offsets to analog signals, interrupted communications, and equipment malfunctions or even equipment failure.

There are two types of noise: conducted noise and radiated noise. Conductive noise flows through electrical conductors, while radiated noise flows through the air. A simple example is shown in ***Figure 1***. In this example, a controller is communicating to a laptop PC over an Ethernet network. The system is subjected to various noise sources, such as a motor, a 2-way radio, and a power supply. Conductive noise from the motor flows through power wires to the input power and then to the controller. Conductive noise from the power supply of the PC flows through the Ethernet cable to the controller and radiated noise flows through the air from the motor and from a 2-way radio.

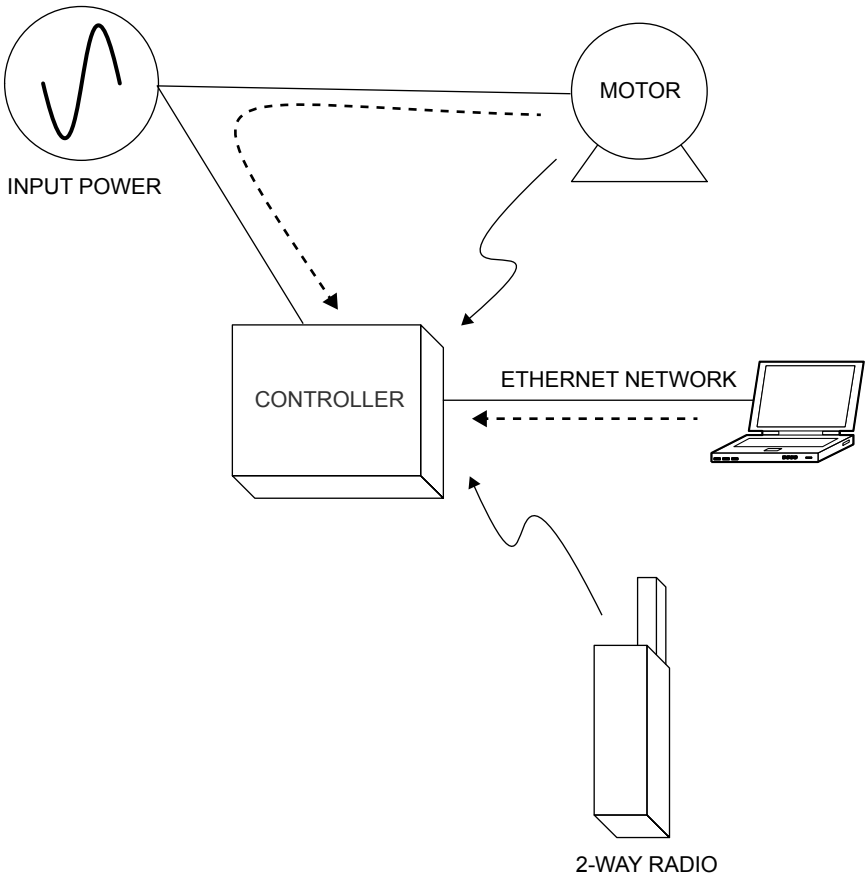

Figure 1 Electrical Noise Example

There are three elements necessary to produce a noise problem: the noise source, the coupling channel, and the receptor. This series of elements is called the “noise path”.

Figure 2 Noise Path

The noise source is the item that creates the electrical noise. Examples of noise sources include a contactor making or breaking a current, a power supply, a transient on the AC line from a starting motor or welding equipment, and variable frequency drives.

The coupling channel transmits the noise from the noise source to the receptor. Examples of coupling channels include wires, panels, metal enclosures, cables, and the air.

The receptor is the equipment that is affected by the noise. Examples of receptors include programmable logic controllers, personal computers, and variable frequency drives.

The effects of electrical noise can be minimized by breaking the noise path. The first step in breaking the noise path is to analyze the system to identify the noise source, the affected equipment (receptor), and how the noise is transmitted from the source to the affected equipment (receptor).

After identifying these factors, take one of three courses of action to break the noise path: The first option is to suppress the noise at the source. The second option is to make the receptor equipment less sensitive to the noise. The last option is to configure the coupling channel to minimize the noise transmission.

◆ Guidelines to Mitigate Electrical Noise

Yaskawa products go through an extensive set of environmental tests prior to releasing for production, including many tests that subject the products to electrical noise. This testing helps identify guidelines under which Yaskawa products will achieve optimum performance. Following these guidelines will help achieve the most trouble-free operation possible.

■ Ground the Variable Frequency Drive (VFD)

Properly ground equipment to earth ground to minimize noise currents from interrupting the controllers and communications. Normally, equipment will have internal circuits referenced to earth ground. The equipment chassis ground must be solidly terminated to building ground using the lowest impedance conductor possible.

For Yaskawa drives, the incoming 3-phase power should include a ground conductor from the AC power source that is terminated to the drive terminal identified in the drive Technical Manual. The 3-phase motor conductors should also include a ground conductor from the motor that is terminated to the drive terminal identified in the drive Technical Manual. Mount the drive to a metal panel that is connected to the building ground, where the mounting screws help conduct ground currents from the drive to the building ground. Noise currents will attempt to find a path back to the source, and if there are poorly connected ground wires, the noise currents may flow in the Ethernet cable and interrupt communications.

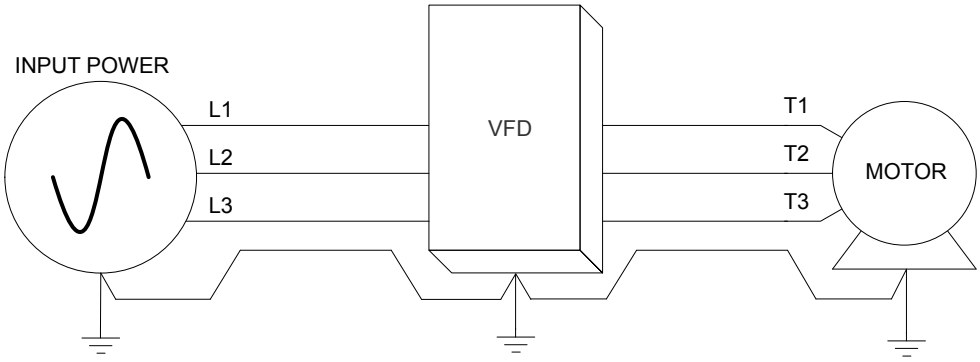

Figure 3 Grounding

■ Ground the Ethernet Option

Properly ground the Ethernet option board to minimize noise currents and noise radiation from interrupting communications. Typically there is a chassis ground wire on the Ethernet option card that must be connected to the proper drive terminal for best noise immunity operation. Follow the guidelines as instructed in the Ethernet option installation guide and technical manual.

■ Ground the Switches and Other Equipment

Properly ground the Ethernet switches and other equipment to minimize noise currents and noise radiation from interrupting communications. Typically there is a chassis ground point that should be connected to earth ground. Follow the grounding guidelines in the technical manuals for those equipments.

■ Use Shielded CAT5e or Better Ethernet Cable

It is strongly recommended that shielded CAT-5e or better patch cable is used for all network cables connected to Yaskawa equipment. The shield will protect the signals from any radiated noise sources. In general, the shield is connected to the case of the Ethernet connector, which is connected to the chassis ground of the drive or switch. It is important to follow the grounding recommendations mentioned above so that any radiated or conducted noise on the shield can be channeled to earth ground to minimize their effects from corrupting the data on the Ethernet signal wires.

■ Route the Ethernet Cable

It is strongly recommended to separate Ethernet cabling from power and control wiring. Route the cables as far away as possible from sources of RF radiation; 5 feet minimum is recommended. If a cable must cross power lines, it should do so at right angles. A good reference for cable routing is PUB00148 available at www.odva.org.

◆ Managed Ethernet Switches with IGMP Snooping

Yaskawa products support the star network topology. Star networks require a hub or a switch. An Ethernet patch cable is connected from each piece of equipment to the hub or switch. A hub retransmits any data packets received from one port to all of the other ports, while a switch retransmits data packets from one port to only those ports with a device that is intended to receive the data packet. Therefore, a switch can help reduce the amount of data packets that a device must process. If network traffic is high, the use of a hub can flood the connected devices with data packets, some of which were not intended for all devices. This unintended flow of data may reach the point where some equipment does not receive data packets of which it was the intended recipient. \

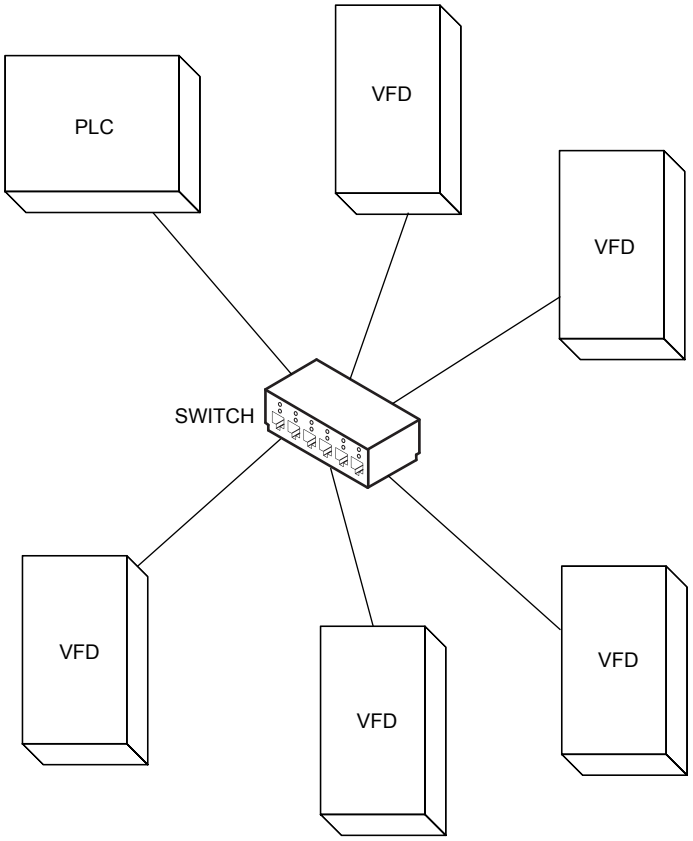

Figure 4 Star Network Topology

Yaskawa recommends the use of managed switches with the capabilities outlined in ***Table 2***:

Table 2 Recommended Properties of Managed Switches

Switch Type	Properties
IGMP Snooping	Switches implementing IGMP snooping are strongly recommended. When IGMP snooping is used, devices will only receive the multicast packets in which they are interested. EtherNet/IP is one protocol that makes use of multicast messages. Without IGMP snooping, all the devices on the network will be flooded with multicast messages that may not be intended for them. Processing an abundance of unintended messages may cause the devices to miss the reception of some messages due to high network traffic.
100 Mbps	Yaskawa products support both 10 Mbps and 100 Mbps speeds, but 100 Mbps speeds allow more data to be passed in a given amount of time to improve network throughput.
Full Duplex	Yaskawa products support both half and full duplex. Half duplex uses the same wires to transmit and receive, which will result in collisions and the devices having to resend data. Full duplex is a more efficient means of communications because it allows simultaneous transmit and receive with no collisions.
Port Mirroring	Port mirroring allows one network switch port to watch the signals from another switch port. This allows a device to be attached a port to log network traffic from the mirrored port, which can assist with any possible troubleshooting.
Auto-Negotiation	The connection made between the switch and the device connected to each port will go through a process to determine the network speed (10 Mbps or 100 Mbps) and the duplex (half or full) for that port.

■ Auto-Negotiation

All devices (e.g., switches, PLC Ethernet ports, Yaskawa options) should be set to auto-negotiate. In auto-negotiation, the connection made between two devices connected directly by an Ethernet cable will go through a process to determine the network speed (10 Mbps or 100 Mbps) and the duplex setting (half or full) for that connection. If one side is in auto-negotiate and the other side is not, the auto-negotiate side will only do half-duplex since it can only negotiate duplex if both sides are in auto-negotiate.

■ Scanning Rates

Consideration should be given on the amount of network traffic being created based upon the I/O scan rate setting of the Programmable Logic Controller. The lower the value for the scan rate (i.e., RPI for EtherNet/IP), the more often packets of data will be sent by the PLC and the devices to which it is communicating. Decreasing values for scan rates will result in more traffic, eventually to the point at which a device can no longer keep up with the data and will start to miss packets. Each protocol has differences on the types of messages and the delivery methods over Ethernet; however, in general, it is advisable to use the highest value for scan rate that the control system can tolerate.

For example, a typical setting for a scan rate (i.e., RPI in EtherNet/IP terms) is 20 ms. If the system or machine can tolerate a higher value such as 50 ms, then the higher value should be used. Yaskawa recommends using a scan rate of no less than 10 ms.

■ Separating Business Networks from Industrial Networks

Industrial networks normally process relatively small amounts of data, but cannot tolerate delayed data. Whereas business networks will normally process large amounts of data, but can tolerate delays. It is important to keep these two networks separate to prevent flooding the industrial network with the data from the business network. If business packet data gets onto the industrial network, then the industrial data packets may not be sent when desired. Furthermore, the packets of data from the business network may flood the industrial network, resulting in some or all of the industrial devices to process this data. The delayed industrial packets on a flooded network can result in decreased performance or even shutdown of the automation system or machine.

However, there are benefits to connecting the business network to the industrial network. Two such benefits are the gathering of statistics and the ability to perform remote maintenance. When connecting the business network and the industrial network, take care to separate different parts of the network to keep the traffic separate. In these cases, consider the use of VLANs and subnets. To allow remote personnel to access the industrial network, use a tool such as a VPN client to keep any outside traffic away from the control network.

4 References

The documents and websites listed in ***Table 3*** can be used as supplemental information to this Application Note. Yaskawa manuals can be downloaded from www.yaskawa.com.

Table 3 References

Item	Description	Type
IG.AFD.25	Installation Guide for CM090 Modbus TCP/IP 7-Series Option Kit	Yaskawa manual
IG.AFD.26	Installation Guide for CM092 EtherNet/IP 7-Series Option Kit	
IG.V7.25	Installation Guide for CM091 Modbus TCP/IP V7 Drive Option Kit	
IG.V7.26	Installation Guide for CM093 EtherNet/IP V7 Drive Option Kit	
SIEPYEACOM01	Technical Manual for SI-EN3/V EtherNet/IP V1000 Drive Option	
SIEPYEACOM02	Technical Manual for SI-EM3/V Modbus TCP/IP V1000 Drive Option	
SIEPYEACOM04	Technical Manual for SI-EN3 EtherNet/IP 1000-Series Drive Option	
SIEPYEACOM05	Technical Manual for SI-EM3 Modbus TCP/IP 1000-Series Drive Option	
SIEPYEACOM06	Technical Manual for SI-EP3/V PROFINET V1000 Drive Option	
SIEPYEACOM07	Technical Manual for SI-EP3 PROFINET 1000-Series Drive Option	
TM.AFD.26	Technical Manual for CM092 EtherNet/IP 7-Series Option Kit	
TM.V7.26	Technical Manual for CM093 EtherNet/IP V7 Drive Option Kit	
TOEPYEACOM01	Installation Manual for SI-EN3/V EtherNet/IP V1000 Drive Option	
TOEPYEACOM02	Installation Manual for SI-EM3/V Modbus TCP/IP V1000 Drive Option	
TOEPYEACOM04	Installation Manual for SI-EN3 EtherNet/IP 1000-Series Drive Option	
TOEPYEACOM05	Installation Manual for SI-EM3 Modbus TCP/IP 1000-Series Drive Option	
TOEPYEACOM06	Installation Manual for SI-EP3/V PROFINET V1000 Drive Option	
TOEPYEACOM07	Installation Manual for SI-EP3 PROFINET 1000-Series Drive Option	
www.industrialethernetu.com	Website with Ethernet training modules.	Other
www.odva.org	Website for the organization that supports network technologies bilt on the Common Industrical Protocol (CIP), including EtherNet/IP. EtherNet/IP and CIP references are here, including the EtherNet/IP specification. Also of interest is PUB00148, EtherNet/IP Media Planning and Installation Manual.	
www.yaskawa.com	Website of Yaskawa America, Inc. Information on products can be found here, including technical manuals, training material, and other application notes.	
Ott, Henry W. Noise Reduction Techniques in Electronic Systems - 2nd Edition. Canada: John Wiley & Sons, Inc., 1988. ISBN 0-471-85068-3	Reference book covering the practical aspects of noise suppression and control in electronic circuits.	

Revision History

The revision dates and the numbers of the revised manuals appear on the bottom of the back cover.

Date of Publication	Revision Number	Section	Revised Content
September 2011	-	-	First Edition
September 2011	1	Section 3	Switched section headings “Ground the Ethernet Option” and “Ground the Switches and Other Equipment”.

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