XM Series

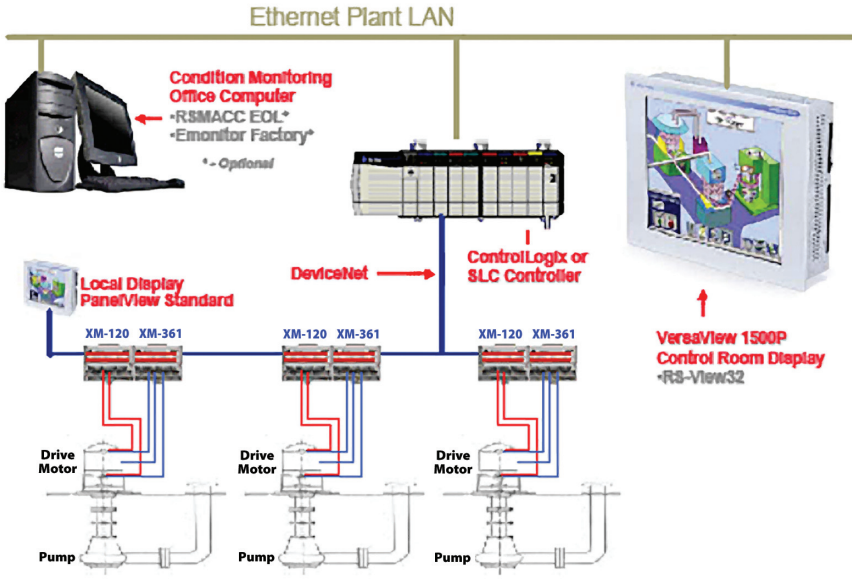
Optimizing the Value in Water / Wastewater Applications

Allen-Bradley

The XM Series moves beyond the typical vibration monitoring and protection system that has been used in Water / Wastewater applications and brings new capabilities to significantly benefit the utility. Like most equipment, the XM Series must be correctly installed and interfaced to achieve maximum benefit and value for the utility.

With its modular design, the XM Series was intended for distributed installations rather than centralized systems. To minimize the costs associated with wiring sensors back to a central location, mount the required XM Series modules as close to the signal source as is convenient. All of the modules are suitable for operation in -20°C to +65°C environments and all carry the CSA Class I, Division 2, Group A, B, C, D rating.

The distributed systems can be interconnected into a single integrated system through a single DeviceNet cable. This system can then be interfaced to a variety of plant control systems either through a direct DeviceNet connection or via a gateway to almost any of the control networks in use today. If network connectivity is not available in a specific plant, traditional relay contact and 4-20 mA analog interfaces can be employed.



Typical Water / Wastewater System Architecture

LISTEN. THINK. SOLVE.®

General Concepts

Historically in W/WW applications, the vibration monitoring system provides basic relay contact outputs for a "warning" and a "danger" level vibration alarm for pre-catastrophic failure detection. Generally each alarm level was a single output that was a combined signal from all sensors on the machine. Occasionally, 4-20 mA analog outputs were taken from each sensor to display on the HMI system.

For any basic machinery catastrophic failure protection system that utilizes overall vibration measurements, this is usually adequate and the XM Series is fully compatible with this approach. However, the XM Series provides integral DeviceNet communications, so interfacing to a control PLC via DeviceNet (or through a gateway to another control network) rather than via physical wires, can reduce installed costs and dramatically increase the amount of data available. Each alarm is now available separately and every measured value can be passed to the control system for display on an HMI. Rather than having just an "overall" vibration alarm for the machine, detailed information is immediately available to operations and maintenance personnel. *The value of the basic protection system is increased.*

The XM-120/121/122 modules go a step further. These modules also generate additional data that can provide predictive maintenance information well in advance of a potential catastrophic failure condition. Using the integral spectrum analysis with frequency band alarms, the XM-120/121/122 modules can detect and alarm machine problems early in the mechanical degradation process. This is extremely valuable information for the Utility's maintenance team to help them avoid unplanned machinery outages but it is useless if the system interfaces do not properly communicate this information.

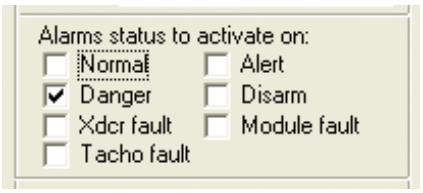
Whenever a system includes the XM-120/121/122 modules, the system interface must communicate the frequency band alarm information to the utility's maintenance team or the predictive maintenance value of these modules is wasted. For each sensor, these modules will provide an overall vibration alarm for catastrophic failure shutdown protection and four frequency band alarms. At a minimum, these four band alarm signals must be passed to the utility's maintenance team. The best solution is one of the network interface options for easy transfer of all the band alarm and measured value data to the people who will use it. If no networks exist, the alarms could be converted to relay contact outputs for a hardwire interface. If I/O is extremely limited, the band alarms could be combined into a single warning relay signal, but this significantly reduces the information content.

If network connectivity is not available, and sometimes even when it is, a local HMI display on the machinery floor can be useful. A PanelView Standard for DeviceNet or a PanelView Plus with DeviceNet interface can be used for direct interface to XM Series modules via DeviceNet with no other controller involved. Alarm displays for all modules on the DeviceNet can be set up along with analog display pages for overall and frequency band measurements.

Whether you are designing a basic protection system or an advanced system with predictive maintenance capabilities, the value of the system for the utility is increased when network interfaces are used instead of discrete wired systems. If the system uses XM-120/121/122 modules, always include some method to communicate the spectrum band alarm information to the maintenance staff.

XM Series Alarms

Depending on the measurements being made in a specific XM Series module, there are between 2 and 18 different alarms that can be configured in an XM Series measurement module. In some modules, the alarms are preassigned to specific measurements. In others, any measurement made within the module can be assigned to any alarm.



Every alarm can be configured to activate when its associated measured value is above/below a setpoint or inside/outside a range. These setpoints and range limits are freely programmable. Each alarm has two setpoint levels associated with it: "alert" and "danger".

Each alarm signal is actually a 3-bit binary data field that represents the conditions shown at the left. The data field for each alarm is part of the DeviceNet message data and is available to the plant control system as a digital input. Also the alarm information is used as control input data for all XM Series relays. When configuring a relay, any or all of the conditions shown can be selected to activate a relay control input.

XM Series Relays

Every 2-channel XM Series measurement module contains one Double Pole Double Throw (DPDT) relay within the module and can

control four additional "virtual" relays. A virtual relay is available as an output on the DeviceNet network or all four can be converted to physical relays by mounting an XM-441 Relay Expansion module to the right side of the XM Series measurement module.

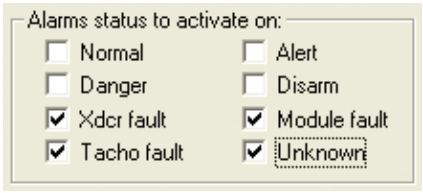
Every 6-channel XM Series measurement module can control eight virtual relays. Adding two XM-441 Relay Expansion modules will convert them to eight physical DPDT relays.

A relay that is contained in or controlled by a measurement module can only be activated based on alarm signals generated within that specific measurement module. These relays can only accept one or two control inputs (alarms) and have AND/OR logic. These relays will function independent of the DeviceNet connection.

The XM-440 Master Relay module is more versatile. The XM-440 functions as a network master or shared master on the DeviceNet network and can access all the alarm signals and the relay status of any XM Series measurement module that is in its network scan list.

The XM-440 contains four physical DPDT relays and eight virtual relays. Adding two XM-441 Relay Expansion modules will provide twelve physical relays for the XM-440. Each of these relays can have up to 16 control inputs (alarms or relays) from any module in its scan list. The relays utilize "a" out of "b" voting for the assigned inputs.

Frequently one XM-440 relay is configured as a failsafe system health indicator. It monitors all modules on the scan list for the four conditions shown below. The relay is set as normally closed so any fault on any module or loss of communications or power to any module will deenergize the relay. We recommend implementing this function to provide maximum system reliability.



The XM-440 relays can provide the trigger signal for any XM modules on its scan list if triggered trend data storage is being used. Also, the XM-440 maintains a time stamped event log for alarm and relay status changes on any module in the scan list.

Because the XM-440 module links to the measurement modules via DeviceNet, it is not necessary for the XM-440 to be physically adjacent to the other modules. If it would make system wiring more convenient if the relay contacts were physically located in a different place, lower your installation cost further by mounting the XM-440 close to where the output contacts will be utilized.

DeviceNet

All of the XM Series modules function as active nodes on a DeviceNet network and utilize DeviceNet for all external data communications. All measurement modules are DeviceNet slaves and the XM-440 can be configured as a DeviceNet master or shared master. DeviceNet scanner modules for the PLC are normally configured as DeviceNet masters; however, it is best to configure the XM-440 as the primary master for its slaves for machinery protection. Gateways to other networks can be either DeviceNet masters or shared masters or can operate as simple data pass-through devices.

For details about the configuration of DeviceNet networks, refer to the "Planning and Installation Manual — DeviceNet Cable System" published by ODVA (formerly Open DeviceNet Vendors Association) and available for download from the internet at: http://www.odva.org/index.htm.

Messaging

The XM Series modules utilize multiple DeviceNet messaging protocols. Change Of State (COS) messages are used for communicating changes in relay and alarmstatus. The COS message ranges from 2 bytes to

Assembly instance 100								
Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	Relay 1 status	Set point multiplier	Alarm status 2			Alarm status 1		
1	Relay 2 status		Alarm status 4			Alarm status 3		
2	Relay 3 status		Alarm status 6			Alarm status 5		
3	Relay 4 status		Alarm status 8			Alarm status 7		
4	Relay 5 status		Alarm status 10			Alarm status 9		
5			Alarm status 12			Alarm status 11		
6			Alarm status 14			Alarm status 13		
7			Alarm status 16			Alarm status 15		

9 bytes, depending on the number of alarms and relays supported within the module and has highest priority on the DeviceNet network. The diagram above shows the 8 byte COS message format for an XM-120 module. COS messages are broadcast by a slave module whenever a monitored state changes and can be read by any master or shared master that has this module in its scan list.

The second messaging technique used by the XM Series modules is Poll messaging. Poll messaging is used by a DeviceNet master to request data from a specific XM Series slave module on the network. Poll messaging is used to pass the analog measurement values for the XM Series measurement modules to the higher level control systems. All of the XM Series analog

values are double-word (4 byte) data values. There are preconfigured Assembly Instances for the measured values that range from 8 bytes to 124 bytes in length depending on the XM Series module. The Poll message size can be reduced by transmitting only the data values actually required at the higher level control system. Each value is a floating point number that takes 4 bytes. In addition, it is possible to configure a custom Assembly Instance that can include alarm setpoint and relay configuration information along with the measured values.

Explicit messaging is the final class of message protocols used by the XM Series. Explicit messaging allows a DeviceNet gateway or master to read any specific piece of information that is contained in a XM Series module – either data values or configuration settings. Explicit messaging can be used to read data that has not been mapped to an I/O data table in a scanner module. Explicit messaging is the primary communication protocol used for HMI when using an OPC Server interface. Explicit messaging through an Ethernet gateway is also used to transfer time waveform and frequency spectrum data or captured trend data from a XM Series module to a higher level control system.

The Allen-Bradley® PLC products can interface directly to DeviceNet through the use of the appropriate scanner card in the I/O rack. With ControlLogix, use the 1756-DNB to connect to the XM Series. When configured as a DeviceNet master scanner, data from the XM module is mapped to the I/O data table of the 1756-DNB and is then available to the ControlLogix as standard I/O data. The 1756-DNB can also be configured as a simple pass-through device which allows full access to all data from the XM Series modules directly on the backplane bus of the ControlLogix rack. Data, including spectrums and time waveforms, can then be directly passed to the EtherNet/IP connection on the ControlLogix for transfer to other Rockwell Automation vibration analysis software such as RSMACC Enterprise Online (EOL) and Emonitor software.

For use with the SLC-500 Series PLCs, the 1747-SDN will be required. For the PLC-5 Series, use the 1771-SDN module in the I/O rack. Both of these SDN modules are DeviceNet master scanners and all data is mapped to an I/O table for transfer to the PLC. Neither of these platforms offer a direct connection to Ethernet. All data must pass through the PLC processor before it can be transferred to Ethernet. Because of this, the direct DeviceNet connection to either processor should be limited to COS and analog Poll data. Attempting to pass spectrum and time waveform data using Explicit messaging will consume excessive amounts of processor capacity and impact system performance. All XM Series analog values are double-word floating-point data, so with the SLC-500 Series it will be necessary to swap the word order in ladder to allow the data to be properly read by the processors.

Several non-Allen-Bradley PLC products offer DeviceNet scanner modules as part of their PLC systems or through third-party suppliers. If these scanners comply with the ODVA standards, they should work correctly with the XM Series.

The XM Series modules can generate a significant amount of data on DeviceNet and the data available from a multi-module XM system can easily exceed the data table capacity of most DeviceNet scanners. Each different scanner module has a different data table capacity (some 3rd party scanners are rather limited) so it is important to carefully evaluate the data requirements on a system and plan the data table layout and Poll message design to ensure all critical information can be accessed in the PLC. Start by allocating the COS messages and then add Poll message data as required and as data table space is available.

Gateways

There are a variety of gateways available to connect the DeviceNet network to other types of networks. Rockwell Automation gateways support both ControlNet and Ethernet/IP networks. Third-party gateways such as the Anybus-X gateway from HMS Industrial Networks can support interfaces to networks such as Modbus TCP, Modbus Plus, Modbus RTU, Profibus, etc.

Rockwell Automation offers the 1788-EN2DN gateway for interfacing to an Ethernet/IP network. This gateway will connect to any other equipment that supports Ethernet/IP and allows access to the XM Series modules with the RSMACC EOL and Emonitor Gateway software. It can be configured to simply pass through all of the data from all of the XM modules or it can function as a DeviceNet scanner with the inherent data table limitation of a scanner. The 1788-EN2DN can handle 496 bytes of mapped data.

The 1788-CN2DN is a similar product that is designed to support ControlNet interfaces. It also can function as a pass through device or as a DeviceNet scanner. It will handle 496 bytes of mapped data.

The Anybus-X gateway from HMS Industrial Networks will link the XM Series DeviceNet network to most industrial networks available from other equipment suppliers. The

gateway can transfer 512 bytes of data and the output format is restricted by the requirements of the network it is interfacing to.

All of the DeviceNet scanners and gateways are configured by using RSNetWorx software for DeviceNet and require RSLinx software to provide the required communications drivers.

Through the use of the appropriate gateway or scanner module, the XM Series can be linked to virtually any other control system network for easy transfer of data between the systems.

HMI Displays

Using a PanelView Standard for DeviceNet or a PanelView Plus with DeviceNet interface option, it is possible to provide a full graphic HMI display capability for an XM Series system without adding any other controller. Both of these displays can communicate directly to the XM Series modules and access all alarm and measurement values using OPC/DDE topics. They are ideal for providing local operator displays in the machinery areas. The PanelView Standard and PanelView Plus have features that make it easy to configure with the XM Series and bring needed graphic details.

Typical displays would show all of the module alarms and relay status information on a master alarm panel. Additional display pages would be used for analog dial or bar displays of the overall and frequency band vibration levels versus the alarm set points for each sensor. Programming these displays would require PanelBuilder for the PanelView Standard and FactoryTalk View ME for the PanelView Plus.

These displays are only capable of showing the single-value analog information. They can't display time waveforms or frequency spectrums from a XM-120/121/122 module. The PanelView Plus can also trend data from any analog parameter.

Displaying all of the information available from the XM Series modules requires the use of software that was designed specifically for the XM Series. On a local basis, the Serial Configuration Utility that ships with every module can fully configure any XM Series module and view any data from the module including alarm status, time waveforms, spectrums, and triggered trend or start-up / coast-down data. With a DeviceNet to Ethernet gateway connection path to the XM system, the RSMACC EOL software can be used to perform almost all of the same functions from a remote location. Using the Emonitor Gateway software, all of the XM module data can be loaded into the Emonitor software database for long term data archive and analysis as part of a comprehensive predictive maintenance program.

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Publication ICM-PP003A-EN-P - May 2009