

# SKF Multilog On-Line System IMx-M



User Manual Part No. 32179800-EN  
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Protection FW 378  
IMx-M Manager 2.1.31

**⚠ WARNING!** Read this manual before using this product. Failure to follow the instructions and safety precautions in this manual can result in serious injury, damage to the product, or incorrect readings. Keep this manual in a safe location for future reference.

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US 6,437,692 • US 6,489,884 • US 6,513,386 • US 6,633,822 • US 6,789,025 • US 6,792,360 •  
US 7,103,511 • US 7,697,492 • WO/2003/048714

### General Product Information

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# 1 Introduction

## Important Messages

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The following messages are important information that require special care in order to have a safe and reliable IMx-M system.



***Important messages, instructions and information in this manual must be followed carefully. Otherwise, harm might occur to equipment and/or personnel.***



***IMx-M shall be used for speed alarming only. It shall not be used to protect/trip machine on overspeed. IMx-M does not fulfill the requirements related to overspeed protection.***



***All safety critical decisions must be driven by the data from the protection module.***

- ***Always use relay outputs for the safety/danger triggering.***
- ***Use @ptitude Observer only for monitoring purposes.***
- ***Use 4-20 mA outputs only for monitoring purposes.***
- ***Use Modbus data only for monitoring purposes.***

***Note: Be sure to always monitor the circuit fault status (circuit fault relay).***



***In order to ensure a safe system, installation, configuration and maintenance of the system must be done by trained personnel only.***



***An IMx-M rack/cabinet contains circuit boards that are static sensitive. Therefore, appropriate precautions must be used to prevent electrostatic discharge (ESD) when handling circuit boards, refer [Rack/Cabinet](#).***



***Each module must be placed correctly in the designated slot. The designated slot of the each module is shown in [Front Panel](#) in Drawings and Connections section.***



**A condition monitoring module (CMM) and a protection module (PRM) must be installed as a pair in order to ensure the internal power redundancy.**



**Due to the physical reason, when mounting a pair of CMM and PRM, must always mount the PRM before the CMM in order to avoid any damages to the PRM. However, when dismantling a pair of CMM and PRM, it must be the other way around. Always dismantle the CMM before the PRM. Otherwise, the PRM can be seriously damaged.**



**In general, all signal cables must be routed as far away as possible from the high voltage cables.**



**It is always recommended to use high quality shielded cables and care must be taken to ensure that the shield is properly connected to eliminate interference and noise.**



**Grounding procedure must be handled with special care to prevent ground loops:**

- **Be sure to read "[Signal Grounding](#)" and "[Signal Isolation](#)" chapters thoroughly and understand them.**
- **SKF USB isolator cables must always be used when connecting to IMx-M USB ports.**
- **Equipment connected to buffered outputs must be isolated from the protective earth.**
- **Instrument ground (IGND) should be connected and joined to protective earth/ground at one point only.**
- **In general, it is recommended to connect shield to the ground in only one side of the sensor/signal cable to avoid potential ground loops.**



**An IMx-M rack must be connected to protective earth since surge suppressors are connected between network terminals and protective earth.**



**Make sure that protective earth and instrument ground (IGND) are properly connected before connecting any of the input or output terminals of IMx-M rack.**



**All wires and cables connected to input and output terminals shall have a flammability rating VW-1, FT-1 or fulfill the requirements according to IEC 60332-1-2 or IEC 60332-2-2.**



**Because of the redundant power supply, both supply circuits (power connectors AC1 and AC2) must be disconnected before maintenance. Refer to [Mains Power](#) section.**



**Caution to a possible hazard due to mains power double pole/neutral fusing.**



**An IMx-M rack must be situated in a cabinet with a metal bottom or plastic bottom with flammability classification of at least V-1. The cabinet must fulfill at least IP 20.**



**Each IMx-M rack must be equipped with a forced ventilation which has a feed of at least 3 x 95 m<sup>3</sup>/h (unrestricted airflow). The rack environment temperature shall be kept as low as possible, ideally below 30 °C / 86 °F.**

- **IMx-M is designed to operate in an environment of maximum operating temperature of 65 °C / 149 °F. However, operating IMx-M at this temperature shall be avoided as it will drastically shorten the lifetime of all components.**
- **PRM with revision number 20 and above has an internal temperature measurement device/sensor. The internal temperature is monitored and registered via Event Log. If the rack is operated above 65 °C / 149 °F, the warranty will be voided.**
- **The recommended fan tray is of at least 3 x 12 cm fan and must be mounted directly above or below each IMx-M rack (see [Cooling](#) section for the proper installation guidelines).**
- **The cooling fan must be UL or CSA approved and inspected regularly for optimal performance.**



**The IMx-M rack is a class A equipment intended for use in an industrial environment.**



*The usage of 4-20 mA outputs is only for monitoring purposes. Use relay outputs for safety alert/danger triggering.*



*In order to release rack/slot disarm the following conditions must be met:*

- *Rack disarm shall not be released until the rack is configured properly and is running with a correct firmware. Be sure to read "[Disarm](#)" chapter and "[Protection Firmware Update](#)" chapter thoroughly and understand them.*
- *Slot disarm shall not be released until the protection module and the associated relay module are configured properly and are running with a correct firmware. Be sure to read "[Disarm](#)" chapter and "[Protection Firmware Update](#)" chapter thoroughly and understand them.*
- *Evaluate circuit faults with the diagnostic command "cf" before rack/slot disarm is released. Be sure to read "[Circuit Faults \(cf\)](#)" chapter thoroughly and understand it.*
- *Evaluate channel alarms after a configuration update but before disarm is released to avoid unwanted alert/danger alarms triggered upon arm of channel/rack/slot.*
- *Note: A premature release of rack/slot disarm may cause a missing or invalid configuration, which would be indicated as a circuit fault.*



*In order to perform hot-swap, the following conditions must be met: (See section [Hot-swap](#) for proper procedures)*

- *The rack must be set in rack disarm mode before the hot-swap procedure takes place. Be sure to read "[Disarm](#)" chapter thoroughly and understand it.*
- *After the hot-swap but before the rack/slot disarm is released, user must ensure that the rack/protection module and the associated relay module are properly configured. Be sure to read "[Protection Configuration Update](#)" chapter thoroughly and understand it. Evaluate circuit faults with the diagnostic command "cf" as described in chapter "[Circuit Faults \(cf\)](#)".*
- *After the hot-swap but before the rack/slot disarm is released, user must ensure that the rack/protection module and the associated relay module are running with a correct firmware. Be sure to read "[Protection Firmware Update](#)" chapter thoroughly and understand it. It is always recommended to check with the diagnostic command "[intd0](#)" that the correct firmware is running on all protection MCUs. Evaluate circuit faults with the diagnostic command "cf" as described in chapter "[Circuit Faults \(cf\)](#)".*
- *In case of hot-swap of a power supply unit, be sure to read "[Power Supply](#)" chapter thoroughly and understand it.*



*DIP switch settings must be handled with a special care to prevent any damage to the IMx-M rack:*

- *Do NOT change DIP switch settings while the IMx-M rack is powered-up, as this may cause damage and void warranty.*
- *Before powering up the IMx-M rack, make sure that DIP switch settings are properly set to match the recommendations for the connected sensors. Incorrect settings may cause permanent damage to the IMx-M rack.*



The @ptitude Observer Monitor in turn can be connected to e.g. a LAN network making it possible for several of @ptitude Observer clients to link to this network.

It is also possible to connect different types of on-line units in the same network, for example, IMx-M together with IMx-S and DMx.

## IMx-M General Overview



Figure 1 - 2.  
A Fully Equipped IMx-M Rack.

The above figure shows an example of a fully equipped IMx-M rack with (from left to right) two redundant power supply units, three relay modules and four pairs of a condition monitoring module and a protection module.

- Each module may also be referred to as a “slot”.

### IMx-M Rack and Components

Designed to fit into a 19" rack enclosure, an IMx-M rack is equipped with the following components:

- Power supply unit (PSU or PSU slot)
  - Two redundant power supply units
- Relay module (RLM or RLM slot)
  - Up to three relay modules
  - Each relay module has 32 relays (28 SPDT and four DPDT), hence up to 96 relays in total with up to three RLM

- All relays are placed upon relay modules except for circuit fault and disarmed relays which are placed upon protection module.
- All relays upon relay modules are user configurable.
- Condition monitoring module and protection module pair ("CMM + PRM" or "CMM + PRM slot")
- Up to four pairs of a condition monitoring module and a protection module
- Analog channels
  - Each CMM + PRM slot has 16 analog signal inputs
  - Up to 64 analog signal inputs in total when having four CMM + PRM slots
  - The dynamic signal inputs are configurable for a wide variety of sensors. Signals, such as acceleration, velocity and displacement or other parameters are easily adopted. Each input can also be configured for standard accelerometers, 4–20 mA or  $\pm 23$  V.
  - Several measurement points may be attached to one channel and both AC and DC measurements can be measured on the same channel
- Digital channels
  - Each CMM + PRM slot has eight digital channels
  - Up to 32 digital channels in total when having four CMM + PRM slots
  - Digital channels are available for measuring speed, trigger or digital status; for example, indicating when a measurement can take place

### IMx-M System Main Parts

- **Machine protection part** for the safety related functions which consists of protection modules and relay modules.
- **Condition monitoring part** for early fault detection (non-safety related functions) which consists of condition monitoring modules.
- Power supply units are a common part for both machine protection and condition monitoring.

### IMx-M's Unique Features

- Individual conditions for alert and danger may be set for each measurement point.
- Each channel has indicators for alert and danger. However, it is also possible to manually bypass the alert and danger functionality.
- The rack is offering remote reset of latching alert/danger conditions.
- All channels are fully computed in parallel, both condition monitoring and machine protection.
- The built-in hardware auto-diagnosis system continuously checks all sensors, cabling and electronics for any faults, signal interruption, short circuits or power failure.



- The design ensures that a single circuit failure cannot affect more than two measurement channels and it is possible to detect and indicate the circuit failure.
- The system makes it possible to have selected channels configured for redundancy. All channels are designed to prevent any one channel from affecting any other channel.

### **Condition Monitoring Module (CMM) Buffer Storage Capacity**

- Each condition monitoring module has 8 MB flash memory used for the following.
  - 2 MB for firmware, configuration files, etc.
  - 2 MB for trend value buffer
    - About 13 000 vibration trend values can be buffered
    - Speed and process data use half the space of vibration
  - 4 MB for spectra and time signal buffer
    - About 250 spectra using 1 600 lines with phase and time signal can be buffered
    - If more lines are used, the number of spectra is reduced.
    - If less lines are used, the number of spectra is increased
  - When the buffer gets full, the oldest data is thrown away.

### **Initiating an IMx-M**

- The machine protection configuration is done through the application tool called [IMx-M Manager](#) and a (portable) computer using the USB interface located on protection modules or via @ptitude Observer over an Ethernet connection.
- The condition monitoring configuration is done through @ptitude Observer software.
- All initial [network configuration](#) parameters, such as IP address, IMx identification number, etc. are done through the application tool called IMx-M Manager. The parameters are stored first in a separate configuration file, then transferred to the IMx-M memory.
- The configuration is retained in the event of power losses, so that the IMx-M can start automatically when power returns.

### **IMx-M Mean Time to Failure (MTTF)**

IMx-M MTTF was calculated to 20,8 years, where the protection module has 25,2 years, the relay module has 139,6 years and the backplane has 772,3 years.

The calculation was done under the environmental conditions 40 °C / 104 °F and for the following configuration of the IMx-M machinery protection system:

- two analog input channels
- four alarm relay outputs
- two analog buffered outputs
- one digital eddy current probe input
- one digital buffered output
- two front panel analog buffered outputs
- one front panel buffered digital output
- two RS485 outputs
- Disarm input, disarm relay and circuit fault relay

## Safety Considerations

---

The following are some of the PRM safety related issues that should be considered.

**Table 2-1: PRM related safety considerations.**

Cause	Effect
PRM firmware is being updated	Protection functionality of PRM slot is not active and all relays go to non energized state.
PRM configuration is being updated	Protection functionality of PRM slot is not active and all relays go to non energized state.
Updating CMM FW through the Observer database distribution (automated)	Rack signaling CF (circuit fault) = Rack not trustable unless Modbus is used to verify channel status registers and the register System Status 1.
Updating the CMM firmware directly on the rack by using the IMx-M Manager (USB)	PRM slot signaling CF = PRM slot not trustable unless Modbus is used to verify channel status registers and the register System Status 1.
Entering Maintenance mode	Protection functionality of PRM slot is not active because PRM slot has to be disarmed to enter the maintenance mode.
Updating Observer software (uninstall old version and install new version, put new firmware in DB, etc.)	Rack signaling CF = Rack not trustable unless Modbus is used to verify channel status registers and the register System Status 1.
Change or update CMM settings or configuration via Observer	Rack signaling CF = Rack not trustable unless Modbus is used to verify channel status registers and the register System Status 1. Because CMM is rebooting, PRM cannot store safety events and will be signaling circuit fault.
Change or update CMM settings or configuration via IMx-M Manager (USB)	PRM Slot signaling CF = PRM slot not trustable unless Modbus is used to verify channel status registers and the register System Status 1. Because CMM is rebooting, PRM cannot store safety events and will be signaling circuit fault.
Disarm (slot or rack)	Protection functionality of PRM slot is not active, refer <a href="#">Disarm</a> .
Hot-swap of any module in the rack	Protection functionality of Rack is not active because the rack (all slots) shall be in disarm mode during a properly performed hot-swap procedure.

## Accuracy

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### Facts to Consider Regarding Accuracy

- Protection modules (PRM) and condition monitoring modules (CMM) can show different values due to the following reasons.
  - They are two separate individual measurement devices.
  - They have two different purposes. PRM is to optimize the quick response time as defined in API 670 whereas CMM is to optimize the early fault detection.
  - They use two different measurement algorithms.
  - They have two different filter setups.
- API 670 specifies  $\pm 1\%$  and  $\pm 0,5$  dB filters in passband which leads to  $\pm 6\%$  in total.
- Calibration of reference instruments does not mean it is exact. It only means that it is within the specification.
- Note that most reference instruments are not accurate for low frequencies below 50 Hz.
- The following diagram shows an example of same or different readings for PRM and CMM depending on the input signal frequency in conjunction with filters.

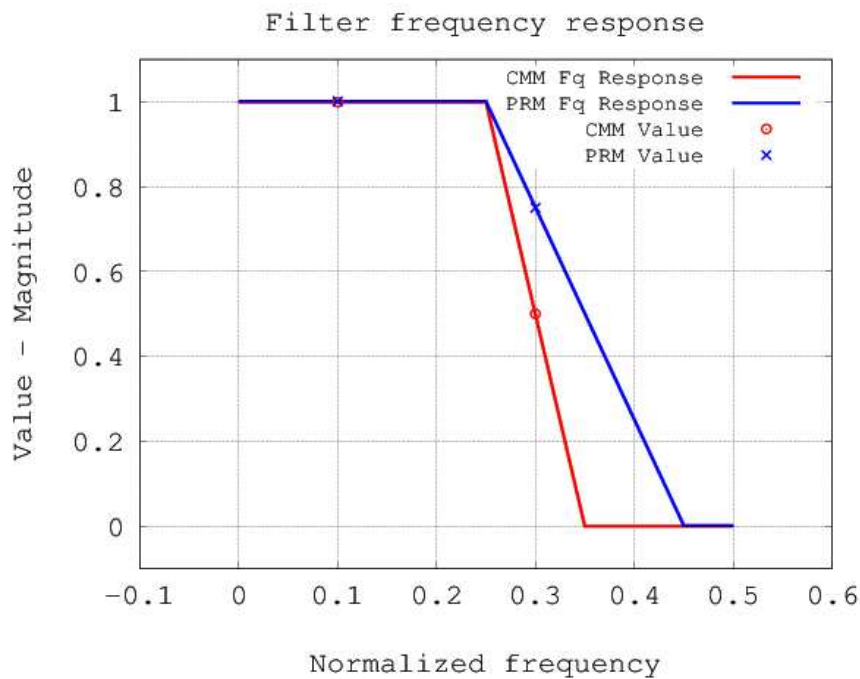


Figure 2 - 1.  
Comparison of PRM and CMM Readings.

### **Accuracy is Relative to API 670 Defined Full Scale**

Example:

For an amplitude accuracy of 2 %

API 670 defined full scale: Axial position  $\pm 1$  mm  $\Rightarrow$  Accuracy =  $\pm 20$   $\mu$ m

#### **Incorrect:**

Measured value = 52  $\mu$ m

Input signal = 50  $\mu$ m

Error = Measured value – Actual value = 52 - 50  $\mu$ m = 2  $\mu$ m

Error in % = Error / Input signal  $\Rightarrow$  2 / 50  $\Rightarrow$  4% error

#### **Incorrect:**

Measured value = 0.01  $\mu$ m

Input signal = 0  $\mu$ m

Error = Measured value – Actual value = 0.01 - 0  $\mu$ m = 0.01  $\mu$ m

Error in % = Error / Input signal  $\Rightarrow$  0.01 / 0  $\Rightarrow$  Infinite

#### **Correct:**

Error = Measured value – Actual value = 52 - 50  $\mu$ m = 2  $\mu$ m

Error in % = Error / API 670 Full scale = 2 / 1000  $\Rightarrow$  0.2% error

## Measurement Types

---

### Analog Channels

- [Casing Vibration](#)
- [Eccentricity](#)
- [Gap](#)
- [Other](#)
- [Piston Rod Drop](#)
- [Position](#)
- [Radial Shaft Vibration](#)
- [Temperature](#)

### Combined Measurements

- [Absolute Shaft Vibration](#)
- [Complementary Differential Expansion](#)
- [Piston Rod Drop XY](#)
- [Temperature Difference](#)

### Digital Channels

- [Speed](#)

## Absolute Shaft Vibration

**Absolute shaft vibration** is a technique for determining the total amount of shaft displacement relative to some point in free space (such as the securing bulkhead). The concept is shown in the figure below.

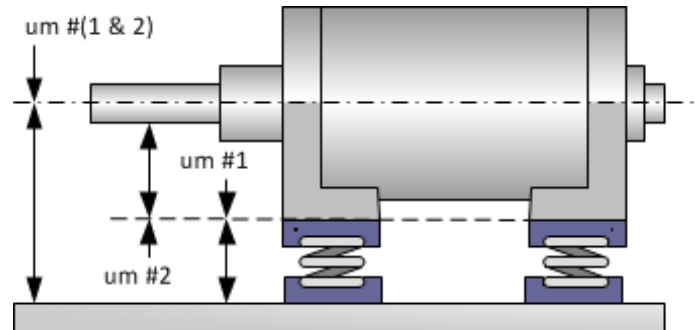


Figure 2 - 2.  
Absolute Shaft Vibration.

However, what actually is observed here is that absolute displacement is the difference between two different forms of displacement, namely:

- Displacement of the machine relative to the securing bulkhead ( $\mu\text{m}$  #1), which can be determined by means of a velocity sensor secured to a fixed point (such as a bearing casing), the output of which is integrated to a displacement value in  $\mu\text{m}$  or mil.

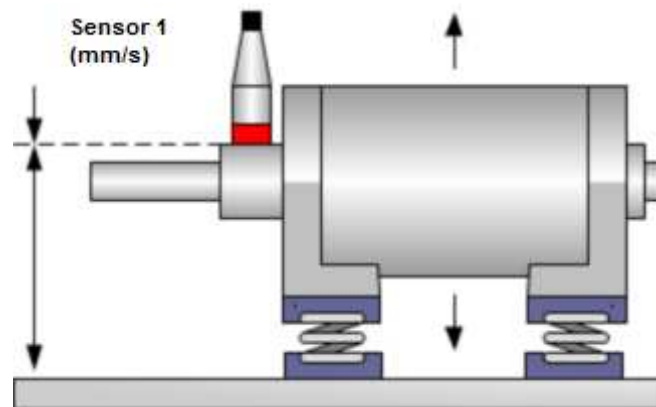


Figure 2 - 3.  
Measuring the Vibration of the Machine.

- Displacement of the shaft relative to the machine itself ( $\mu\text{m}$  #2), which can be determined by means of a proximity probe, secured firmly to the machine casing.

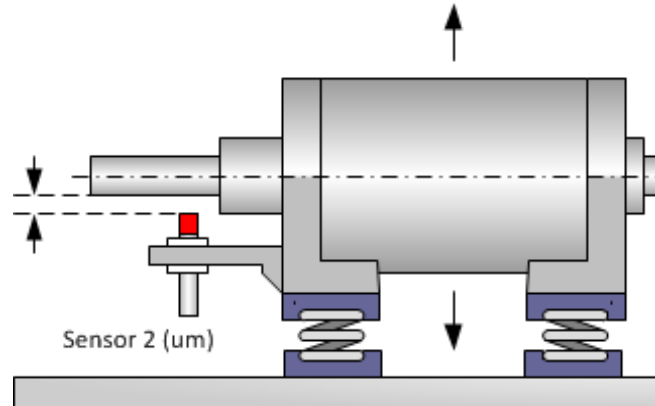


Figure 2 - 4.  
Measuring the Vibration of the Shaft Relative to the Machine.

Therefore, to determine the absolute shaft displacement, what must be done is to attach both a velocity sensor and a shaft displacement probe to the machine being analyzed, then either sum or subtract the returned displacement values (see figure below).

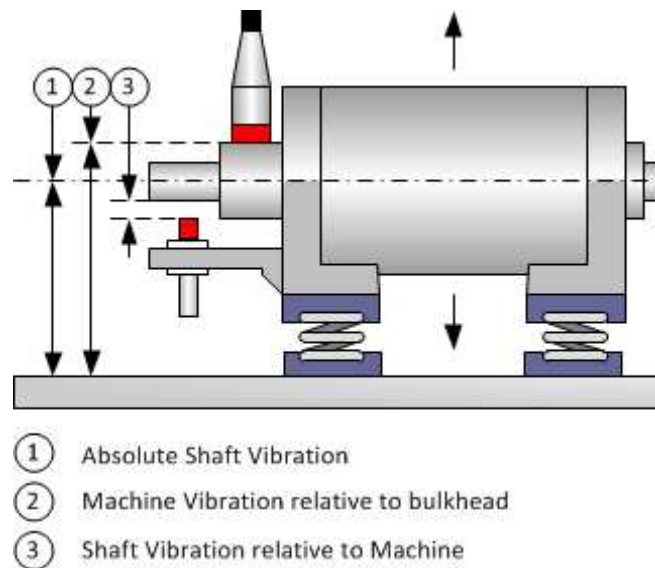


Figure 2 - 5.  
Determining the Absolute Shaft Vibration.

### Casing Vibration

**Casing vibration** is used for measuring vibration on machines such as gears, pumps, fans, and motors equipped with rolling element bearings (API670 definition).



## Complementary Differential Expansion

**Complementary Differential Expansion (CDE)** uses signals from two analog channels of combined measurements to extend the measurement range.

This setup is required to determine the axial displacement of the proximity probe collar, due to thermal expansion of the main rotor shaft. As the shaft expands, the proximity collar moves away from one sensor towards a second sensor, effectively doubling the total proximity sensing range.

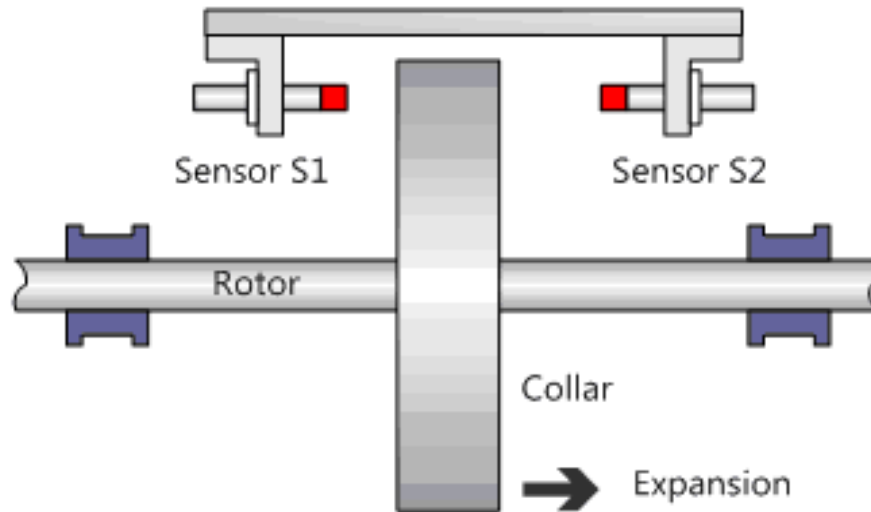


Figure 2 - 6.  
Complementary Sensor Setup.

For this example:

- Sensitivity of sensor S1 and S2 is 1 000 mV/mm.
- Sensor S1 will be connected to Channel 1 and sensor S2 to Channel 2.
- We will assume that the collar is closer to sensor S1 when there is no rotor expansion, but closer to sensor S2 when the rotor is at maximum expansion.
- Channel 1 will have the target positive direction set as "Active / Normal (away from probe)" whereas Channel 2 will be set in reverse.
- Sensor S1 is selected as the master sensor. It is the output of this sensor which will determine when measuring of the displacement will switch from Sensor S1 to Sensor S2.

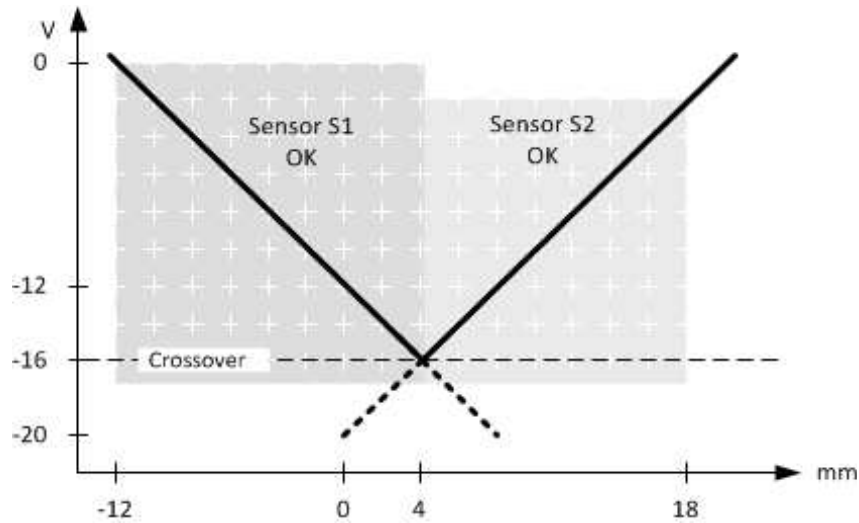


Figure 2 - 7.  
Example of a Complementary Sensor Graph.

### Eccentricity

**Eccentricity** is used for measuring the bow of a rotor at slow roll. It measures peak to peak within the measuring range of 3 to 600 rpm by using displacement sensor.

### Gap

The **Gap** measurement and alarming is provided to enable the measurement of the probe tip to object distance.

It is also possible to configure alarms which among other uses can be used to enable protection from damage that caused by the shaft coming too close to the sensor and touching sensor and/or machine.

The Gap measurement is essentially picking out the DC component of the sensor signal. This measurement value, obtained in volt, can be used to measure the long term/low frequency displacement/movement of the shaft. To make it useful for protection there are a set of configurable alarms associated with the Gap measurement.

The Gap alarm levels are configurable in volts, which is also the measurement unit used for the Gap measurement.

- The user should exercise caution when translating Gap distances into volts.

The Gap alarming can be used in conjunction with Radial shaft vibration or Eccentricity as a means of protecting the shaft from touching the proximity probe by setting an alarm if the shaft gets outside the configured alarm levels.

### Supported sensor-types

Typically it is used in combination with proximity probes of Eddy current type.

The Gap measurement value and alarm status is available to the user through the following interfaces:

- Front panel Display/LEDs
- Modbus

### Other

The measurement type **Other** is provided to enable the use of arbitrary industry standard sensors or converters with either 0-10 V output or 4-20 mA output.

The engineering unit is user configurable and covers a broad range of physical properties.

The measurement is, due to the low cutoff frequency of the filter applied to the in signal, effectively a DC measurement.

The measurement value is then produced by applying zero level and sensitivity to the raw measurement value.

### Measurement with Voltage Output Sensor

$$\text{Measurement value}[EU] = \frac{\text{input signal}[mv] - \text{zerolevel}[mV]}{\text{sensitivity}\left[\frac{mV}{EU}\right]}$$

EU: Engineering unit

### Current (4-20 mA) or Voltage (0-10 V)

The measurement can be configured for either voltage output probes or current output probes.

- If the environment is electrically noisy, or the sensor cable lengths are long it may be preferred to use a current output probe and configure the measurement for Current.

### Precautions / Special Care

Although the used sensor itself may have an extremely high resolution output, it is necessary to consider the resolution of the different parts making up the whole measurement system and the resulting resolution of the measurement value. For example, factors affecting measurement resolution are input resolution of the PRM and the measurement configuration parameters.

It is possible to configure a measurement in such a way that the utilized input voltage range is so small that the measurement will suffer loss of resolution.

The user should exercise great care while:

- selecting sensor in order to optimize the measurement range to the sensors output range
- evaluating the PRM input range for the configured measurement
- evaluating if the resulting resolution matches the desired resolution



***Important - When the channel is configured for measuring current (mA) the user is strongly advised to make sure the input ratings of the analog channel is not exceeded. Allowed input range for current measurements is 0 - 30 mA.***



***Important - Standard 0-10 V or 4-20 mA process control signaling does not mean that IMx-M can read any possible DC voltage or current in this range. If other voltage ranges or current ranges are utilized there may be loss of accuracy and resolution. The specified measurement performance is only guaranteed with either 0-10 V or 4-20 mA signalling. Accuracy  $\pm 1\%$  ( $\pm 2,9\%$  for 4-20 mA) is only fulfilled if the complete 0-10 V or complete 4-20 mA range is utilized to reflect the configured full scale.***



## Piston Rod Drop

The piston rod drop measurement is provided for the purpose of monitoring the piston rider band wear to prevent the piston from contacting the cylinder liner.

The piston rod drop measuring system is not only affected by rider band wear but all piston rod movements. The cause of the movements could also be one or more of the following:

- Rod mechanical runout due to crosshead-to-cylinder misalignment in the measurement plane.
- Cross head play / wear
- Rod deflection.
- Forces imposed by load and process condition changes.

All these factors occur to varying extents in all reciprocating machines and will affect the measurement which could lead to wrong conclusions regarding the rider band wear, especially so when Average Mode is used.

Single channel measurements can be configured as well as measurements of two primary channels combined into an X-Y-measurement.

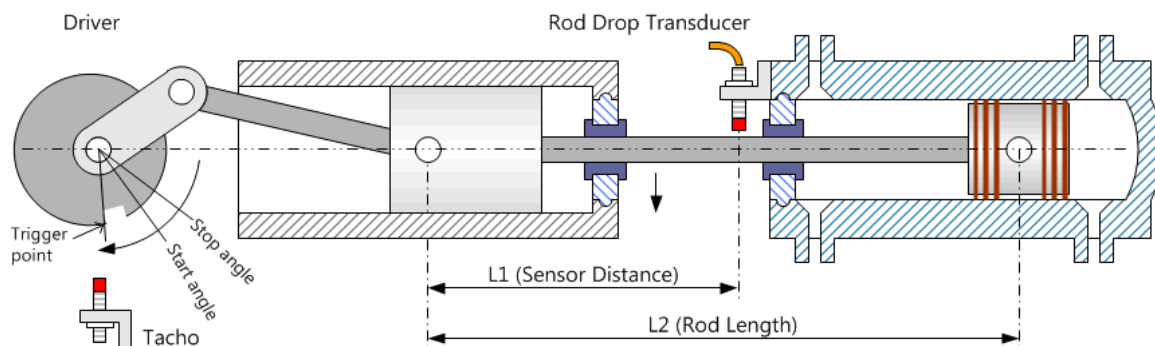


Figure 2 - 8.  
Piston Rod Drop Configuration.

There are sensors measuring the position of the piston rod and a tacho sensor which is used to measure the rotation speed but also providing the zero degree reference point.

The tacho sensor must deliver only one pulse per revolution.

The position measuring has no filters other than a hardware input low pass filter.

### Piston Rod Drop Physical Properties

#### Start angle and Stop angle

The Start angle and Stop angle are configured in degrees relative to the trigger point. They specify the part of the revolution at which the measurement will be based. Start and stop angles close to the end of the revolution should be avoided. See "Measurement Angle" and "Measurement Angles and Non Constant Speed" in [Triggered Mode](#).

### **Rod length and sensor distance**

The rod length and sensor distance are used to translate the measured piston rod drop, at the sensor position, into the piston drop at the piston center pin position.

### **Offset**

The Offset is configured in the selected engineering unit ( $\mu\text{m}$  or mils) and can be used to set the measurement to zero. This is done by configuring the offset to the actual measurement value, obtained either from the [Local Display](#) or over [Modbus](#).

The offset is subtracted from the measurement at the very end of the calculations. Because of this the user can compensate the measurement without the need of performing any tedious calculations to convert the desired compensation in  $\mu\text{m}$  (micrometers) or mils to millivolt.

The configurable offset will affect the measurement in the following way:

$$\textit{Measurement} = \textit{measurement before offset compensation} - \textit{offset}$$

If the offset is configured to a positive value the measurement will be decreased with the value of offset. A negative offset value will increase the measured value with the same amount.

### **Offset vs. Zero Level**

This offset parameter, which is piston rod drop specific, should not be confused with the configurable sensor zero level parameter. Although the same result can be obtained by altering either of them, they are fundamentally different.

While the offset operates at the end of the calculations and with the selected engineering unit ( $\mu\text{m}$  or mils) the zero level operates at the very beginning of the calculations and in millivolt.

## **Operating Modes**

There are three measurement modes of which two are user configurable through the IMx-M Manager software.

The configurable modes are **Average mode** and **Triggered mode**.

The third mode **Runout mode** is a measurement mode which will be activated automatically when specific conditions are met.

**Note:** In order to avoid running the system in Runout mode inadvertently which could happen in case of loss of speed/trigger signal, the user shall enable low speed alarming.

This will ensure that “digital input stuck at low/high” is detected as a circuit fault.

The alarm setting must be configured for each digital input in use, including the inputs connected to buffered outputs. See [Alarm Levels for Speed Type](#) in Digital Channels in IMx-M Manager.

### Average Mode

In Average mode the measurement is the mean of all the samples collected between two adjacent trigger pulses.

$$Measurement = \frac{1}{\text{number of samples}} * \sum_{\text{Start Angle}=0}^{\text{Stop Angle}=360} \text{samples}$$

### Triggered Mode

In Triggered mode the measurement is the mean of the samples collected between the configured start angle and stop angle. The reference point (zero degree) is the point where the speed sensor will deliver a falling edge to the digital input.

$$Measurement = \frac{1}{\text{number of samples}} * \sum_{\text{Start Angle}}^{\text{Stop Angle}} \text{samples}$$

### Measurement Angle

A wide measurement angle will provide a measurement based on a greater number of samples. This will attenuate random noise in the in signal and the measurement accuracy will be better.

The narrowest measurement angle at the highest supported speed will deliver a measurement based on one single sample and any noise present in the in signal will appear in the measurement.

The number of samples a measurement is based on is a function of the sample rate, the rotational speed of the machine and the configured measurement angle. The Sample rate is 20 480 Hz.

$$Number\ of\ samples = \frac{Sample\ rate}{\frac{rpm}{60}} * \frac{Start\ angle - Stop\ angle}{360}$$

**Note:** There is always a minimum of 1 sample in a measurement.

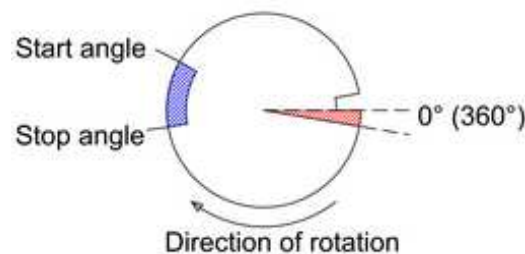


Figure 2 - 9.  
Visualization of Start and Stop Angles.

Red shading indicates unsafe angles close to trigger point. (360°).



- If start and stop angles are configured close to the end of the revolution (360°) special care should be exercised to make sure that speed variations (see [Measurement Angles and Non Constant Speed](#)) will not cause the measurement to be terminated early or not performed at all.

### **Measurement Angles and Non Constant Speed**

During a speed change an error in the measurement can be introduced. When the speed stabilizes the actual angles will again be the same as the configured and the measurement will be true.

Increasing speed:

- The angles between which the measurement is performed will be amplified. The measurement will be such as if both start and stop angle had greater values than configured.
- The measurement window will be wider than configured.
- In the extreme case, the measurement could be terminated early or not be performed at all. This condition happens when there is an extreme speed change so that the derived start angle and/or stop angle is reached after a new trigger pulse is received.

Decreasing speed:

- The actual measurement will be performed earlier in the revolution than configured.
- The measurement window will be narrower than configured.

The following is an example of how the configured measurement angles are translated to actual angles during constant speed, increasing speed, and decreasing speed. In triggered mode the measurement is the mean of the samples collected between the configured start angle and stop angle. The reference point (0°) is the point where the speed sensor will deliver a falling edge to the digital input.

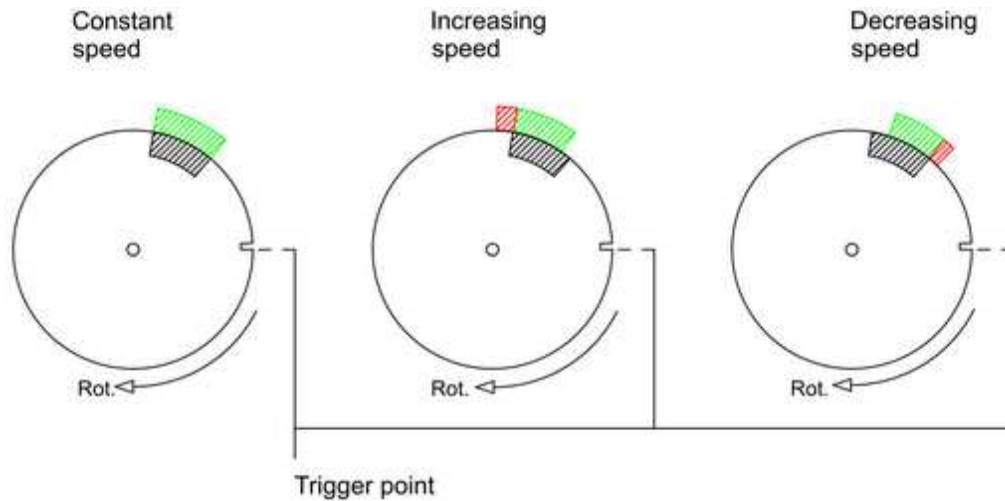


Figure 2 - 10.  
Effect of speed changes on measurement angles.

- Desired measurement angles shaded on the inside of the circle.
- Actual angles shaded on the outside of the circle:
  - Green color is the part of the measurement falling inside the configured angles.
  - Red shading is the part which falls outside the configured angles.
- The speed change depicted is 10% up/down between two measurement cycles.

#### **Runout Mode**

The Runout mode is a measurement mode which is based on a fixed time (fixed number of samples) and thus independent of machine speed.

This measurement mode will be activated automatically:

- When measured speed is below 10 rpm, for example when:
  - The machine is being shut down or is at standstill
  - The machine is starting and the speed is still below 10 rpm
  - The speed sensor circuit fails
- If the associated digital channel is NOT configured for the Speed measurement

The measurement is the average of the samples collected during a fixed time (0.8 seconds). At the completion of one measurement the next one will immediately be initiated.

$$\text{Measurement} = \frac{1}{\text{number of samples}} * \sum_{t=0s}^{0.8s} \text{samples}$$

### Transition between Runout Mode and Normal Mode

The transition to Runout mode from Normal mode (which denotes Average or Trigger mode) occurs when the measured speed drops below 10 rpm. When the measured speed goes above 10 rpm, the system will enter Normal mode from Runout mode.

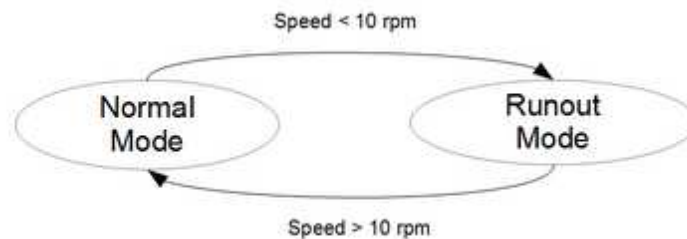


Figure 2 - 11.  
Transition Between Runout Mode and Normal Mode.

### Piston Rod Drop Combined Measurement

It is possible to configure a combined measurement for each pair of analog measurements. For piston rod drop the combined measurement will be the directionless magnitude of the vector formed by the addition of the two primary measurements.

The measurement mode of the primary and the combined measurements must be configured to the same type.

$$\text{Combined measurement} = \sqrt{\text{measurement Ch A}^2 + \text{measurement Ch B}^2}$$

Note that even though the individual channels show 0 as value, the combined measurement value may be other than 0. This is because the Scale setup for the individual channels may not cover the actual value range (e.g. negative values), but since the combined (3rd) channel is always a positive value it will be visible in the same range.

### Trigger System and Measuring Angles

In order for the measurement system to operate correctly, in both Average mode and Triggered mode, it is required that the digital channel is configured for measuring speed.

For both **Average mode** and **Triggered mode** this input is needed to give the reference point (zero degree angle) at which ongoing measurements are finalized and new ones initiated. There may be only one pulse per revolution.

In **Triggered mode** the Speed measurement is also needed to derive where in the revolution to perform the configured measurement, i.e. where the measuring window starts and ends (see [Measurement Angle](#)).

The measurements will be triggered by the falling edge, transition from higher to lower voltage, in the signal on the digital input.

The following displays a linear time depiction of the trigger signal received on the digital input and the measuring windows location relative the trigger pulse.

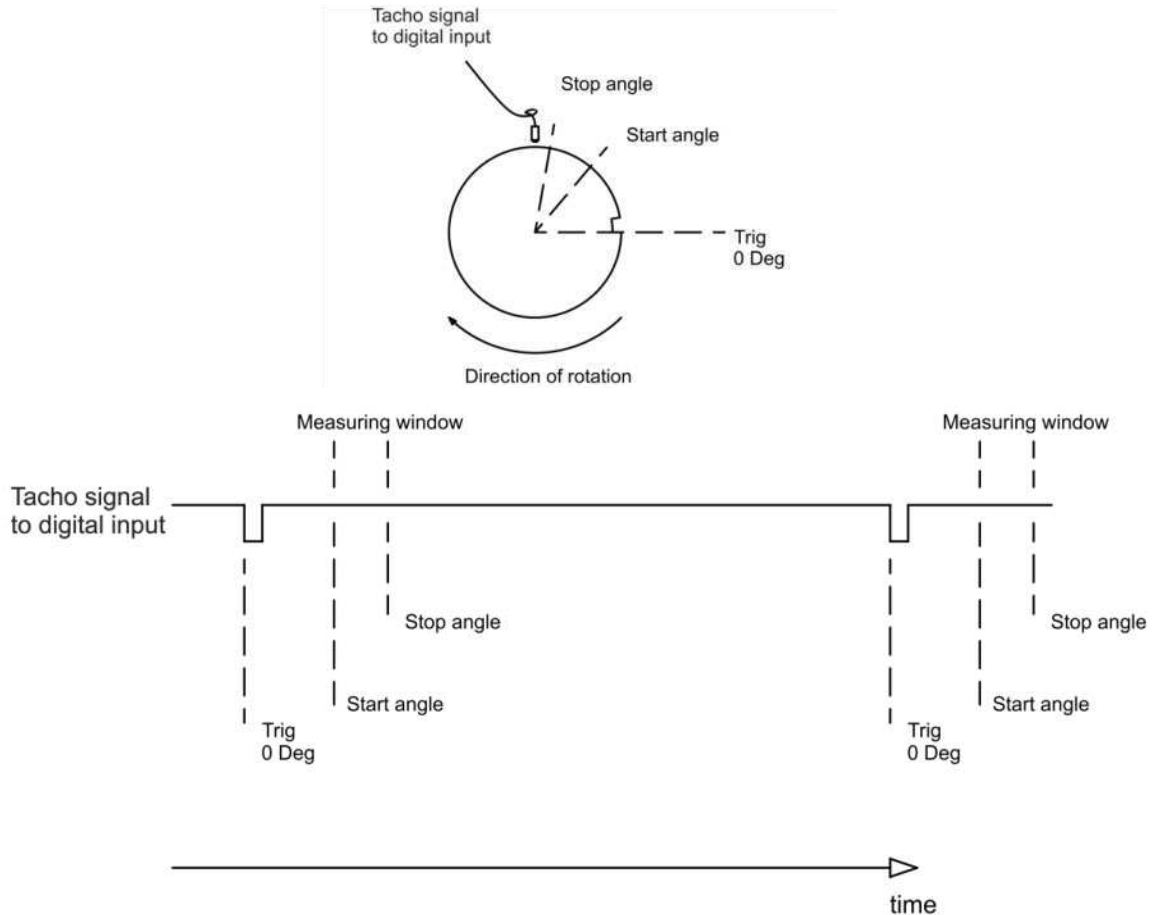


Figure 2 - 12.  
Trigger Signal Received on Digital Input.

### Trigger Physical Interface

The digital input is used to acquire the speed and the trigger point phase reference.

#### Using One Tacho Signal Source as Trigger to Many Triggered Measurements

When there is a need for triggering several Piston rod drop measurements, distributed over several analog channel pairs, from one single phase reference transducer / tacho sensor the following approach shall be deployed.

1. Connect the sensor to one digital input
2. Connect the remaining digital inputs to the buffered digital output associated with the digital input at which the sensor is connected.

**Note:** Make sure the digital inputs are correctly configured as described in [Digital Inputs](#) in Hardware Configuration.

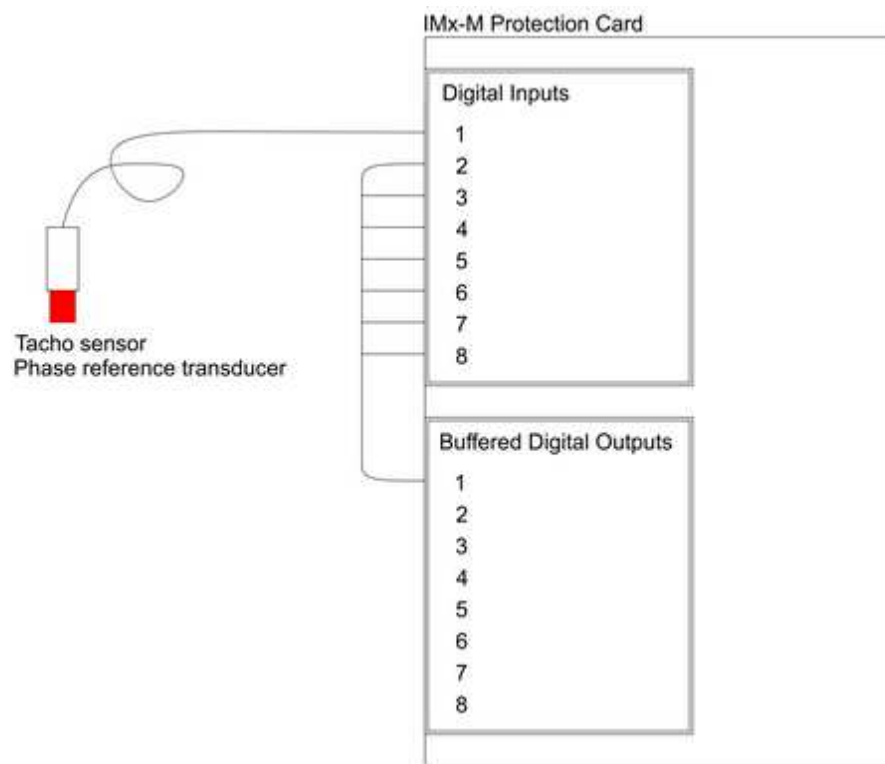


Figure 2 - 13.  
Distributing One Tacho Signal Source to Several Digital Inputs.

### Using Digital Input as Measurement Trigger

One digital channel input is directly connected to a defined pair of analog channels.

- Digital channel input 1 to Analog Channel 1 and 2
- Digital channel input 2 to Analog Channel 3 and 4
- Digital channel input 3 to Analog Channel 5 and 6
- ...
- Digital channel input 7 to Analog Channel 13 and 14
- Digital channel input 8 to Analog Channel 15 and 16

If a digital channel input needs to be used as the trigger for an analog channel that is not directly connected as stated above, then that digital channel signal must be routed to the correct digital channel input via an external cable from a digital channel buffered output to the digital channel input in question. The digital channel buffered outputs (Buf D) are located on the rear of each CMM + PRM slot as described in [Buffered Outputs](#).

For an example, to use digital channel 3 input as the trigger for the measurement at analog channel 14 requires the cabling from the digital channel 3 buffered output to the digital channel 7 input.

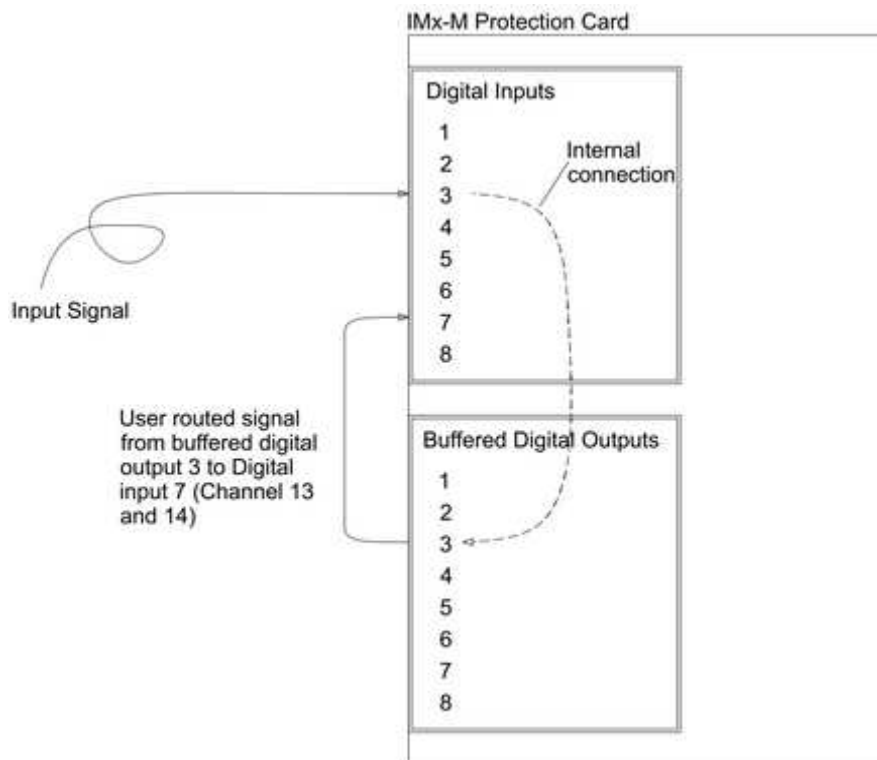


Figure 2 - 14.  
Using Digital CH 3 Input as the Measurement Trigger.

### Position

**Position** measures a position of an object (e.g. axial position) by use of displacement sensor in order to detect thrust bearing failure.

## Radial Shaft Vibration

**Radial shaft vibration** (RSV) measures the vibration of the machine shaft in a direction perpendicular to the shaft longitudinal axis by the use of a displacement sensor (proximity probe).

## Speed

**Speed** is a measurement of shaft rotation speed in revolutions per minute and may be used specifically for speed measurements. However, it is also used as an input parameter for [piston rod drop](#) measurements and the edge of the input pulse is used as trigger.

The measurement is derived from the measured period time of the number of pulses configured per revolution.

- The number of input pulses per revolution must be 1 when the channel is used as trigger for Piston Rod Drop.

There is a peak speed detection function. Peak speed for a digital channel will be stored (as events) if both of the following conditions are met:

- The detected peak speed value is above alarm level
- No new peak speed value is detected within 1 minute
  - The 1 minute delay is to avoid numerous events during acceleration. This will also mean that the event will be generated after 1 minute from the detection of the peak speed. The time stamp in the event is the time of the detection.



**Important: Peak speed will not be updated during slot disarm.**

- Peak speed value is available through Modbus and Event Log.
- It is possible to reset (set to zero) the peak speed value via the [local display](#), the [imported \(write single\) Modbus register](#) and Ethernet (Observer).



**Important: Reset of peak speed will reset all peak speed values within the slot.**

## Temperature

**Temperature** is measured with RTD (PT100) sensors. The measurement range is –20 to +150 °C (–4 to +302 °F)

**Temperature difference** measures the temperature difference between two Temperature measurement type channels.

Verifying the accuracy of temperature measurements for FAT or similar testing requires extremely high precision reference instruments and components as well as careful connections and cabling. This is because 1 °C corresponds to a resistance change of only 0.385 ohm.

Similarly field calibration (by trained service personnel) requires careful adherence to the procedure to achieve best results.

For Temperature Difference the configured scale must be symmetrical, refer [Acquisition](#).

## Alarms

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The IMx-M Protection Module supports a number of different types of alarms

- **Alert:** A configured parameter value at which an Alert alarm is activated in order to warn of a condition that requires corrective action.
- **Danger:** A configured parameter value at which shutdown of the machine is required to be performed either automatically or manually.

The output of a measurement channel is compared against the configured alert and danger levels. The sensor input levels are also compared to configured Sensor OK values. If any of these levels are violated and the conditions of configured hysteresis and enter/leave delay times are met the alarms and circuit fault status will be updated and communicated.

Relay Modules are configured to listen to this alarm status and system status/circuit fault information. If the configured relay activation conditions are fulfilled the relay will be activated.

See also [Circuit Faults \(cf\)](#).

- A channel going into Danger state will always cause the channel to Alert state as well, even if Alert setting was disabled. In such case, the channel status is Alert and Danger.

### Trip Multiply Factor

Some measurement types support the enabling of a trip multiply factor which can alter the alert and danger levels with a configurable value when the Trip Multiply input is active. Trip Multiply can be configured to affect either the alert, danger or both. Trip Multiply is usually activated during machine start up in order to avoid triggering alarms, for instance when the machine passes through speeds/frequencies with increased resonant vibrations.

The activation of trip multiply at the slot is done via:

- [Digital Channels](#) interface by selecting the Trip-multiply input type
- [Local display selection keypad](#) located on the front of condition monitoring module
- Modbus register 259 as described in [Imported \(Write Single\) Modbus Register](#)

The activation of trip multiply at the channel level is done via:

- [Local display selection keypad](#) located on the front of condition monitoring module
- Modbus register 260 as described in [Imported \(Write Single\) Modbus Register](#)



## Alarm Status Propagation

When the status of a measurement channels, system status, relay status or other system critical events occurs the internal status registers are updated and the new status information is made available on the communication bus of the rack. This way the status information propagates in the rack and then out of the rack to other systems.

Alarm status, relay activation changes and system status are all reflected on the internal communication bus and the other modules can respond appropriately to the status.

The status changes also causes both the PRM and RLM to create Protection Events and Relay Events which will be communicated to the CMM in which they will be stored (See [Event Log](#)).

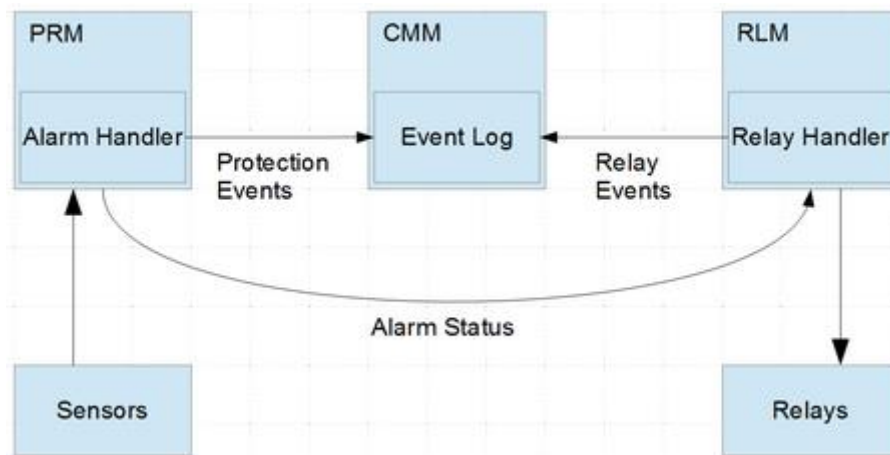


Figure 2 - 15.  
Propagation of Alarm Status and Events.

PRM: The alarm status information update process

1. Measurement performed
2. Measurement value evaluated against configured alarm levels and hysteresis
3. Alarm status information updated and made available
4. LED indicators in front panel updated

RLM: The relay activation process

1. Alarm status information received
2. Relays activated according to relays configuration and alarm status
3. LED indicators updated

CMM: Storing of protection and relay events in the event log

1. Alarm status or relay status received as events
2. Event stored in event log

### Alarm Trigger Filtering

Under certain conditions there could arise such a situation that the alarm status would toggle rapidly between alarm and no alarm. The PRM provides two configurable means to handle this, **hysteresis** and **enter/leave times**.

- Configuration parameter **Leave time** is available for digital channels only.



***Important - Alert/danger ON trigger will be delayed by the configured alert/danger enter time. Whereas alert/danger "Off" trigger will be delayed by the configured alert/danger leave time.***

### Hysteresis

Hysteresis value is used to prevent rapid alarm state switching when the measurement value is hovering around the configured alarm level but still changing enough to cross the alarm level.

The hysteresis value is used to determine an adjusted value at which to leave the alert/danger state. The hysteresis value would normally be large enough to encompass the anticipated fluctuations/noise.

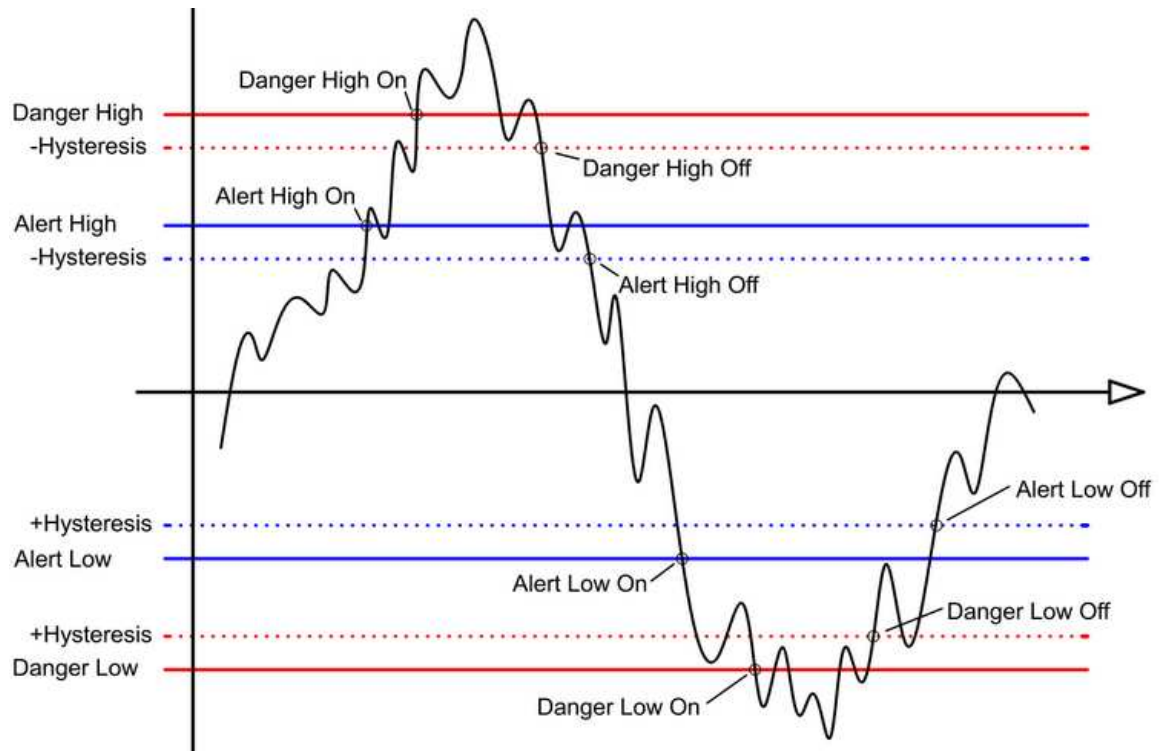


Figure 2 - 16.  
Demonstration of Alarm Switching On and Off.

Table 2-3: Alarm switch on/off value.

Alarm	Alarm Switch On Value	Alarm Switch Off Value
Alert High	Alert high level value	Alert high level value - Alert hysteresis value
Alert Low	Alert low level value	Alert low level value + Alert hysteresis value
Danger High	Danger high level value	Danger high level value - Danger hysteresis value
Danger Low	Danger low level value	Danger low level value + Danger hysteresis value

### Alarm Delayed Trigger and Release

The alarm enter and leave times are used as filters to prevent triggering alarms in a situation where the alarm level could be exceeded for brief periods of time, because of noise or other process specific reasons, even though there were no real alarm condition.

- **Enter time:** The period of time for a channel to have exceeded an alarm level before an actual alarm condition is raised. Alert/Danger "ON" trigger will be delayed by this Enter Time.
- **Leave time (only for digital channels):** The period of time which a channel in an alarm state has to be out of its alarm operating range (alarm level adjusted with configured **hysteresis**) before the alarm condition is canceled. Alert/Danger "OFF" trigger will be delayed by this Leave Time.

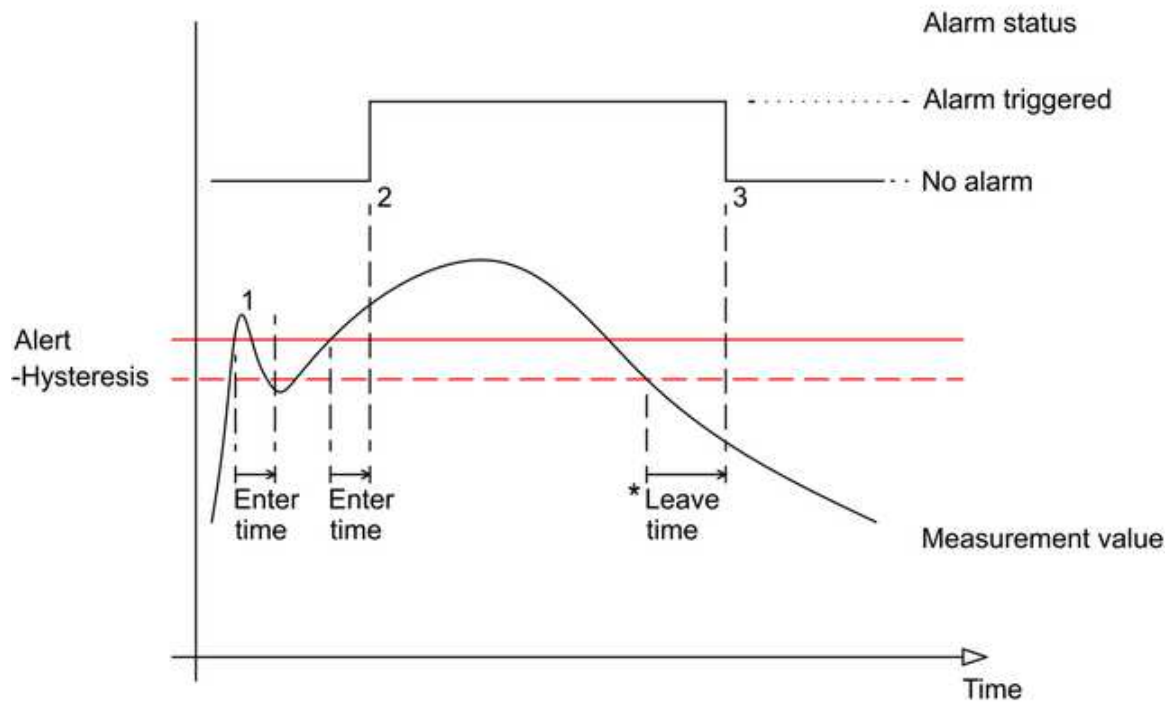


Figure 2 - 17.  
Enter/Leave Time Example.

The example of alarm status change shown in the diagram above;

1. The alert has not triggered: The measurement value has exceeded the alarm level for a shorter duration than the enter time.
2. The alert has triggered: The measurement value has exceeded the alarm level for longer duration than the enter time.
3. The alert has released: The measurement value drops below the hysteresis adjusted alarm level and remains below for the duration of the leave time.

\*Only for digital channels

### First Out Indication

**First Out** is set when an armed channel enters a danger state.

- **Channel First Out Slot** is the first channel that reaches the danger state amongst all the channels in the protection module.
- **Channel First Out Rack** is the first channel that reaches the danger state amongst all the channels in the rack.
- **First Out** will trigger on analog channels, Gap and calculated combined channels.
- First out will NOT be set if a channel is already in danger state when the channel or slot is armed.

- When actioning a ‘Reset of latching functions’, the first out indication will be reset but will not move to any other channel that is already in danger state. Only a channel entering danger state can become ‘First out’.

## Relays

Each IMx-M rack can be fitted with a maximum of three relay modules. Each relay module contains 32 separate relays, consisting of 28 single pole, double throw (SPDT) and four double pole, double throw (DPDT) relays. This means that each IMx-M rack can have up to a maximum of 96 relays available for configuration and use.

All relays of all relay modules throughout the IMx-M rack have access to the alarm status of all MCUs of all the protection modules in the rack.

The management of relay module configuration, access to the circuit fault status report and realization of slot disarm are done slot wise.

- Relay module 1 is associated with slot1 (accessed through protection module 1)
- Relay module 2 is associated with slot2 (accessed through protection module 2)
- Relay module 3 is associated with slot3 (accessed through protection module 3)

For information on how to configure relay modules see [Configuring a Relay Module](#).



**Important - When relays are configured to trigger on channels in more than one protection module (so called "shared relays") the following are important to consider:**

- **Shared relays are only recommended to use for semi critical machines. It is NOT for critical machines.**
- **In order to engage disarm when there are shared relays, it is strongly recommended always to use rack disarm input to disarm the entire rack at once.**
- **Upon a configuration or firmware update, all protection modules that depend on the shared relays will be affected.**
- **Circuit faults affecting shared relays will only be reported by the associated protection module. Be sure to evaluate the circuit faults of the relay module and other protection modules that utilize the shared relays.**
- **Circuit faults related to internal communication of a protection module utilizing shared relays will also be reported by the associated protection module (the relay module will indicate circuit fault if it does not receive data from the associated protection module).**
- **Latching relays always need to be reset from the associated protection module. Note that a relay that is latched in alarm at the point of disarm (the channel at this point is OK), will still change state if a latching reset is issued.**
- **Hot-swap of a relay module containing shared relays will affect all protection modules that are associated with the shared relays.**
- **Hot-swap of a protection module with shared relays in different slots will affect the associated relay modules.**

## Relays on Relay Modules

- Relays 1 to 28 are of SPDT (Single pole, double throw) type and relays 29 to 32 are of DPDT (Double pole, double throw) type.
- Relays are software configured without any need for DIP switch settings. The software configuration of relays is described in [Configuring a Relay Module](#) via IMx-M Manager.
- Relays are based on flexible relay logic with Voting as well as and/or logic.
- Relays can be configured as normally energized or normally de-energized. Normally energized has the power on all the time until the relay is triggered. In such case, relay goes into alert/danger upon power failure.
  - Default state for alert is energized.
  - Default state for danger is de-energized.

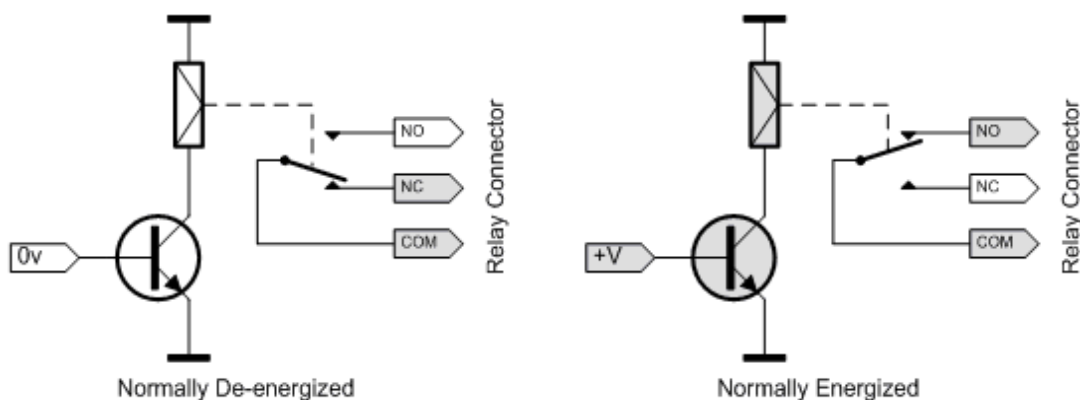


Figure 2 - 18.  
Relay Connector Configuration.

- Relays can be configured for latching or non-latching alert/danger.
- Relays can be connected as normally open or normally closed.
- Relays have redundant relay functionality.
  - Several relays can be configured to a single channel.
  - Relays associated to different protection modules can be configured to a single channel.
- Each relay module provides LED status indicator for each relay as described in [Relay Module \(RLM\)](#) within LED Indicators.
- For the physical layout of relay connectors, refer to [Relay Module \(RLM\) Connections](#).

The following table shows the different relay types and their behaviors.

Table 2-4: Behavior of channel status relays.

Behavior of Channel Status Relays on Relay Module							
Ch Relay Type	Ch Alert	Ch Danger	Ch Not OK	Ch Start	Ch Disarm	Slot Disarm (see note)	Relay Status
Analog Ch Disarm	-	-	-	Off	Off	Off	Not triggered
	-	-	-	Off	X	On	Triggered
	-	-	-	Off	On	X	Triggered
	-	-	-	On	-	-	**
Analog Ch Not OK	-	-	Off	Off	Off	Off	Not triggered
	-	-	X	X	X	On	Previous status
	-	-	X	X	On	Off	Not triggered
	-	-	On	X	Off	Off	Triggered
	-	-	-	On	-	-	**
Analog Ch Alert	Off	Off	Off	Off	Off	Off	Not triggered
	X	X	X	X	X	On	Previous status
	X	X	X	X	On	Off	Not triggered
	X	X	On	Off	Off	Off	Not triggered
	X	On	Off	Off	Off	Off	Triggered
	On	X	Off	Off	Off	Off	Triggered
	-	-	-	On	-	-	**
Analog Ch Alert or Ch Not OK*	Off	Off	Off	Off	Off	Off	Not triggered
	X	X	X	X	X	On	Previous status
	X	X	X	X	On	Off	Not triggered
	X	X	On	Off	Off	Off	Triggered
	X	On	X	Off	Off	Off	Triggered
	On	X	X	Off	Off	Off	Triggered
	-	-	-	On	-	-	**
Analog Ch Danger	-	Off	Off	Off	Off	Off	Not triggered
	-	X	X	X	X	On	Previous status
	-	X	X	X	On	Off	Not triggered
	-	X	On	Off	Off	Off	Not triggered
	-	On	Off	Off	Off	Off	Triggered
	-	-	-	On	-	-	**

Behavior of Channel Status Relays on Relay Module							
Ch Relay Type	Ch Alert	Ch Danger	Ch Not OK	Ch Start	Ch Disarm	Slot Disarm (see note)	Relay Status
Analog Ch Danger or Ch Not OK*	-	Off	Off	Off	Off	Off	Not triggered
	-	X	X	X	X	On	Previous status
	-	X	X	X	On	Off	Not triggered
	-	X	On	Off	Off	Off	Triggered
	-	On	X	Off	Off	Off	Triggered
	-	-	-	On	-	-	**
Power Supply Failure Indicator	-	-	-	-	-	-	See <a href="#">Available Relay Types</a> in IMx-M Manager section.
Digital Ch Alert	Off	Off	-	Off	Off	Off	Not triggered
	X	X	-	X	X	X	Previous status
	X	X	-	X	On	Off	Not triggered
	X	X	-	Off	Off	Off	Not triggered
	X	On	-	Off	Off	Off	Triggered
	On	X	-	Off	Off	Off	Triggered
	-	-	-	On	-	-	**
Digital Ch Danger	-	Off	-	Off	Off	Off	Not triggered
	-	X	-	X	X	On	Previous status
	-	X	-	X	On	Off	Not triggered
	-	X	-	Off	Off	Off	Not triggered
	-	On	-	Off	Off	Off	Triggered
	-	-	-	On	-	-	**

- = Not applicable

X = Don't care

On = 1

Off = 0

\* Channel used to configure relay alarm voting "2 out of 2" or "2 out of 3"

\*\* Refer to the table [Behavior of Relay at Channel Startup](#)

**Note:** The behavior of slot disarm applies when the slot associated with the source channels is disarmed. As an example, if a relay on RLM1 is configured to act on a channel or channels from slot 2, only a slot 2 disarm would result in the behavior listed in the table.



### Safety Consideration When Configuring Relays

It is important to configure relays correctly to ensure that one circuit fault affects no more than two channels.

Each relay module consists of eight processors and each processor controls four relays.

When configuring a redundant relay setup, select relays of different processors.

For example, use relay 1 and relay 5 to ensure that one circuit fault does not affect both relays. See the table below for details of relay assignments.

**Table 2-5: Relay assignments.**

Relay Assignments	
Processor (Relay MCU)	Relay
1	1 to 4
2	5 to 8
3	9 to 12
4	13 to 16
5	17 to 20
6	21 to 24
7	25 to 28
8	29 to 32

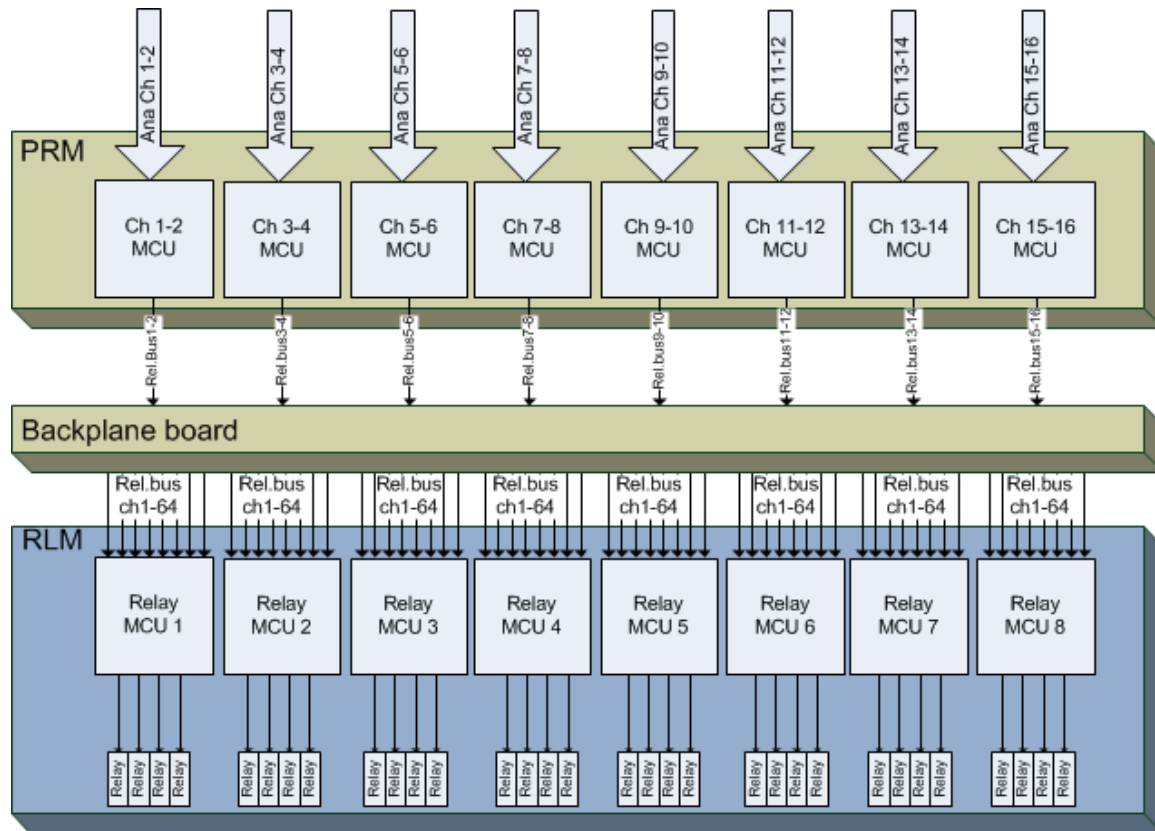


Figure 2 - 19.  
MCU and Relay Aggregation.



**Important - It is important to configure relays correctly to ensure that one circuit fault affects no more than two channels. Each relay module is comprised of eight individual processors, and each processor controls four relays.**

### Slot Status Relays on Protection Module

In addition to the relays on relay modules, each protection module also has the following two slot status relays located in the back of each CMM + PRM slot.

- Slot Status Relay Circuit Fault (CF or Cf)
  - The slot status relay circuit fault is normally energized when there is no circuit fault.
  - Any detected circuit fault will de-energize the circuit fault relay.
  - A detected circuit fault will be indicated by "COMMON Circuit Fault" LED indicator on the front of protection module.
- Slot Status Relay Disarm (Dis)
  - The slot status relay disarm is energized during slot disarm.

These two slot status relays are not user configurable.

For the physical location of slot status relays, refer to [Protection Module \(PRM\)](#).

For the layout of slot status relays, refer to [RS485, Relay Outputs, Rack Disarm](#) in CMM + PRM Slot Connections chapter.

**Table 2-6: Behavior of slot status relays.**

Behavior of Slot Status Relays							
Slot Status Relay	Ch Alert	Ch Danger	Ch Not OK	Ch Start	Ch Disarm	Slot Disarm	Relay Status
Disarm	-	-	-	Off	Off	Off	Not triggered
	-	-	-	Off	Off	On	Triggered
	-	-	-	Off	On	Off	Not triggered
	-	-	-	Off	On	On	Triggered
	-	-	-	On	-	-	**
Circuit Fault	-	-	Off	Off	-	-	Not triggered
	-	-	On	-	Off	-	Triggered
	-	-	Off	On	-	-	**
	-	-	On	-	On	-	Not triggered

- = Not applicable

\*\* Refer to the table [Behavior of Relay at Channel Startup](#)

## Behavior of Relay at Channel Startup

Table 2-7: Behavior of relay at channel startup.

Behavior of Relay at Channel Startup				
Current Operational Mode	Relay Status			
	Channel Relay on Relay Module		Slot Status Relay on Protection Module	
	Normally Energized	Normally De-energized	Disarm	Circuit Fault
<b>Configuration update (slot disarm assumed)</b>	Previous status + triggered due to reboot	Previous status + not triggered due to reboot	Triggered with a short not triggered due to reboot	Triggered
<b>FW update (slot disarm assumed)</b>	Previous status + triggered due to reboot	Previous status + not triggered due to reboot	Triggered with a short not triggered due to reboot	Triggered
<b>Mains power up*</b>	Triggered due to mains power off	Not triggered due to mains power off	Previous status + not triggered during mains power off	Triggered
<b>Protection module hot swap (slot disarm assumed)</b>	Previous status	Previous status	Triggered + not triggered during module removal	Triggered
<b>Relay module hot swap (slot disarm assumed)</b>	Triggered due to relay module removal	Not triggered due to relay module removal	Triggered	Triggered

\*During reset or power down, all relays will be in non-energized state.

## Protection Part Operation

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### Startup

Channel startup time after boot is maximum 30 seconds.

During startup time, the analog channel status will be "Startup + Circuit fault". See [Register "Analog Ch Status" Bit Definition](#).

System startup sequence example:

- System power off

If system is powered up it should be powered off in a secure way as recommended below. It is to avoid any damage that could occur to other parts of the system or connected systems when powering down.

  1. Disarm system
  2. Disconnect power
- System configuration
  1. Configure [hardware](#)
    - a. [DIP switch settings](#)
    - b. Connect cables (sensors, relay outputs, circuit fault relay, disarm, 4-20 mA, RS485, Ethernet, etc.).
    - c. Verify sensors and connections.
  2. Create system configuration in IMx-M Manager
- System power on
  1. Disarm system
  2. Connect power
  3. System power on
  4. Ensure proper firmware is loaded in the PRM
  5. Download configuration from IMx-Manager via USB
- Protection Startup
  1. Protection Module (Channel) startup time after boot is maximum 30 seconds.
  2. During startup time,
    - a. Status LED green fast blinking
    - b. Circuit Fault LED red
    - c. The analog channel status will be "Startup + Circuit fault". See [Register "Analog Ch Status" Bit Definition](#).

3. When Status LED is slow blinking green,
  - a. Check that there are no circuit faults - Circuit Fault LED should no longer be lit up.
    - If circuit fault LED is still lit up the user is advised to use the diagnostic command cf and check the cause of the circuit fault.
4. Evaluate any alarm conditions that could trigger relays.
5. Arm system (rack)
  - System is now up and running protecting the machine.

For condition monitoring startup see @plitude Observer User Manual (Document Part Number 32170900).

### Circuit Faults (cf)

The system will signal **Circuit Fault** if some condition has arisen that prevents the system from measuring/protecting correctly.

The Circuit Fault is indicated by

- LED in front panel
- Dedicated relay output
- Status register readable over Modbus, USB and over Ethernet.
- Event log

The status register presents the cause of the Circuit Fault. For decoding of CF status bits see tables below or use [IMx-Manager CF](#).

The cf diagnostic command only checks the protection module, of which a USB is connected to, and it's associated relay module.

Each relay module is associated with a protection module;

Relay module 1 with protection module 1,

Relay module 2 with protection module 2,

Relay module 3 with protection module 3.



**Important** - See also chapter "[Relays on Relay Modules](#)" and "[Behavior of Slot Status Relays](#)" for details when shared relays are used.



**Important** - A circuit fault always overrides danger/alert in events (danger/alert is checked, but ignored when circuit fault is reported). You might see entries in the Event log of danger/alert reported on measurements with cable faults. This is logged only for internal event tracing purposes.

### PRM Circuit Faults

If any bit representation of PRM circuit faults is not 0x0000, then the PRM circuit fault relay will be triggered and the PRM circuit fault LED will be ON indicating a circuit fault.

- For PRM master bit representations, refer to the table "Protection Module Circuit Faults - PRM-Master", below to decode circuit fault condition(s).
- For PRM slaves 0 to 7 bit representations, refer to the table "Protection Module Circuit Faults - PRM-S0 to PRM-S7", below to decode circuit fault condition(s).

**Table 2-8: Protection module circuit faults - PRM-M.**

Protection Module Circuit Faults - PRM-Master		
Bit representation <sup>1</sup>	Condition	Comments
(0x0000) (No bit set)	CF_STATUS_OK	Normal. No errors.
0x0001	CF_CONFIG	User configuration dependent: Check IMx-M configuration settings. Check the PRM position.
0x0002	CF_RS485INT	Internal RS485 communication error - check that modules are firmly positioned:  Master and slave may have different FW versions in use - check the current FW version in use (intd0) on both master and slave.  Also check the FW version of CMM.
0x0004	CF_CFG_MISMATCH	Configuration mismatch detected: See " <a href="#">Protection Configuration Update</a> " chapter.
0x0008	CF_SELFTEST	Check for self test errors during startup.
0x0010	CF_DOWNLOAD	Download mode.
0x0020	CF_MODBUS	Check RS485 L1-L2.
0x0040	CF_4-20MA	Check 4-20 mA outputs. Check that CMM/PRM is firmly positioned
0x0080	CF_SPI	Check that CMM/PRM is firmly positioned
0x0100	CF_24VA	PSU 1 voltage failure: User configuration dependent. Check IMx-M configuration settings. Check that PSU 1 is firmly positioned.
0x0200	CF_24VB	PSU 2 voltage failure: User configuration dependent. Check IMx-M configuration settings. Check that PSU 2 is firmly positioned.
0x0400	CF_CALIB2	Calibration table error:  Check that modules are firmly positioned.

Protection Module Circuit Faults - PRM-Master		
Bit representation <sup>1</sup>	Condition	Comments
0x0800	IOMASTER_CF_ INTVOLT1	Internal voltage warning: Use the command " <a href="#">adc1</a> " for more information.
0x1000	IOMASTER_CF_ INTVOLT2	Redundant power failure: Use the command " <a href="#">adc1</a> " for more information.
0x2000	IOMASTER_CF_ TEMPERATURE	Internal temperature of the protection module is either lower than -20 °C or higher than 65 °C. Refer to <a href="#">Cooling</a> section to keep the internal temperature low.
0x4000	IOMASTER_CF_ DISARM	Backplane EEPROM status error: Use the local display to update disarm status.
0x8000	CF_STARTUP	Indicated during startup phase.

<sup>1</sup>Important:

- Bit representation is in hexadecimal digits.
- Bit representation can be a combination of more than one condition.

Example:

Bit representation of 0x16A is equal to 0x0002 CF\_RS485INT +  
0x0008 CF\_SELFTEST +  
0x0020 CF\_MODBUS +  
0x0040 CF\_4-20MA +  
0x0100 CF\_24VA

Refer to [Bit Representation of Combined Conditions](#) for combined conditions.



Table 2-9: Protection module circuit faults - PRM-S0 to PRM-S7.

Protection Module Circuit Faults - PRM-S0 to PRM-S7		
Bit representation <sup>3</sup>	Condition	Comments
<b>(0x0000)</b> <b>(No bit set)</b>	CF_STATUS_OK	Normal. No errors.
<b>0x0001</b>	CF_CONFIG	User configuration dependent. Check IMx-M configuration settings. Check the PRM position.
<b>0x0002</b>	CF_RS485INT	Internal RS485 communication error - check that modules are firmly positioned. Master and slave may have different firmware versions in use - check the current firmware version in use (intd0) on both master and slave.
<b>0x0004</b>	CF_CFG_MISMATCH	Configuration mismatch detected. See " <a href="#">Protection Configuration Update</a> " chapter.
<b>0x0008</b>	CF_SELFTEST	Check for self test errors during startup.
<b>0x0010</b>	CF_DOWNLOAD	Download mode.
<b>0x0020</b>	CF_AD	A/D converter error. Contact SKF support.
<b>0x0040</b>	CF_CH_A	Fault includes cable fault on channel A. Analog channel not OK. Channel DC bias out of the sensor OK window <sup>1</sup> Check wires <sup>2</sup>
<b>0x0080</b>	CF_CH_B	Fault includes cable fault on channel B. Analog channel not OK. Channel DC bias out of the sensor OK window <sup>1</sup> Check wires <sup>2</sup>
<b>0x0100</b>	CF_STARTUP	Indicated during startup phase.
<b>0x0200</b>	CF_CH_A_CFLATCH	Latching CF indicator on channel A <sup>2</sup>
<b>0x0400</b>	CF_CH_B_CFLATCH	Latching CF indicator on channel B <sup>2</sup>

<sup>1</sup> Sensor OK window is a user selectable configuration setting for [sensor](#) when configuring an analog channel.

<sup>2</sup> Check if the wire connection is according the following table "Slaves and Corresponding Channels".

**Table 2-10: Slaves and the corresponding channels.**

<sup>2</sup> Slaves and Corresponding Channels		
Slave	Channel A	Channel B
0	Channel 1	Channel 2
1	Channel 3	Channel 4
2	Channel 5	Channel 6
3	Channel 7	Channel 8
4	Channel 9	Channel 10
5	Channel 11	Channel 12
6	Channel 13	Channel 14
7	Channel 15	Channel 16

<sup>3</sup>Important:

- Bit representation is in hexadecimal digits.
- Bit representation can be a combination of more than one condition.

Example:

Bit representation of 0x036A is equal to 0x0002 CF\_RS485INT +  
 0x0008 CF\_SELFTEST +  
 0x0020 CF\_AD +  
 0x0040 CF\_CH\_A +  
 0x0100 CF\_STARTUP +  
 0x0200 CF\_CH\_A\_CFLATCH

Refer to [Bit Representation of Combined Conditions](#) for combined conditions.

**Register "PRM CF Selftest" Bit Definition**

**Table 2-11: PRM CF Selftest bit definition.**

Register "PRM CF - Selftest" Bit Definition**	
Bit representation*	Description
(0x0000) (No bit set)	Not used
0x0001	Selftest startup
0x0002	Selftest FW CRC
0x0004	Selftest configuration CRC
0x0008	Selftest RAM RO
0x0010	Selftest CSTACK
0x0020	Selftest ISTACK
0x0040	Selftest RAM
0x0080	Selftest PSM

**PRM CF Warning**

**Table 2-12: Protection module CF warning.**

Protection Module CF Warning**		
Bit representation*	Condition	Comments
<b>(0x0000)</b> (No bit set)	CF_WARNING_NONE	Normal. No errors.
<b>0x0001</b>	CF_WARNING_TEMP_ALERT	Internal temperature of PRM is higher than 60 °C
<b>0x0002</b>	CF_WARNING_TEMP_DANGER	Internal temperature of PRM is either higher than 65 °C or lower -20 °C.

*\*Important:*

- Bit representation is in hexadecimal digits.
- Bit representation can be a combination of more than one condition.

*Example:*

*Bit representation of 0x0003 is equal to 0x0001 CF\_WARNING\_TEMP\_ALERT +  
0x0002 CF\_WARNING\_TEMP\_DANGER*

*Refer to [Bit Representation of Combined Conditions](#).*

\*\* See [Event Log](#) chapter

### RLM Circuit Faults

If any bit representation of RLM circuit faults is not 0x0000, then the PRM circuit fault relay will be triggered and the PRM circuit fault LED will be ON indicating a circuit fault.

- For RLM Master (relay master) bit representations, refer to the table Relay Module Circuit Faults – RLM Master, below to decode circuit fault condition(s).
- For RLM Slave 0 to RLM Slave 7 (relay slaves 0 to 7) bit representations, refer to the table Relay Module Circuit Faults – RLM Slave 0 to 7 (Relay Slaves 0 to 7), below to decode circuit fault condition(s).

Table 2-13: Relay module circuit faults – RLM Master.

Relay Module Circuit Faults - RLM Master (Relay Master)		
Bit representation*	Condition	Comments
(0x0000) (No bit set)	CF_STATUS_OK	Normal. No errors.
0x0001	CF_CONFIG	User configuration dependent: Check IMx-M configuration settings. Check the PRM position.
0x0002	CF_RS485INT	Internal RS485 communication error: Check modules are firmly positioned. Master and slave may have different firmware version in use - check the current firmware version in use (intd0) on both master and slave.
0x0004	CF_CFG_MISMATCH	Configuration mismatch detected: See " <a href="#">Protection Configuration Update</a> " chapter.
0x0008	CF_SELFTEST	Check for self test errors during startup.
0x0010	CF_DOWNLOAD	Download mode.
0x0020	CF_24VA	PSU 1 voltage failure: User configuration dependent. Check IMx-M configuration settings. Check PSU 1 is firmly positioned.
0x0040	CF_24VB	PSU 2 voltage failure: User configuration dependent. Check IMx-M configuration settings. Check PSU 2 is firmly positioned
0x0080	CF_5V1	Internal 5 V error: Contact SKF support
0x0100	CF_5V2	Internal 5 V error: Contact SKF support
0x0200	CF_TEMP	Internal temperature high/alert.
0x0400	RELMASTER_CF_DISARM	Backplane EEPROM status error: Use the local display to update disarm status.

Relay Module Circuit Faults - RLM Master (Relay Master)		
Bit representation*	Condition	Comments
0x0800	-	Not used
0x1000		
0x2000		
0x4000		
0x8000	CF_STARTUP	Indicated during startup phase.

*\*Important:*

- Bit representation is in hexadecimal digits.
- Bit representation can be a combination of more than one condition.

*Example:*

*Bit representation of 0x036A is equal to 0x0002 CF\_RS485INT +  
0x0008 CF\_SELFTEST +  
0x0020 CF\_24VA +  
0x0040 CF\_24VB +  
0x0100 CF\_5V2 +  
0x0200 CF\_TEMP*

*Refer to [Bit Representation of Combined Conditions](#).*

**Table 2-14: Relay module circuit faults – RLM Slave 0 to 7.**

<b>Relay Module Circuit Faults – RLM Slave 0 to 7 (Relay Slaves 0 to7)</b>		
<b>Bit representation*</b>	<b>Condition</b>	<b>Comments</b>
<b>(0x0000)</b> <b>(No bit set)</b>	CF_STATUS_OK	Normal. No errors.
<b>0x0001</b>	CF_CONFIG	User configuration dependent: Check IMx-M configuration settings.
<b>0x0002</b>	CF_RS485INT	Internal RS485 communication error: Check modules are firmly positioned. Master and slave may have different firmware version in use - check the current firmware version in use (intd0) on both Master and slave.
<b>0x0004</b>	CF_CFG_MISMATCH	Configuration mismatch detected: See " <a href="#">Protection Configuration Update</a> " chapter.
<b>0x0008</b>	CF_SELFTEST	Check for self test errors during startup.
<b>0x0010</b>	CF_DOWNLOAD	Download ongoing.
<b>0x0020</b>	CF_RELBUS_S1	PRM 1, relay bus error: Check configuration. Check PRM 1 is firmly positioned.
<b>0x0040</b>	CF_RELBUS_S2	PRM 2, relay bus error: Check configuration. Check PRM 2 is firmly positioned.
<b>0x0080</b>	CF_RELBUS_S3	PRM 3, relay bus error: Check configuration. Check PRM 3 is firmly positioned.
<b>0x0100</b>	CF_RELBUS_S4	PRM 4, relay bus error: Check configuration. Check PRM 4 is firmly positioned.
<b>0x0200</b> <b>0x0400</b> <b>0x0800</b> <b>0x1000</b> <b>0x2000</b> <b>0x4000</b>	-	Not used
<b>0x8000</b>	CF_STARTUP	Indicated during startup phase

**\*Important:**

- Bit representation is in hexadecimal digits.
- Bit representation can be a combination of more than one condition.

*Example:*

*Bit representation of 0x016A is equal to 0x0002 CF\_RS485INT +  
0x0008 CF\_SELFTEST +  
0x0020 CF\_RELBUS\_S1 +  
0x0040 CF\_RELBUS\_S2 +  
0x0100 CF\_RELBUS\_S4*

*Refer to [Bit Representation of Combined Conditions](#).*

### CMM Circuit Faults

If any bit representation of a condition monitoring module circuit faults is not 0x0000, then the protection module circuit fault relay will be triggered and the protection module Circuit Fault LED will be indicating a circuit fault.

**Table 2-15: Protection module diagnostics of CMM circuit fault – CM.**

<b>Protection Module Diagnostics of Condition Monitoring Module Circuit Faults - CM</b>		
<b>Bit Representation*</b>	<b>Condition</b>	<b>Comments</b>
<b>0x0002</b>	CF_RS485INT	Internal RS485 communication error. Event log storage is not available. - Check that condition monitoring module is firmly positioned. - Check the FW version in use.

\*Bit representation is in hexadecimal digits.



### Bit Representation of Combined Conditions

Bit representations can be combinations of more than one condition. The following table lists possible combinations in the form of triggered bits in hexadecimal.

**Table 2-16: Bit representation of combined conditions.**

Bit representation in Hex	Triggered Bits	Bit representation in Hex	Triggered Bits
0x1000	0x1000	0x0010	0x0010
0x2000	0x2000	0x0020	0x0020
0x3000	0x2000, 0x1000	0x0030	0x0020, 0x0010
0x4000	0x4000	0x0040	0x0040
0x5000	0x4000, 0x1000	0x0050	0x0040, 0x0010
0x6000	0x4000, 0x2000	0x0060	0x0040, 0x0020
0x7000	0x4000, 0x2000, 0x1000	0x0070	0x0040, 0x0020, 0x0010
0x8000	0x8000	0x0080	0x0080
0x9000	0x8000, 0x1000	0x0090	0x0080, 0x0010
0xA000	0x8000, 0x2000	0x00A0	0x0080, 0x0020
0xB000	0x8000, 0x2000, 0x1000	0x00B0	0x0080, 0x0020, 0x0010
0xC000	0x8000, 0x4000	0x00C0	0x0080, 0x0040
0xD000	0x8000, 0x4000, 0x1000	0x00D0	0x0080, 0x0040, 0x0010
0xE000	0x8000, 0x4000, 0x2000	0x00E0	0x0080, 0x0040, 0x0020
0xF000	0x8000, 0x4000, 0x2000, 0x1000	0x00F0	0x0080, 0x0040, 0x0020, 0x0010
0x0100	0x0100	0x0001	0x0001
0x0200	0x0200	0x0002	0x0002
0x0300	0x0200, 0x0100	0x0003	0x0002, 0x0001
0x0400	0x0400	0x0004	0x0004
0x0500	0x0400, 0x0100	0x0005	0x0004, 0x0001
0x0600	0x0400, 0x0200	0x0006	0x0004, 0x0002
0x0700	0x0400, 0x0200, 0x0100	0x0007	0x0004, 0x0002, 0x0001
0x0800	0x0800	0x0008	0x0008
0x0900	0x0800, 0x0100	0x0009	0x0008, 0x0001
0x0A00	0x0800, 0x0200	0x000A	0x0008, 0x0002

Protection  
 Protection Part Operation

---

Bit representation in Hex	Triggered Bits
<b>0x0B00</b>	0x0800, 0x0200, 0x0100
<b>0x0C00</b>	0x0800, 0x0400
<b>0x0D00</b>	0x0800, 0x0400, 0x0100
<b>0x0E00</b>	0x0800, 0x0400, 0x0200
<b>0x0F00</b>	0x0800, 0x0400, 0x0200, 0x0100

Bit representation in Hex	Triggered Bits
<b>0x000B</b>	0x0008, 0x0002, 0x0001
<b>0x000C</b>	0x0008, 0x0004
<b>0x000D</b>	0x0008, 0x0004, 0x0001
<b>0x000E</b>	0x0008, 0x0004, 0x0002
<b>0x000F</b>	0x0008, 0x0004, 0x0002, 0x0001

## Local Display and Local Display Selection Keypad

The local display and local display selection keypad are located on the front of each [condition monitoring module \(CMM\)](#).

They are used to locally control and supervise the protection part.

- The display is normally in screen saver mode (off) and is activated when a key is pressed on the keypad. The screen saver is reactivated after 10 minutes of key inactivity.
- Use the keypad to navigate through the menus, the white help text at the bottom of the display describes the key functionality in each menu.

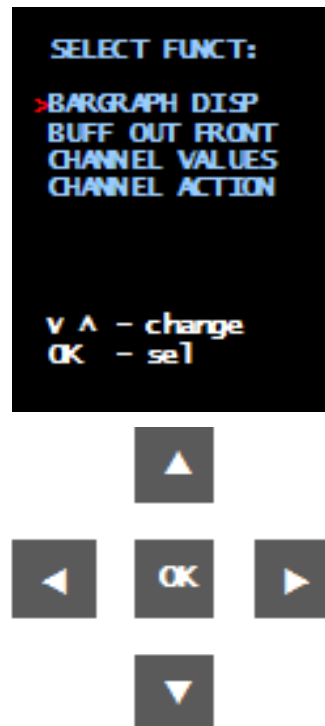


Figure 2 - 20.  
Local Display and Selection Keypad.

### Menu tree:

- Bar graph Display
  - Bar graph 1
  - Bar graph 2
- Buffer Outputs Front
  - Buffered output 1, Analog
  - Buffered output 2, Analog
  - Buffered output 3, Digital
- Channel Values
  - Analog channel 1-16 and Combined measurement 1-8

- Analog channel 1-16 bias (same as Gap)
- Digital channel 1-8
- Digital channel peak 1-8
- Channel Action (optional PIN-code protected)
- [Arm/Disarm Slot](#)
- [Arm/Disarm Channel](#)
  - Analog
  - Digital
- [Reset Slot](#)
  - Latch Functions
  - Digital Peak
- [Trip Multiply Slot](#)
- [Trip Multiply Channel](#)
- [Maintenance](#)

### Start Menu

The start menu contains the following four sub menus.

- Bargraph Display
- Buff Out Front
- Channel Values
- Channel Action (optional PIN-code protected)

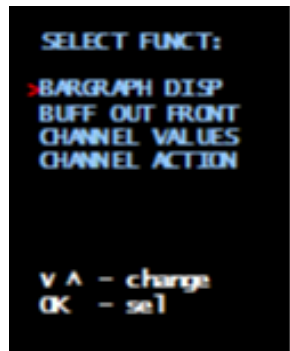


Figure 2 - 21.  
Start Menu.

1. Select a function with up and down arrows.
2. Confirm the selection with **OK**.

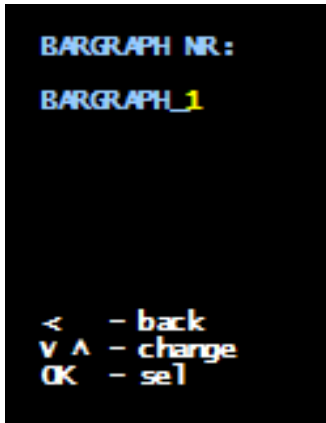
### Bar Graph Display

The IMx-M can show two bar graphs with values from analog channel 1 to 16 or combined measurements 1 to 8.

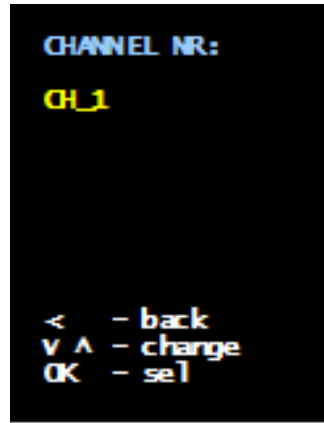
The **channel alarm levels** are displayed in the background: green for normal, yellow for alert and red for danger.

The **channel value** is displayed as a blue bar and also printed in text at the top together with engineering unit and detection type.

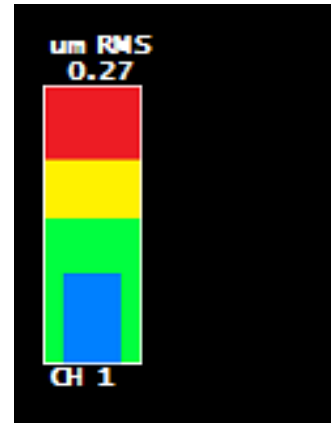
1. Select bar graph number (1 or 2) with up and down arrows.
2. Confirm the selection with **OK**.
3. Select a channel with up and down arrows, from analog channel 1 to 16 or combined measurement 1 to 8.
4. Confirm the selection with **OK**.
5. To set the second bar graph, repeat steps 1 to 4.



To select graph number



To select a channel



Bar graph 1 display

Figure 2 - 22.  
Bar Graph.

### Buffered Outputs Front Menu

Select channels to be connected to the three buffered outputs at the front of the protection module, two analog channels and one digital channel. For detailed information, refer to [Front Panel BNC Buffered Outputs](#) of Buffered Outputs.

1. Select a buffered output number (1 to 3) with up and down arrows.

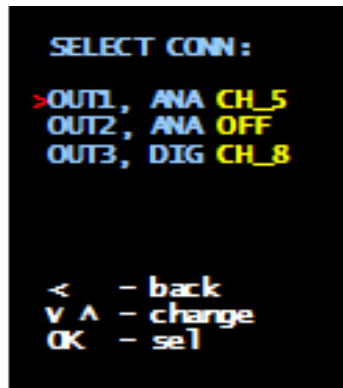


Figure 2 - 23.  
To Select a Buff Out.

2. Confirm the selection with **OK**.
3. Select a channel with up and down arrows.
  - Buff out 1 and Buff out 2: A channel can be selected from analog channels 1 to 16.
  - Buff out 3: A channel can be selected from digital channels 1 to 8.



Figure 2 - 24.  
Examples of Buffered Output.

4. Confirm the selection with **OK**.

### Channel Values

The Channel Value menu shows channel values with engineering unit and/or detection type for all channels (if applicable).

- **Analog Ch Values:** Displays engineering unit and detection type of all analog channels 1 to 16 and combined measurements 1 to 8.
  - **Analog Ch Bias:** Displays analog channel bias in mV (or uA if configured for 4-20 mA input) for all analog channels bias (same as Gap) 1 to 16.
  - **Digital Ch Val:** Displays engineering unit of all digital channels 1 to 8.
  - **Digital Ch Peak:** Displays engineering unit of all digital channels peak 1 to 8.
1. Select values to be shown with up and down arrows.

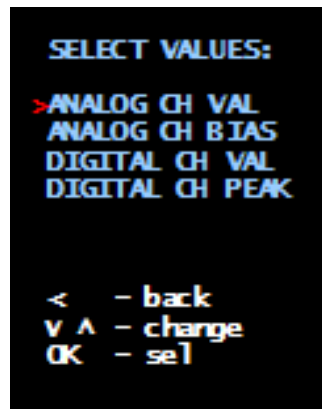


Figure 2 - 25.  
Channel Values Menu.

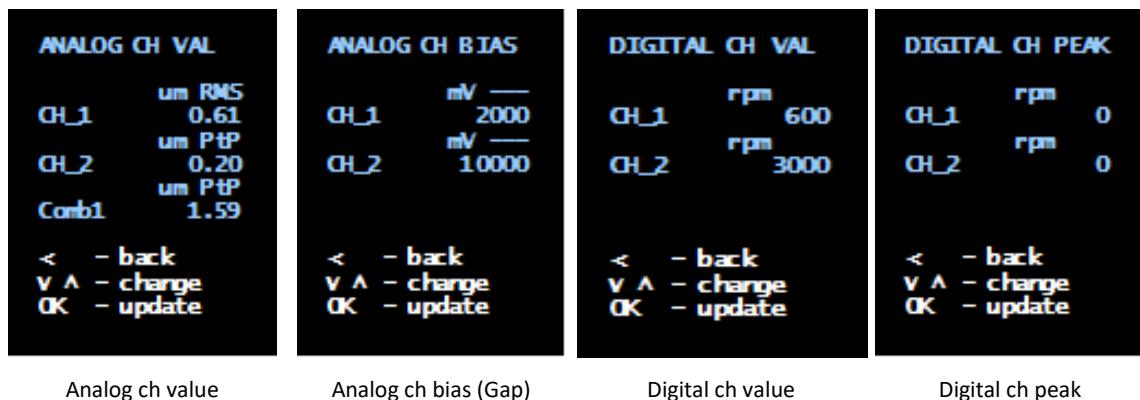


Figure 2 - 26.  
Display - Channel Values.

2. Confirm the selection with **OK**.
3. Use up and down arrows to see all channel values.

### Channel Action

The Channel Action menu includes actions that are able to change the setting of the protection part. The menu can be protected by a 4-digit PIN code (detailed information described in [Assigning Protection Settings \(PRM\)](#)) when setting slot properties.

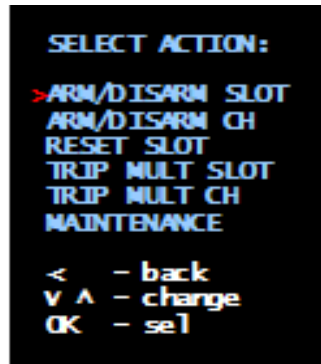
The Channel Action menu contains five sub menus:

- [Arm/Disarm Slot](#) (detailed information described in [Slot Disarm](#) chapter).
- [Arm/Disarm Channel](#) (detailed information described in [Channel Disarm](#) chapter).
- [Reset Slot](#)
- [Trip Multiply Slot](#)
- [Trip Multiply Channel](#)
- [Maintenance](#)

1. Option: Enter the 4-digit PIN code by using up, down, left and right arrows. Confirm the PIN code with **OK**.



Optional PIN code



Ch action menu

Figure 2 - 27.  
Display - Channel Action.

2. Select an action with up and down arrows.
3. Confirm the selection with **OK**.



### Arm/Disarm Slot

1. Confirm the arm slot or disarm slot action with **OK**.
  - Arm/disarm of slot will not affect individual channel disarm status.



Figure 2 - 28.  
Display - Arm/Disarm Slot.

### Arm/Disarm Ch

1. Use up and down arrows to mark a channel type; **Analog** or **Digital**.
2. Select channel type with **OK**.
3. Use up and down arrows to select a channel number.

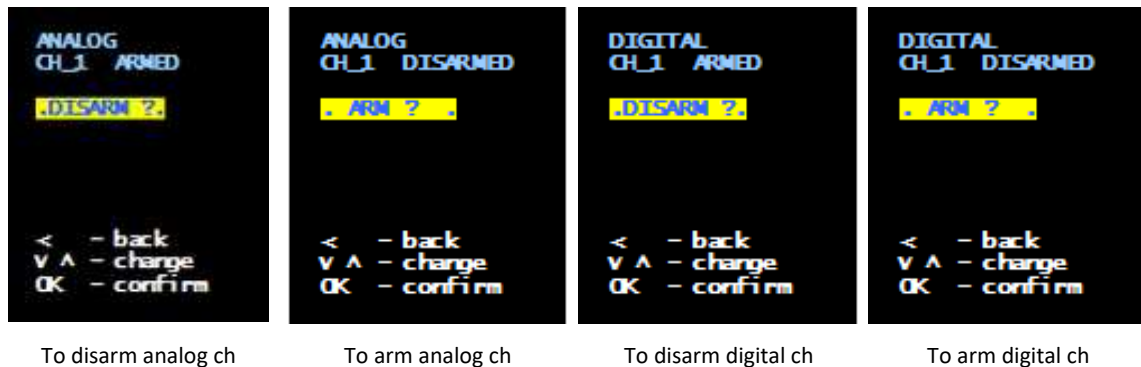


Figure 2 - 29.  
Display - Arm/Disarm Ch.

4. Confirm the arm channel or disarm channel action with **OK** (toggle value).

### Reset Slot

1. Use up and down arrows to select a **RESET SLOT** function; **LATCH FUNCTIONS** or **DIGITAL PEAK**.



Reset slot menu



To reset latching function



To reset digital peak

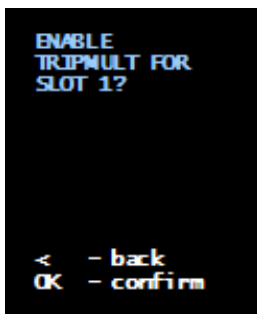
Figure 2 - 30.  
Display - Reset Slot.

2. Select the function with **OK**.
3. Confirm the Reset Function with **OK**.

### Trip Mult Slot

1. Confirm the enable or disable trip multiply for the slot with **OK**.
  - Slot trip multiply will activate/deactivate/override channel trip multiply status.

Trip multiply status will be stored in the backplane and will be restored after power cycle or hot-swap.



To enable trip mult slot 1



Trip mult enabled



To disarm trip mult slot 1

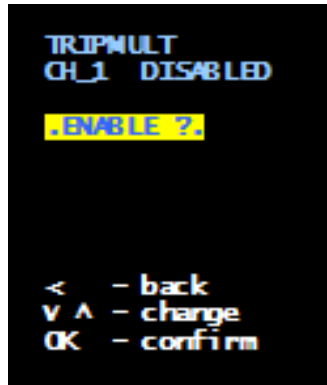


Trip mult disabled

Figure 2 - 31.  
Display - Trip Multiply Slot.

### Trip Mult Ch

1. Select an analog channel between 1 and 16 with up and down arrows.
2. Confirm enable or disable trip multiply for the selected channel with **OK** (toggle value).
  - Trip multiply status will be stored in the backplane and will be restored after power cycle or hot-swap.



To enable ch1 trip mult



To disable ch1 trip mult

Figure 2 - 32.  
Display - Trip Mult Ch.

### Maintenance

1. In order to set the slot in the maintenance mode, the slot has to be in disarm mode. If not, go back to [Channel Action menu](#) and select **Arm/Disarm Slot** and disarm the slot.



Figure 2 - 33.  
CMM Status Showing NORMAL.

2. Confirm the maintenance mode with **OK**. This will change CMM status from NORMAL to MAINTENANCE and the local display will start to flash (screen saver disabled).
3. Wait until the Ethernet connection status LED "Con" is OFF (located on CMM).
4. The slot is now ready for IMx-M Manager Maintenance View connection.

5. To exit the maintenance mode, leave the maintenance menu first, then IMx-M Manager Maintenance View has to be closed. Within 2 minutes the slot will return to the normal mode and the local display will stop flashing.
  - The slot will automatically leave the maintenance menu after 10 minutes of no key activity.



***Important - Events will not be saved in CMM during the maintenance mode.***

## Disarm

There are three different types of disarm;

- [Channel disarm](#)
- [Slot disarm](#)
- [Rack disarm](#)



**Important** - In order to engage disarm when relays are configured to trigger on channels in more than one protection module or solely on channels of a PRM in a different slot, it is strongly recommended always to use [rack disarm input](#) to disarm the entire rack at once.

The disarm status is stored in the backplane and will be recovered after a power cycle or hot-swap procedure.

### Channel Disarm

- Channel disarm can be set through Local display selection keypad by selecting CHANNEL ACTION then ARM/DISARM CH. [Local display selection keypad](#) is located on each condition monitoring module.
- It can also be set through Modbus register 258 as described in [Imported \(Write Single\) Modbus Register](#).

The characteristics of channel disarm:

- Latching cable fault is not triggered during channel disarm.
- Latching cable fault issued before disarm is kept during channel disarm mode (user must be sure to manually reset latching cable faults).
- Alert relays go to state OK when associated channel(s) enter channel disarm mode.
- Danger relays go to state OK when associated channel(s) enter channel disarm mode.
- Not OK relays go to state OK when associated channel(s) enter channel disarm mode.
- For the behavior of channel disarm relay, refer to the table [Behavior of channel status relays](#) in Relays chapter.
- For combined measurements, if the corresponding channel X or channel Y is in channel disarm, then the combined measurement will be set to channel disarm.
- **Warning!** Exercise extreme caution where N-out-of-N alarm logic is being used, as any of those channels in disarm will mean that the condition will never be TRUE (relay can never be triggered).

### Slot Disarm

Slot disarm affects the protection module (PRM) and consequentially, (only) the relays which are associated with the channels in that slot.

Slot disarm can be set through one of the following:

- Via the local display selection keypad which is located on each condition monitoring module, as shown in [Condition Monitoring Module \(CMM\)](#).

For detailed information refer to [Local Display and Local Display Selection Keypad](#) chapter.

- Via a digital input when configured as "slot disarm" which is described in [Configuring Digital Channels](#) chapter.



**Important - If a digital input was configured for slot disarm, then the new configuration to be downloaded/synchronized must have the same digital input configured as "slot disarm".**

- Via Modbus register 257 as described in [Imported \(Write Single\) Modbus Register](#).
- Via Ethernet connection from @ptitude Observer.

The characteristics of slot disarm:

- Latching cable fault may be triggered during slot disarm. User must reset latching cable faults manually before the release of disarm.
- Latching cable fault issued before disarm is kept during the slot disarm mode. User must reset the latching cable faults manually.
- Alert relay status is unchanged by a slot disarm and subsequent changes in channel alarm status will not be reflected by the relay whilst the disarm remains active.
- Danger relay status is unchanged by a slot disarm and subsequent changes in channel alarm status will not be reflected by the relay whilst the disarm remains active.
- Not OK relay status is unchanged by a slot disarm and subsequent changes in channel alarm status will not be reflected by the relay whilst the disarm remains active. Note however that a latching cable fault condition can be triggered during a slot disarm, so the user should check and where necessary reset any such latched faults before re-arming the slot.
- Note that whilst a relay state change cannot be triggered by channels in a disarmed slot, a relay that is latched in alarm at the point of disarm (the channel at this point is OK) will still change state if a latching reset is issued.
- Disarm relay on protection module is triggered only for slot disarm mode (not channel disarm mode).
- Protection module and relay module must be configured properly before slot disarm is released.
- Enable/disable of slot disarm does not affect individual channel disarm status.

- For the behavior of slot disarm relay, see the table [Behavior of Slot Status Relay](#) in Relays chapter.


### Rack Disarm


Rack disarm affects the entire rack.


Rack disarm can be set through rack disarm input on the rear panel of a protection module (labeled as "Disarm"). The location of a rack disarm input is shown in [Protection Module \(PRM\)](#) section . Impact on slot level is same as for slot disarm. Note that functionally, setting all slots individually in (slot) disarm is the same as a rack disarm.


### Release of Rack/Slot Disarm after Configuration

- After a configuration, rack/slot disarm may be released (hence armed) only after the system startup.
- The system startup takes about 30 seconds and is indicated by LED System status with green fast flash.

 **Important** - A premature release of rack/slot disarm may cause a missing or invalid configuration which results in MCU slaves not getting the new configuration and system will then indicate a circuit fault.

 **Important** - Disarm must not be released until the rack/protection module and the associated relay module are running with a proper firmware. Be sure to read "[Protection Firmware Update](#)" chapter thoroughly and understand it.

 **Important** - Rack/protection module and the associated relay module must be properly configured before disarm is released after each configuration update. Be sure to read "[Disarm](#)" chapter thoroughly and understand it. Evaluate circuit faults with diagnostic command "cf" as described in "[Circuit Faults \(cf\)](#)" chapter.


 **Important** - Evaluate channel alarms before disarm is released to avoid unwanted alert/danger alarms triggered upon arm of the channel or rack.


### Protection Configuration Update


Protection module configuration update is done by downloading a configuration file to a protection module via the application tool IMx-M Manager or via @ptitude Observer with Ethernet connection.


Configuration file is a .bin file generated by the IMx-M Manager application tool.


In order to download a configuration file to a protection module refer to **Send PRM Configuration** option in [PRM Serial Interface](#) within IMx-M Manager chapter.

 **Important - Do not arm the slot while the configuration file is still downloading. This can result in an invalid configuration, forcing the system to indicate a circuit fault condition.**

 **Important - Rack/slot must be set in disarm mode before the protection configuration synchronization procedure takes place. Be sure to read "[Disarm](#)" chapter thoroughly and understand it.**

 **Important - Do not turn off the power during the protection configuration update process.**

 **Important - If a digital input was configured for slot disarm, then the new configuration to be downloaded/synchronized must have the same digital input configured as "slot disarm".**

 **Important – If updating to a new (changed CRC) configuration and an RLM is present in the slot, be aware that the RLM will restart (relays will be de-energized).**


## Protection Firmware Update


Protection firmware update is done by downloading a firmware by using the application tool IMx-M Manager.


Refer to **Update Firmware** option in [PRM Serial Interface](#) within IMx-M Manager chapter.

It is strongly recommended to;

- check the version of the firmware to ensure the correct version after each firmware update by using the diagnostic command "intd0" as described in [Protection Part Diagnostic Commands](#).
- have the same version of the firmware for all the slots within the rack.

 **Important - Rack/slot must be set in slot disarm mode before the protection firmware updating procedure takes place. Be sure to read "[Disarm](#)" chapter thoroughly and understand it.**

 **Important - Do not turn off the power during the protection firmware update process.**

 **Important – If updating PRM FW and an RLM is present in the slot, be aware that the RLM will restart even if it already has the revised FW version (relays will de-energize). See '[Hot Swap](#)' for further information.**



## IMx-M Manager

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### Installation of IMx-M Manager

The installation of the IMx-M Manager application tool is done via @ptitude Observer installation, **Custom Setup** option where IMx-M Manager can be selected and installed. For detailed information refer to @ptitude Observer Installation Manual.

### Introduction to IMx-M Manager

IMx-M Manager is a tool which enables the user to configure the condition monitoring modules, protection modules and relay modules within an IMx-M rack.

For the physical installation, each protection module must be paired with a condition monitoring module to form a CMM + PRM pair.

In the IMx-M Manager a **slot** consists of the configurations for the CMM + PRM pair.

From the IMx-M Manager's configuration point of view, configuring a "slot" means configuring the CMM network settings, a PRM and an associated RLM.

The following are performed slot wise only:

- Configuration of channels and relays
- Circuit fault status report
- Activation of slot disarm of protection module and relay module
- Configuration of network connection

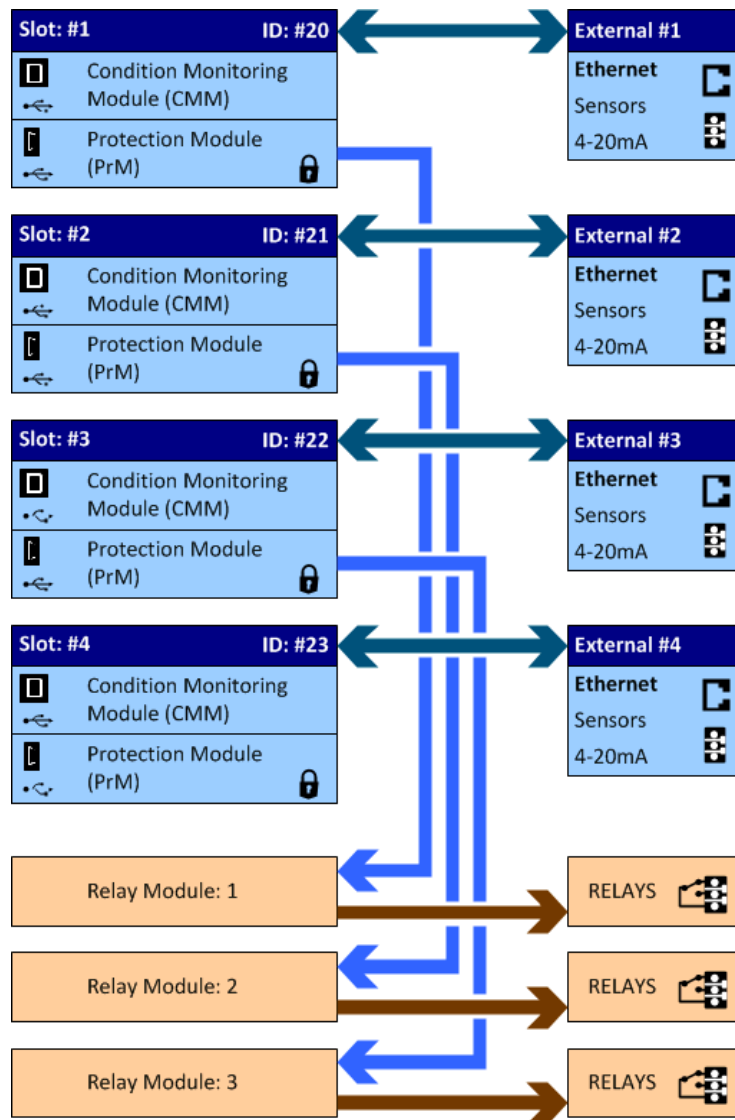


Figure 2 - 34.  
IMx-M Manager Configuration Overview.

For a fully equipped IMx-M rack, the configuration file of each slot contains the following:

- Slot 1: the configurations of CMM 1, PRM 1 and RLM 1
- Slot 2: the configurations of CMM 2, PRM 2 and RLM 2
- Slot 3: the configurations of CMM 3, PRM 3 and RLM 3
- Slot 4: the configurations of CMM 4 and PRM 4.

Although only one master project file (\*.mhf) is required per project (plant), because condition monitoring and machine protection parts operate completely independently of each other, two additional and distinct configuration files are created by the IMx-M Manager for each slot within the rack.

- **Master Project File (\*.mhf)** contains the hierarchy configuration of the project (plant) and CMM comments of each channel.
- **Network Configuration File (\*.imx)** contains the network configuration of a slot. This network configuration file is downloaded to the CMM via its front panel (type 2) USB connector.
- **Slot Configuration File (\*.bin)** contains the machine protection configurations of a slot (configuration of PRM and the associated RLM). This file is downloaded separately to the protection module via its front panel (Mini B) USB connector.

This means that for an IMx-M rack with all four slots populated, shall need to have nine files created (one master project file, four network configuration files and four slot configuration files) with eight of those files being downloaded to the rack.

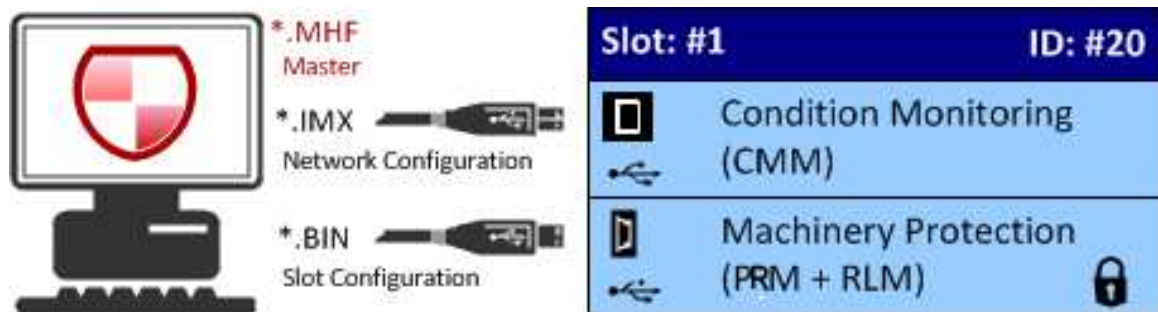


Figure 2 - 35.  
Dual Configuration Download.

**!** *Important - PC connection to the condition monitoring module must only be made via an SKF USB Isolator.  
PC connection to the protection module must similarly also only be made via an SKF mini-USB Isolator.*

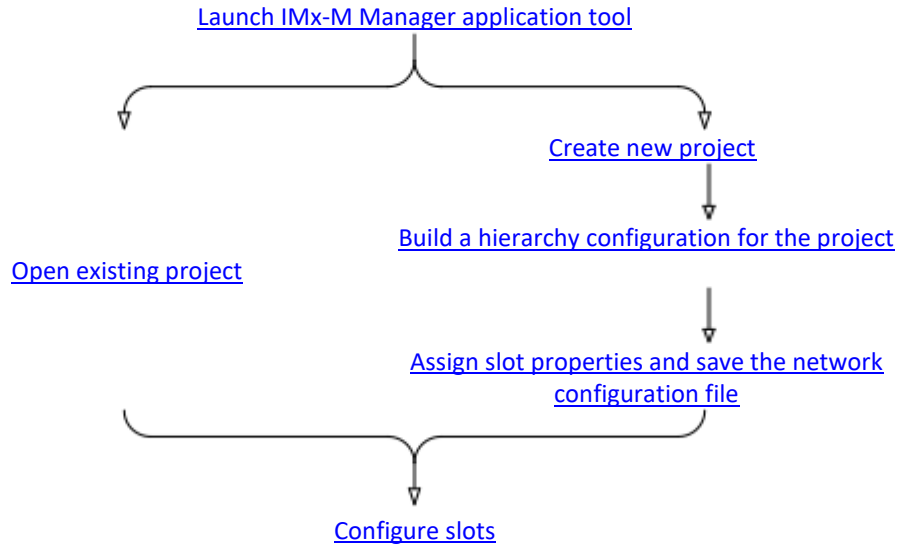
**!** *Important - A slot Configuration File cannot be downloaded to the protection module while the slot is still ARMED. The procedure for slot disarm is detailed in [Slot Disarm](#) chapter.*

**!** *Important - With PCs running either Windows 7 or Windows 8, the required USB drivers will be downloaded and installed automatically. For PCs running legacy OSes (such as Windows XP), please refer to the @ptitude Observer installation DVD.*

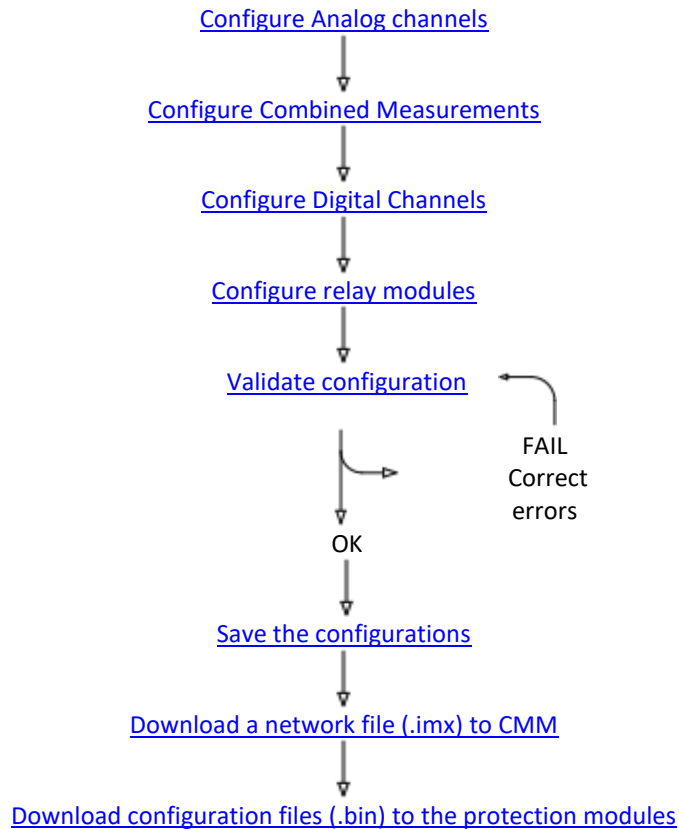
## Project Creation and Configuration Flow

The following flow charts illustrate the steps needed to create a properly working project (plant).

### Project Creation and Configuration Flow:



### Slot Configuration Flow:



## Launching the Application

When the application is initially launched the user has the option to either create a new master project file (known as a project) or to edit an existing one.

## Creating a New Project

Select **Create New Project**, enter appropriate values into each of the enabled text fields and press the **OK** button.

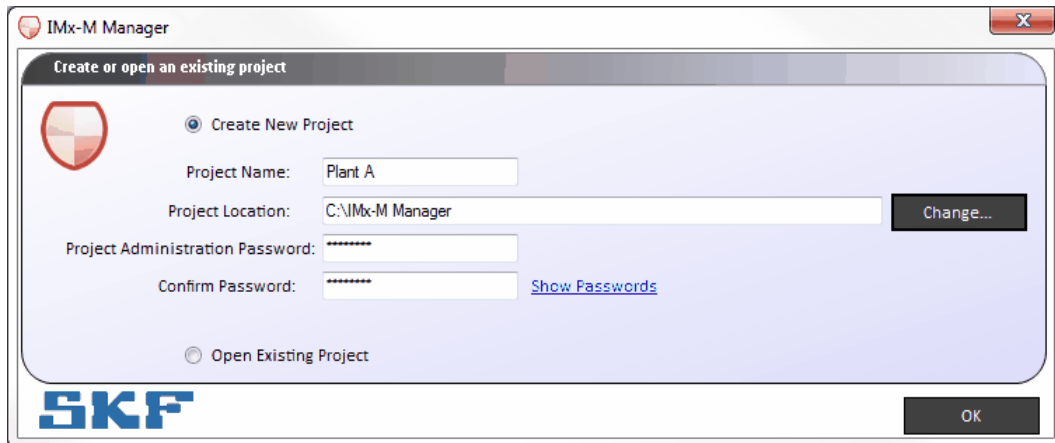


Figure 2 - 36.  
Creating a New Project.

Remember when creating a new project that the name chosen should represent the plant level of the system, and not a specific area or rack, as these will be added as the project hierarchy.

**Project Administration Password** must be a string of characters that is minimum 6 characters long (ASCII). It will be required to save any changes to the existing project.

## Editing an Existing Project

Select Open Existing Project.

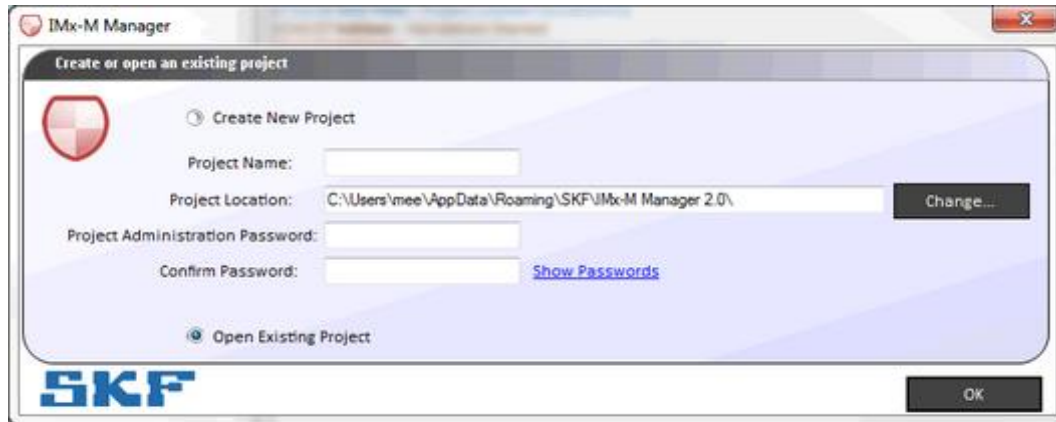


Figure 2 - 37.  
Editing a Project (Master Project File).

As soon as this option is selected, a "File Open" dialog will be launched. Use this dialog to browse the location of the existing project to open the desired master project file (\*.mhf).

Once the master project file has opened, the IMx-M Manager will launch into its main view and validate any slot configuration files (.bin) that are present in the project (see below).

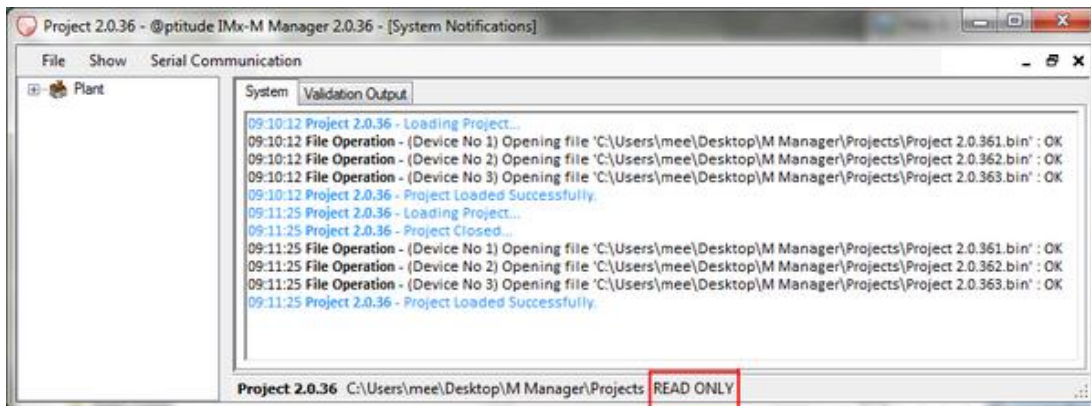


Figure 2 - 38.  
Viewing an Existing Project.

Note on the figure above, that the project is listed as READ ONLY. This status can only be reset to ADMINISTRATION MODE after the project password has been entered.

## Entering Administration Mode

Before any existing project configuration can be changed, the user must first enter a password to allow the Manager to enter the administration mode. The password dialog will be launched automatically as soon as the user attempts to save any changes to the configuration.



Figure 2 - 39.  
Entering Administration Mode.

## Navigating IMx-M Manager Main Menu

### "File" Menu Selection

#### New Project

Use this menu option to create a new IMx-M Manager project. If an existing project is already open, a message will be prompted to close the open project before continuing.

#### Open Existing Project

Use this menu option to open an existing IMx-M Manager project (file type \*.mhf). If a project is already open, a message will be prompted to close the open project before continuing.

#### Recent Projects

Displays a list of existing IMx-M Manager projects that have been recently opened and can be immediately opened. If a project is already open, a message will be prompted to close the open project before continuing.

#### Project Properties

Use this menu option to display the properties of the currently open IMx-M Manager project.

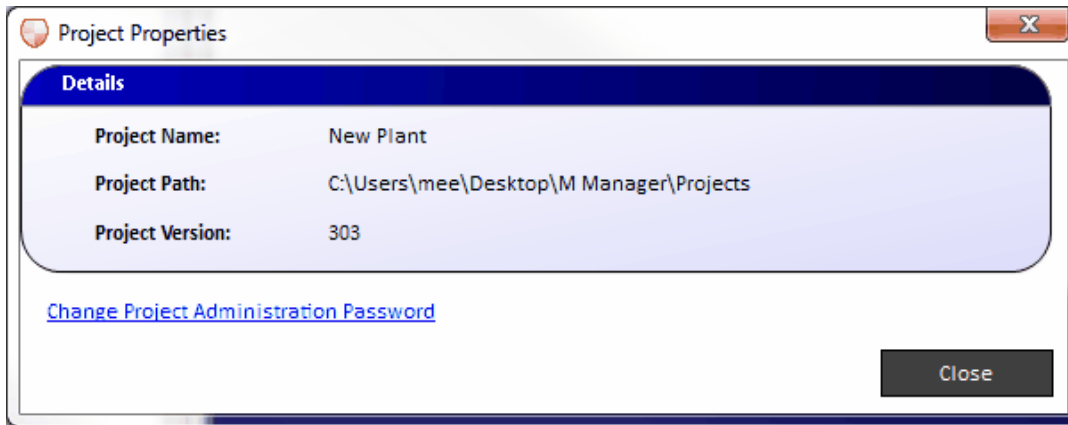


Figure 2 - 40.  
Viewing the Project Properties.

This menu option also allows the **Project Administration Password** to be changed by clicking on the underlined hyperlink (see above).

#### **Administration Mode**

Use this menu option to force the currently open project into the administrator mode. A password will be required to complete this step.

#### **Observer Database Connection**

**Observer database connection** allows to connect or disconnect to the Observer database.

Note that in order to be able to use this function, IMx-M Manager must have a project opened. Every time a new project is open, the Observer database connection will be set to Off.

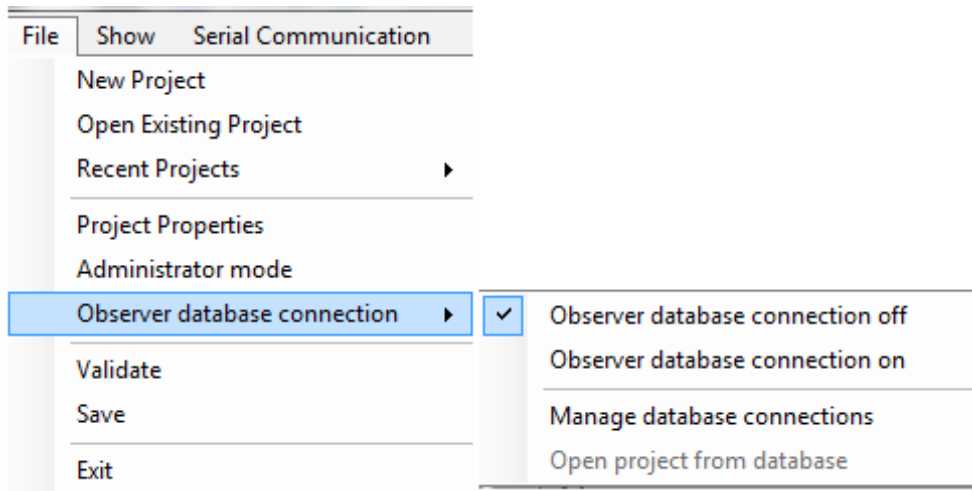


Figure 2 - 41.  
Observer Database Connection.

- If Observer database connection is ON, IMx-M Manager configurations can be imported automatically to the Observer database when performing **Save** function.



- IMx-M configuration file in the Observer database can be sent to IMx-M manager for updates to the file. This can be done by establishing the **Observer database connection on** and **Open Project from database** to make changes. It then can be imported back to the Observer database by performing **Save** function.
- IMx-M Manager can get the Observer database file to save it in the local file system. It then can be used for analysis and/or distribution. The location of the saved file is listed in the IMx-M Manager System Log.

### Validate

Use this menu option to validate the current project configuration. Although a validation is always executed prior to saving a configuration, it is still important to regularly validate an open project.

The validation output has following types:

- **OK:** No validation error found. This configuration can be saved and downloaded to a protection module.

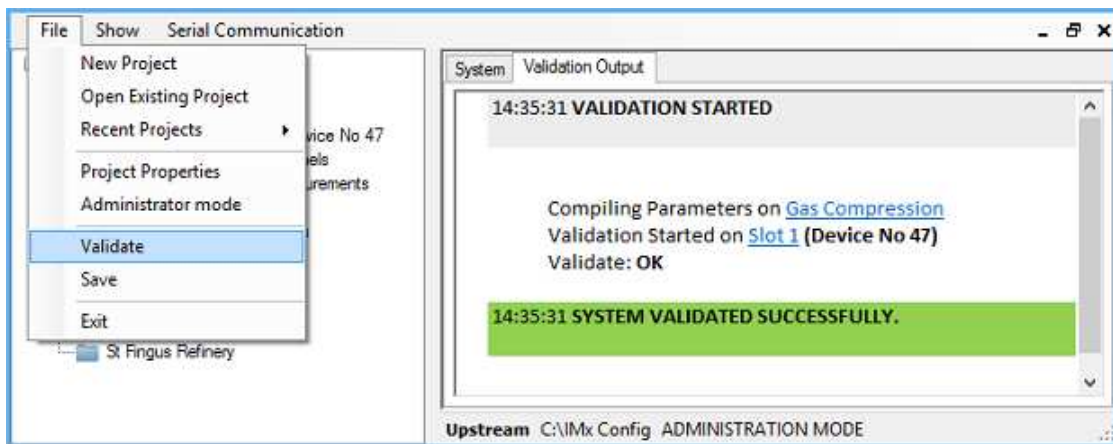


Figure 2 - 42.  
A Successful Validation of a Project Configuration.

- **Error (Severe Error):** Validation error is severe and the configuration cannot be saved. Note that the severity of the error is notified only when **Save** is executed for the project. For the severe error message, refer to [Save](#) in "File" Menu Selection chapter.



Figure 2 - 43.  
A Validation Failure with (Severe) Error.

- **Error (Non-Severe Error):** Validation error exists but the configuration can be saved. However, this configuration file cannot be downloaded to a protection module.

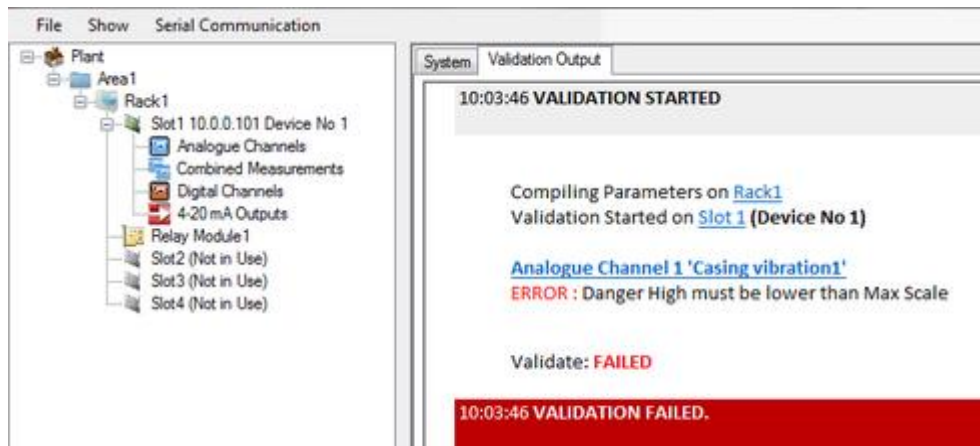


Figure 2 - 44.  
A Validation Failure with (Non-severe) Error.

- **Warning:** Warning is not considered as a validation error. This configuration can be saved and downloaded to a protection module. However, it is recommended to check the warning message and consider the consequences.

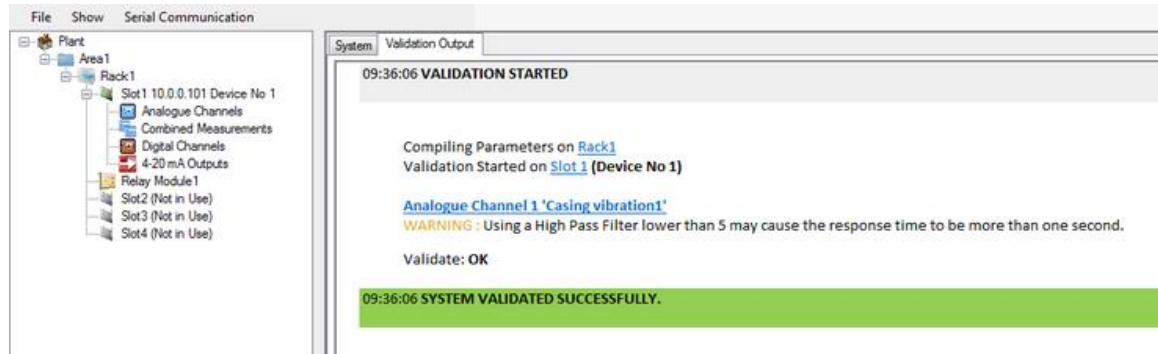


Figure 2 - 45.  
A Validation with Warning.

### **Save**

Use this menu option to save the currently open project.

Save function first executes the validation of the configuration. For detailed validation output types refer to [Validate](#) in "File" Menu Selection chapter.

If the project contains severe configuration errors, then the save process will be aborted, and the following message will be displayed.

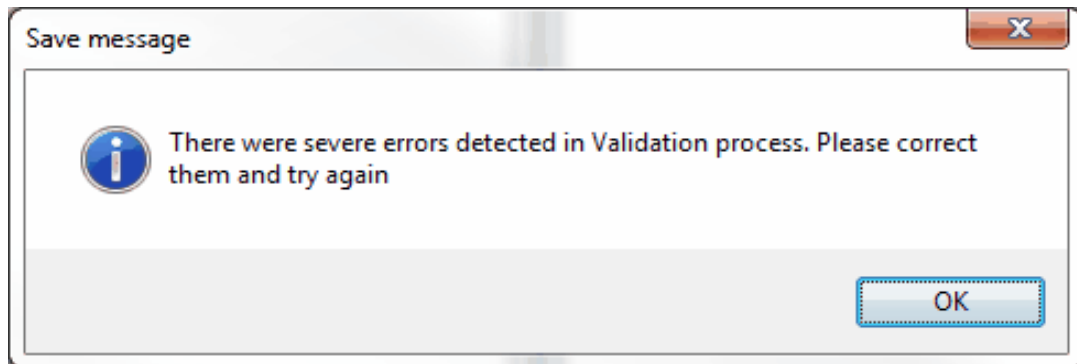


Figure 2 - 46.  
Save Aborted Due to Severe Validation Errors.

If this project contains configuration errors (non-severe), then the save process will continue with the following message and will allow to save the project.



Figure 2 - 47.  
Non-severe Validation Error Can Be Saved.

However, in order to be able to download the protection configuration for the slot, all types of validation errors must be eliminated.

The saved configuration file (.bin) will be stored in the same directory as the hierarchy project file (.mhf).

The default location and filename are 'C:\Users\[user name]\AppData\Roaming\SKF\IMx-M Manager x.y\[project name + device number of the slot].bin'. The location and filename are listed in **System log** window as shown below.

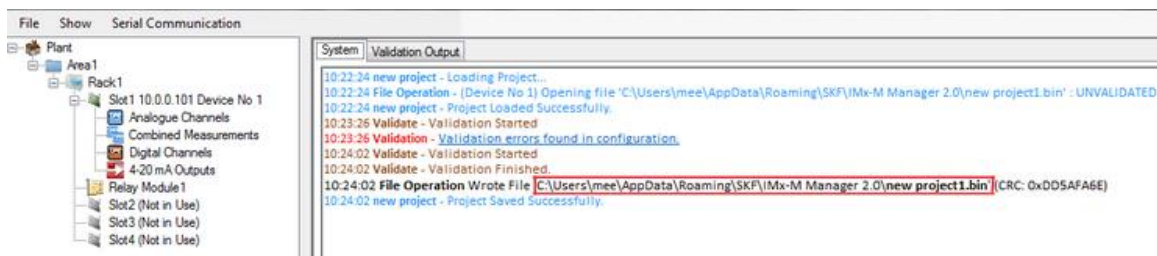



Figure 2 - 48.  
System Notification Window Showing the Location of ".bin" Configuration File.

 **Important - Configurations are only saved via this menu option and not continuously as the project is being configured. This means that in the event of a system failure (a PC crash), any work not saved will be lost. So remember to use the Save option regularly.**

#### Exit

Use this menu option to exit from the application. If the current project has unsaved changes, then the following message will be displayed.

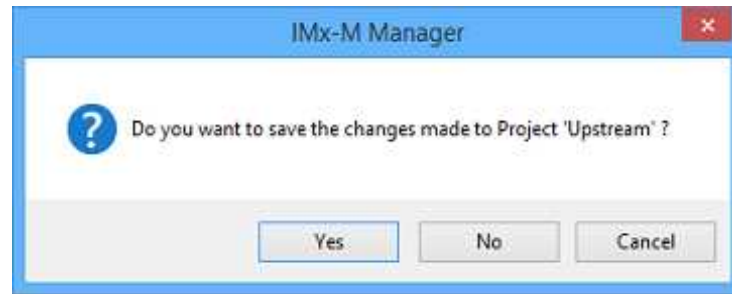


Figure 2 - 49.  
Saving Changes Prior to the Application Closing.

If there are severe validation errors, then exiting the application without correcting those errors will cause all and any changes made being lost.

### "Show" Menu Selection

**System Notifications** displays system messages.

### "Serial Communication" Menu Selection

**COM Port** indicates the serial port interface for the communication.

Serial (USB) interface on a condition monitoring module (CMM serial interface) is used to transfer the network configuration to the IMx-M rack slot wise.

Serial (USB) interface on protection module (PRM serial interface) is used to transfer the slot configuration and relay configuration to the IMx-M rack slot wise.

- Refer to [How to Select COM Port](#) to find out which COM port number to use or to change COM port number.
- The USB port for CMM serial interface is located on the front panel of each condition monitoring module. See [Condition Monitoring Module \(CMM\)](#) chapter for the physical location of the USB port. The actual physical connection between the host PC and a condition monitoring module is described in the [Condition Monitoring Module Serial \(USB\) Interface](#) chapter.
- The USB port for PRM serial interface is located on the front panel of each protection module. See [Protection Module \(PRM\)](#) chapter for the physical location of the USB port. The actual physical connection between the host PC and a protection module is described in the [Protection Module Serial \(USB\) Interface](#) chapter.
- Use a SKF USB isolator cable. Connect the USB cable to a free USB port of the PC. Connect the other end of the USB cable to either the condition monitoring module's USB port or the protection module's USB port. The connected module is where the slot configuration will be updated.



**Important - SKF USB isolator cables shall always be used when connecting to IMx-M USB ports.**

- USB driver installation instruction is found in @ptitude Observer DVD.

**Command** is where commands or instructions are entered manually.

### **How to Select COM Port**

#### **To Find Windows Allocated COM Port Number:**

- Open **Control Panel** window and select **System**.
- Select Device Manager.
- Double click on **Ports (COM & LPT)** to see the available USB Serial Port as shown, below.

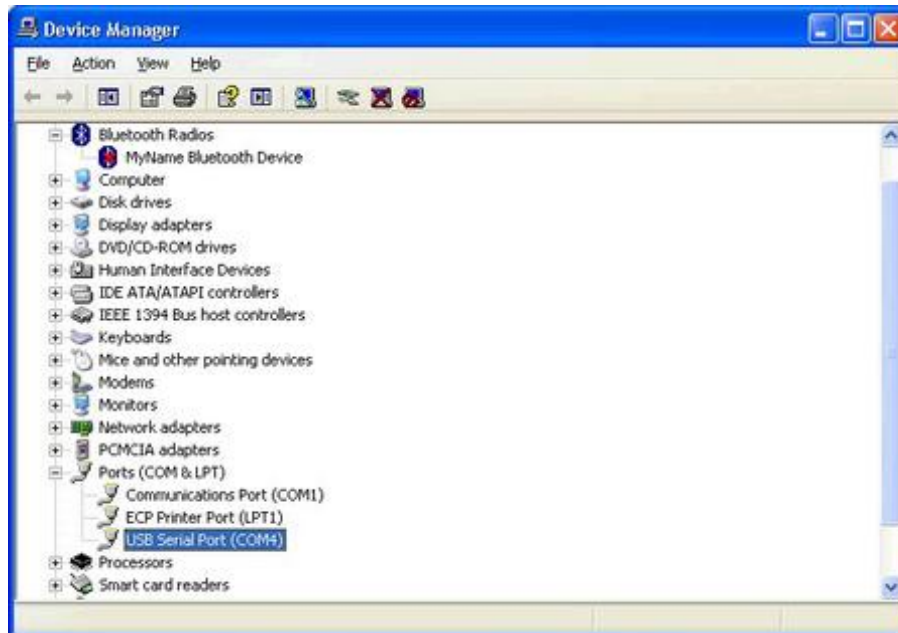


Figure 2 - 50.  
Windows COM Port Device Manager.

#### **To change COM Port Number:**

- Continue from the above steps.
- Double click on **USB Serial Port**, then select **Port Settings** option.

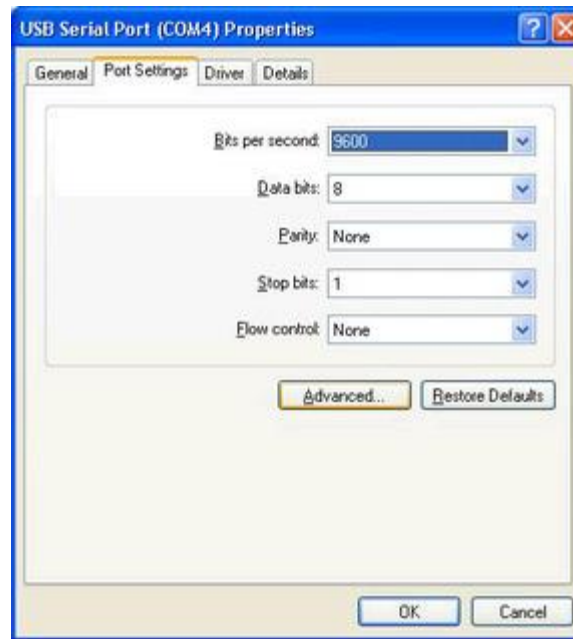


Figure 2 - 51.  
Example of Windows COM Port Settings.

- Select **Advanced...** and change the COM Port Number.

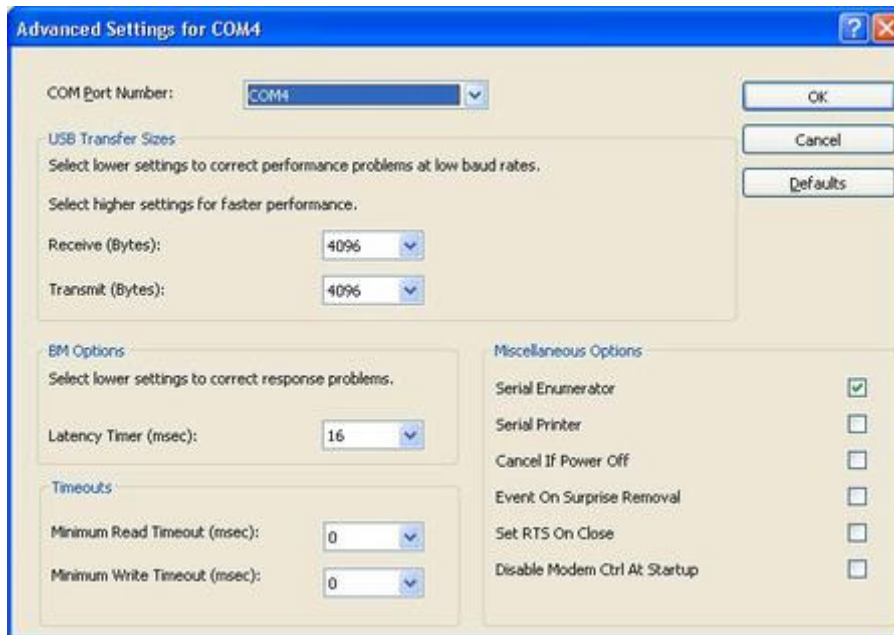


Figure 2 - 52.  
Example of COM Port Advanced Settings.

- COM Port Number can be changed to any number greater than 2. Ensure that the port number is not in use by any other hardware installed in the computer.

### CMM Serial Interface

Use this menu option to show and enable the CMM Serial Commands (see figure below).

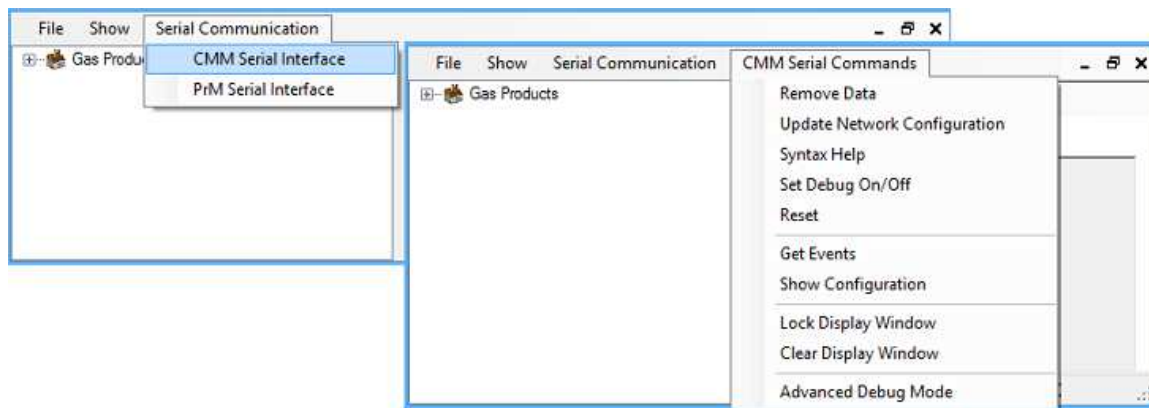


Figure 2 - 53.

Selecting and Displaying the “CMM Serial Commands” Menu.

- **Remove Data** deletes all the measurement data and event log that the IMx-M Manager has collected and stored in the memory.
  - As a general rule, always run this command after an installation to make sure that incorrect/invalid data are removed.
- **Update Network Configuration** updates the Network configuration file (.imx) on a selected CMM. This will launch a file browser, which should be used to select a correct Network configuration (\*.imx) file.

Once selected, the process of updating the file to the CMM will start automatically, with a status of the update being displayed on the IMx-M Manager.



**Important** –Once the network configuration update has completed, the CMM will be automatically restarted. During this restart period, connection to the PRM will be lost. This means that any alarm or trip state will not have the associated transient data during the restart.

- **Syntax Help** gives the user access to syntax help in the current prompt.
  - It is a good practice to use this interface before the download of any file to ensure that the communication has been established with the CMM.
  - If there is no access to syntax help, change the COM port and try it again.
  - When the syntax help access is established, the on-line device is ready to be updated.
- **Set Debug On/Off** prints/not prints measurement values of which the CMM is currently measuring, for example, > PROCESS 69.617386 - ANA10000004 on channel 4, DBID = 10000004.



- **Reset** performs a software reset.
- **Get Events** stores all events from the rack to a file in user readable format. See [Event Log](#) for detailed event information.
- **Show Configuration** displays the current measurement configuration of the CMM.
- **Lock Display Window** is a toggle button which locks/unlocks the contents on the output display window. This can be useful when a user wants to copy and paste information from the output window.
- **Clear Display Window** clears the output window.
- **Advanced Debug Mode** shall only be used by experienced installation engineers in cooperation with SKF Condition Monitoring Center.

#### PRM Serial Interface

Use this menu option to show and enable the PRM Serial Commands.

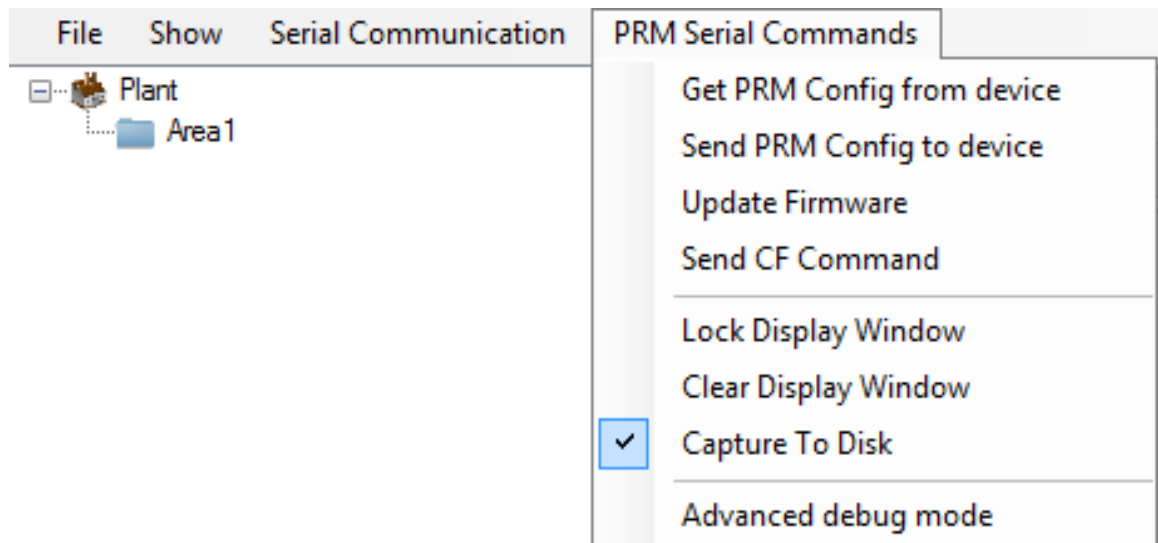


Figure 2 - 54.

Selecting and Displaying the “PRM Serial Commands” Menu.

- **Get PRM Config from device** reads the slot configuration file currently in use by the protection module to which a USB is connected and creates a .bin file.
- **Send PRM Config to device** sends a configuration file from IMx-M Manager to the protection module to which USB is connected.



**Important** - Do not rearm the slot while the configuration file is still downloading. This can result in an invalid configuration, forcing the system to indicate a circuit fault condition.



**Important** - Rack/slot must be set in slot disarm mode before the protection configuration synchronization procedure takes place. Be sure to read "[Disarm](#)" chapter thoroughly and understand it.



**Important** - Do not turn off the power during the protection configuration update process.



**Important** - If the configuration of a slot is to be updated and the slot is disarmed through a digital input, it is strongly ADVISED to make sure that the same digital input is configured as slot disarm input. Failing to do so will lead to unintentionally arming of the slot when the slot restarts and the new configuration is activated.



**Important** - See also chapter "[Relays on Relay Modules](#)" and "[Behavior of Slot Status Relays](#)" for details when shared relays are used.

- Select a protection module ".Bin" file that will be used for the configuration.  
".Bin" file is created when the project configuration is saved. Refer to [Save](#) in "File" Menu Selection chapter.  
Note that if the default location for projects is used, to be able to browse a file, Folder Options of Windows setting must be set to "Show hidden files, folders, and drives". It is done on the computer via Organize\Folder and search options\View\Hidden files and folders.
- Enter the PIN code of the already existing configuration in the protection module, NOT the PIN code of the new configuration that will be downloaded.  
  
If there is no PIN code, then"0000" (four zeroes) may be entered.
- If the download is successful, the protection module will restart with the new configuration and the new PIN code will take effect.
- Check that there are no circuit faults before disarm is released.
- Check that there are no channel alarms before disarm is released.
- The protection configuration update process can take about one minute.
- **Update Firmware** downloads a protection firmware to the protection module to which a USB is connected.



**Important** - System must be set in slot disarm mode before the protection firmware update procedure takes place. Be sure to read "[Disarm](#)" chapter thoroughly and understand it.



**Important** - See also chapter "[Relays on Relay Modules](#)" and "[Behavior of Slot Status Relays](#)" for details when shared relays are used.



**Important** - Do not turn off the power during the protection firmware update process.

- Select a ".a48" firmware file to be downloaded.
- Enter the PIN code of the already existing configuration in the protection module.
- If there is no PIN code, then "0000" (four zeroes) may be entered.
- When the download is successfully completed, the protection module will reboot with the newly updated firmware version.
- It is strongly recommended to check the version of the firmware to ensure the correct version after each firmware update by using a diagnostic command "intd0" as described in [Protection Part Diagnostic Commands](#).
- It is also strongly recommended to have the same version of the firmware for all the slots within the rack.
- **Send CF Command** displays all the circuit faults along with descriptions of the current slot (all channel and relay configurations).
- **Lock Display Window** is a toggle button which locks/unlocks the contents on the output display window. This can be useful if a user wants to copy and paste information from the output window.
- **Clear Display Window** clears the output window.
- **Capture to Disk** saves responses or messages generated by commands and interfaces to a file. It will be located in the same directory as the currently open project.
- **Advanced debug mode** shall not be used. This is only for a critical fault recovery situation where SKF Condition Monitoring Center must be contacted first.

## Validating and Saving Protection Configurations

Validating and Saving are done on the Project level which include configurations of all the installed slots.

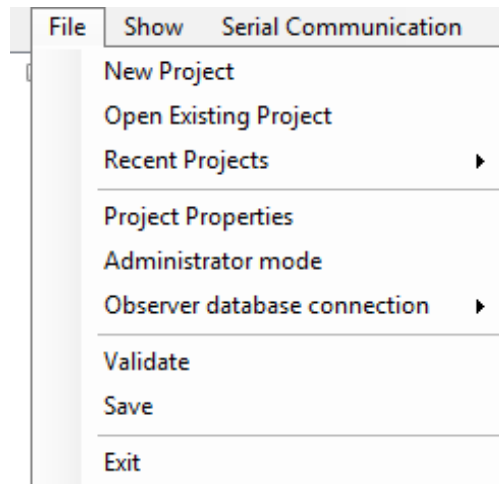


Figure 2 - 55.  
"File" Menu.

To validate slot configurations, from the Main Menu, select **File** and **Validate**.

Assuming there are no issues, return to the main menu, select **File** and then **Save**. This will either create a new, or update an existing master project file (\*.mhf) and slot configuration files (\*.bin).

Detailed information is to be found in [Validate](#) and [Save](#) in "File" Menu Selection chapter.

### **Sending Protection Configuration to Protection Module**






Once the slot configuration has been validated and the configuration file (\*.bin) has been created and saved, this slot configuration file can be sent to a protection module.

#### **Disarming a Slot**

Before the slot configuration file can be sent, the slot must be disarmed. See [Slot Disarm](#) for different ways to disarm slot.

#### **Sending Protection Configuration to PRM**

The procedure of sending the protection configuration (.bin) to protection module is described in the [PRM Serial Interface](#) in "Serial Communication" Menu Selection.

-  **Important** - Do not arm slot while the configuration file is still downloading. This can result in an invalid configuration, forcing the system to indicate a circuit fault condition.
-  **Important** - Rack/slot must be set in slot disarm mode before the protection configuration sending procedure takes place. Be sure to read "[Disarm](#)" chapter thoroughly and understand it.
-  **Important** - Do not turn off the power during the protection configuration update process.
-  **Important** - If the configuration of a slot is to be updated and the slot is disarmed through a digital input, it is strongly ADVISED to make sure that the same digital input is configured as slot disarm input. Failing to do so could lead to unintentionally arming of the slot when the slot restarts and the new configuration is activated.
-  **Important** - For detail information when shared relays are used, also see chapter "[Relays on Relay Modules](#)" and "[Slot Status Relays on Protection Module](#)" in Relays chapter.

#### Checking for Circuit Faults

After updating the slot configuration and before arming the slot, both the PRM and the RLM shall be checked for circuit fault conditions.

There are two ways to do this: either from the lower "Command" text box, by entering the command "cf", or from the main menu selecting "PRM Serial Commands" and "Send CF Command".

Either method will instruct the slot to query all channels and relay configurations for circuit faults. If everything is OK, then all returned result values will be zero.

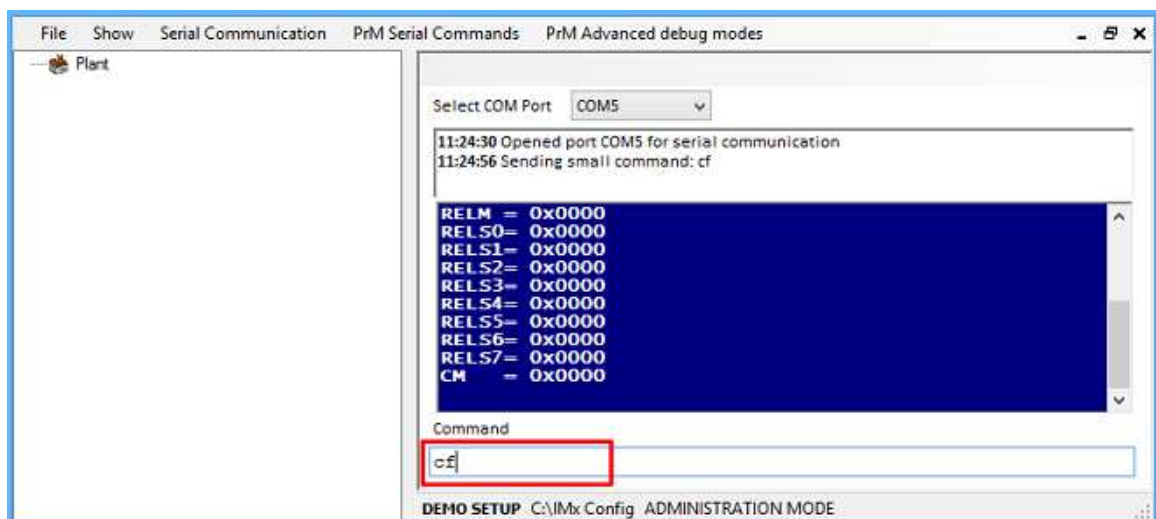


Figure 2 - 56.

Checking for Circuit Faults by cf Command.

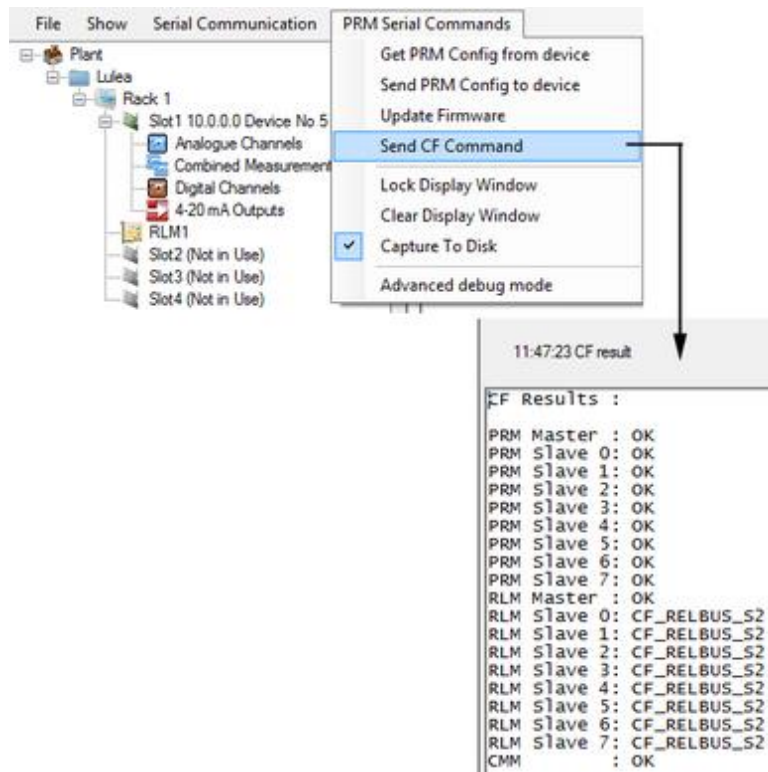


Figure 2 - 57.  
Checking for Circuit Faults by Sending CF Command.

For circuit fault diagnostic conditions and descriptions, see [Circuit Faults \(cf\)](#).

### Establishing a Connection between Host PC and Protection Module

Connection between the host PC and the protection module can be done in two different ways.

#### Using a Mini-USB Cable

The actual physical connection between the host PC and the protection module is described in the [Protection Module Serial \(USB\) Interface](#) chapter.

Refer to "Serial Communication" Menu Selection for the [selection of COM port](#).

#### Using an Ethernet Cable

Downloading the slot configuration file to a protection module using an Ethernet cable is done via @ptitude Observer. For detailed information, refer to @ptitude Observer User Manual (Document Part Number 32170900).

### Getting Protection Configuration from Protection Module

In order to get the protection configuration that is in use by the protection module and update the IMx-M Manager with it, do the following:

- Establish a Connection between Host PC and protection module.
- Get the Protection configuration file by performing **Get PRM Config from device** via [PRM Serial Command](#).

- Right click on the slot and select **Copy From ...** then **File ...**. Select the file that was created by **Get PRM Config from device**.
- Perform [Save](#).

## Export to Excel File

The IMx-M Manager allows configurations to be exported as a Microsoft Excel Workbook from plant, area, rack and slot nodes.

These workbook configurations can be used as reference.

An advantage of this feature is that it allows these levels of the configuration to be exported in a readable format for reference and use by external bodies.

A workbook can be created and exported from the plant, area or rack levels of the configuration hierarchy, with each created workbook containing all child elements of the selected hierarchy node (see figure below).

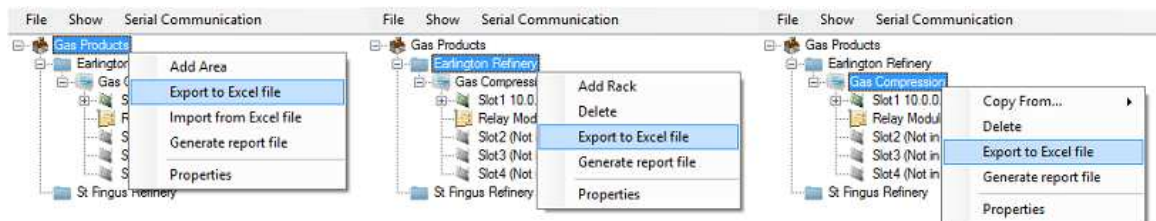


Figure 2 - 58.

Exporting a Configuration File as an Excel Workbook.

The created workbook will contain the following worksheets:

- **Analog Channels:** contains the full parameter set of all enabled analog channels.
- **Combined Measurements:** contains the full parameter set of all combined channels.
- **Digital Channels:** contains the full parameter set of all enabled digital channels.
- **4-20 mA out:** contains the full parameter set of all enabled 4–20 mA.
- **Relays:** contains the full parameter set of all relay module configurations.
- **Notes:** information on engineering unit and all rack\slot worksheet settings.

Note that the created workbook will not include CMM properties, Modbus configuration, PSU configuration, Slot names and system configuration of empty slots and relays.

## Import from Excel File

Import of an Excel file can only be performed at the Plant level and into an empty configuration (see figure below):

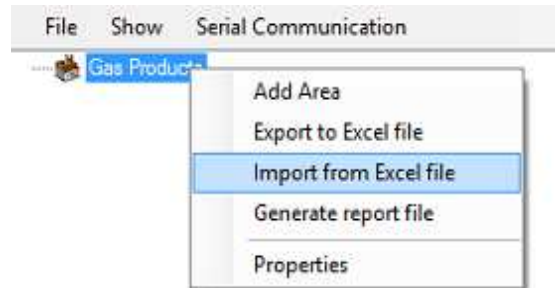


Figure 2 - 59.  
Importing IMx-M Configuration from an Excel Workbook.



**Important - When importing a configuration from Excel, be aware that there will be a loss of precision. For an example, an alarm value exported at 2001.781 will be imported as 2001.8.**

## Generate Report File

**Generate Report** can be executed from different nodes such as the plant, an area, a rack or a slot. Right click on a desired node and select **Generate report file**.

The report is created in Portable Document Format (.pdf) or MS word (.doc) file format.

Note that if the report is generated from the plant or an area node, the report for each rack will be created in separate files.

A report of an individual channel or relay is done by **Print** function.

## Maintenance View

Maintenance View is intended to be used during system installation and maintenance for troubleshooting and verification purposes. It makes it possible to verify measurement values, alarms, sensor OK status and relay operation on all protection channels. It also allows to create an AT (Acceptance Test) report.



**Important - Events will not be saved in CMM during the maintenance mode. As an effect of this username/configuration change information will NOT be stored by the CMM when sending a configuration to the PRM during maintenance mode.**



**Procedure to access the Maintenance View:**

1. Maintenance View is available on slot nodes. Right click on a slot and select **Maintenance View**.
2. In order to enable the IMx-M Manager Maintenance View to connect to the PRM the following conditions must be met:
  - a. Maintenance mode must be activated on the PRM in the rack.  
(Refer to [Maintenance](#) on how to set the slot in "maintenance mode".)
  - b. The Ethernet connection status LED "Con" must be OFF.
    - By entering the maintenance mode, IMx-M will stop communicating to any @Observer Monitor process that is running.
3. In the Maintenance View, IMx-M connection address may be changed, if needed. The default connection address is the CMM network setting when [Setting Slot Properties](#).
4. Press **Connect** to continue.
5. After the connection is established, certain values will be updated every 2 seconds reflecting live data. However, no data will be captured or buffered in the CMM + PRM module during the maintenance mode. In addition, events registered during the maintenance mode will not be saved.
6. When maintenance mode is active, it is possible to arm the slot in order to evaluate its behavior to real or other injected signals when armed.



***Important - Arming the system may cause relays to trigger. Alarms must be evaluated before arming.***

7. Once Maintenance View is closed, it may take up to 2 minutes to get the communication back to @Observer Monitor. The Ethernet connection status LED "CON" shall be ON.



***Important - Entering or leaving maintenance mode will not affect arm/disarm state which will remain unchanged. The slot will stay in the state it was (arm/disarm) when maintenance mode is terminated.***



***Important - Any triggered latching alarm will stay active when leaving maintenance mode. Before arming the slot, alarms should be evaluated and any triggered latching alarms should be handled appropriately (reset if needed).***

## Status

Status displays the slot status and circuit fault results.

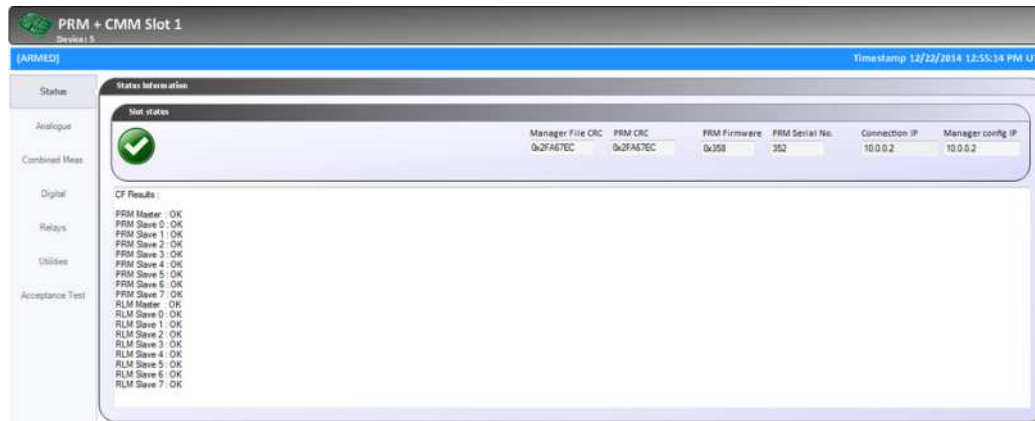


Figure 2 - 60.  
Maintenance View - Slot Status.

- **Manager File CRC** is the IMx-M Manager configuration file CRC of the slot that Maintenance View was selected from the hierarchy view. The CRC is assigned when the configuration file is saved.
- **PRM CRC** is from the configuration file (.bin) that is in use by the protection module. This configuration is the one Maintenance view will be using.
- During the Maintenance mode, when any configuration change is needed, first check to see if the Manager File CRC is the same as this PRM CRC. If they are the same, changes can be made directly in the Manager. However, if they are not the same, first this PRM configuration file must be imported to the Manager before any changes can be made. Refer to [Getting Protection Configuration from Protection Module](#), then restart the Maintenance View.
- If any changes were made, remember to [send the changed slot configuration file to protection module](#).
- **PRM Firmware** is the FW in use by PRM
- **PRM Serial No.** is the PRM HW serial number
- **Connection IP** is the network address of the CMM + PRM slot which is in use. This address (CMM IP-ADDRESS) is shown via [Maintenance](#) option under [Channel Action Menu](#) from the [Local Display Selection Keypad](#).
- **Manager config IP** is the network address of the slot for which Maintenance View was opened. This is the property of CMM + PRM slot setting.

## Analog

Analog option displays all analog channels status.

No.	Type	Name	E.U.	Danger Low	Alert Low	Value	Alert High	Danger High	Filter Freqs	-NOK	GAP Value	+NOK	Channel Status
1	Piston Rod Drop (Triggered Mode)	PRD Ch1	[µm]	OK	OK	2000	1000	1000	<None>	20	0.007	2	ENABLED ALERT DANGER
2	Piston Rod Drop (Triggered Mode)	PRD Ch2	[µm]	OK	OK	2000	1000	1000	<None>	20	0.003	2	ENABLED ALERT DANGER
3	Radial shaft vibration	ASV Ch1	[µm]	N/A	N/A	0.391	150	150	10-1000 Hz	20	0.002	2	ENABLED
4	Caseing vibration	ASV Ch2	[µm]	N/A	N/A	0.58	50	50	10-1000 Hz	20	0.003	20	ENABLED
5	Other	um measurement mV	[mV]	OK	0.5	-99.997	Off	OK	DC	1	0	12	ENABLED ALERT
6	Not configured	-	-	-	-	-	-	-	-	-	-	-	-
7	Caseing vibration	-	[µm]	N/A	N/A	1.128	125	125	10-1000 Hz	2	0.001	10	ENABLED
8	Not configured	-	-	-	-	-	-	-	-	-	-	-	-
9	Temperature	Temp 1	[C]	19.002	19.002	19.799	26.8	30.000	DC	30	0.109	150	ENABLED
10	Temperature	Temp 2	[C]	-5.273	-2.699	51.2	51.2	51.2	DC	25	0.097	120	ENABLED
11	Radial shaft vibration	ASV 1 RSV	[µm]	N/A	N/A	0.201	50	50	10-1000 Hz	18	0	4	ENABLED GAP_ALERT GAP_DANGER
12	Caseing vibration	ASV 2 Caseing	[µm]	N/A	N/A	0.5	100	80	10-1000 Hz	2	0.005	10	ENABLED
13	Complementary Differential Expansion	Shaft Expansion X1	[mm]	N/A	N/A	11.995	N/A	N/A	DC	17	0.005	1	ENABLED
14	Complementary Differential Expansion	Shaft Expansion X2	[mm]	N/A	N/A	12	N/A	N/A	DC	17	0.004	2	ENABLED
15	Position	Position meas	[mm]	0.70	-0.5	0.635	0.5	0.70	DC	20	0.002	2	ENABLED ALERT
16	Eccentricity	Ecc testing	[µm]	N/A	N/A	0	125	125	0-10Hz	20	0	2	ENABLED

Figure 2 - 61.  
Maintenance View - Analog Channel Status.

The following fields are updated.

- **Value** is the value in the assigned E.U.
- **Gap Value** is the value in V.
- Channel Status

## Combined Meas

Combined Meas option displays all combined measurement channels status.

No.	Type	Name	E.U.	Danger Low	Alert Low	Value	Alert High	Danger High	Channel Status
1	Piston Rod Drop (Triggered Mode)	PRD combined	[µm]	N/A	N/A	2000	1000	1000	ENABLED ALERT DANGER DANGER_FIRST_OUT_SLOT DANGER_FIRST_OUT_RACK
2	Absolute shaft vibration	Shaft Vibration	[µm]	N/A	N/A	0.061	100	150	ENABLED
3	Not configured	-	-	-	-	-	-	-	-
4	Not configured	-	-	-	-	-	-	-	-
5	Temperature Difference	Temp diff	[C]	30.000	-21.817	22.298	30	43.00	ENABLED
6	Absolute shaft vibration	Shaft Vib 2089	[µm]	N/A	N/A	1.556	100	150	ENABLED
7	Complementary Differential Expansion	CDE POINT 1	[mm]	-11.5	-10.5	11.995	16.5	17.5	ENABLED
8	Not configured	-	-	-	-	-	-	-	-

Figure 2 - 62.  
Maintenance View - Combined Measurement Channel Status.

The following fields are updated.

- **Value** is the value in E.U.
- Channel Status

## Digital

Digital option displays all digital channels status.

No.	Type	Name	E.U.	Pulses/Rev	Danger Low	Alert Low	Speed Value	Alert High	Danger High	Peak Speed	Channel Status
1	Speed	PRD speed	[rpm]	1	Off	0	0	Off	Off	0	ENABLED ALERT
2	Speed	-	[rpm]	1	Off	0	0	Off	Off	0	ENABLED ALERT
3	Disabled	-	-	-	-	-	-	-	-	-	-
4	Disabled	-	-	-	-	-	-	-	-	-	-
5	Latching alarms reset	Latching reset	-	-	-	-	-	-	-	-	Latching reset
6	Speed	ASV	[rpm]	1	Off	Off	0	6400	6800	0	ENABLED
7	Slot disam	Slot disam	-	-	-	-	-	-	-	-	Slot disam
8	Tripmultiply input	Tripmultiply	-	-	-	-	-	-	-	-	Tripmultiply

Figure 2 - 63.  
Maintenance View - Digital Channel Status.

The following fields are updated.

- Speed Value
- Peak Speed
- Channel Status

## Relays

Relay option displays the status of each relay.

No.	Type	Triggered	Configured Latching	Configured Normally Energized	Circuit Fault
1	NOT IN USE	-	-	-	-
2	NOT IN USE	-	-	-	-
3	NOT IN USE	-	-	-	-
4	NOT IN USE	-	-	-	-
5	NOT IN USE	-	-	-	-
6	NOT IN USE	-	-	-	-
7	NOT IN USE	-	-	-	-
8	NOT IN USE	-	-	-	-
9	NOT IN USE	-	-	-	-
10	NOT IN USE	-	-	-	-
11	NOT IN USE	-	-	-	-
12	NOT IN USE	-	-	-	-
13	NOT IN USE	-	-	-	-
14	NOT IN USE	-	-	-	-
15	NOT IN USE	-	-	-	-
16	ANALOGUE CHANNEL DANGER or NOT OK	ID	No	No	-
17	NOT IN USE	-	-	-	-
18	NOT IN USE	-	-	-	-
19	NOT IN USE	-	-	-	-
20	NOT IN USE	-	-	-	-
21	NOT IN USE	-	-	-	-
22	ANALOGUE CHANNEL ALERT	1	Yes	Yes	-
23	ANALOGUE CHANNEL ALERT	0	No	Yes	-
24	ANALOGUE CHANNEL DANGER	ID	No	No	-
25	NOT IN USE	-	-	-	-
26	NOT IN USE	-	-	-	-
27	NOT IN USE	-	-	-	-
28	NOT IN USE	-	-	-	-
29	ANALOGUE CHANNEL ALERT	ID	No	Yes	-
30	NOT IN USE	-	-	-	-
31	ANALOGUE CHANNEL NOT OK	0	No	Yes	-
32	ANALOGUE CHANNEL ALERT or NOT OK	ID	Yes	Yes	-

Figure 2 - 64.  
Maintenance View - Relay Status.

It is recommended to arm the slot in order to get the real data via [Utilities](#) option. The following fields are updated.

- Triggered
- Circuit Fault

### Utilities

Through Utilities, it is possible to set the rack into arm mode (**ARM Rack**) while in Maintenance mode to allow testing the complete measurement chain from sensor to relay output. This will allow to test proper relay operation using simulated inputs, e.g. simulate an Alert condition.

It is also possible to reset latching alarms (**Reset Latched**) and peak speed (**Reset Peak Speed**) while in Maintenance mode.



Figure 2 - 65.  
Maintenance View – Utilities.

### Acceptance Test

The aim of Acceptance Test is to produce a report which shows that all channels and relays were checked for correct values and functionality.



Figure 2 - 66.  
Maintenance View - Acceptance Test.

Perform the following steps in the given order:

1. Start by pressing "Begin Acceptance Test". This will automatically start with analog channels.
2. Open each tab and check the values of each channel
3. For each channel, set "Accepted" or "Not Accepted" in the AT result column.
4. Enter Acceptance Report Information which are required.
5. Press "Create Acceptance Test Report" to generate the report.

No.	AT result	AT Value	AT BIAS/DC Value	Type	Name	E.U.	Danger Low	Alert Low	Value	Alert High	Danger High	Filter Freqs	-NOK	GAP Value	+NOK	Channel Stat
1	Not Accepted	2000	0.006	Piston Rod Drop (Triggered Mode)	PRD CH1	[µm]	OK	OK	2000	1000	1000	<None>	20	0.006	2	ENABLED /
2	Not Accepted	2000	0.003	Piston Rod Drop (Triggered Mode)	PRD CH2	[µm]	OK	OK	2000	1000	1000	<None>	20	0.002	2	ENABLED /
3	Accepted	0.281	0.002	Radial shaft vibration	ASV CH1	[µm]	OK	N/A	0.281	150	150	10-1000 Hz	20	0.021	2	ENABLED
4	Accepted	0.427	0.003	Casing vibration	ASV CH2	[µm]	OK	N/A	0.427	50	150	10-1000 Hz	20	0.003	20	ENABLED
5	Accepted	99.997	0	Other	µm measurement mV	[µm]	OK	0.5	99.997	OK	OK	DC	1	0	12	ENABLED
6	-	-	-	Not configured	-	-	-	-	-	-	-	-	-	-	-	-
7	Accepted	0.977	0.002	Casing vibration	-	[µm]	OK	N/A	0.977	125	150	10-1000 Hz	2	0.002	18	ENABLED
8	-	-	-	Not configured	-	-	-	-	-	-	-	-	-	-	-	-
9	Accepted	19.199	0.109	Temperature	Temp 1	[C]	19.120	19.002	19.199	26.8	24.000	DC	30	0.109	150	ENABLED
10	Accepted	-2.699	0.097	Temperature	Temp 2	[C]	0.482	-5.272	-2.699	51.2	0.0	DC	20	0.097	120	ENABLED
11	Accepted	0.201	0	Radial shaft vibration	ASV 1 RSV	[µm]	OK	N/A	0.201	50	75	10-1000 Hz	18	0	4	ENABLED
12	Accepted	0.363	0.004	Casing vibration	ASV 2 Casing	[µm]	OK	N/A	0.3	100	200	10-1000 Hz	2	0.004	18	ENABLED
13	Accepted	11.995	0.005	Complementary Differential Expansion	Shaft Expansion X1	[mm]	OK	N/A	11.995	N/A	N/A	DC	17	0.005	1	ENABLED
14	-	-	-	Complementary Differential Expansion	Shaft Expansion X2	[mm]	OK	N/A	0	N/A	N/A	DC	17	0.004	3	ENABLED
15	-	-	-	Position	Position mes	[mm]	OK	0.5	0.635	0.5	0.5	DC	20	0.002	2	ENABLED
16	-	-	-	Eccentricity	Ecc testing	[µm]	OK	N/A	0	125	150	0-10Hz	20	0	2	ENABLED

Figure 2 - 67.  
Maintenance View - Acceptance Test for Analog Channels.

In this example, **(11/14)** means that 11 analog channels out of 14 configured channels were checked and Acceptance Test results were set.



Figure 2 - 68.  
Maintenance View - Acceptance Test for Combined Measurements.



Figure 2 - 69.  
Maintenance View - Acceptance Test for Digital Channels.



PRM + CMM Slot 1  
Device: 9  
[ARMED] Timestamp 12/22/2014 1:09:58 PM UTC

Relay Live Status							
No.	AT Result	AT Value	Type	Triggered	Configured Latching	Configured Normally Energized	Circuit Fault
1	-	-	NOT IN USE	-	-	-	-
2	-	-	NOT IN USE	-	-	-	-
3	-	-	NOT IN USE	-	-	-	-
4	-	-	NOT IN USE	-	-	-	-
5	-	-	NOT IN USE	-	-	-	-
6	-	-	NOT IN USE	-	-	-	-
7	-	-	NOT IN USE	-	-	-	-
8	-	-	NOT IN USE	-	-	-	-
9	-	-	NOT IN USE	-	-	-	-
10	-	-	NOT IN USE	-	-	-	-
11	-	-	NOT IN USE	-	-	-	-
12	-	-	NOT IN USE	-	-	-	-
13	-	-	NOT IN USE	-	-	-	-
14	-	-	NOT IN USE	-	-	-	-
15	-	-	NOT IN USE	-	-	-	-
16	Accepted	0	ANALOGUE CHANNEL DANGER or NOT OK	0	No	No	-
17	-	-	NOT IN USE	-	-	-	-
18	-	-	NOT IN USE	-	-	-	-
19	-	-	NOT IN USE	-	-	-	-
20	-	-	NOT IN USE	-	-	-	-
21	-	-	NOT IN USE	-	-	-	-
22	Not Accepted	1	ANALOGUE CHANNEL ALERT	1	Yes	Yes	-
23	Accepted	1	ANALOGUE CHANNEL ALERT	0	No	Yes	-
24	Accepted	0	ANALOGUE CHANNEL DANGER	0	No	No	-
25	-	-	NOT IN USE	-	-	-	-
26	-	-	NOT IN USE	-	-	-	-
27	-	-	NOT IN USE	-	-	-	-
28	-	-	NOT IN USE	-	-	-	-
29	Accepted	0	ANALOGUE CHANNEL ALERT	0	No	Yes	-
30	-	-	NOT IN USE	-	-	-	-
31	Accepted	0	ANALOGUE CHANNEL NOT OK	0	No	Yes	-
32	Accepted	0	ANALOGUE CHANNEL ALERT or NOT OK	0	Yes	Yes	-

Accept Do not Accept Clear

Figure 2 - 70.  
Maintenance View - Acceptance Test for Relays.

## Protection Module Configuration with IMx-M Manager

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### Building a Configuration Hierarchy

All IMx-M Manager projects are built as a hierarchy consisting of the following levels:

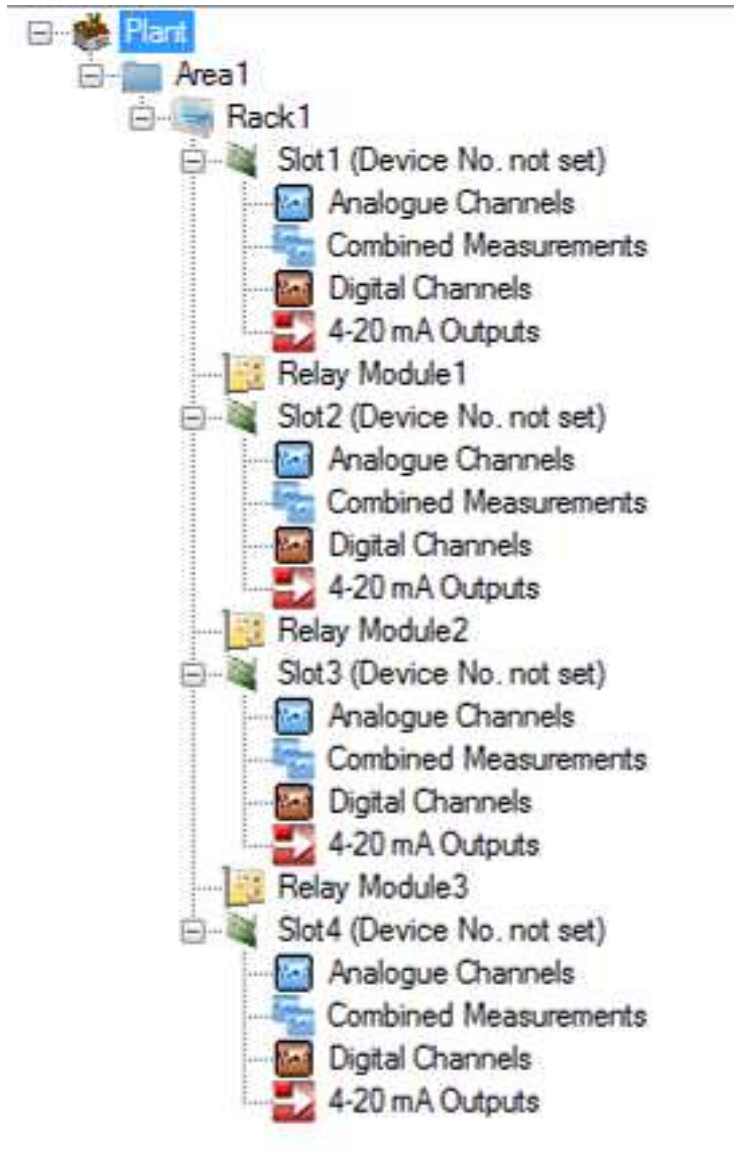


Figure 2 - 71.  
IMx-M Manager Configuration Hierarchy Example.

### Adding a Plant Node

This is the main project root node and shows the name “Plant” when the project is initially created.

To change the name of this node to something more appropriate, right-click on the plant node, select **Properties** and enter the new plant name in the text box.

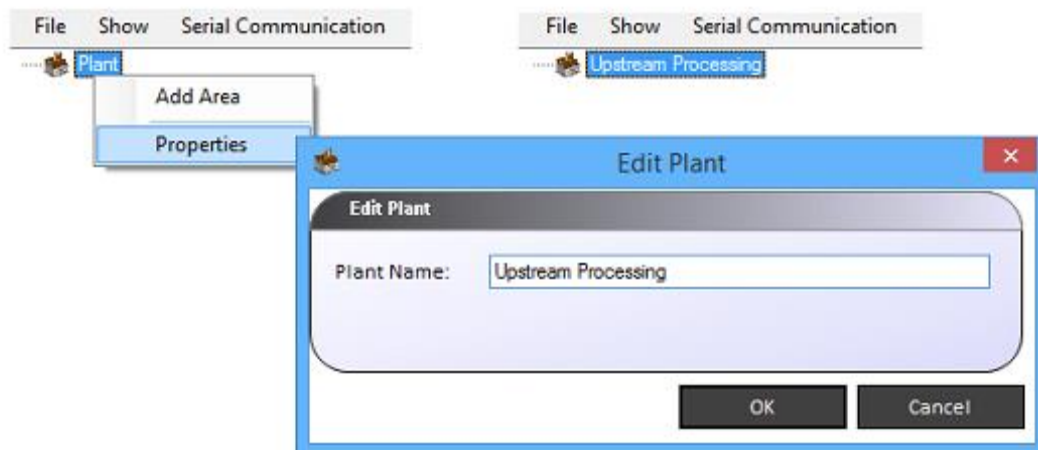


Figure 2 - 72.  
Editing the Plant Name.

### Adding an Area Node

Each plant node can contain any number of area nodes, with each area acting as a container for the individual IMx-M racks.

To add a new area to the plant, simply right-click on the plant node, and select the option **Add Area**.

- Although an area can be renamed or deleted, as it is merely a hierarchy container, it cannot be copied.

### Adding Rack, Slot and Relay Nodes

Each rack node acts as a container for the maximum four slots (CMM + PRM pairs) and the maximum three relay modules that can be added.

To add a new rack to an area, simply right-click on the area node and then select the option **Add Rack** from the pop-up menu. This will launch the dialog as shown in the figure below:

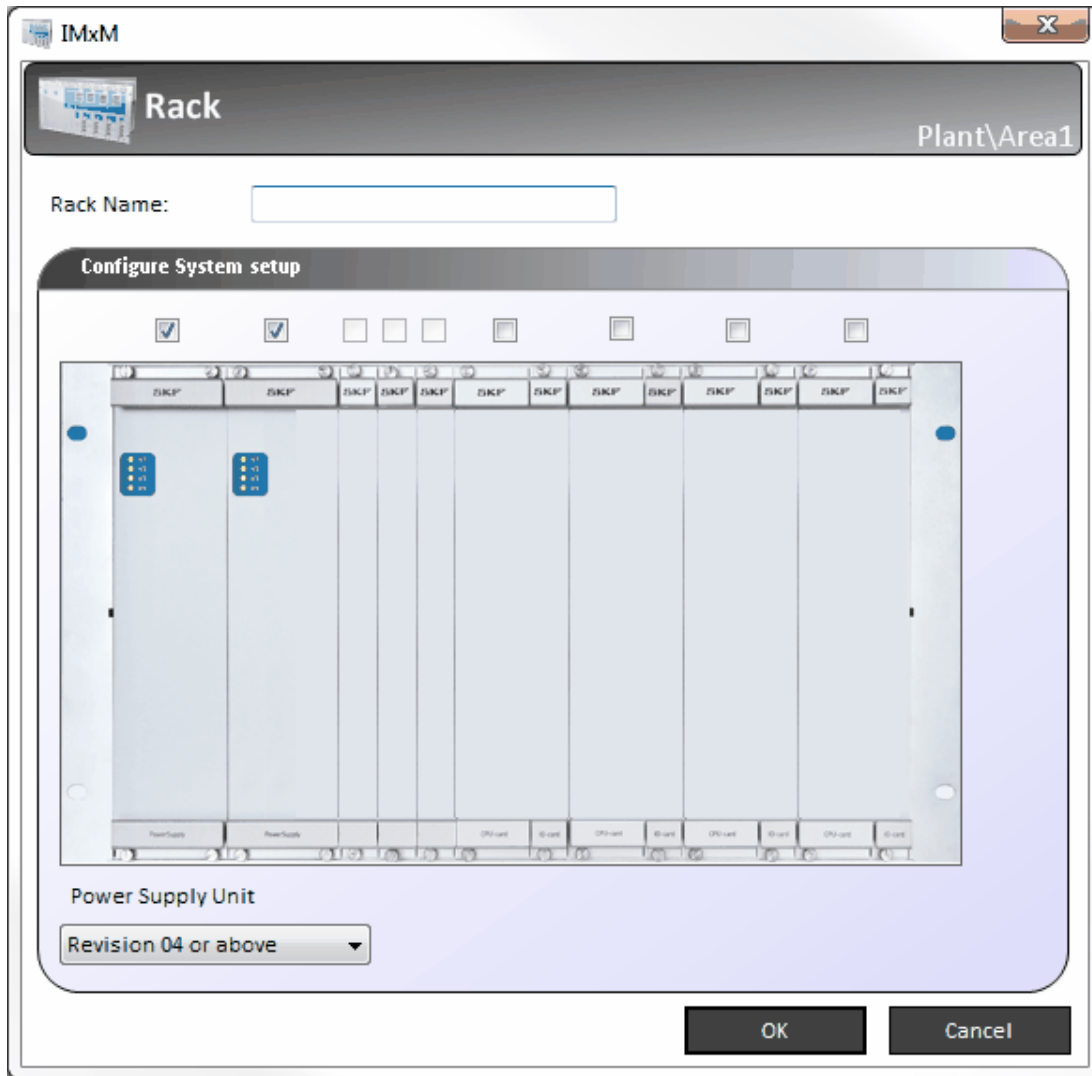


Figure 2 - 73.  
Adding a New Rack to the Hierarchy.

This dialog shows a representation of an empty IMx-M rack with two power supply units fitted and fault detections enabled.

#### **Rack Name**

The first task is to assign a name to this rack. Given that each rack is a physical item mounted in a geographical area, the name chosen should always be an easier reference for future use (E.g. "MOL ROOM LOWER RACK").

#### **Configure System setup**

The next task is to effectively "build" this virtual rack by populating each of the four empty CMM + PRM slots and then adding a relay module to its associated CMM + PRM slot. However as the rack can only hold a maximum of three relay modules, these can only be associated with the first three CMM + PRM slots in the rack.

In the figure shown below, slots ONE, TWO and THREE (Slot 1, Slot 2, Slot 3) have been added to the rack, however only relay module 1 has been added which is automatically associated with Slot 1.

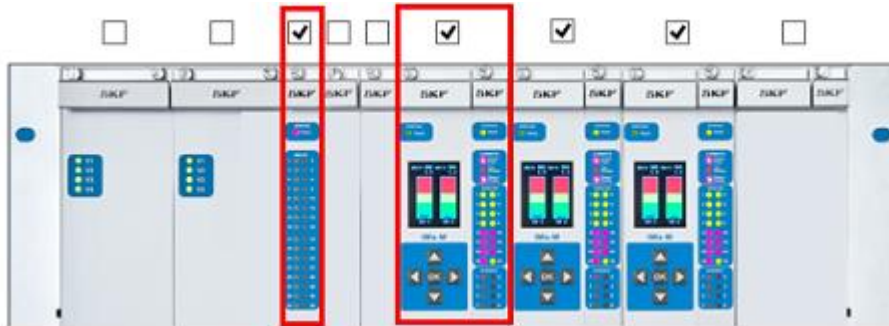


Figure 2 - 74.  
Adding Slots and a Relay Module to the Rack.

### Power Supply Unit

- The check boxes above each power supply unit are only to enable the fault detection within that unit.

Although these fault levels are user configurable, they depend on the power supply hardware revision. The recommended levels (default values) are:

- Power supply hardware **revision 03 or below**: 22 000 mV to 26 000 mV
- Power supply hardware **revision 04 or above**: 24 000 mV to 27 500 mV

Therefore, select a correct power supply unit revision number.

Once a rack has been added to the hierarchy and populated, it should be visible in the hierarchy view.

However, it will not yet be possible to save this configuration as the default state of a newly added rack is unable to pass the pre-save validation checks. To confirm this, from the main menu, select **File** and then **Validate**. The validation output page will then show why the validation check failed. For more detailed information refer to [Validate](#) and [Save](#) in "File" Menu Selection section.

### Setting Slot Properties

Each slot must be:

- assigned a unique **Device Number** between #1 and #255 for the database to which it is connected.
- assigned a unique **IP Address** for the network with which it is intended to communicate. This IP address can be either fixed or allocated dynamically via DHCP.
- pointed towards an IMx Monitor Service endpoint (consisting of an IP address and port number) that will receive and process the condition monitoring data.

To assign slot property settings, select and right-click on an unassigned slot from on the configuration hierarchy, and select **Properties**.

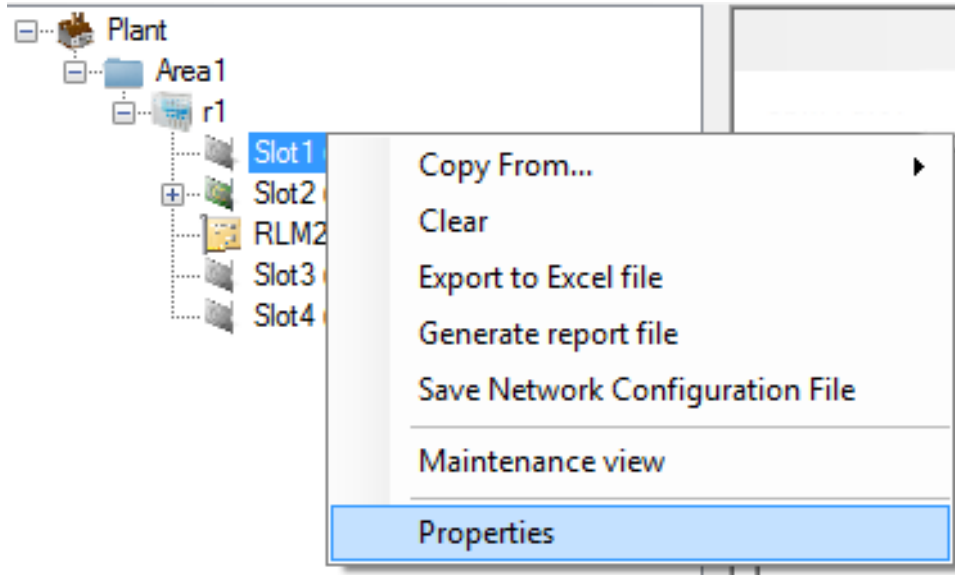


Figure 2 - 75.  
Launching the Slot Properties Dialog.

Each IMx-M slot has two core property settings:

- [Assigning Protection Settings \(PRM\)](#) where a device number (slot identity) and Modbus settings are set.
- [Configuring Network Settings \(CMM\)](#) where the network settings are set.

#### **Assigning Protection Settings (PRM)**

This will launch the PRM + CMM slot properties dialog **PRM** where a unique device number (slot identity), PIN code and Modbus settings are set.

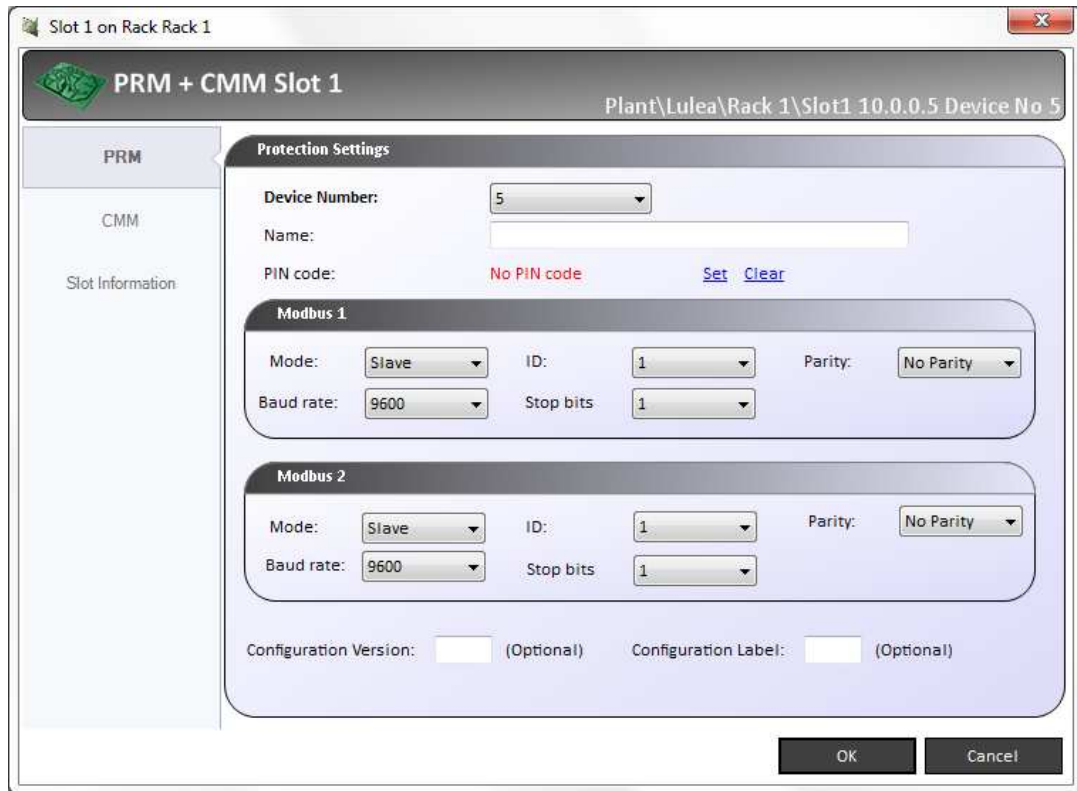


Figure 2 - 76.  
Slot Properties Dialog.


**Device Number:** Each slot must be assigned with a device number between 1 and 255 that is unique to the database to which the slot is connected.

**Name:** Enter a suitable name for the Slot.

**PIN code:** This acts as a simple four digit security lock to allow users to send the configuration settings to the slot or allow users to change the slot state of arm/disarm. To enter a PIN code, simply click on the text **Set** and enter a value as shown below:



Figure 2 - 77.  
Entering a PIN Code.

 **Important - It is strongly recommended to set a PIN code to avoid risk to set system in unwanted states and to avoid unauthorized access.**

- It is also possible to clear this PIN code by pressing the “Clear”. However, after the IMx-M Manager has been closed, the

Administration password must be entered before this action can be executed.

To recover the lost PIN code, use IMx-M Manager Password Recovery Tool which is found in the @ptitude Observer installation DVD.

**Configuration Version:** This optional setting allows to keep track of configuration history by assigning a version number to the configuration.

**Configuration Label:** This optional setting allows to keep track of configuration history by assigning a memorable name to the configuration.

### Modbus

Modbus 1 settings are for the protection module Modbus connector L1, whereas Modbus 2 settings are for the protection module Modbus connector L2.

For detailed information on protection part Modbus functionality, refer to [Modbus \(L1, L2\) for Protection Part](#) within Modbus Configuration chapter.

Note that both Modbus connections have access to the same system values.

- **Mode** can be either Slave or Master. However, currently only the functionality of Slave is supported.
- **ID** is the Slave ID (1-255) for Modbus. Do not set to same Slave ID for both connections if they are on the same physical RS485 bus.
- **Parity** provides data validation which can be set to No Parity, Odd Parity or Even Parity.
- **Baud rate** defines the speed of the serial link in bits per second.
- **Stop bits** defines the number of bits terminating a transmission which can be 1 or 2.

### Configuring Network Settings (CMM)

Each slot requires network parameters to be set before a network configuration (\*.imx) file can be created and saved, ready for the USB download to the condition monitoring module.

**Network** defines how the IP settings are to be configured. There are 3 different ways to set the IP settings.

**Use fixed IP Address** allows to enter IP Address, subnet mask and primary gateway of the IP settings manually. This option must be used with a great care not to duplicate an existing address which can result in both devices being locked from communicating over the network.



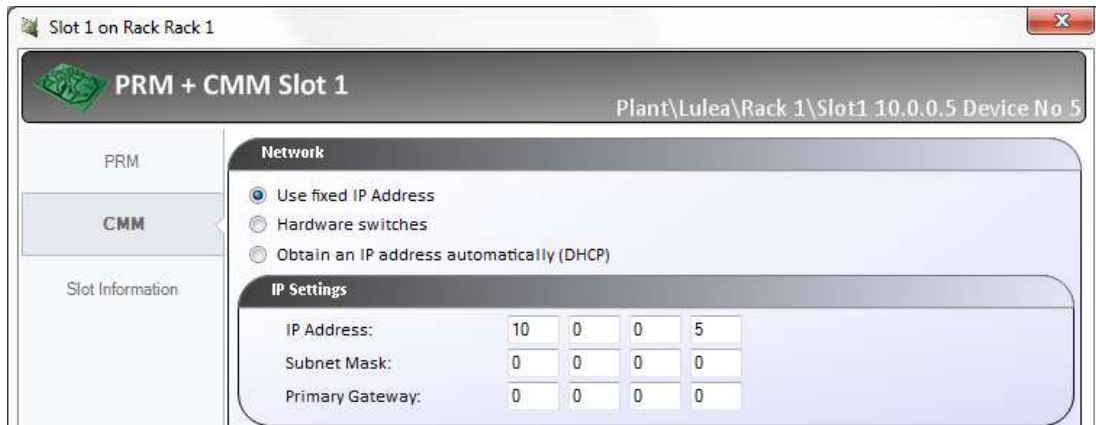


Figure 2 - 78.  
Assigning the Slot a Fixed IP Address.

**Hardware switches** means that the network configuration is done by setting HEX rotary switch manually. The HEX rotary switch for IMx-M is located inside the rack, back of the right-most panel (looking at the rack from the front panel).

For the network configuration by hardware switches, the following logic must be fulfilled.

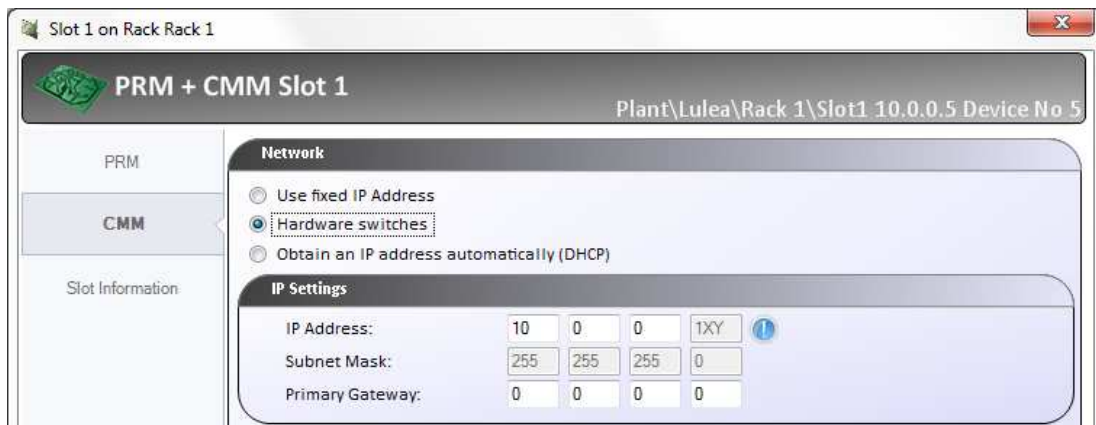


Figure 2 - 79.  
Setting the IP Address by Using Hardware Switches.

- It is required to set the first three part of the IP address of IP Settings manually.
- The last part of the IP address will be controlled by the HEX rotary switch on IMx-M. For example, 10.0.0.1XY, where XY is derived from a combination of the CMM + PRM slot number and the HEX rotary switch position (see the table below).

**Table 2-17: TCP/IP address/Slot ID when configured by HEX rotary switch.**

HEX rotary switch (x1)	TCP/IP address/Slot ID			
	CMM + PRM Slot 1	CMM + PRM Slot 2	CMM + PRM Slot 3	CMM + PRM Slot 4
0	Software defined	Software defined	Software defined	Software defined
1	01	02	03	04
2	05	06	07	08
3	09	10	11	12
↓	↓	↓	↓	↓
9	33	34	35	36
A	37	38	39	40
↓	↓	↓	↓	↓
F	57	58	59	60

Factory default configuration TCP/IP address: 10.0.0.1XY

- These last two digits will also form the slot ID.
- The HEX rotary switch has to be set manually.
- The HEX rotary switch for IMx-M is located inside, back of the right-most panel (looking at the rack from the front panel). In order to access it, first turn off the power, then take the right-most panel out.
- If the right-most slot has been mounted with a CMM + PRM pair, the CMM must be dismantled first before the PRM due to the physical reason. Otherwise, PRM can be damaged seriously. However, when mounting the CMM + PRM pair back to the right-most slot, the PRM must be mounted before the CMM.

So, if a common IP address of 10.0.0.1XY was set for all four CMM + PRM slots and all four CMM + PRM slots had the HEX rotary switch set to position #3, then each of the four CMM + PRM slots would have the following IP addresses assigned:

CMM + PRM Slot 1: 10.0.0.109  
 CMM + PRM Slot 2: 10.0.0.110  
 CMM + PRM Slot 3: 10.0.0.111  
 CMM + PRM Slot 4: 10.0.0.112

Again, because this is using a series of fixed IP address, great care must be taken to ensure that they do not clash with any existing network addresses.

**Obtain an IP address automatically (DHCP)** allows the system to get the IP address. However, this option depends on the availability of a DHCP Server being available on the IMx-M network, and in many process locations this cannot be guaranteed.



Figure 2 - 80.

Using DHCP to Automatically Assign the Slot IP Address.

- **@ptitude Observer Monitor IP Address** and **Port** number are the IP address and Port number of the computer where the @ptitude Observer Monitor has been installed. This information is needed to send and retrieve data to and from the server application.
- **Use DNS** supports domain name server implementation by allowing the server's primary name and the secondary name. The secondary name is optional.

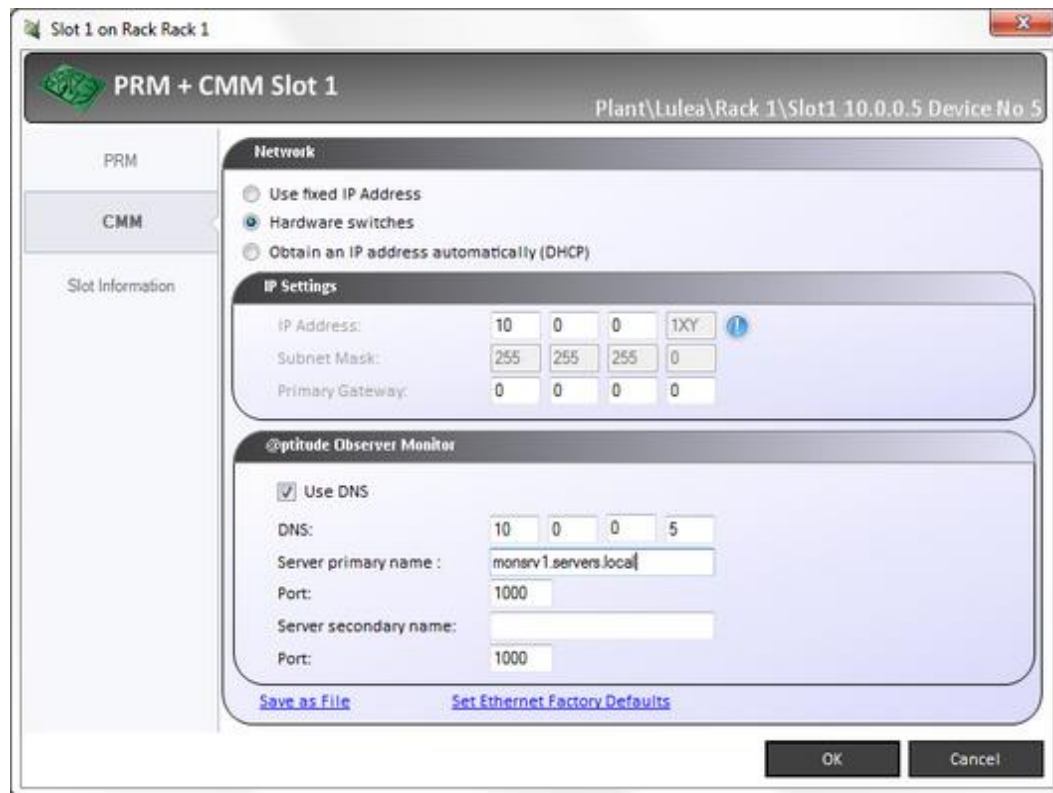


Figure 2 - 81.  
Using DNS with Hardware Switches to Assign the Slot IP Address.

**Save as File** creates a Network configuration file, ready for USB download to the condition monitoring module of this slot. The process of actually connecting to, and downloading this file to the condition monitoring module is described in [Updating Network Configuration](#). By default, the name of the network file will be "SysCfg\_#.IMX" where # is the device number of the slot.

**Set Ethernet Factory Defaults** sets all the values back to the factory default values.



**Important – Please consult the IT department or provider to ensure that whatever port is selected and entered, all firewalls between the slot and the actual service have this port opened for bidirectional data traffic.**

#### Saving a Network Configuration

Once the network settings for the selected slot have been entered, a network configuration file (\*.imx) can be created and saved, ready for the USB download to the condition monitoring module.

To create a network configuration file of the selected slot, simply right-click on the slot and select **Save Network Configuration File** or select **Save as File** when configuring network settings as described above.

#### Updating Network Configuration

Once a slot Network configuration file has been created and saved successfully, the condition monitoring module can be updated with this Network configuration file (\*.imx).

The actual physical connection between the host PC and the condition monitoring module is described in the [Condition Monitoring Module Serial \(USB\) Interface](#) in CM Part Configuration section.

The procedure of updating the Network configuration file is described in the [CMM Serial Interface](#) in "Serial Communication" Menu Selection.

### Configuring a Slot

Each IMx-M slot has four setting groups that can be configured from within the hierarchy configuration; Analog Channels, Combined Measurements, Digital Channels and 4-20 mA Outputs.

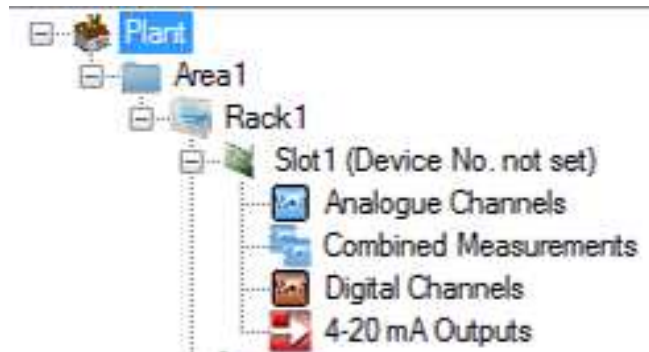


Figure 2 - 82.  
Four Groups of Slot Settings.

Configuration of a slot can be copied from an existing slot. Right-click on a slot and choose **Copy From...** option and choose an existing slot.

Configuration of a selected slot can also be cleared by right-clicking on a slot and choosing **Clear** option.

### Configuring Analog Channels

Configuring an individual channel is a two stage process which involves initiating a channel and configuring the channel.

From the main configuration hierarchy, select and expand the target slot and then click on the analog channels icon. This will then display the current status of each of the 16 analog channels for this slot.

## Protection

### Protection Module Configuration with IMx-M Manager

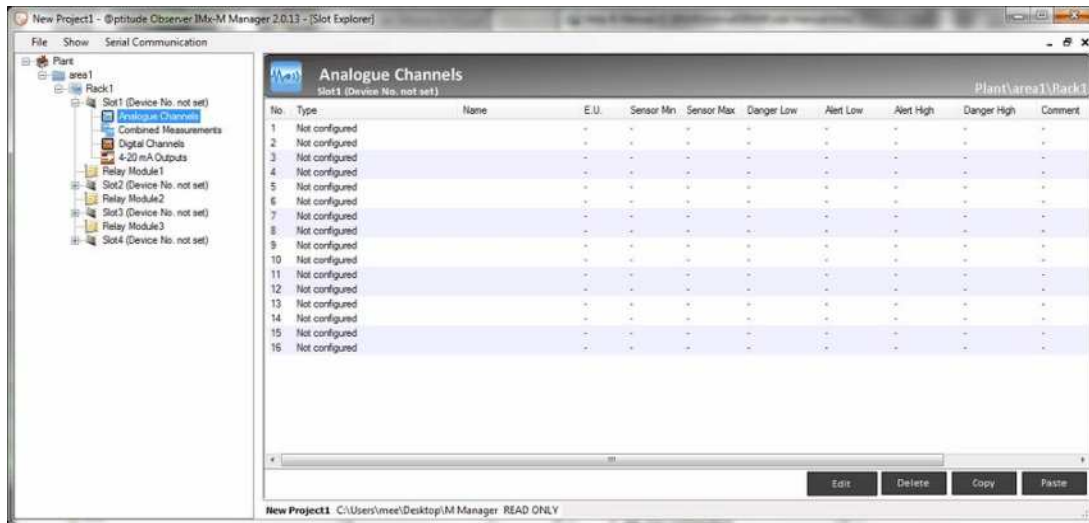


Figure 2 - 83.  
Example of IMx-M Manager Analog Channels List.

In order to configure analog channels, select one channel at a time and click on **Edit** or double click on a channel.

In order to delete analog channels, select one channel at a time and click on **Delete** or right-click on a channel and select **Delete**.

Configuration of analog channels can be copied from other existing analog channels by using **Copy** and **Paste** options. **Copy** and **Paste** options are also available with the right-click on a channel.

Right-click on a channel or multiple channels and select **Change** in order to edit Alarm Levels and Gap Alarm Levels (if applicable) as shown below.

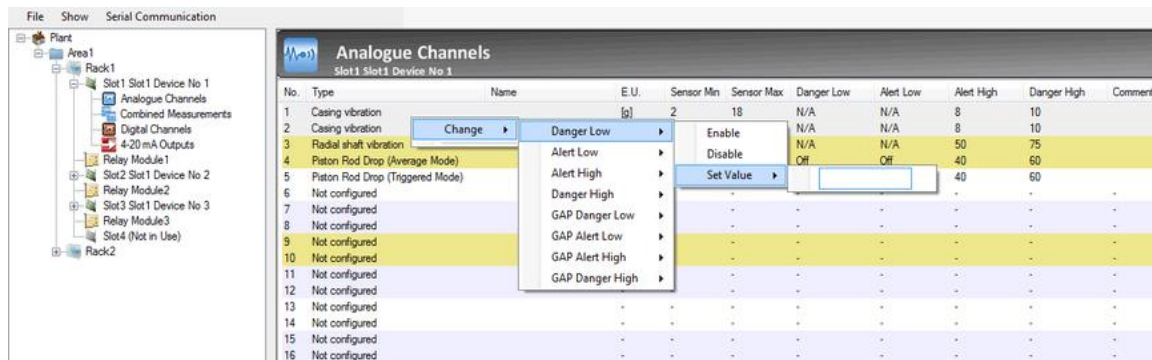


Figure 2 - 84.  
Example of IMx-M Manager Analog Multi Channel Configuration.

Multiple channels are selected by holding the Ctrl button.

The entered Set Value will be updated for all the selected channels.

### Initiating an Analog Channel

The following table shows the physical metrics of analog channels.

**Table 2-18: Analog channel parameter combinations.**

Type	Math Method	EU	Detection <sup>2</sup>	Channel
<a href="#">Temperature</a>	-	C, F	-	9 to 16
<a href="#">Radial shaft vibration</a>	-	μm, mils	PtP	1 to 16
<a href="#">Position</a>	-	mm, mils, μm	-	1 to 16
<a href="#">Complementary Differential Expansion</a>	-	mm, mils, μm	-	1 to 16 (involves both channels of a pair)
<a href="#">Piston Rod Drop (Average Mode)</a>	-	mils, μm	-	1 to 16
<a href="#">Piston Rod Drop (Triggered Mode)</a>	-	mils, μm	-	1 to 16
<a href="#">Casing vibration<sup>1</sup></a>	None	m/s <sup>2</sup> (m/s <sup>2</sup> ), g, ips, mm/s	P, PtP, RMS	1 to 16
	Single integration	μm, ips, mils, mm/s	P, PtP, RMS	
<a href="#">Eccentricity</a>	-	μm, mils	PtP	1 to 16
<a href="#">Gap</a>	-	mV	-	1 to 16
<a href="#">Other<sup>3</sup></a>	-	psi, bar, mbar, Pa, hPa, kPa, MPa, kg/cm <sup>2</sup> , cmHg, mA, A, mV, V, kV, C, F, Deg, W, kW, MW, kVA, %, mH, T, μm, mm, mils, ips, m/s <sup>2</sup> (m/s <sup>2</sup> ), g	-	1 to 16

<sup>1</sup> For **Casing vibration** type, the **Detection** of "RMS" is recommended if the **Math Method** is "single integration".

<sup>2</sup> **Detection** types are true types; PtP (true peak to peak), P ("true peak to peak" /2), RMS (true root mean square averaging)

<sup>3</sup> Analog measurement type Other does not allow a user defined EU. Instead an EU can be selected from the list of predefined engineering units.

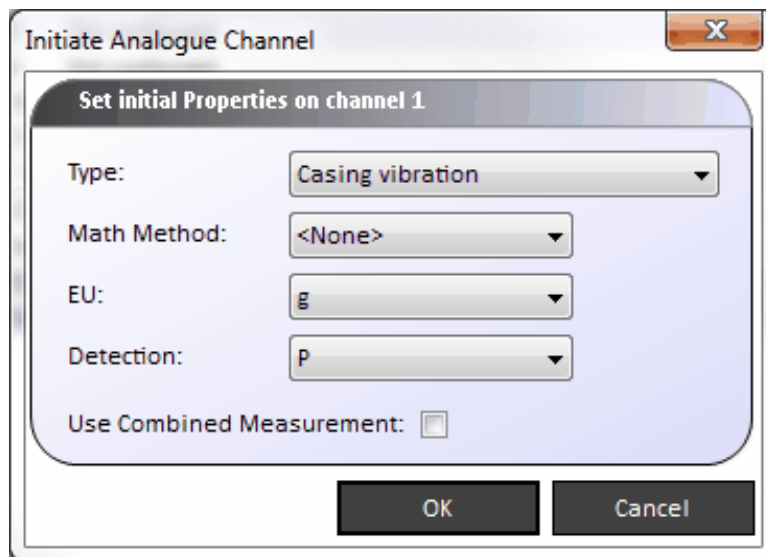


Figure 2 - 85.  
Initiating an Analog Channel.

**Type:** Currently permitted analog channel types are the following.

**Temperature** applies to channels 9 to 16 only.

For detailed information refer to the measurement type [Temperature](#).

**Radial shaft vibration** type is available on all channels.

For detailed information refer to the measurement type [Radial Shaft Vibration](#) and the [configuration example of a Radial shaft vibration channel](#).

**Position** type is available on all channels.

For detailed information refer to the measurement type [Position](#).

**Complementary Differential Expansion** uses signals from two channels to extend measurement range. This type has to be one of a combined measurements.

For detailed information refer to the measurement type [Complementary Differential Expansion](#) and the configuration example of [Complementary Differential Expansion](#).

**Piston Rod Drop (Average Mode)** measures the displacement of the piston rod over the entire cycle. This type is available on all channels.

For detailed information refer to the measurement type [Piston Rod Drop](#) and the configuration example of [Piston Rod Drop](#).

**Piston Rod Drop (Triggered Mode)** type is available on all channels.

For detailed information refer to the measurement type [Piston Rod Drop](#) and the configuration example of [Piston Rod Drop](#).

**Casing vibration** type is available on all channels.

For detailed information refer to the measurement type [Casing Vibration](#) and the [configuration example of a Casing vibration channel](#).

**Eccentricity** type is available on all channels.

For detailed information refer to the measurement type [Eccentricity](#).



**Other** measurement type allows the user to configure an analog channel with user defined properties within the following system defined constraints. For detailed information refer to the measurement type [Other](#).

- EU has to be one of the predefined engineering units. See the table above, Analog channel parameter combinations.
- The analog measurement type "Other" is specifically intended to be used in conjunction with the standard 0-10 V or 4-20 mA process control signaling (signal converters).



**Important - Standard 0-10 V or 4-20 mA process control signaling does not mean that IMx-M can read any possible DC voltage or current in this range. If other voltage ranges or current ranges are utilized there may be loss of accuracy and resolution. The specified measurement performance is only guaranteed with either 0-10 V or 4-20 mA signalling.**

- System defined constraints are found under each properties, if any.

**Sensitivity:** applies to the Other channel type only. It allows to specify the sensor sensitivity as volt or amp ratio.

**Math Method:** applies to Casing Vibration channel type only. It determines the method by which the reference accelerometer signal can be mathematically redefined (via single integration) as a velocity signal.

**EU (Engineering Units):** These are the engineering units for the selected channel. This has to match the physical sensor type and take account of any integration that will be performed. For example, displacement sensors should have displacement units as should velocity transducers with 'Math Method' set to single integration.

**Detection:** This is the type of signal rectification that is to be used in processing the returned signal. This can be set to "RMS" (true Root Mean Square Averaging), PtP (true Peak to Peak) or "P" (true Peak to Peak / 2).

- Once an analog channel has been initiated with the above mentioned settings, these initialization settings cannot be changed. In order to change them, the analog channel has to be deleted and reconfigured.

### Configuring an Analog Channel

Once the initial channel settings have been entered, and the **OK** button pressed, the main **Analog Channel** configuration dialog will be immediately launched.

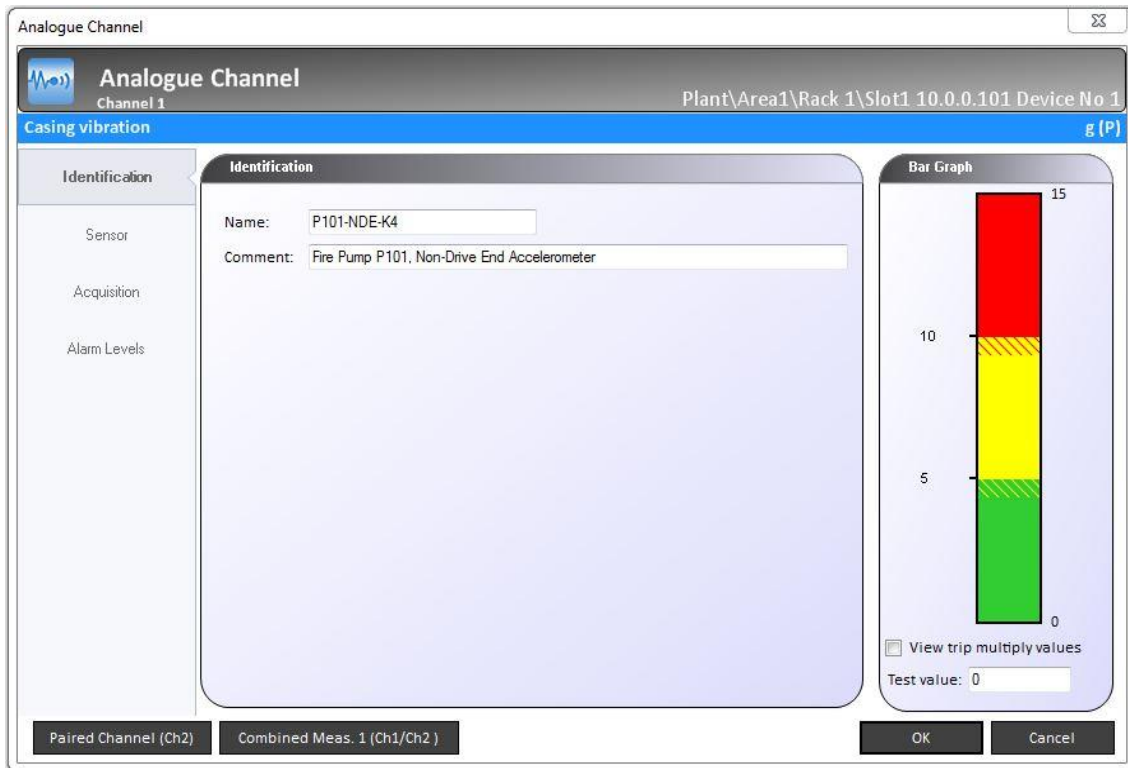


Figure 2 - 86.  
Analog Channel Configuration Dialog.

**Bar Graph** displays the alarm level, hysteresis and trip multiply factor against the entered test value. Note that the entered test value is not stored.

#### Identification

##### **Name**

A 20 character field which can usefully be used to identify the sensor location, type and/or tag.

##### **Comment**

A free text field for additional information. Note that this text is only stored in the project and not in the actual configuration.

### Sensor

The actual sensor configuration is based on the selected channel type. The following table lists settings available for each channel type.

**Table 2-19: Sensor configuration settings.**

Type	Sensitivity	Zero Level	Offset	Sensor OK, Min & Max	Sensor Fail Value	Latching Sensor Fault	Piston Rod Drop settings
Temperature			√	√	√	√	
Radial shaft vibration	√			√		√	
Position	√	√		√		√	
Complementary Differential Expansion (individual ch)	√	√		√		√	
Piston Rod Drop (Average Mode)	√	√		√		√	√
Piston Rod Drop (Triggered Mode)	√	√		√		√	√
Casing vibration	√			√		√	
Eccentricity	√			√		√	
Other	√	√		√	√	√	

- **Sensitivity:** specifies the sensor sensitivity such as volt or amp ratio.
- **Zero Level:** specifies the voltage or current value which equals zero on the measurement scale.
- **Offset:** sets the temperature offset for the sensor.
- **Sensor OK Settings (Min & Max):** these two properties are used to define an acceptable range for values returned by the sensor. Any reading that falls out of these limits will trigger a circuit fault condition.
  - It is strongly recommended to configure Sensor OK settings within  $\pm 23$  V and not to disable Sensor OK.
- **Sensor Fail Value:** this applies to Temperature and Other channel types. This is the value that the system will present upon the detection of sensor failure. The sensor fail value can be either **Scale Min**, **Scale Max** or **Measured**.
  - When a sensor fail has been detected, the measured value is not reliable but may give an indication of what type of error it could be (out of range, short circuit, open circuit, etc.).
  - Selecting **Measured** as Sensor Fail value: The presented value will never be outside the configured max/min scale.

**Example 1:** Behavior of measurement value output when Sensor OK min and max are configured outside of Scale min and max.

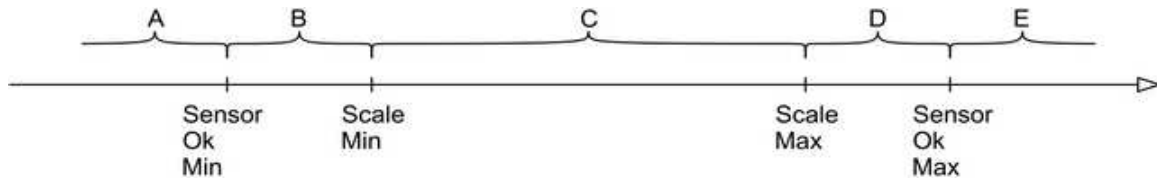
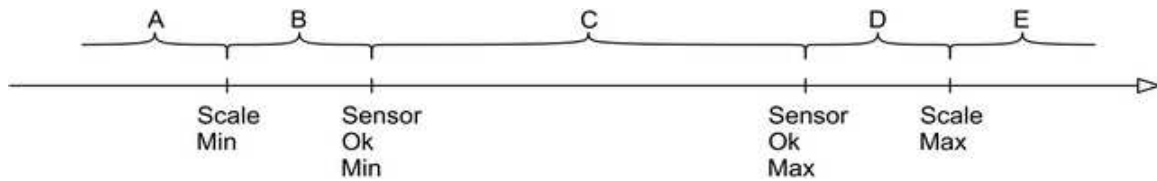


Table 2-20: Sensor fail value behavior example 1.

		Range according to the diagram above				
		A (sensor fail)	B	C	D	E (sensor fail)
Configured Sensor fail value	Measured	Scale Min	Scale Min	Measured	Scale Max	Scale Max
	Scale Min	Scale Min	Scale Min	Measured	Scale Max	Scale Min
	Scale Max	Scale Max	Scale Min	Measured	Scale Max	Scale Max

**Example 2:** Behavior of measurement value output when Sensor OK min and max are configured inside of Scale min and max.



**Table 2-21: Sensor fail value behavior example 2.**

		Range according to the diagram above				
		A (sensor fail)	B (sensor fail)	C	D (sensor fail)	E (sensor fail)
Configured Sensor fail value	Measured	Scale Min	Measured	Measured	Measured	Scale Max value
	Scale Min	Scale Min	Scale Min	Measured	Scale Min	Scale Min value
	Scale Max	Scale Max	Scale Max	Measured	Scale Max	Scale Max value

- Latching Sensor Fault:** In the event of a sensor fault being detected, this option (when checked) will retain the fault condition until it is acknowledged by the operator.

This fault can be acknowledged by either:

- Selecting "Latching Alarms Reset" via a [Digital Channels](#).
- Resetting a fault condition via the [Local Display Keypad](#) on the condition monitoring module.
- Writing to Modbus Register 261 or 265 as described in the section [Imported \(Write Single\) Modbus Registers](#).
- @ptitude Observer over an Ethernet connection.

- Piston Rod Drop:** This group of settings relate specifically to reciprocating compressors.

The following sensor configuration settings are available:

- **Start Angle & Stop Angle:** Used in Triggered Mode and configured in degrees relative to the trigger point to specify the part of the revolution at which the measurement will be based.
- **Offset:** Measurement value offset for actual Piston Drop (in  $\mu\text{m}/\text{mils}$ ). The Offset is configured in the selected engineering unit ( $\mu\text{m}$  or mils) and can be used to set the measurement to zero. This is done by configuring the offset to the actual measurement value, obtained either from the [Local Display](#) or over [Modbus](#).  
If offset is configured to a positive value the measurement will be decreased with the value of offset. A negative offset value will increase the measured value with the same amount.
- **Sensor distance & Rod length:** The rod length and sensor distance are used to translate the measured piston rod drop, at the sensor position, into the actual piston drop at the piston center pin position.
- For detailed information on Piston rod drop, refer to [Piston Rod Drop](#) and [Configuration Example of a Piston Rod Drop](#).

- Calculation Help:** This is an optional feature for Other analog channel type only. This is to help with the calculation of sensitivity and zero level based on

the given sensor range (Min and Max). The calculated values are not stored. For different sensitivity and/or zero level value, the new calculated value must be generated via Calculation Help.

**Acquisition**

Acquisition is to set the channel acquisition properties based on the actual sensor type.

Table 2-22: Sensor type acquisition properties.

Type	Scale Min	Scale Max	Target Positive Direction	Filter Selection	User Defined Filter
Temperature	√	√		DC only	
Radial shaft vibration		√		√	√
Position	√	√	√	DC only	
Complementary Differential Expansion (individual ch)	√	√	√	DC only	
Piston Rod Drop (Average Mode)	√	√	√	No filter	
Piston Rod Drop (Triggered Mode)	√	√	√		
Casing vibration		√		√	√
Eccentricity		√		0-10 Hz	
Other	√	√		DC only	

- **Scale (Min & Max):** These are used to set the max/min values for the measurement, including Modbus. This also sets the channel's minimum & maximum achievable values, on the CMM front panel display.
  - The scale range from minimum to maximum has to include zero (0). For example, the range of 0 to 100 or -1 to 100 is acceptable but the range of 1 to 100 is not acceptable.
  - Only integers are supported.

The range of this scale is also used for 4–20 mA output where:

  - Min corresponds to 4mA.
  - Max corresponds to 20mA.
- **Target Positive Direction:** When set to "Active", an increasing probe gap will produce a rising value. When set to "Inactive", an increasing probe gap will produce a falling value.

- **Filter:** Filter roll off factor is 24 dB/Octave (4<sup>th</sup> order) for both High Pass Filter and Low Pass Filter.

The deviation in the pass band is within  $\pm 0,5$  dB.

Configuring a filter appropriately is very important:

- To limit the influence of noise, choose a filter that is as tight as possible around the frequency band of interest.
- If possible, it is recommended to use RMS rather than PtP in the application.

Available Filter Ranges:

- **DC:** 0 to 0,625 Hz filter for temperature and process data such as pressure or flow.
- **0 to 10 Hz:** narrow range for Eccentricity.
- **10 to 1 000 Hz:** mostly for velocity (according to API 670).
- **1 to 600 Hz:**
- **4 to 4 000 Hz:**
- **5 to 1 000 Hz:** for equipment with shaft speed of 300 to 750 rpm.
- **10 to 5 000 Hz:** for a specified acceleration.
- **1 000 to 10 000 Hz:** mostly for acceleration.
- **User defined:** allows user to manually set the filter ranges.

Limitations on Low Pass Filter Usage:

- For low pass filter > 1 000, no Integration allowed.
- For low pass filter > 2 400, no combined measurements allowed.
- For low pass filter > 4 800, only one channel in the pair may be used.

Limitations on High Pass Filter Usage:

- For high pass filter < 5 Hz, no integration allowed and measurement time will increase.

Limitations on User Defined Filter Usage:

- High pass filter  $\geq 1$  Hz
- $150 \text{ Hz} \leq \text{low pass filter} \leq 5\,000 \text{ Hz}$ . Additionally low pass filter can also be set to 10 000 Hz.
- Low pass filter > 5,7 \* high pass filter. However, filter band of 30–150 Hz and 100–300 Hz are allowed.
- The limitations on both low and high pass filter usages stated above are also applied to the limitations on the user defined filter usage.

**Table 2-23: Valid filter selections for different measurement types.**

Type	Filter
Temperature	DC
Radial shaft vibration	10–1 000 Hz, 5–1 000 Hz, 1–600 Hz, 4–4 000 Hz, 10–5 000 Hz <sup>1</sup> 1 000–10 000 Hz <sup>1</sup> User defined
Position	DC
Complementary differential expansion	DC
Piston rod drop (average mode)	-
Piston rod drop (triggered mode)	-
Casing vibration	10–1 000 Hz 1–600 Hz 4–4 000 Hz <sup>2</sup> 5–1 000 Hz 10–5 000 Hz <sup>1,2</sup> 1 000–10 000 Hz <sup>1,2</sup> User defined
Eccentricity	0–10 Hz
Other	DC
Gap	DC

<sup>1</sup>If this filter is activated, then only one channel of the pair can be used.

<sup>2</sup>This filter cannot be used if integration is selected.



### Alarm Levels

Alarm levels are divided into Alert and Danger (See [Alarms](#) section). The actual available settings are dependent on the selected channel type.

**Table 2-24: Sensor type alarm levels.**

Type	Low	High	Enter Time	Trip Multiply Factor	Trigger Relay	Hysteresis
Temperature	√	√	√		√	√
Radial shaft vibration		√	√	√	√	√
Position	√	√	√		√	√
Complementary Differential Expansion (individual ch)						
Piston Rod Drop (Average Mode)	√	√	√		√	√
Piston Rod Drop (Triggered Mode)	√	√	√		√	√
Casing vibration		√	√	√	√	√
Eccentricity		√	√		√	√
Other	√	√	√		√	√

- **Low and High:** these check boxes enable or disable the associated alarm setting.

- A channel going into Danger state will always cause the channel to Alert state as well, even if Alert setting was disabled. In such case, the channel status is Alert and Danger.

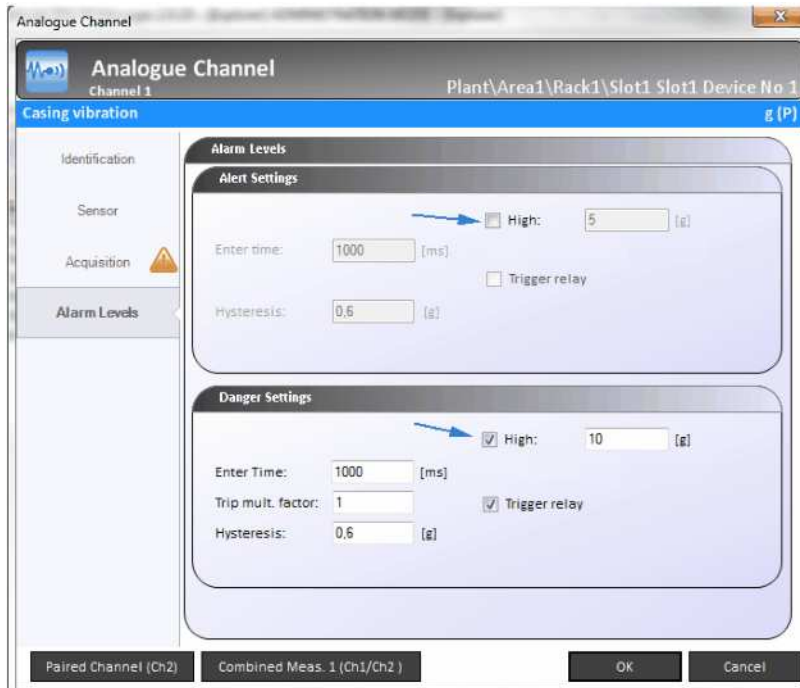


Figure 2 - 87.  
Example of Alert Disabled but Danger Enabled.

- **Enter Time:** represents the period for a channel to have exceeded an alarm level before an actual alarm condition is raised. Alert/Danger ON trigger will be delayed by this Enter Time.
- **Trip Multiply Factor:** use this value to temporarily increase the already set alarm levels when trip multiply is activated. The entered factor must be between the values of 1 and 25, with a single decimal being allowed (i.e. 1.5)
- **Trigger Relay:** check this box if an alarm condition shall trigger a relay. A channel can be set for trigger relay on more than one alarm settings such as alarm levels, Gap alarm levels and combined measurement alarm levels. If a channel is set for more than one trigger relay, the relay will trigger when at least one alarm condition is met. It is using an "OR" logic.
- **Hysteresis:** Use this value to prevent rapid alarm state switching. Hysteresis values are used to determine when to leave the alert/danger state (See [Hysteresis](#)).



**Important - Alert/danger ON trigger will be delayed by the configured alert/danger enter time.**

### Gap Alarm Levels

This additional alarm group is also divided into two distinct types; alert and danger.

As these alarms relate specifically to the use of proximity probes, they can only be set when using Radial Shaft Vibration or Eccentricity channel types.

Supported alarm settings are the following. See [Alarm Levels](#) section, above for detailed descriptions.

- **Low and High:** measured in Volts.
- **Enter Time**
- **Trigger Relay**
- **Hysteresis:** measured in Volts.

### Configuring Combined Measurements

Combined measurements are effectively additional channel types which are derived from two existing consecutive channels that are grouped as a pair, where each signal is of the same (EU) unit type.

For example, combined measurement 1 is based on pre-configured analog channel 1 and 2, combined measurement 2 is based on pre-configured analog channel 3 and 4, combined measurement 7 is based on pre-configured analog channel 13 and 14 and combined measurement 8 is based on pre-configured analog channel 15 and 16.

As each slot supports 16 analog channels, it is possible to add a maximum of eight combined measurements to a slot. The concept is shown in the figure below.

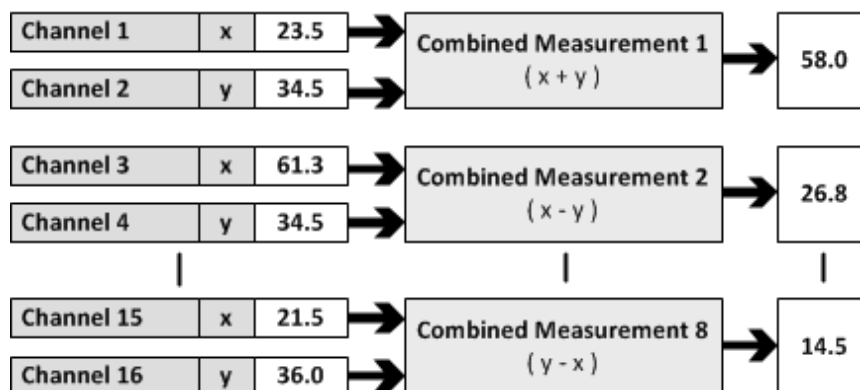


Figure 2 - 88.  
Examples of Combined Measurements.

- The combined measurement value may differ from the sum/difference of the individual channel's values depending on the measurement type and a possible phase shift between the input signals.

## Identification

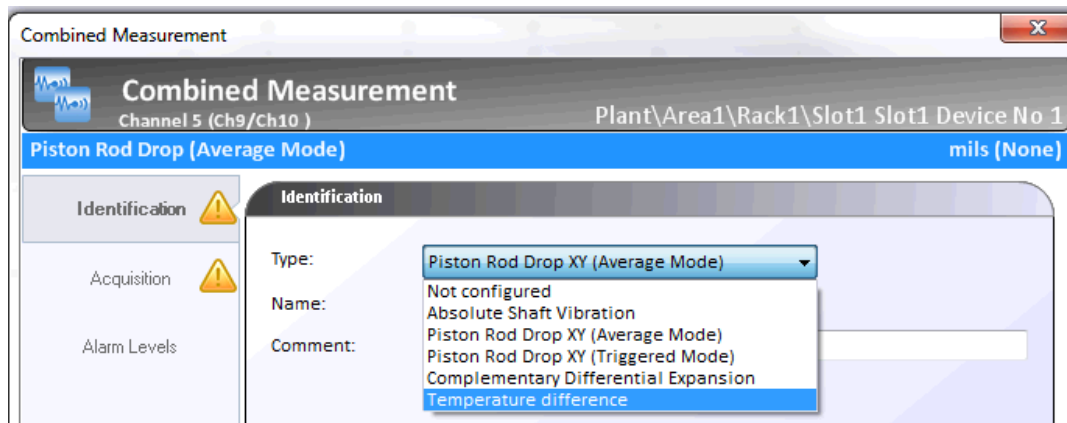


Figure 2 - 89.  
Combined Measurement Identification - List of Types.

**Type:** Currently permitted combined measurement types are the following:

**Absolute Shaft Vibration** can be applied to all combined measurements 1 through 8. For detailed information refer to the measurement type [Absolute Shaft Vibration](#) and the [configuration example of a Absolute shaft vibration](#).

**Piston Rod Drop XY (Average Mode)** can be applied to all combined measurements 1 through 8. For detailed information refer to the measurement type [Piston Rod Drop](#) and the [configuration example of a Piston rod drop](#).

**Piston Rod Drop XY (Triggered Mode)** can be applied to all combined measurements 1 through 8. For detailed information refer to the measurement type [Piston Rod Drop](#) and the [configuration example of a Piston rod drop](#).

**Complementary Differential Expansion** can be applied to all combined measurements 1 through 8. For detailed information refer to the measurement type [Complementary differential expansion](#) and the [configuration example of a Complementary differential expansion](#).

**Temperature Difference** can be applied to combined measurements 5, 6, 7 and 8. For detailed information refer to the measurement type [Temperature](#).

Every type should be given a name and comment to assist in identifying the combined measurement.

**Name:** A 20 character field which can usefully be used to identify the measurement location, type and/or tag.

**Comment:** A free text field for additional information. Note that this text is only stored in the project and not in the actual configuration.

## Sensor

The following sensor configuration applies to the Complementary Differential Expansion combined measurement type only.

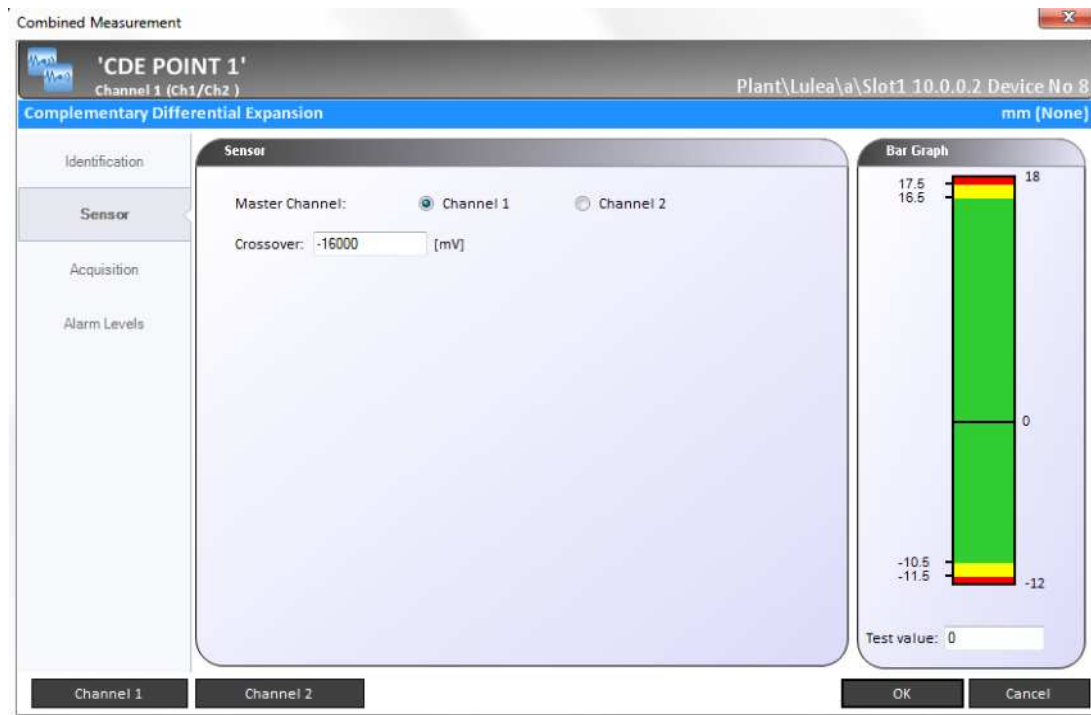


Figure 2 - 90.  
Combined Measurement Sensor Settings (CDE only).

- **Master Channel:** The sensor connected to this master channel is the master probe and decides when to switch over to the other sensor depending on the crossover voltage.
- **Crossover:** It is the voltage that controls when to switch between the 2 sensors.

For detailed information, refer to [Configuration Example of a Complementary Differential Expansion](#).

### Acquisition

Acquisition is to set the combined measurement acquisition properties based on the combined measurement type.

**Table 2-25: Combined measurement acquisition properties.**

Type	EU	Detection	Comb. calc	Scale Min	Scale Max
Absolute Shaft Vibration	√	√	√		√
Piston Rod Drop XY (Average Mode)	√				√
Piston Rod Drop XY (Triggered Mode)	√				√
Complementary Differential Expansion	√			√	√
Temperature Difference	√		√	√	√

- **EU (Engineering Units):** These are the engineering units for the selected combined channel (final measurement result). This must be the same as the underlying analogue channels.
- **Detection:** This is the type of Signal Rectification that is to be used in processing the returned signal. This can be set to “RMS” (true Root Mean Square Averaging), PtP (true Peak to Peak) or “P” (true Peak to Peak / 2).
- Comb. calc (Combination calculation):

The available combination calculations for channels **Ch X** and **Ch Y** of an Absolute Shaft Vibration type are:

**Ch X + Ch Y**

**Ch X – Ch Y**

**Ch Y – Ch X**

The available combination calculations for channels **Ch X** and **Ch Y** of a Temperature Difference type are:

**Ch X – Ch Y**

**Ch Y – Ch X**

- **Scale (Min & Max):** These are used to set the max/min values for the measurement, including Modbus. This also sets the channel’s min/max achievable values, on the CMM front panel display.
  - The scale range from minimum to maximum has to include zero (0). For example, the range of 0 to 100 or -1 to 100 is acceptable but the range of 1 to 100 is not acceptable.
  - For Temperature Difference the scale min & max must be symmetrical. Example: -25 °F to +25 °F or -40 °C to +40 °C. **-35 °F to +20 °F not allowed.**

- The range of this scale is also used for 4–20 mA output where:
  - Min corresponds to 4mA.
  - Max corresponds to 20mA.

**Alarm Levels**

Alarm levels are divided into Alert and Danger. The actual available settings are dependent on the selected combined measurement type. See also [Alarms](#) section.

**Table 2-26: Alarm level configuration options for Combined Measurements.**

Type	Low	High	Enter Time	Trip Multiply Factor	Hysteresis	Trigger relay on Channel #
Absolute Shaft Vibration		√	√	√	√	√
Piston Rod Drop XY (Average Mode)		√	√		√	√
Piston Rod Drop XY (Triggered Mode)		√	√		√	√
Complementary Differential Expansion	√	√	√		√	√
Temperature Difference	√	√	√		√	√

- **Low and High:** these check boxes enable or disable the associated alarm setting.
  - A channel in Danger state will always cause the channel to Alert state as well, even if Alert setting was disabled. In that case, the channel status is Alert and Danger.

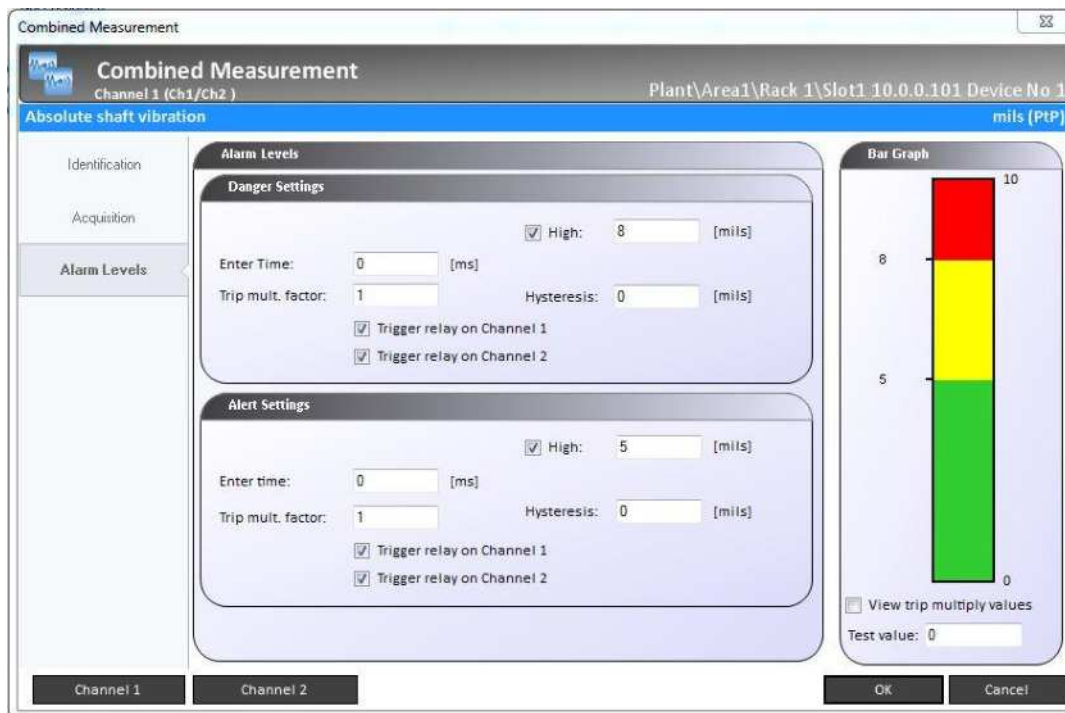


Figure 2 - 91.  
Absolute Shaft Vibration Type Alarm Levels Setting.

- **Enter Time:** represent the period for a channel to have exceeded an alarm level before an actual alarm condition is raised. Alert/Danger ON trigger will be delayed by this Enter Time.
- **Trip Multiply Factor:** use this value to temporarily increase the already set alert and danger levels. The entered factor must be between the values of 1 and 25, with a single decimal being allowed (i.e. 1.5).
- The activation of trip multiply at the slot is done via:
  - [Digital channels](#) interface by selecting the trip multiply input type
  - [Local display selection keypad](#) located on the front of condition monitoring module
  - Modbus register 259 as described in [Imported \(Write Single\) Modbus Register](#)
- The activation of trip multiply at the channel level is done via:
  - [Local display selection keypad](#) located on the front of condition monitoring module
  - Modbus register 260 as described in [Imported \(Write Single\) Modbus Register](#)



**Table 2-27: Trip multiply activation logic for combined measurement.**

Trip multiply activation logic for Combined measurement		
Ch X	Ch Y	Combined measurement (of Ch X and Ch Y)
Not activated	Not activated	Not activated
Activated	Not activated	Activated
Not activated	Activated	Activated
Activated	Activated	Activated

- It is not possible to activate trip multiply for only the combined measurement.
- Slot trip multiply will activate/deactivate/override channel trip multiply status.

The trip multiply status is stored in the backplane and will be recovered after a power cycle or hot-swap procedure.

- **Trigger relay on Channel #:** use this check box to select whether an alarm condition of the selected channel number should trigger a relay.
- A channel can be set for trigger relay on more than one alarm settings such as alarm levels, Gap alarm levels and combined measurement alarm levels. If a channel is set for more than one trigger relay, the relay will trigger when at least one alarm condition is met. It is using an "OR" logic.

**Important facts to be considered for combined measurements:**

- If a corresponding channel X or channel Y is in channel disarm, the combined measurement will be in channel disarm and relay will not be triggered.
- Slot disarm will affect combined measurement.
- For CDE combined measurement: If **both** corresponding channel X and channel Y are in channel circuit fault, the combined measurement will be in channel circuit fault and relay will not be triggered.
- For other types of combined measurements: If a corresponding channel X **or** channel Y is in channel circuit fault, the combined measurement will be in channel circuit fault and relay will not be triggered.

## Configuring Digital Channels

To configure a digital channel, from the configuration hierarchy, select **Digital Channels** and then either double-click on or select one from the displayed eight channels and press the **Edit** button (see figure below).

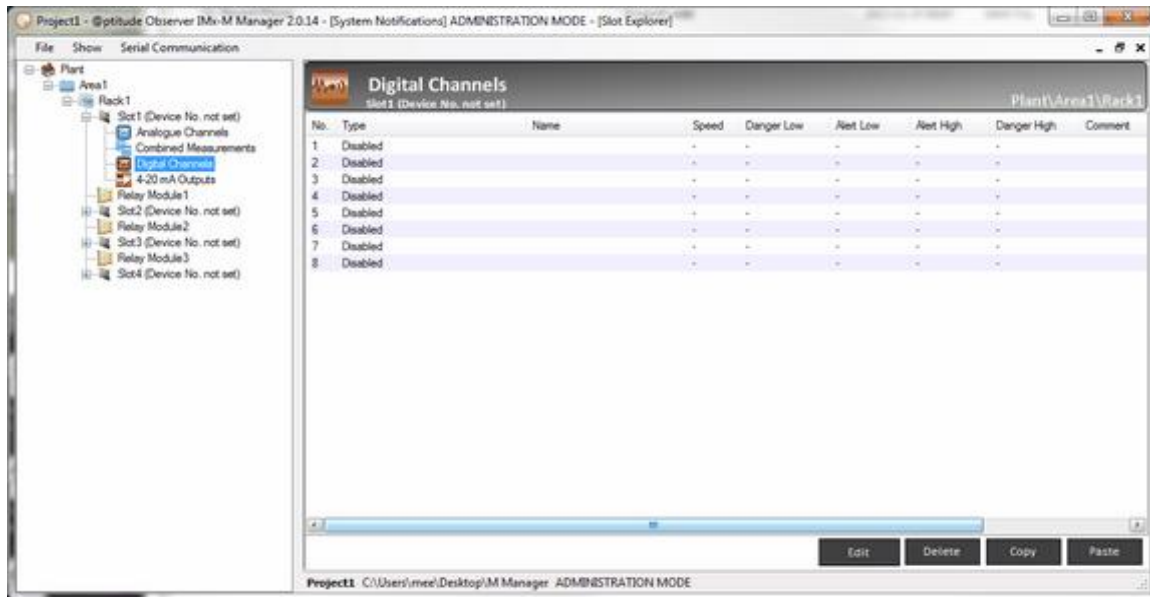


Figure 2 - 92.  
List of Digital Channels.

This will launch the digital channel setup dialog as shown in the figure below:

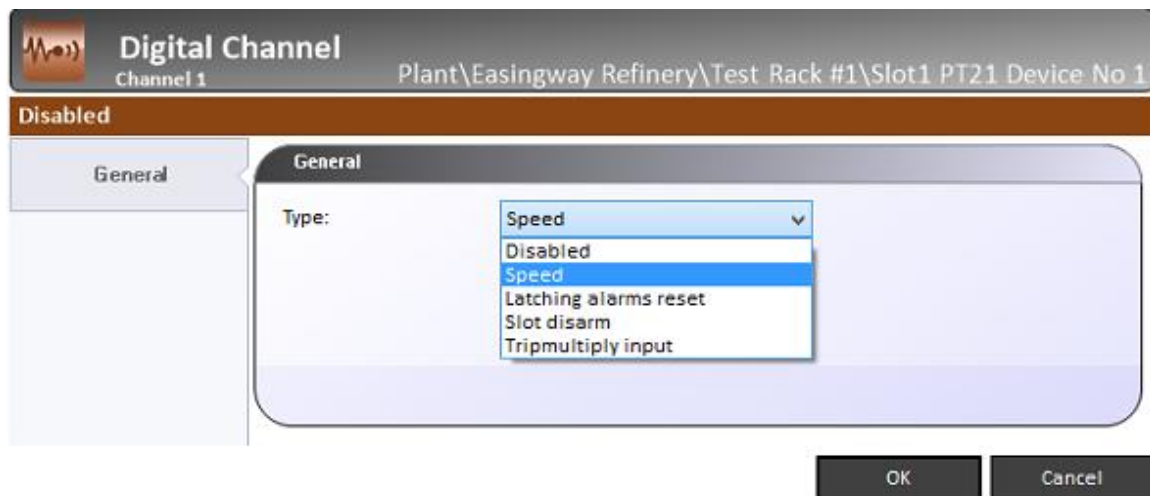


Figure 2 - 93.  
Configuring a Digital Channel.

- **Speed** enables the selected digital channel as a [Speed](#) type channel.
- **Latching Alarms Reset** is used as the acknowledgment of a latching sensor fault on slot wise. It will bring the **sensor OK** status slot wise back to normal if the

current status is normal. It will also inactivate any latching relays and first out condition.

- The configuration of [latching sensor fault](#) is set at each analog channel's sensor configuration interface.
- Configuration of [latching relay](#) is set at the general settings for relays as described in [Configuring a Relay Module](#) chapter.
- **Slot Disarm** is to disarm the slot by using the digital input.



**Important - If the configuration of a slot is to be updated and the slot is disarmed through a digital input, it is strongly advised to make sure that the same digital input is configured as slot disarm input. Failing to do so could lead to unintentionally arming of the slot when the slot restarts and the new configuration is activated.**

- **Tripmultiply Input** activates the trip multiply setup entered at each analog channel configuration interface for alert/danger settings on a slot wise basis.
  - Slot trip multiply will activate/deactivate/override channel trip multiply status.

The tripmultiply status is stored in the backplane and will be recovered after a power cycle or hot-swap procedure.

Once the digital channel type has been selected, the setup dialogue will be refactored based on the chosen type.

For the speed (or tachometer input) channel type, this will include additional fields to support through the general and alarm levels settings.

For all other digital channel types (latching alarm reset, slot disarm and trip multiply input), only the name and comment fields are available.

#### **Name**

A 20 character field which can usefully be used to identify the digital channel type and/or tag.

#### **Comment**

A free text field for additional information. Note that this text is only stored in the project and not in the actual configuration.

### General Settings for Speed Type

The following additional General settings are for the Speed (or tachometer input) channel type.

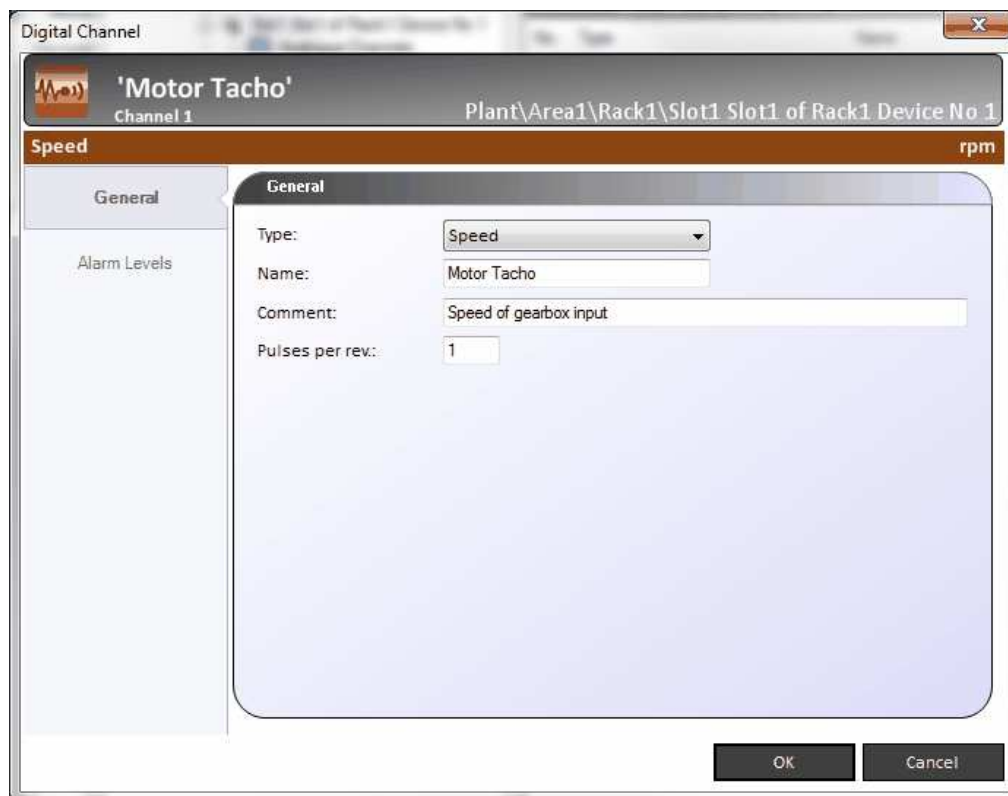



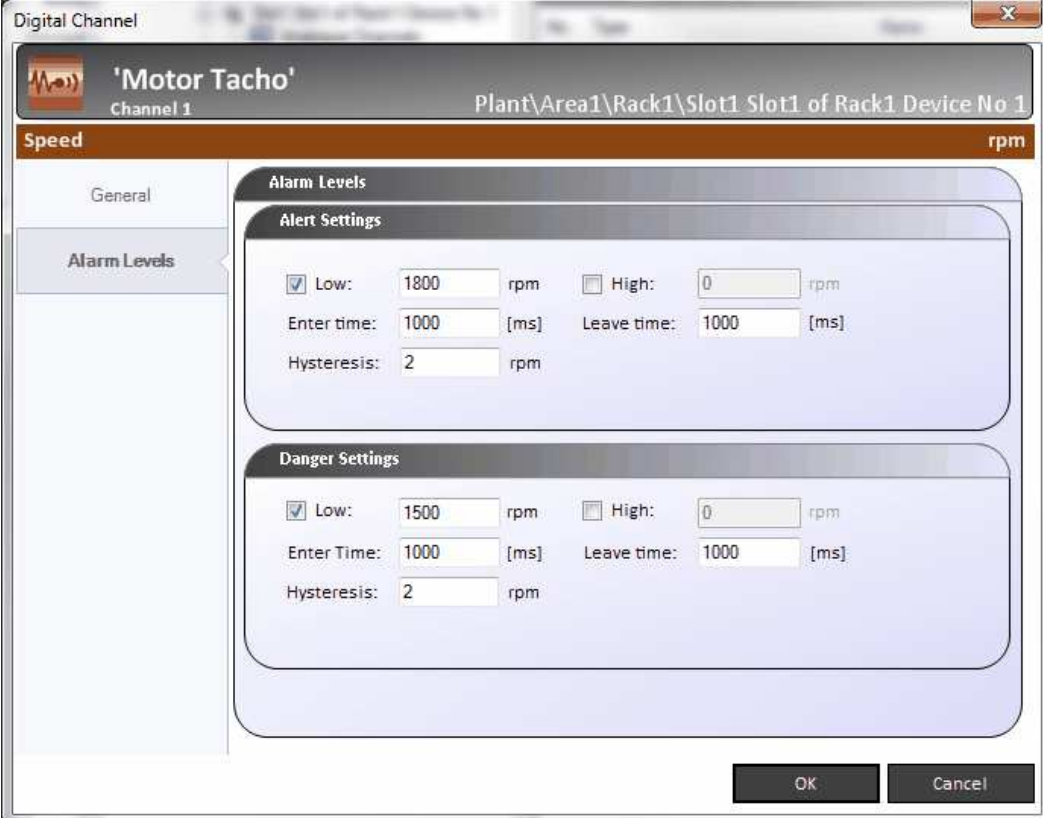
Figure 2 - 94.  
Entering Speed Properties.

- **Pulses per rev:** Number of pulses per revolution used to compute the correct speed.
  - Must be 1 when a channel is used as trigger for Piston Rod Drop triggered measurements.

### Alarm Levels for Speed Type

The following additional Alarm Levels settings are for the Speed (or tachometer input) channel type.

 **Important - IMx-M shall be used for speed alarming only. It shall not be used to protect/trip machine on overspeed. IMx-M does not fulfill the requirements related to overspeed protection.**



The screenshot shows a software window titled 'Digital Channel' with a sub-window 'Motor Tacho'. The window is for 'Channel 1' located at 'Plant\Area1\Rack1\Slot1 Slot1 of Rack1 Device No 1'. The 'Speed' parameter is set to 'rpm'. The 'Alarm Levels' section is active, showing 'Alert Settings' and 'Danger Settings'. Both sections have 'Low' and 'High' checkboxes checked. The 'Alert Settings' section has 'Low' set to 1800 rpm, 'High' to 0 rpm, 'Enter time' to 1000 ms, and 'Leave time' to 1000 ms. The 'Hysteresis' is set to 2 rpm. The 'Danger Settings' section has 'Low' set to 1500 rpm, 'High' to 0 rpm, 'Enter Time' to 1000 ms, and 'Leave time' to 1000 ms. The 'Hysteresis' is set to 2 rpm. 'OK' and 'Cancel' buttons are at the bottom right.


Figure 2 - 95.  
Entering Speed Alarm Levels (Alert and Danger).

- **Low / High:** these check boxes enable or disable the associated alarm setting.
- The alarm range for Speed type is 0 to 65 000 rpm.
  - A channel going into Danger state will always cause the channel to Alert state as well, even if Alert setting was disabled. In such case, the channel status is Alert and Danger.
- **Enter Time:** represent the period for a channel to have exceeded an alarm level before an actual alarm condition is raised. Alert/Danger ON trigger will be delayed by this Enter Time.
- **Leave Time:** represents the period which a channel in alarm has to be in its normal operating range before the alarm condition is canceled. Alert/Danger "Off" trigger will be delayed by this Leave Time.

- **Hysteresis:** use this value to prevent rapid alarm state switching. Hysteresis values are used to determine when to leave the Alert/Danger state.
- For detailed information refer to Hysteresis setting in [Alarm Levels](#) when configuring an analog channel.

### Configuring 4-20 mA Outputs

4-20 mA output is used as means of carrying analog signals from IMx-M protection to the distributed control system (DCS).



**Important –The use of 4-20 mA outputs should be limited to monitoring purposes only. For protection and safety alert/danger triggering relay outputs must be used.**

Each slot offers 16 4-20 mA outputs which can either be directly assigned to an analog input channel or a combined measurement. See below for some examples.

- 4-20 mA output 1 relates to analog ch 1 or combined measurement 1 (Ch1/Ch2)
- 4-20 mA output 2 relates to analog ch 2 or combined measurement 1 (Ch1/Ch2)
- 4-20 mA output 3 relates to analog ch 3 or combined measurement 2 (Ch3/Ch4)
- 4-20 mA output 4 relates to analog ch 4 or combined measurement 2 (Ch3/Ch4)
- ...
- 4-20 mA output 15 relates to analog ch 15 or combined measurement 8 (Ch15/Ch16)
- 4-20 mA output 16 relates to analog ch 16 or combined measurement 8 (Ch15/Ch16)

To configure a 4-20 mA output, either double-click on the required output in the main work view, or select a 4-20 mA output and press the “Edit” button.



Figure 2 - 96.  
Configuring 4-20 mA Outputs.

This will launch the 4-20 mA Output setup dialog as shown in the figure below, where the required 4-20 mA Output type can be selected and confirmed with the OK button.

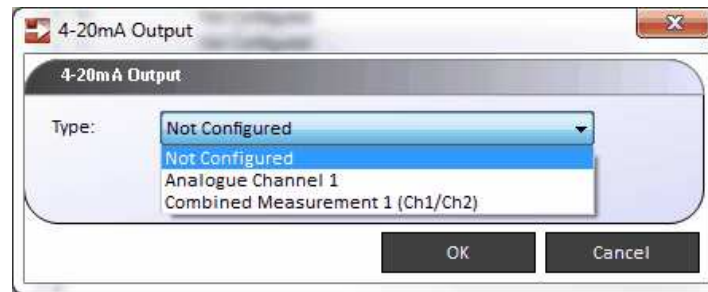


Figure 2 - 97.  
Selecting a 4-20 mA Output type.

### Configuring a Relay Module

The configuration of relays is described below. For information on relays see section [Relays](#).

To configure a specific relay module, from the configuration hierarchy, simply select a relay module to configure. A list of status for each of the 32 relays will then be displayed in the main work view.

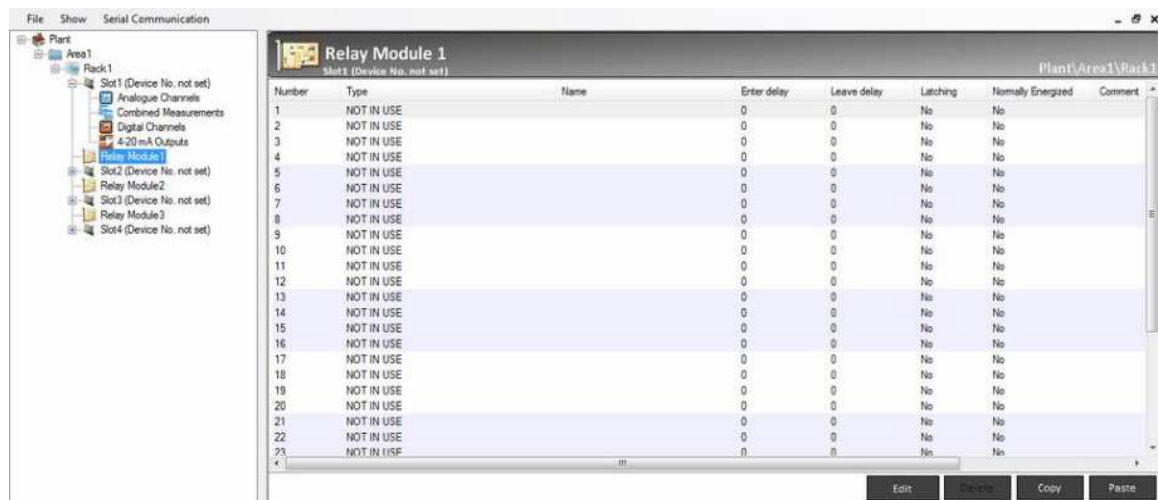


Figure 2 - 98.  
Configuring a Relay Module.

By default, all relay types are set to NOT IN USE.

To actually enable and configure a relay for use, either double-click on, or select a target relay number and press the **Edit** button. This will launch the **Relay** dialog as shown in the figure below:

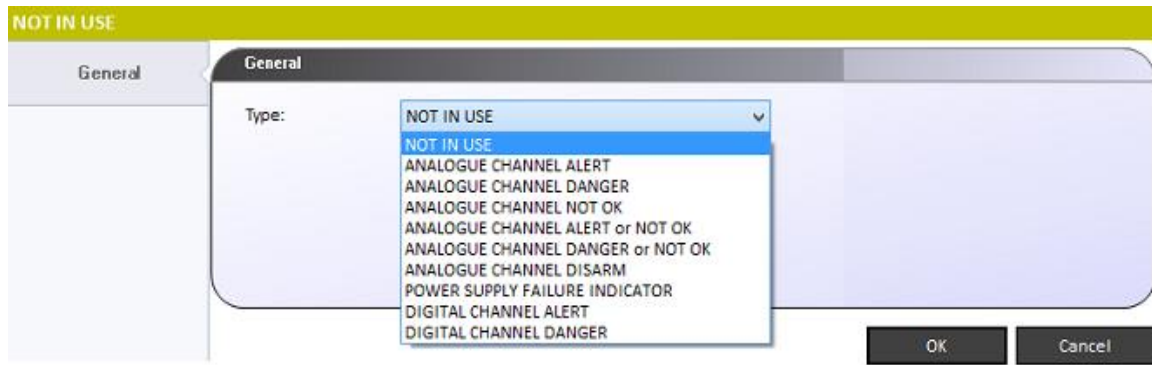


Figure 2 - 99.  
Selecting a Relay Type.

From this dialog, first select a relay type from the drop down list and then allow the dialog to refactor itself based on this selection.

With the exception of Power Supply Failure Indicator, each of the available relay types will allow for both **General Configuration** and **Channel Setup** as shown in the figure below.

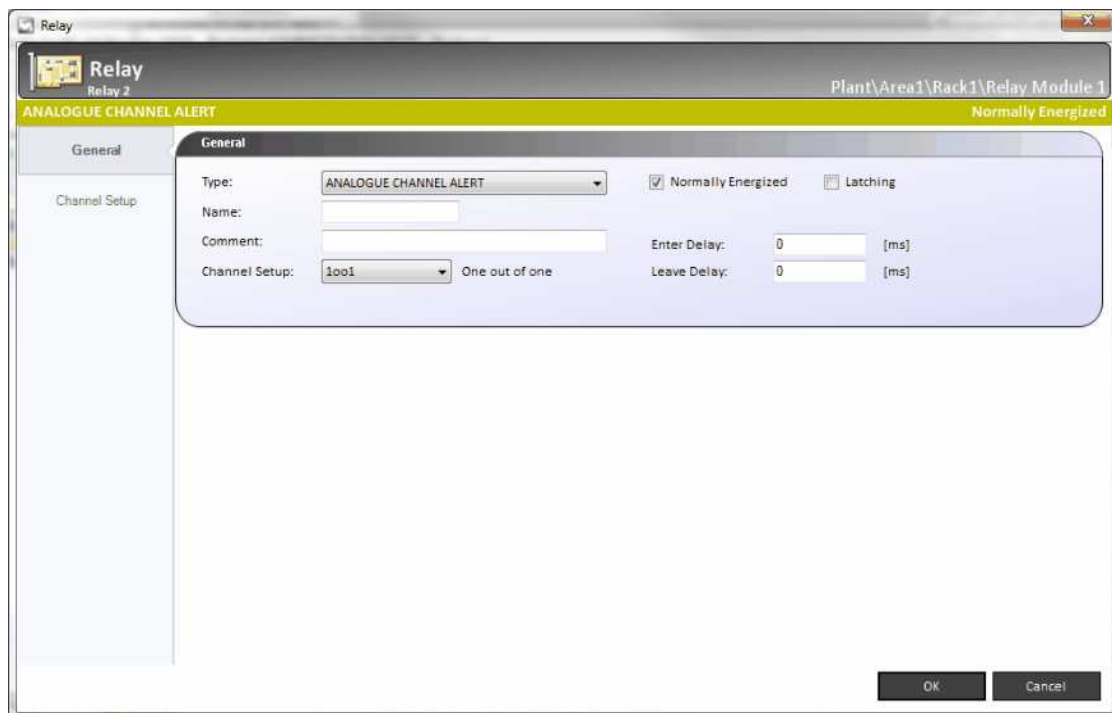


Figure 2 - 100.  
Relay General Setting.



### Available Relay Types

“Relay Type” means the alarm state that represents a cause for a relay trigger condition.

The available types are:

**Table 2-28: Relay Types.**

Relay Type	Description
<b>Analog Channel Alert</b>	When an analog channel is in ALERT, a candidate will be put forward to vote on whether the relay should be triggered or not.
<b>Analog Channel Danger</b>	When an analog channel is in DANGER, a candidate will be put forward to vote on whether the relay should be triggered or not.
<b>Analog Channel Not OK</b>	When an analog channel is NOT OK, a candidate will be put forward to vote on whether the relay (ch status Circuit Fault) should be triggered or not.
<b>Analog Channel Alert or Not OK</b>	Based on the previously mentioned (first three) relay types, but used to configure relay candidates for “2 out of 2” or “2 out of 3” voting.
<b>Analog Channel Danger or Not OK</b>	Based on the previously mentioned (first three) relay types, but used to configure relay candidates for “2 out of 2” or “2 out of 3” voting.
<b>Analog Channel Disarm</b>	When an analog channel is DISARMED, a candidate will be put forward to vote on whether the relay should be triggered or not.
<b>Power Supply Failure Indicator</b>	Indicates that a fault has been detected in one or in both power supply units (configurable). Voting is not required; a relay will be immediately triggered.
<b>Digital Channel Alert</b>	When a digital channel is in ALERT, a candidate will be put forward to vote on whether the relay should be triggered or not.
<b>Digital Channel Danger</b>	When a digital channel is in DANGER, a candidate will be put forward to vote on whether the relay should be triggered or not.

### General Settings for Relays

For each selected relay type, the following configuration settings are available.

**Table 2-29: Relay type configuration settings.**

Relay Type	Normally Energized	Latching	Enter Delay (ms)	Leave Delay (ms)	Ch Setup	PSU1	PSU2
Analog Ch Alert	√	√	√	√	√		
Analog Ch Danger	√	√	√	√	√		
Analog Ch Not OK	√	√	√	√	√		
Analog Ch Alert or Not OK	√	√	√	√	√		
Analog Ch Danger or Not OK	√	√	√	√	√		
Analog Ch Disarm	√	√	√	√	√		
Power Supply Failure Indicator	√	√				√	√
Digital Ch Alert	√	√	√	√	√		
Digital Ch Danger	√	√	√	√	√		

- Normally Energized
- Although the output of each relay can be externally wired for either normally open (NO) or normally closed (NC) operation, it is also possible to determine the default “energized” state for the relay. Normally open and normally closed are the indication of the default contact states when the relay is de-energized.
- The advantage of having a relay configured for normally energized operation is that in the event of the rack losing power, the relay would immediately switch to a fault condition.
- Latching
- When the relay is set for "Latching" and the relay is activated, it will stay in that state until it is reset. Resetting can be done via either:
  - The Digital Channel interface by selecting Latching alarms reset type
  - The Local Display selection keypad on the front of the condition monitoring module

- Modbus Register 261 or 265 as described in [Imported \(Write Single\) Modbus Register](#)
- Via Ethernet connection from @ptitude Observer

Having to manually reset a fault condition ensures that all such conditions have to be acknowledged and acted on by someone.

- Name
- A 20 character field which can usefully be used to identify the relay name or tag. Note that, for relays, this text is only stored in the project and not in the actual configuration.
- Comment
- A free text field for additional information. Note that this text is only stored in the project and not in the actual configuration.
- Enter Delay

This represents the time in milliseconds that an alarm or danger condition has to exist before the selected relay is activated into its alarm state.

- Channel Alarm Enter time + Relay Enter Delay will be the total Enter Time for triggering the relay.

- Leave Delay

This represents the time in milliseconds after an alarm or danger condition has ended before the selected relay is deactivated from its alarm state.

**Note:** Leave delay is not applicable to a relay configured as Latching.

- Channel Setup

Channel setup options are basic channel setup voting based on "n out of N" logic. Detailed information is provided in the next section, [Channel Setup for Relays](#).

- Power Supply Unit 1 / Power Supply Unit 2.

These are only for the Power Supply Failure Indicator type.

This selection controls upon which a power supply unit failure relay shall be activated.

### Channel Setup for Relays

Although a relay module configuration is associated with a particular slot (CMM + PRM pair) number, each of the 32 relays on that relay module can trigger on a channel alarm condition across all four protection modules.



**Important - In order to engage disarm when relays are configured to trigger on channels in more than one protection module, it is strongly recommended always to use rack disarm input to disarm the entire rack at once.**

The alert condition triggering is based on simple Boolean logic, based on polling of the candidate alarm states for different channel combinations, and these combinations can be spread across all four protection modules.

Basic channel setup voting is based on simple "n out of N" logic (for example 1 out of 3); the concept of which is shown in the figure below.

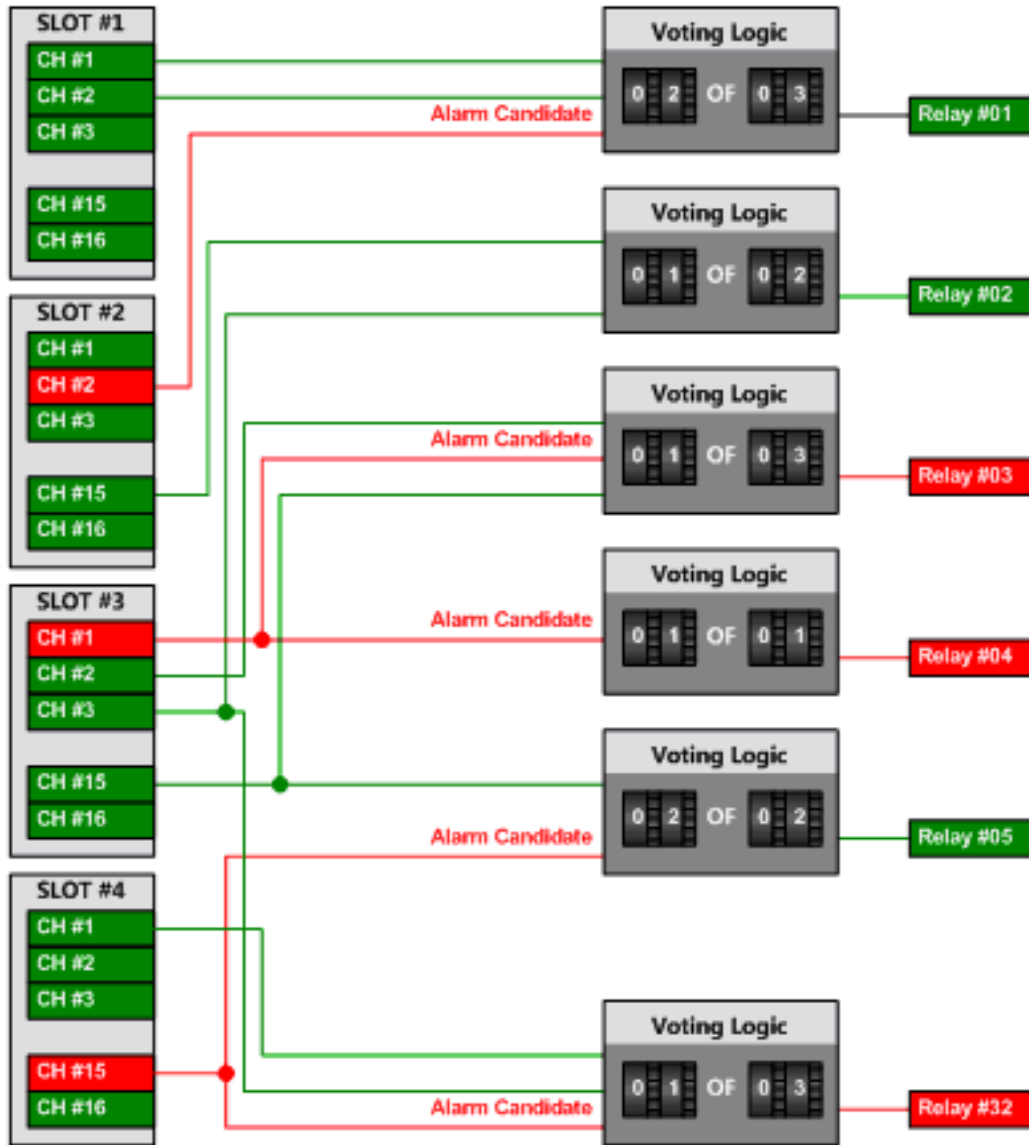


Figure 2 - 101.  
 Relay Triggering by Using Alarm Candidate "n out of N" Voting.

Currently any individual relay can be triggered using either combinations of candidate alarms from the 16 analog channel outputs or combinations of candidate alarms from the eight digital channel outputs. These combinations are described in the table below.

**Table 2-30: Channel setup options for relay.**

Ch Setup	Description
<b>1oo1</b>	<b>One out of One:</b> The single channel selected must be in either alert or danger* before the relay will trigger.
<b>1oo2</b>	<b>One out of Two:</b> At least one out of two selected analog channels must be in either alert or danger* before the relay will trigger.
<b>1oo3</b>	<b>One out of Three:</b> At least one out of three selected channels must be in either alert or danger* before the relay will trigger.
<b>1ooN</b>	<b>One out of Many:</b> At least one out of all selected channels must be in either alert or danger* before the relay will trigger.
<b>2oo2</b>	<b>Two out of Two:</b> Both of the selected channels must be in either alert or danger* before the relay will trigger.
<b>2oo3</b>	<b>Two out of Three:</b> At least two out of three selected channels must be in either alert or danger* before the relay will trigger.
<b>3oo3</b>	<b>Three out of Three:</b> All three of the selected channels must be in either alert or danger* before the relay will trigger.
<b>Advanced</b>	See section <a href="#">Advanced Analog and Digital Channel Setup</a> .

\*dependent on whether relay type is Alert or Danger.

Before continuing, it is worthwhile making sure that we have a clear grasp of what all this actually means.

So, using the above table, let's look at the state 2oo2 (Two out of Two). Assuming that the relay type is set to "Alert or Not OK", then each channel will submit an alarm candidate if its condition is either "Not OK", or is in "Alert or Danger".

**Table 2-31: Relay voting 2 out of 2.**

Relay Voting "Two out of Two" Candidates		
Ch 1 Condition	Ch 2 Condition	Relay State
Normal	Normal	Not Triggered
Normal	Not OK	Not Triggered
Normal	Alert or Danger	Not Triggered
Not OK	Normal	Not Triggered
Not OK	Not OK	Triggered
Not OK	Alert or Danger	Triggered
Alert or Danger	Normal	Not Triggered
Alert or Danger	Not OK	Triggered
Alert or Danger	Alert or Danger	Triggered

Now let's look at the state 2oo3 (Two out of Three). Again, assuming that the relay type is set to "Alert or Not OK", then each channel will submit an alarm candidate if its condition is either "Not OK", or is in "Alert or Danger".

**Table 2-32: Relay voting 2 out of 3.**

Relay Voting "Two out of Three" Candidates			
Ch 1 Condition	Ch 2 Condition	Ch 3 Condition	Relay State
Normal	Normal	Normal	Not Triggered
Normal	Normal	Not OK	Not Triggered
Normal	Normal	Alert or Danger	Not Triggered
Normal	Not OK	Normal	Not Triggered
Normal	Not OK	Not OK	Triggered
Normal	Not OK	Alert or Danger	Triggered
Normal	Alert or Danger	Normal	Not Triggered
Normal	Alert or Danger	Not OK	Triggered
Normal	Alert or Danger	Alert or Danger	Triggered
Not OK	Normal	Normal	Not Triggered
Not OK	Normal	Not OK	Triggered
Not OK	Normal	Alert or Danger	Triggered
Not OK	Not OK	Normal	Triggered
Not OK	Not OK	Not OK	Triggered
Not OK	Not OK	Alert or Danger	Triggered
Not OK	Alert or Danger	Normal	Triggered
Not OK	Alert or Danger	Not OK	Triggered
Not OK	Alert or Danger	Alert or Danger	Triggered
Alert or Danger	Normal	Normal	Not Triggered
Alert or Danger	Normal	Not OK	Triggered
Alert or Danger	Normal	Alert or Danger	Triggered
Alert or Danger	Not OK	Normal	Triggered

<b>Relay Voting “Two out of Three” Candidates</b>			
<b>Ch 1 Condition</b>	<b>Ch 2 Condition</b>	<b>Ch 3 Condition</b>	<b>Relay State</b>
Alert or Danger	Not OK	Not OK	<b>Triggered</b>
Alert or Danger	Not OK	Alert or Danger	<b>Triggered</b>
Alert or Danger	Alert or Danger	Normal	<b>Triggered</b>
Alert or Danger	Alert or Danger	Not OK	<b>Triggered</b>
Alert or Danger	Alert or Danger	Alert or Danger	<b>Triggered</b>

**Important note for Relay Voting**

A channel set to channel disarm presents as a persistent Normal state as does a channel in Normal state at the time of a slot level disarm.

Consequently any “N out of N” logic utilizing this channel will never trigger the relay and “n out of N” will only trigger in a reduced set of circumstances.

General rule for n out of N: if at least  $[1 + N - n]$  channels are disarmed the relay will never activate.

### Basic Analog and Digital Channel Setup

Using the basic (n out of N) channel setup logic, to actually select which channels to use, simply select the Channel Setup Tab page then from the displayed list, select the target channel(s) from all available slot(s).

Remember that there are 16 analog channels and eight digital channels per slot. And each of the 32 relays on that relay module can be triggered by an alert condition across all four slots.

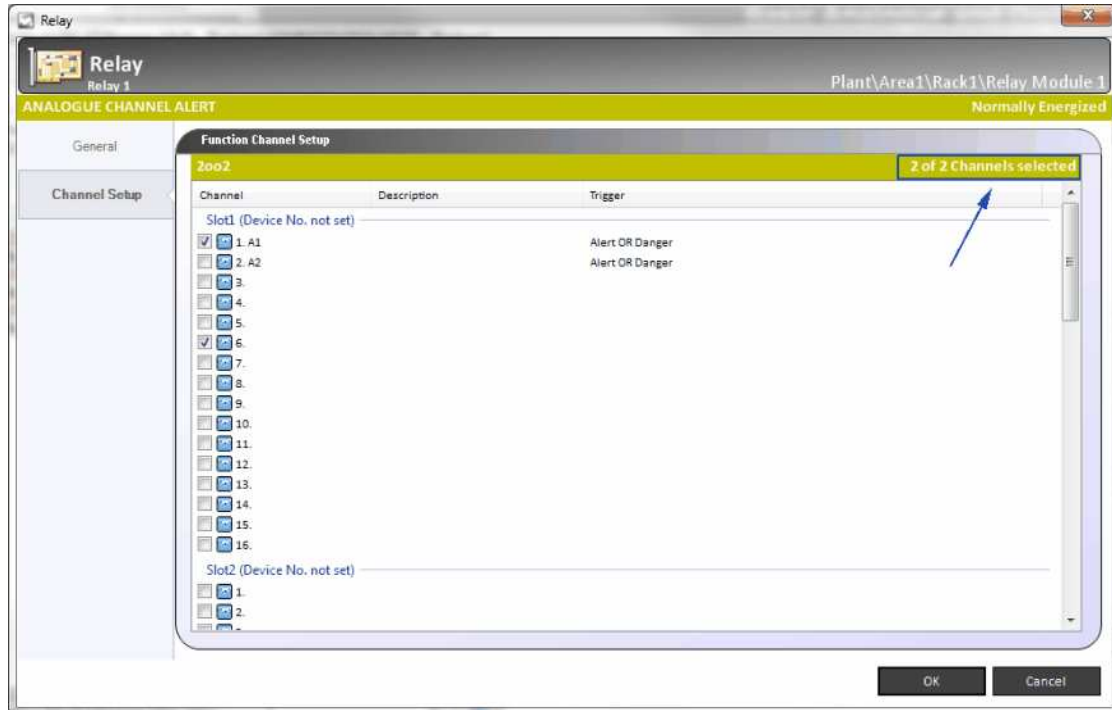


Figure 2 - 102.  
Configuring Relay Voting - "2 out of 2".

In this example, relay will be triggered if both channels (ch1 and ch6 of Slot1) are in alert.

The highlighted text in the figure above provides a feedback on how many channels have been selected, against how many channels need to be selected.



### Advanced Analog and Digital Channel Setup

Although basic “n out of N” voting logic is a very powerful technique for configuring relay logic, there are circumstances where it is simply not versatile enough. For those situations, the IMx-M Manager allows for the flexible logic grouping of up to three separate conditions, simply by selecting the **Advanced...** Channel Setup option.

For an example: RELAY = (CH1 OR CH2) AND (CH3 OR CH4) AND (CH5 OR CH6)

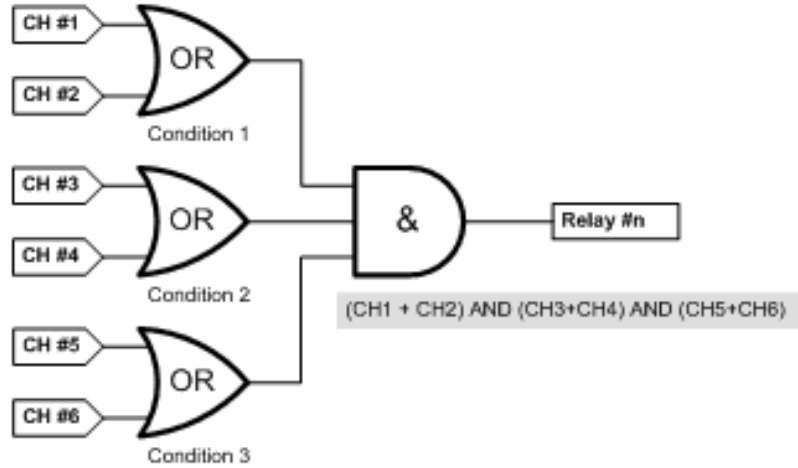


Figure 2 - 103.  
Example of Advanced Channel Setup.

We would configure the Channel Setup dialog as shown in the figure below.

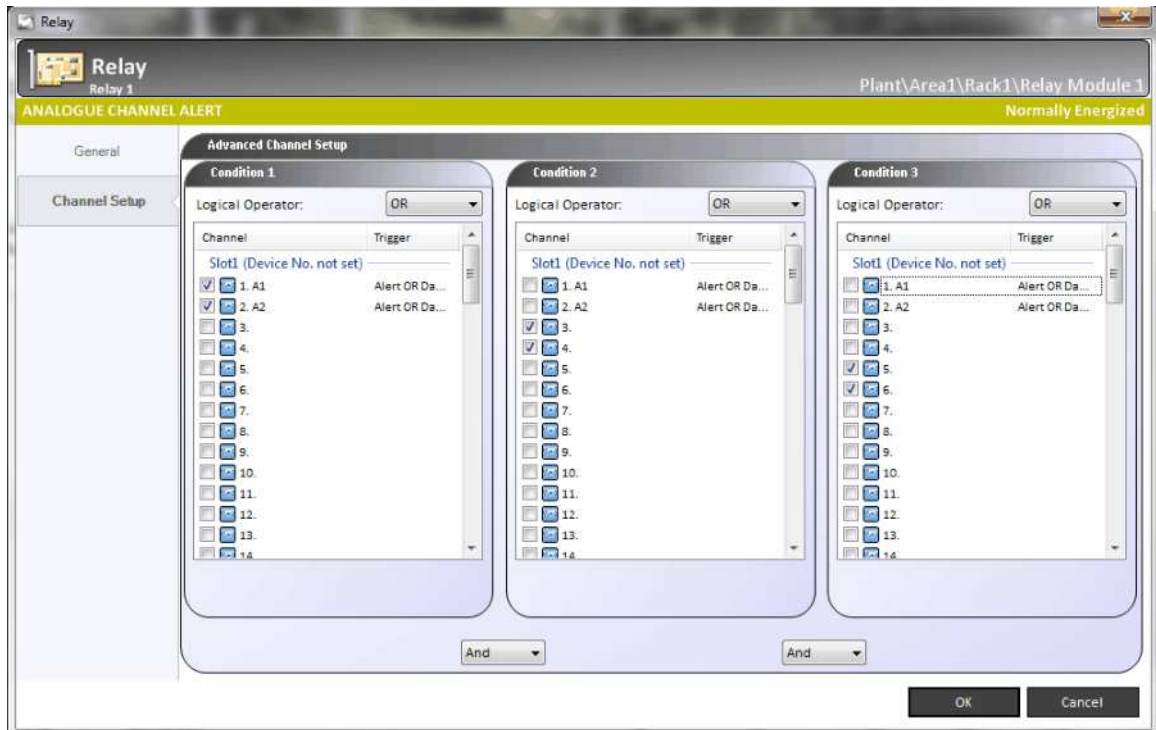


Figure 2 - 104.  
Configuring an Advanced Channel Setup.

However, when configuring Advanced Channel logic, remember that in many instances it may be possible (assuming the source channels are from the same slot) to greatly simplify expressions by the use of Boolean logic.

For example, the three condition expression: (CH1 OR CH2) AND (CH1 AND CH3 AND CH4) OR (CH4 OR CH5)

Can be expressed as:

»  $(CH1+CH2) \times (CH1 \times CH3 \times CH4) + (CH4 + CH5)$

»  $CH1 \times CH1 \times CH3 \times CH4 + CH1 \times CH2 \times CH3 \times CH4 + CH4 + CH5$

Remember that  $x.x = x$ , so the above expression simplifies to:

»  $CH1 \times CH3 \times CH4 + CH1 \times CH2 \times CH3 \times CH4 + CH4 + CH5$

»  $CH1 \times CH3 \times CH4 \times (1 + CH2) + CH4 + CH5$

Remember also  $(1 + x) = 1$ , and  $(1.x) = x$ , so the expression above simplifies to:

»  $CH1 \times CH2 \times CH3 \times CH4 + CH4 + CH5$

While  $x + x.y = x$ , so the expression further simplifies to:

»  $CH4 + CH5$

Although this clearly only applies to channels from the same slot, it is always worth considering what simplifications can be made when implementing an advanced (logic based) solution.

## Configuration Examples

### Absolute Shaft Vibration

#### Configuring a Casing Vibration Channel

Edit an analog channel setting by setting the **Type** to Casing vibration, the **Math Method** to Single integration, the Engineering Units (**EU**) to  $\mu\text{m}$ , and the **Detection** type to Peak-to-Peak (PtP), P (true Peak) or RMS (true Root Mean Square Averaging).

The channel selected must be one of a channel pair (i.e. If channel 3 is selected, the shaft vibration channel must be channel 4, or if channel 6 is selected, the shaft vibration channel must be channel 5).

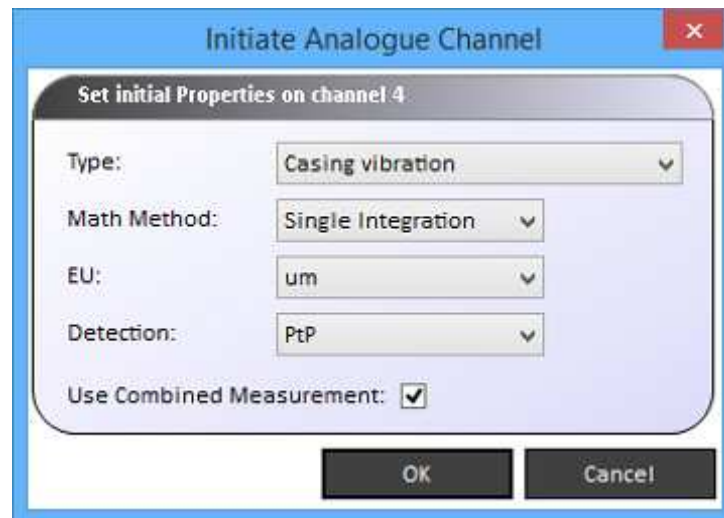


Figure 2 - 105.  
Initiating a Casing Vibration Analog Channel.

For this example, we will configure the casing vibration channel as shown in the three figures below.

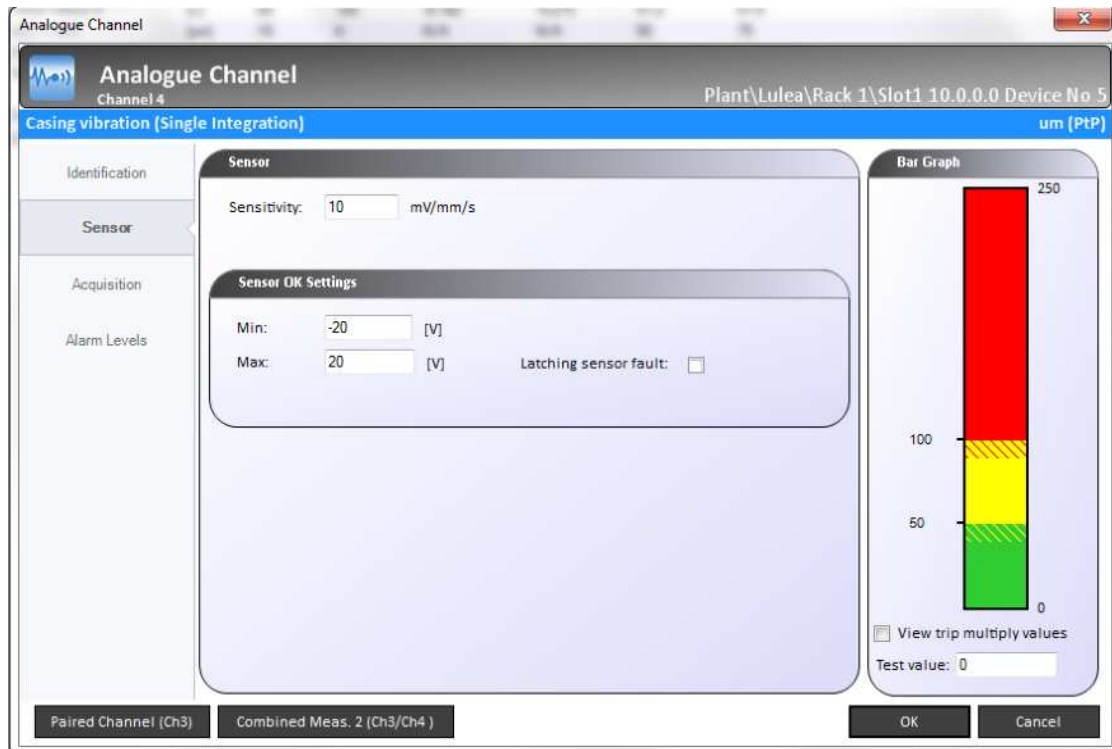


Figure 2 - 106.  
Entering the Sensor Parameters.



Figure 2 - 107.  
Entering the Acquisition Parameters.

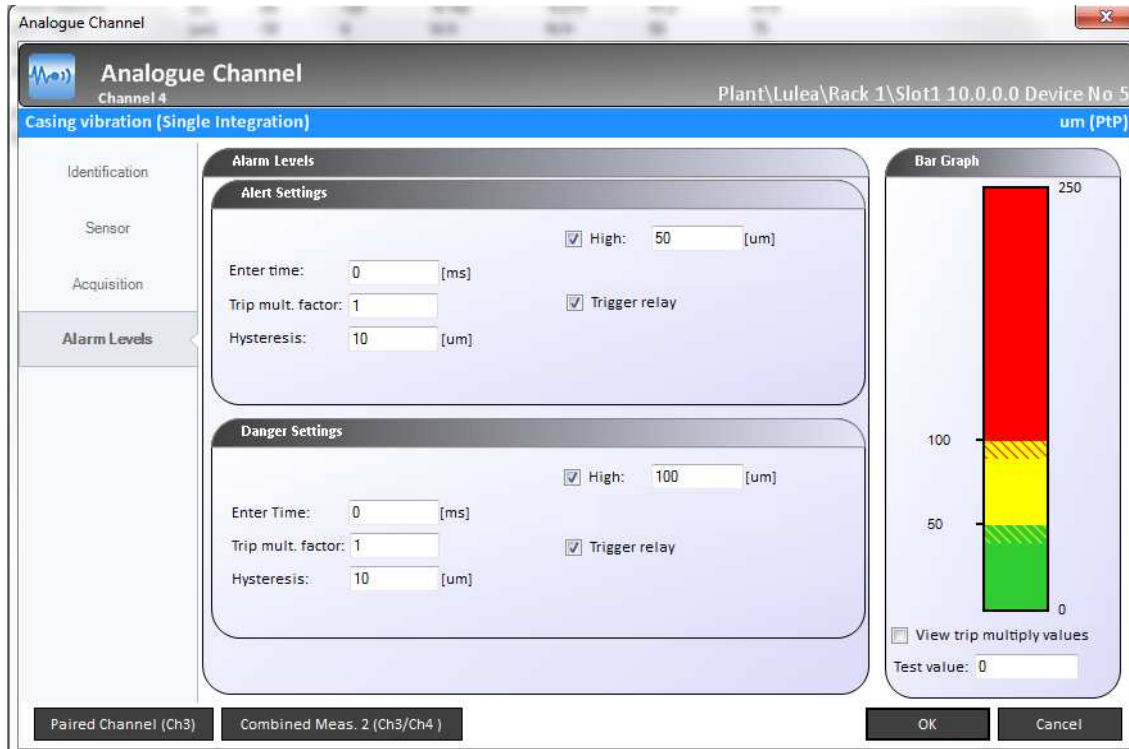


Figure 2 - 108.  
Setting the Alarm Levels.

### Configuring a Radial Shaft Vibration Channel

Edit an analog channel by setting the **Type** to Radial shaft vibration, the Engineering Units (**EU**) to  $\mu\text{m}$ , and the **Detection** type to Peak-to-Peak (PtP).

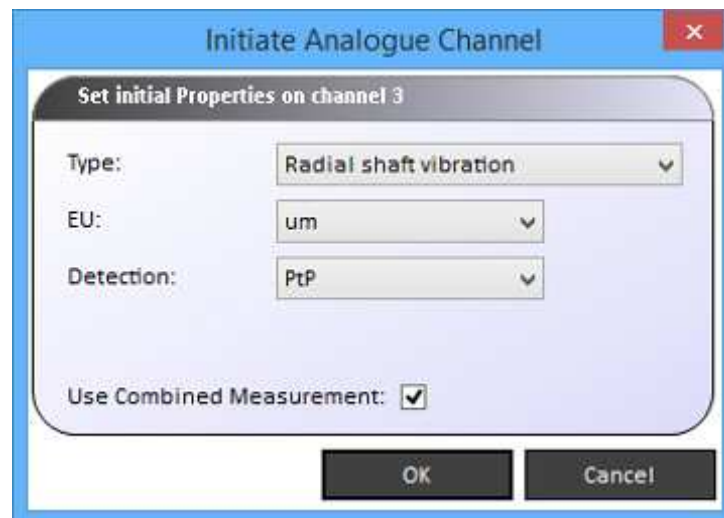


Figure 2 - 109.  
Initiating a Radial Shaft Vibration Channel.

For this example, we will configure the radial shaft vibration channel as shown in the three figures below:

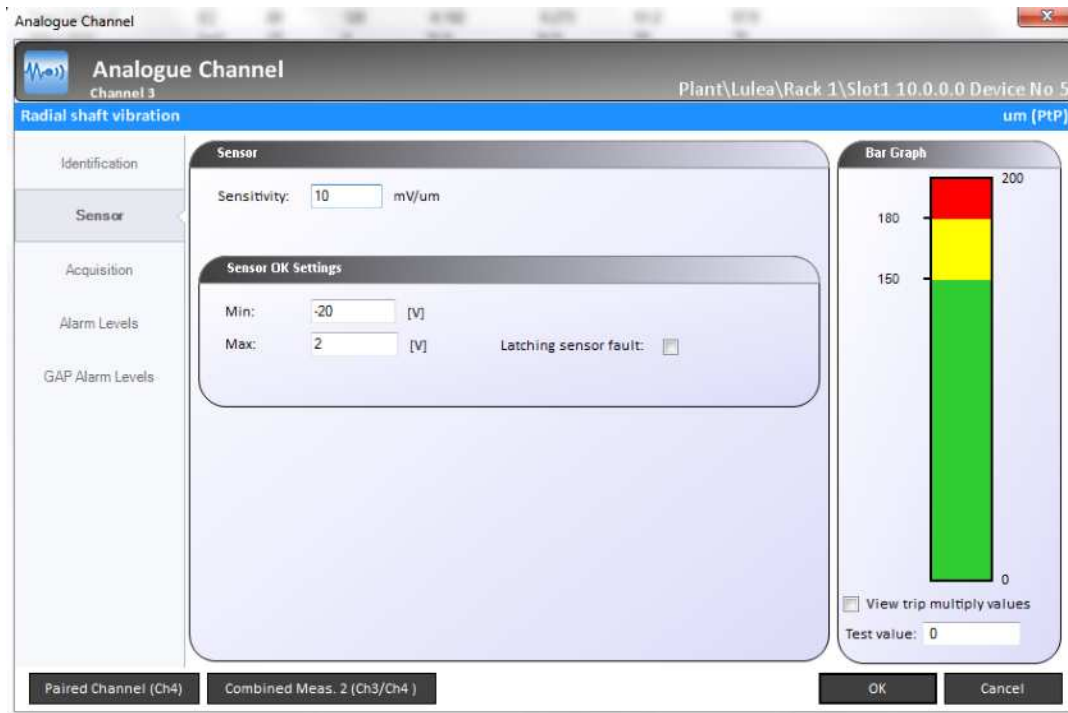


Figure 2 - 110.  
Entering the Sensor Parameters.



Figure 2 - 111.  
Entering the Acquisition Parameters.



Figure 2 - 112.  
Setting the Alarm Levels.

For this example, once a radial shaft vibration channel has been configured, the combined measurement can either be configured by pressing the **OK** button and selecting the new measurement from the “Combined Measurements” configuration branch, or by instead pressing the “Combined Meas 2 (Ch3/Ch4)” button (see figure above). This will save the current channel settings, then launch a new “Combined Measurement” dialogue.

#### **Configuring an ASV Combined Measurement Channel**

To complete the process of creating an absolute shaft vibration (ASV) measurement, configure a new combined measurement (for this example consisting of both channel 3 and channel 4).

Once the Combined Measurement dialogue is opened, set the **Type** to Absolute Shaft Vibration and enter a name.



Figure 2 - 113.  
Setting a Combined Measurement Type.

Go to the Acquisition tab.





Figure 2 - 114.  
Setting the Acquisition Settings.

Set the calculation type, **Comb. calc**, to CH3 + CH4. Whether the displacement should be added or subtracted is based upon the position of the machine sensors.

It is recommended to set **Detection** to RMS.

### Complementary Differential Expansion

For detailed information on CDE measurement, see [Complementary Differential Expansion](#) chapter.

#### **Configuring a Master Channel**

First, we need to initiate a new master channel, which will detect the collar moving away from the sensor. For this example we will select analog channel 1, and choose the **Type** "Complementary Differential Expansion". We will then set the engineering units (**EU**) to "mm".

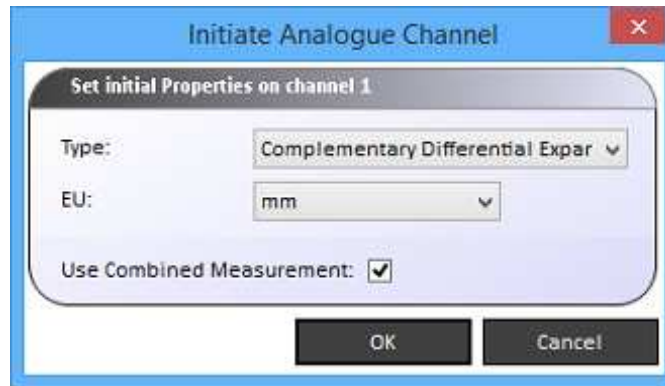


Figure 2 - 115.  
Creating the Master Channel (Channel 1).

Although we are describing this as the master channel, this status is actually assigned within the combined measurement, and is covered later in this example.



Figure 2 - 116.  
Assigning a Name to the Master Channel.

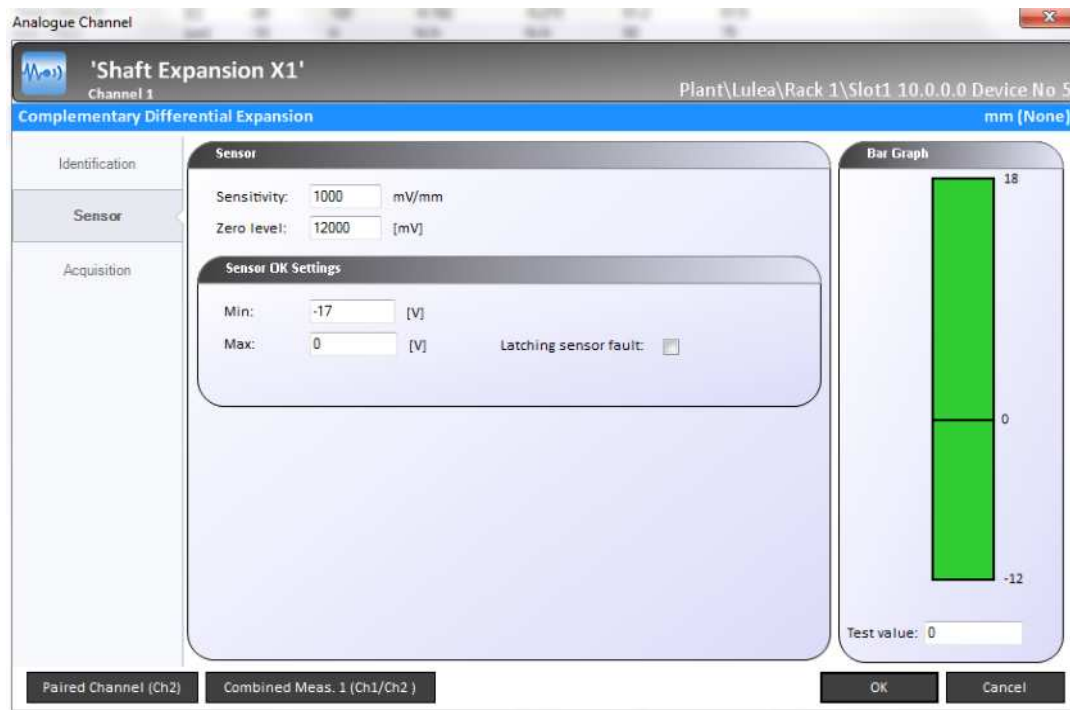


Figure 2 - 117.  
Entering the Master Channel Sensor Values.

Once the basic sensor parameters have been entered, we then need to set the **Target Position Direction** to “Active / Normal (Away From Probe)”. See figure below:

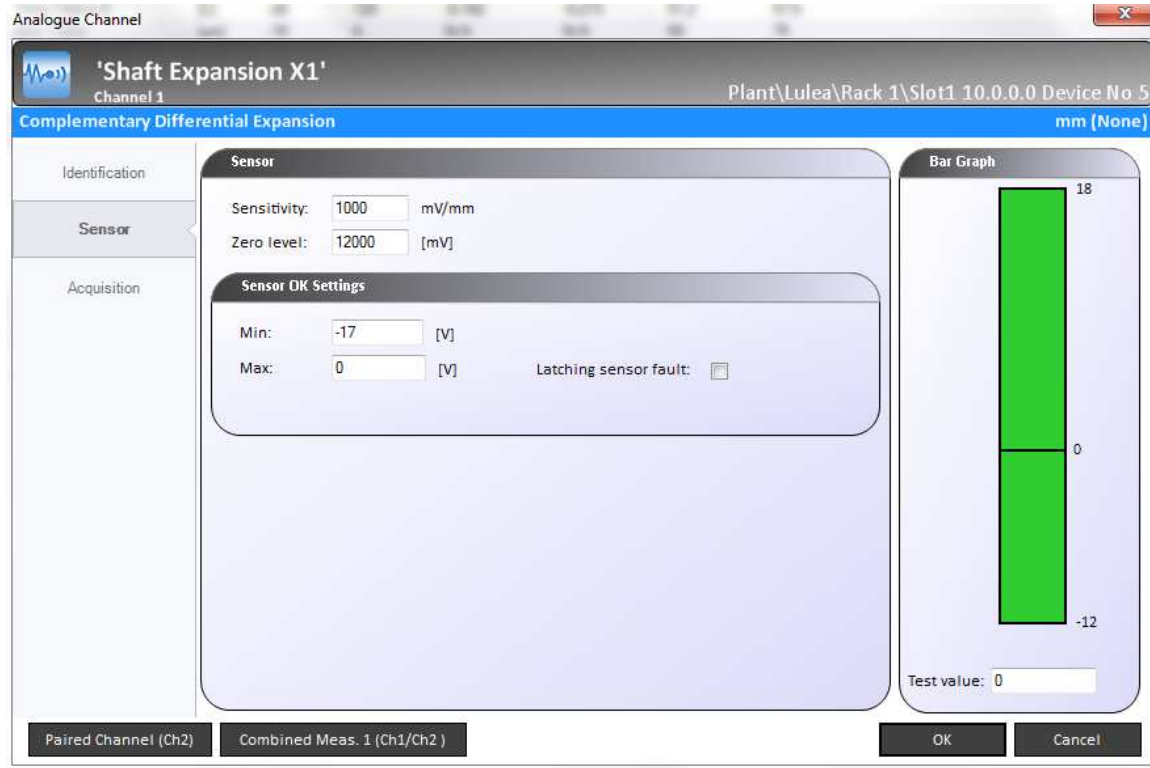


Figure 2 - 118.  
Entering the Master Channel Acquisition Values.

Once master channel has been configured, the slave can either be configured by pressing the **OK** button, or by instead pressing the “Paired Channel (Ch2)” button (see figure above). This will save the current channel settings and then launch a new “Initiate Channel” dialog for the paired channel (Ch2).

### **Configuring a Dependent (Slave) Channel**

As with the master channel setup just covered, the slave channel must be assigned with the same **Type** and **EU**.

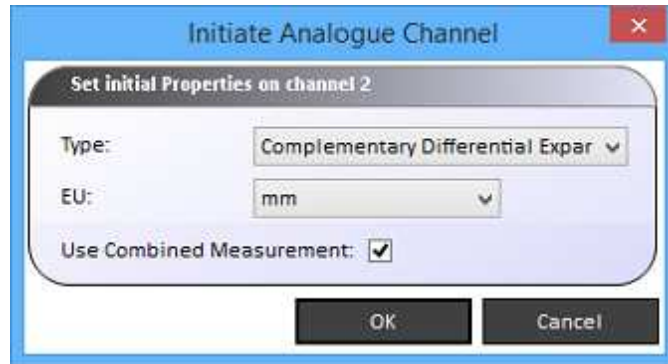


Figure 2 - 119.  
Creating the Slave Channel (Channel 2).

For this example, we will just identify the slave channel as “Shaft Expansion X2”.

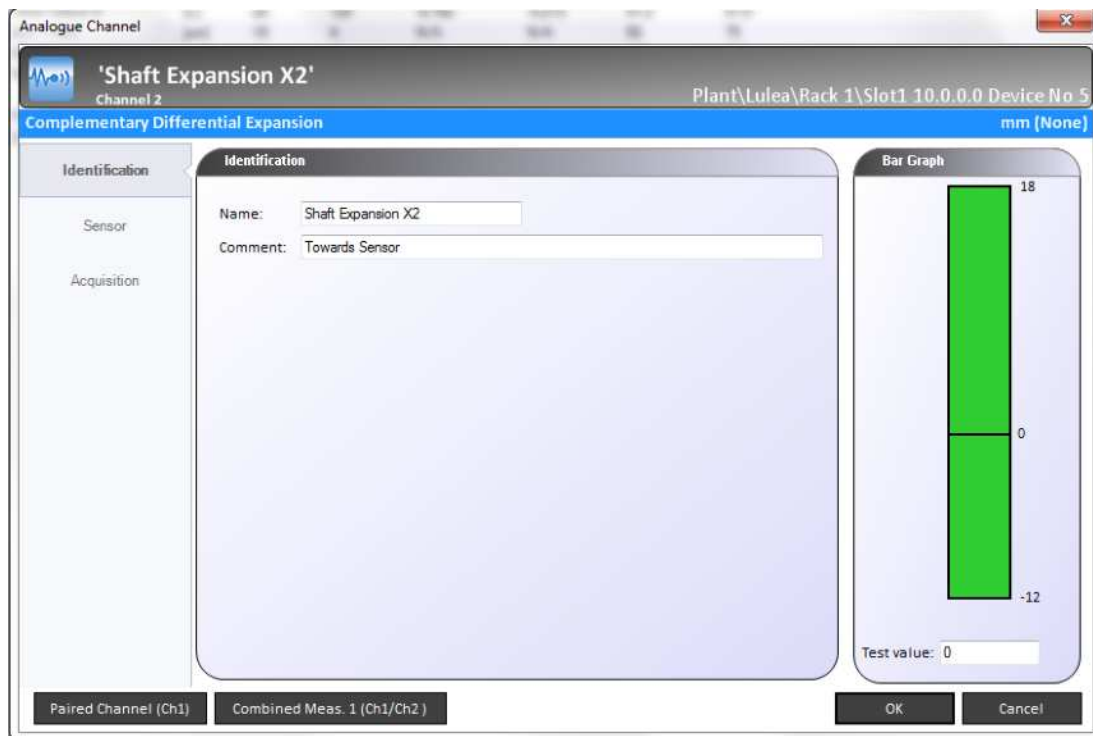


Figure 2 - 120.  
Naming the Slave Channel.

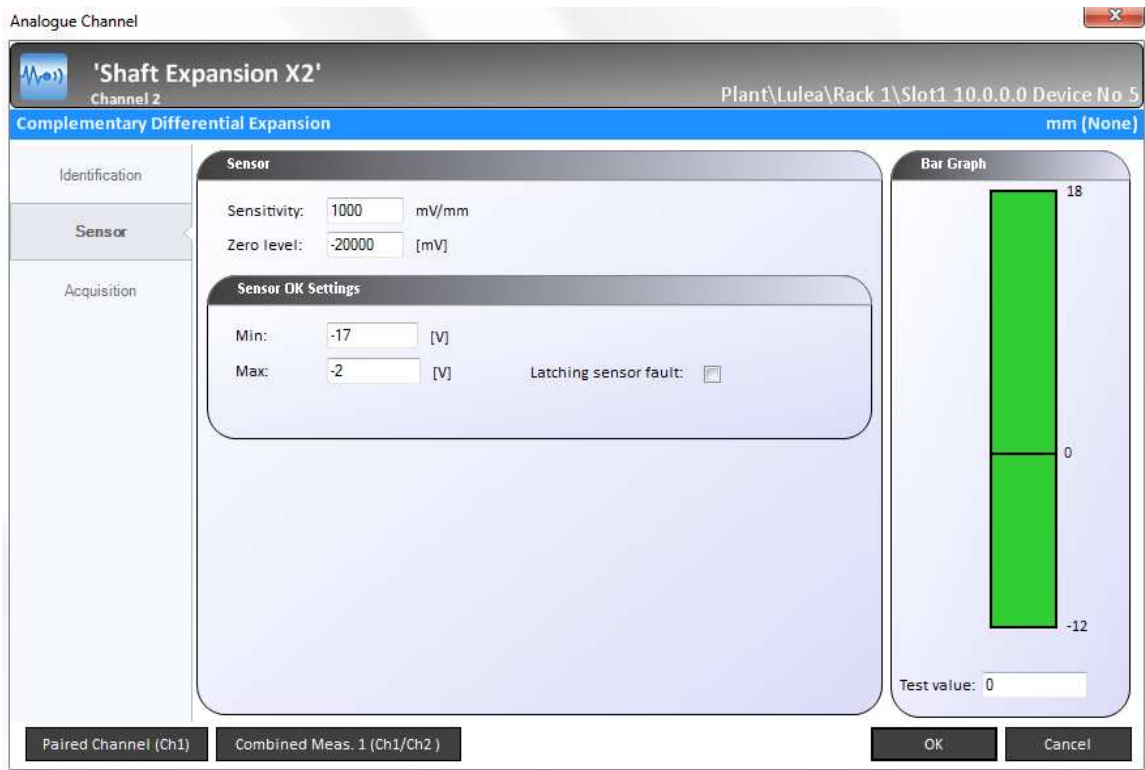


Figure 2 - 121.  
Entering the Slave Channel Sensor Values.

Once the basic sensor parameters have been entered, we then need to set the **Target Position Direction** to "Inactive / Counter (Towards Probe)". See figure below:

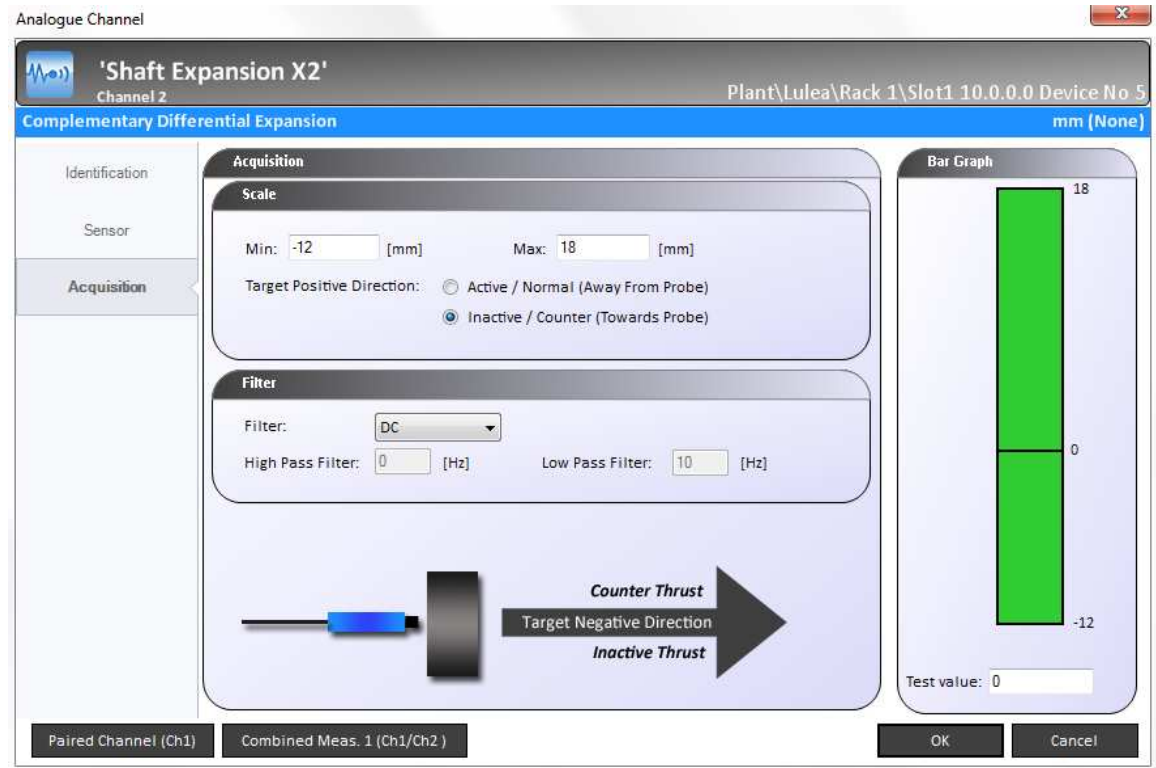


Figure 2 - 122.  
Entering the Slave Channel Acquisition Values.

After the slave channel has been configured, the combined measurement can either be configured by pressing the **OK** button and selecting the new measurement from the “Combined Measurements” configuration branch, or by instead pressing the “Combined Meas 1 (Ch1/Ch2)” button (see figure above). This will save the current channel settings and then launch a new “Combined Measurement” dialog.

#### **Configuring a CDE Combined Measurement Channel**

To complete the process of creating a Complementary differential expansion measurement, we need to configure a new combined measurement (consisting of both channel 1 and channel 2).

Once the combined measurement dialogue is opened, first we need to set the actual **Type** to “Complementary Differential Expansion”, then enter a suitable name as shown in the figure below.



Figure 2 - 123.  
Setting the Combined Measurement Type.

The next step is to set the **Master Channel** on the "Sensor" tab page. For this example, we will be selecting Channel 1, however the actual channel number shown is determined by exactly what channel pairs actually make up the combination.





Figure 2 - 124.  
Selecting the Master Channel and Crossover Voltage.

Once the master channel has been selected, set the **Crossover** point in "mV". This is the point at which the measurement will switch from using sensor S1 on channel 1 to sensor S2 on channel 2. For this example, we will be using -16 000 mV.

With the sensor setup configured, all that remains is to assign the acquisition parameters and the alarm values (see figured below).



Figure 2 - 125.  
Entering the Combined Measurement Acquisition Values.



Figure 2 - 126.  
Entering the Combined Measurement Alarm Values.

- For a Complementary differential expansion measurement, the individual channels cannot have any alarms set. Instead, the alarms are set to the combined channel.

### Piston Rod Drop (PRD)

The PRD measurement is used to monitor the piston rider band wear to avoid the piston touching the cylinder lining. See also [Piston Rod Drop](#) chapter.

In this example a pair of analog channels and their associated combined measurement are configured for PRD. The associated digital channel is configured for Speed measurement to provide speed information and measurement trigger.

**Note:** This example considers the triggered mode but can easily be applied to the average mode by ignoring the “start angle” and “stop angle”.

#### Configuring an Analog Channel Pair

Edit an analog channel by setting the **Type** to Piston Rod Drop (Triggered mode), the Engineering Units (EU) to  $\mu\text{m}$ , and check the “Use Combined Measurement”.

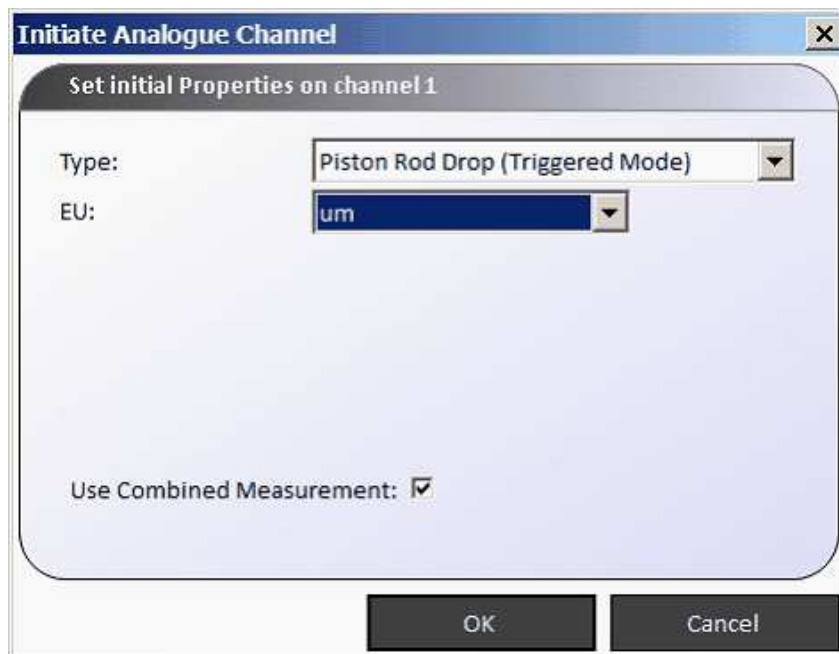


Figure 2 - 127.  
Initiating a Piston Rod Drop Channel.

For this example, the PRD channels will be configured as shown in the figures below.

Enter sensor parameters, measurement window angles, physical parameters of the piston rod, and piston rod offset compensation. The warning triangle informs that the paired channel (Ch2 in this example) must be configured the same way because the combined measurement is activated.



Figure 2 - 128.  
Configuration for Piston Rod Drop.

Clicking **Configure** brings up a graphical view of a compressor with some of the parameters relation to the physical object shown in the picture.

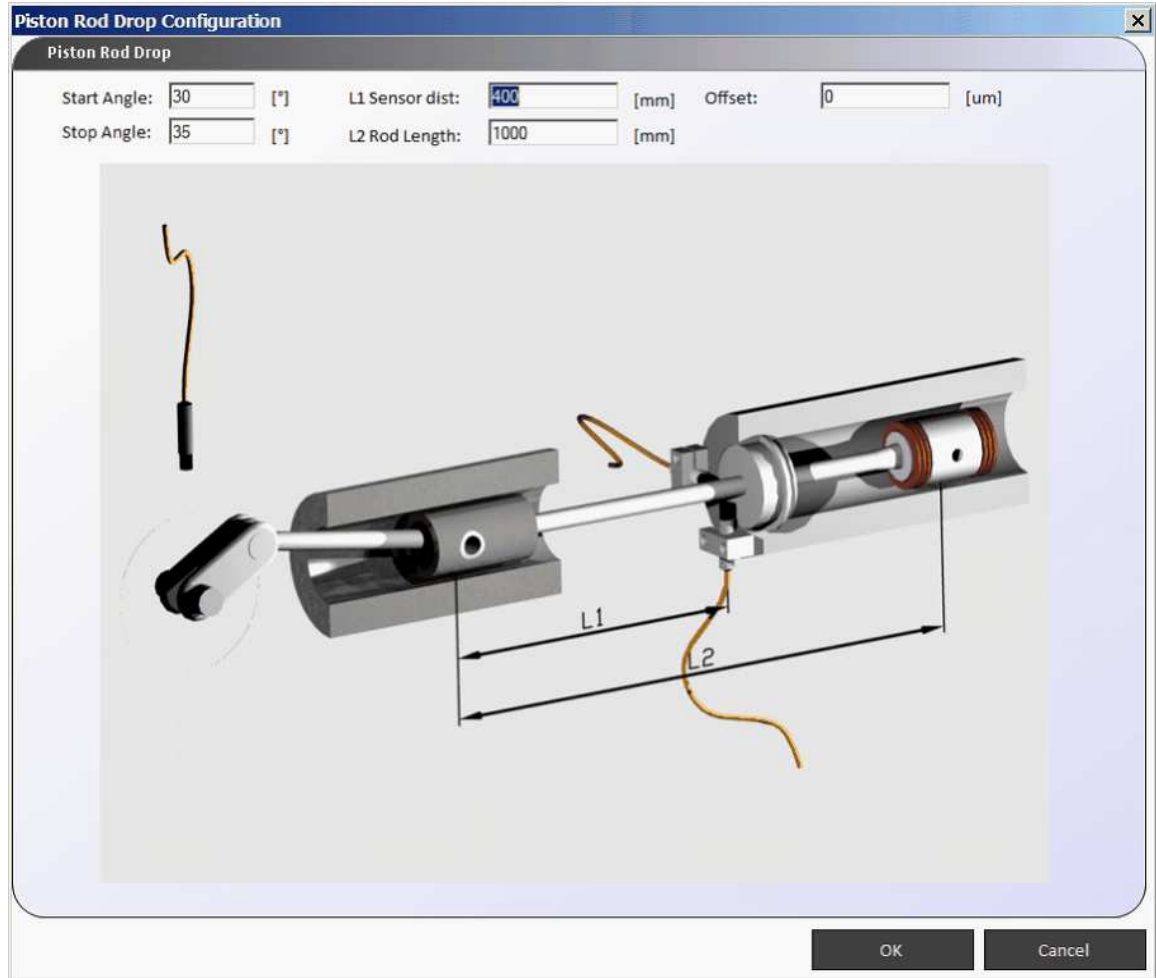


Figure 2 - 129.  
Entering Parameters Specific for Piston Rod Drop.

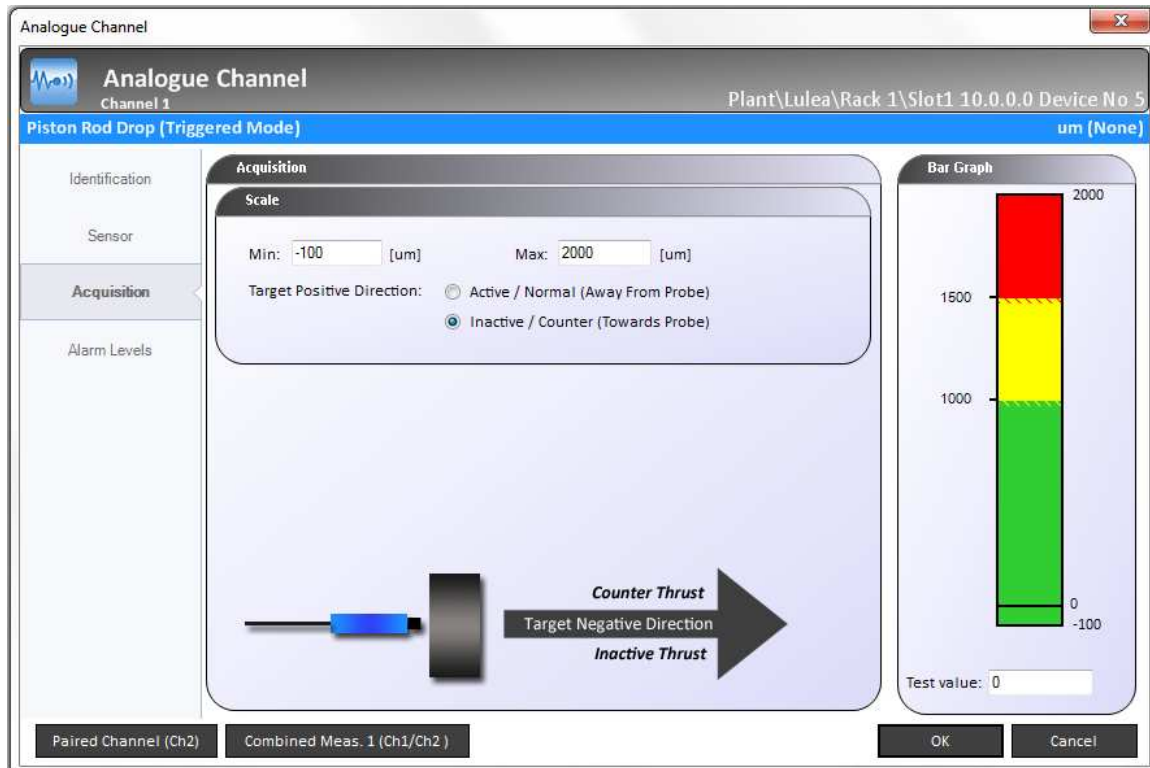


Figure 2 - 130.  
Acquisition Parameters.

**Target Positive Direction:** When set to “Active”, an increasing probe gap will produce a rising value. When set to “Inactive”, an increasing probe gap will produce a falling value.

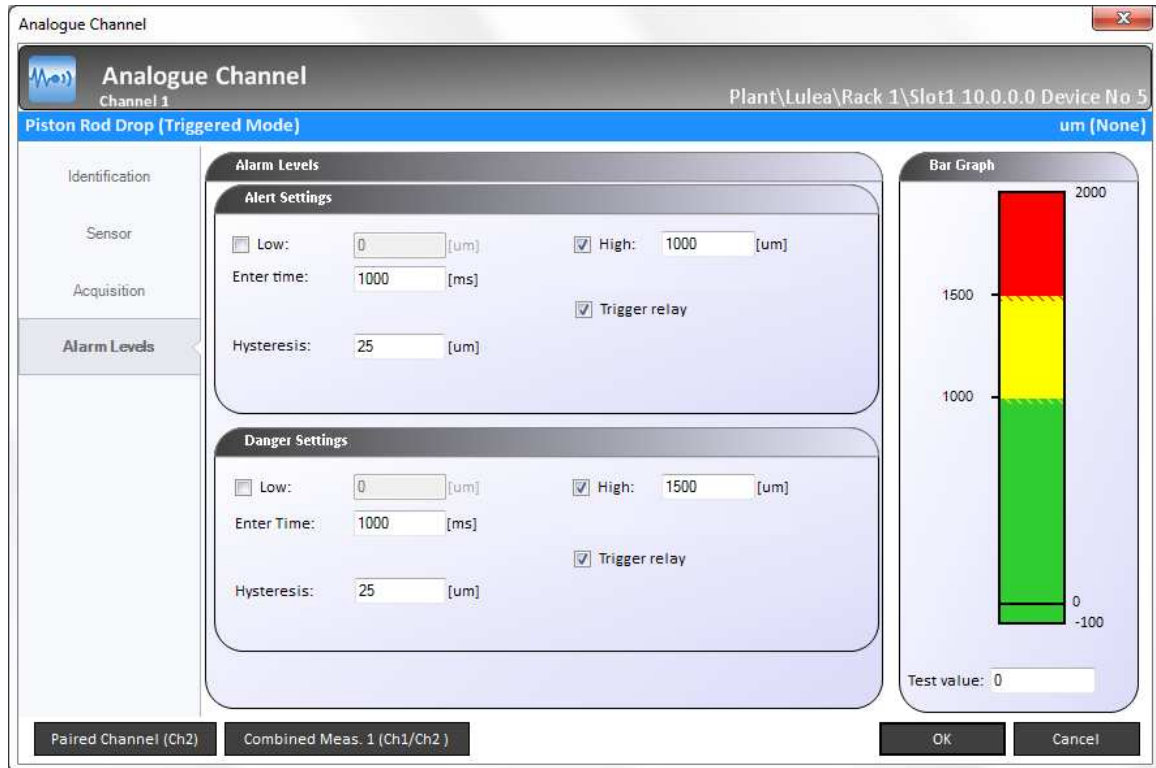


Figure 2 - 131.  
Configuring Active Alarms and Alarm Parameters for Channel 1.

For this example, once the Piston rod drop channel 1 has been configured, either Piston rod drop channel 2 or the combined measurement can be configured.

- By pressing the OK button and selecting the new measurement from the "Analog channels" or "Combined Measurements" configuration branch.
- Alternatively, by pressing the "Paired Channel (Ch2)" or the "Combined Meas 1 (Ch1/Ch2)" button (see figure above). This will save the current channel settings, and then launch a new "Analog Channel" or "Combined Measurement" dialogue.

This example continues with the clicking of "Paired Channel (Ch2)" which brings up the "Initiate Analogue Channel" dialogue box.

Initiate the analog channel two. The fields are automatically filled in with the same values as for channel one because "Use Combined Measurement" was checked during the initiation of analog channel one.

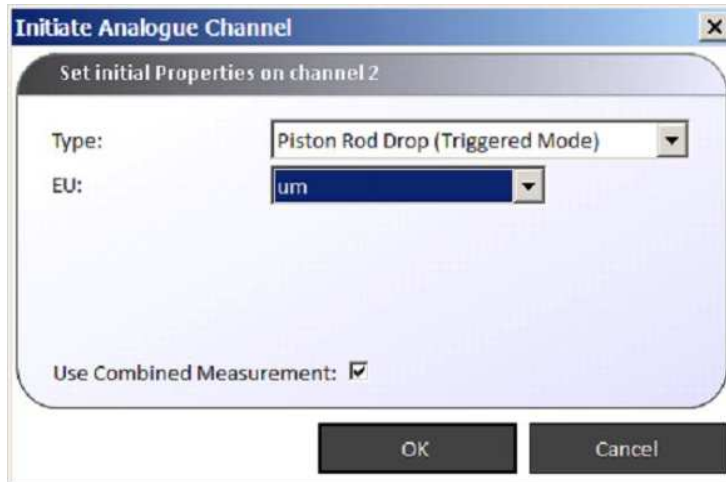


Figure 2 - 132.  
Initiating Analog Channel 2.



Figure 2 - 133.  
Parameters for Channel 2.



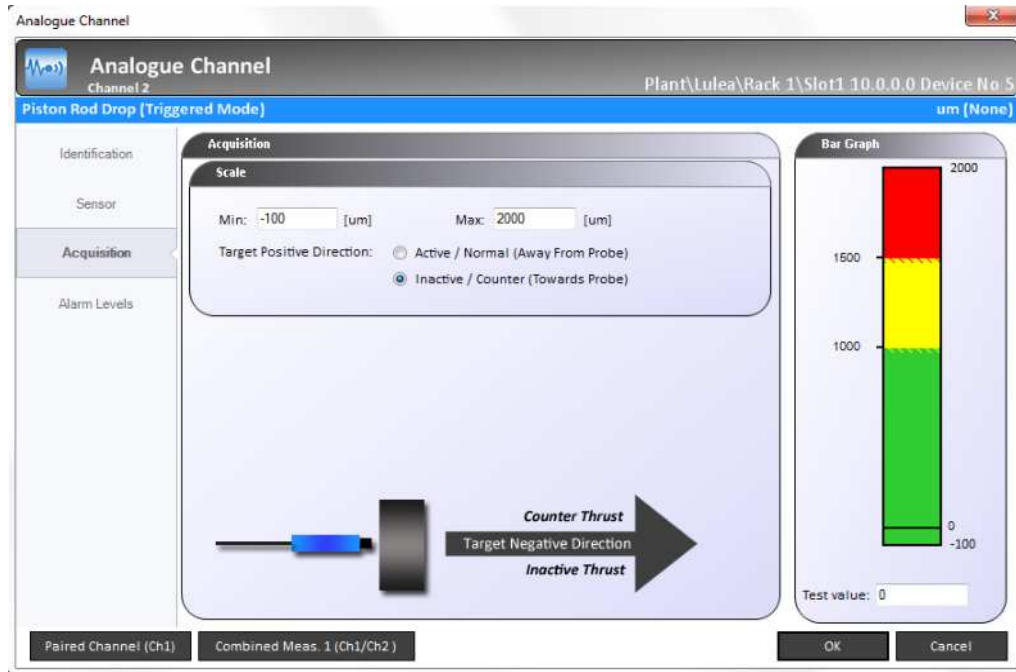


Figure 2 - 134.  
Enter Acquisition Parameters.



Figure 2 - 135.  
Configuring Active Alarms and Alarm Parameters for Channel 2.

Both of the analog channels are now configured for Piston rod drop measurements.

**Configuring a PRD Combined Measurement Channel**

To configure the combined measurement, click the “Combined Meas 1 (Ch1/Ch2)” button (see figure above). This will save the current channel settings, then launch a new “Combined Measurement” dialogue.

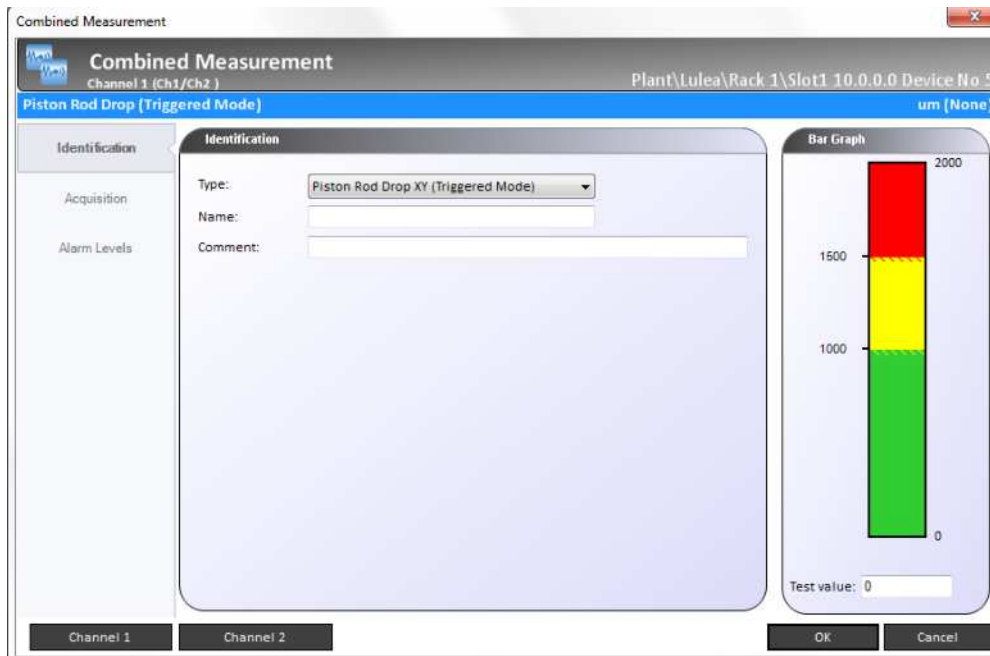


Figure 2 - 136.  
Selecting the Measurement Type for the Combined Measurement.



Figure 2 - 137.  
Acquisition Parameters for the Combined Measurement.

For alarm parameters for the combined measurement, only high alarms are available because of the underlying mathematics which only produce results equal to and greater than zero.



Figure 2 - 138.  
Alarm Parameters for the Combined Measurement.

### **Configuring a Speed Digital Channel**

To make the Piston rod drop measurement work in the selected mode the associated digital channel **MUST** be configured for speed measurement.

When a digital channel is used together with Piston rod drop the **“Pulses per rev.”** **MUST** be **“1”** and nothing else. If not **“1”** the Piston rod drop measurements will not work correctly.

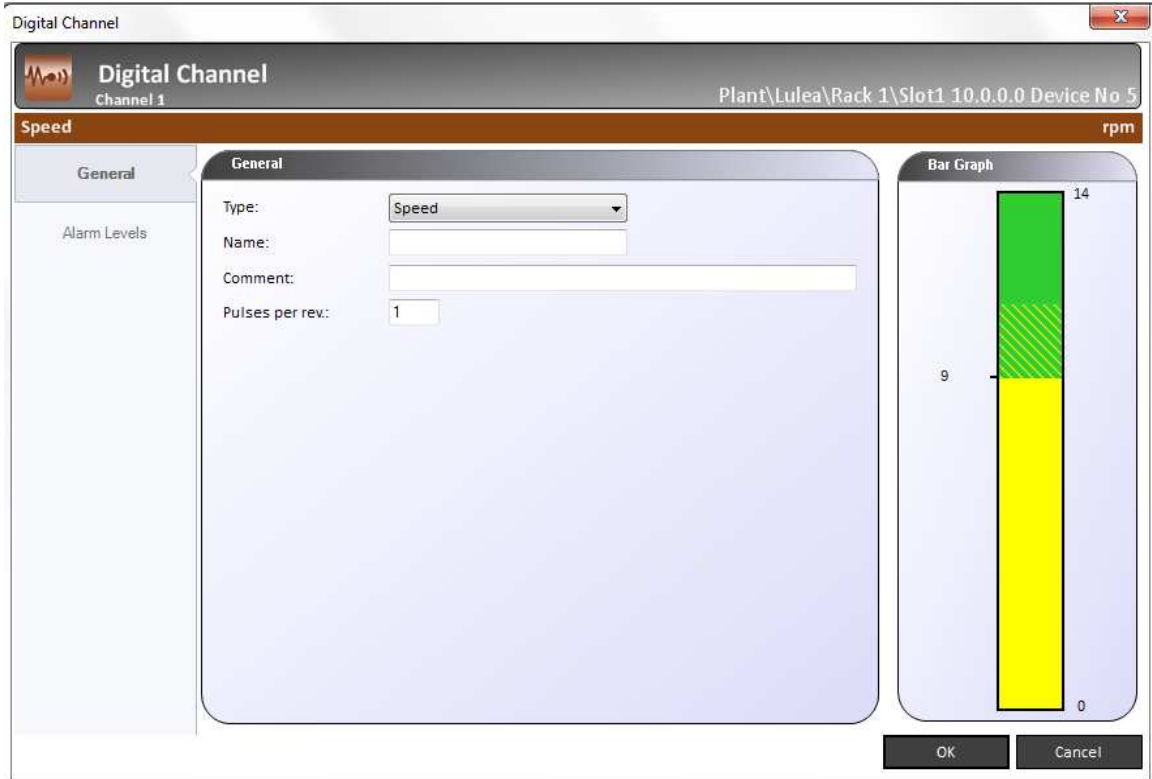


Figure 2 - 139.  
Configuring Speed Measurement for Digital Channel 1.

In order to detect if the Piston rod drop measurement inadvertently has gone into "Runout mode", possibly by a tacho sensor fault, a low speed alarm is configured to trigger when the speed stays below 10 rpm for at least 30 seconds.

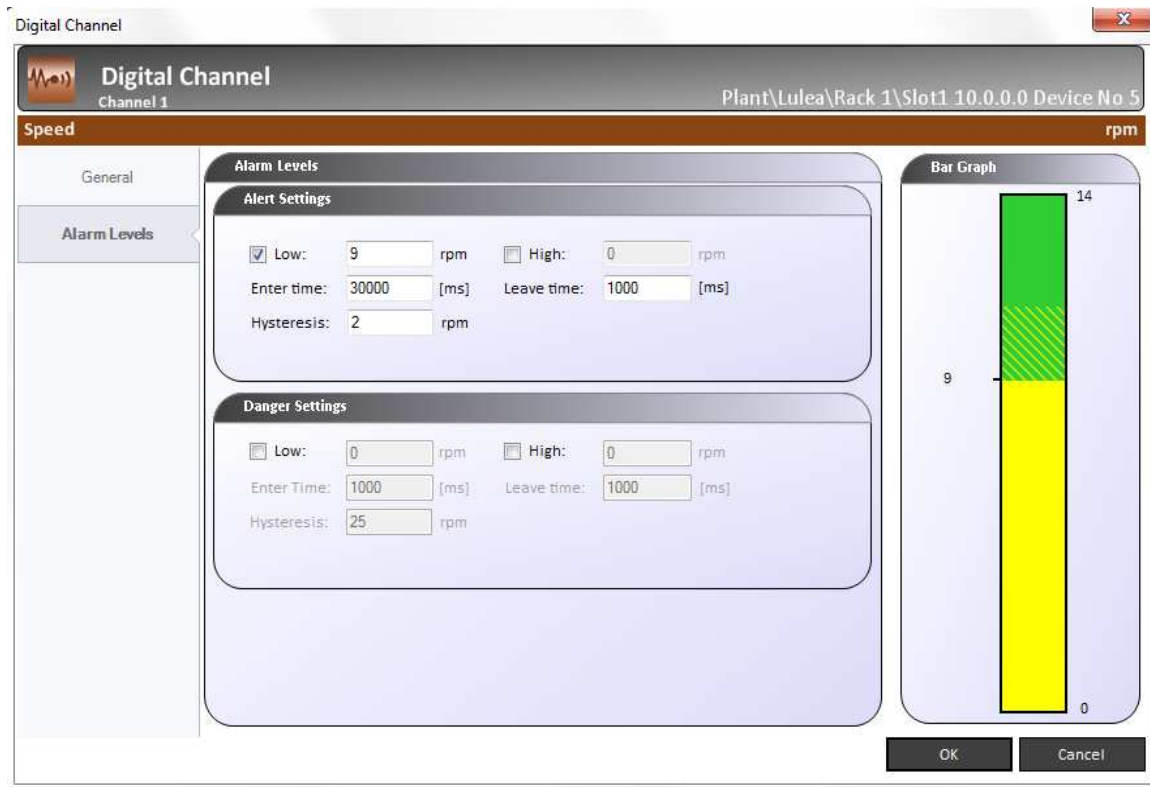


Figure 2 - 140.  
Configuring Alarms for Speed.

## GAP

### Configuring GAP Alarms

In this example, the main measurement has been configured to be a measurement of radial shaft vibration but could as well have been eccentricity.

Scenario: "During the installation of the probe the probe gap was adjusted to produce an output of about -10 volts. Measuring the output voltage with a quality precision voltmeter gives a Gap voltage of -10083 mV, which is accepted as close enough to the center of the probe linear output range."

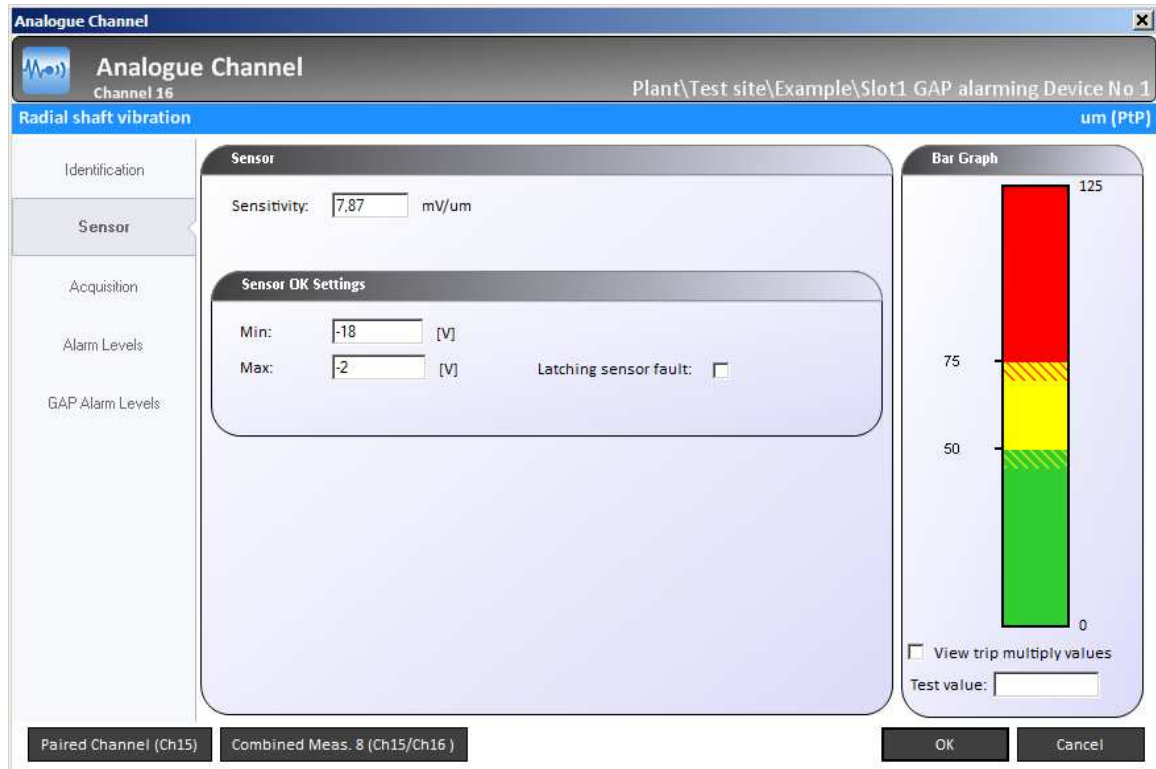


Figure 2 - 141.  
Configuring Gap Sensor.

The **Sensitivity** is set to 7.87 mV/ $\mu$ m (200 mV/mil) to match the sensor output.  
The **Sensor OK Setting** levels are configured to -18 and -2 volts, to enable usage of as much as possible of the probes linear range.

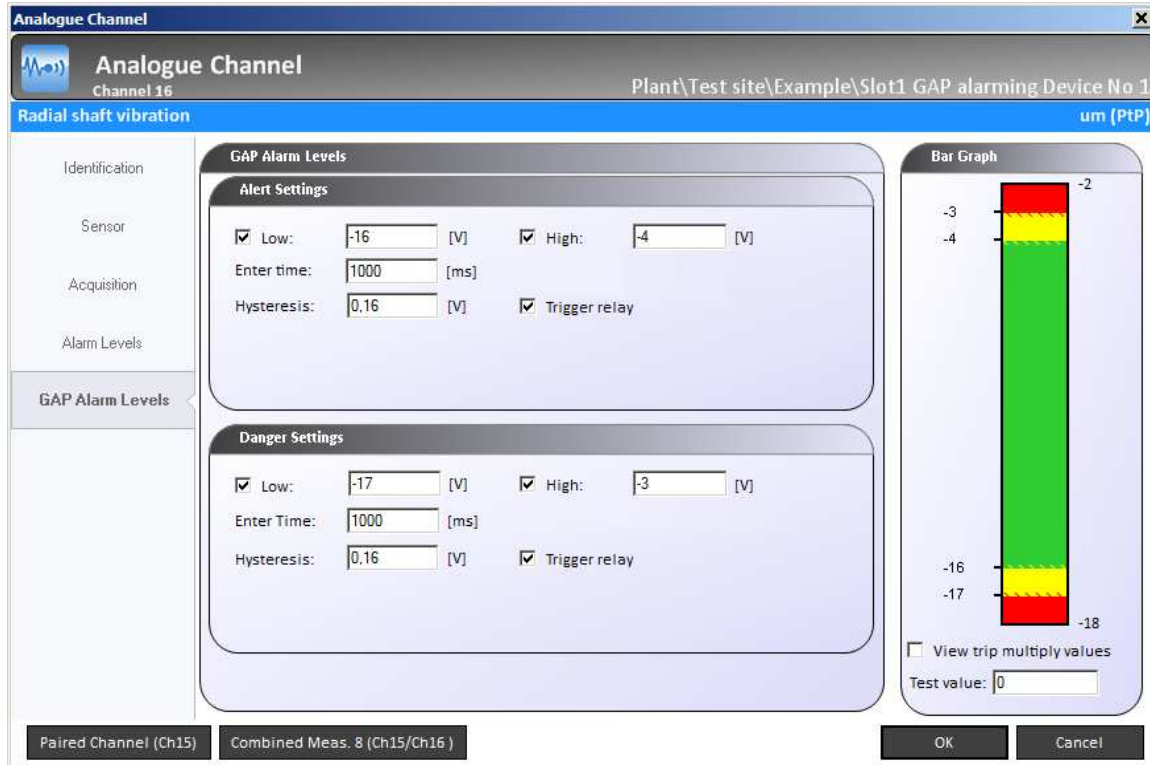


Figure 2 - 142.  
Configuring Gap Alarm Levels.

The gap alarm levels are set to:

- **Alert:** -16 and -4 volts – corresponding to a smallest probe gap of 254  $\mu\text{m}$
- **Danger:** -17 and -3 volts – corresponding to a smallest probe gap of 127  $\mu\text{m}$

The alarm **Enter time** is configured to 1 000 milliseconds in order to lessen false triggering of alarms by increasing immunity against noise.

The **Hysteresis** is set to 0.16 volts (20.3  $\mu\text{m}$ ) for both alert and danger alarms.

Both alert and danger alarms are set to **trigger relay**.

By clicking **OK** in the lower right the channel configuration is finished.

### Other

The procedure to configure an analog channel for Other measurement is explained in the form of a walk through example.

**Scenario:** There is a plant with its final outcome of a process containing waste water that are potently toxic to both environment and humans. The waste water is collected in a container which should be emptied regularly and neutralizes the toxic compounds in the water. To improve the safety, an alarm is to be installed to protect against overflowing of the container.

1. To begin the configuration of an analog channel for this kind of measurement and alarming, double click on a not configured analog channel which will open up the initiation dialog box.



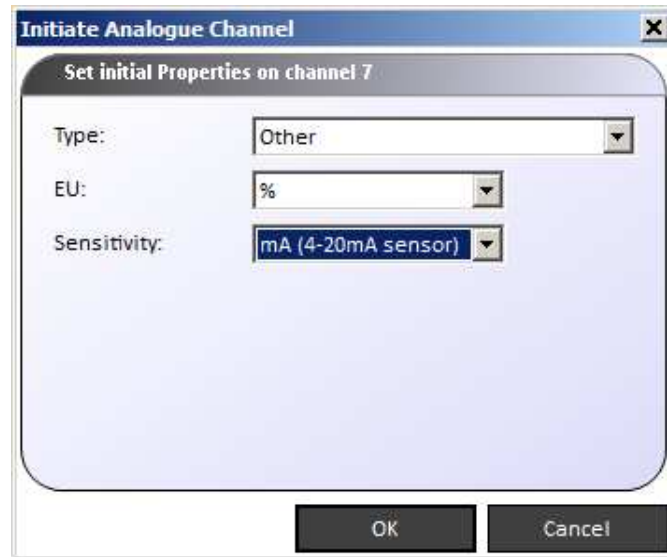


Figure 2 - 143.  
Initiating an Other Channel.

2. Set the initiation parameters as the following and press OK.
  - **Type** to Other
  - Engineering Unit (**EU**) to %
  - **Sensitivity** field to a mA (4-20 mA sensor)
  -

Note that type Other, based on a 4-20 mA sensor will require appropriate hardware configuration (DIP switch settings for 4-20 mA source), refer [Hardware Configuration](#) section.

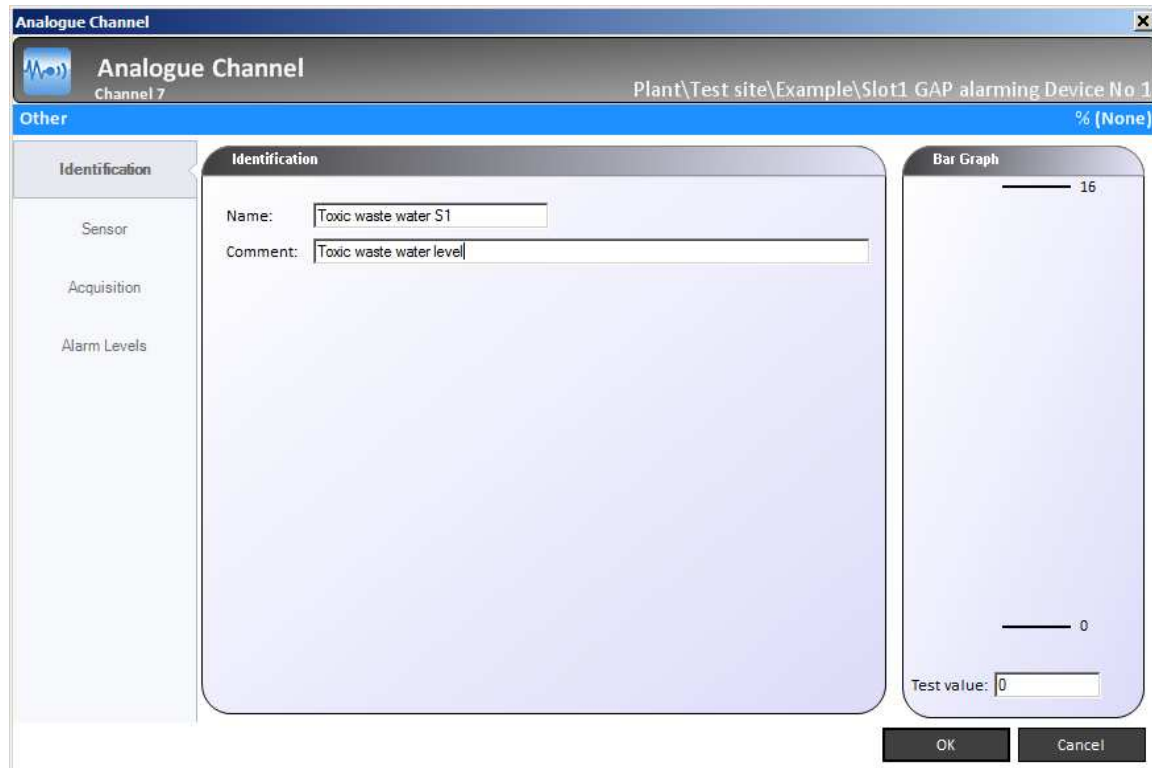


Figure 2 - 144.  
Giving a Name to the Channel Measurement.

3. Set the Identification parameters by naming the channel measurement.

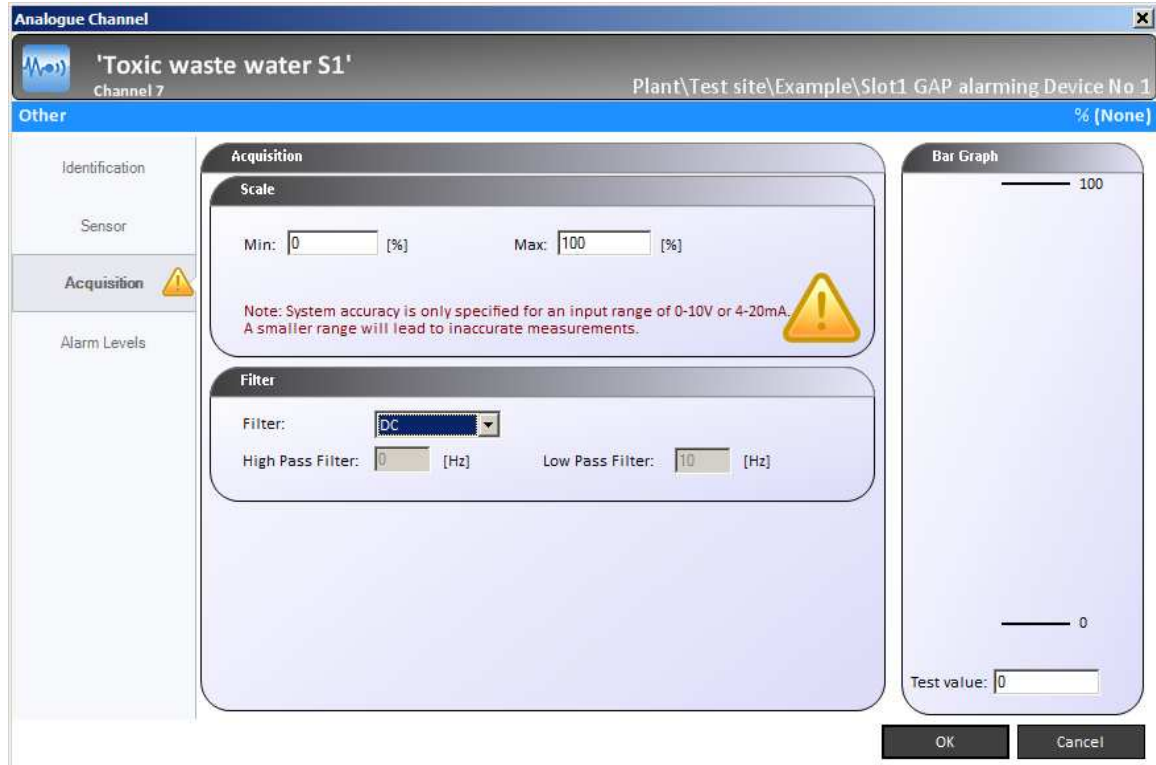


Figure 2 - 145.  
Entering Acquisition Parameters.

4. Set the acquisition parameters.
  - **Min** and **Max** scales are configured to 0% and 100%.
  - Clicking on the **Filter** selection box to select a filter shows that only the DC filter is selectable and selected.
  - It also causes a warning triangle to appear. Placing the cursor over the triangle shows a message of what is wrong. The red text in the Scale box also gives a hint of what went wrong.

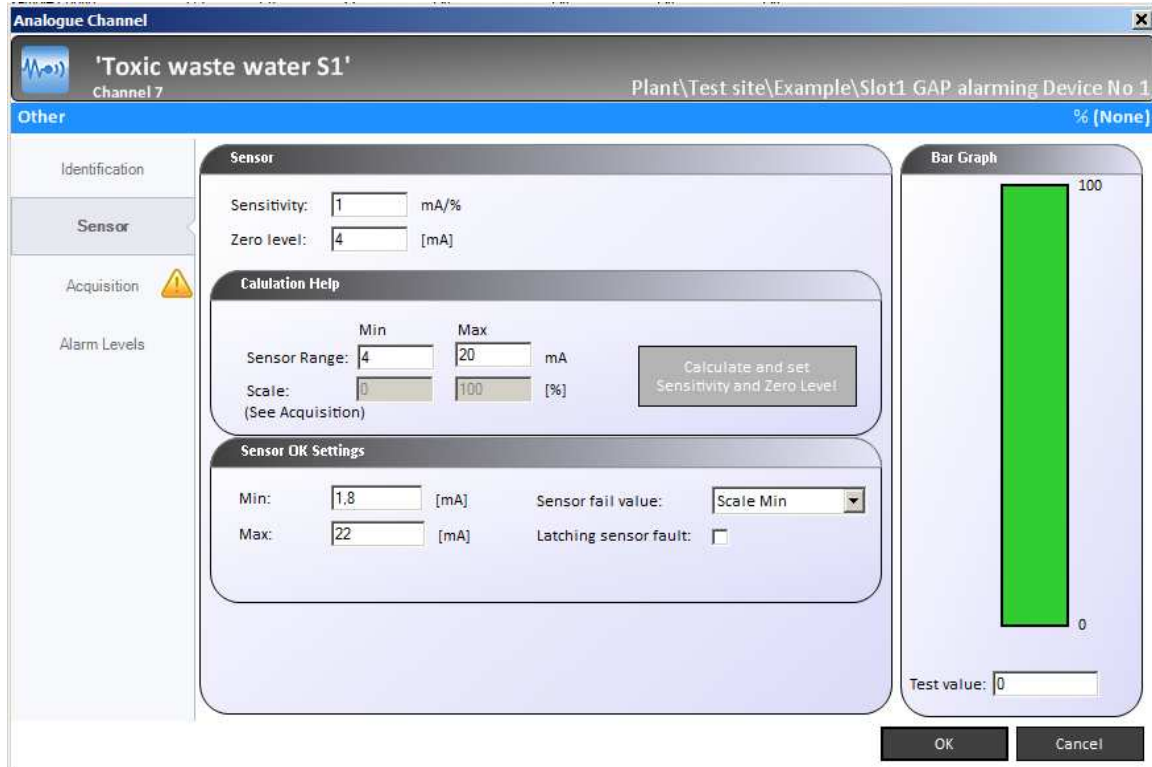


Figure 2 - 146.  
Using the Calculation Help.

5. Set the Sensor parameters.
  - Use the **Calculation Help** to calculate sensitivity and zero level to comply with the previously specified scale.

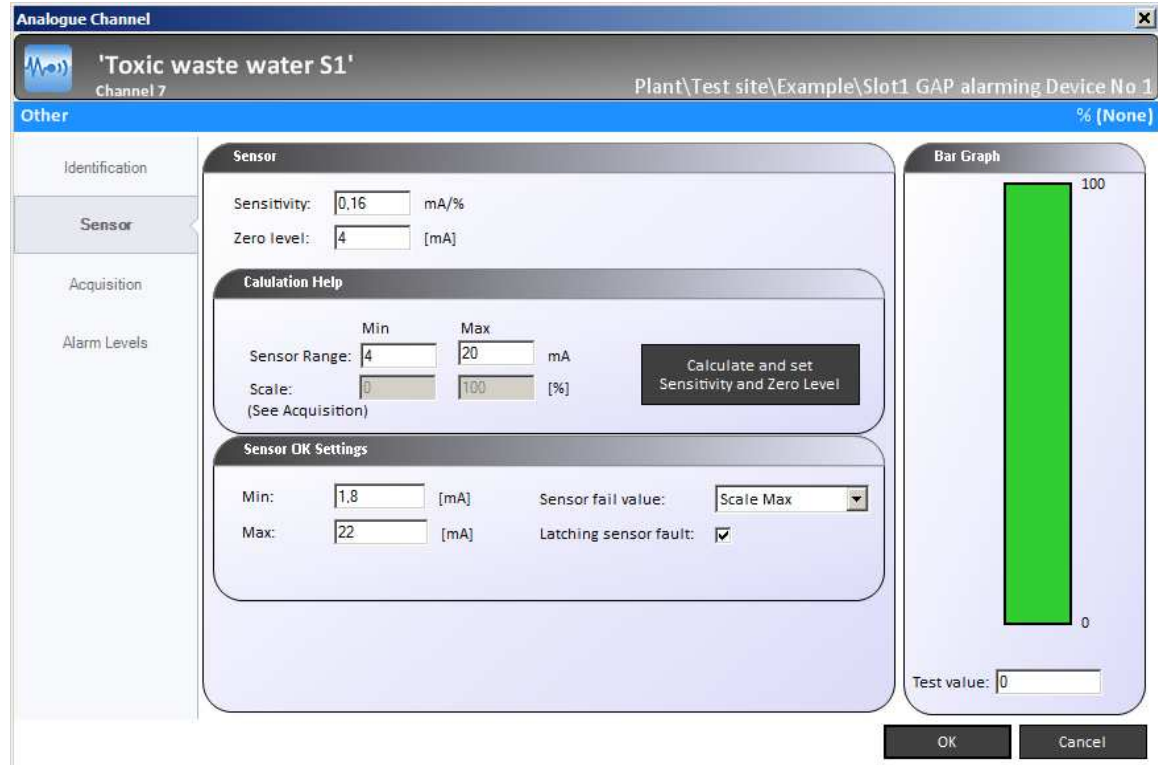


Figure 2 - 147.  
Getting the Sensor Parameters by Calculation Help.

- After pressing the button "**Calculate and set Sensitivity and Zero Level**" in the Calculation Help box, new values are automatically calculated and set for the **Sensitivity** and **Zero level**. The warning symbol disappears after the parameter values are set.
- The value of the **Sensitivity** is changed from 1 to 0.16 mA/% in order to give a reading of 0% for 4mA and 100% for 20mA.
- The **Zero level** is in this case unchanged from its default value.
- The **Sensor OK** levels are configured to 1.8 and 22 mA to give a slight margin to the sensor maximum output (20mA) and minimum output (4mA).

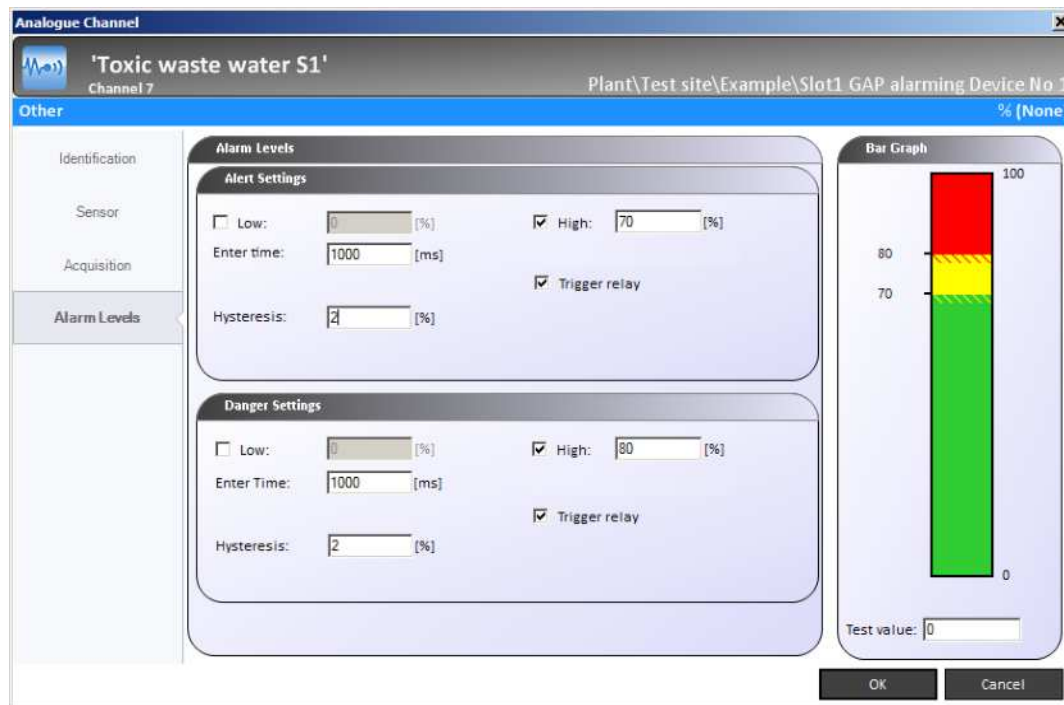


Figure 2 - 148.  
Configuring Active Alarms and Alarm Parameters for a Channel.

6. Set the Alarm Levels parameters.

Only high level alarms will be configured because it is not a problem if there is no “toxic waste water” in the container. (It is assumed that the emptying of the container works as it should as long as it is not reaching the full level.)

- The **Alert High** alarm is configured with the level set to 70%.
- **Enter time** of the Alert High are set to 1 000 ms.
- **Hysteresis** of the Alert High is set to 2%.
- **Trigger relay** of the Alert High is checked to enable relays to be drawn based on this alarm.
- A **Danger High** alarm is also configured with the level set to 80%.
- **Enter time** of the Danger High are set to 1 000 ms.
- **Hysteresis** of the Danger High is set to 2%.
- **Trigger relay** of the Danger High is also checked to enable relays to be drawn based on this alarm.

The configured alarm levels are shown in the **Bar Graph** to the right.

Green – Normal.

Yellow – Alert.

Red – Danger.

Yellow hatching on green – Alert hysteresis.

Red Hatching on yellow – Danger hysteresis.

7. By clicking **OK** in the lower right, the channel configuration is finished.

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## Modbus

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### Modbus (L1, L2) for PRM

The Modbus protocol allows for only one master, but many slaves (See [RS485 Modbus](#)). Modbus slaves respond to requests from the Modbus master.

Currently, IMx-M protection part supports Modbus slave functionality only.

A Modbus slave can export (read) or import (write single) values from Modbus registers, following requests of the Modbus master.

- Modbus frame format is RTU.
- The request is limited to maximum 57 registers per request.
- Refer to [Exported \(Read\) Modbus Registers](#) for the detailed available functions that can be read to the Modbus master. Exported Modbus registers provide all of analog, digital and combined channel measurement values and status, system status, Modbus statistics and information on protection module, firmware, IMx-M Manager and PRM configuration.
- Refer to [Imported \(Write Single\) Modbus Registers](#) for the detailed available functions that can be written from the Modbus master. Note that the imported Modbus registers are limited to command registers.

To configure RS485 Modbus L1 and L2 settings via IMx- M Manager, refer to [Modbus](#) in Assigning Protection Settings (PRM) chapter.

### Exported (Read) Modbus Registers

An IMx-M protection part Modbus slave provides channel status and has all of its measured analog and digital channels available for export at the request of the Modbus master.

### Important facts

- Only the defined registers can be accessed by an Export/Read function.
- It is not possible to read multiple register blocks where there are gaps of undefined registers in the address range between the blocks. e.g. A multiple block of register numbers from 513 to 576 cannot be read since there are gaps (undefined registers) between 529 and 560.
- Exported (Read) registers are Read-only.

### Notes on Implementation

- Modbus registers translate according to the table "Exported (Read) Modbus registers", below.
- The read function code is 0x04.

**Table 2-33: Exported (Read) Modbus Registers.**

Exported (Read) Modbus Registers				
IMx-M item	Register number <sup>(1)</sup>	Function	Data type	Min and Max
Analog Ch 1 Value	1	Value of Analog Ch 1	Signed 16 bits	-32 768 to +32 767
Analog Ch 1 Scale	2	Scale for Analog Ch 1	Unsigned 16 bits	0 to 65 535
↓	↓	↓	↓	↓
Analog Ch 16 Value	31	Value of Analog Ch 16	Signed 16 bits	-32 768 to +32 767
Analog Ch 16 Scale	32	Scale for Analog Ch 16	Unsigned 16 bits	0 to 65 535
Digital Ch 1 Value	33	rpm	Unsigned 16 bits	0 to 65 535
↓	↓	↓		
Digital Ch 8 Value	40	rpm		
Analog Ch 1 Status	41	See table <a href="#">Register "Analog Ch Status" Bit Definition</a>	16-bit mask	-
↓	↓			
Analog Ch 16 Status	56			
System Status 1	57	See table <a href="#">Register "Slot Status 1" Bit Definition</a>	16-bit mask	-
Analog Ch 1 DC-bias	58	Analog Ch 1 DC-bias [mV]	Signed 16 bits	-32 768 to +32 767
↓	↓	↓		
Analog Ch 16 DC-bias	73	Analog Ch 16 DC-bias [mV]		
Dig Ch 1 Peak RPM	74	Digital Ch 1 Peak Speed	Unsigned 16 bits	0 to 65 535
↓	↓	↓		
Dig Ch 8 Peak RPM	81	Digital Ch 8 Peak Speed		



Exported (Read) Modbus Registers				
IMx-M item	Register number <sup>(1)</sup>	Function	Data type	Min and Max
Dig Ch 1 Status	82	See table <a href="#">Register "Digital Ch Status" Bit Definition</a>	16-bit mask	-
↓	↓			
Dig Ch 8 Status	89			
RLM Slave 0 Relay Status	129	Relays 1 to 4 <sup>(6)</sup>	16-bit mask	-
↓	↓	↓		
RLM Slave 7 Relay Status	136	Relays 29 to 32 <sup>(6)</sup>		
System Status 2	257	See table <a href="#">Protection Module Circuit Faults - PRM-M</a>	16-bit mask	-
Analog Ch 1 Sensor OK Max Threshold	513	Analog Ch 1 Sensor OK max threshold <sup>(5)</sup>	Signed 16 bits	-32 768 to +32 767
↓	↓	↓		
Analog Ch 16 Sensor OK Max Threshold	528	Analog Ch 16 Sensor OK max threshold <sup>(5)</sup>		
Analog Ch 1 Sensor OK Min Threshold	561	Analog Ch 1 Sensor OK min threshold <sup>(5)</sup>	Signed 16 bits	-32 768 to +32 767
↓	↓	↓		
Analog Ch 16 Sensor OK Min Threshold	576	Analog Ch 16 Sensor OK min threshold <sup>(5)</sup>		
Modbus L1 Statistics <sup>(2)</sup>	609	Number of Short frame errors	Unsigned 16 bits	0 to 65 535 <sup>(4)</sup>
	610	Number of Long frame errors		
	611	Number of CRC errors		
	612	Number sent		
	613	Number received		
	614	Number of Rx timeout errors		
	615	Number of Uart errors		

Exported (Read) Modbus Registers				
IMx-M item	Register number <sup>(1)</sup>	Function	Data type	Min and Max
<b>Modbus L2 Statistics<sup>(2)</sup></b>	616	Number of Short frames	Unsigned 16 bits	0 to 65 535 <sup>(4)</sup>
	617	Number of Long frames		
	618	Number of CRC errors		
	619	Number sent		
	620	Number received		
	621	Number of Rx timeout		
	622	Number of Uart errors		
<b>Analog Ch 1 Alert Low</b>	657	Analog Ch 1 Alert Low threshold	Signed 16 bits	-32 768 to +32 767 (see also corresponding analog channel Alert/Danger Scale Factor)
↓	↓	↓		
<b>Analog Ch 16 Alert Low</b>	672	Analog Ch 16 Alert Low threshold		
<b>Analog Ch 1 Alert High</b>	705	Analog Ch 1 Alert High threshold	Signed 16 bits	-32 768 to +32 767 (see also corresponding analog channel Alert/Danger Scale Factor)
↓	↓	↓		
<b>Analog Ch 16 Alert High</b>	720	Analog Ch 16 Alert High threshold		
<b>Analog Ch 1 Danger Low</b>	753	Analog Ch 1 Danger Low threshold	Signed 16 bits	-32 768 to +32 767 (see also corresponding analog channel Alert/Danger Scale Factor)
↓	↓	↓		
<b>Analog Ch 16 Danger Low</b>	768	Analog Ch 16 Danger Low threshold		
<b>Analog Ch 1 Danger High</b>	801	Analog Ch 1 Danger High threshold	Signed 16 bits	-32 768 to +32 767 (see also corresponding analog channel Alert/Danger Scale Factor)
↓	↓	↓		
<b>Analog Ch 16 Danger High</b>	816	Analog Ch 16 Danger High threshold		

Exported (Read) Modbus Registers				
IMx-M item	Register number <sup>(1)</sup>	Function	Data type	Min and Max
Analog Ch 1 Alert/Danger Scale Factor	849	See table <a href="#">Analog Ch Alert/Danger Threshold Scaling Factors</a>	16-bit mask	-
↓	↓			
Analog Ch 16 Alert/Danger Scale Factor	864			
Analog Ch 1 Trip Multiply Factor	897	See table <a href="#">Analog Ch Trip Multiply Factor Definition</a>	16-bit mask	-
↓	↓			
Analog Ch 16 Trip Multiply Factor	912			
Protection Module <sup>(3)</sup>	945	Serial number MSB	Unsigned 16 bits MSB	Unsigned 32 bits (0x00000000 to 0xFFFFFFFF)
	946	Serial number LSB	Unsigned 16 bits LSB	
FW Version <sup>(3)</sup>	947	FW Version	Unsigned 16 bits	0x0000 to 0xFFFF (0 to 65 535)
CFG <sup>(3)</sup>	948	Configuration Label MSB	Two 8-bit unsigned char MSB	Four ASCII bytes (characters) <i>E.g. ABCD</i>
	949	Configuration Label LSB	Two 8-bit unsigned char LSB	
	950	Configuration version	Two 8-bit unsigned char	Two ASCII bytes (characters) <i>E.g. AB</i>
IMx-M Manager <sup>(3)</sup>	951	IMx-M Manager version MSB	Two 8-bit unsigned char MSB	Four ASCII bytes (characters) <i>E.g. ABCD</i>
	952	IMx-M Manager version LSB	Two 8-bit unsigned char LSB	
CFG CRC32 <sup>(3)</sup>	953	CFG CRC32 MSB	Unsigned 16 bits MSB	Unsigned 32 bits (0x00000000 to 0xFFFFFFFF)
	954	CFG CRC32 LSB	Unsigned 16 bits LSB	
Dig Ch 1 Alert Low	1025	Digital Ch 1 Alert Low Threshold	Unsigned 16 bits	0 to 65 535
↓	↓	↓		
Dig Ch 8 Alert Low	1032	Digital Ch 8 Alert Low Threshold		

Exported (Read) Modbus Registers				
IMx-M item	Register number(1)	Function	Data type	Min and Max
Dig Ch 1 Alert High	1033	Digital Ch 1 Alert High Threshold	Unsigned 16 bits	0 to 65 535
↓	↓	↓		
Dig Ch 8 Alert High	1040	Digital Ch 8 Alert High Threshold	Unsigned 16 bits	0 to 65 535
↓	↓	↓		
Dig Ch 1 Danger Low	1073	Digital Ch 1 Danger Low Threshold	Unsigned 16 bits	0 to 65 535
↓	↓	↓		
Dig Ch 8 Danger Low	1080	Digital Ch 8 Danger Low Threshold	Unsigned 16 bits	0 to 65 535
↓	↓	↓		
Dig Ch 1 Danger High	1081	Digital Ch 1 Danger High threshold	Unsigned 16 bits	0 to 65 535
↓	↓	↓		
Dig Ch 8 Danger High	1088	Digital Ch 8 Danger High Threshold	Signed 16 bits	-32 768 to +32 767
↓	↓	↓		
Analog Ch 1 Gap Alert Low	1121	Analog Ch 1 Gap Alert Low Threshold [mV]	Signed 16 bits	-32 768 to +32 767
↓	↓	↓		
Analog Ch 16 Gap Alert Low	1136	Analog Ch 16 Gap Alert Low Threshold [mV]	Signed 16 bits	-32 768 to +32 767
↓	↓	↓		
Analog Ch 1 Gap Alert High	1169	Analog Ch 1 Gap Alert High Threshold [mV]	Signed 16 bits	-32 768 to +32 767
↓	↓	↓		
Analog Ch 16 Gap Alert High	1184	Analog Ch 16 Gap Alert High Threshold [mV]	Signed 16 bits	-32 768 to +32 767
↓	↓	↓		
Analog Ch 1 Gap Danger Low	1217	Analog Ch 1 Gap Danger Low Threshold [mV]	Signed 16 bits	-32 768 to +32 767
↓	↓	↓		
Analog Ch 16 Gap Danger Low	1232	Analog Ch 16 Gap Danger Low Threshold [mV]		

Exported (Read) Modbus Registers				
IMx-M item	Register number(1)	Function	Data type	Min and Max
<b>Analog Ch 1 Gap Danger High</b>	1265	Analog Ch 1 Gap Danger High Threshold [mV]	Signed 16 bits	-32 768 to +32 767
↓	↓	↓		
<b>Analog Ch 16 Gap Danger High</b>	1280	Analog Ch 16 Gap Danger High Threshold [mV]		
<b>Comb 1 Alert Low</b>	1329	Combined Ch 1 Alert Low Threshold	Signed 16 bits	-32 768 to +32 767 (see also corresponding Combined ch Alert/Danger Scale Factor)
↓	↓	↓		
<b>Comb 8 Alert Low</b>	1336	Combined Ch 8 Alert Low Threshold		
<b>Comb 1 Alert High</b>	1337	Combined Ch 1 Alert High Threshold	Signed 16 bits	-32 768 to +32 767 (see also corresponding Combined ch Alert/Danger Scale Factor)
↓	↓	↓		
<b>Comb 8 Alert High</b>	1344	Combined Ch 8 Alert High Threshold		
<b>Comb 1 Danger Low</b>	1377	Combined Ch 1 Danger Low Threshold	Signed 16 bits	-32 768 to +32 767 (see also corresponding Combined ch Alert/Danger Scale Factor)
↓	↓	↓		
<b>Comb 8 Danger Low</b>	1384	Combined Ch 8 Danger Low Threshold		
<b>Comb 1 Danger High</b>	1385	Combined Ch 1 Danger High Threshold	Signed 16 bits	-32 768 to +32 767 (see also corresponding Combined ch Alert/Danger Scale Factor)
↓	↓	↓		
<b>Comb 8 Danger High</b>	1392	Combined Ch 8 Danger High Threshold		
<b>Comb 1 Trip Multiply Factor</b>	1425	See table <a href="#">Analog Ch Trip Multiply Factor Definition</a>	16-bit mask	-
↓	↓			
<b>Comb 8 Trip Multiply Factor</b>	1432			

Exported (Read) Modbus Registers				
IMx-M item	Register number(1)	Function	Data type	Min and Max
<b>Comb 1 Ch Status</b>	1433	See table <a href="#">Register "Analog Ch Status" Bit Definition</a>	16-bit mask	-
↓	↓			
<b>Comb 8 Ch Status</b>	1440			
<b>Comb 1 Ana Value 1</b>	1473	Combined Ch 1 Analog Value 1	Signed 16 bits	-32 768 to +32 767
↓	↓	↓		
<b>Comb 8 Ana Value 1</b>	1480	Combined Ch 8 Analog Value 1		
<b>Comb 1 Ana Value 2</b>	1481	Combined Ch 1 Scale	Unsigned 16 bits	0 to 65 535
↓	↓	↓		
<b>Comb 8 Ana Value 2</b>	1488	Combined Ch 8 Scale		
<b>Comb 1 Alert/Danger Scale Factor</b>	1521	See table <a href="#">Analog Ch Alert/Danger Threshold Scaling Factors</a>	16-bit mask	-
↓	↓			
<b>Comb 8 Alert/Danger Scale Factor</b>	1528			
<b>Analog Ch 1 Alarm enable/disable info</b>	1585	See table <a href="#">Register "Analog Ch Alarm Enable/Disable" Bit Definition</a>	16-bit mask	-
↓	↓			
<b>Analog Ch 16 Alarm enable/disable info</b>	1600			

Exported (Read) Modbus Registers				
IMx-M item	Register number <sup>(1)</sup>	Function	Data type	Min and Max
Comb Ch 1 Alarm enable/disable info	1633	See table <a href="#">Register "Combined Ch Alarm Enable/Disable" Bit Definition</a>	16-bit mask	-
↓	↓			
Comb Ch 8 Alarm enable/disable info	1640			
Gap Ch 1 Alarm enable/disable info	1681	See table <a href="#">Register "Analog Ch Alarm Enable/Disable" Bit Definition</a>	16-bit mask	-
↓	↓			
Gap Ch 16 Alarm enable/disable info	1696			
Digital Ch 1 Alarm enable/disable info	1729	See table <a href="#">Register "Digital Ch Alarm Enable/Disable" Bit Definition</a>	16-bit mask	-
↓	↓			
Digital Ch 8 Alarm enable/disable info	1736			

(1) Modbus register number 1 is equivalent to Modbus address 0x0000.

(2) Registers 609 to 622 must be read as one block, all at one single request.

(3) Registers 945 to 954 must be read as one block, all at one single request.

(4) For registers 609 to 622 when counter reaches its maximum value (65 535), the next incremental max value will cause the counter to wrap to zero.

(5) For registers 513 to 576 (Analog Sensor OK Max/Min) presented value is in mV except when measurement type is configured as **Temperature**. For Temperature measurement, sensor OK limit is either in °C or °F presented with one decimal. (Value is 10 times bigger than real value since last digit is the decimal value.)

(6) Each relay status register (129-136) contains in the lowest 4-bits the status of the 4 relays controlled by that RLM slave. Bit set means the relay is active (in its alarm state). It does not directly indicate the state of the relay (energized or not). Bits 4-15 are not used.

Example:

Register 130 returns 0x0001

Relay 5 is activated, relays 6-8 are not.

MSB = Most Significant Bits

LSB = Least Significant Bits

Register "Slot Status 1" Bit Definition



**Important - System status 1 (register 57) must be evaluated continuously to ensure the validity of Modbus data.**

Table 2-34: Register "Slot status 1" bit definition.

Register "Slot Status 1" Bit Definition	
Bit representation*	Description
(0x0000) (No bit set)	Slot armed
0x0001	Slot disarmed 1 = Slot is disarmed 0 = Slot is armed
0x0002	Slot circuit fault 1 = Slot has circuit faults detected 0 = Slot has no circuit faults detected
0x0004	Slot internal communication error 1 = Modbus data is not valid <sup>(1)</sup> 0 = Modbus data is valid

(1) Bit is triggered by the following Circuit Fault bits on any of the PRM slaves - CF\_RS485INT, CF\_CFG\_MISMATCH, CF\_CONFIG

**\*Important:**

- Bit representation is in hexadecimal digits.
- Bit representation can be a combination of more than one condition.

*Example:*

*Bit representation of 0x0006 is equal to*

*0x0002 System status - Slot circuit fault +*

*0x0004 System status - Slot internal communication error*

*Refer to [Bit Representation of Combined Conditions](#) for combined conditions.*



**Register "Analog Ch Status" Bit Definition**

**Table 2-35: Register "Analog ch status" bit definition (TRUE=1).**

Register "Analog Ch Status" Bit Definition	
Bit representation*	Description
(0x0000) (No bit set)	Ch not configured.
0x0001	Ch enabled
0x0002	Ch alert
0x0004	Ch startup
0x0008	Ch danger
0x0010	Ch danger first out slot
0x0020	Ch circuit fault. <b>Note:</b> Ch circuit fault overrides all other status. For CDE combined measurement: if both corresponding channels X and Y are in ch circuit faults, the CDE combined measurement will be in ch circuit fault. For other types of combined measurements: if a corresponding channel X or channel Y is in ch circuit fault, the combined measurement will be in ch circuit fault.
0x0040	Ch disarmed For all types of combined measurements: if a corresponding channel X or channel Y is in channel disarm, then the combined measurement will be set to channel disarm.
0x0080	Slot disarmed For all types of combined measurements: if corresponding channels X and Y are in slot disarm, then the combined measurement will be set to slot disarm.
0x0100	Trip multiply
0x0200	Ch is a part of CDE setup but not used for the moment
0x0400	Ch danger first out of rack
0x0800	Ch Gap alert
0x1000	Ch Gap danger

**\*Important:**

- Bit representation is in hexadecimal digits.
- Bit representation can be a combination of more than one condition.

*Example:*

*Bit representation of 0x016A is equal to 0x0002 Ch alert +  
0x0008 Ch danger +  
0x0020 Ch circuit fault +  
0x0040 Ch disarmed +  
0x0100 Trip multiply*

*Refer to [Bit Representation of Combined Conditions](#) for combined conditions.*

### Analog Ch Alert/Danger Threshold Scaling Factors

Table 2-36: Bit coding of alert/danger threshold scaling factors

Analog/Combined Ch Alert/Danger Threshold Scaling Factors	
Bit 7-6	Scale factor for Low Alert threshold
Bit 5-4	Scale factor for High Alert threshold
Bit 3-2	Scale factor for Low Danger threshold
Bit 1-0	Scale factor for High Danger threshold

*00 = Not scaled (value in alarm register is multiplied by 1)*

*01 = Value in alarm registers has been multiplied by 10*

*10 = Value in alarm register has been multiplied by 100*

*11 = Value in alarm register has been multiplied by 1000*

*Example:*

*Bit 4 is 1 and bit 5 is 0, so this means the High Alert threshold value has been multiplied by 10, for transfer.*

*The value transferred in the register is read as 125 so taking into account the scaling factor applied, the actual threshold value is  $125/10 = 12.5$*

### Analog Ch Trip Multiply Factor Definition

Table 2-37: Analog ch trip multiply factor definition.

Analog Ch Trip Multiply Factor Definition	
High byte	used for Danger Trip Multiply
Low byte	used for Alert Trip Multiply
Value representation: Value (between 10 and 250) is represented with one decimal, therefore 10 = 1.0 and 250 = 25.0.	

**Register "Analog Ch Alarm Enable/Disable" Bit Definition****Table 2-38: Register "Analog ch alarm enable/disable" bit definition (TRUE=1).**

Register "Analog Ch Alarm Enable/Disable" Bit Definition	
Bit representation*	Description
(0x0000) (No bit set)	Alarm Disabled
0x0001	Alert Low
0x0002	Alert High
0x0004	Danger Low
0x0008	Danger High
0x0010	N/A
0x0020	N/A
0x0040	N/A
0x0080	N/A

**\*Important:**

- Bit representation is in hexadecimal digits.
- Bit representation can be a combination of more than one condition.

**Analog Ch Values**

Both Value 1 and Value 2 of each analog channel are used to get the total value of that analog channel.

Value 1 keeps the measured value of the analog channel, relative to the scale in Value 2.

Max of Value 1 (32 767) is equal to the scale value in Value 2.

Analog channel value = (Value 1 / 32 767) \* Value 2

Example 1:

Value 1 = -23 920

Value 2 = 10

Total value of that channel is then  $-23\,920 / 32\,767 * 10 = -7,3$

Example 2:

Value 1 = 10 000

Value 2 = 5 000

Total value of that channel is then  $10\,000 / 32\,767 * 5\,000 = 1\,526$

### Register "Digital Ch Status" Bit Definition

Table 2-39: Register "Digital ch status" bit definition (TRUE=1).

Register "Digital Ch Status" Bit Definition	
Bit representation*	Description
(0x0000) (No bit set)	Ch not configured.
0x0001	Ch enabled
0x0002	Ch alert
0x0004	Ch startup
0x0008	Ch danger
0x0040	Ch disarmed
0x0080	Slot disarmed

**\*Important:**

- Bit representation is in hexadecimal digits.

- Bit representation can be a combination of more than one condition.

Example: Bit representation of 0x004A is equal to 0x0002 Ch alert +  
0x0008 Ch danger +  
0x0040 Ch disarmed

Refer to [Bit Representation of Combined Conditions](#) for combined conditions.

### Register "Digital Ch Alarm Enable/Disable" Bit Definition

Table 2-40: Register "Digital ch Alarm enable/disable" bit definition (TRUE=1).

Register "Digital Ch Alarm Enable/Disable" Bit Definition	
Bit representation*	Description
(0x0000) (No bit set)	Alarm Disabled
0x0001	Alert Low
0x0002	Alert High
0x0004	Danger Low
0x0008	Danger High

**\*Important:**

- Bit representation is in hexadecimal digits.

- Bit representation can be a combination of more than one condition.

### Digital Ch Values

When a digital channel is set up for speed measurement, the Modbus register value is shown in rpm.

### Register "Combined Ch Alarm Enable/Disable" Bit Definition

Table 2-41: Register "Combined ch Alarm enable/disable" bit definition (TRUE=1).

Register "Combined Ch Alarm Enable/Disable" Bit Definition	
Bit representation*	Description
(0x0000) <b>(No bit set)</b>	Alarm Disabled
0x0001	Alert Low
0x0002	Alert High
0x0004	Danger Low
0x0008	Danger High
0x0010	Ch A Alert Trigger Relay (n/a for Ch B)
0x0020	Ch A Danger Trigger Relay (n/a for Ch B)
0x0040	Ch B Alert Trigger Relay (n/a for Ch A)
0x0080	Ch B Danger Trigger Relay (n/a for Ch A)

**\*Important:**

- Bit representation is in hexadecimal digits.

- Bit representation can be a combination of more than one condition.

Example: Bit representation of 0x006A is equal to

0x0002 Alert low +

0x0008 Danger high +

0x0020 Ch A Danger trigger relay +

0x0040 Ch B Alert trigger relay

Refer to [Bit Representation of Combined Conditions](#) for combined conditions.

### Imported (Write Single) Modbus Registers

An IMx-M protection part Modbus slave has registers that can be written from the Modbus master.

#### Notes on Implementation

- Modbus registers translate according to the table below.
- The write single function code is 0x06.
- The read function code is 0x03 (for registers with read/write access).

**Table 2-42: Imported (write single) Modbus registers.**

Imported (Write Single) Modbus Registers			
Register number <sup>(1)</sup>	Access	Function	Definition
257	Write-only	Set disarm slot (same as register 264)	1 = disarm 0 = arm
258	Read-Write <sup>(5)</sup>	Set disarm analog ch 1 to 16 <sup>(2)</sup>	MSB = Ch 16, LSB = Ch 1 1 = disarm 0 = arm
259	Read-Write <sup>(5)</sup>	Set trip multiply slot <sup>(6)</sup>	1 = enable slot TM 0 = disable slot TM
260	Read-Write <sup>(5)</sup>	Set trip multiply analog ch 1 to 16 <sup>(2)</sup>	MSB = Ch 16, LSB = Ch 1 1 = TM active 0 = TM not active
261	Read-Write <sup>(5)</sup>	Set latching reset <sup>(4)</sup>	1 = reset latching alarms / relays 0 = do nothing
262	Read-Write <sup>(5)</sup>	Set disarm digital ch 1 to 8 <sup>(3)</sup>	Bit 7 = Ch 8, LSB (Bit 0) = Ch 1 1 = disarm 0 = arm
263	Read-Write <sup>(5)</sup>	Set digital peak (slot) reset <sup>(4)</sup>	1 = reset digital peak 0 = do nothing
264	Read-Write <sup>(5)</sup>	Set disarm slot (same as register 257)	1 = disarm 0 = arm
265	Read-Write <sup>(5)</sup>	Reset latched Sensor Faults and/or latched relays on an individual PRM/RLM slave MCU, level <sup>(4)</sup> (7).	Bits 7 to 0 (latched sensor faults) <ul style="list-style-type: none"> <li>• MSB (bit 7) = Ch 15 and 16,</li> <li>• LSB (bit 0) = Ch 1 and 2</li> </ul> Bits 15 to 8 (latched relays) <ul style="list-style-type: none"> <li>• MSB (bit 15) = Relay 29 to 32,</li> <li>• LSB (bit 8) = Relay 1 to 4</li> </ul> 1 = reset latching faults / relays 0 = do nothing

<sup>(1)</sup> Modbus register number 1 is equivalent to Modbus address 0x0000.

- (2) All 16 analog channels are handled in a single write.
- (3) All 8 digital channels are handled in a single write.
- (4) This value is NOT written permanently in the register. One write = one reset.
- (5) A read of a register will get the previous written value by Modbus. It will not reflect the current system status or whether the command was executed or not.
- (6) Slot TM will activate/deactivate channel TM status
- (7) Causes a 1 s reset pulse which will be extended by 1 s if another reset instruction is received within that time frame.

MSB = Most significant bits

LSB = Least significant bits

### **Modbus (L3) for CMM**

Modbus (L3) has no function (engineering and manufacturing use only).





# Condition Monitoring

## Condition Monitoring Part Operation

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For Observer clients, refer to @ptitude Observer User Manual (Document Part Number 32170900).

## Condition Monitoring Data Analysis

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For Observer clients, refer to @ptitude Observer User Manual (Document Part Number 32170900).

The condition monitoring results are stored in the @ptitude Observer.

Results from the IMx-M rack are further processed by @ptitude Observer machine diagnostics into machine condition results such as trends and clear text messages showing machinery faults detected.

These results can be easily accessed using the @ptitude Observer software. The @ptitude Observer database is a Microsoft SQL Server database with open access which gives customer specific solutions the opportunity to read any of the data that is stored. Also, it is possible to exchange data via an OPC Server.

## IMx-M Time

---

Each IMx-M condition monitoring module has a backup power capacitor which keeps the time for at least a month in case IMx-M was disconnected from a power inlet.

To correct or set IMx-M CMM time, use one of the following methods.

### Automatic Time Synchronization

This method is preferable since IMx-M CMM will continuously synchronize the time with the computer that has @ptitude Observer Monitor running.

In order to synchronize time, IMx-M CMM uses NTP protocol which resides in Windows as a built-in function for NTP time synchronization.

In order to activate time synchronization, follow the steps below.

Note that these steps are needed only on the computer where the @ptitude Observer Monitor is running.

1. Open Port 123 in the Firewall. This is done a bit differently depending on the operating system and eventually external firewall.
2. Go to Services and check that "Windows Time" service start-up method is set to "Automatic" and is started.

3. Double click on the file called "EnableTimeSync.reg" in the Observer DVD. This will enter information in the registry to enable the time synchronization service on the computer.
4. Stop and start "Windows Time" service to have this change take effect.
5. IMx-M CMM will synchronize the time continuously every 1 000 seconds.
  - The IMx-M CMM will synchronize its time directly after a restart or power up.

### **Manual Set Time**

Use "Set time" function in SKF @ptitude Observer application. The function is found at a tab menu called "On-line", then "IMx units/MasCon" interface.

## Installation

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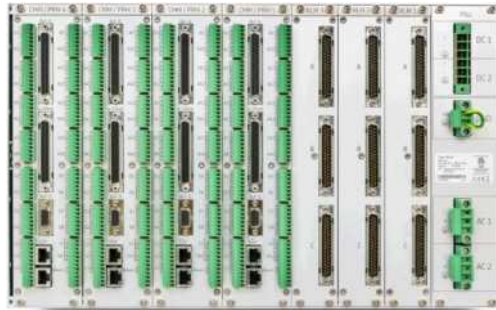


Figure 4 - 1.  
IMx-M Rear Panel.

The installation of an IMx-M rack must be carried out according to the instructions and advice given in this manual. Any deviation from these directions can be made only after consulting SKF Condition Monitoring Center Luleå.

Installation errors can lead to a situation where the system does not work as intended and machinery faults go undetected. Therefore, contact the IMx-M application engineer at the slightest doubt during the installation.

***Important - Installation errors which require the involvement of SKF Condition Monitoring Center Luleå personnel in order to rectify the start of the system, might be debited.***

### Scenario

It is important to assess and evaluate the site where the system is to be installed.

Before beginning the installation, draw a plan of what the installation should look like after the completion. Among other things, consider lengths of cables, where can electrical power to the IMx-M racks be connected, where should the @plitude Observer Monitor be installed and positioned and who should analyze the data measured. Good and thorough planning is the basis for a successful solution and installation.

Make a detailed layout of the equipment, the network, and distances between components. Include specifically the IMx-M rack(s), the @plitude Observer Monitor computer, the database server computer and all hubs/routers in the network. Specify network configuration of each components, such as IP addresses and subnet masks. SKF application engineers and service engineers need these information in order to assist.

### Rack / Cabinet

An IMx-M rack contains circuit boards that are static sensitive. Therefore, use appropriate precautions to prevent Electrostatic Discharge (ESD) when handling circuit boards.

The following are some of the ways to prevent ESD:

- Use an ESD wrist strap when handling circuit boards
- Use a grounding mat when handling circuit boards
- Use correct packaging materials such as antistatic bags when transferring circuit boards

The IMx-M rack shall be mounted inside a cabinet at a location where it is not exposed to unnecessary radiant heat or strong magnetic fields.

Mount the IMx-M rack and make sure that it is firmly attached.

The ambient temperature is found in [Environmental](#) within Technical Data.



**Important - IMx-M rack contains circuit boards that are static sensitive. Therefore, use appropriate precautions (examples above) to prevent ESD when handling circuit boards.**



**Important - Different types of modules must be positioned correctly in the rack. The positions of the different types of modules are shown in [Front Panel](#) in Drawings and Connections chapter.**



**Important - A condition monitoring module (CMM) and a protection module (PRM) must be installed as a pair in order to ensure the internal power redundancy.**



**Important - Due to the physical reason, when mounting a pair of CMM and PRM, must always mount the PRM before the CMM in order to avoid any damages to the PRM. However, when dismantling a pair of CMM and PRM, it must be the other way around. Due to the physical reason, must always dismantle the CMM before the PRM. Otherwise, the PRM can be seriously damaged.**



**Important - An IMx-M rack must be situated in a cabinet with a metal bottom or plastic bottom with flammability classification of at least V-1. The cabinet must fulfill at least IP 20.**



**Important** - Each IMx-M rack must be equipped with a forced ventilation which has a feed of at least 3 x 95 m<sup>3</sup>/h (unrestricted airflow). The rack environment temperature shall be kept as low as possible, ideally below 30 °C / 86 °F. The cooling fan must be UL or CSA approved.

## Cooling



**Important** - Each IMx-M rack must be equipped with a forced ventilation which has a feed of at least 3 x 95 m<sup>3</sup>/h (unrestricted airflow). The rack environment temperature shall be kept as low as possible, ideally below 30 °C / 86 °F. The cooling fan must be UL or CSA approved.



**Important** - Each IMx-M rack must always have a working fan solution to avoid overheating, even in lower ambient temperatures. Make sure to use the embedded fan trays monitoring and alarm functionality to detect and quickly resolve a potential fan breakdown to avoid system damage.



**Important** - Overall system reliability and mean time between failure (MTBF) is greatly affected by the operating temperature, thus it is recommended to maintain as low operating and rack environment temperatures as possible.

IMx-M is designed to operate in a maximum temperature of 65 °C / 149 °F. However, operating IMx-M at this temperature shall be avoided as it will drastically shorten the lifetime of all components.

Internal rack temperature is monitored and registered via Event Log. If the rack is operated above 65 °C / 149 °F, the warranty will be voided.

It is recommended to use two power supply units always, not only for redundancy but also to reduce the stress/temperature on each module and hence maximize the MTBF for the power supply units.

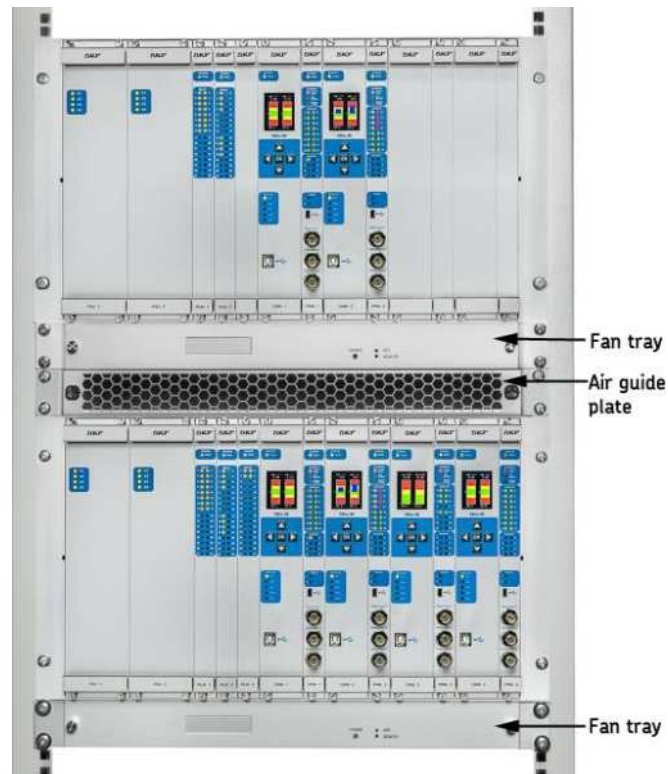


Figure 4 - 2.  
A 19" Cabinet Installed with Two IMx-M Racks and Cooling Devices.

The following diagram shows two IMx-M racks installed in a 19" cabinet with two fan trays (one for each rack) and an air guide plate showing diverted airflow.

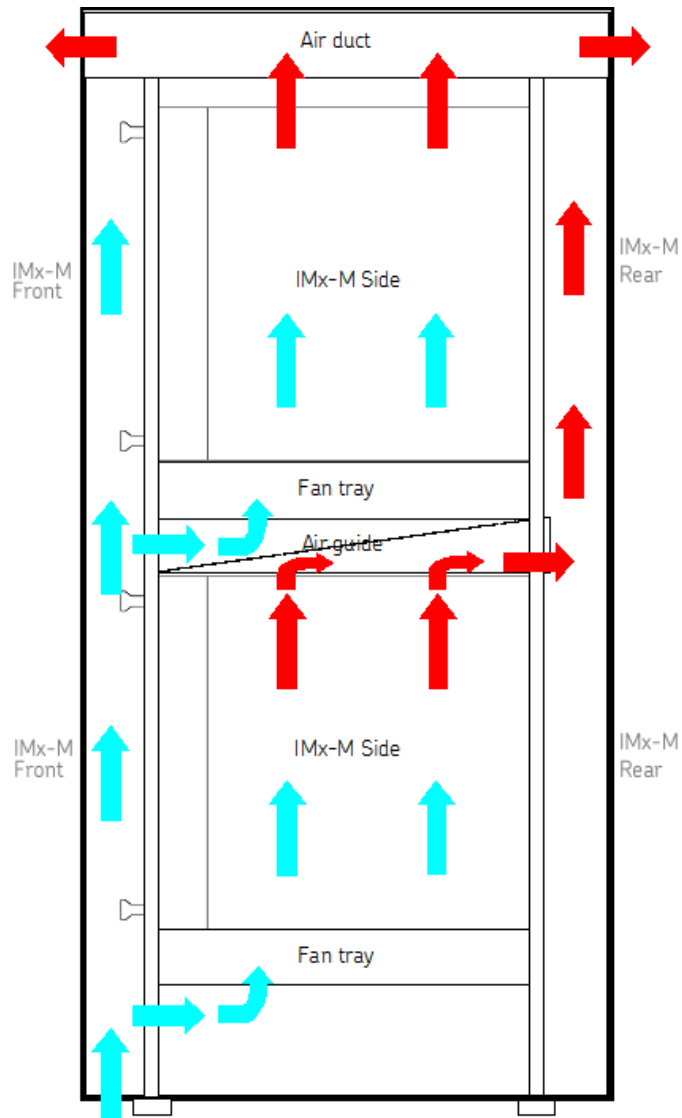


Figure 4 - 3.  
Illustration of Desired Diverted Airflow.

One fan tray and an air guide plate shall be mounted for each IMx-M rack:

- The fan tray must be mounted directly below each IMx-M rack.
- The air guide plate must be mounted directly above each IMx-M rack.

The following cooling components are recommended:

- Fan tray, article number: Rittal 3352.500
- Guide frame, article number: Rittal 3357.100
- Air guide plate, article number: Schroff 10713-144

When using the fan tray, the maximum allowed ambient operating temperature shall be 55 °C (131 °F) under normal operating conditions

- Normal operating conditions are defined as all channels are loaded with 17 mA each. For higher loads the maximum allowed ambient temperature must be lowered.



**Important: If CMM + PRM slot 4 is to be used, the maximum allowed ambient temperature must not exceed 45 °C (113 °F).**

For assembly and installation instructions of the fan tray, refer to the supplier's documentation. It is important to ensure that the cables are secured in a proper way to relieve the pressure from connectors.

The fan tray must be inspected regularly and clean any air intake filters for optimal performance to ensure proper ventilation.

### General Electrical Interface



**Important - All wires and cables connected to input and output terminals shall have a flammability rating VW-1, FT-1 or fulfill the requirements according to IEC 60332-1-2 or IEC 60332-2-2.**

### Sensor Cables

When routing a sensor cable, it is important that the cable is firmly fixed. The cable should never be allowed to vibrate or oscillate, since this affects the capacitance of the cable, and thereby the measurement result.

The sensor cable may not be routed or bundled together with supply cables since doing so can generate strong magnetic fields.

To connect the IMx-M rack to sensors, the following cable type is recommended:

- Shielded, twisted pair 2 x 2 x 0,5 mm<sup>2</sup> (FKAR-PG 2 x 2 x 0,50, DUE 4002 or corresponding)
- Cable type shall have a flammability rating VW-1, FT-1 or fulfill the requirements according to IEC 60332-1-2 or IEC 60332-2-2.



**Important - In general, all sensor cables must be routed as far away as possible from the high voltage cables. If this cannot be done, care should be taken to use high quality shielded cables.**

### Supply Cable


To connect an IMx-M rack to 230 V AC or 110 V AC, use the following:

- FKLK 3 x 1,5 mm<sup>2</sup> or EKLK 3 x 1,5 mm<sup>2</sup> or corresponding, with minimum voltage requirement 300 V and minimum temperature -40 °C.
- Cable type shall have a flammability rating VW-1, FT-1 or fulfill the requirements according to IEC 60332-1-2 or IEC 60332-2-2.
- Supply cable shall be protected by a 10A D-type fuse.



- Appropriate, clearly marked, all-pole local isolators should be provided to enable the rack to be de-energized for maintenance.

It is required that the IMx-M rack must be connected to protective ground/earth (PE). Refer to [Mains Power](#) for attaching power cable to the mains power/power grid.

 **Important - The cross section area of the PE wire must be equal or greater than the cross section area of the power wires. The PE wire should be color labeled green/yellow. However, in some countries, other cable requirements may apply.**

### Signal Grounding

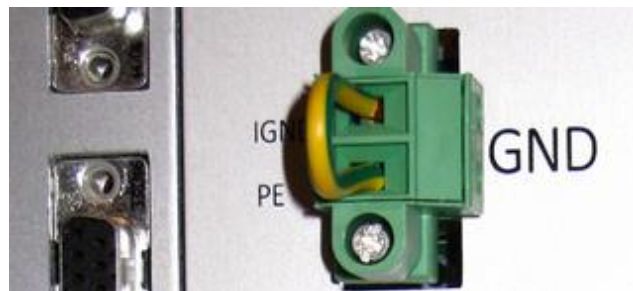




Figure 4 - 4.

Instrument Ground Jumper - Instrument Ground (IGND) Connected to Protective Ground (PE).

- If instrumentation ground is available, connect the instrumentation ground to IGND, and connect the protective ground to PE. Otherwise, connect a cable as shown in the figure, above.
- Analog input's shield and digital input's shield are connected to IGND and should always be separated from Protective ground to eliminate noise/interference.
- Buffered outputs are relative to instrument ground. If system is set up for separate grounding (PE and IGND) then user must ensure that buffered outputs are connected to IGND systems or systems with isolated/differential inputs.
- USB galvanic isolator provided by SKF should always be used to prevent ground loops.
- If an IMx-M rack is used with separate grounding (PE and IGND), then GND connector jumper (as shown in the figure above) should be removed and instrument ground is connected to IGND pin.

 **Important - Signal grounding procedure must be handled with special care to avoid ground loops. Be sure to read this "Signal Grounding" chapter thoroughly and understand it.**

 **Important - The sensor shield and/or sensor inner shield should be connected either to the sensor or to the IMx-M rack depending on the cable and the sensor type, but NOT to both.**



**Important** - If an IMx-M rack is used with only one ground (PE), then a GND jumper (PE connected to IGND) must always be in place (as shown in the figure above). Otherwise, If the IMx-M rack is used with separate grounding (PE and IGND), then GND connector jumper should be removed and instrument ground is connected to IGND pin.



**Important** - SKF USB isolator cables shall always be used when connecting to IMx-M USB ports.



**Important** - Equipment connected to buffered outputs must be isolated from the protective earth.



**Important** - IGND signals should be connected to protective earth/ground at one point only.



**Important** - An IMx-M rack must be connected to protective earth since surge suppressors are connected between network terminals and protective earth.

### Signal Isolation

Galvanic isolated parts (Maximum allowed voltage difference relative to protective earth is 40 V):

- 4–20 mA output block (not individually isolated)
- Ethernet ports (individually isolated)
- Protection redundant Modbus RS485 L1, L2 (individually isolated)
- All relays are potential free relays (individually galvanic isolated).
- Digital inputs D1-D8 are optically isolated inputs (individually isolated)
- Disarm input
- **(Note:** shared ground terminal with RS485, L2)

Electrical isolated parts, differential inputs:

- Analog inputs are differential inputs and support common mode up to  $\pm 25$  V relative to IGND.


Parts relative to Instrument Ground IGND (should be used with care to prevent ground loops, see also [Signal Grounding](#)):

- Buffered outputs (connect only to isolated /differential inputs).

- USB ports are relative to instrument ground.

 **Important - Signal grounding procedure must be handled with special care to avoid ground loops. Be sure to read "Signal Grounding" chapter thoroughly and understand it.**

 **Important - SKF USB isolator cables shall always be used when connecting to IMx-M USB ports.**

 **Important - Equipment connected to buffered outputs must be isolated from the protective earth. See also "Signal Grounding" chapter.**

### Mains Power

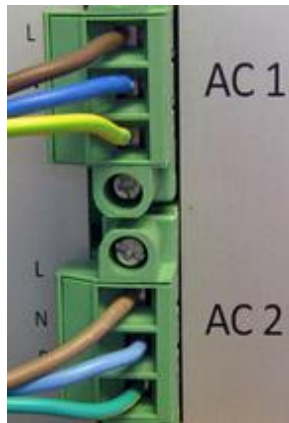


Figure 4 - 5.  
Power Connectors.

An IMx-M rack has two power connectors available, AC1 for power supply unit 1 and AC2 for power supply unit 2, one for each redundant power supply unit. Each power supply unit is independently capable of supplying power for the entire monitor system (IMx-M rack) including sensors.

The rack is grounded through the protective earth lead of the power cable. Therefore, it is important to make sure that the earth terminal of the power cable is properly connected to the protective earth lead before connecting any of the input or output terminals of the rack.

Surge suppressors are connected between network terminals and protective earth. Therefore, equipment must be connected to an earthed mains socket-outlet.

In order to attach the power cable to mains power, follow the directions below.

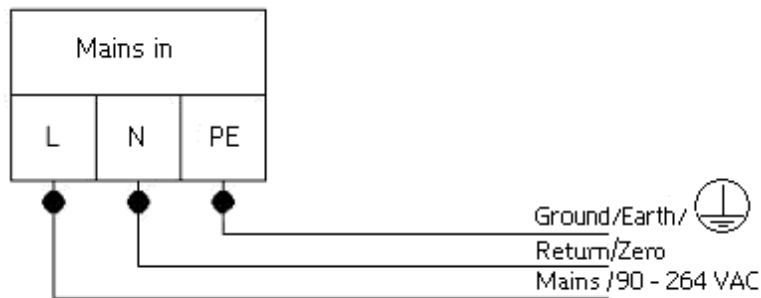


Figure 4 - 6.  
Power Cable Connection.

1. First connect the (green-yellow) protective earth wire to the PE terminal.
2. Connect the (blue) neutral wire to the N terminal.
3. Connect the (brown or black) live wire to the L terminal.

IMx-M redundant power supply requires that before obtaining access for maintenance, both supply circuits (power connectors AC1 and AC2) must be disconnected.

Refer to [Power Supply](#) in Technical Data section for power requirements.



**Important - IMx-M Mains Power Connectors must not be used as a mains power disconnect device.**



**Important - For the permanently connected IMx-M rack, an external all pole power switch must be installed to be able to disconnect the IMx-M rack from the mains power grid. The switch must be labeled "IMx-M" or similar. On/off position must be clearly marked. The switch must be located close to the IMx-M rack, within operator's easy reach. If two switches are used, one for each power supply unit, they must be placed close to each other.**



**Important - Make sure that the power is turned off, before touching the power cable. Touching the leads of a powered cable can cause serious injuries.**



**Important - In some countries, one must be certified in order to connect the IMx-M rack to the power grid.**



**Important** - Since the rack is grounded through the protective earth lead of the power cable, make sure that the earth terminal of the power cable is properly connected to the protective earth lead before connecting any of the input or output terminals of the rack.



**Important** - All wires and cables connected to input and output terminals shall have a flammability rating VW-1, FT-1 or fulfill the requirements according to IEC 60332-1-2 or IEC 60332-2-2.



**Important** - Because of the redundant power supply, both supply circuits (power connectors AC1 and AC2) must be disconnected before maintenance.

### Power Supply

There are two power supply units for an IMx-M rack. Each power supply unit can individually power a fully equipped rack.



**Important** - Power supply unit revision 3 or below cannot be combined with power supply unit revision 4 or above. Therefore, when replacing a power supply unit, it is important to check the other power supply unit's revision number in order to ensure that power supply units can be combined.

**For example, the system cannot have one power supply unit revision 3 and the other power supply unit revision 4.**

When a power supply unit has all the LED indicators OFF, it is the indication of no power presence on that particular power supply unit.

- First check to see if mains power cables are in right places and firmly attached as shown in Mains Power.
- If the LED indicators are still OFF, then power fuses must be checked and/or replaced.

The fuses are located on the power supply unit as shown in the drawing, below. Refer to [Power Fuses](#) for more information about the power fuses required by IMx-M.

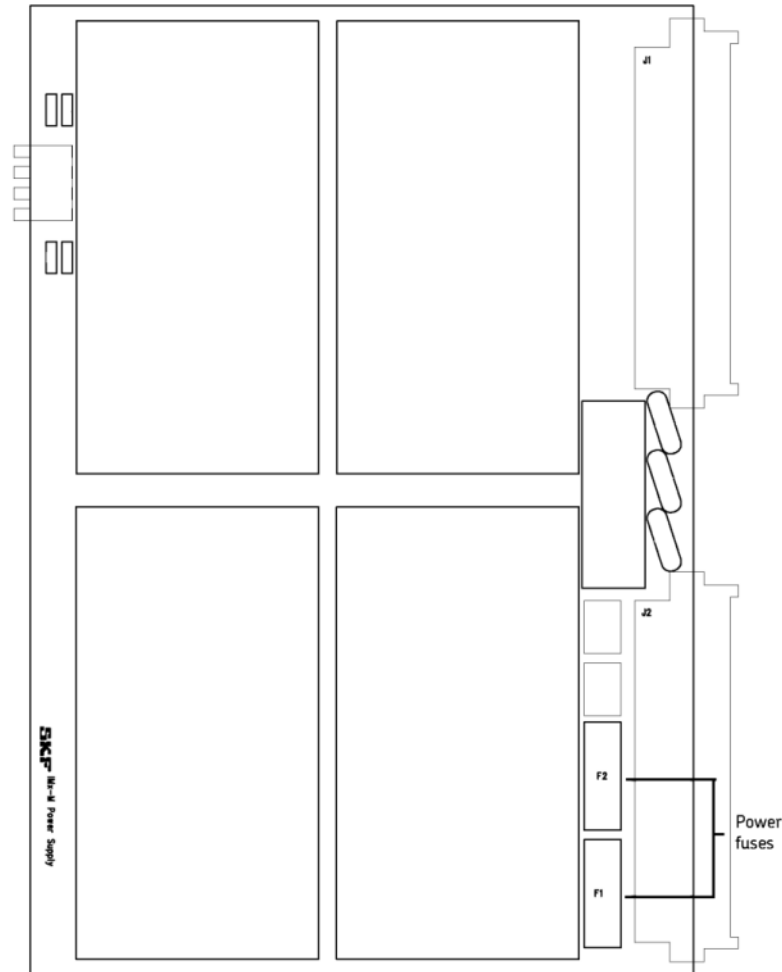


Figure 4 - 7.  
Power Fuses.

### Power Fuses

The power fuses are slow blow 6,3 A (6,3 AT 250 V, 5 x 20 mm).

After operation of the fuse, due to mains power double pole (neutral) fusing, parts of the equipment that remain energized might represent a hazard during servicing.



**Important - Caution to a possible hazard due to mains power double pole/neutral fusing.**

### Inrush Current

The maximum inrush current is 70 A.

### Sensor Power Output


Each channel, both analog and digital, has built-in individual 24 V (23.5–28 V) sensor power supply.

The maximum current output is 30 mA per channel.

- The total sensor power output of each CMM + PRM slot shall not exceed 15 W (total sensor power output of 16 analog channels and 8 digital channels).

For more information see DIP switch settings in [Analog Inputs](#) and [Digital Inputs](#).

## Condition Monitoring Part Electrical Interface

 **Important - All wires and cables connected to input and output terminals shall have a flammability rating VW-1, FT-1 or fulfill the requirements according to IEC 60332-1-2 or IEC 60332-2-2.**

### Communication Cable

For a length of up to 15 meters, it is recommended to use a pre-fabricated Ethernet cable FTP type, CAT5/6. For a longer cable length, use S-FTP Ethernet cable CAT5/6.

Note that a CAT5/6 twisted pair (TP) Ethernet cable has maximum working distance of 100 m. If longer cable lengths are needed, fibre optic cables may be used along with needed converters such as converters for fibre optic to CAT5 Ethernet and vice versa.

### Data Communication

An IMx-M rack communications are compliant with the Ethernet standard 10/100 Mbit.

Each CMM + PRM pair has two Ethernet ports which work like an internal switch.

### Ethernet Cable

The Ethernet TP cable on the back of each CMM + PRM slot is connected at one of the standard Ethernet RJ45 connections, named ETH1 and ETH2. Both Ethernet ports have auto detection of crossover or straight through Ethernet cable connection. Basically, each CMM + PRM slot has a 2-port built-in Ethernet switch. Refer to [Rear Panel](#) section for the view of the terminals.

**Table 4-1: IMx-M Ethernet connections**

<b>ETH1</b>	RJ45 Ethernet 1
<b>ETH2</b>	RJ45 Ethernet 2

It is possible to connect a CMM + PRM slot in a daisy chain. The number of CMM + PRM slots that can be connected in a single cable layout can be varied. However, it is recommended no more than 8 CMM + PRM slots in a single cable layout in order to minimize the loss of sensitivity.

For the behaviors and their corresponding descriptions of Ethernet LEDs, refer to [Condition Monitoring Module \(CMM\)](#) within LED Indicators.

## Hardware Configuration

When referring to DIP switch settings 0 means "Off" and 1 means ON.

Table 4-2: DIP switch setting definition.

DIP Switch Setting	Definition
0	OFF
1	ON

## General Configuration

### Analog Inputs

Three positions (P, A, B) and a shield (S) are available for each analog input sensor for connecting sensor cables to each CMM + PRM slot. However, depending on the sensor type, two or three positions are used.

Shield connection (S) is internally connected to instrumentation ground (IGND).

The DIP switch settings for connected analog sensors must be applied according to tables, below.

For the location of analog channel DIP switches, refer to [DIP Switches on Protection Module](#).



**Important** - Grounding procedure must be handled with special care to prevent ground loops. Be sure to read "[Signal Grounding](#)" and "[Signal Isolation](#)" chapters thoroughly and understand them.



**Important** - Do NOT change DIP switch settings while the IMx-M rack is powered-up, as this may cause damage and void warranty.



**Important** - Before powering up the IMx-M rack, make sure that DIP switch settings are properly set to match the recommendations for the connected sensors. Incorrect settings may cause permanent damage to the IMx-M rack.



Analog input Ch 1-8 - Front end

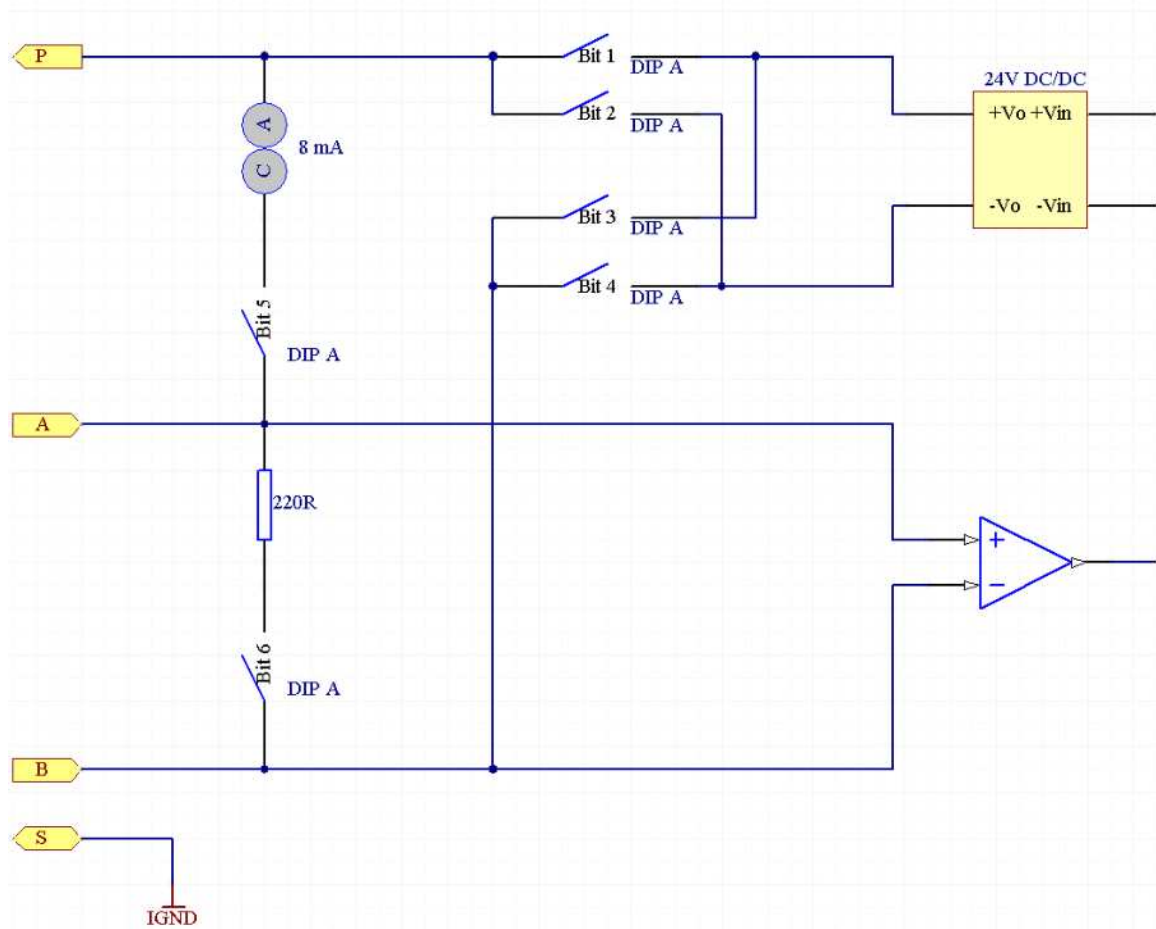


Figure 4 - 8.  
Analog Input Channel 1-8 Front End.

**Table 4-3: Analog input channels 1–8.**

Analog Input Channel 1 to 8			
Signal	Terminal		DIP A settings 123456
Standard accelerometer vibration (8 mA constant current source)	N.C. + Signal/Pwr Com. Shield	P A B S	100110
Voltage source (–23 to +23 V)	N.C. + Signal Com. Shield	P A B S	000000
4–20 mA source*	N.C. + Signal – Signal Shield	P A B S	000001
B-Sensor* (sensor with 4–20 mA output)	+24 V Signal Com. Shield	P A B S	100101
Eddy current probe (–24 V)	–24 V Signal Com. Shield	P A B S	011000
Voltage source powered from the IMx (max 30 mA)	+24 V Signal Com. Shield	P A B S	100100
4–20 mA* (IMx powered)	+ Signal – Signal N.C. Shield	P A B S	100101

N.C. = Not Connected

\* All 4–20 mA inputs have built-in internal 220 Ω shunt resistor.

Analog input Ch 9-16 - Frontend

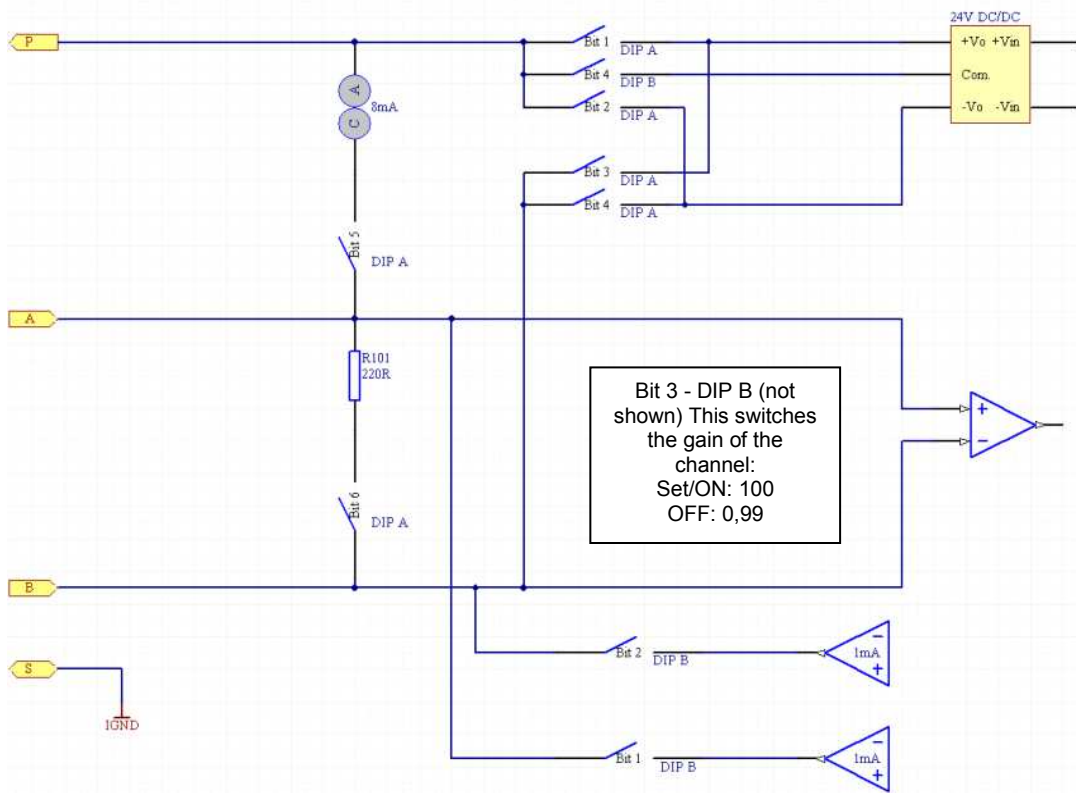
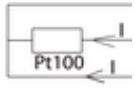


Figure 4 - 9.  
Analog Input Channel 9-16 Front End.

Table 4-4: Analog input channels 9–16.

Analog Input Channels 9 to 16				
Signal	Terminal		DIP A settings	DIP B settings
			123456	1234
Standard accelerometer vibration	N.C. + Signal/Pwr Com. Shield	P A B S	100110	0010
Voltage source (–23 to +23 V)	N.C. + Signal Com. Shield	P A B S	000000	0010
4–20 mA source*	N.C. + Signal – Signal Shield	P A B S	000001	0010
B-Sensor* (sensor with 4–20 mA output)	+24 V Signal Com. Shield	P A B S	100101	0010
Eddy current probe (–24 V)	–24 V Signal Com. Shield	P A B S	011000	0010
Voltage source powered from the IMx (max 30 mA)	+24 V Signal Com. Shield	P A B S	100100	0010
3-wire RTD	 Shield	P A B S	000000 (PRM with serial number >= 260)	1101 (PRM with serial number >= 260)
			010000 (PRM with serial number < 260)	1100 (PRM with serial number < 260)
4–20 mA* (IMx powered)	+ Signal – Signal N.C.Com. Shield	P A B S	100101	0010

N.C. = Not Connected

\* All 4–20 mA inputs have built-in internal 220 Ω shunt resistor.

### Digital Inputs

Three positions (A, B, O) and a shield (S) are available for each digital input sensor to connect to each CMM + PRM slot. However, depending on the sensor type, 2 or 3 positions are used.

- Shield connection (S) is internally connected to instrumentation ground (IGND).

 **Important - Eddy current probe input can only be used at 2 Hz or higher.**

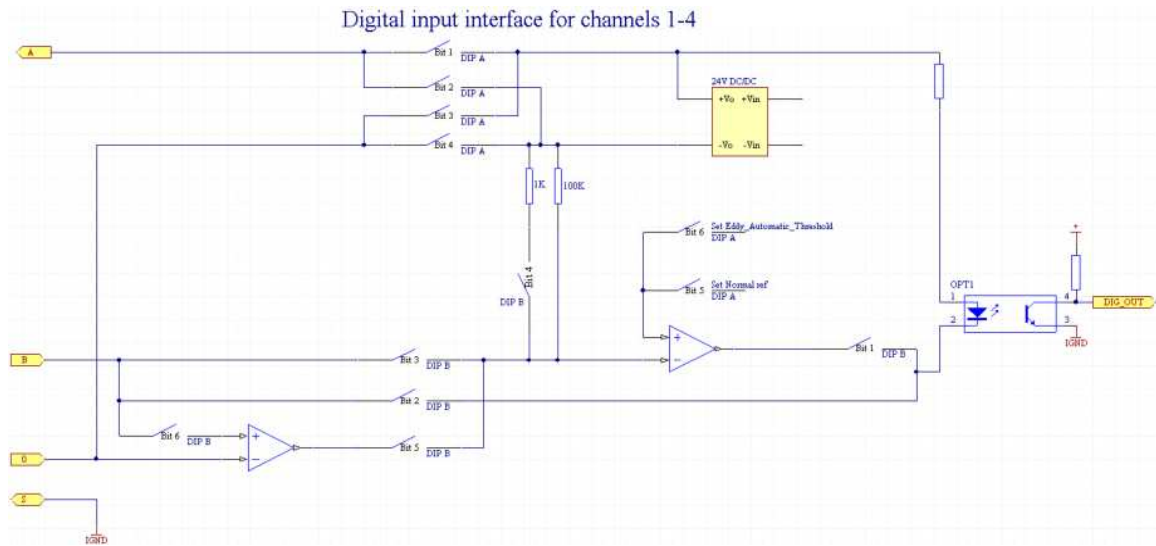


Figure 4 - 10.  
Digital Input Interface for Channels 1-4.

**Table 4-5: Digital input sensor cables for channels 1-4.**

Digital Input Sensor Cables for Channels 1 to 4				
Signal	Terminal		DIP A	DIP B
			123456	123456
Tacho 2-wire (24 V internally powered)	+	A	100110	101100
	-	B		
	N.C.	0		
	Shield	S		
Tacho 3-wire NPN (24 V internally powered)	+24 V	A	100110	010000
	Signal	B		
	0 V	0		
	Shield	S		
Tacho 3-wire PNP (24 V internally powered)	+24 V	A	100110	101000
	Signal	B		
	0 V	0		
	Shield	S		
Pulse 12–24 V (external power)	+	A	100010	010000
	-	B		
	N.C.	0		
	Shield	S		
Pulse TTL (external power)	N.C.	A	000110	101000
	+	B		
	-	0		
	Shield	S		
Eddy current probe (+24 V)	24 V	A	100101	100011
	Signal	B		
	0 V	0		
	Shield	S		
Eddy current probe (-24 V)	-24 V	A	011001	100011
	Signal	B		
	0 V	0		
	Shield	S		
Reset of latching alert/danger. Activation of trip multiply. Activation of disarm.	N.C.	A	000110	010000
	Short circuit	B		
	B to 0	0		
	Shield	S		

N.C. = Not Connected

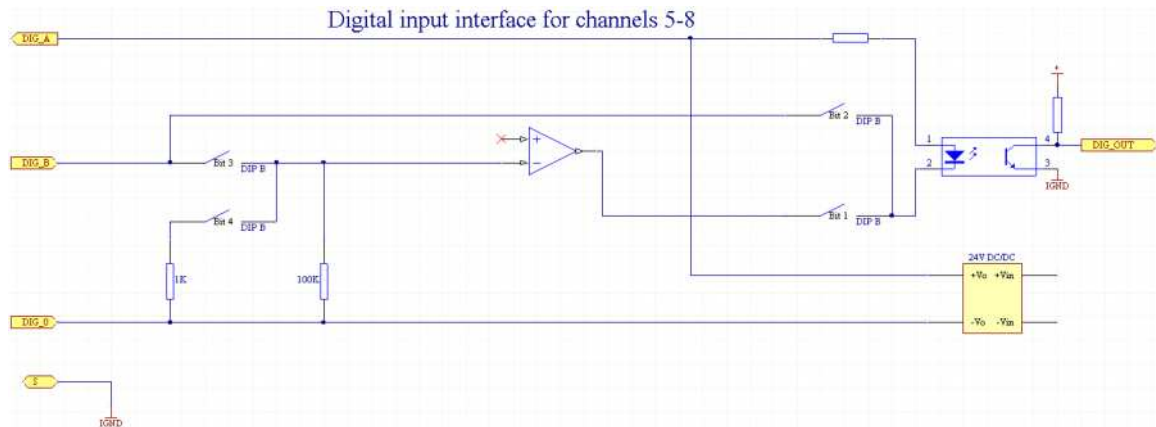


Figure 4 - 11.  
Digital Input Interface for Channels 5-8.

**Table 4-6: Digital input sensor cables for channels 5-8.**

Digital Input Sensor Cables for Channels 5 to 8			
Signal	Terminal		DIP B settings
			1234
Tacho 2-wire (24 V internally powered)	+	A	1011
	–	B	
	N.C.	O	
	Shield	S	
Tacho 3-wire NPN (24 V internally powered)	+24 V	A	0100
	Signal	B	
	0 V	O	
	Shield	S	
Tacho 3-wire PNP (24 V internally powered)	+24 V	A	1010
	Signal	B	
	0 V	O	
	Shield	S	
Pulse 12–24 V (external power)	+	A	0100
	–	B	
	N.C.	O	
	Shield	S	
Pulse TTL (external power)	N.C.	A	1010
	+	B	
	–	O	
	Shield	S	
Reset of latching alert/danger. Activation of trip multiply. Activation of disarm.	N.C.	A	0100
	Short circuit	B	
	B to O	O	
	Shield	S	

N.C. = Not Connected

For the location of digital channel DIP switches, refer to [DIP Switches on Protection Module](#) drawing.



### Speed/Tacho - Minimum Pulse Widths

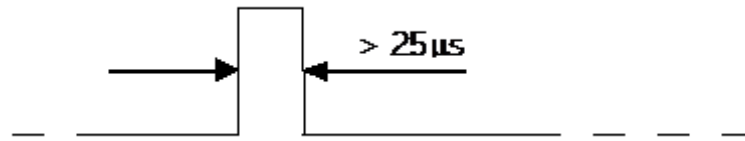


Figure 4 - 12.  
Minimum Pulse Width for an Electrical Positive Tacho Signal.

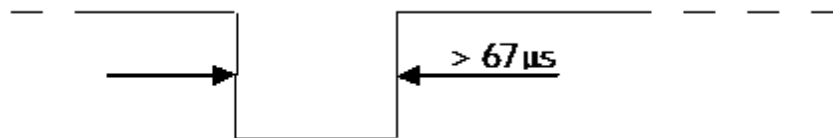


Figure 4 - 13.  
Minimum Pulse Width for an Electrical Negative Tacho Signal.

### **Buffered Outputs**

#### Rear Buffered Outputs

On the rear of each CMM + PRM slot there are 16 buffered analog outputs marked as "Buf A" and 8 buffered digital outputs marked as "Buf D" as shown in [Protection Module \(PRM\)](#)

- The buffered analog signal is divided by 2.

The measuring instrument connected to these buffered outputs must compensate for this. This can be done by using a sensitivity that is 50% of the connected sensor. For example, if the sensor is 100 mV/g, then set the sensitivity on the measuring instrument to 50 mV/g.

- The buffered analog outputs are maximum  $\pm 11$  V and cutoff frequency (-3 dB) is at 60 kHz
- The buffered digital outputs are 5 V TTL signal.

#### Front Panel BNC Buffered Outputs

In addition to the rear buffered outputs, IMx-M offers a feature where a user can select up to three channels to be directed to front panel, buffered output, BNC connectors.

These BNC connectors (2 for analog buffered outputs and 1 for digital buffered output) are located on the front panel of the protection module, as shown in [Protection Module \(PRM\)](#).

- The channel selection can be done using the [Local display selection keypad](#) located on the front panel of each condition monitoring module. Refer to [Condition Monitoring Module \(CMM\)](#) for the location of the local display selection keypad.
- One channel per buffered output can be selected.

- First two outputs are for analog signals and the third output is for a digital signal.
- The buffered analog signal is divided by 2.

The measuring instrument connected to these buffered outputs must compensate for this. This can be done by using a sensitivity that is 50% of the connected sensor. For example, if the sensor is 100 mV/g, then set the sensitivity on the measuring instrument to 50 mV/g.

- The buffered analog outputs are maximum  $\pm 11$  V and cutoff frequency (-3 dB) is at 60 kHz.
- The buffered digital outputs are 5 V TTL signal.

## Protection Part Configuration

### RS485 Modbus

Each protection module has 2 separate RS485 Modbus connections L1 and L2 for redundant operation.

The physical locations of RS485 connection L1 and L2 are found in the back of CMM + PRM slot as shown in [Protection Module \(PRM\)](#).

The connection diagram is found in [RS485, Relay Outputs, Rack Disarm](#) section.

The RS485 Modbus for protection module shall only be terminated at the end(s) of the bus. At each protection module, termination of 120  $\Omega$  can be manually activated by DIP switch as shown in the table below.

**Table 4-7: RS485 Modbus termination DIP switch settings for L1, L2.**

RS485 Modbus Termination DIP Switch Settings		
L1	L2	DIP Switch Setting 1234
OFF	OFF	0000
ON	OFF	1000
OFF	ON	0100
ON	ON	1100

The location of RS485 Modbus termination DIP switch is found in [DIP Switches on Protection Module](#) drawing.

#### 4-20 mA Output

Each CMM + PRM slot offers 16 4–20 mA Outputs. This connection is used for sending protection measurement values from the CMM + PRM slot to the distributed control system (DCS). Each 4–20 mA output can be configured to reflect the value of analog channel measurement or related combined measurement.

Each 4–20 mA Output is updated every 640 ms.

The values are related to the scale setup in 4-20 mA Outputs configuration via IMx-M Manager. 4 mA will correspond to the minimum scale value and 20 mA to the maximum scale value with a linear scaling between those values.

Examples are shown below.

- Scale configured to 0 to 10 will give

4 mA = 0

20 mA = 10

- Scale configured to -10 to 30 will give

4 mA = -10

8 mA = 0

20 mA = 30

➤ A cable fault will result in less than 3 mA output.

Selection of the output voltage is done via a jumper (JMP2). The jumper (JMP2) is located on the condition monitoring module as shown in the [DIP Switch and Jumper on Condition Monitoring Module](#) DIP Switch and Jumper on Condition Monitoring Module drawing. The configuration of jumper is shown below.

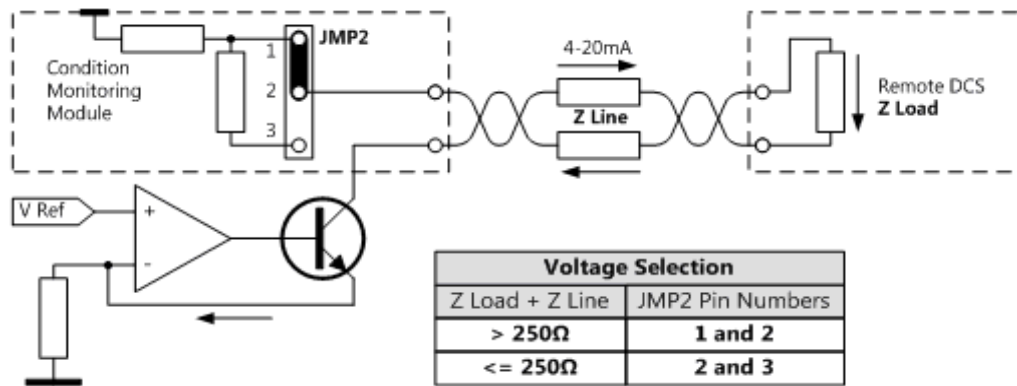


Figure 4 - 14.  
4–20 mA Output Voltage Selection.

The pinouts of 4-20 mA 37-Pin D-sub are listed in [4-20 mA Out](#) in the CMM + PRM Slot Connections chapter.

 **Important - The usage of 4-20 mA Outputs is only for monitoring purposes. Use relay outputs for safety alert/danger triggering.**

#### Protection Module Serial (USB) Interface

Serial (USB) interface on a protection module may be used to transfer the protection firmware (\*.a48) and/or configuration file (\*.bin) created via [IMx-M Manager](#) to a protection module slot wise.

The USB port for the protection configuration is located on the front panel of each protection module. See [Protection Module \(PRM\)](#) in Drawings and Connections chapter for the physical location.

#### Selecting the correct Mini-USB Cable

Ensure that the correct (isolated) Mini-USB cable is selected for use. Do not use an ordinary Mini-USB cable.



Figure 4 - 15.  
Selecting the Correct Mini-USB Cable.

#### Establishing a Connection between Host PC and a Protection Module

Connect a Mini-USB cable between the Host PC and the protection module as shown in the figure below:

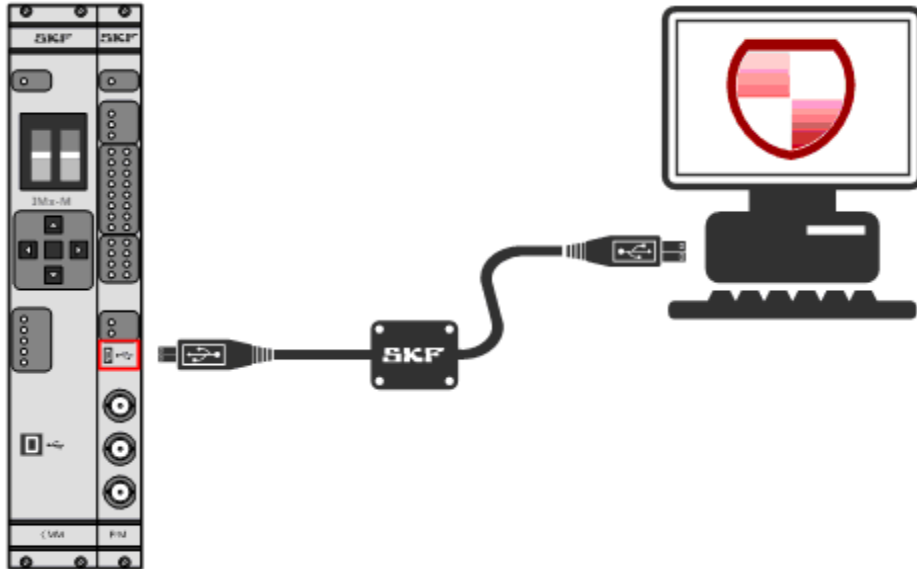



Figure 4 - 16.  
Mini-USB Connection to Protection Module.

 **Important - SKF USB isolator cables shall always be used when connecting to IMx-M USB ports.**

## Condition Monitoring Part Configuration

### Condition Monitoring Module Serial (USB) Interface

Serial (USB) interface on a condition monitoring module is used to transfer the [network configuration file](#) created via IMx-M Manager to a condition monitoring module slot wise.

The USB port for CM network configuration is located on the front panel of each condition monitoring module. See [Condition Monitoring Module \(CMM\)](#) in Drawings and Connections chapter for the physical location.

### Selecting the correct USB Cable

Ensure that the correct (isolated) USB cable is selected for use. Do not use an ordinary USB cable.



Figure 4 - 17.  
Selecting the Correct USB Cable.

## Establishing a Connection between Host PC and a Condition Monitoring Module

Connect a USB cable between the Host PC and the condition monitoring module as shown in the figure below.

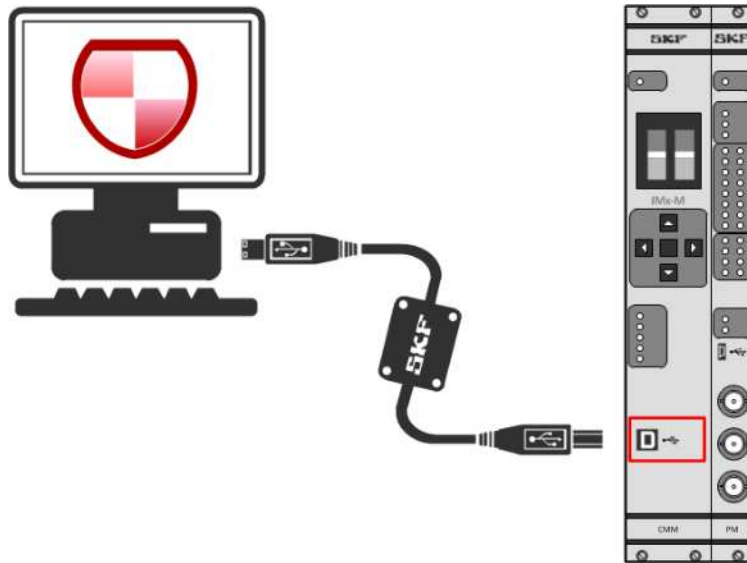


Figure 4 - 18.  
Connecting the USB Cable.

Connect the SKF USB Isolator cable to a free USB port of the PC. Connect the other end to a condition monitoring module USB port. This connected condition monitoring module is where the CMM + PRM slot network configuration will be located.



**Important - SKF USB isolator cables shall always be used when connecting to IMx-M USB ports.**

## LED Indicators

### Power Supply Unit (PSU)



Green LEDs **V1**, **V2**, **V3**, and **V4** on each power supply unit indicate the power presence of condition monitoring module (CMM) and protection module (PRM) pairs.

**Table 4-8: PSU LED indicators.**

LED Indicator	Behavior	Description
V1	Green On	Power present on CMM 1 and PRM 1
	Off	No power on CMM 1 and PRM 1
V2	Green On	Power present on CMM 2 and PRM 2
	Off	No power on CMM 2 and PRM 2
V3	Green On	Power present on CMM 3 and PRM 3
	Off	No power on CMM 3 and PRM 3
V4	Green On	Power present on CMM 4 and PRM 4
	Off	No power on CMM 4 and PRM 4

Figure 4 - 19.  
PSU Front View.

## Relay Module (RLM)

The following table summarizes the behavior of LED indicators on each relay module.

Table 4-9: RLM LED indicators.

LED Indicator	Behavior	Description
STATUS Ready	Red	Internal system error
	Green slow flash	Relay module configured & running
	Green fast flash	Rack startup
Relay Ch1 to Ch32	On	Relay configured but relay logic not triggered
	Flash	Relay configured and relay logic triggered
	Off	Relay not configured. Startup or updating configuration while the protection module and relay module are disarmed.



Figure 4 - 20.  
RLM Front View.



## Condition Monitoring Module (CMM)

The following table summarizes the behavior of LED indicators on each condition monitoring module.

Table 4-10: CMM LED indicators.

LED Indicator	Behavior	Description
STATUS Ready	Red	Internal CMM error
	Green slow flash	CMM configured & running
	Green fast flash	CMM startup
Con	Green on	SKF @ptitude Observer Monitor is connected
	Green slow flash	Trying to connect SKF @ptitude Observer Monitor
	Green fast flash	Server forced the connection
	Off	Server not connected
Link1, Link2	Green on	Ethernet link connected
	Yellow flash	Traffic on the network
Act1, Act2	Off	Ethernet link not connected

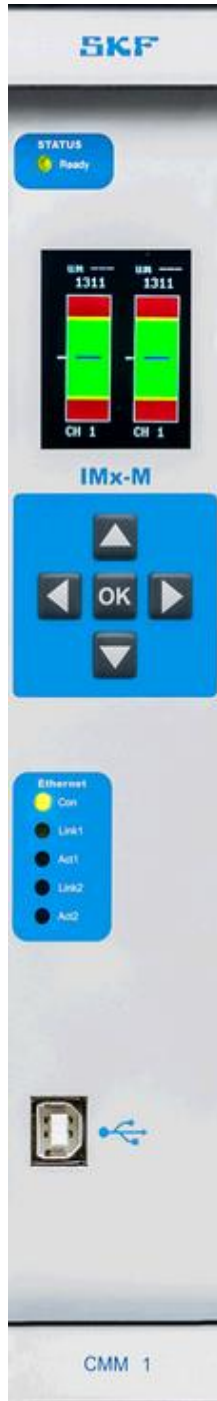


Figure 4 - 21.  
CMM Front View.

## Protection Module (PRM)

The following table summarizes the behavior of LED indicators on each protection module.



Figure 4 - 22.  
PRM Front View.

Table 4-11: PRM LED indicators.

LED Indicator	Behavior	Description
STATUS Ready	Red	Internal PRM error
	Green slow flash	PRM configured & running
	Green fast flash	PRM startup
Circuit Fault	On	Circuit fault
	Off	Circuit OK
Trip Multiply	On	Trip multiply active for one or more channels
	Off	No trip multiply
Disarm Config	On	PRM & associated relays disarmed
	Off	PRM & associated relays armed
ANALOG Ch1 to Ch16* Behavior listed in the order of priority, high to low (bigger # = higher priority)  For Combined Measurement type CDE, see the separate table, below.	Off (10)	<b>Channel not configured</b> The analog channel is not configured.
	Yellow fast flash (9)	<b>Ch Disarm + Ch Not OK/Alert/Danger</b> The analog channel is disarmed and the current channel status is any combination of: - Analog ch is not OK, alert or danger - Gap is alert and/or danger - Combined measurement ch is alert and/or danger
	Green fast flash (8)	<b>Ch Disarm + Ch OK</b> The analog channel is disarmed and the current channel status is: - Analog ch is OK - Gap is OK - Combined measurement ch is OK
	Toggle between green / red / yellow (7)	<b>Channel Circuit Fault (Not OK)</b> The current channel status is: - Analog ch is not OK.
	Red slow flash (6)	<b>Channel Danger + Danger First Out</b> One of analog ch, Gap or combined measurement ch is danger first out. Current channel status is any combination of: - Analog ch is alert and danger - Gap is alert and danger - Combined measurement ch is alert and danger

LED Indicator	Behavior	Description
<b>ANALOG Ch1 to Ch16*</b> Behavior listed in the order of priority, high to low (bigger # = higher priority)  For Combined Measurement type CDE, see the separate table, below.	Red (5)	<b>Channel Danger</b> Current channel status is any combination of: - Analog ch is Alert and Danger - Gap is Danger - Combination measurement ch is Alert and Danger
	Yellow slow flash (4)	<b>Channel Alert + Danger First Out</b> One of Analog ch, Gap or Combination measurement ch is Danger First Out and current channel status is any combination of: - Analog ch is Alert - Gap is Alert - Combination measurement ch is Alert
	Yellow (3)	<b>Channel Alert</b> Current channel status is any combination of: - Analog ch is Alert - Gap is Alert - Combination measurement ch is Alert
	Green slow flash (2)	<b>Channel OK + Danger First Out</b> One of Analog ch, Gap or Combination measurement ch is Danger First Out and the current channel status is: - Analog ch is OK - Gap is OK - Combination measurement ch is OK
	Green (1)	<b>Channel OK</b> The current channel status is: - Analog ch is OK - Gap is OK - Combination measurement ch is OK
<b>DIG/SPD Ch1 to Ch8</b>	On	Digital input logic one.
	Flash	Digital input toggle.
	Off	Digital input logic zero.
<b>RS485 Ch1 and Ch2</b>	On/Flash	Communication indicator.

\* Combined measurement types **Absolute Shaft Vibration, Piston Rod Drop XY (Average and Triggered)** and **Temperature Difference** consisting of ch X and ch Y:

- If ch X is disarm/circuit fault and ch Y is armed, then ch X LED shows status of ch X and combined measurement. See [Disarm](#) chapter.
- If ch X is armed and ch Y is disarm/circuit fault, then ch Y LED shows status of ch Y and combined measurement. See [Disarm](#) chapter.

For a combined measurement type **Complementary Differential Expansion** consisting of ch X and ch Y:

- The individual analog ch X and Y cannot have any alarms set. The alarms are set to the combined measurement channel.
- If both ch X and ch Y are disarmed/circuit fault, then the combined measurement ch status is disarmed/circuit fault.
- If ch X or ch Y shows alert/danger, then the combined measurement ch status is alert/danger.

**Table 4-12: PRM LED indicators - Analog ch1 to ch16 for CDE combined measurement.**

<b>LED Indicator ANALOG ch1 to ch16 for Complementary Differential Expansion</b>	
<b>Behavior (in priority order, high to low)</b>	<b>Description</b>
Off (10)	<p><b>Channel not used for the moment</b> Value from this channel is not used for the moment (Decided by the defined crossover voltage).</p> <p>Current channel status is: - Analog ch is OK and Part of CDE but not used for the moment. <b>Note/Warning:</b> This is presented status. One channel may be out of its sensor OK range, but that will not be presented until both channels are out of their sensor OK range. - Combination measurement ch status may be anything, depending on LED on the other analog channel</p>
Yellow fast flash (9)	<p><b>Channel Disarm + Channel Not OK/Alert/Danger</b> The analog channel is disarmed and the current channel status is: - Combination measurement ch is disarmed and may also be any combination of; alert, danger, danger first out, circuit fault (sensor not OK)</p>
Green fast flash (8)	<p><b>Channel Disarm + Channel OK</b> The analog channel is disarmed and the current channel status is: - Combination measurement ch is OK and disarmed and may also be danger first out</p>
Toggle between green / red / yellow (7)	<p><b>Channel Circuit Fault (Not OK)</b> The current channel status is: - Both channels are in circuit fault (sensor not OK) - Combination measurement ch is in circuit fault (sensor not OK)</p>
Red slow flash (6)	<p><b>Channel Danger + Danger First Out</b> Current channel status is: - Analog ch is used for the moment - Combination measurement ch is alert, danger and danger first out</p>
Red (5)	<p><b>Channel Danger</b> Current channel status is: - Analog ch is used for the moment - Combination measurement ch is alert and danger</p>

LED Indicator ANALOG ch1 to ch16 for Complementary Differential Expansion	
Behavior (in priority order, high to low)	Description
Yellow slow flash (4)	<b>Channel Alert + Danger First Out</b> Current channel status is: - Analog ch is used for the moment - Combination measurement ch is alert and danger first out
Yellow (3)	<b>Channel Alert</b> Current channel status is: - Analog ch is used for the moment - Combination measurement ch is alert
Green slow flash (2)	<b>Channel OK + Danger First Out</b> The current channel status is: - Analog ch is used for the moment - Combination measurement ch is OK and danger first out
Green (1)	<b>Channel OK</b> The current channel status is: - Analog ch is used for the moment - Combination measurement ch is OK



**Important:**

- **Only the indication of highest priority will be shown.**
- **An indication of lower priority will be masked by a higher priority indication even if the conditions for each of them are fulfilled.**
- **Higher priority number means higher priority.**

**Example:**

Yellow fast flash (9) indication: **Ch Disarm + Ch Not OK/Alert/Danger**

The analog channel is disarmed and the current channel status is any combination of:

- Analog ch is not OK, alert or danger
- Gap is alert and/or danger
- Combined measurement ch is alert and/or danger

If the channel was armed, the indication would change to reflect one or more of the three status conditions above.

## Protection Part Diagnostic Commands

Diagnostic commands are used to obtain information on various conditions of the IMx-M system.

Diagnostic information will be available for the protection module to where the mini USB cable is connected. Therefore, connect a mini USB cable to the protection module for which various conditions will be checked.

Diagnostic commands can be performed by using the application tool IMx-M Manager provided by @ptitude Observer DVD.

Set the Serial Communication to [PRM Serial Interface](#) and enter the following commands manually on the Command area.



**Important - It is strongly recommended to use the diagnostic interface in disarmed mode only.**

**Table 4-13: Protection part diagnostic commands.**

Command	Description
adc1	Status of internal power and the PRM internal temperature
<a href="#">cf</a>	Current circuit fault status (it is recommended to use "Send CF Command" via IMx-M Manager's <a href="#">PRM Serial Commands</a> )
cfguser	User configuration events by entering 8-character user name after the command
ch	Analog channel status
dumpcfg	Current user configuration (it is recommended to use "Get PRM Config from device" via IMx-M Manager's <a href="#">PRM Serial Commands</a> )
intd0	Current FW versions in use by the PRM and RLM. Use this command to ensure all slaves are running proper FW.
mb10	Modbus 1 (RS 485 connection L1) statistics
mb20	Modbus 2 (RS 485 connection L2) statistics
reboot	Reboot command
sver	FW version in use by the PRM and RLM. This shall only be used when the system is disarmed.
ver	FW version information

## Condition Monitoring Part Diagnostic Commands

Condition monitoring part diagnostic commands are available for the condition monitoring module to where USB cable is connected. Therefore, connect a USB cable to the condition monitoring module for which various conditions will be checked. The [USB port](#) is located on the front of condition monitoring module.

Diagnostic commands can be performed by using the application tool IMx-M Manager provided by @ptitude Observer DVD.

Set the Serial Communication to [CMM Serial Interface](#) and enter the following commands manually on the **Command** area.

The following diagnostic commands are specific for IMx-M only.

**Table 4-14: CMM part diagnostic commands.**

Command	Description
prot	Current status of internal CMM and protection part communication
GET_EVENT	Event log of protection part. Refer to <a href="#">Event Log</a> for detailed information on output.

### Network Related Condition Codes

Via a condition monitoring module USB port, status codes are presented regarding to the current network (Ethernet) status of the the condition monitoring module to which the USB is connected.

The most common status codes are described below.

**Table 4-15: Network related condition codes.**

Code	Description	Possible Cause
t_connect returned error 2	IMx has no connection to Ethernet or no response from server.	Ethernet cable not connected / no link. Server computer is offline. Communication port (default 1000) from IMx to Monitor blocked by firewall.
t_connect returned error 7	Ethernet link exists but no connection to Monitor application.	Monitor application not started. Network configuration is not set up properly. Communication port (default 1000) from IMx to Monitor blocked by firewall.
t_connect returned error 8	Ethernet connection reset.	Computer's firewall is ON. IMx IP address is banned.
t_connect returned error 18	TCP/IP stack ran out memory.	Data removal and network packet handling at the same time. Removing data causes the system to use memory needed for network packet.
t_connect returned error 33	IMx is set to "Obtain IP address automatically" from DHCP server but DHCP server is not responding.	DHCP server is down or does not exist.

## Hardware Maintenance

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The IMx-M hardware, for example the IMx-M rack, is virtually maintenance free. However, we advise the customers to make an annual inspection of the equipment.

### Maintenance of Sensors

Visual inspections for looseness or any physical damage on sensors, sensor cables and connectors shall be conducted on regular basis, such as annually.

In addition, sensors shall be maintained according to the individual sensor manufacturer's instruction.

### Ventilation Fan

Ventilation fans in the system shall be cleaned regularly in order to maintain the full ventilation capacity.

### Hot-swap

For the service purpose, modules can be dismantled or mounted by trained personnel or service personnel during the normal operation.

Note the following conditions for hot-swap:

- All modules in front panel are hot-swappable.
- Rack must be in disarmed mode.
- A PRM must have DIP switches correctly set before insertion into the rack.
- Hot swapped modules must then be configured correctly (updated), before the rack/slot is armed.

#### To hot-swap a CMM, perform the following steps:

1. Disarm the rack.
2. Remove the CMM and insert a new CMM according to the [Changing PSU or CMM](#) instruction.
3. When all STATUS Ready LEDs indicate that all the modules in the rack are configured and running (slow green flash), arm the rack.

#### To hot-swap a PRM, perform the following steps:

1. Disarm the rack.
2. First, remove the corresponding CMM (left side of the PRM) according to the [Changing PSU or CMM](#) instruction steps 1 to 3.
3. Remove the protection module according to the [Changing RLM or PRM](#) instruction steps 1 to 4.
4. Take the new protection module and match all DIP switches of the new module to all DIP switches of the old module. For simplicity, we propose a systematic approach by starting with the DIP switches of analog channel 1 and work through them till analog channel 16, then work on digital channel 1 through digital



channel 8. Refer to [DIP Switches on Protection Module](#) for the physical locations of DIP switches.

5. Insert the new PRM according to the [Changing RLM or PRM](#) instruction steps 5 and 6.

**Note 1:** PRM with firmware version prior to 192 must be pre-configured with the same configuration (CRC match) as the old PRM.

**Note 2:** Check that the PRM has correct FW (use command "intd0"). If FW needs updating and there is an RLM in the slot that shouldn't be updated, then the PRM needs to be temporarily moved to a separate rack/slot during update because a PRM FW update will also update the FW of the associated RLM during which there will be a restart of the RLM (relays will de-energize during that process).

6. Insert the CMM according to the [Changing PSU or CMM](#) instruction steps 4 and 5.
7. Send the configuration to the newly inserted PRM. This can be done via IMx-M Manager or by synchronizing from @ptitude Observer.
8. We suggest using the [Maintenance View](#) to verify that all channel DIP switches are set correctly by verifying their individual BIAS/BOV and AC components. Exit the Maintenance Mode when finished.
9. If all has been verified to satisfaction, no unwanted Circuit Faults exist, and all STATUS Ready LEDs indicate that all the modules in the rack are configured and running (slow green flash), arm the rack.

**To hot-swap a RLM, perform the following steps:**

1. Disarm the rack.
2. Remove the RLM and insert a new RLM according to the instruction [Changing RLM or PRM](#).
3. If a FW update is needed (check with command intd0 to the PRM in the same slot), then perform FW update via the PRM.
4. Download the original configuration to the RLM: using either IMx-M Manager and the associated PRM or by using @ptitude Observer connected via Ethernet to that slot.
5. Check that no unwanted Circuit Faults exist.
6. When all STATUS Ready LEDs indicate that all the modules in the rack/slots are configured and running (slow green flash), arm the rack.

**To hot-swap a PSU, perform the following steps:**

1. Disarm the rack.
2. Remove the PSU that shall be swapped from the rack according to the [Changing PSU or CMM](#) instruction steps 1 to 3.  
**Warning!** If only one power supply unit is used in the rack, this will mean that the entire rack will be shut down.
3. Insert a new PSU according to the [Changing PSU or CMM](#) instruction steps 4 and 5.  
**Warning!** If two power supply units are used in the rack, make sure to check the compatibility of power supply units. Refer to [Power Supply](#) chapter.
4. When all LEDs on the new power supply unit indicates normal operation and no circuit faults are indicated on other modules, arm the rack.



**Important** - See also chapter "[Relays on Relay Modules](#)" and "[Behavior of Slot Status Relays](#)" for details when shared relays are used.



**Important** - Hazardous voltages are present in backplane during hot-swap. Therefore, hot-swap should be done only by trained personnel.



**Important** - Rack must be set in the rack disarm mode before the hot-swap procedure takes place. Be sure to read "[Disarm](#)" chapter thoroughly and understand it.



**Important** - User must ensure that rack is properly configured before disarm is released after the hot-swap. Be sure to read "[Disarm](#)" chapter thoroughly and understand it. Evaluate circuit faults with diagnostic command "cf" as described in chapter "[Circuit Faults \(cf\)](#)".



**Important** - Evaluate channel alarms before disarm is released to avoid unwanted alert/danger alarms triggered upon arm of the channel or rack.



**Important** - User must ensure that the rack is running with a correct firmware before disarm is released after the hot-swap. Be sure to read "[Protection Firmware Update](#)" chapter thoroughly and understand it. It is always recommended to check with diagnostic command "intd0" that the correct firmware is running on all protection MCUs. Evaluate circuit faults with diagnostic command "cf" as described in chapter "[Circuit Faults \(cf\)](#)".



**Important** - In case of hot-swap of power supplies, read chapter "[Power Supply](#)" thoroughly and understand it.



**Important** - Different types of Modules must be positioned correctly in the rack. The positions of the different types of modules are shown in [Front Panel Drawings and Connections](#) section.



**Important** - Due to the physical reason, when mounting a CMM + PRM slot, must always mount the PRM before the CMM in order to avoid any damages to the PRM. However, when dismantling a CMM + PRM slot, it must be the other way around. Must always dismantle the CMM before the PRM. Otherwise, the PRM can be seriously damaged.

## Changing Modules



**Important** - Rack must be set in the rack disarm mode before any module is removed. Be sure to read "[Disarm](#)" chapter thoroughly and understand it.

### Changing PSU or CMM:

1. Unscrew the top and bottom screws just enough to loose the attachment from the rack. Note that the screws shouldn't be removed completely.
2. Take a firm grip of the top and bottom extraction handles of the module, preferably on the left side of the extraction handles.
3. Pull the module firmly straight out of the rack.
4. Insert the new module on to the rails and push it straight in.
5. Tighten the top and bottom screws to fasten the module in place.

### Changing RLM or PRM:

1. If PRM module is to be changed or ejected, first the corresponding CMM (left side of the PRM) must be removed before the PRM. Remove the corresponding CMM according to [Changing PSU or CMM](#) instruction.
2. Unscrew the top and bottom screws just enough to loose the attachment from the rack. Note that the screws shouldn't be removed completely.
3. Grip the extraction levers and bend them outwards simultaneously to eject the module as shown in the figure below.



Figure 4 - 23.  
Demonstration of Ejecting a PRM.

4. Pull the module straight out.
5. Insert the new module onto the rails and push it straight in.
6. Tighten the top and bottom screws to fasten the module in place.

### Changing Module Labels

The labels on the extraction handles or levers can be changed.

Slide the clear label cover sideways as shown in the figure below and insert a desired label in place.

- The modules located in the center need to be ejected from the rack to be able to slide the clear label cover sideways.



**Important - Rack must be set in the rack disarm mode before any module is removed. Be sure to read "[Disarm](#)" chapter thoroughly and understand it.**



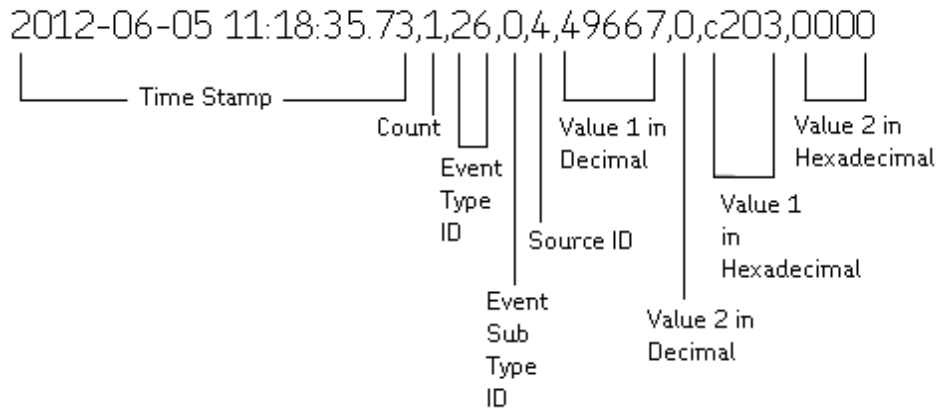
Figure 4 - 24.  
Demonstration of Sliding a Clear Label Cover.

# Event Log

Events are produced by all protection MCUs. Event log is stored in CMM non-volatile flash memory. Minimum of 1 400 latest events can be stored for each CMM + PRM slot.

The events can be read via USB connection of the CMM with the command "GET\_EVENT". Refer to [Condition Monitoring Module \(CMM\)](#) for the physical location of the USB port.

**Example of an event log:**



- When a channel is disarmed (rack-, slot- or channel disarm), channel status events (alert or danger) are not generated. However, circuit fault events (indicating cable fault) will be generated.

Event log can also be read by using "Get Events" functionality in [CMM Serial Interface](#) via IMx-M Manager application tool.

**Table 5-1: Event Log.**

Event Log							
Count	Event Type ID	Event Sub Type ID	Source ID	Value 1 in Decimal Format	Value 2 in Decimal Format	Value 1 in Hexa-decimal Format	Value 2 in Hexa-decimal Format
1 (event type 19 activated)	19 (protection internal comm error: no communication between protection and CM)	0	0	0	0	0	0
-1 (event type 19 deactivated)							
No. of events lost	20 (protection lost event)	0	MCU ID <sup>3</sup>	0	0	0	0

Event Log							
Count	Event Type ID	Event Sub Type ID	Source ID	Value 1 in Decimal Format	Value 2 in Decimal Format	Value 1 in Hexa-decimal Format	Value 2 in Hexa-decimal Format
1	21 (protection ch status - no value)	0	Ch nr 1 to 24: analog ch 1 to 16, comb ch 17 to 24	Ch status <sup>1</sup>	-	Ch status <sup>1</sup>	-
1	21 (protection ch status - analog value)	1	Ch nr 1 to 24: analog ch 1 to 16, comb ch 17 to 24	Ch status <sup>1</sup>	Analog ch value <sup>8</sup> -32768 to +32767	Ch status <sup>1</sup>	Analog ch value <sup>8</sup> -32768 to +32767
1	21 (protection ch status - Gap value)	2	Ch nr 1 to 16: analog ch 1 to 16	Ch status <sup>1</sup>	Gap ch value <sup>8</sup> -32768 to +32767 [mV]	Ch status <sup>1</sup>	Gap ch value <sup>8</sup> -32768 to +32767 [mV]
1	22 (protection relay status)	0	Relay 1 to 32	Relay status <sup>2</sup>	-	Relay status <sup>2</sup>	-
1	23 (protection slot first out)	1	Ch nr 1 to 24: 1 to 16 analog ch, 17 to 24 comb ch	Ch status <sup>1</sup>	-	Ch status <sup>1</sup>	-
1	23 (protection rack first out)	2	Ch nr 1 to 24: 1 to 16 analog ch, 17 to 24 comb ch	Ch status <sup>1</sup>	-	Ch status <sup>1</sup>	-
1	24 (protection circuit fault)	0	MCU ID <sup>3</sup>	Circuit fault <sup>4</sup>	CF selftest <sup>5</sup>	Circuit fault <sup>4</sup>	0
1	24 (protection CF warning)	1	MCU ID <sup>3</sup>	CF warning <sup>10</sup>	-	CF warning <sup>10</sup>	-
1	25 (protection config update)	0	MCU ID <sup>3</sup> (All devices when new config)	Config CRC bit 31–16	Config CRC <sup>6</sup> bit 15–0	Config CRC bit 31–16	Config CRC <sup>6</sup> bit 15–0
1	25 (protection config restart)	1	MCU ID <sup>3</sup> (PRM Master at startup)	Config CRC bit 31–16	Config CRC <sup>6</sup> bit 15–0	Config CRC bit 31–16	Config CRC <sup>6</sup> bit 15–0
1	25 (protection config user name)	2	MCU ID <sup>3</sup>	username bytes 1 & 2	username bytes 3 & 4	username bytes 1 & 2	username bytes 3 & 4
1	25 (protection config user name)	3	MCU ID <sup>3</sup>	username bytes 5 & 6	username bytes 7 & 8	username bytes 5 & 6	username bytes 7 & 8



Event Log							
Count	Event Type ID	Event Sub Type ID	Source ID	Value 1 in Decimal Format	Value 2 in Decimal Format	Value 1 in Hexa-decimal Format	Value 2 in Hexa-decimal Format
1	25 (protection config PRM status)	4	MCU ID <sup>3</sup>	PRM status <sup>11</sup>	-	PRM status <sup>11</sup>	-
1	26 (protection firmware)	0	MCU ID <sup>3</sup>	FW version	-	FW version	-
1	27 (protection restart)	0	MCU ID <sup>3</sup>	Reboot reason code	-	Reboot reason code	-
1	28 (protection dig ch status)	1	Digital ch 1 to 8	Dig Ch status <sup>7</sup>	-	Dig Ch status <sup>7</sup>	-
1	28 (protection dig ch peak speed)	2	Digital ch 1 to 8	Peak speed 0 to 65535 rpm	-	Peak speed 0 to 65535 rpm	-
1	28 (protection dig ch value)	3	Digital ch 1 to 8	Dig ch status <sup>7</sup>	Ch value <sup>9</sup> 0 to +65535	Dig ch status <sup>7</sup>	Ch value <sup>9</sup> 0 to +65535

<sup>1</sup> Ch status: according to [Register "Analog Ch Status" Bit Definition](#) described in Exported (Read) Modbus Registers chapter

<sup>2</sup> Relay status: 1 = active, 0 = not active (does not show energized/de-energized)

<sup>3</sup> MCU ID: PRM master = 1, PRM slaves = 2 to 9, RLM master = 10, RLM slaves = 11 to 18

<sup>4</sup> Circuit fault according to [Protection Module Circuit Faults](#). Definition depends upon MCU ID

<sup>5</sup> CF selftest according to [Register "PRM CF Selftest" Bit Definition](#).

<sup>6</sup> Protection configuration event which holds the high 16 bits of CRC configuration.

<sup>7</sup> Digital ch status: according to [Register "Digital Ch Status" Bit Definition](#) described in Exported (Read) Modbus Registers chapter

<sup>8</sup> Analog channel value is scaled relative to configured full scale.

Gap channel value is in mV.

Value is sampled when alarm enter time has expired.

<sup>9</sup> Value is sampled when alarm enter/leave time has expired

<sup>10</sup> Circuit fault warning according to [Protection Module CF Warning](#)

<sup>11</sup> PRM status bit definition: 0x0000 = normal mode, 0x0001 = maintenance mode



## Troubleshooting Guide

Troubleshooting Guide is intended as an aid when IMx-M system is not functioning correctly.

It is designed for instrumentation engineers and others with sufficient knowledge of electrical troubleshooting in electronic systems with a 230 V/110 V power supply and of the risks that this can mean in case of incorrect procedure.

SKF Condition Monitoring Center Luleå strives to provide information that is as accurate as possible. However, SKF Condition Monitoring Center Luleå cannot be held responsible for any injury or damage to persons or material that can occur in the interpretation of, or due to actions taken on the basis of information in this document.



**Warning - The guarantee becomes void if IMx-M racks are damaged through incorrect intervention in the hardware, or a patently incorrect connection in contravention of directions given.**

### Problems and Symptoms

---

#### **Protection Module and Condition Monitoring Module have matching filter but the results are different**

This is not a problem. The cause of this deviation is because there are differences in both measurement algorithms and filter characteristics between machinery protection and condition monitoring. Refer to [Accuracy](#) for more information.

#### **Sensor signal disappears or is abnormally changed for single channels**

Possible causes:

- Broken sensor cable
- Short circuit in sensor cable
- Sensor fault
- Hardware fault with IMx-M input stage
- Grounding loop

Suggested solution:

- Carry out sensor/cable test.

#### **A sensor repeatedly generates a false alarm or varies abnormally**

Possible causes:

- Broken sensor cable/contact
- Incorrectly mounted sensor
- Hardware fault with IMx-M input stage
- Signal disturbed by external noise

- Grounding loop

Suggested solution:

- First carry out sensor/cable test. In addition, check the sensor mounting. If this yields no result, contact SKF Condition Monitoring Center Luleå.

#### **Speed signal unobtainable/faulty for a certain machine**

Possible causes:

- Cable fault (short circuit/broken) to speed sensor
- Faulty speed sensor, or faulty installation
- Speed signal too weak/impedance too high for IMx-M
- Pulse duration too long or too short / frequency too low or too high
- Faulty IMx-M speed input
- Incorrect setting in hardware

Suggested solution:

- Test speed input.

#### **Analog input gives faulty/no signal**

Possible causes:

- Cable fault (short circuit/break) to sensor
- Faulty sensor
- Faulty earthing
- Incorrect setting in hardware
- Faulty IMx-M input

Suggested solution:

- Carry out control of sensor and cabling.

#### **IMx-M alarm relay does not activate despite of warning or alarm**

Possible causes:

- Disarm active

Suggested solution:

- Check the configuration.

#### **@ptitude Monitor ceases to work with a certain IMx-M rack**

Possible causes:

- Loss of voltage in IMx-M rack
- Hardware fault in IMx-M rack, such as power supply or processor module
- Break in Ethernet network

Suggested solution:

- Check the voltage of IMx-M rack. In addition, check the Ethernet built-in LED indicator behavior.
- If the problem continues, refer to "Application Note Testing and troubleshooting IMx network connections" in Application notes which is accessible at the top right hand corner of News in Observer screen of @ptitude Observer.

#### **@ptitude Monitor completely ceases to function**

Possible causes:

- Monitor PC non-functional
- Monitor software incorrectly set
- Ethernet switch non-functional
- Cable break in Ethernet network
- Firewall configuration incorrect
- Database non-functional

Suggested solution:

- Carry out "Checking monitor" in Component Check of this chapter.

#### **Modbus communication not working properly**

Suggested solution:

- Carry out "Checking Modbus connection, Protection part L1 and L2" in Component Check of this chapter.

## **Component Check**

### **Checking sensor and sensor cabling for vibration channels**

1. Determine the rack number and channel number of the channel in question through the measurement point information in the software, or through the list of terminal blocks.
2. Measure the DC voltage between the sensor wires on the IMx-M terminal block using a digital voltmeter. See the table below for the normal voltage values with and without a connected sensor respectively.

**Table 6-1: Normal voltage.**

Sensor type	Normal operating bias voltage (DC V)	Open circuit voltage (DC V)
Standard accelerometer	8 to 12 V	+24 V

3. Is the voltage within the normal working range?

YES: The cabling to the sensor is probably OK, and the sensor electronics have normal input impedance. If the sensor signal is still not perceived to be normal, one should try changing the sensor.

NO: Continue to step 5.

4. Does the fault remain after changing the sensor?  
YES: The fault may be in the analog input section of the IMx-M rack. Contact SKF Condition Monitoring Center Luleå for service and further information.  
NO: Sensor fault. The sensor is defective and must be replaced.
5. Is the voltage close to zero (typical  $< \pm 0.5$  V)?  
YES: There is probably a short circuit in the cable, or the sensor is defective. First, verify that the voltage rises to normal open circuit voltage when one of the sensor cable poles is disconnected from the terminal block of the IMx-M rack.  
NO: Continue to step 9.
6. Did the voltage rise to normal open circuit voltage?  
YES: Continue to step 8.  
NO: The sensor is not receiving power, continue below.
7. Is the sensor a standard type?  
YES: These are powered internally from the IMx-M rack. If the IMx-M rack does not supply open circuit voltage with input open, then the IMx-M input is probably damaged, or the input is not configured to supply a power feed to the sensor. Contact SKF Condition Monitoring Center Luleå.
8. The fault is in the sensor cable or the sensor. Go out to the sensor, and disconnect the cable at this end. Reconnect the cable on the IMx-M terminal block, and again measure the voltage over these two poles. Does the short circuit remain?  
YES: The sensor cable (or contact) has a short circuit. Repair the cabling.  
NO: The sensor is defective. Replace the sensor.
9. Is the voltage close to the open circuit voltage?  
YES: There is a break in the cable or the sensor is damaged. Continue below.  
NO: If the voltage appears to be neither within the normal working range, close to zero nor close to open circuit voltage, then the fault is an unusual one. First, check that the measurement was correctly carried out, then contact SKF Condition Monitoring Center Luleå. Remaining faults can be due to a damaged sensor or a damaged IMx-M input. First, disconnect one pole of the sensor cable, and measure the open circuit voltage to verify whether the open circuit voltage is normal. If it is normal, then the fault is probably in the sensor, otherwise the fault is in IMx-M.

10. Disconnect the connector from the sensor and short circuit the pins in the sensor contact, then remeasure the voltage on the IMx-M terminal block. Did the voltage sink to close to zero (<0.5 V)?

YES: There is an internal break in the sensor, or the contact is oxidized. First, try cleaning the contact before replacing the sensor.

NO: There is a break in the cable. Repair the cabling.

#### **Checking sensor and sensor cabling for analog channels**

1. Determine the rack number and channel number of the channel in question through the measurement point information in the software, or through the list of terminal blocks.
2. Measure the DC voltage between the sensor cable poles on the IMx-M terminal block using a digital voltmeter.
3. Does the terminal block have the expected voltage level (see sensor sensitivity and the current actual value of the measured object)?

YES: The sensor and cabling are probably OK. If the actual value is still not perceived to be normal, then the fault is probably in the channel settings, or there is a hardware fault in the IMx-M rack. Continue below.

NO: Continue to step 5.

4. Check through the current settings for the channel in question in the software. Determine the amplification, zero level, and the conversion to the user's rack. Furthermore, the cable check must be OFF (N). If this still does not produce the correct actual value, then the input card is probably damaged. Contact SKF Condition Monitoring Center Luleå.
5. The cable or the sensor is probably damaged. Test the cabling by disconnecting at the sensor end and connecting e.g. a 1.5 V battery. Does the input now measure the voltage?

YES: The sensor is probably not functioning correctly. However, first check that the channel is correctly configured according to the terminating resistor. In the list of terminal blocks, it can be determined whether the channel in question has a terminating resistor for current circuit. Check that this corresponds in reality, and that it corresponds to the sensor's mode of operation.

NO: The cabling is probably damaged. Continue to step 6.

6. Cable is probably damaged. However, first try disconnecting one of the poles on the cable from the IMx-M terminal block. If the voltage is OK, then the fault is in the IMx-M rack input stage. Otherwise, the cable is damaged and needs to be repaired.
7. Does the fault remain after replacing the sensor?

YES: The fault can be in the analog input part of the IMx-M rack. Contact SKF Condition Monitoring Center Luleå.

NO: It is a sensor fault. The sensor is defective and must be replaced.

### Checking speed input

1. Determine the rack number and speed input of the channel in question through the software measurement point setting or through the list of terminal blocks.
2. Measure the signal on the IMx-M terminal block using an oscilloscope or similar. Make sure to use an isolated oscilloscope.
3. Is there an expected speed signal on the IMx-M terminal block?

YES: The signal can be too weak or at too high impedance for the IMx-M speed input to be triggered. Sufficient voltage ripple (peak to peak) is shown in the electrical specifications. If the signal level is sufficient, then the IMx-M input is defective or the software is incorrectly configured. Check the settings in the program for the rack number and input number of the speed measurement point. Contact SKF Condition Monitoring Center Luleå for consultation.

NO: The cable is damaged, or the sensor is not sending the correct output signal. Check that the installation of the sensor is correct (is the machine rotating?). If this produces no result, check the cable. The entire chain from cable to input can be tested by linking a signal generator with a suitable frequency and amplitude at the sensor end. However, note that IMx-M normally supplies power to a sensor (as shown in the equipment list), which is why a coupling capacitor must then be connected in series, to avoid ruining the signal generator.

### Checking Monitor

1. Check first, whether the @ptitude Observer Monitor PC is functioning as it should be.
2. Try restarting the computer, if there is any doubt as to the status of the @ptitude Observer Monitor software.
3. Check also that the Ethernet network is functioning and that the @ptitude Observer Monitor computer can write to the server disk.

### Checking system circuit fault after a configuration download

1. If the rack/slot is armed (disarm released) within approximately 30 seconds after a configuration download, it could cause a missing/invalid configuration and the system could indicate a circuit fault.
2. 30 seconds is the approximate time needed to distribute configuration internally.
3. In this case of a circuit fault, the Channel status LEDs located on protection module are flashing, toggling between green/red/yellow while the STATUS Ready LED is slow flashing green (indicating a condition of protection module configured & running).



4. A protection part diagnostic command "cf" via IMx-M Manager tool would display circuit fault condition such as:

IOM = 0x8000  
IOS0 to IOS7 = 0x0101  
RELM, RELS0 to RELS7 = 0x0001

Then, the system resets every couple of minutes, still showing circuit fault condition such as:

IOM = 0x0000  
IOS0 to IOS7 = 0x0101  
RELM, RELS0 to RELS7 = 0x0001

5. The only way to solve this problem is to download a configuration again and wait till system startup before release disarm.

#### **Checking Modbus connection, protection part L1 and L2**

1. Check that the physical connections of RS485 cable wire are done correctly:

A, Data + (non-inverting)

B, Data - (inverting)

2. Check that transmission characteristics are defined correctly.

The settings in the protection configuration shall match the settings of the connected device that shall communicate with the IMx-M (for example, DCS), Baud rate, stop bits, etc.

3. Check that the Modbus Master-Slave pair address is entered correctly and that the selected slave device ID (1 - 247) is unique on the RS485 line. If L1 and L2 are connected to same RS485 line, then they shall have separate slave ID's as well.

4. Check that RS485 termination is done correctly.

If needed, it's possible to connect a termination resistor of 120 Ohm to the device at the end of the RS485 bus. This could be done by setting RS485 DIP switch 1 (L1) and 2 (L2) to ON. See chapter [DIP Switches on Protection Module](#).

5. The RS485 LEDs of the front of the PRM shall flash at the same rate as the RS485 communication. If the communication rate is high, a steady light will be shown.

Diagnostic commands mb10 and mb20 may also give some information about the Modbus communication.

They will report number of received and transmitted messages for L1 (mb10) and L2 (mb20) and if errors are detected. See chapter [Protection Part Diagnostic Commands](#).

## Firmware Recovery

### Problem

The replacement of a module or an unsuccessful installation of firmware may result in the PRM indicating a CF for internal communications problem.

Table 6-2: FW version compatibility.

		FW version of PRM slave, RLM master and RLM slave			
		192	214	236	> 300
FW version of PRM master	192	OK	Not OK	Not OK	OK
	214	Not OK	OK	OK	OK
	236	Not OK	OK	OK	OK
	> 300	Not OK	Not OK	Not OK	OK

OK: FW versions are compatible and can be upgraded without further actions.

Not OK: FW versions are not compatible and can NOT be upgraded. First, the PRM master FW must be changed to the same FW version as the slaves. Then the FW upgrade to the desired version is possible.



**Important - It is strongly advised to disarm the slot before executing the diagnostic command "sver".**

#### To obtain the FW versions, do the following:

1. Start IMx-M Manager serial interface to PRM.
2. Put the slot in disarm mode.
3. Use **Advanced debug mode**, run command "**Slave version**" from the menu. This command automatically perform the diagnostic commands **intd0** and **sver**.
4. Evaluate the results of **intd0**.
  - ✓ If the result from **intd0** shows firmware versions on all lines, then there is no internal communication problem. FW upgrade can be done without further actions.
  - ✓ If the result from **intd0** shows firmware version 0000 on some of the lines, then go to the step 5.
5. Evaluate the results of **sver**.
  - ✓ If the result shows firmware version that was 0000 in step 4 but now is non-zero, then there is an internal communication problem. Check the table "FW version comparability" and continue to **Resolution**.

### Resolution

To solve the problem the PRM master firmware (IOM) must be downgraded to the same firmware as the slaves.

1. Use the recovery firmware installed in the IMx-M Manager directory.
2. Install the recovery firmware to the PRM master using:

- a. **PRM serial interface -> Advanced debug mode**
- b. **Advanced debug mode -> Update Master Firmware**

When PRM master have the same firmware as the slaves the internal communication problem is solved and a normal firmware upgrade can be done for both PRM master and PRM slaves.

**Example:**

The following is an internal communication problem caused by using different firmware versions as described below.

- PRM master (IOM) using firmware version 359.
- PRM slaves (IOS) using firmware version 236.
- RLM master (RELM) and slaves (RELS) using firmware version 236.

Check firmware versions with the command **Slave version**.

In this example, only the PRM master FW version is shown in the response as below. It is because PRM slaves and RLM master and slaves are not the same as the PRM master FW version.

**Response from PRM:**

```
intd0
FW Versions:
IOM = 0359
IOS0 = 0000
IOS1 = 0000
IOS2 = 0000
IOS3 = 0000
IOS4 = 0000
IOS5 = 0000
IOS6 = 0000
IOS7 = 0000
RELM = 0000
RELS0= 0000
RELS1= 0000
RELS2= 0000
RELS3= 0000
RELS4= 0000
RELS5= 0000
RELS6= 0000
RELS7= 0000

MFW CRC: E6DFA50A

SFW CRC: 00000000

sver
FW Versions:
IOM = 0359
IOS0 = 0236
IOS1 = 0236
IOS2 = 0236
IOS3 = 0236
IOS4 = 0236
IOS5 = 0236
```

IOS6 = 0236  
IOS7 = 0236  
RELM = 0236  
RELS0= 0236  
RELS1= 0236  
RELS2= 0236  
RELS3= 0236  
RELS4= 0236  
RELS5= 0236  
RELS6= 0236  
RELS7= 0236

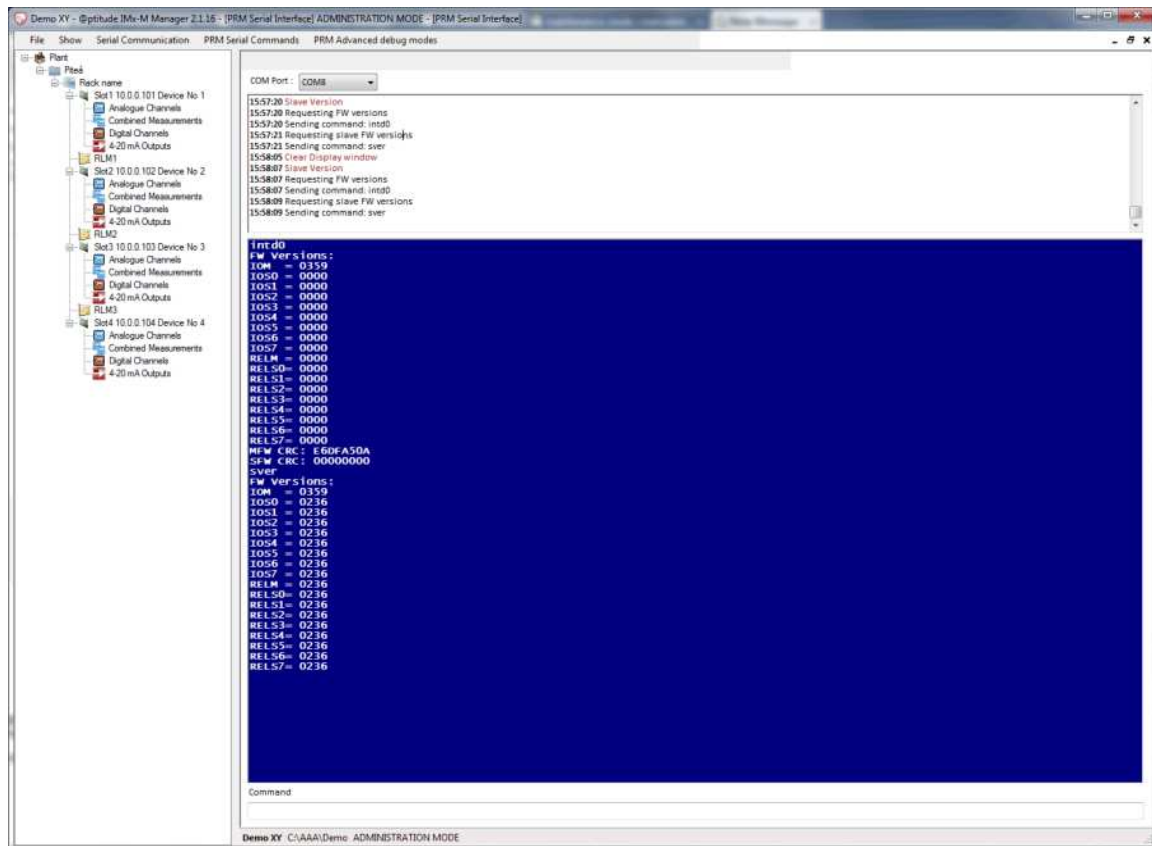


Figure 6 - 1.  
Responses from PRM.

### **Environmental**

---

- 19" rack mounted, 6U high
- Size (height x width x depth): 266 x 482 x 240 mm (10.5 x 19 x 9.4 in.)
- Weight: 13,6 kg (30 lb.) for a fully equipped rack
- Temperature range:
  - –20 to +70 °C (–4 to +158 °F) in storage
  - –20 to +65 °C (–4 to +149 °F) in operational mode
- Encapsulation IP 20
- Humidity 95% (relative) non-condensing
- Overvoltage category II
- Pollution degree 2
- Altitude maximum 2 000 m (6 562 ft.)

### **Rack**

---

- 2 Power Supply Units
- 4 condition monitoring modules and 4 protection modules (always mounted in pairs)
- 3 relay modules
- Screw terminals, RJ45 and D-sub connectors on the rear
- Event Log: minimum of 1 400 latest events can be stored on each CMM + PRM slot

### **Power Supply**

---

- 90 to 240 VAC, 47 to 63 Hz, 300 W maximum
- Redundant option, individual mains terminals

## Power Consumption

---

- The power consumption and heat dissipation is dependent of number of slots equipped in the rack and can be approximated as follows:

Power to the rack = number of slots used x 75 W (including sensor power etc.)  
(max 300 W)

Heat dissipation from rack = number of slots used x 50 W (max 200 W)

- Usage of redundant power has no significant effect on the above numbers.

## Analog Inputs - Protection & CM

---

- 16 to 64 analog differential inputs
- Half of the total number of analog differential inputs (which can be 8 to 32 analog inputs) supports RTD (Pt100, 3-wire) temperature sensors
- Temperature input sensor Pt100 (100  $\Omega$  at 0 °C, 0.00385  $\Omega$ / °C)
- Individual 24 V (23.5-28 V) power supply, maximum 30 mA per channel
- Selectable standard accelerometer power supply (constant current 8 mA)
- Input range:  $\pm 23$  V
- Impedance: >100 k $\Omega$

## Digital Inputs - Protection & CM

---

- 8 to 32 digital opto-isolated inputs
- Half of the total number of digital opto-isolated inputs (which can be 4 to 16 digital opto-isolated inputs) supports Eddy current probes
- Individual 24 V (23.5-28 V) power supply, maximum 30 mA per channel
- Disarm functionality

## Outputs - Protection

---

- 16 to 64 electrically isolated 4–20 mA outputs
- Buffered analog channels on D-sub, maximum  $\pm 11$  V, signal 1:2, cutoff frequency (-3 dB) at 60 kHz
- Buffered digital channels on D-sub, 5 V TTL signal
- Two selectable buffered analog channels on front panel BNC, maximum  $\pm 11$  V, signal 1:2, cutoff frequency (-3 dB) at 60 kHz
- One selectable buffered digital channel on front panel BNC, 5 V TTL signal
- Up to 96 configurable relay outputs (Disarm, Alert, Danger, Not OK and Voting)

- Slot status circuit fault (CF) relay output
- Slot disarm (Dis) relay output

### **Analog Measurement - Protection**

---

- 16-bit AD conversion enabling continuous transient capture (no gain or AC/DC switching required)
- True simultaneous sampling of all 64 channels (no multiplexing)
- Simultaneous sampling of different channels with different sampling rates
- Frequency range: from DC to 10 kHz
- Dynamic range: 90 dB
- Signal to noise ratio: 90 dB
- Cross-talk rejection: 100 dB
- Accuracy amplitude:  $\pm 2\%$  (Velocity 1 000 to 10 000 Hz,  $\pm 3\%$ )  
Typical accuracy amplitude  $< \pm 1\%$  of API 670 defined full scale range.  
**Note:** Filters  $\pm 0,5$  dB in passband
- Accuracy measurement type Other:  
 $\pm 1\%$  for 0-10 VDC input  
 $\pm 2,9\%$  for 4-20 mA input

**Note:** Accuracy  $\pm 1\%$  ( $\pm 2,9\%$  for 4-20 mA) is only fulfilled if the complete 0-10 V or complete 4-20 mA range is utilized to reflect the configured full scale.

### **Digital Measurement – Protection**

---

- Frequency range: 0,1 Hz to 7,5 kHz (Eddy current probe low frequency limit 2 Hz)
- Required pulse width:  $> 25 \mu\text{s}$  for electrical positive,  $> 67 \mu\text{s}$  for electrical negative
- Accuracy frequency: 0,05% of measurement value (typically 0,01% up to 2,5 kHz)
- Peak speed detection.

### Relay - Protection

---

- Maximum switching voltage: up to 60 V DC, 30 V RMS/42,4 V peak
- Maximum switching capacity: 60 W, 62,5 VA
- Maximum switching current: max 2 A peak, max 1 A continuously
- Mechanical endurance: typical  $10^8$  operations
- Electrical endurance: minimum  $10^5$  operations at maximum rating
- Category of protection: hermetically sealed (RTV)

### Signal Processing - Protection

---

- Measurements:  
Radial shaft vibration, Casing vibration, Position, Temperature, Absolute shaft vibration, Eccentricity (PtP 3–300 rpm), Complementary differential expansion, Piston rod drop (average / triggered)
- Detection types:  
true Peak to Peak, true Zero to Peak ("true Peak to Peak" / 2), true RMS
- Math type: integration
- Filter Options:  
5–1 000 Hz, 10–1 000 Hz for all channels  
10–5 000 Hz or 1 000–10 000 Hz as a single channel on paired channels  
User defined filters
- Detection of sensor and cable fault
- Watchdog and self testing

### Interface - Protection

---

- USB diagnostic service interface
- RS485/Modbus L1–L2

### Analog Measurement - CM

---

- 24-bit AD conversion enabling continuous transient capture (no gain or AC/DC switching required)
- True simultaneous sampling of all 64 channels (no multiplexing)
- Simultaneous sampling of different channels with different sampling rates
- Frequency range: from DC to 40 kHz
- Dynamic range: 120 dB



- Signal to noise ratio: 90 dB
- Cross-talk rejection: 100 dB
- Accuracy amplitude:
  - ±2% (up to 10 kHz),
  - ±5% (10 to 20 kHz)
  - ±10% (20 to 30 kHz)
  - ±20% (30 to 40 kHz)
- Accuracy phase ±3° (up to 100 Hz)

### **Digital Measurement - CM**

---

- Frequency range: 0,1 Hz to 7,5 kHz (Eddy current probe low frequency limit 2 Hz)
- Required pulse width: > 25 µs for electrical positive, > 67 µs for electrical negative
- Accuracy frequency: 0,05% of measurement value (typically 0,01% up to 2,5 kHz)
- Pulse counting

### **Signal Processing - CM**

---

- Time waveform
- Vector analysis with circular alarms
- FFT 400 to 6 400 lines
- DPE (Digital Peak Enveloping)
- SKF Enveloping
- Integration/Derivation in frequency domain
- Window function: Hanning
- Customer formulated mathematical equations
- Dynamic alarm levels, active range determined on multiple parameters
- Data storage on time, event or alarm condition
- Data buffering in flash memory when communication link is down
- Detection of sensor and cable fault
- Watchdog and self testing

### **Interface - CM**

---

- Ethernet: 100 Mbit RJ45, TCP/IP, switch functionality

- USB diagnostic service interface
- RS485/Modbus L3 for CM part is not available for use

### Miscellaneous

---

- CE conformity according to;  
EN 61000-6-4:2007, EN 61000-6-2:2005  
EN/IEC61010-1:2010, EN/IEC61010-1:2001
- ETL certified according to;  
UL61010-1 2<sup>nd</sup> Edition  
CAN/CSA-22.2 No 61010-1-12
- Calibration, traceable to BIPM
- Certified Standards:  
IEC 61010-1: 2010  
IEC 61010-1: 2001  
UL 61010-1, 2<sup>nd</sup> Edition  
CAN/CSA-22.2 No. 61010-1-12  
AS 61010-1: 2003
- IMx-M MTTF calculations:  
IMx-M machine protection system: 20,8 years  
Protection Module: 25,2 years  
Relay Module: 139,6 years  
Backplane: 772,3 years

**Note:** the above calculations are based on a system comprised of two analog and one speed channel, refer [MTTF](#) section for full details.

### Quality Control

---

SKF Condition Monitoring Center Luleå is ISO 9001:2008 certified

Drawings and Connections

IMx-M Rack Drawing with Dimensions

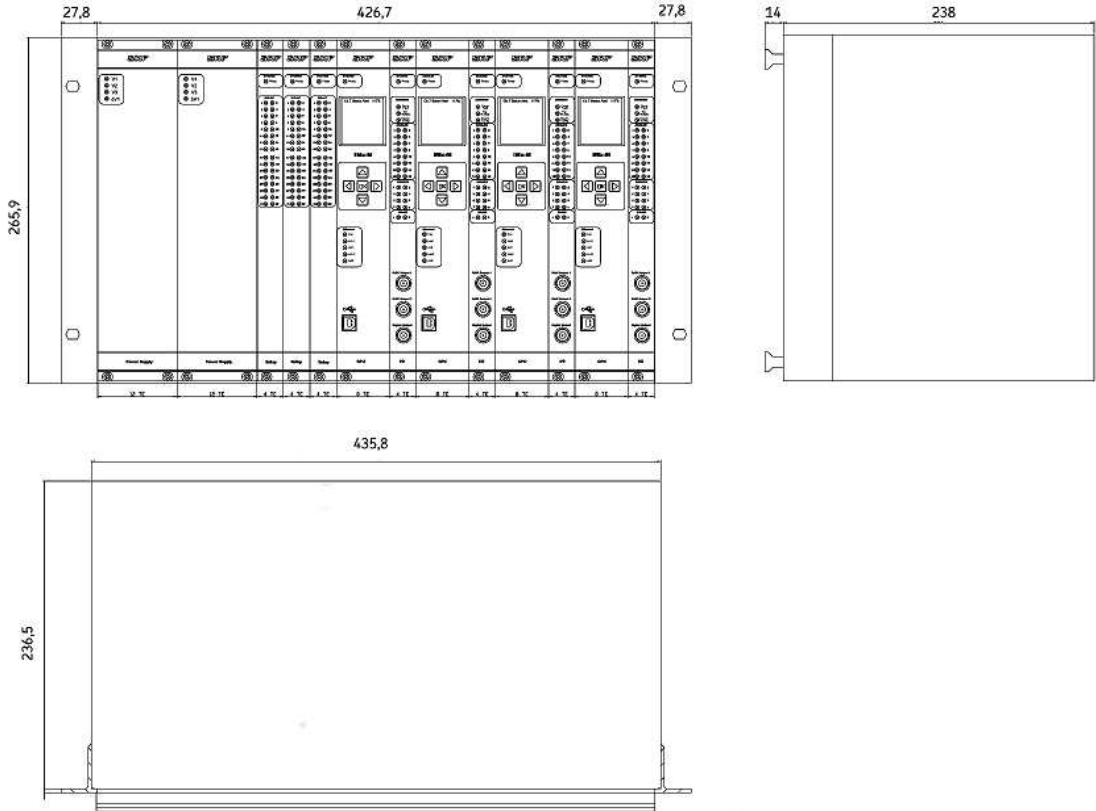


Figure 7 - 1.  
IMx-M Rack Dimensions.

### Front Panel

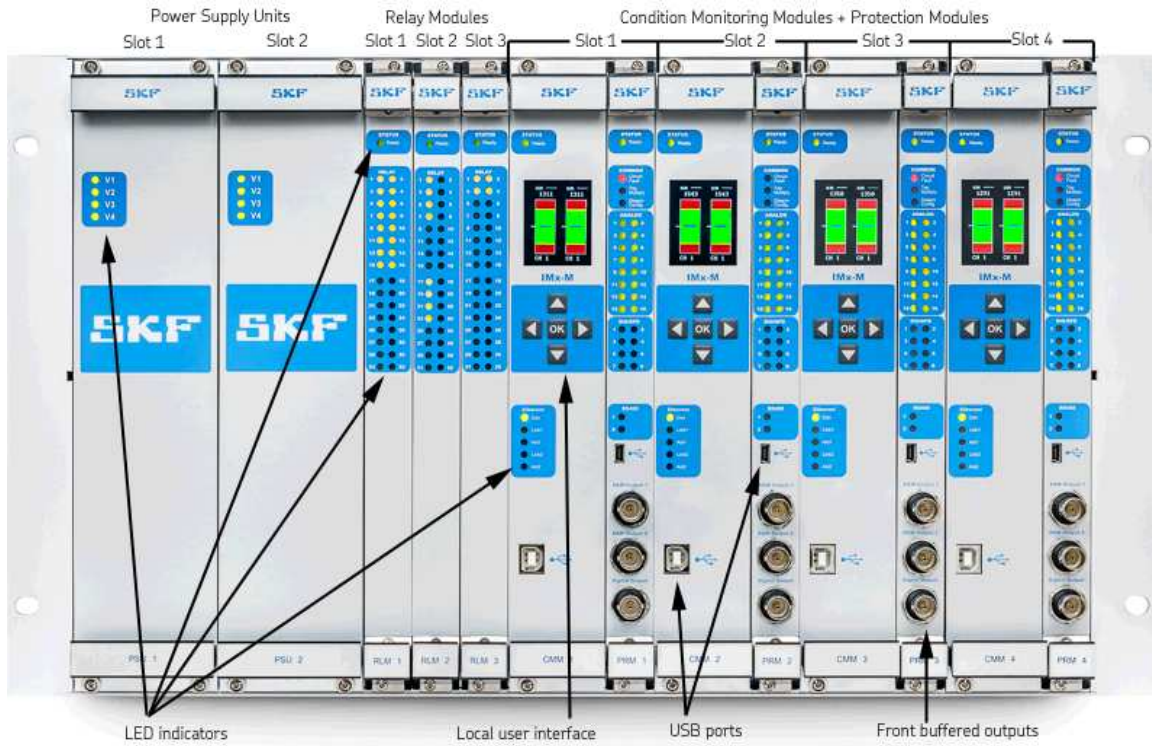


Figure 7 - 2.  
IMx-M Front Panel.

## Rear Panel

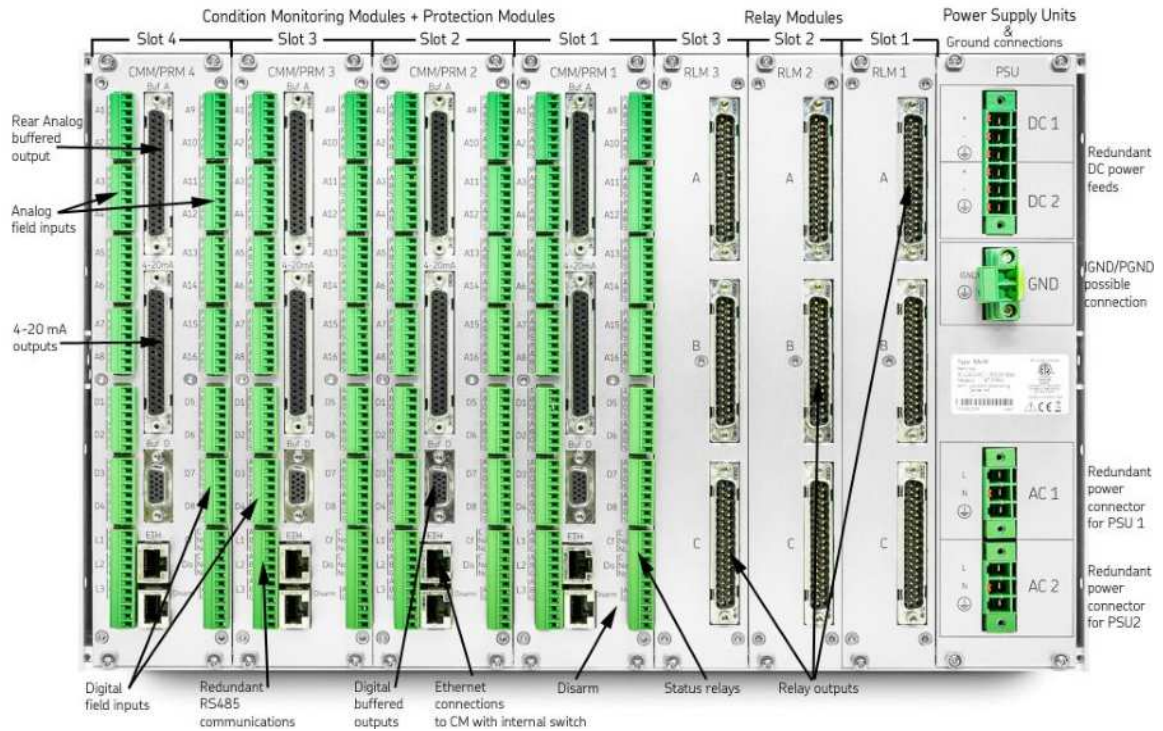


Figure 7 - 3.  
 IMx-M Rear Panel.

### Power Supply Unit (PSU)

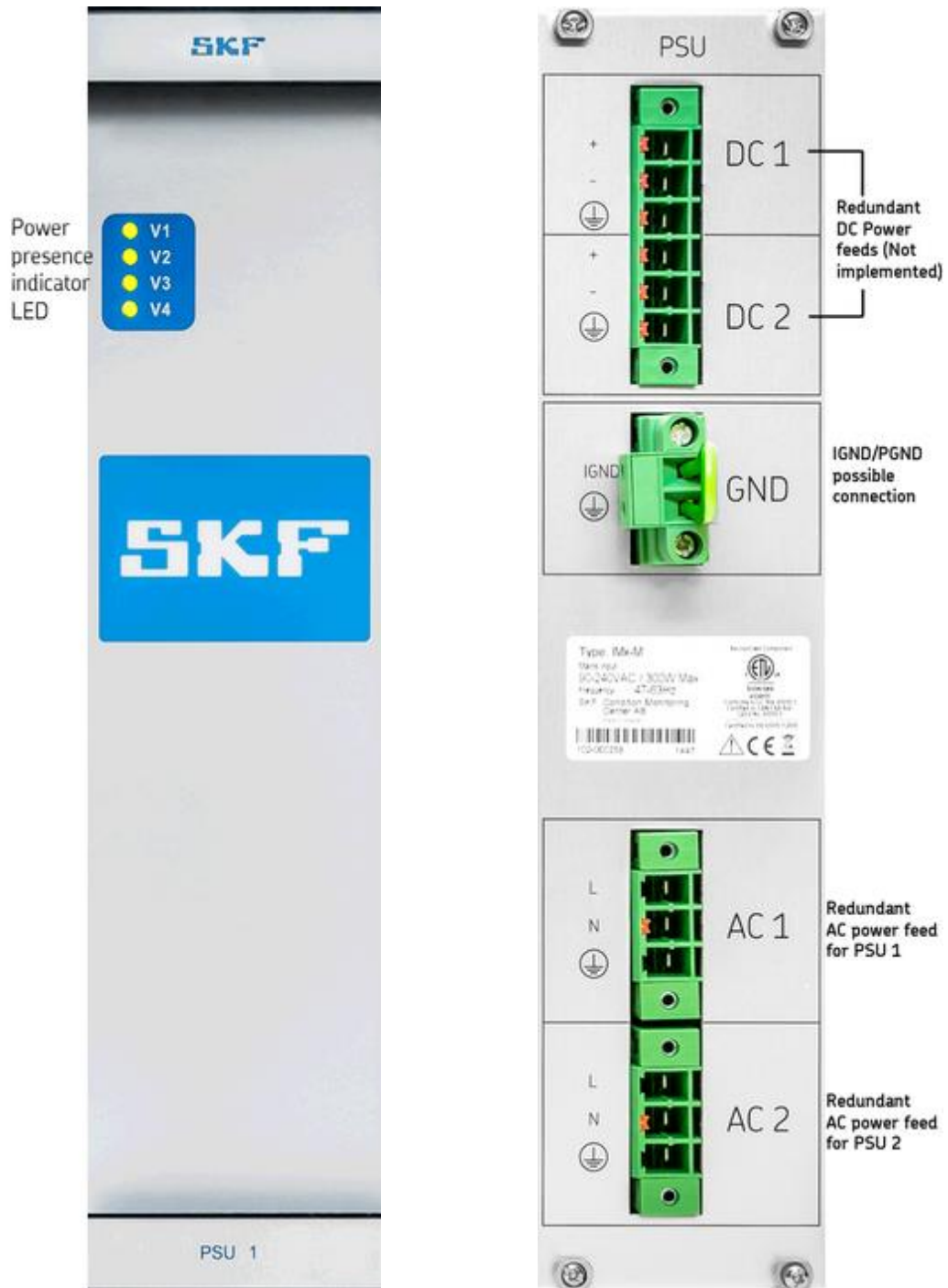


Figure 7 - 4.  
IMx-M PSU Front and Rear View.

**Relay Module (RLM)**

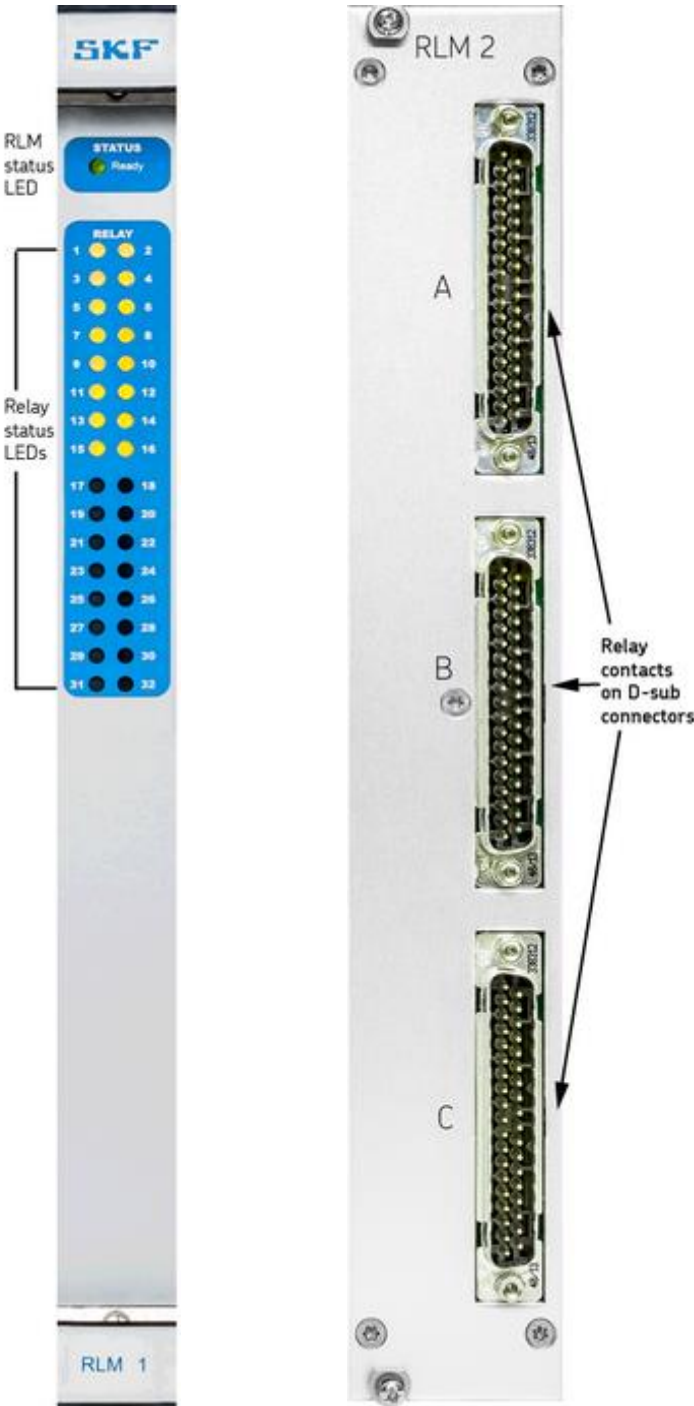


Figure 7 - 5.  
IMx-M RLM Front and Rear View.

### Condition Monitoring Module (CMM)

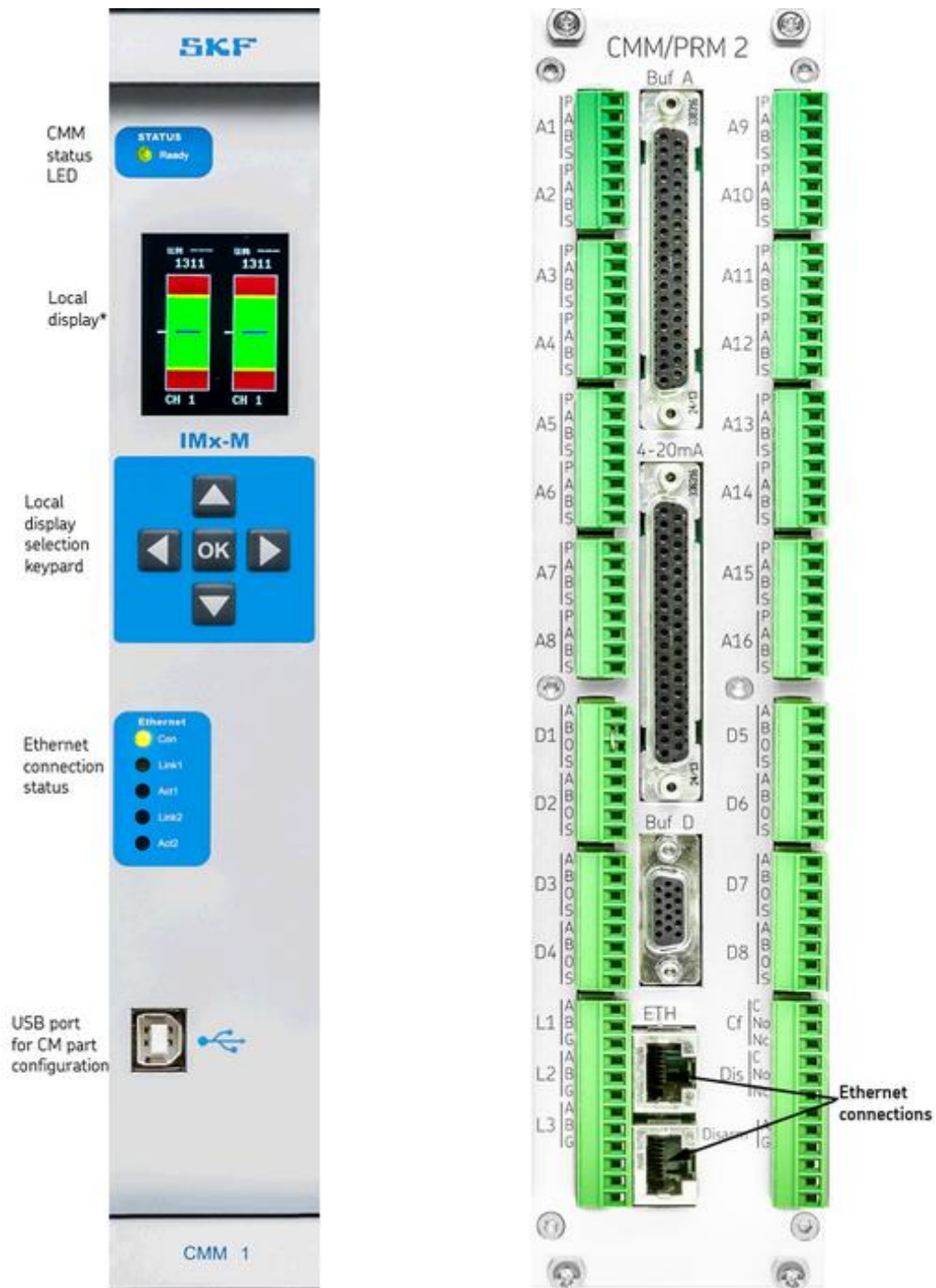


Figure 7 - 6.  
IMx-M CMM Front View and Rear View of CMM+PRM Slot.

\*Local display and Local display selection keypad are used to locally control the protection part. For detailed information, refer to [Local Display and Local Display Selection Keypad](#).



### Protection Module (PRM)

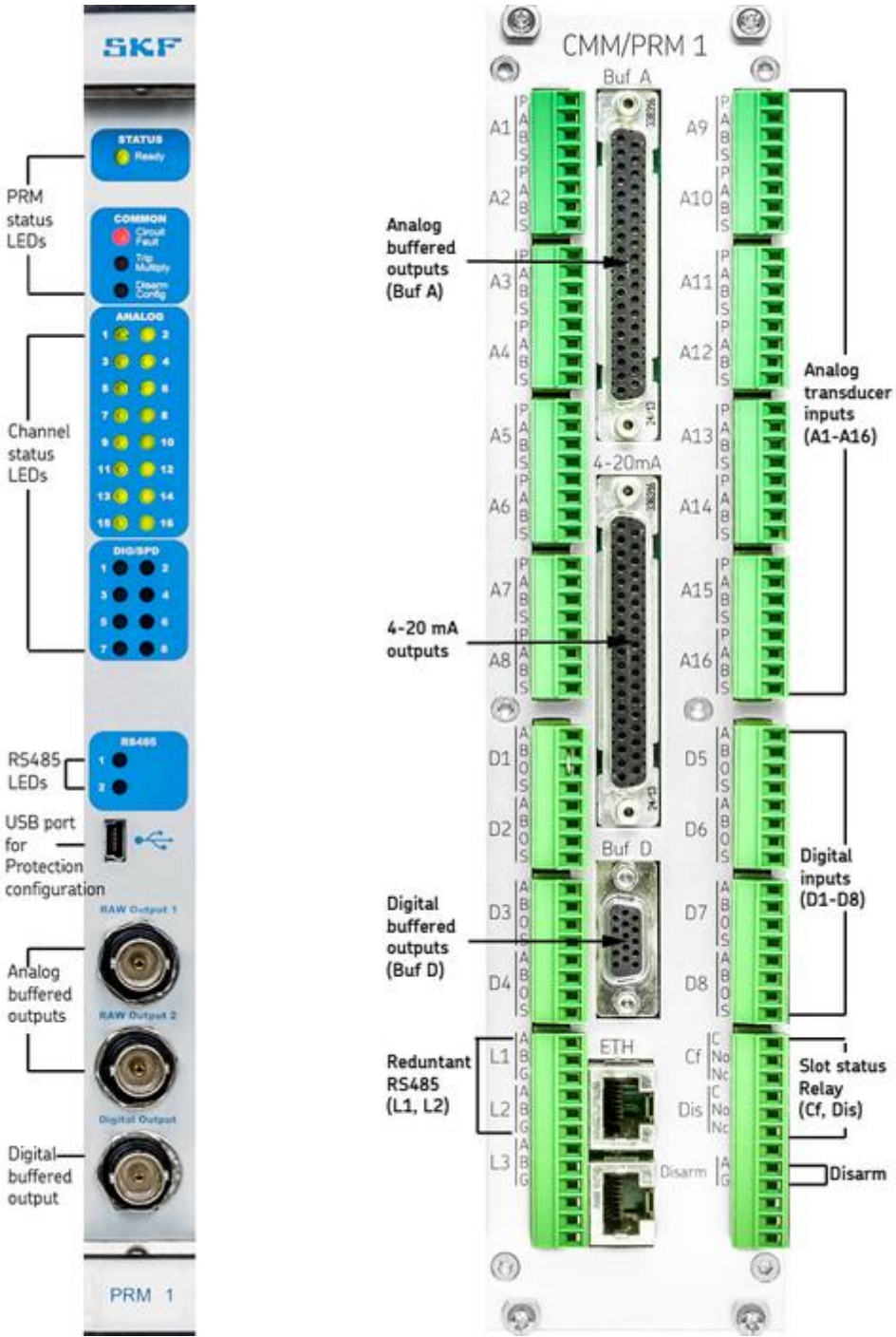


Figure 7 - 7.  
IMx-M Protection Module Front View and Rear View of CMM + PRM Slot.

## CMM + PRM Slot Connections



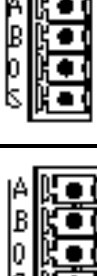




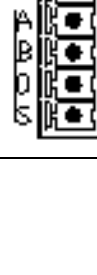
### Analog Inputs

Table 7-1: CMM + PRM slot connections - Analog Inputs.

Analog Inputs on the back of CMM+PRM Slot											
A1		A1 P	Analog ch 1 Power	A9		A9 P	Analog ch 9 Power				
		A1 A	Analog ch 1 A			A9 A	Analog ch 9 A				
		A1 B	Analog ch 1 B			A9 B	Analog ch 9 B				
		A1 S	Analog ch 1 Shield			A9 S	Analog ch 9 Shield				
		A2				A2 P	Analog ch 2 Power	A10		A10 P	Analog ch 10 Power
						A2 A	Analog ch 2 A			A10 A	Analog ch 10 A
A2 B	Analog ch 2 B			A10 B	Analog ch 10 B						
		A2 S	Analog ch 2 Shield			A10 S	Analog ch 10 Shield				
A3		A3 P	Analog ch 3 Power	A11		A11 P	Analog ch 11 Power				
		A3 A	Analog ch 3 A			A11 A	Analog ch 11 A				
		A3 B	Analog ch 3 B			A11 B	Analog ch 11 B				
A4		A3 S	Analog ch 3 Shield	A12		A11 S	Analog ch 11 Shield				
		A4 P	Analog ch 4 Power			A12 P	Analog ch 12 Power				
		A4 A	Analog ch 4 A			A12 A	Analog ch 12 A				
		A4 B	Analog ch 4 B			A12 B	Analog ch 12 B				
		A4 S	Analog ch 4 Shield			A12 S	Analog ch 12 Shield				
A5		A5 P	Analog ch 5 Power	A13		A13 P	Analog ch 13 Power				
		A5 A	Analog ch 5 A			A13 A	Analog ch 13 A				
		A5 B	Analog ch 5 B			A13 B	Analog ch 13 B				
A6		A5 S	Analog ch 5 Shield	A14		A13 S	Analog ch 13 Shield				
		A6 P	Analog ch 6 Power			A14 P	Analog ch 14 Power				
		A6 A	Analog ch 6 A			A14 A	Analog ch 14 A				
		A6 B	Analog ch 6 B			A14 B	Analog ch 14 B				
		A6 S	Analog ch 6 Shield			A14 S	Analog ch 14 Shield				
A7		A7 P	Analog ch 7 Power	A15		A15 P	Analog ch 15 Power				
		A7 A	Analog ch 7 A			A15 A	Analog ch 15 A				
		A7 B	Analog ch 7 B			A15 B	Analog ch 15 B				
A8		A7 S	Analog ch 7 Shield	A16		A15 S	Analog ch 15 Shield				
		A8 P	Analog ch 8 Power			A16 P	Analog ch 16 Power				
		A8 A	Analog ch 8 A			A16 A	Analog ch 16 A				
		A8 B	Analog ch 8 B			A16 B	Analog ch 16 B				
		A8 P	Analog ch 8 Shield			A16 S	Analog ch 16 Shield				

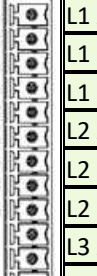
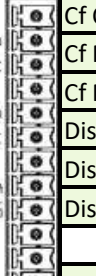
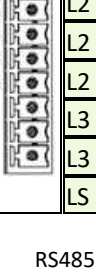
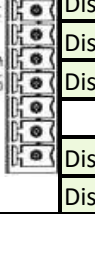
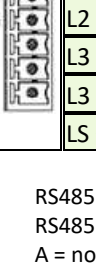
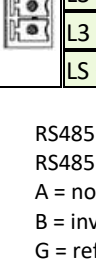
**Digital Inputs**

**Table 7-2: CMM + PRM slot connections - Digital Inputs.**

Digital Inputs on the back of CMM+PRM Slot							
D1		D1 A	Digital ch 1 A	D5		D5 A	Digital ch 5 A
		D1 B	Digital ch 1 B			D5 B	Digital ch 5 B
		D1 O	Digital ch 1 O			D5 O	Digital ch 5 O
		D1 S	Digital ch 1 Shield			D5 S	Digital ch 5 Shield
D2		D2 A	Digital ch 2 A	D6		D6 A	Digital ch 6 A
		D2 B	Digital ch 2 B			D6 B	Digital ch 6 B
		D2 O	Digital ch 2 O			D6 O	Digital ch 6 O
		D2 S	Digital ch 2 Shield			D6 S	Digital ch 6 Shield
D3		D3 A	Digital ch 3 A	D7		D7 A	Digital ch 7 A
		D3 B	Digital ch 3 B			D7 B	Digital ch 7 B
		D3 O	Digital ch 3 O			D7 O	Digital ch 7 O
		D3 S	Digital ch 3 Shield			D7 S	Digital ch 7 Shield
D4		D4 A	Digital ch 4 A	D8		D8 A	Digital ch 8 A
		D4 B	Digital ch 4 B			D8 B	Digital ch 8 B
		D4 O	Digital ch 4 O			D8 O	Digital ch 8 O
		D4 S	Digital ch 4 Shield			D8 S	Digital ch 8 Shield

**RS485, Relay Outputs, Rack Disarm**

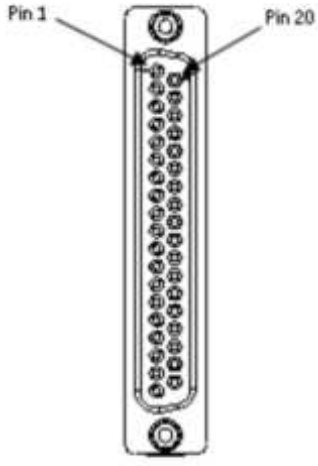
**Table 7-3: CMM + PRM slot connections - RS485, Relay Outputs and Rack Disarm.**

RS485, Relay Outputs, Rack Disarm on the back of CMM+PRM Slot											
L1		RS485		Cf		Relay Outputs					
		L1 A	RS485 Line 1 A			Cf C	Circuit fault relay common				
		L1 B	RS485 Line 1 B			Cf No	Circuit fault relay normally open				
		L1 G	RS485 Line 1 GND			Cf Nc	Circuit fault relay normally closed				
		L2				L2 A	RS485 Line 2 A	Dis		Dis C	Disarm relay common
						L2 B	RS485 Line 2 B			Dis No	Disarm relay normally open
						L2 G	RS485 Line 2 GND			Dis Nc	Disarm relay normally closed
		L3				L3 A	RS485 Line 3 A	Rack Disarm			
						L3 B	RS485 Line 3 B				
		LS				L3 G	RS485 Line 3 GND	Disarm A	Disarm A		
				Disarm G	Disarm GND						

RS485 L1 and L2 are connected to PRM.  
 RS485 L3 is connected to CMM. Not used.  
 A = non-inverting  
 B = inverting  
 G = reference ground

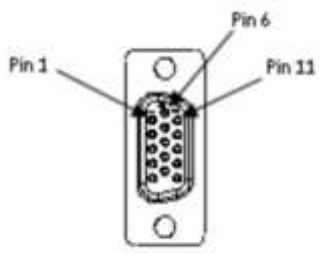
**Buffered Analog Channel Out**

**Table 7-4: CMM + PRM slot connections - buffered analog channel out.**

Buffered Analog Channels Out				Buf A, D-Sub (37p) on a CMM + PRM slot
Pin	Connection	Pin	Connection	 <p>View from rear of the rack</p>
1	Analog Ch 1 A	20	IGND	
2	Analog Ch 2 A	21		
3	Analog Ch 3 A	22		
4	Analog Ch 4 A	23		
5	Analog Ch 5 A	24		
6	Analog Ch 6 A	25		
7	Analog Ch 7 A	26		
8	Analog Ch 8 A	27		
9	Analog Ch 9 A	28		
10	Analog Ch 10 A	29		
11	Analog Ch 11 A	30		
12	Analog Ch 12 A	31		
13	Analog Ch 13 A	32		
14	Analog Ch 14 A	33		
15	Analog Ch 15 A	34		
16	Analog Ch 16 A	35		
17	IGND	36		
18		37		
19		-		

**Buffered Digital Channel Out**

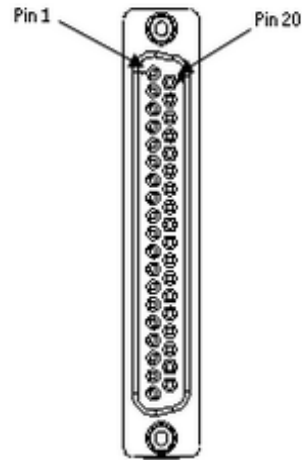
**Table 7-5: CMM + PRM slot connections - buffered digital channel out.**

Buffered Digital Channels Out		Buf D, D-Sub (15p) on a CMM + PRM slot
Pin	Connection	 <p>View from rear of the rack</p>
1	Digital Ch 1 A	
2	Digital Ch 2 A	
3	Digital Ch 3 A	
4	Digital Ch 4 A	
5	Digital Ch 5 A	
6	Digital Ch 6 A	
7	Digital Ch 7 A	
8	Digital Ch 8 A	
9 - 15	IGND	

**4-20 mA Out**

**Table 7-6: CMM + PRM slot connections for 4-20 mA out.**

Output	Pin	4-20 mA Out ch
1	1	4-20mA Out 1+
	20	4-20mA Out 1-
2	2	4-20mA Out 2+
	21	4-20mA Out 2-
3	3	4-20mA Out 3+
	22	4-20mA Out 3-
4	4	4-20mA Out 4+
	23	4-20mA Out 4-
5	5	4-20mA Out 5+
	24	4-20mA Out 5-
6	6	4-20mA Out 6+
	25	4-20mA Out 6-
7	7	4-20mA Out 7+
	26	4-20mA Out 7-
8	8	4-20mA Out 8+
	27	4-20mA Out 8-
9	9	4-20mA Out 9+
	28	4-20mA Out 9-
10	10	4-20mA Out 10+
	29	4-20mA Out 10-
11	11	4-20mA Out 11+
	30	4-20mA Out 11-
12	12	4-20mA Out 12+
	31	4-20mA Out 12-
13	13	4-20mA Out 13+
	32	4-20mA Out 13-
14	14	4-20mA Out 14+
	33	4-20mA Out 14-
15	15	4-20mA Out 15+
	34	4-20mA Out 15-
16	16	4-20mA Out 16+
	35	4-20mA Out 16-
-	17	NC
	36	
	18	
	37	
	19	



4-20 mA D-Sub (37p)  
 View from rear of the rack

## Relay Module (RLM) Connections

Table 7-7: Relay Module connections.

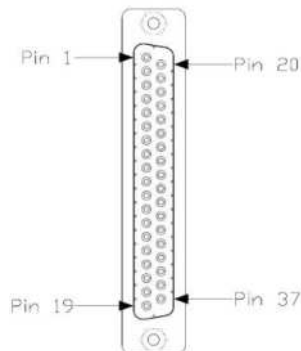
Relay Connector A

Relay nr	Pin (before rev. 3)	Pin (from rev.3)	Relay connection
1	1	19	Re1Com
	2	18	Re1NO
	3	17	Re1NC
2	4	16	Re2Com
	5	15	Re2NO
	6	14	Re2NC
3	7	13	Re3Com
	8	12	Re3NO
	9	11	Re3NC
4	10	10	Re4Com
	11	9	Re4NO
	12	8	Re4NC
5	13	7	Re5Com
	14	6	Re5NO
	15	5	Re5NC
6	16	4	Re6Com
	17	3	Re6NO
	18	2	Re6NC
-	19	1	No Connection

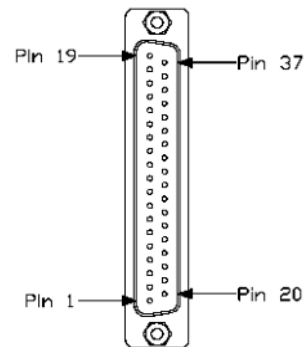
Relay nr	Pin (before rev. 3)	Pin (from rev.3)	Relay connection
7	20	37	Re7Com
	21	36	Re7NO
	22	35	Re7NC
8	23	34	Re8Com
	24	33	Re8NO
	25	32	Re8NC
9	26	31	Re9Com
	27	30	Re9NO
	28	29	Re9NC
10	29	28	Re10Com
	30	27	Re10NO
	31	26	Re10NC
11	32	25	Re11Com
	33	24	Re11NO
	34	23	Re11NC
12	35	22	Re12Com
	36	21	Re12NO
	37	20	Re12NC

ReXCom = Relay nr X, Common  
 ReXNO = Relay nr X, Normally Open  
 ReXNC = Relay nr X, Normally Closed

For default relay connection in normally de-energized / normally energized, see [Relays on Relay Modules](#).



Pin numbers for relay connector board before rev. 3 (female), front side



Pin numbers for relay connector board from rev. 3 (male), front side

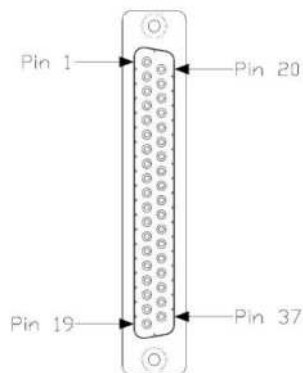
Relay Connector B

Relay nr	Pin (before rev. 3)	Pin (from rev.3)	Relay connection
13	1	19	Re13Com
	2	18	Re13NO
	3	17	Re13NC
14	4	16	Re14Com
	5	15	Re14NO
	6	14	Re14NC
15	7	13	Re15Com
	8	12	Re15NO
	9	11	Re15NC
16	10	10	Re16Com
	11	9	Re16NO
	12	8	Re16NC
17	13	7	Re17Com
	14	6	Re17NO
	15	5	Re17NC
18	16	4	Re18Com
	17	3	Re18NO
	18	2	Re18NC
-	19	1	No Connection

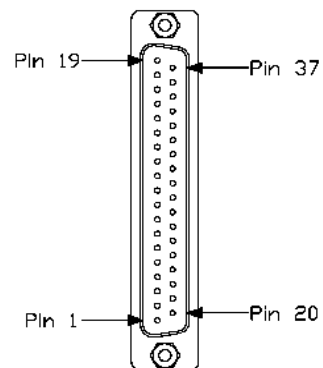
Relay nr	Pin (before rev. 3)	Pin (from rev.3)	Relay connection
19	20	37	Re19Com
	21	36	Re19NO
	22	35	Re19NC
20	23	34	Re20Com
	24	33	Re20NO
	25	32	Re20NC
21	26	31	Re21Com
	27	30	Re21NO
	28	29	Re21NC
22	29	28	Re22Com
	30	27	Re22NO
	31	26	Re22NC
23	32	25	Re23Com
	33	24	Re23NO
	34	23	Re23NC
24	35	22	Re24Com
	36	21	Re24NO
	37	20	Re24NC

ReXCom = Relay nr X, Common  
 ReXNO = Relay nr X, Normally Open  
 ReXNC = Relay nr X, Normally Closed

For default relay connection in normally de-energized / normally energized, see [Relays on Relay Modules.](#)



Pin numbers for relay connector board before rev. 3 (female), front side



Pin numbers for relay connector board from rev. 3 (male), front side

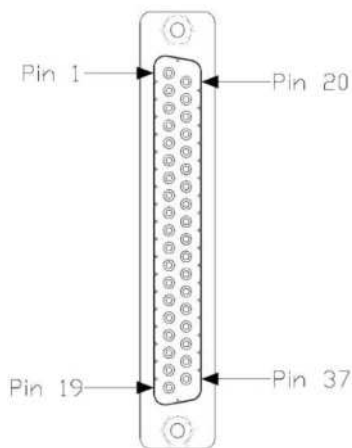
Relay Connector C

Relay nr	Pin (before rev. 3)	Pin (from rev.3)	Relay connection
25	1	19	Re25Com
	2	18	Re25NO
	3	17	Re25NC
26	4	16	Re26Com
	5	15	Re26NO
	6	14	Re26NC
27	7	13	Re27Com
	8	12	Re27NO
	9	11	Re27NC
28	10	10	Re28Com
	11	9	Re28NO
	12	8	Re28NC
29	13	7	Re29Com1
	14	6	Re29NO1
	15	5	Re29NC1
	16	4	Re29Com2
	17	3	Re29NO2
	18	2	Re29NC2
-	19	1	No Connection

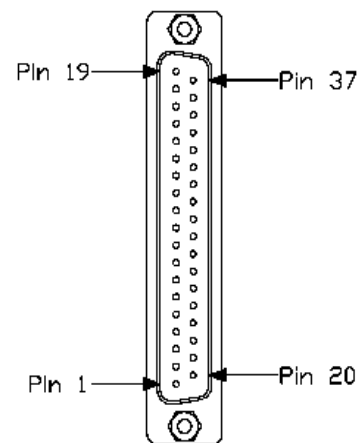
Relay nr	Pin (before rev. 3)	Pin (from rev.3)	Relay connection
30	20	37	Re30Com1
	21	36	Re30NO1
	22	35	Re30NC1
	23	34	Re30Com2
	24	33	Re30NO2
	25	32	Re30NC2
	31	26	31
27		30	Re31NO1
28		29	Re31NC1
29		28	Re31Com2
30		27	Re31NO2
31		26	Re31NC2
32	32	25	Re32Com1
	33	24	Re32NO1
	34	23	Re32NC1
	35	22	Re32Com2
	36	21	Re32NO2
	37	20	Re32NC2

ReXCom = Relay nr X, Common  
 ReXNO = Relay nr X, Normally Open  
 ReXNC = Relay nr X, Normally Closed

For default relay connection in normally de-energized / normally energized, see [Relays on Relay Modules](#).



Pin numbers for relay connector board before rev. 3 (female), front side



Pin numbers for relay connector board from rev. 3 (male), front side



### DIP Switches on Protection Module

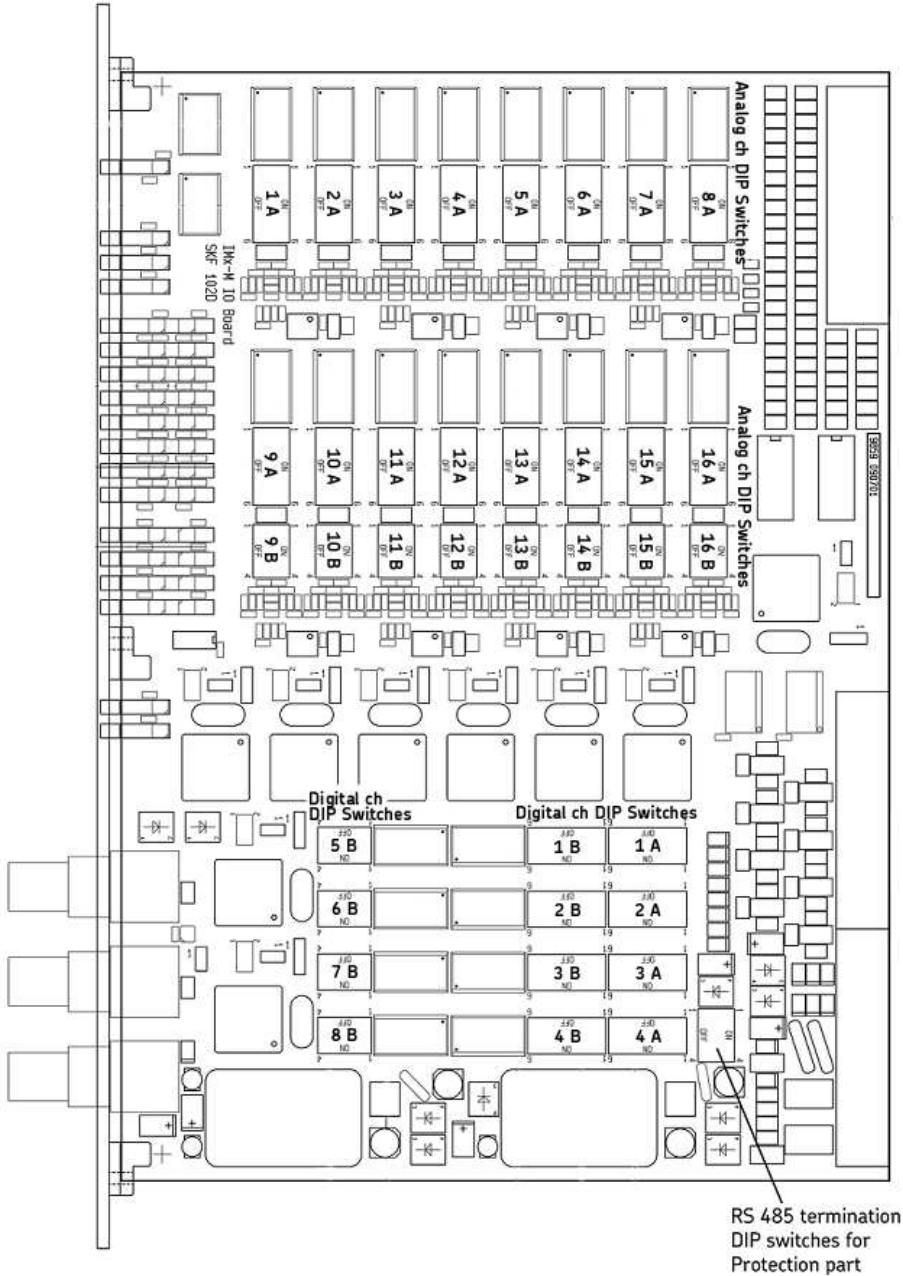


Figure 7 - 8.  
DIP Switches on a Protection Module.

### DIP Switch and Jumper on Condition Monitoring Module

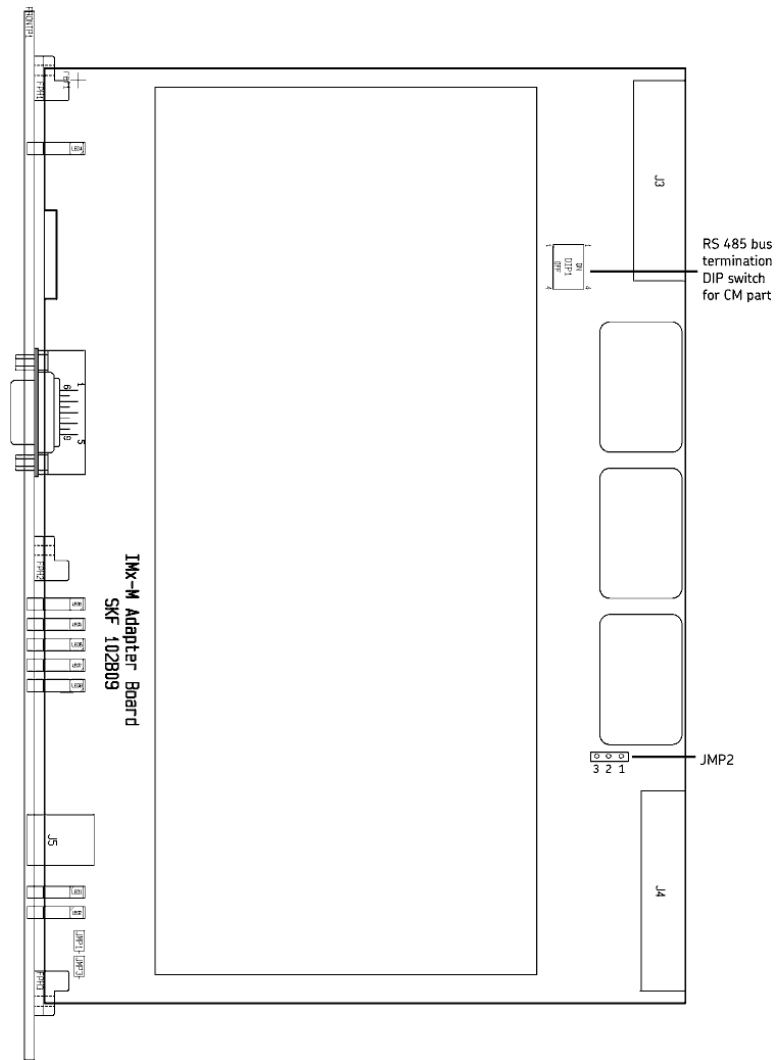


Figure 7 - 9.  
DIP Switches and Jumpers on Condition Monitoring Module.

## Part Number Information

### Main Components

SKF Multilog On-line System IMx-M (necessary rear connector boards and SKF Multilog IMx-M Manager included)

Part number		CMON 5000-aa-b-cc
<b>aa</b>	<b>Number of channels</b>	
16	16 channels	
32	32 channels	
48	48 channels	
64	64 channels	
<b>b</b>	<b>Number of power supplies</b>	
1	1 power supply	
2	2 power supplies	
<b>cc</b>	<b>Number of relays</b>	
32	32 relays	
64	64 relays (for 32, 48 or 64 channels only)	
96	96 relays (for 48 or 64 channels only)	

Figure 8 - 1.  
Structure for part numbers.

Standard rack part numbers	Description – SKF Multilog IMx-M rack with:
CMON 5000-16-2-0	16 channels, 2 power supplies
CMON 5000-16-2-32	16 channels, 2 power supplies, 32 relays
CMON 5000-32-2-0	32 channels, 2 power supplies
CMON 5000-32-2-32	32 channels, 2 power supplies, 32 relays
CMON 5000-32-2-64	32 channels, 2 power supplies, 64 relays
CMON 5000-48-2-0	48 channels, 2 power supplies
CMON 5000-48-2-32	48 channels, 2 power supplies, 32 relays
CMON 5000-48-2-64	48 channels, 2 power supplies, 64 relays
CMON 5000-48-2-96	48 channels, 2 power supplies, 96 relays
CMON 5000-64-2-0	64 channels, 2 power supplies
CMON 5000-64-2-32	64 channels, 2 power supplies, 32 relays
CMON 5000-64-2-64	64 channels, 2 power supplies, 64 relays
CMON 5000-64-2-96	64 channels, 2 power supplies, 96 relays

Figure 8 - 2.  
Standard rack part numbers.

### Add-on modules

- **CMON 5000-16-AN:** 16 channel Machine Protection and Condition Monitoring add-on module pair, including rear connector board (CMON 2118)
- **CMON 5000-32-RE:** 32 channel Relay add-on module, including rear relay input / output connector board (CMON 2119)

### Components

- **CMON 2007:** 19 inch rack enclosure including backplane and power terminal card
- **CMON 2102:** Machine Protection module (maximum four per rack)
- **CMON 2103:** Condition Monitoring module (one per CMON 2102)
- **CMON 2109:** Relay module
- **CMON 2118:** Machine Protection and Condition Monitoring pair input / output rear connector board (maximum four per pack)
- **CMON 2119:** Relay module input / output rear connector board (one per installed relay module)
- **CMON 2202:** Power Supply unit (maximum two per rack)

---

## Spare parts & accessories

---

### Wiring connector blocks

- **CMON 9010:** Screw terminal block to be used for the relay connectors (use with matching cable CMON 9011 or CMON 9012)
- **CMON 9014:** Screw terminal block to be used for the 4 to 20 mA and / or buffered analogue output connectors (use with matching cable CMON 9011 or CMON 9012)
- **CMON 9016:** Screw terminal block to be used for the Digital connectors (use with matching cable CMON 9017 and CMON 9018)
- Cables
- **CMON 9011:** Cable with one male and one female D-type connector to be used for the relay connection. Connects between the relay output connector and a matching screw terminal block e.g. CMON 9010. Cable length: 1 meter (3.3 feet).
- **CMON 9012:** Cable with one male and one female D-type connector to be used for the relay connection. Connects between the relay output connector and a matching screw terminal block e.g. CMON 9010. Cable length: 2 meters (6.6 feet).
- **CMON 9013:** Cable to be used for the Relay connector, wiring to a normal terminal block interface. Cable length: 2 meters (6.6 feet).
- **CMON 9015:** Cable to be used for the 4 to 20 mA connector wiring to a normal terminal block. Cable length: 2 meters (6.6 feet).
- **CMON 9017:** Cable with D-type connector to be used for the Digital connection. Connects between the Digital output connector and a matching screw terminal block CMON 9016. Cable length: 1.5 meters (4.9 feet).
- **CMON 9018:** Cable with D-type connector to be used for the Digital connection. Connects between the Digital output connector and a matching screw terminal block CMON 9016. Cable length: 3 meters (9.8 feet).
- **CMON 9019:** Cable to be used for the Digital connector wiring to a normal terminal block. Cable length: 3 meters (9.8 feet).
- Miscellaneous
- **CMON 2131:** SKF Multilog IMx-M blanking plate kit (to cover slots without modules in them). The blank cover plate kit includes:
  - Two (2) each Power Supply module plates
  - Four (4) each Machine Protection module plates
    - Four (4) each Condition Monitoring module plates
    - Three (3) each Relay module plates
- **CMON 2132:** SKF Multilog IMx-M spare connector kit. Contains spare green terminal connectors for one Machine Protection and Condition Monitoring module pair and all connectors needed on the power supply.

- **CMON 2133:** Isolated USB cable set for use with the SKF Multilog IMx-M (contains two USB cables).
- Installation and training
- Installation and training available through your local SKF supplier or representative.
- Product Support Plans (PSP)

A range of Product Support Plans is available to protect your investment. Contact your local SKF representative for additional information.

## Electrical Waste



Electrical waste and electrical equipment should be recycled as specified by the WEEE-directive and not be placed in the general refuse. Product should be sent to an approved recycling centre for safe recycling, recovery, reuse or returned to SKF for proper recycling.



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973 34 Luleå  
Sweden





# 10 Glossary

ASV	Absolute shaft vibration
AT	Acceptance test
CF	Circuit fault
CDE	Complementary differential expansion
CMM	Condition monitoring module
DPDT	Double pole, double throw
ESD	Electrostatic discharge
IGND	Instrument ground
MCU	Micro controller unit
MTBF	Mean time between failure
MTTF	Mean time to failure
PRD	Piston rod drop
PRM	Protection module
PSU	Power supply unit
RLM	Relay module
RSV	Radial shaft vibration
SPDT	Single pole, double throw
LSB	Least significant bits
MSB	Most significant bits

Bit numbering example for a 16-bit entity:

<b>MSB</b>	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0	<b>LSB</b>
<b>Byte</b>	High/most significant byte								Low/Least significant byte								



# Appendix A

## Limited Warranty

### SKF – Limited Warranty

#### WARRANTY

Subject to the terms and conditions contained herein and provided that there is no applicable written agreement between the selling entity in the SKF Group (“SKF”) and the Buyer specifically covering the sale of the Products (as defined below) that includes a product warranty, SKF warrants to the Buyer that for the warranty period indicated below the products sold by SKF that are listed below (the “Products”), when properly installed, maintained and operated, will be free from defects in material and workmanship and shall be fit for the ordinary purposes for which the Products are designed.

#### BUYER’S LIMITED REMEDIES

This limited warranty defines SKF’s sole and exclusive liability and Buyer’s sole and exclusive remedy for any claim arising out of, or related to, any alleged deficiency in any Product sold by SKF, even if such claim is based on tort (including negligence or strict liability), breach of contract, or any other legal theory. If the Product does not conform to this limited warranty, Buyer must notify SKF or SKF’s authorized service representative within thirty (30) days of discovery of the nonconformity; provided, however, that SKF shall not be liable for any claim for which notice is received by SKF more than thirty (30) days following the expiration of the applicable warranty period for the Product. Upon receipt of timely notification from Buyer, SKF may, at its sole option, modify, repair, replace the Product, or reimburse Buyer for any payment made by Buyer to SKF for the purchase price of the Product, with such reimbursement being pro-rated over the warranty period.

#### WARRANTY PERIOD

Except as expressly provided below, the warranty period for each Product shall

commence on the date the Product is shipped by SKF to Buyer.

#### 90-DAY WARRANTY

Products warranted for ninety (90) days by SKF are as follows: cable assemblies, MARLIN QuickConnect (MQC), magnetic temperature probes, and all refurbished equipment.

#### ONE-YEAR WARRANTY

Products warranted for one (1) year by SKF are as follows: all Microlog products and accessories, all Microlog Inspector applications including hand-held computers, all MARLIN data managers (MDM), all MARLIN Condition Detectors (MCD), all Wireless Machine Condition Detectors (WMCD), all Multilog Condition Monitoring Units (CMU, TMU), Multilog Local Monitoring Units (LMU), all Multilog Wireless Monitoring Units (WMx), Multilog On-line System Wireless Vibration Transmitter ISA100, all Wireless Monitoring Systems V/T, all Vibration PenPlus, all Machine Condition Advisors (MCA), all Machine Condition Indicators (MCI), all transmitters, all Monitor Interface Modules (MIM), all Machine Condition Transmitters (MCT), all MicroVibes and Custom Products with the prefix of CMCP (with the exception of any consumable or expendable items), Shaft Alignment Systems TKSA 60 and TKSA 80 including hand-held computer, measuring units and accessories.

#### TWO-YEAR WARRANTY

Products warranted for two (2) years by SKF are as follows: all standard Eddy Probes, Eddy Probe Drivers, and Eddy Probe Extension Cables, all Multilog On-line Systems (DMx, IMx), all Wireless Machine Condition Sensors, and all M800A and VM600 Machinery Monitoring Systems.

For all On-line Systems (as defined below) that have satisfied Criteria 1 and 2 below, the warranty period shall be either thirty (30) months from the date the On-line System is shipped by SKF to Buyer, two (2) years from the date the On-line System is installed and commissioned by SKF, or two (2) years from the date on which the installation of the On-line

System has been audited and commissioned by SKF or its authorized service representative, whichever period ends first.

#### Criteria 1.

Devices used with a Multilog On-line System (IMx), Multilog Condition Monitoring Unit (CMU), Multilog Local Monitoring Unit (LMU), including, but not limited to, the sensing device, the interconnect cabling, junction boxes, if any, and the communications interface, must consist only of SKF-supplied or SKF-approved devices and/or components. The computer provided by Buyer must meet the requirements stipulated by SKF.

#### Criteria 2.

SKF or its authorized service representative has installed the On-line System or has audited the installation and commissioned the On-line System.

“On-line Systems” are defined as systems consisting of Multilog On-line System (IMx), Multilog Condition Monitoring Unit(s) (CMU), Multilog Local Monitoring Unit(s) (LMU), and any sensing or input devices, the interconnect cabling between the sensing or input devices and the Multilog On-line System (IMx), Multilog Condition Monitoring Unit(s) (CMU), Multilog Local Monitoring Unit(s) (LMU), and the cabling between the Multilog On-line System (IMx), Multilog Condition Monitoring Unit (CMU), Multilog Local Monitoring Unit (LMU) and the proprietary SKF communications interface with the host computer.

#### FIVE-YEAR WARRANTY

Products warranted for five (5) years by SKF are as follows: special seismic sensors.

#### LIMITED LIFETIME WARRANTY

Products covered under this Limited Lifetime Warranty (as set forth below) are as follows: standard seismic sensors of the CMSS 2XXX and CMSS 7XX series (accelerometers and velocity transducers) as marked and published in the SKF Vibration Sensor Catalogue.

- (A) Subject to the terms herein, SKF will provide a “Limited Lifetime Warranty” for the products specified above sold by SKF after April 15, 2014. Under the Limited Lifetime Warranty, those products shall, at the time of shipment, be free from defects in material and workmanship. If any of these products fail to meet the terms of this Limited Lifetime Warranty during the life of such products, SKF, in its sole discretion, will repair, replace or exchange the products for the same model if the necessary components for the products are still available to SKF on a commercially reasonable basis. SKF will not provide a Limited Lifetime Warranty on products damaged by accident, abuse, misuse, neglect, improper installation, problems with electrical power, natural disaster, or by any unauthorized disassembly, repair or modification.
- (B) Upon receipt of any product covered by the Limited Lifetime Warranty, SKF will pay all shipping charges to send the repaired, replaced or exchanged product to the original point of shipment. SKF reserves the right to decline repair or replacement if no fault is found in the product.
- (C) For any warranty claim, the original Buyer must provide SKF with the applicable model and serial numbers, the date of purchase, the nature of the problem, and proof of purchase. SKF, in its sole discretion, will determine if the Buyer must return the product covered under this warranty to SKF.
- (D) The express warranty set forth in the Limited Lifetime Warranty is in lieu of and excludes any and all other warranties express or implied, including, but not limited to, the implied warranties of merchantability and fitness for a particular purpose.
- (E) SKF’s sole obligations under this Limited Lifetime Warranty are set forth in paragraphs (A) and (B), and SKF’s liability under this Limited Lifetime Warranty shall not exceed the purchase price of the

product, plus any shipping and handling charges that SKF may be obligated to pay pursuant to paragraph (B).

- (F) **IN NO EVENT SHALL SKF BE LIABLE OR OBLIGATED TO THE BUYER OR ANY OTHER PERSON FOR SPECIAL, EXEMPLARY, PUNITIVE, INCIDENTAL, DIRECT, INDIRECT, GENERAL OR CONSEQUENTIAL DAMAGES (INCLUDING, BY WAY OF EXAMPLE ONLY, LOST PROFITS OR SAVINGS, LOSS OF BUSINESS OR LOSS OF USE) OR ANY OTHER LOSS, COST OR EXPENSE IN CONNECTION WITH THE PRODUCTS REGARDLESS OF WHETHER OR NOT ANY OF THE FOREGOING WERE FORESEEABLE OR THAT SKF WAS ADVISED AS TO THE POSSIBILITY OF SUCH DAMAGES, LOSS, COST, OR EXPENSE.**
- (G) The Limited Lifetime Warranty applies solely to the original Buyer and is non-transferrable.

#### OTHER SKF PRODUCTS

Any SKF product supplied hereunder but not covered by this limited warranty shall be either covered by the applicable SKF limited warranty then in place for such product or, if no such warranty exists, shall be covered by the 90-day warranty stated above.

#### THIRD PARTY PRODUCT WARRANTIES

For any third party products sold to Buyer by SKF, SKF will transfer to Buyer any warranties made by the applicable third party product vendor to the extent such warranties are transferable.

#### CONDITIONS

As a condition to SKF's warranty obligations hereunder and if requested or authorized in writing by SKF, Buyer shall forward to SKF any Product claimed by Buyer as being defective. Buyer shall prepay all transportation charges to SKF's factory or authorized service center. SKF will bear the cost of shipping any replacement Products to Buyer. Buyer agrees to pay SKF's invoice for the then-current price of any

replacement Product furnished to Buyer by SKF, if the Product that was replaced is later determined by SKF to conform to this limited warranty.

SKF shall not be obligated under this limited warranty or otherwise for normal wear and tear or for any Product which, following shipment and any installation by SKF (if required by the contract with the Buyer), has, in SKF's sole judgment, been subjected to accident, abuse, misapplication, improper mounting or remounting, improper lubrication, improper repair or alteration, or maintenance, neglect, excessive operating conditions or for defects caused by or attributable to the Buyer, including without limitation Buyer's failure to comply with any written instructions provided to Buyer by SKF.

SKF shall be free to conduct such tests, investigations and analysis of the Products returned to SKF, as it deems reasonable and proper in the exercise of its sole judgment. As a further condition to SKF's obligations hereunder, Buyer shall offer its reasonable cooperation to SKF in the course of SKF's review of any warranty claim, including, by way of example only, Buyer's providing to SKF any and all information as to service, operating history, mounting, wiring, or re-lubrication of the Product which is the subject of the Buyer's warranty claim.

#### **EXCEPT WARRANTY OF TITLE AND FOR THE WARRANTIES EXPRESSLY SET FORTH IN HEREIN, IT IS UNDERSTOOD AND AGREED THAT:**

- (A) **SKF MAKES NO OTHER WARRANTY, REPRESENTATION OR INDEMNIFICATION, EITHER EXPRESS OR IMPLIED, INCLUDING WITHOUT LIMITATION ANY IMPLIED WARRANTY OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE, OR NON-INFRINGEMENT;**
- (B) **IN NO EVENT SHALL SKF BE LIABLE OR OBLIGATED FOR SPECIAL, EXEMPLARY, PUNITIVE, INCIDENTAL, DIRECT, INDIRECT, GENERAL OR CONSEQUENTIAL DAMAGES (INCLUDING, BY WAY OF EXAMPLE ONLY, LOST PROFITS OR SAVINGS, LOSS OF BUSINESS OR LOSS OF**

**USE) OR ANY OTHER LOSS, COST OR EXPENSE IN CONNECTION WITH THE PRODUCTS AND RELATED SERVICES, IF ANY, PROVIDED BY SKF, AND THIS DISCLAIMER SHALL EXTEND AS WELL TO ANY LIABILITY FOR NONPERFORMANCE CAUSED BY SKF'S GROSS OR ORDINARY NEGLIGENCE, AND IN ALL CASES REGARDLESS OF WHETHER OR NOT ANY OF THE FOREGOING WERE FORESEEABLE OR THAT SKF WAS ADVISED AS TO THE POSSIBILITY OF SUCH DAMAGES, LOSS, COST, OR EXPENSE; AND**

- (C) NO PERSON HAS BEEN AUTHORIZED BY SKF TO MAKE ANY FURTHER OR CONTRARY INDEMNITIES, REPRESENTATIONS OR WARRANTIES ON BEHALF OF SKF. THE FOREGOING LIMITATIONS AND DISCLAIMERS OF LIABILITY SHALL BE MADE APPLICABLE TO THE SALE OF ANY PRODUCT BY SKF TO THE FURTHEST EXTENT PERMITTED BY APPLICABLE LAW.**

The exclusive remedies provided in this limited warranty shall not be deemed to have failed of their essential purpose so long as SKF is willing and able to perform to the extent and in the manner prescribed in this limited warranty.

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CM-F0001 EN  
Revision Z, October 2016

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