SKF Multilog On-Line System IMx-W

User Manual Part No. 32146100-EN
Revision T

⚠**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.*

SKF Group

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Introduction

Important Messages

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

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

> ⚠️ *In order to fulfill fire enclosure requirements the following must be ensured:*
>
> – *The cabinet must always be mounted using all four supplied mounting brackets.*
>
> – *All unused cable ways must be closed with the supplied blind plugs.*
>
> – *All cable glands and blind plugs must be made of material with fire protection V-1 or better.*

> ⚠️ *Important messages related to mains power (see Mains Power section as well):*
>
> – *In some countries, you have to be certified in order to connect an IMx-W to the power grid*
>
> – *Make sure that the power is disconnected before the installation.*
>
> – *Mains cable must be properly fixed with a cable gland to prevent the cord from strain, twist or move. See Cable Glands section as well.*
>
> – *In order to prevent a hazardous event, mains cable Neutral (N) and Line (~) wires must be secured together with a cable tie (for example, a nylon cable tie CV-100K) close to the mains power connector.*
>
> – *For permanently connected IMx-W, an external all pole power switch must be installed in order to be able to disconnect the IMx-W from the mains power grid. The switch must be labeled "IMx-W" or similar. On/Off position must be clearly marked. The switch must be located close to the IMx-W, within operator's easy reach.*

> ⚠️ *Before the use of external mains output, be sure to read External Mains Out section carefully.*
>
> – *All externally provided equipment must be evaluated individually and approved together with IMx-W unit regarding EMC and safety requirements (CE and ETL). Always consult SKF CMC Luleå before the usage of the external mains output.*

System Overview

IMx-W, WindCon is a part of the SKF Multilog On-line System product range. IMx-W, WindCon is designed to be used in the wind power industry. In conjunction with SKF @ptitude Observer Monitor Service and SKF @ptitude Observer client, the IMx-W, WindCon forms a complete and flexible on-line turbine condition monitoring system tool. This enables trending, analyzing and preventing of catastrophic machine failures.
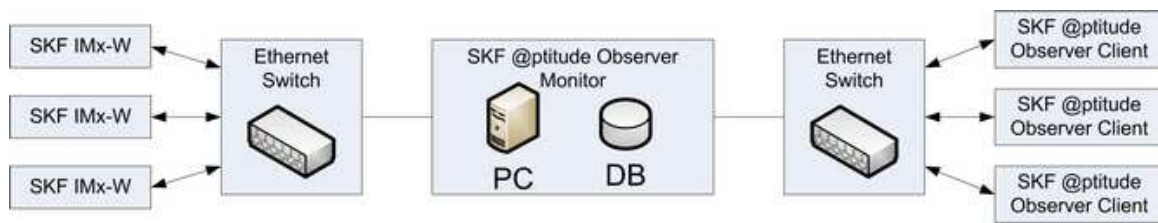
Figure 1 - 1.
System Overview of IMx-W, WindCon On-line System.

The figure above illustrates how IMx-W, WindCon units are linked together in a network that is connected via LAN to @ptitude Observer Monitor Service. The @ptitude Observer Monitor Service in turn, can be connected to e.g. LAN network making it possible for several of @ptitude Observer clients to link to this network.

@ptitude Observer clients can also be installed on the same computer as the @ptitude Observer Monitor Service login software. Through a general interface known as ODBC (open database connectivity), it is possible to link the login computer and @ptitude Observer Monitor Service to an existing database for an existing control or processing system, if desired. The @ptitude Observer Monitor Service, @ptitude Observer clients and the database can be separated from each other as long as they are on the same network where ODBC calls can travel freely.

It is also possible to connect different types of on-line units in the same network, for example, IMx-W, WindCon together with other MasCon/IMx systems.

IMx-W, WindCon Unit

Figure 1 - 2.
IMx-W, WindCon Unit.

IMx-W, WindCon Unit

The IMx-W, WindCon unit is a modern industrial product designed for on-line vibration monitoring.

- The unit is highly environmentally resilient, and is specially adapted to withstand machines where damage might develop and/or where periodical monitoring is difficult to carry out.

- The IMx-W, WindCon unit should be mounted inside a nacelle, onto a vertical structure (e.g. wall), as far away as possible from vibrating or high voltage objects.

- There are two different types of cabinet for IMx-W, WindCon unit; Painted steel cabinet and Stainless steel cabinet. The type of cabinet is chosen by the customer upon purchasing of the unit. Refer to IMx-W, WindCon Drawings for the drawing of cabinets.

Analogue Channels

- Up to 16 analogue channels can be connected to each IMx-W, WindCon unit.

Digital Channels

- Up to 2 digital sensors can be connected to each IMx-W, WindCon unit.

- The digital inputs can interface with all standard types of digital inputs/sensors, including trigger level of 5 to 14 V.

Network Configuration

- The IMx-W, WindCon is provided with a default IP address 10.0.0.101 and server IP address 10.0.0.1.

- However, if there is a need to change the IP address within the range of 10.0.0.X, it can be done by turning the HEX rotary switches on the main board. It will change the X value from 101 to 199.

- Furthermore, if there is a need to change the entire IP address, use the On-line Configurator tool which is provided with @ptitude Observer. Refer to Network Configuration.

- All initiation parameters such as IP address, IMx identification number, etc. are stored first in a separate configuration file, then transferred to the IMx-W, WindCon memory through the serial interface. These are retained in the events of power losses, so that the IMx-W, WindCon can start automatically when the power returns.

Storage Capacity

Each IMx-W, WindCon unit 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 you use more lines, the number of spectrum is reduced.

    If you use less lines, the number of spectrum is increased

- When the buffer gets full, the oldest data is thrown away.

LED Indicators

The IMx-W, WindCon card has two rows of LED indicators on the front panel as shown below:
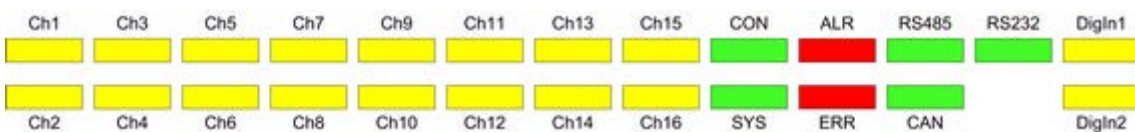

Figure 1 - 3.
LED Indicators on the Front Panel.

- Yellow LEDs **Ch1** to **Ch16** represent the sixteen analogue input channels.

- Green LED **CON** indicates the status of connection to the @ptitude Observer Monitor Service.

- Green LED **SYS** indicates the system status.

- Red LED **ALR** indicates measurement alarms/warnings.

- Red LED **ERR** indicates system error(s).

- Green LEDs **RS485, RS232** and **CAN** indicate receive and transmit communication activity (not in use).

- Yellow LEDs **DigIn1** and **DigIn2**, also known as Tacho1 and Tacho2, indicate the status of digital inputs.

The following summarizes the behavior of each LED indicator described above, and its corresponding status.

Table 1-1: Status of LED indicators

LED Indicator	Behaviour	Description
Ch1–Ch16	On Off Slow flash Fast flash	Channel configured & running Channel not configured Channel cable fault Channel warning/alarm
CON	On Off Slow flash Fast flash	Connected Not connected Trying to connect Server forced connection
SYS	On Flash	System configured & running System start-up
ALR	On Off Flash	Warning indicator No alarm Alarm indicator
ERR	On/Flash	System fault
RS232	Off	Not in use
RS485	Off	Not in use
CAN	Off	Not in use
DigIn1, DigIn2	On Off Flash	Input logic one Input logic zero Input toggle

If the boot code does not discover any errors or is manually halted, the main measurement software will be started. While the main software is reading the configuration and setting up the system, the SYS LED is flashing and each channel's LED is lit as it gets defined. When the system configuration is done, the SYS LED will stop flashing but will stay on. There is a thirty seconds delay to ensure that the sensors are producing valid results before the system starts measuring.

If an alarm occurs, the LED for the actual channel will start flashing. Slow flash of a channel LED indicates the channel cable fault where as the fast flash indicates a warning/alarm. In addition, the red LED ALR (alarm) will also light up. However, this only works after the IMx-W, WindCon has been configured and collected some data for measurements, because only then alarms can be checked according to the alarm and danger levels.

RS485, RS232 and CAN LEDs are not in use.

Digital In 1 and Digital In 2 indicate the status of digital inputs. On indicates logical one (1) and off indicates logical zero (0). Whereas, flash indicates input toggle.
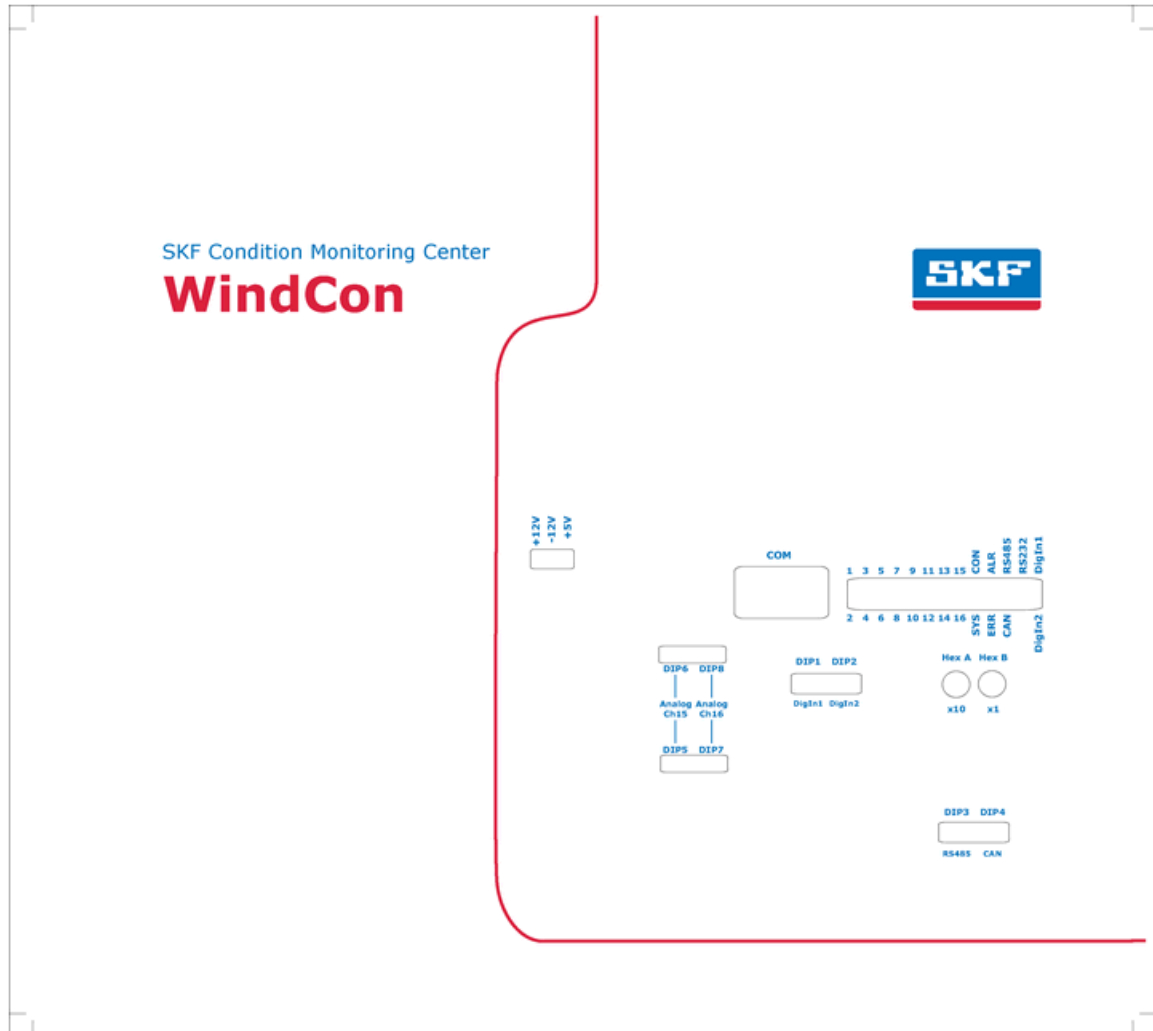
Figure 2 - 1.
IMx-W, WindCon Front Panel Inside of a Cabinet.

The installation of a IMx-W, WindCon system 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 with the SKF IMx-W, WindCon team or personnel from SKF Condition Monitoring Center Luleå. Otherwise, the installation will not be approved and the start-up of the system can not be carried out until the errors are rectified.

> *Important – Installation errors which require the involvement of SKF Condition Monitoring Center Luleå personnel in order to rectify the start-up of the system, might be debited.*

Safety and Requirements

It is important to assess and evaluate the current site for safety instructions and stipulations.

During the installation work, make oneself acquainted with the valid safety stipulations for the specific turbine. Different types of wind turbines can have different safety hazards and safety instructions. In all cases, read the instructions carefully and act accordingly.

If the IMx-W, WindCon vibration sensors are to be mounted with glued pads, the temperature must be observed. The glue used for these pads, or studs will not solidify below 16 ºC (*60.8 ºF*).

Note that, even when ambient temperature is well below 16 ºC (*60.8 ºF*), installations can still take place with glue by using the heat of the turbine. In such a case, make sure the wind turbine has been running until the installation starts. Usually, the gearbox provides enough heat for several hours after the turbine has been stopped which guarantees a solid glue connection. However, when in doubt, measure the temperature.

An IMx-W, WindCon unit 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

> ⚠️ *Important - IMx-W, WindCon unit contains circuit boards that are static sensitive. Therefore, use appropriate precautions to prevent ElectroStatic Discharge (ESD) when handling circuit boards.*

Scenario

It is also important to assess and evaluate the current site where the system is to be installed.

Draw a plan on a piece of paper to demonstrate, how you would like this installation to look like after it is completed, and then consider if it can be achieved. Among other things, consider lengths of cables, where electrical power to the IMx-W, WindCon units can be connected, where the @ptitude Observer Monitor Service should be installed and positioned and who should analyse the data. 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-W, WindCon unit, the SQL server computer, the @ptitude Observer Monitor Service computer and all hubs/routers in the network.

Specify each component's network configuration such as IP addresses and subnet mask. Application engineers can not help you if you do not have these information up front.

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.

When SKF supplies the GPRS router, it makes use of a "lifeline" connection to an SKF server at IP: 80.126.94.126. This is an integral part of the application solution.

> *Important – Failure of this communication path will force the GPRS router to reboot itself constantly and can hamper the success of the application. This is especially valuable to consider when the GPRS forms a part of the customers internal IP network (VPN). In such case, SKF must be informed of this before ordering the GPRS, so that SKF can disable the lifeline functionality of the GPRS router.*

Vibration Sensor Cable

When routing a vibration sensor cable, it is important that the cable is firmly fixed. The cable must not be allowed to vibrate or oscillate, since this effects the capacitance of the cable, and thereby the measurement result.

The sensor cable may not be routed or bundled together with supply cables, which generate strong magnetic fields, such as supplies to generator, yaw and pitch-motor drives, radiators, electronic frequency converters, etc.

> *Important – In general, all cables must be routed as far away as possible from the high voltage electrical cables. If this cannot be done, care should be taken to use high quality shielded cables.*

Other Sensor Cables

To connect IMx-W, WindCon to other sensors, such as speed sensor, displacement sensor, pressure sensor, data communication RS485, etc, use the following:

- Shielded, twisted pair 2 x 0,5 mm^2 (FKAR-PG 1 x 2 x 0,50, DUE 4002 or corresponding), with minimum voltage requirement 300 V and minimum temperature −40 ºC (*−40 °F*).

Supply Cable

To connect IMx-W, WindCon to 240 VAC or 120 VAC, use the following or better:

- FKLK 3 x 1,5 mm^2 (*16 AWG*) or EKLK 3 x 1,5 mm^2 (*16 AWG*) or corresponding, with minimum voltage requirement 300 V and temperature range of −40 to +70 ºC (*−40 to +158 °F*).

It is required that the IMx-W, WindCon must be connected to protective ground/earth (PE). Refer to Mains Power for attaching power cable to the mains power or 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.*

> *Important – Mains cable must be properly fixed with a cable gland to prevent the cord from strain, twist or move. See Cable Glands section as well.*

Cable Glands

The shield of IMx-W, WindCon sensor cable should be cut off at the entrance of the cabinet and be shielded off from the cabinet by an isolating cable gland.

> *Important – All unused cable ways must by closed with the supplied blind plugs. All cable glands and blind plugs must be made of material with fire protection V-1 or better.*

Mains Power

In order to attach power cable to the mains power grid, follow the direction below.

- First connect the green-yellow wire to the protective earth (PE) rail.

- Connect another green-yellow wire from PE-rail to mains PE terminal.

- Connect the blue wire to the neutral (N) terminal.

- Connect the brown or black wire to the line (~) terminal.

Figure 2 - 2.
Mains Power Connection.

Refer to the tables in <u>Wire Connections</u> and the drawing of <u>Connectors and Switches Location</u> for connectors naming and location details.

Power inlet fuses are slow blow 2A (T2A 250 V, 5 x 20 mm) and mounted internally on the location labeled as F1 and F2. Refer to <u>Connectors and Switches Location</u>.

Refer to <u>Power Supply</u> in Technical Data section for power requirements.

> *Important – In some countries, you have to be certified in order to connect an IMx-W to the power grid.*

> *Important – Make sure that the power is disconnected before the installation.*

> *Important – For permanently connected IMx-W an external all pole power switch must be installed in order to be able to disconnect the IMx-W from the mains power grid. The switch must be labeled "IMx-W" or similar. On/Off position must be clearly marked. The switch must be located close to the IMx-W, within operator's easy reach.*
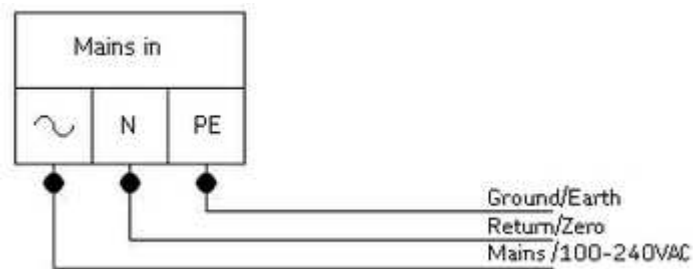
Figure 2 - 3.
Mains Power Terminal (See also the figure below for the cable tie arrangement).
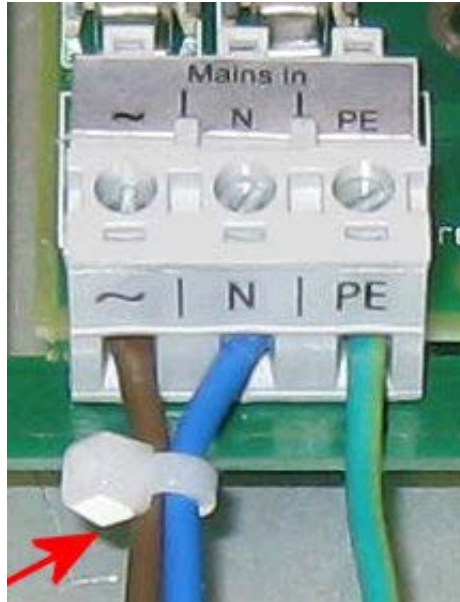
Figure 2 - 4.
Mains Cable Wires Secured with a Cable Tie.

> *Important – In order to prevent a hazardous event, mains cable Neutral (N) and Line (~) wires must be secured together with a cable tie (for example, a nylon cable tie CV-100K) close to the mains power connector.*

External Mains Out

> *Important – All externally provided equipment must be evaluated individually and approved together with IMx-W unit regarding EMC and safety requirements (CE and ETL). Always consult SKF CMC Luleå before the usage of the external mains output.*

In order to attach power cable to the external equipment via the external mains out connector, follow the direction below.

- First connect the green-yellow wire from the external equipment to the protective earth (PE) rail.

- Connect another green-yellow wire from PE-rail to external mains out PE terminal.

- Connect the blue wire to the neutral (N) terminal.

- Connect the brown or black wire to the line (~) terminal.

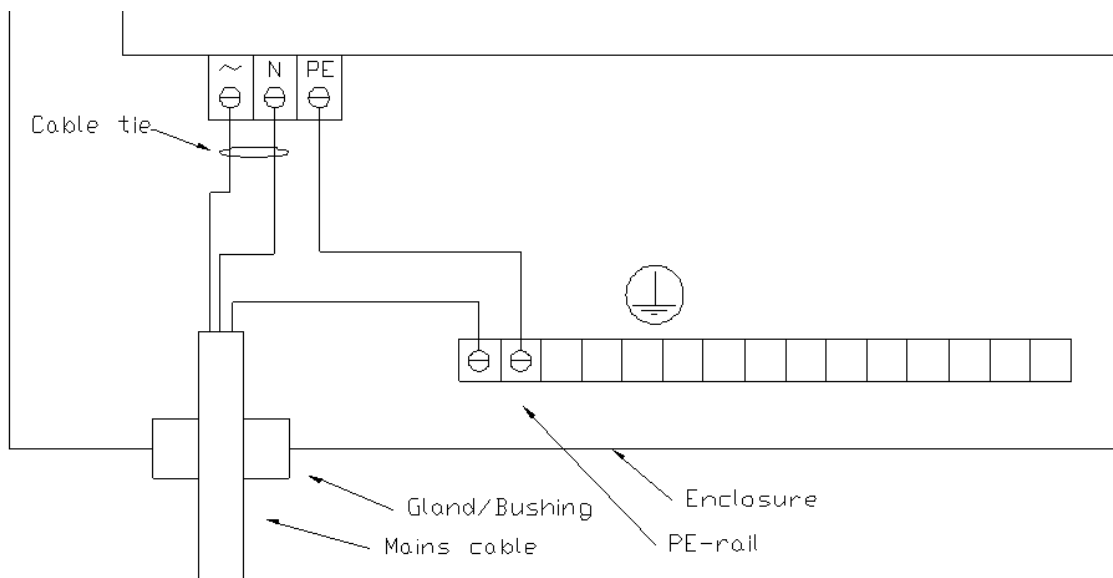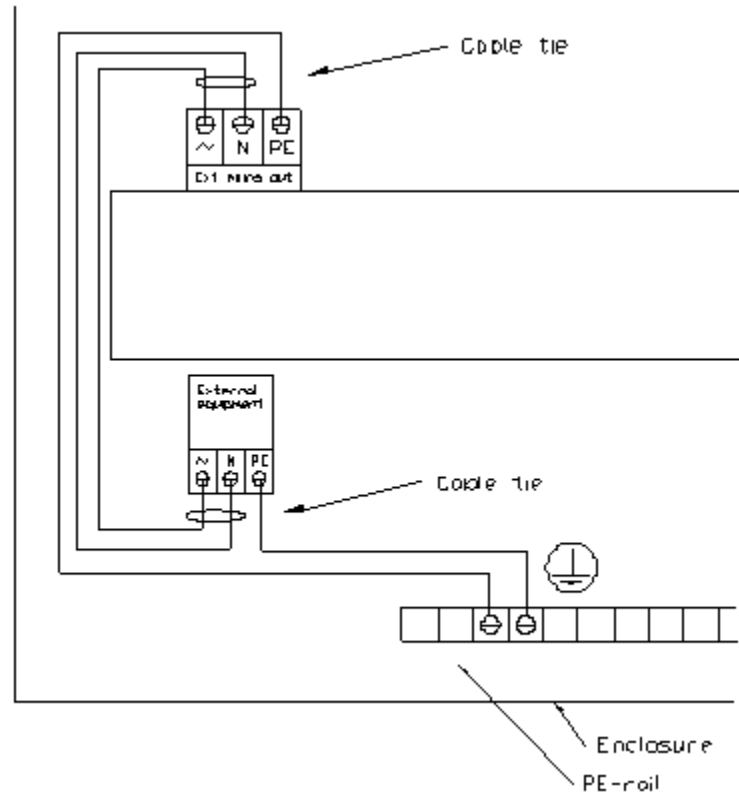Figure 2 – 5.
External Mains Out Power Connection.

The maximum allowed external mains output is 0,35 A.

The cable should have the following specification or better:

- FKLK 3 x 0,75 mm² (*19 AWG*) or EKLK 3 x 0,75 mm² (*19 AWG*) or corresponding, with minimum voltage requirement 300 V and temperature range of -40 to +70 ºC (*−40 to +158 °F*).

Important – In order to prevent a hazardous event, external mains out cable neutral (N) and line (∼) wires must be secured together with a cable tie (for example, a nylon cable tie CV-100K) close to both the external mains out connector and the external equipment mains connection.

Important – External mains out must be connected according to the above information to avoid causing harm to equipment or personnel.

Important – External mains output must be carefully used to secure lightning protection.

Communication Cable

For length up to 15 meters, it is recommended to use pre-fabricated FTP Ethernet twisted pair cable FTP type, CAT5/6.

For longer cable length, it is recommended to use S-FTP (screened shielded twisted pair) Ethernet cable CAT5/6.

Data Communication

IMx-W, WindCon unit data communications are compliant with the Ethernet standard 10/100 Mbit. IMx-W, WindCon has two Ethernet ports which work like an internal switch.

Ethernet

The Ethernet TP cable on the IMx-W, WindCon is connected at one of the standard Ethernet RJ45 connections. Both Ethernet ports have auto detection of crossover or straight through Ethernet cable connection. Basically, IMx-W, WindCon has a built-in Ethernet switch. It is possible to connect several IMx-W, WindCon units in a daisy chain, with up to eight units in a single cable layout. If the system is correctly connected to another network device, the green LED lights up. The yellow LED flickers when there is traffic on the network.
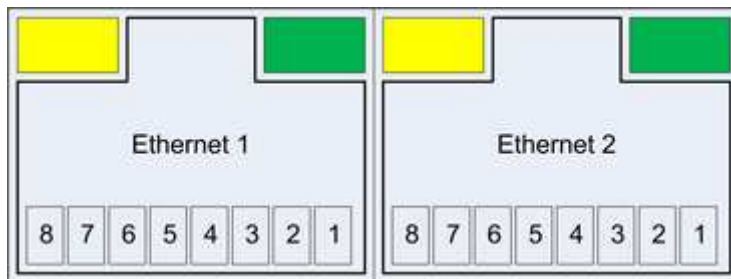
Figure 2 - 6.
Ethernet Outlet.

Table 2-1: Ethernet Pin/LED.

Ethernet 1–2	
Pin/LED	Description
1	Transmit data (+)
2	Transmit data (–)
3	Receive data (+)
4	N.C. (Not Connected)
5	N.C. (Not Connected)
6	Receive data (–)
7	N.C. (Not Connected)
8	N.C. (Not Connected)
Yellow LED	Ethernet traffic indicator
Green LED	Ethernet link indicator

Refer to the tables in Wire Connections and the drawing of Connectors and Switches Location for connectors naming and location details.

Mount the IMx-W, WindCon unit and make sure that it is firmly attached. The IMx-W, WindCon unit should be mounted at a location where it is not exposed to unnecessary radiant heat or strong magnetic fields.

Always use the supplied mounting brackets, that are easily mounted onto the back side of the IMx-W, WindCon cabinet. The work of mounting brackets are easily performed from the back side of the cabinet, without the need of opening the cabinet before it is mounted onto the wall. All the needed brackets, screws and gaskets are supplied with the IMx-W, WindCon unit.

> *Important – In order to fulfill fire enclosure requirements, the cabinet must always be mounted using all four supplied mounting brackets.*

Refer to <u>Environmental</u> in Technical Data for detailed information.

In general, when referring to DIP switch settings 0 means Off and 1 means On.

DIP Switches and Jumpers

Most of the settings of IMx-W, WindCon are software configured, but some configurations are hardware (DIP switches and jumpers) configured during installation. It is important that the hardware configured settings are done correctly and well considered based upon used sensors and external connections.

The following chapters describe how IMx-W, WindCon should be set up for different types of sensors and external connections.

Table 3-1: Summary of IMx-W, WindCon DIP switches and jumper settings.

Switch	Switch Description
DIP1	Digital input 1
DIP2	Digital input 2
DIP3	RS485 termination
DIP4	CAN termination
DIP5, DIP6	Analogue input 15/Analogue isolated 15
DIP7, DIP8	Analogue input 16/Analogue isolated 16
JMP2 (behind cover)	Analogue isolated 15 input type
JMP3 (behind cover)	Analogue isolated 16 input type
Hex A, Hex B	TCP/IP address/Unit number

For further information on software configured settings refer to @ptitude Observer User Manual.

Analogue In 1 to 16 and Analogue Isolated 15, 16

Connection of Accelerometers

Special care must be taken when positioning and mounting the accelerometer sensors. Otherwise, measurement result can be effected.

Important – The sensor mounting instructions must be followed carefully.

Location of Vibration Sensors

On a typical turbine with two main bearings, a planetary gear, a three-shaft second stage gear and a generator, SKF proposes the use of nine accelerometers, four low speeds and five standards.
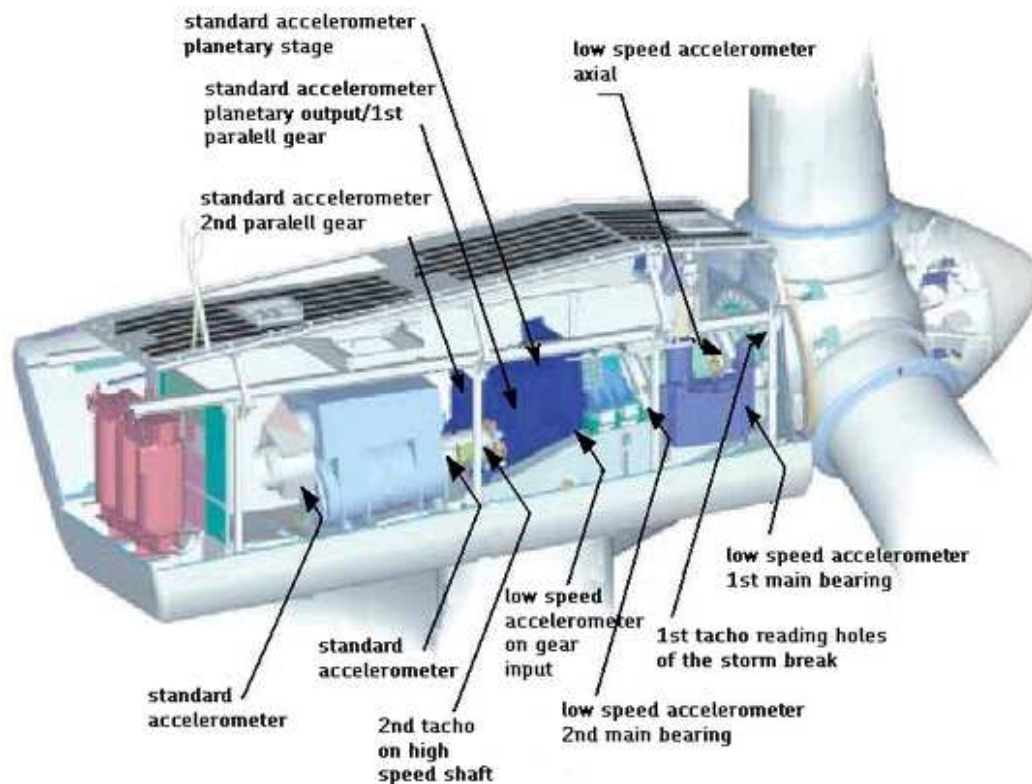
Figure 3 - 1.
An Example of a Turbine.

Main bearing

- Low speed accelerometer sensor in radial direction on the down side of the bearing

- Low speed accelerometer sensor in axial direction, preferably on the downside as well

2nd main bearing

- Low speed accelerometer sensor in radial direction on the down side of the bearing

Planetary gear

- Low speed accelerometer sensor on gear input in radial direction on the entrance bearing

- Standard accelerometer sensor on top of the planetary gear

2nd stage gear

- Standard accelerometer sensor planetary output/1st parallel gear in radial direction between the entrance and intermediate shaft

- Standard accelerometer sensor 2nd parallel gear in axial direction between intermediate and high speed shaft

Generator

- Standard accelerometer sensor in radial direction on the downside of the rear bearing

- Standard accelerometer sensor in radial direction on the downside of the front bearing

Tacho

- 1st tacho sensor reading holes of the storm break

- 2nd tacho sensor on high speed shaft

Important – It is not always necessary to install two tacho sensors. However, it is preferable to install two tacho sensors on the high speed shaft. If Order tracking is used, the tacho sensors must be installed on the high speed shaft.

Attachment of Vibration Sensors

Important – The basic pre-condition for a successful measurement result requires that the sensor is correctly located with regard to vibration factors.

The attachment of vibration sensors can be done by using M6 bolts or glue.

Attachment by M6 bolts

Figure 3 – 2.
Attachment by M6 Bolts.

- Prepare the surface where the sensor is to be fitted. Paint, rust or other coatings must be removed in order for the sensor to make a good contact with the surface. The area of contact must be as large as possible, and the surface must be flat.

- Drill a hole perpendicular to the surface with a 5 mm bit (depth approximately 10 mm).

- Thread the hole with a M6 threading tap.

- Carefully test-screw the sensor in place, to ensure that good contact has been made.

Important – If the sensor does not fit flat on the surface, and thereby makes a bad contact with it, you must drill a new hole.

- Unscrew the sensor and apply some form of thread lock on the contact surface and mounting screw, e.g. Loctite 242.

- Tighten the sensor with a torque wrench. It is important that the sensor is tightened to the correct torque, to avoid the occurrence of false vibrations. Tightening too hard, besides damaging the thread, causes stress that in return causes signal noises. The correct tightening torque is 3 to 7 Nm.
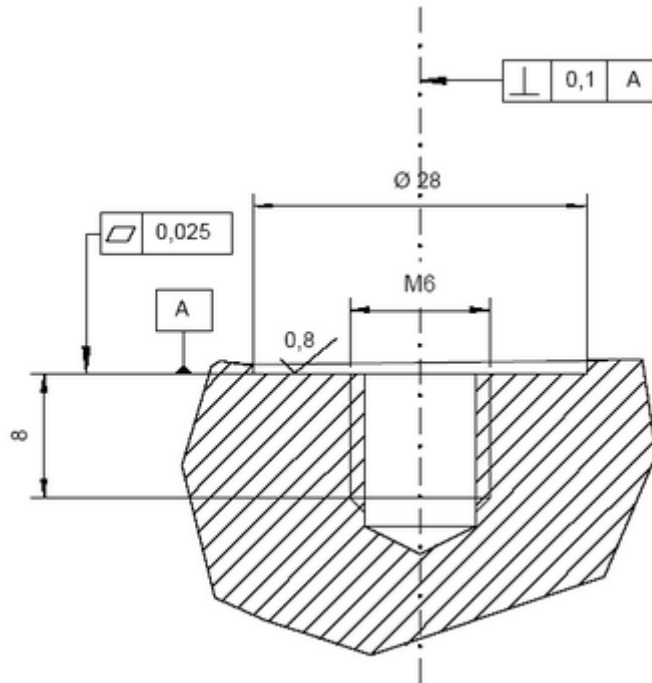
Attachment by glue

- Prepare the surface where the sensor is to be fitted. Paint, rust or other coatings must be removed in order for the sensor to make a good contact with the surface. The area of contact must be as large as possible, and the surface must be flat.

- For a good and professional installation, proper sensor labeling and secure of sensor cable is important.

- Remember to try to keep the sensor cables as far away as possible from high power cables.

- Take precautions to prevent rust after the installation by covering the bare metal parts, for example with a coat of paint.

- Unscrew the sensor and apply some form of thread lock on the contact surface and mounting screw, e.g. Loctite 242.

- Tighten the sensor with a torque wrench. It is important that the sensor is tightened to the correct torque, to avoid the occurrence of false vibrations. Tightening too hard, besides damaging the thread, causes stress that in return causes signal noises. The correct tightening torque is 3 to 7 Nm.

Figure 3 - 3.
Examples of Attachment by Glue.

Connection of Accelerometer Sensor Cables

To connect accelerometer sensor cables to IMx-W, WindCon units, you need to use two-wired sensors. IMx-W, WindCon supports both external powered accelerometers and standard accelerometers. The standard accelerometer power is turned on/off in software configuration. Refer to @ptitude Observer User Manual for more information.

1 – Red (signal)

2 – Black (ground)
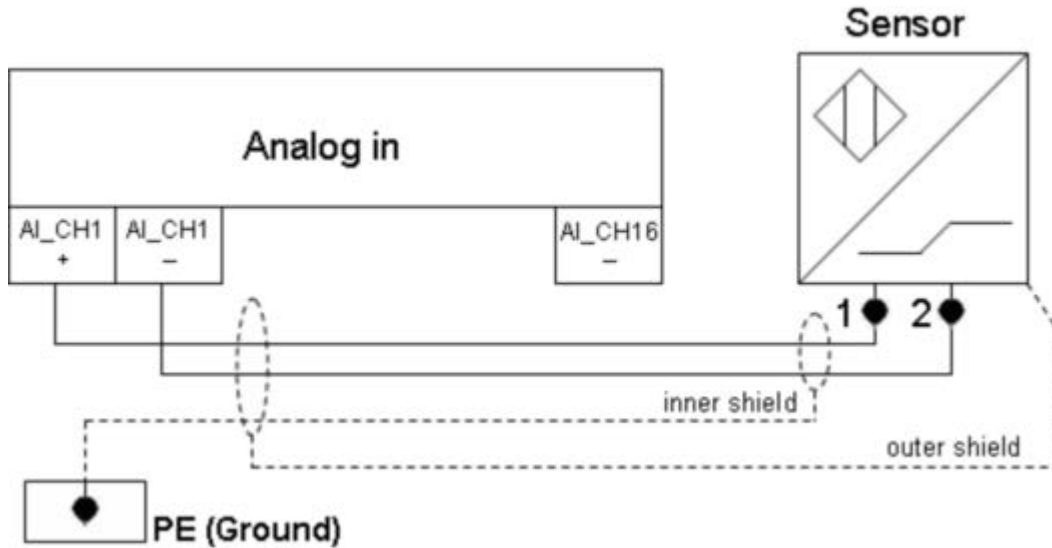
Figure 3 - 4.
Connection of Accelerometer Sensor Cables.

Note that the sensor shield should be connected either to the sensor or to the IMx-W unit depending on the cable and the sensor type, but NOT to both.

Configuration of Analogue/Isolated Inputs

Analogue inputs 15 and 16 have the functionality to act as an ordinary analogue input 15 and 16 or act as analogue isolated input 15 and 16. The analogue input 15 and analogue isolated input 15 share the same screw terminals. Whereas, the analogue input 16 and analogue isolated input 16 share the same screw terminals. Selection between ordinary analogue inputs and analogue isolated inputs are done by DIP switches and jumpers for each channel.

The analogue isolated inputs can act either as voltage inputs or current 4–20 mA inputs. Selection between voltage and current inputs is done by one jumper for each channel.

The ordinary analogue input 15 and 16 have better performance/frequency response compared to the analogue isolated inputs 15 and 16.

Important – If there are high voltage isolation requirements or needs for 4–20 mA current input, use the settings for analogue isolated input 15 or 16. However, if a voltage measurement sensor is required, then channels 15 and 16 can be set up as normal analogue inputs 15 and 16.

Analogue input 15/analogue isolated input ISO15 (voltage/current 4–20 mA)

DIP switches 5 and 6 are used to select between analogue input 15 and analogue isolated input ISO15 (voltage or current 4–20 mA). The default is ordinary analogue input 15.

When analogue channels are set up for isolated input ISO15, you need to check the *Isolated* field at the setup of the individual channels in software.

Table 3-2: Channel 15 DIP switches selection of analogue/analogue isolated input.

Analogue input 15/analogue isolated 15	DIP5	DIP6
Analogue input Ch15 [V]	0011	0011
Analogue isolated Ch15 [*]	1100	1100

*see Jumper selection for analogue isolated inputs, below.

Analogue input 16/analogue isolated input ISO16 (voltage/current 4–20 mA)

DIP7 and DIP8 are used to select between analogue input 16 and analogue isolated input ISO16 (voltage or current 4–20 mA). The default is ordinary analogue input 16.

When analogue channels are set up for isolated input ISO16, you need to check the *Isolated* field at the setup of the individual channels in software.

Table 3-3: Channel 16 DIP switches selection of analogue/analogue isolated input.

Analogue input 16/analogue isolated 16	DIP7	DIP8
Analogue input Ch16 [V]	0011	0011
Analogue isolated Ch16 [*]	1100	1100

*see Jumper selection for analogue isolated inputs, below.

Jumper selection for analogue isolated input ISO15 and ISO16

Jumpers, JMP2 and JMP3 define whether the analogue isolated ISO15 and ISO16 inputs are voltage input measurements or 4–20 mA current input measurements.

The default setting for the analogue isolated inputs is 4–20 mA current inputs.

Table 3-4: Jumper selection for analogue isolated inputs.

*Analogue isolated 15, 16 input type	JMP2 for analogue isolated 15	JMP3 for analogue isolated 16
Voltage	1 to 2	1 to 2
4–20 mA (default)	2 to 3	2 to 3

The jumpers are located behind the front panel which has to be removed in order to adjust them.

Refer to the tables in <u>Wire Connections</u> and the drawing of <u>Connectors and Switches Location</u> for connectors naming and location details.

Flexible Load Sensor

Important – Danger, High Voltage! Installation of flexible load sensor MUST be performed by a qualified electrician.

The flexible load sensor is used to determine the load condition of the turbine and for current analyses.

In the case where only one is placed, current analyses are limited to that electrical phase cable around which the flexible load sensor is placed. For optimal current analyses, one flexible load sensor per phase cable must be used (3 phases = 3 flexible load sensors).

For load calculation, one flexible load sensor is normally enough because we assume closely balanced/loaded phases.

The sensor is easy to install as the sensor loop can be opened and placed around one of the generator phase cables. When sensor is in position, close the loop firmly and secure with the locknut.

Important – Remember to place the power sensor around only one of the generator phase cables.
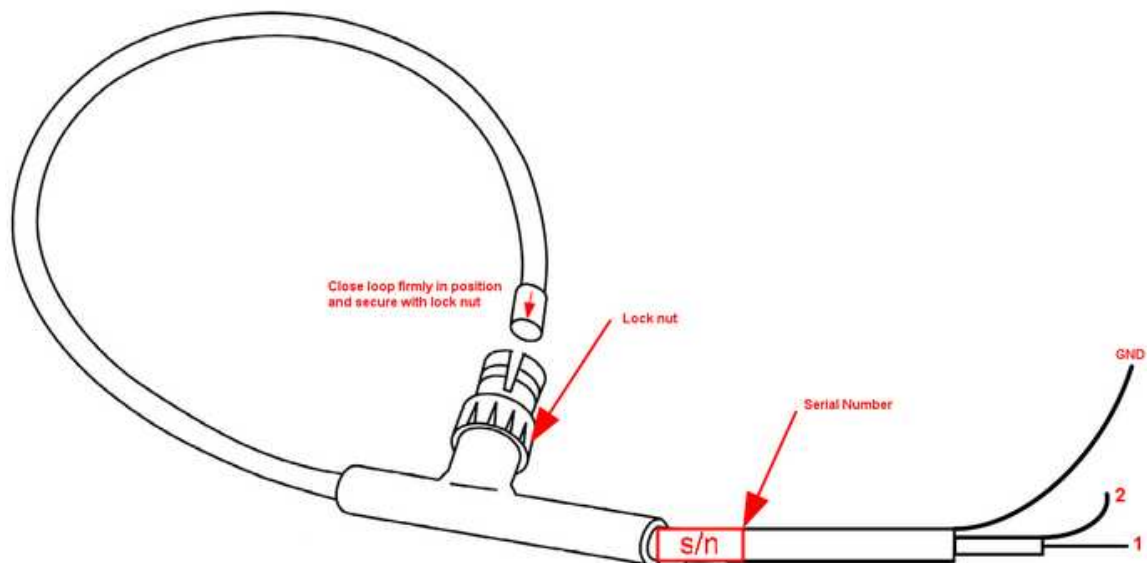
Figure 3 – 5.
Flexible Load Sensor.
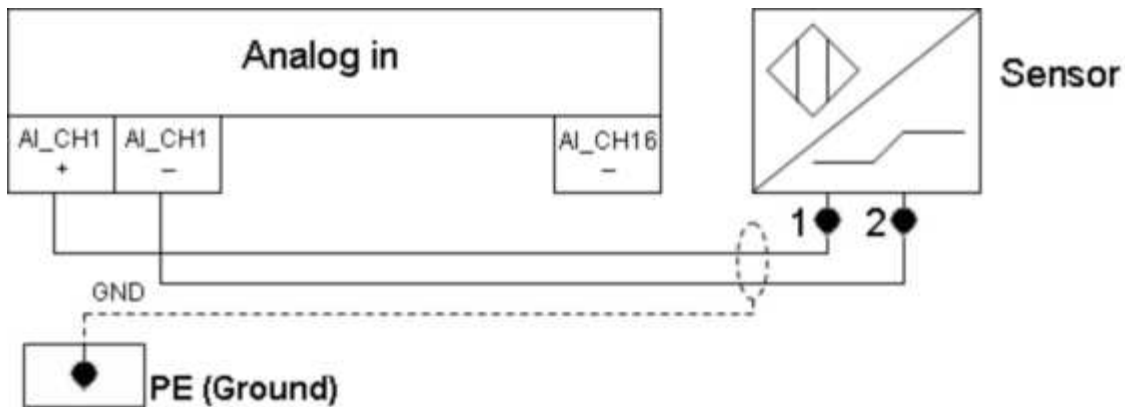
Figure 3 - 6.
Flexible Load Sensor Conductor in Details.

1 – Coax center signal conductor (signal +)

2 – Coax signal shield (signal –)

GND – Should be connected to IMx-W, WindCon power ground strip, since the sensor is fully isolated (10 kV peak).

Important – The flexible sensor GND wire should be connected to IMx-W power ground to prevent signal noise. Note that the flexible load sensor is fully isolated (10 kV peak).

The standard accelerometer power should be turned off for the channel where the flexible load sensor is connected.

The channel power is turned on/off in software configuration. Refer to @ptitude Observer User Manual for more information.

Figure 3 – 7.
Flexible Load Sensor Measuring One of the Generator Phase Cables.

Flexible Load Sensor Configuration

The absolute accuracy of the load sensor calibration is not necessary, since the load sensing is only used to trigger the measurements. As long as it is close enough for indication purposes, it is acceptable. Therefore, it is often enough to use an approximation for the load sensor sensitivity.

Below is a detailed explanation of how to calculate sensitivity for other frequencies, generator voltages and sensor calibration data accurately. Note that, to calculate produced generator power, there are many uncertain variables such as voltage, frequency, power factor, current, power loss and so on. The sensor only measures the current of one phase and the other variables are only an approximation, hence the sensor alone can not be used as an accurate measurement of produced turbine power. However, as we mentioned before, the usage of it is for indicating power and to trigger measurements, it is sufficient enough. The values can manually be finely tuned, but the following example description of sensitivity is often a good enough approximation for triggering measurements.

Step 1 – IMx Unit's analogue channel use for load sensor.
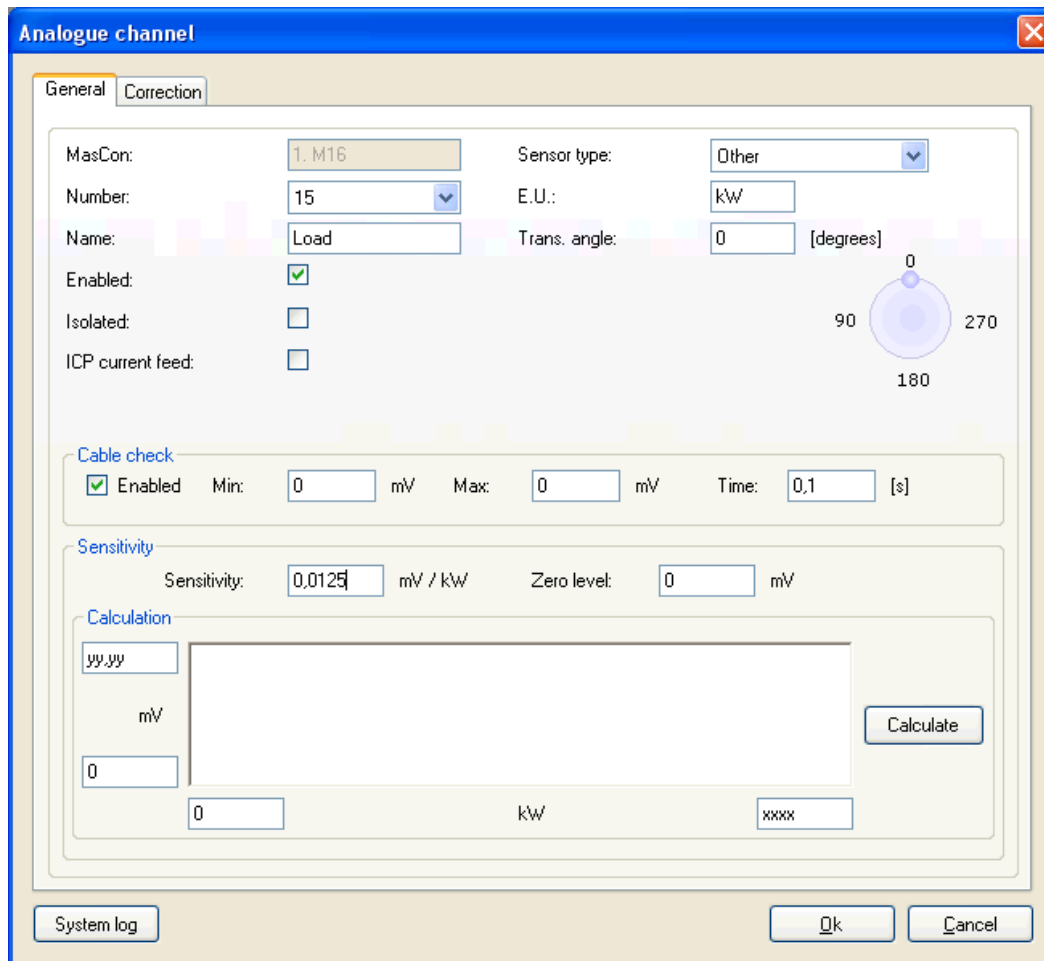
Figure 3 - 8.
IMx Unit's Analogue Channel Use for Load Sensor.

A good approximation for sensitivity is 0,0125 mv/kW (if phase voltage, between phase and N, is 400 VAC and 50 Hz).

Detailed explanation of how to calculate sensitivity:

- Change xxxx [kW] to the maximum power of the generator in kilo watt (kW) for example 1,5 MW turbine = 1 500 kW.

- yy,yy [mV] is the output of the sensor when the generator is producing maximum power.

- The sensor output can be calculated from the following formula:

  Vout(peak) = (2 × pi × f × I × Cal) / sqrt(2) where as

  f = frequency 50 Hz (or 60 Hz)

  I = generator phase current (one phase) when producing maximum power

  Cal = coil sensitivity found in sensor calibration certificate (nominal 68 nVs/A)

Example:

  1 500 kW turbine, 400 V phase voltage, three phase generator (1 500 kW / 3 = 500 kW per phase)

Formula P = U × I => I = P / U gives us

  I = 1 500 kW / (3 × 400 V) = 1 250 Ampere

  Cal = 64,35 nVs/A (from sensor calibration certificate)

  Vout = (2 × pi × 50 × 1 250 × 64,35e^{-9}) / 1,4142 = 17,9 mV peak

Hence

  yy,yy = 17,9 [mV]

  xxxx = 1 500 [kW]

Put the two values from above into each field and click on calculate button and sensitivity will be calculated.

Step 2 – Create a process FFT measurement point for the channel that is connected to the flexible load sensor (normally Ch15 or Ch16).

- Select a machine or a sub machine that a new process FFT measurement point is to be added, in the hierarchy view.

- Click on the right mouse button, select **Add**, then **Point**.

- Select **IMx** unit, then **Process FFT**.
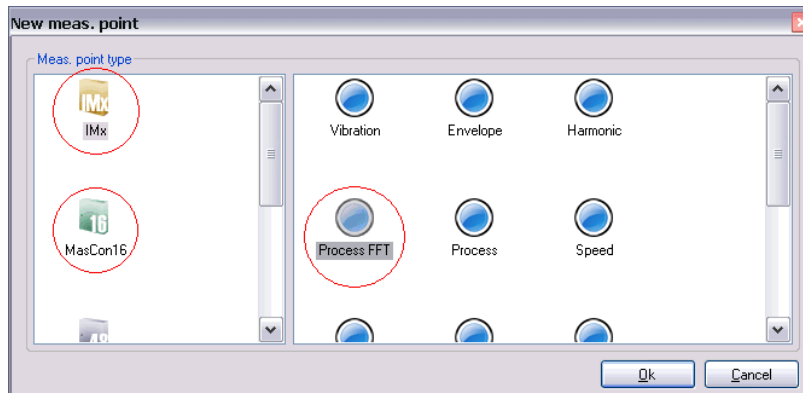
Figure 3 – 9.
Create a Process FFT Measurement Point.

Step 3 – Configure general settings of the process FFT measurement point.
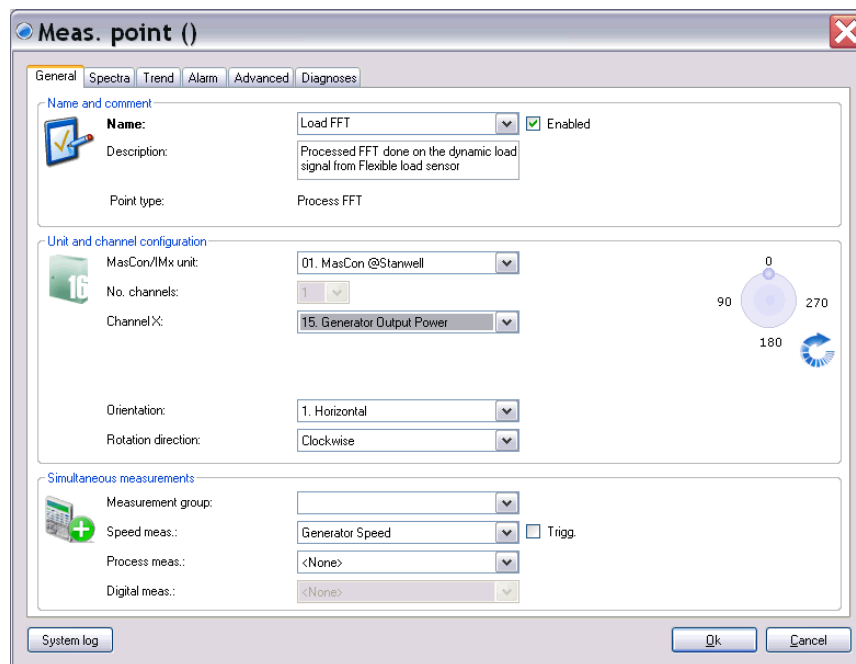
Figure 3 – 10.
General Settings of Process FFT Measurement Point.

Step 4 – Configure spectra settings of the process FFT measurement point.
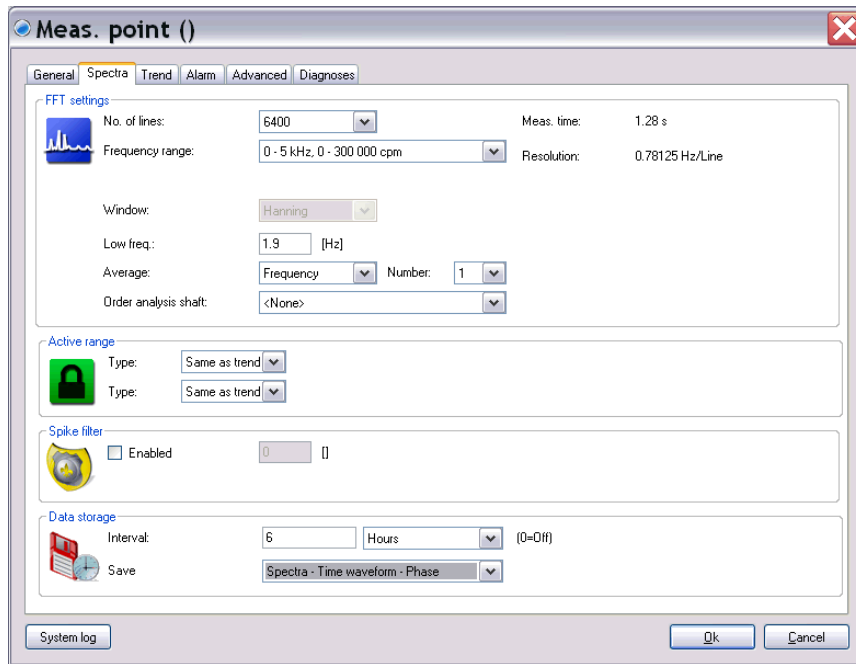
Figure 3 - 11.
Spectra Settings of Process FFT Measurement Point.

Step 5 – Configure trend settings of the process FFT measurement point.
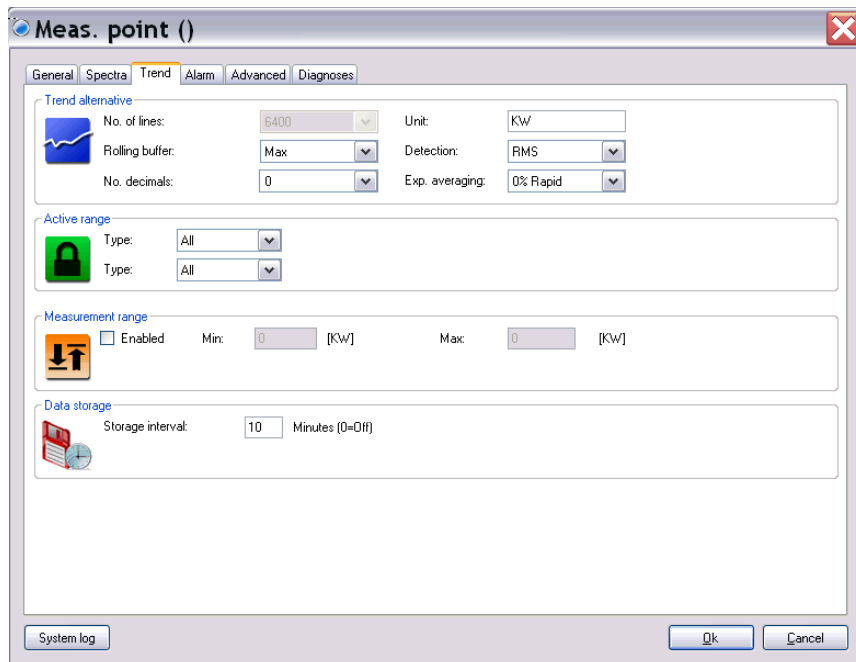
Figure 3 - 12.
Trend Settings of Process FFT Measurement Point.

Step 6 – Configure alarm settings of the process FFT measurement point.
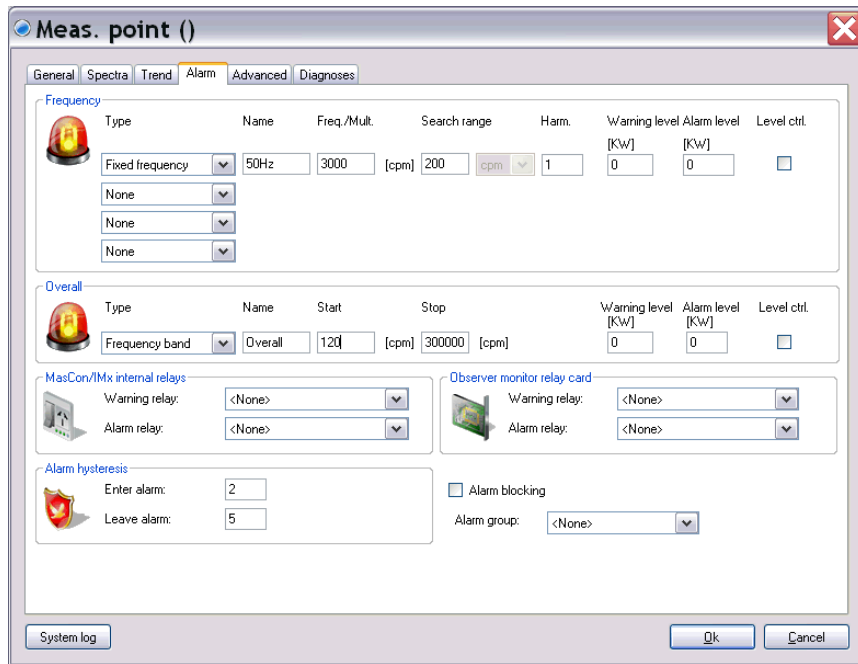
Figure 3 – 13.
Alarm Settings of Process FFT Measurement Point.

Step 7 – Create a new hardware derived measurement point. This is needed because measurement points are the only ones that can be used to trigger other measurements.

- Select a machine or a sub machine that a new derived measurement point is to be added in the hierarchy view.

- Click on the right mouse button, select **Add**, then **Point**

- Select **IMx**, then **Derived point**.
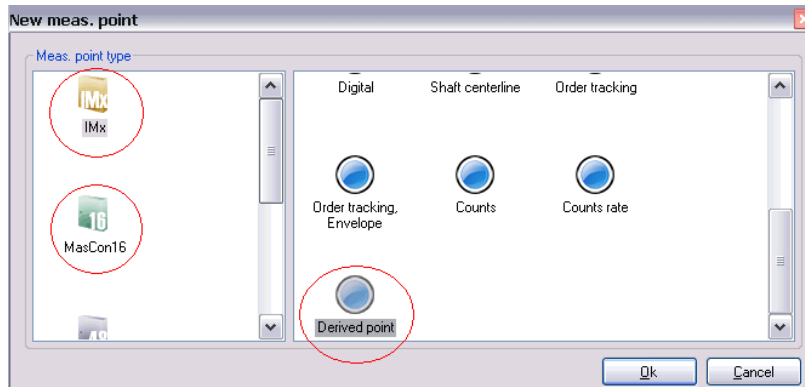
Figure 3 – 14.
Create a Derived Measurement Point.

Step 8 – On the General settings screen, click Add to create the following parameter to use the previously set 50 Hz band as the input. Make sure that you select the correct measurement point and the correct band for the derived measurement point.
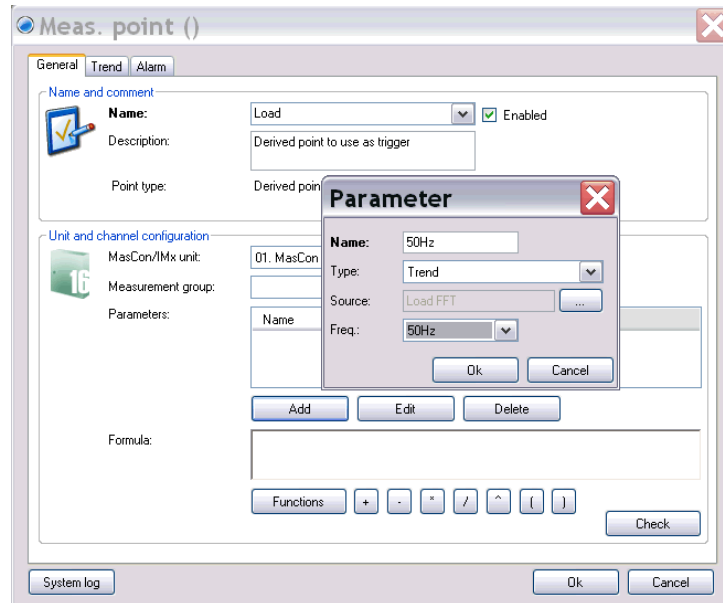
Figure 3 – 15.
Add a Parameter to the Derived Measurement Point.

Step 9 – Configure general settings of the derived measurement point. Functions must have the same names as the names of the parameters you have added.
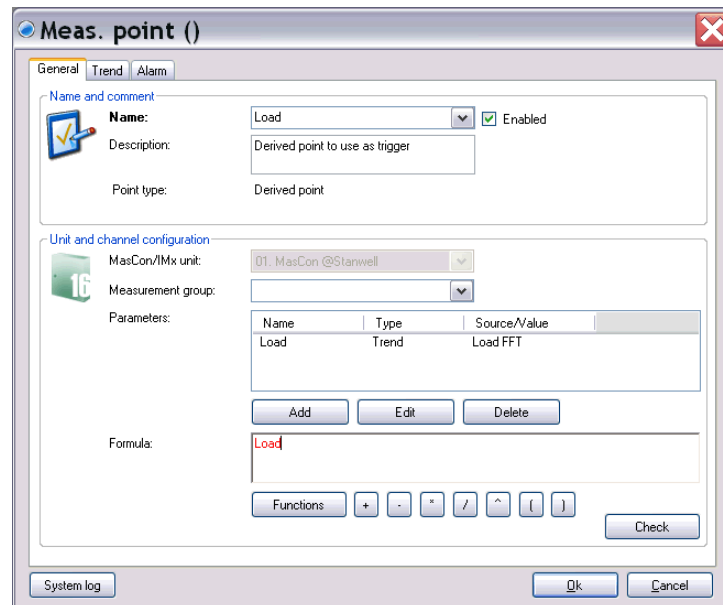
Figure 3 – 16.
General Settings of Derived Measurement Point.

Step 10 – Configure trend settings of the derived measurement point.
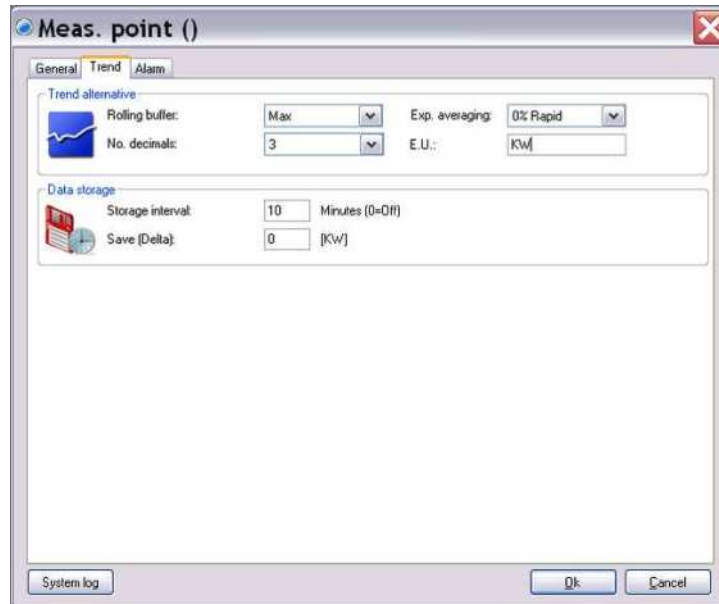
Figure 3 – 17.
Trend Settings of Derived Measurement Point.

It is mandatory to revise and recalibrate your conversion values used here after some measurements were taken on the load sensor.

The Easiest procedure is to correlate your converted load reading in Observer with that of the control system.

For example, if the controller states the output of the turbine to be 2 MW at 10:00:15, and Observer had a reading of 1,5 MW, then you must recalibrate the conversion values to allow Observer to match 2 MW (in this case, you need to increase the values by 25%). This can happen because of mounting and cable losses occurring at the installation.

Digital/Tacho

Connection of Pulse Transmitter (Tacho)

Figure 3 - 18.
Connection of Pulse Transmitter.

A pulse transmitter (tacho), linked to IMx-W, WindCon, is used to measure rotational speed of the main shaft. The tacho could be mounted to detect holes (lack of metal) or something sticking out, like a bolt head (metal). The distance between sensor and the measurement object should be adjusted to 2 to 4 mm when the lack of metal is to be sensed. An example of a sensor implemented to be used to sense the hole in the metal plate is shown above in the figure of Connection of pulse transmitter, above.

If a piece of extruding metal is to be sensed, the following guidelines should be considered.

Mounting instructions	Minimum gap
Gap D	3 x B
Gap W	3 x Sn
Gap T	3 x B
Gap S	1,5 x B
Gap G	6 x Sn
Gap N	20 mm
Diameter of active face B	Ø 18 mm
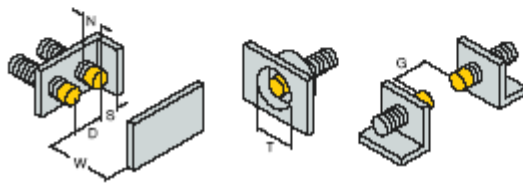
Figure 3 - 19.
Mounting Instruction Guidelines.

Connection of Tacho Cables

In order to connect the tacho cables to IMx-W, WindCon units, both two- and three-wire tacho sensors are supported. They are two-wired, three-wired NPN, three-wired PNP, pulse source TTL and pulse source 12 V. The sensor input terminals and the DIP switches that are used to configure the inputs, are shown in the following diagrams.
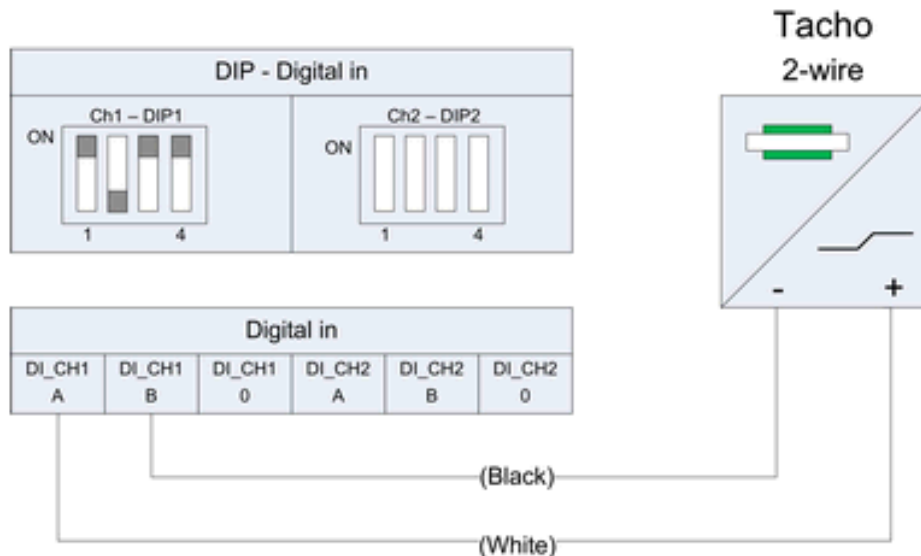
Figure 3 - 20.
Tacho Two-wire.
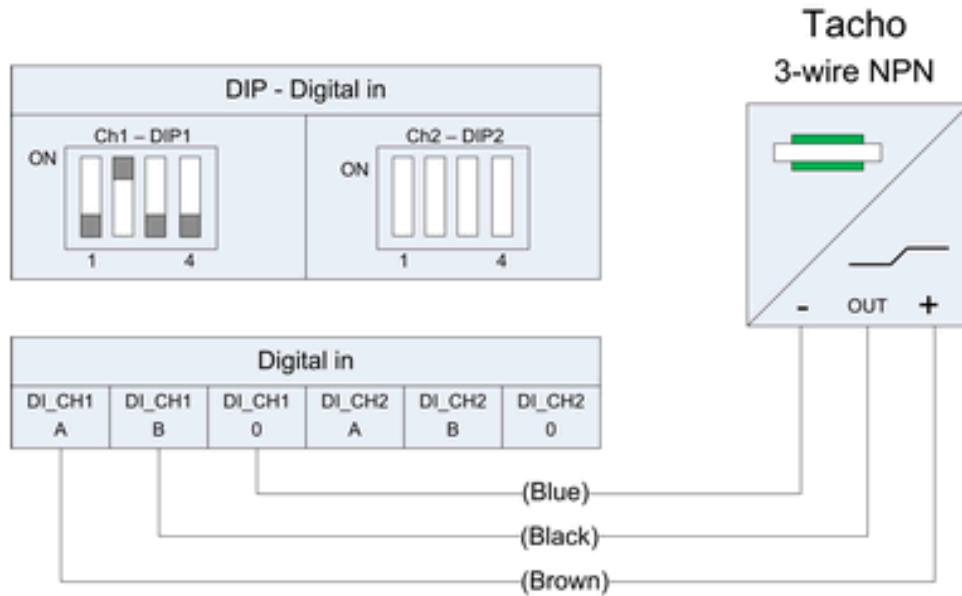
Figure 3 - 21.
Tacho Three-wire NPN.
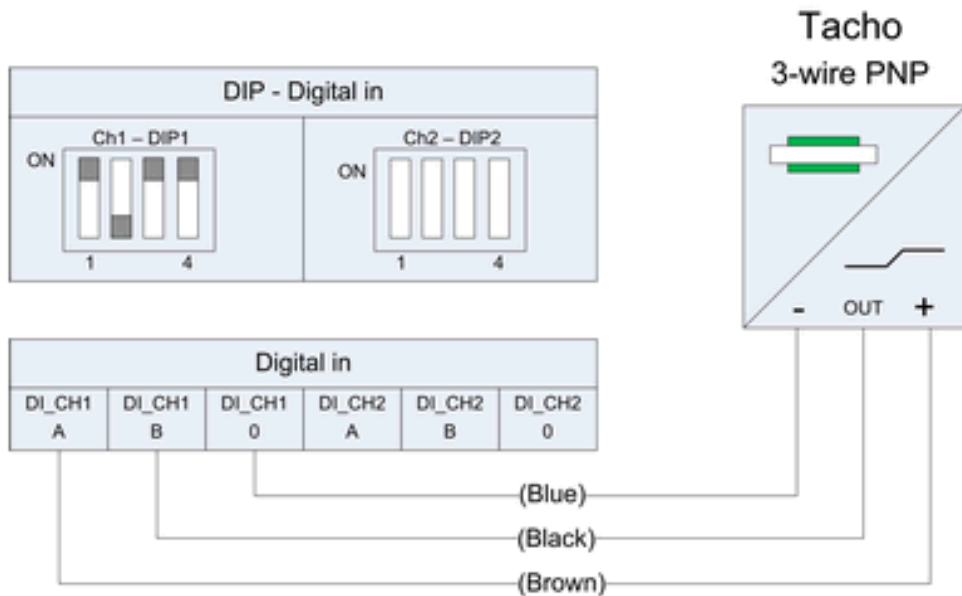
Figure 3 - 22.
Tacho Three-wire PNP.
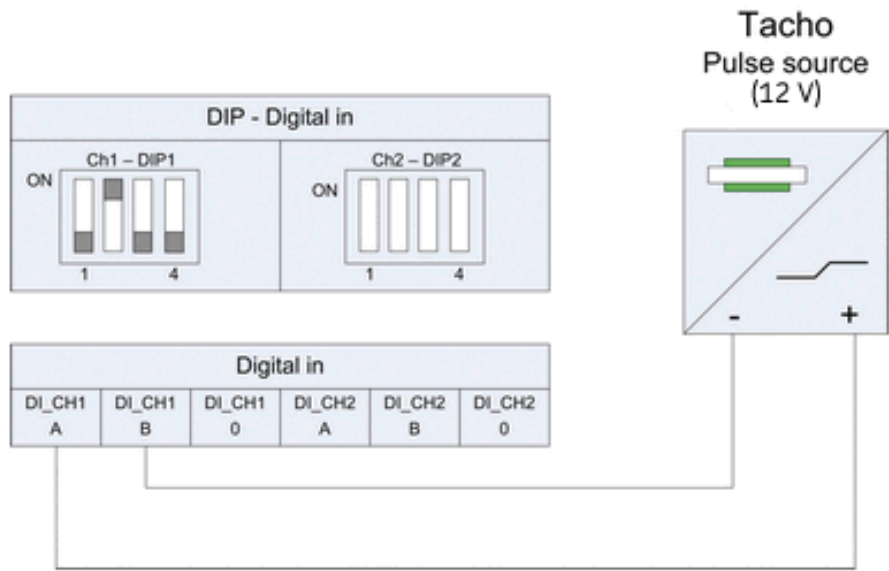
Figure 3 - 23.
Tacho Pulse Source (12 V).
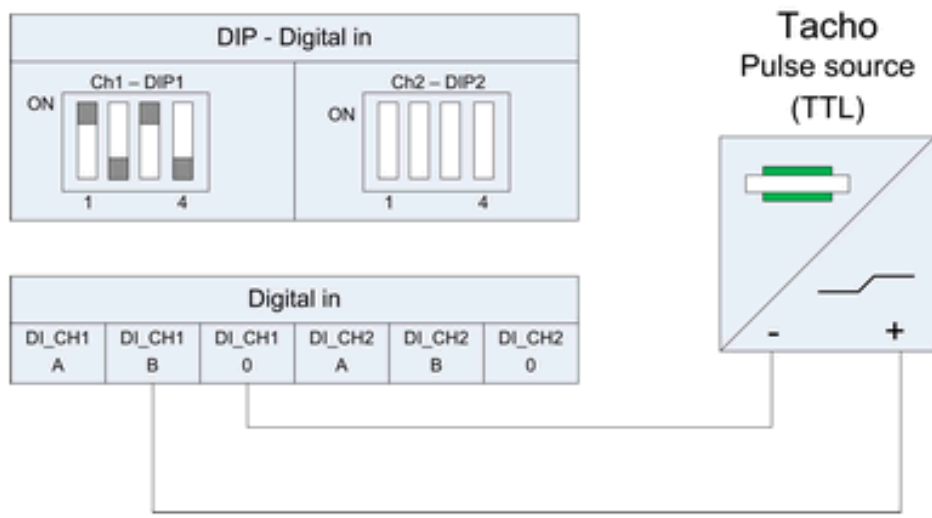
Figure 3 - 24.
Tacho Pulse Source (TTL).

DIP Switches

By default, IMx-W, WindCon is configured to supply power to both digital input/tacho channels (Dig1 and Dig2). The DIP switches control the power (12 V) on/off for the digital input/tacho channels, and can be set to the following configurations.

Note that DIP1 is used to configure digital input channel 1 and DIP2 is used to configure digital input channel 2.

Table 3-5: DIP switch settings for different types of digital inputs/sensors.

Digital input (channel 1 and 2)	Terminal	DIP1 (Dig. input 1)	DIP2 (Dig. input 2)
Tacho two-wire (12 V internally powered)	+ – N.C.	A B 0	1011
Tacho three-wire NPN (12 V internally powered)	Brown Black Blue	A B 0	0100
Tacho three-wire PNP (12 V internally powered)	Brown Black Blue	A B 0	1011
Pulse source (12 V) (external power)	+ – N.C.	A B 0	0100
Pulse source (TTL) (external power)	N.C. + –	A B 0	1010

N.C. = Not Connected (do not connect this particular sensor type to the terminal)

Refer to the tables in Wire Connections and the drawing of Connectors and Switches Location for connectors naming and location details.

Relay Drivers

IMx-W, WindCon has two relay driver outputs that can be connected to a relay as shown below.

For both outputs in total, +12 V power is allowed for the maximum current of 300 mA.
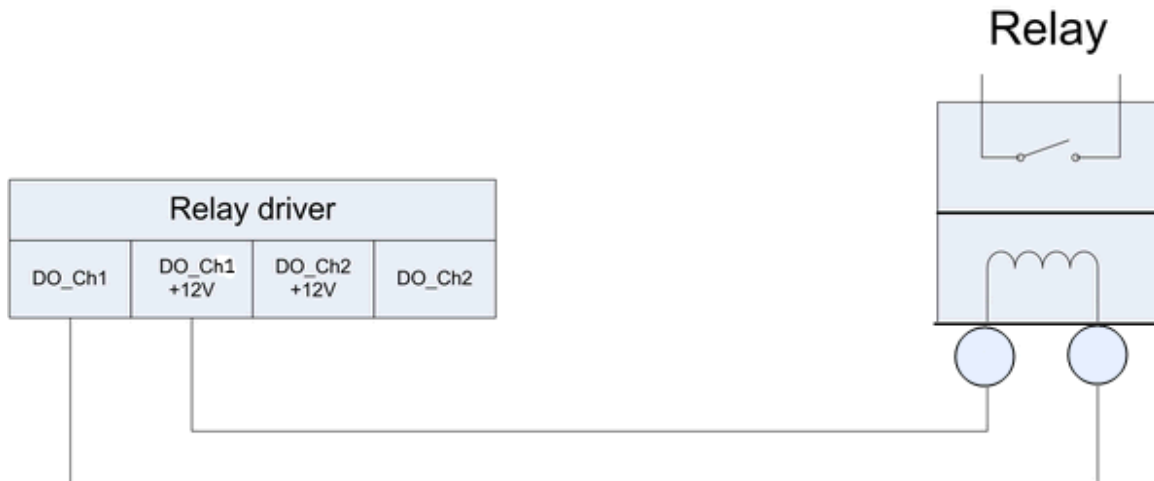
Figure 3 – 25.
Relay Driver Connection of One Output.

Refer to the tables in Wire Connections and the drawing of Connectors and Switches Location for connectors naming and location details.

Note that terminals DO_Ch1 +12V and DO_Ch2 +12V always have the voltage +12V, whereas terminals DO_Ch1 and DO_Ch2 are low side drivers known as open collectors.
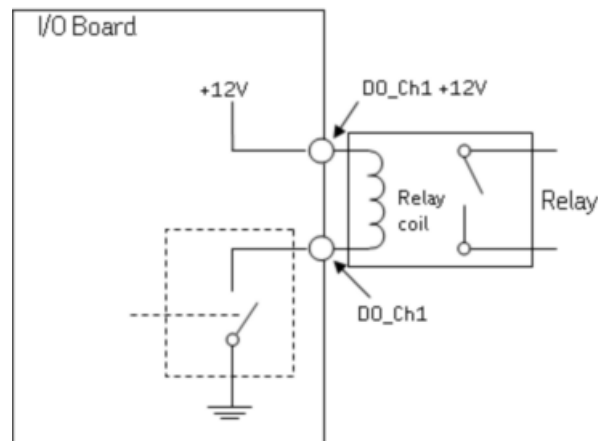
Figure 3 – 26.
Relay Open Collector Driver Showing Alarm Inactive.

CAN-bus

CAN-bus is a high speed serial interface used for interconnecting different systems to IMx-W, WindCon , such as SKF Vogel lubrication systems. If IMx-W, WindCon unit is placed first or last in the CAN-bus chain, then the built-in CAN-bus termination in the IMx-W, WindCon unit must be activated. CAN-bus termination is configured by DIP switches. See Table 3-8, below for details.

*GND (see the diagram, below) - The units that are connected to the CAN-bus must have the same ground potential. Therefore, ensure that all units are connected to the same ground potential. In case of where floating CAN equipment is connected to IMx-W, WindCon CAN-bus, the IMx-W, WindCon CAN GND connector can be used to ensure the same ground potential for the CAN-bus. Normally, all units are connected to the same ground connection and not floating. In such case, IMx-W, WindCon CAN GND connector must not be connected in order to avoid ground loops.

> *Important - To avoid ground loops, ensure that there is only one ground connection to each equipment. The IMx-W, WindCon GND connector can be used in case where connected equipment bus is floating.*

Table 3-6: CAN-bus termination settings.

CAN termination	DIP4
No termination	0000
Termination (default)	1000
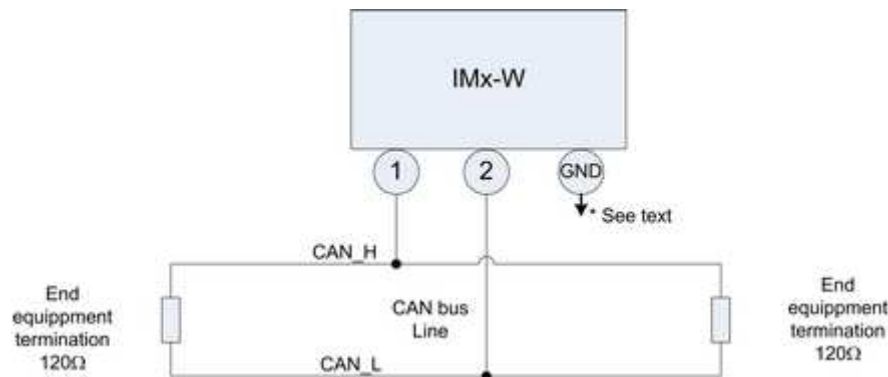
Figure 3 - 27.
CAN-bus Connection and End Termination.

Refer to the tables in Wire Connections and the drawing of Connectors and Switches Location for connectors naming and location details.

RS485/Modbus

RS485/Modbus is used to transfer measurement data from other systems to the IMx-W, WindCon unit. If the IMx-W, WindCon unit is placed first or last in the RS485 bus chain, then the built-in RS485 bus termination in the IMx-W, WindCon unit must be activated. RS485 bus termination is configured by DIP switches (see the table RS485 bus termination settings, below).

*GND (see the diagram, below) – The units that are connected to the RS485 must have the same ground potential. Therefore, ensure that all units are connected to the same ground potential. In case of where floating RS485 equipment is connected to IMx-W, WindCon RS485 bus, the IMx-W, WindCon RS485 GND connector can be used to ensure the same ground potential for the RS485 bus. Normally, all units are connected to the same ground connection. In such case, the IMx-W, WindCon RS485 GND connector must not be connected in order to avoid ground loops.

> *Important – To avoid ground loops, ensure that there is only one ground connection to each equipment. The IMx-W, WindCon GND connector can be used in case where connected equipment bus is floating.*

Table 3-7: RS485 bus termination settings.

RS485 termination	DIP3
No termination	0000
Termination (default)	1000
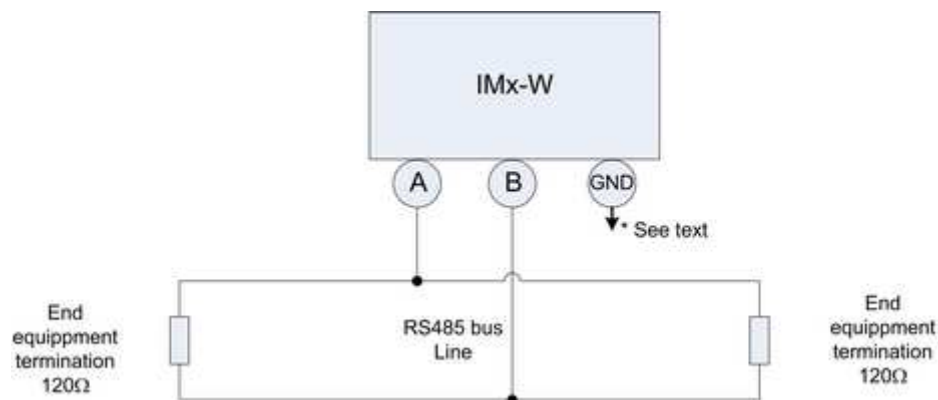
Figure 3 – 28.
RS485 Bus Connection and End Termination.

For more information regarding RS485/Modbus, refer to "Modbus for IMx & Mascon16 User Manual". Also, refer to the tables in Wire Connections and the drawing of Connectors and Switches Location for connectors naming and location details.

Network Configuration

All IMx-W, WindCon units must have an identity number between 1 and 255, unique to the database to which it is connected.

It also requires network settings and the IP number and port number of the @ptitude Observer Monitor Service to which it should be connected.

Keep in mind that most of the time, all IMx-W, WindCon units are on the same network and database, therefore units can NOT have a same IP address or a same unit ID.

The network configuration is done by using the On-line Device Configurator tool. For detailed information, refer to **@ptitude Observer On-line Device Configurator User Manual**.

There are two ways to configure a network and unit ID:

- by **software**: is configured by the software via On-line Device Configurator.

- by **DIP Switches (Hardware)**: is done by configuring HEX rotary switches manually.

By DIP Switches (Hardware)

If you have decided to configure the network manually by hardware, the following logic must be fulfilled.

- Factory default configuration TCP/IP address: 10.0.0.1XY.

- The configuration of DIP switches requires you to set the first three part of the IP address at Create IMx/MasCon16 Config screen of On-line Device Configuration tool.

- However, the last part of the IP address will be controlled by the HEX rotary switches on the IMx-W unit.

- For example, 10.0.0.1XY, where XY is derived from the HEX rotary switches (see the table below).

- These last two digits will also form the unit ID.

- The HEX rotary switches are located on the front panel, right hand side marked as Hex A and Hex B.

- The HEX rotary switches have to be set manually with a small screwdriver.

Table 3-8: TCP/IP address/Unit ID when configured by HEX rotary switches.

TCP/IP address/Unit ID	Hex A (x10)	Hex B(x1)
Software defined	0	0
01	0	1
02	0	2
↓	↓	↓
99	9	9
Factory default configuration TCP/IP address: 10.0.0.1XY		

Serial Configuration Interface (RS232)

RS232 interface is used only when the required basic network configuration setup is being done.

The RS232 connector is located on the front panel of the IMx-W, labeled as DSUB1. See Connectors and Switches Location in IMx-W, WindCon Drawings chapter for the physical location.

Use a null modem serial cable with a 9-pin D-SUB connector.

It is recommended to use a short length cable for RS232 interface in order to maintain full communication speed.

> *Important – RS232 connector is used only when the required basic network configuration setup is being done. Therefore, the cable should not be connected to RS232 connector at any other time.*

Table 3-9: RS232 connector pinout.

RS232 Connector Pinout	
Pin	**Description**
1	N.C. (Not Connected)
2	Rx
3	Tx
4	N.C. (Not Connected)
5	GND
6	N.C. (Not Connected)
7	N.C. (Not Connected)
8	N.C. (Not Connected)
9	N.C. (Not Connected)

Null modem cable wiring

2 ———— 2
3 ———— 3
5 ———— 5

9-pin D-sub (female)   9-pin D-sub (female)
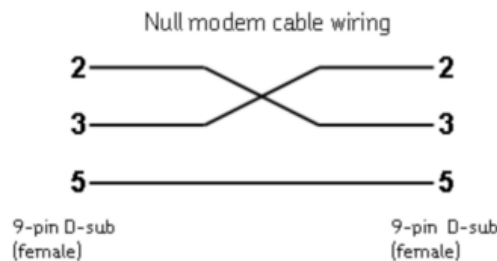
Figure 3 – 29.
Null Modem Cable Wiring.

Network Load

The IMx-W, WindCon system is permanently monitoring, always measuring and collecting data from all the sensors.

The IMx-W, WindCon is connected to the @ptitude Observer Monitor Service by on-line, and data is stored in the database as a separate process from the continuous measuring cycle. The data stored in the database are based on measurement criteria such as alarming, time interval, diagnoses, etc.

The system transfers only a small amount of data for on-line status information, to store trend data and also when an alarm is triggered. The load of the data network is dependant on the IMx-W, WindCon configuration, but normally only a small amount of data is transferred. In case of temporary loss of the network connection, data is still measured and stored locally, so that when IMx-W, WindCon goes on-line again, collected data is transferred to the database. This means that the on-line connection can be as simple as a low byte rate modem, GSM, ADSL, normal Internet or any other communication interface that provides an Ethernet port to connect IMx-W, WindCon and, hence provides the connection to the @ptitude Observer Monitor database. For dial-up modems, data can be continuously collected. For example, once per day, modem is dialed and data is transferred to the database and then back off-line again.

The following are some examples of network load from a normal configuration.

Trend data for 1 measurement point:

- Vibration measurement point = 160 bytes per trend value

- Other measurement point = 50 bytes per trend value

FFT spectra for 1 measurement point:

- Number of lines x 2 bytes (2 bytes if FFT spectra include only amplitude, but 4 bytes if FFT spectra include both amplitude and phase)

Time waveform storage:

- Number of lines x 5,12 bytes per measurement point (2 bytes per sample)

For a normal setup, we can calculate as the following:

Setup:

- 8 vibration measurement points (3 200 lines)

- with time waveform

- 1 speed (tacho) measurement point

- We store FFT spectra with time waveform 1 per day, trend data every 10 minutes, and digital data every 10 minutes.

Calculation for data per day would be:

FFT spectra + time waveform + trend data + digital data

= (8 x 3 200 x 2) + (8 x 3 200 x 5,12) + (8 x 160 x 6 x 24) + (50 x 6 x 24)

= 51 200 + 133 120 + 184 320 + 7 200

= 375 840 bytes per day or 375,8 KB per day

= 11,3 MB/month (average of 30 days per month)

IMx-W Time

IMx-W unit has a backup power capacitor which will keep the time for at least a month if IMx-W is disconnected from a power inlet.

To correct or set IMx-W time, use one of the following methods.

- **Automatic time synchronization**

  This method is preferable since IMx-W will continuously synchronize the time with the computer that has @ptitude Observer Monitor Service running

  IMx-W uses a built-in function (NTP) in Windows for time synchronization.

  In order to activate time synchronization, refer to Time Synchronization chapter in "@ptitude Observer Installation Manual".

- **Manual set time**

  Use "Set time" function in @ptitude Observer which is found under a tab menu called "On-line", then "MasCon/IMx units" interface.

Hardware Maintenance

The IMx-W, WindCon hardware, i.e. IMx-W, WindCon and the sensors are virtually maintenance free, however we advise the customer to do a yearly visual inspection of the equipment.

Performance over Time

There is no significant performance degradation to be expected over time for IMx-W, WindCon hardware.

Dismantling IMx-W

Summary

- Task: Dismantling an IMx-W unit

- Qualification of Operator: Knowledge of IMx-W and sensor system.

- Time: About 15 minutes to dismantle an IMx-W unit

- Number of operators: 1

- Tools: A Phillips screwdriver and an ESD wrist strap

Dismantling Instruction

1. Disconnect the external main power to the IMx-W unit.

2. Open the cabinet door as shown below using the cabinet key.

Figure 4 - 1.
IMx-W Door Closed.

Figure 4 - 2.
IMx-W Door Opened.

3. Unscrew the 4 screws on the front panel as shown below.
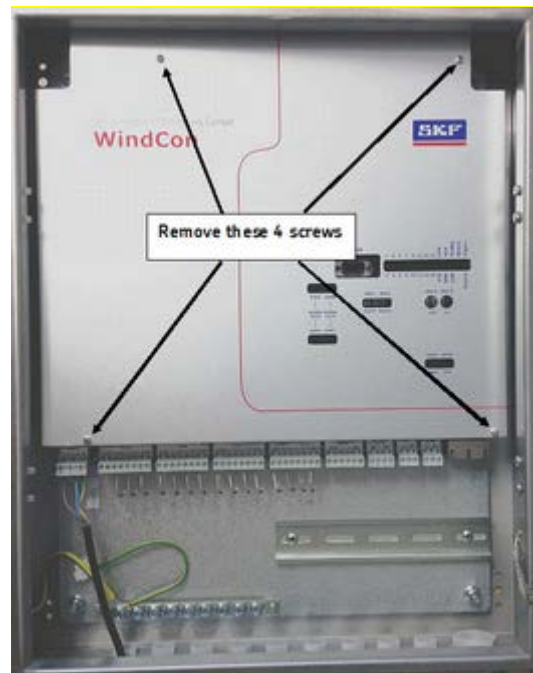
Figure 4 - 3.
Locations of 4 Mounting Screws on Front Panel.

4. Lift the front panel and remove it as shown below.

Figure 4 - 4.
Lift the Front Panel and Remove.

5. Identify the three main components; The PSU (Power Supply), the CPU Board and the Lightning protection board as shown below.
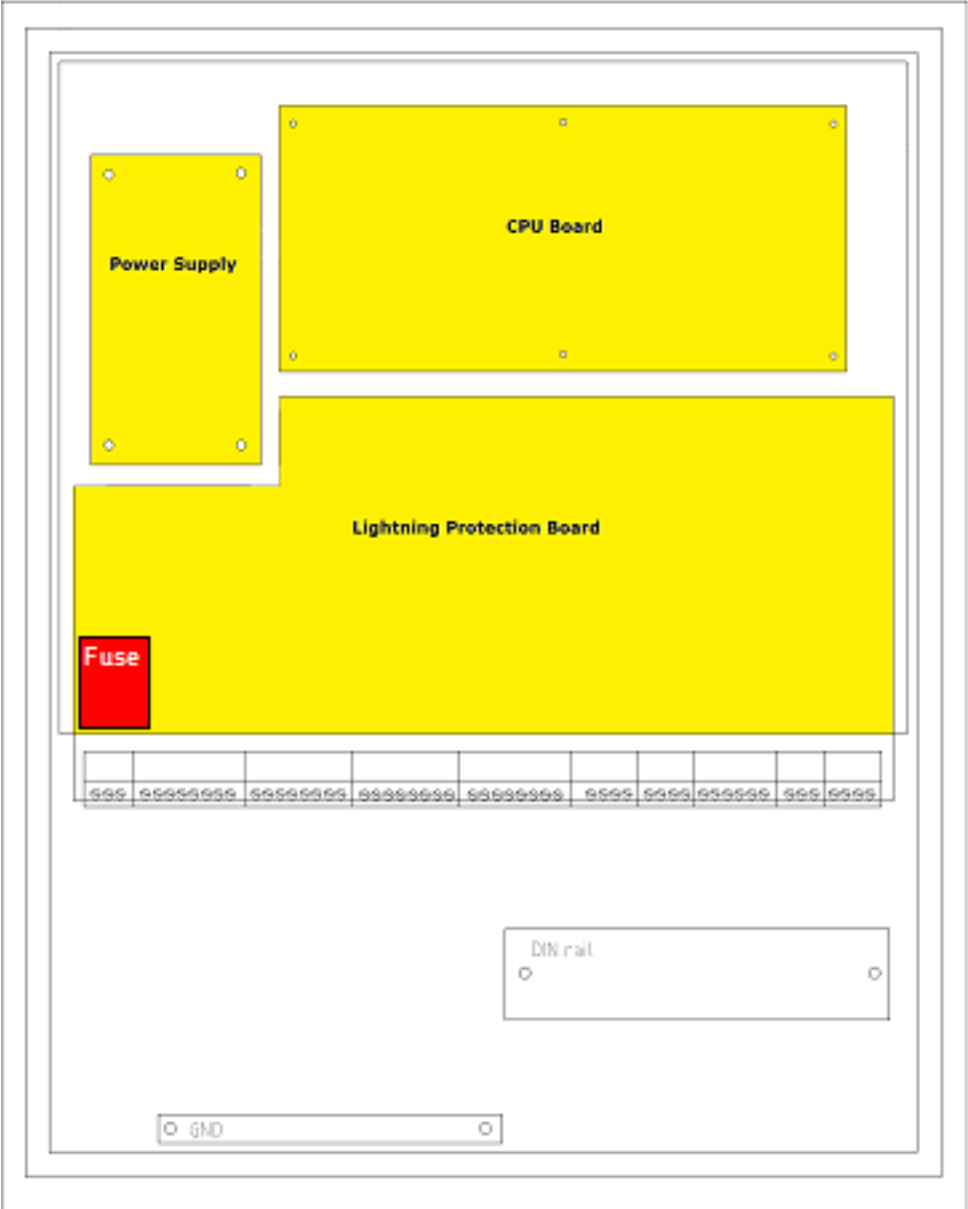
Figure 4 – 5.
Three Main Components in IMx-W.

6. Detach sensors, network cables and main power cable from the Lightning protection board. They are all detached by pulling the connectors as shown below.
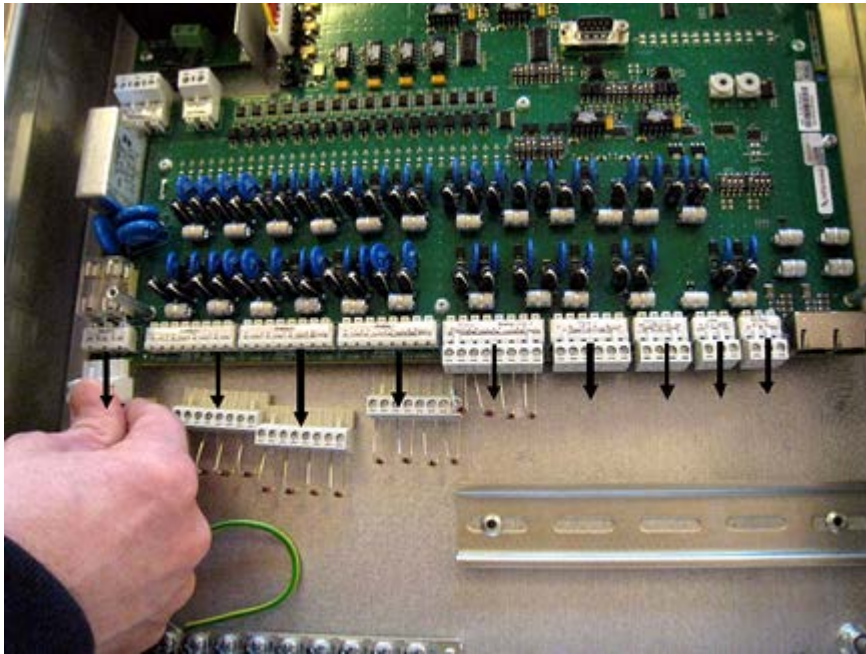
Figure 4 – 6.
Detach All Connectors from Lightning Protection Board.

7. All work on the boards from now on must be performed wearing an ESD wrist strap with galvanic contact to the steel cabinet as shown below.

Figure 4 – 7.
Always Use an ESD Write Strap When Handling the Lightning Protection Board.

8. The Lightning Protection Board is separated from the IMx-W by disconnecting two power supply connectors and unscrewing nine bolts.
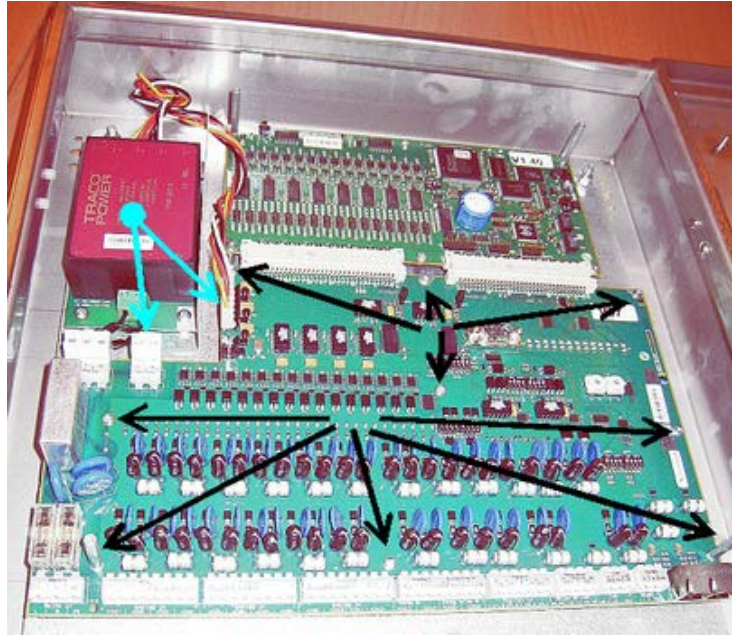
Figure 4 - 8.
Disconnect Power Supply Contacts (blue arrows) and Remove Screws (black arrows).

9. Then, pull the Lightning Protection Board down in the direction of the arrows as shown below to disconnect it from the CPU board.

Figure 4 - 9.
Pull the Lightning Protection Board down to Free It from the CPU Board.

10. Now the Power supply and the CPU board are possible to be detached by removing the screws as shown below.
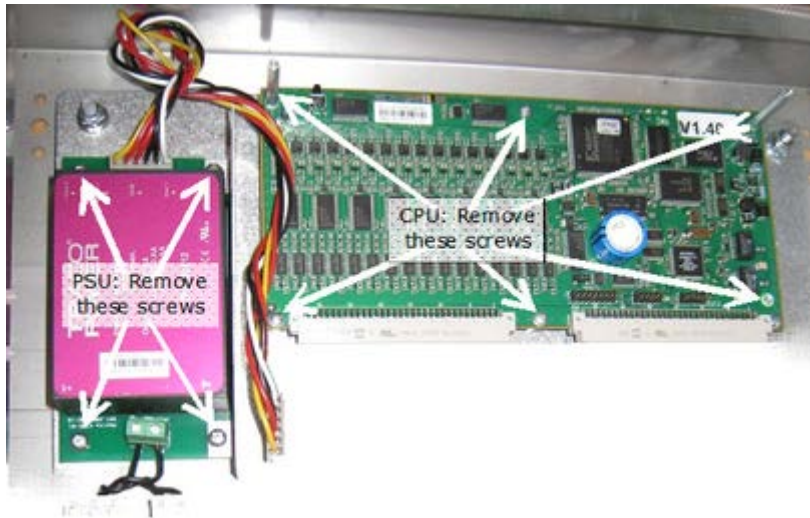
Figure 4 - 10.
Remove Screws to Detach Power Supply and CPU Board.

Assembling IMx-W

The IMx-W is assembled by performing steps 1 to 10 in Dismantling IMX-W in reverse order.

After assembling IMx-W, the Installation and Unit Configuration must be performed accordingly in order to ensure the proper functioning of the IMx-W.

Replacing a Burnt Fuse in IMx-W

1. Perform steps 1, 2, 3 and 4 of in Dismantling IMX-W.

2. Locate the fuses labeled as F1 and F2.
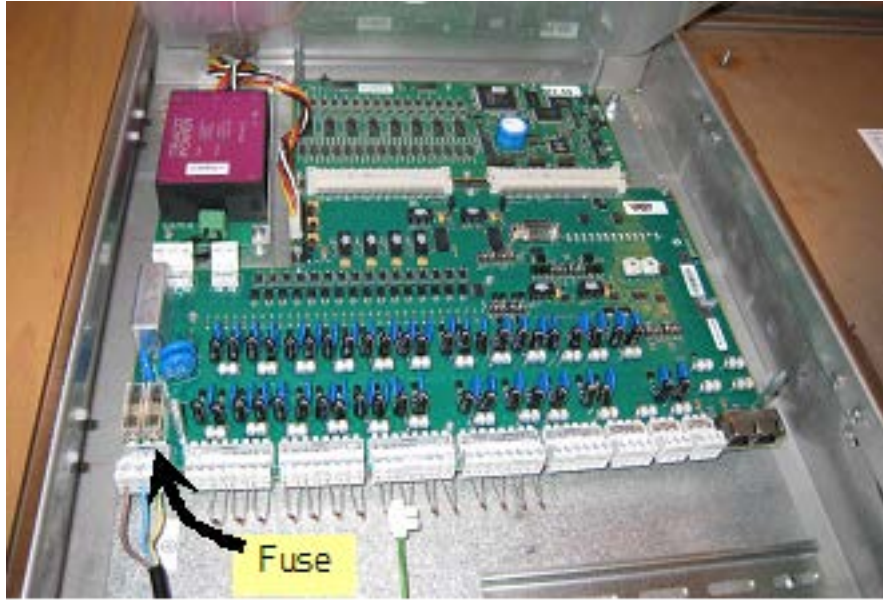
Figure 4 – 11.
Location of Fuses (F1, F2) in IMx-W.

3. Replace the burnt fuse with a slow blow 2A (T2A 250 V, 5 x 20 mm) fuse.

Refer to Mains Power for more detailed information on mains power and power cable attachment.

5
Electrical Waste

Electrical waste and electrical equipment should be recycled according to the WEEE-directive and not be placed in the general refuse. Product should be sent to an approved recycling center for safe recycling, recovery, reuse or sent to SKF Condition Monitoring Center AB for proper recycling.

SKF Condition Monitoring Center AB
Aurorum 30
97775 Luleå
Sweden

6
Technical Data

Environmental

- Size (H x W x D): 500 x 400 x 100 mm (*19.7 x 15.7 x 3.9 in.*)

- Weight: 12 kg (*26.5 lb.*)

- IP rating: IP 65

- Operating temperature range: −20 to +60 °C (*−4 to +140 °F*)

- Storage temperature range: −40 to +70 °C (*−40 to +158 °F*)

- Humidity: 95% (relative) non-condensing

- Installation location: Inside nacelle use only

- Measurement category II

- Pollution degree 2

- Maximum altitude: 2 000 m (*6 561.7 ft.*)

- Two different types of cabinet available: Painted steel cabinet, Stainless steel cabinet

Power Supply

- Power supply: 100 to 240 VAC, 50 to 60 Hz, 0,75 A maximum

Analogue Inputs

- 16 analogue differential inputs

- Software controlled power supply for standard accelerometers (4 mA constant current) for each individual channel

- Simultaneous measurement of all channels

- Input range ±25 V

- Impedance >100 kΩ

Digital Inputs

- Two digital opto-isolated inputs

- Individual 12 V power supply, maximum 40 mA per channel

- Phase voltage range: 3 to 14 V

- Can interface with most standard sensors

Outputs

- Two relay driver outputs

Analogue Measurement

- 24-bit AD conversion enabling continuous data capture without gain or AC/DC switching necessary

- Simultaneous sampling of all 16 channels (no multiplexing), and one A/D converter for each channel

- 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 20 kHz), ±5% (20 to 40 kHz)

- Accuracy phase: ±3° (up to 100 Hz)

- Automatic detection of sensor fault and cable fault (software configurable)

Digital Measurement

- Frequency range: 0,1 Hz to 12,5 kHz
  - Required pulse width:
    > 4 μs for electrical positive,
    > 40 μs for electrical negative
- Accuracy frequency: 0,05% of measurement value (typically 0,01% up to 2,5 kHz)
- Pulse counting

Signal Processing

- Time waveform

- Vector analysis with circular alarms

- FFT: 100 to 6 400 lines

- DPE (Digital Peak 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

- Detection of sensor and cable fault

- Watchdog and self testing

Interface

- Ethernet: 100 Mbit RJ45, TCP/IP (two ports), switch functionality

- Ethernet switch possible for daisy chaining

- RS232 service interface

- CAN-bus interface for data sharing with other systems

- RS485 (Modbus) interface for data sharing with other systems

Data Processing

- 64 MB RAM for data processing (from serial number >=12000)

Miscellaneous

- Calibration traceable to BIPM (international bureau of weights and measures)

- CE certified according to EN 61000

- EMC immunity according to EN 61000-6-2

- EMC emission according to EN 61000-6-3

- Lightning protection: EN 61000-4-5, ±4 kV line-earth, ±2 kV line-line, ±4 kV signal

- Support IEC 61850

- GL certified

Quality Control

SKF Condition Monitoring Center Luleå is ISO 9001:2008 certified.

7
Troubleshooting Guide

Troubleshooting Guide is intended as an aid when IMx-W 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.

> ➢ Note – The guarantee becomes void if IMx-W units are damaged through incorrect intervention in the hardware, or a patently incorrect connection in contravention of directions given.

Problems and Symptoms

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-W input stage

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-W input stage

- Signal disturbed by external noise

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-W

- Faulty IMx-W speed input

- Incorrect setting in hardware

Suggested solution:

- Test speed input.

Analogue input gives faulty/no signal

Possible causes:

- Cable fault (short circuit/break) to sensor

- Faulty sensor

- Faulty earthing

- Incorrect setting in hardware

- Faulty IMx-W input

Suggested solution:

- Carry out control of sensor and cabling.

Load input gives faulty/no input signal

Possible causes:

- Cable fault (short circuit/break) to sensor

- Faulty sensor signal

- Faulty earthing

- Faulty IMx-W load input

- Incorrect setting in software

Suggested solution:

- The load input acts as an analogue input. Therefore, first carry out cabling/input test. Contact SKF Condition Monitoring Center Luleå if this gives no result.

IMx-W alarm relay does not activate despite of warning alarm

Possible causes:

- Cabling fault from IMx-W to alarm panel

- Configuration error in software

- Hardware fault in IMx-W unit

Suggested solution:

- Check the relay signal. Refer to "Checking relay signal" in Component Check of this chapter.

Monitor ceases to work from a certain IMx-W unit

Possible causes:

- Loss of voltage in IMx-W unit

- Hardware fault in IMx-W unit, such as power supply or processor module

- Break in Ethernet network

Suggested solution:

- Check the voltage of IMx-W unit. In addition, check the Ethernet built-in LED indicator behavior.

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:
- Refer to "Checking monitor" in Component Check of this chapter.

Component Check

Checking sensor and sensor cabling for vibration channels

1. Determine the unit 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-W terminal block using a digital voltmeter. See the table below for the normal voltage values with and without a connected sensor respectively.

Table 7-1: 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 analogue input section of the IMx-W unit. 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 < ±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-W unit.

   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-W unit. If the IMx-W unit does not supply open circuit voltage with input open, then the IMx-W 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-W 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-W 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-W.

10. Disconnect the connector from the sensor and short circuit the pins in the sensor contact, then remeasure the voltage on the IMx-W 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 analogue channels

1. Determine the unit 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-W 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-W unit. 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 unit. 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-W terminal block. If the voltage is Ok, then the fault is in the IMx-W unit 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 analogue input part of the IMx-W unit. 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 unit 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-W terminal block using an oscilloscope or similar. Make sure to use a potential free oscilloscope.

3. Is there an expected speed signal on the IMx-W terminal block?

   YES: The signal can be too weak or at too high impedance for the IMx-W 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-W input is defective or the software is incorrectly configured. Check the settings in the program for the unit 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-W 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 relay signal

1. Determine the unit number of the alarming channel through the software measurement point setting or though the list of terminal blocks.

2. Disconnect the relay connection from the IMx-W unit in question. Carefully check to see if the relay output caused to trip the machines. Measure the voltage between the alarm relay poles.

3. Has the relay been activated (voltage approximately 12 V)?

   YES: The fault is in the cabling or output connections from IMx-W.

   NO: Check the software configuration for measurement point settings to find out whether the channel in question is allowed to activate the alarm relay. If this is not the case, then change the setting. Contact SKF Condition Monitoring Center Luleå, if the channel is permitted to activate the relay, but does not do so.

Checking monitor

1. Check first, whether the @ptitude Observer Monitor Service 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 Service software.

3. Check also that the Ethernet network is functioning and that the @ptitude Observer Monitor Service computer can write to the server disk.

Checking Modbus sensor

1. Start @ptitude Observer On-line Device Configurator program located in the @ptitude Observer directory.

2. Click **Start serial interface.**

3. On the Serial interface screen, enter the COM port number and type in the word "modbus" in the command box.

4. Statistics on communication and the contents of the import registers will appear on the screen.

   The statistics are:

   - Frame errors (short and long)

   - Checksum errors

   - The number of messages sent

   - The number of messages received

   - The number of timeouts of requests

5. A properly working Modbus communication should exhibit increasing sent and received messages, but not exhibit significant increase of errors or timeouts.

6. In case of errors or timeouts, check that all of the following are correctly installed:

   - Physical connections of RS485 cable wires are done correctly

   - Transmission characteristics are defined correctly

   - The Modbus Master-Slave pair address is entered correctly

7. This process of checking Modbus sensor can be done several times during the test to diagnose the communications or lack of it.

<div align="right">

8
Summary

</div>

Switch Settings

Table 8-1: TCP/IP address/Unit ID when configured by HEX rotary switches.

TCP/IP address/Unit number	Hex_A (x 10)	Hex_B (x 1)
Software defined 01 02 ↓ 99	0 0 0 ↓ 9	0 1 2 ↓ 9
Factory default configuration TCP/IP address: 10.0.0.1XY		

Table 8-2: Summary of IMx-W, WindCon DIP switches and jumper settings.

Switch	Switch Description
DIP1	Digital input 1
DIP2	Digital input 2
DIP3	RS485 termination
DIP4	CAN termination
DIP5, DIP6	Analogue input 15/Analogue isolated 15
DIP7, DIP8	Analogue input 16/Analogue isolated 16
JMP2 (behind cover)	Analogue isolated Ch15 input type
JMP3 (behind cover)	Analogue isolated Ch16 input type
Hex A, Hex B	TCP/IP address/Unit number

Table 8-3: Channel 15 DIP switches selection of analogue/analogue isolated input.

Analogue input 15/Analogue isolated 15	DIP5	DIP6
analogue input Ch15 [V] analogue isolated Ch15 [*]	0011 1100	0011 1100

* See below, Jumper selection for analogue isolated inputs.

Table 8-4: Channel 16 DIP switches selection of analogue/analogue isolated input.

Analogue input 16/Analogue isolate 16	DIP7	DIP8
analogue input Ch16 [V] analogue isolated Ch16 [*]	0011 1100	0011 1100

* See below, Jumper selection for analogue isolated inputs.

Table 8-5: Jumper selection for analogue isolated inputs.

* Analogue isolated 15 and 16 (input types)	JMP2 for analogue isolated 15	JMP3 for analogue isolated 16
Voltage 4–20 mA (default)	1–2 2–3	1–2 2–3

Table 8-6: DIP switch settings for different types of digital inputs/sensors.

Digital input (channel 1 and 2)	Terminal		DIP1 (Dig. input 1)	DIP2 (Dig. input 2)
Tacho 2-wire (12 V internal power)	+ – N.C.	A B 0	1011	
Tacho 3-wire NPN (12 V internal power)	Brown Black Blue	A B 0	0100	
Tacho 3-wire PNP (12 V internal power)	Brown Black Blue	A B 0	1011	
Pulse source (12 V) (external power)	+ – N.C.	A B 0	0100	
Pulse source (TTL) (external power)	N.C. + –	A B 0	1010	

N.C. = Not connected (do not connect this particular sensor type to the terminal).
DIP1 is used to configure digital input 1 channel.
DIP2 is used to configure digital input 2 channel.

Table 8-7: CAN-bus termination settings.

CAN Termination	DIP4
No termination Termination (default)	0000 1000

Table 8-8: RS485 bus termination settings.

RS485 Termination	DIP3
No termination Termination (default)	0000 1000

LED Status

Table 8-9: Status of LED indicators.

LED Indicator	Behaviour	Description
+12 V front LED	On Off	Voltage OK Voltage fails
-12 V front LED	On Off	Voltage OK Voltage fails
+5 V front LED	On Off	Voltage OK Voltage fails
Ch1–Ch16	On Off Slow flash Fast flash	Channel configured & running Channel not configured Channel cable fault Channel warning/alarm
CON	On Off Slow flash Fast flash	Connected Not connected Trying to connect Server forced connection
SYS	On Flash	System configured & running System start-up
ALR	On Off Flash	Warning indicator No alarm Alarm indicator
ERR	On/Flash	System fault
RS232	Off	Not in use
RS485	Off	Not in use
CAN	Off	Not in use
DigIn1, DigIn2	On Off Flash	Input logic one Input logic zero Input toggle

Wire Connections

Table 8-10: Wire connections for external mains out.

External mains out	
Pin	**Description**
1 2 3	~ N PE (protective earth)

Table 8-11: Wire connections for mains in.

Mains in	
Pin	Description
1	~
2	N
3	PE (protective earth)

Table 8-12: Wire connections for analogue input 1 to 4.

Analogue input 1 to 4	
Pin	Description
1	Analogue in Ch1 (+)
2	Analogue in Ch1 (–)
3	Analogue in Ch2 (+)
4	Analogue in Ch2 (–)
5	Analogue in Ch3 (+)
6	Analogue in Ch3 (–)
7	Analogue in Ch4 (+)
8	Analogue in Ch4 (–)

Table 8-13: Wire connections for analogue input 5 to 8.

Analogue input 5 to 8	
Pin	Description
1	Analogue in Ch5 (+)
2	Analogue in Ch5 (–)
3	Analogue in Ch6 (+)
4	Analogue in Ch6 (–)
5	Analogue in Ch7 (+)
6	Analogue in Ch7 (–)
7	Analogue in Ch8 (+)
8	Analogue in Ch8 (–)

Table 8-14: Wire connections for analogue input 9 to 12.

Analogue input 9 to 12	
Pin	Description
1	Analogue in Ch9 (+)
2	Analogue in Ch9 (–)
3	Analogue in Ch10 (+)
4	Analogue in Ch10 (–)
5	Analogue in Ch11 (+)
6	Analogue in Ch11 (–)
7	Analogue in Ch12 (+)
8	Analogue in Ch12 (–)

Table 8-15: Wire connections for analogue 13 to 16, analogue isolated input 15 to 16.

Analogue input 13 to 16 and Analogue isolated input 15 to 16	
Pin	Description
1	Analogue in Ch13 (+)
2	Analogue in Ch13 (–)
3	Analogue in Ch14 (+)
4	Analogue in Ch14 (–)
5	Analogue in Ch15/Analogue isolated input Ch15 (+)
6	Analogue in Ch15/Analogue isolated input Ch15 (–)
7	Analogue in Ch16/Analogue isolated input Ch16 (+)
8	Analogue in Ch16/Analogue isolated input Ch16 (–)

Table 8-16: Wire connections for digital/tacho in 1 to 2

Digital/Tacho in 1 to 2	
Pin	Description
1	Digital in Ch1 (A)
2	Digital in Ch1 (B)
3	Digital in Ch1 (0)
4	Digital in Ch2 (A)
5	Digital in Ch2 (B)
6	Digital in Ch2 (0)

Table 8-17: Wire connections for relay driver 1 and 2.

Relay driver 1 and 2	
Pin	Description
1	Digital out Ch1
2	Digital out Ch1 (+12 V)
3	Digital out Ch2 (+12 V)
4	Digital out Ch2

Table 8-18: Wire connections for CAN.

CAN	
Pin	Description
1	CAN_H
2	CAN_L
3	GND

Table 8-19: Wire connections for RS485 (Modbus).

RS485 (Modbus)	
Pin	Description
1	RS485_A
2	RS485_B
3	GND

Table 8-20: Wire connections for Ethernet 1 and 2.

Ethernet 1 and 2	
Pin/LED	Description
1	Transmit data (+)
2	Transmit data (–)
3	Receive data (+)
4	N.C. (Not Connected)
5	N.C. (Not Connected)
6	Receive data (–)
7	N.C. (Not Connected)
8	N.C. (Not Connected)
Yellow LED	Ethernet traffic indicator
Green LED	Ethernet link indicator

Table 8-21: RS232 connector pinout.

RS232 Connector Pintout	
Pin	Description
1	N.C. (Not Connected)
2	Rx
3	Tx
4	N.C. (Not Connected)
5	GND
6	N.C. (Not Connected)
7	N.C. (Not Connected)
8	N.C. (Not Connected)
9	N.C. (Not Connected)

IMx-W, WindCon Drawings

Stainless Steel Cabinet Drawings

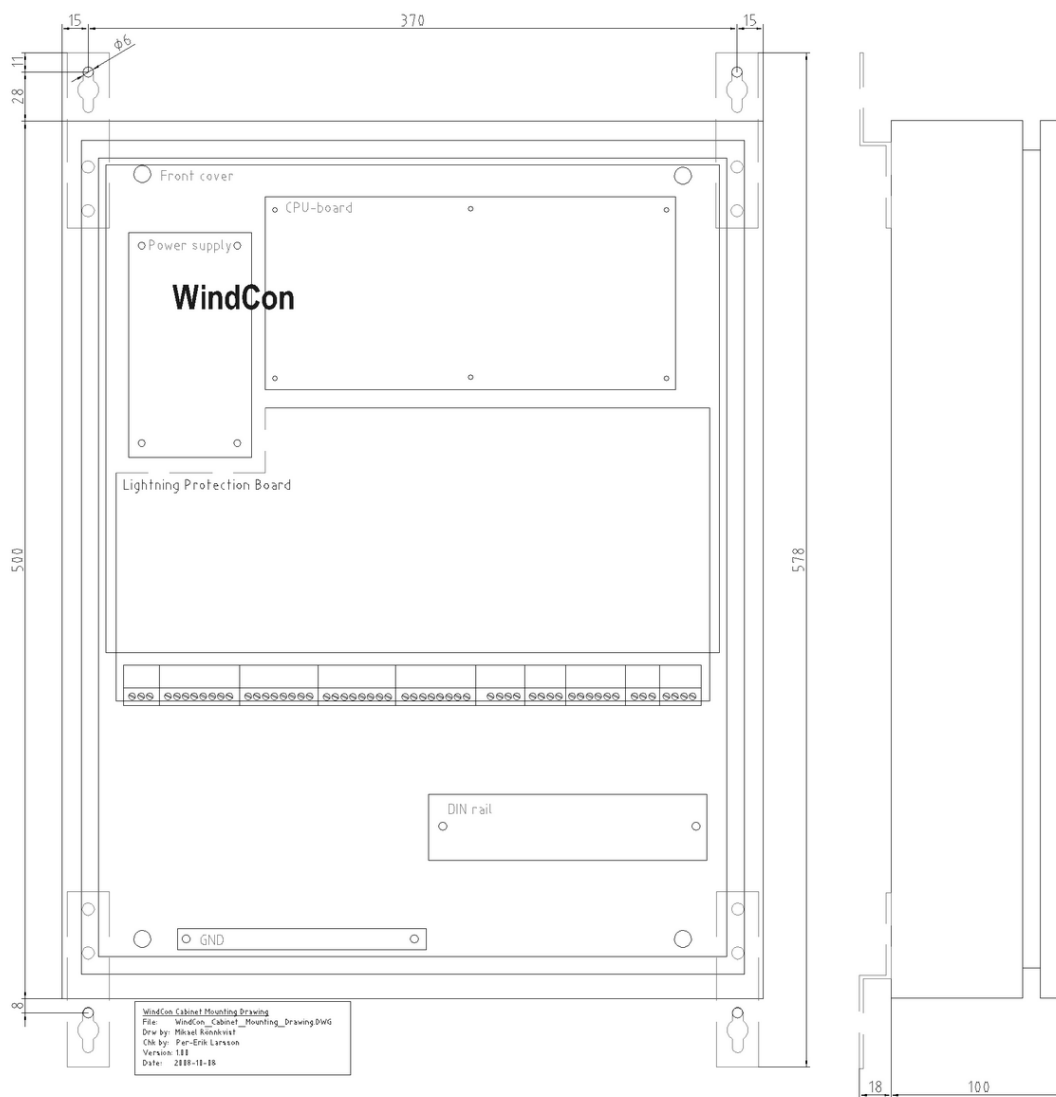### Stainless Steel Cabinet

Figure 9 - 1.
Stainless Steel Cabinet Drawing with Mounting Brackets.
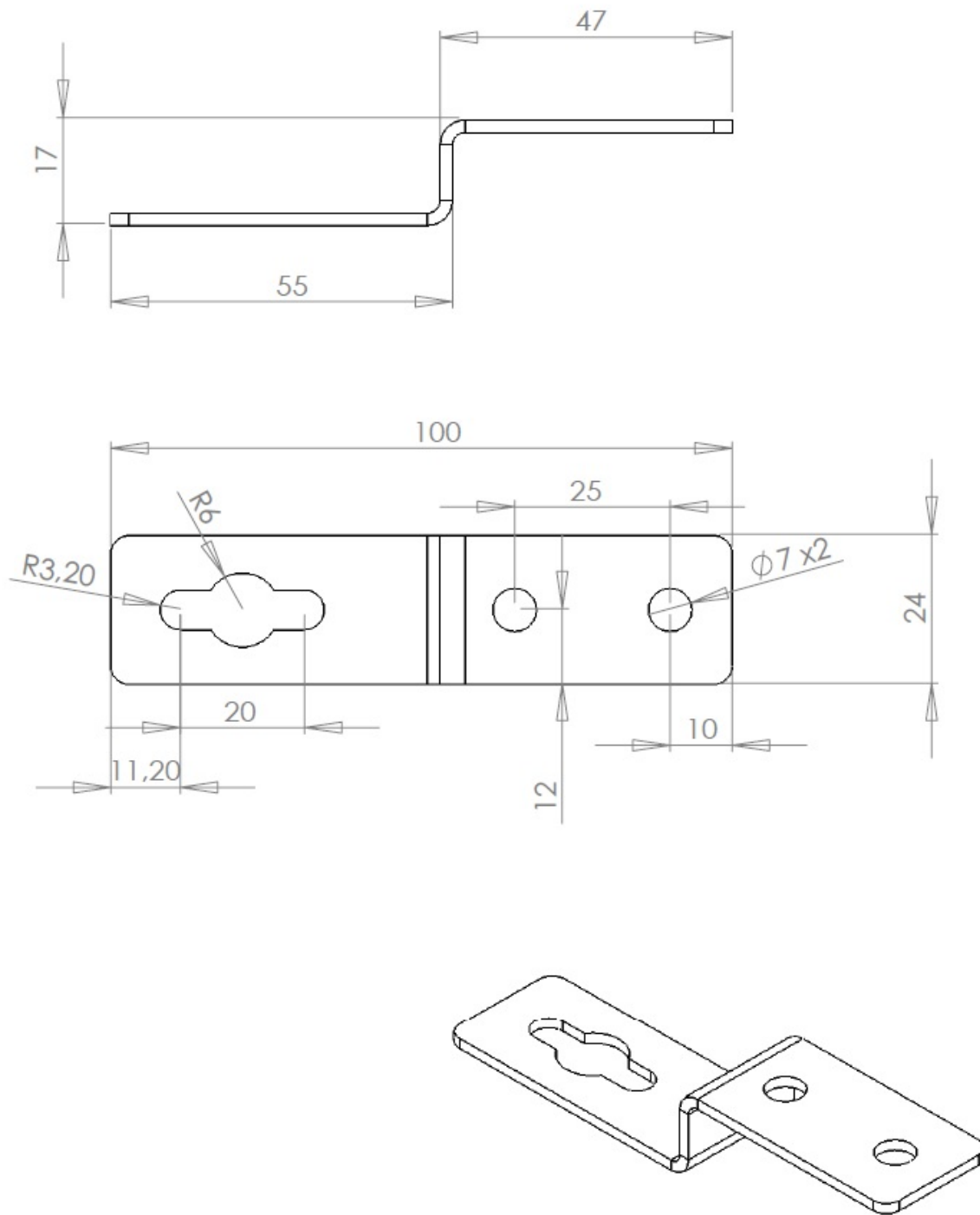
Stainless Steel Cabinet Mounting Bracket

Figure 9 - 2.
Stainless Steel Cabinet Mounting Bracket.

Stainless Steel Cabinet Bottom Holes

Figure 9 – 3.
Stainless Steel Cabinet Bottom Holes.

Painted Steel Cabinet Drawings

Painted Steel Cabinet

Figure 9 – 4.
Painted Steel Cabinet Drawing with Mounting Brackets.

Painted Steel Cabinet Mounting Bracket

Figure 9 – 5.
Painted Steel Cabinet Mounting Bracket.
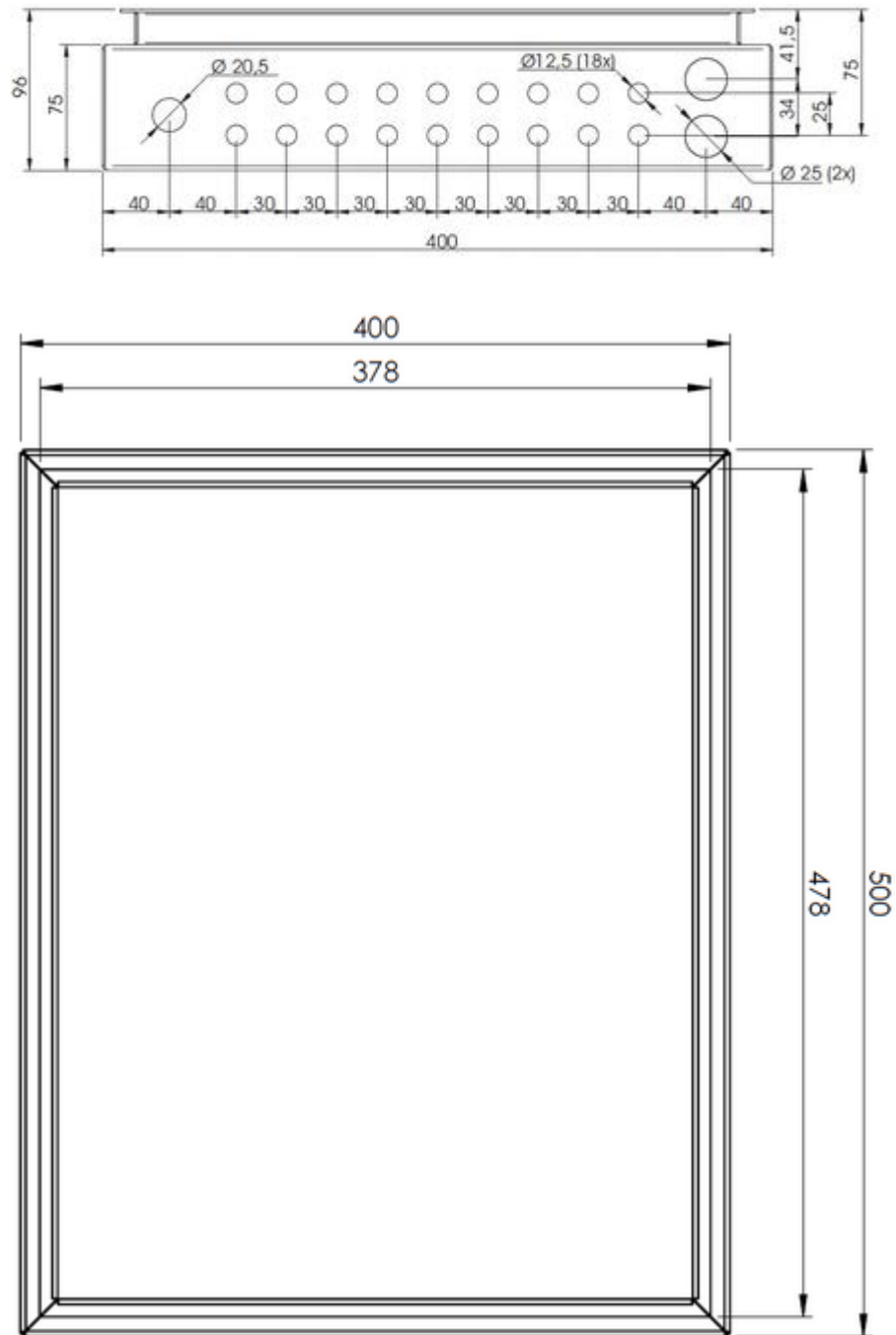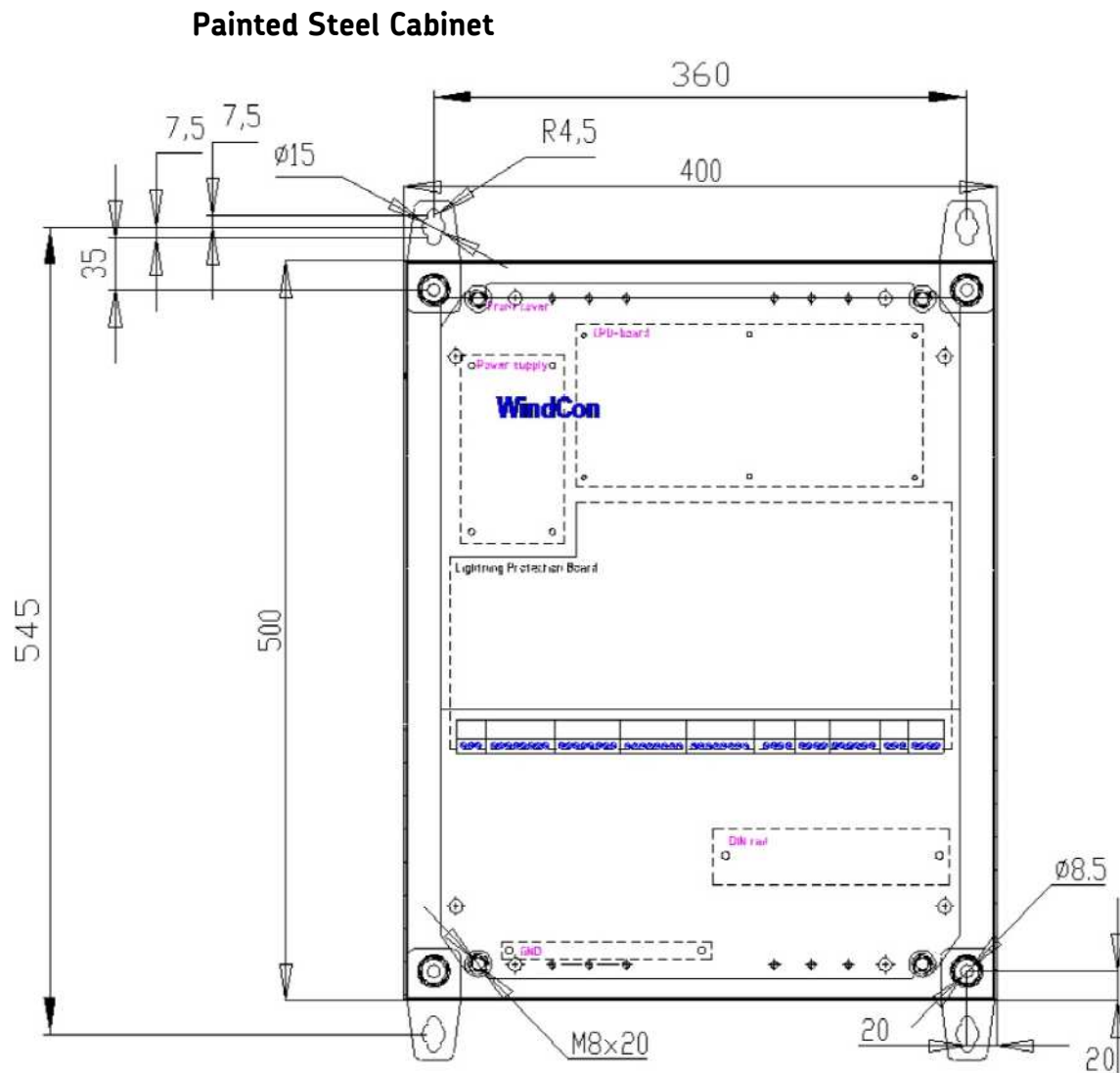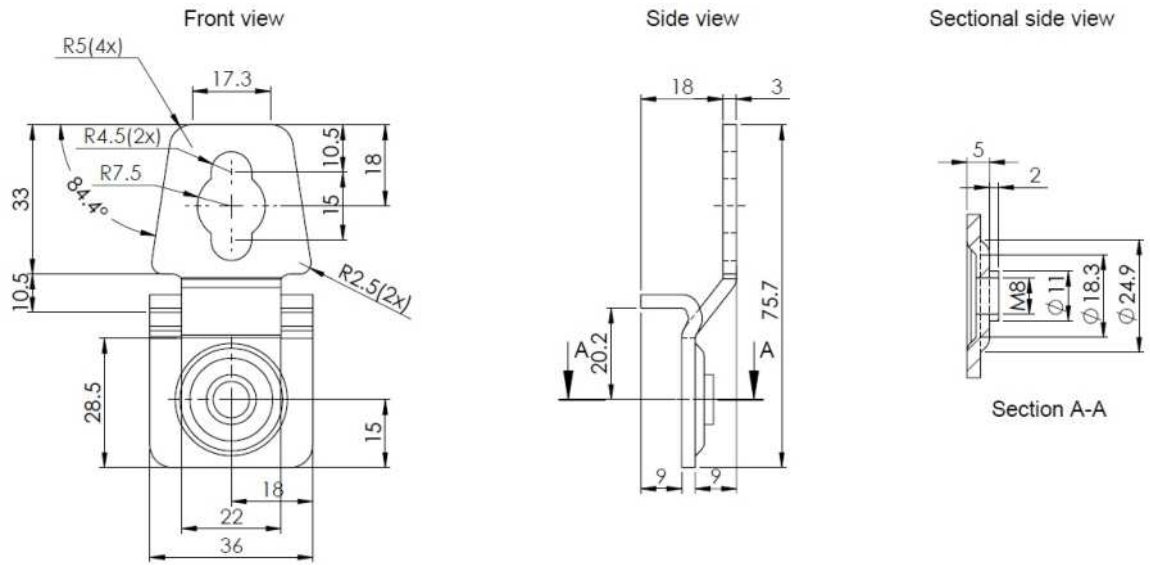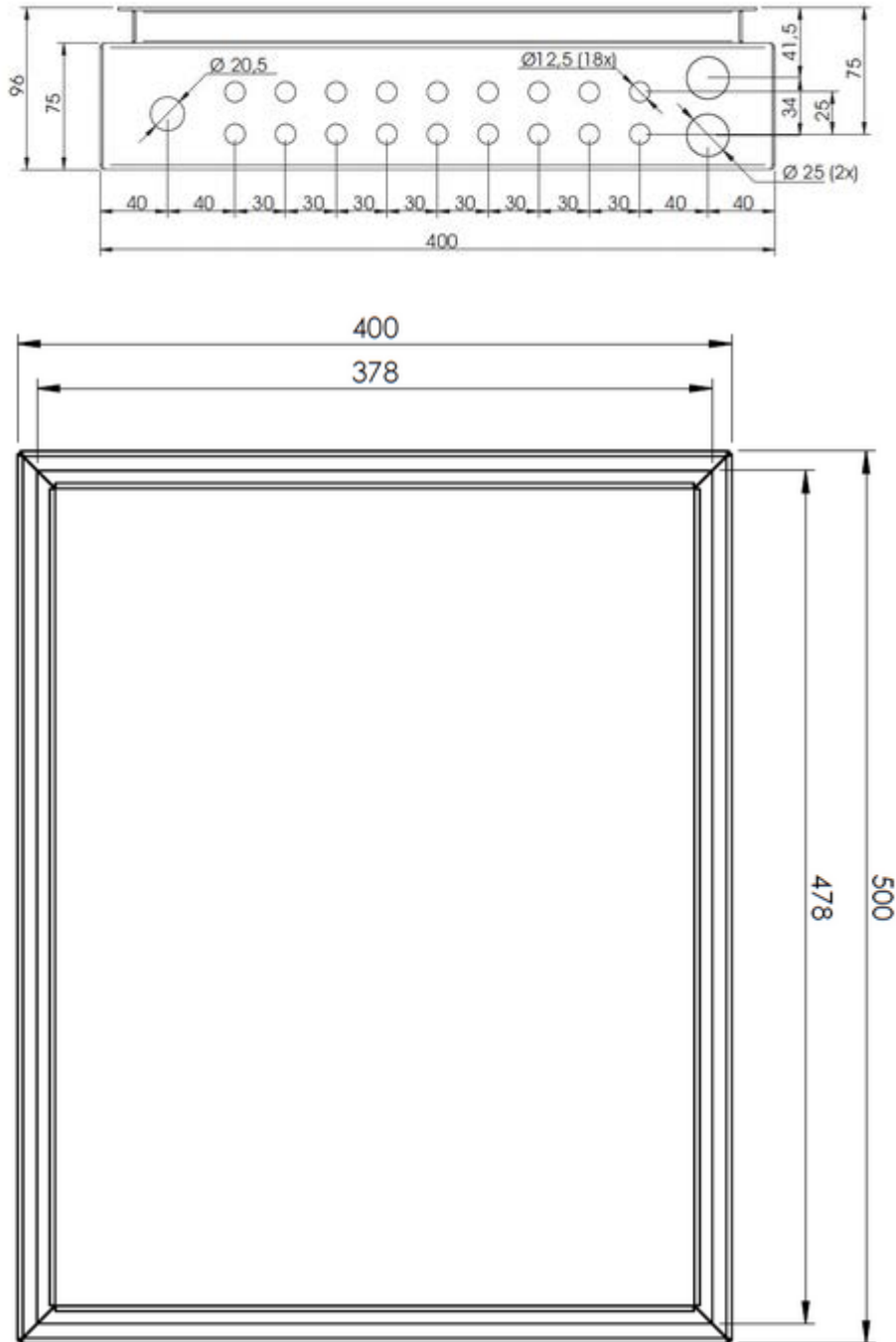
Painted Steel Cabinet Bottom Holes

Figure 9 – 6.
Painted Steel Cabinet Bottom Holes.
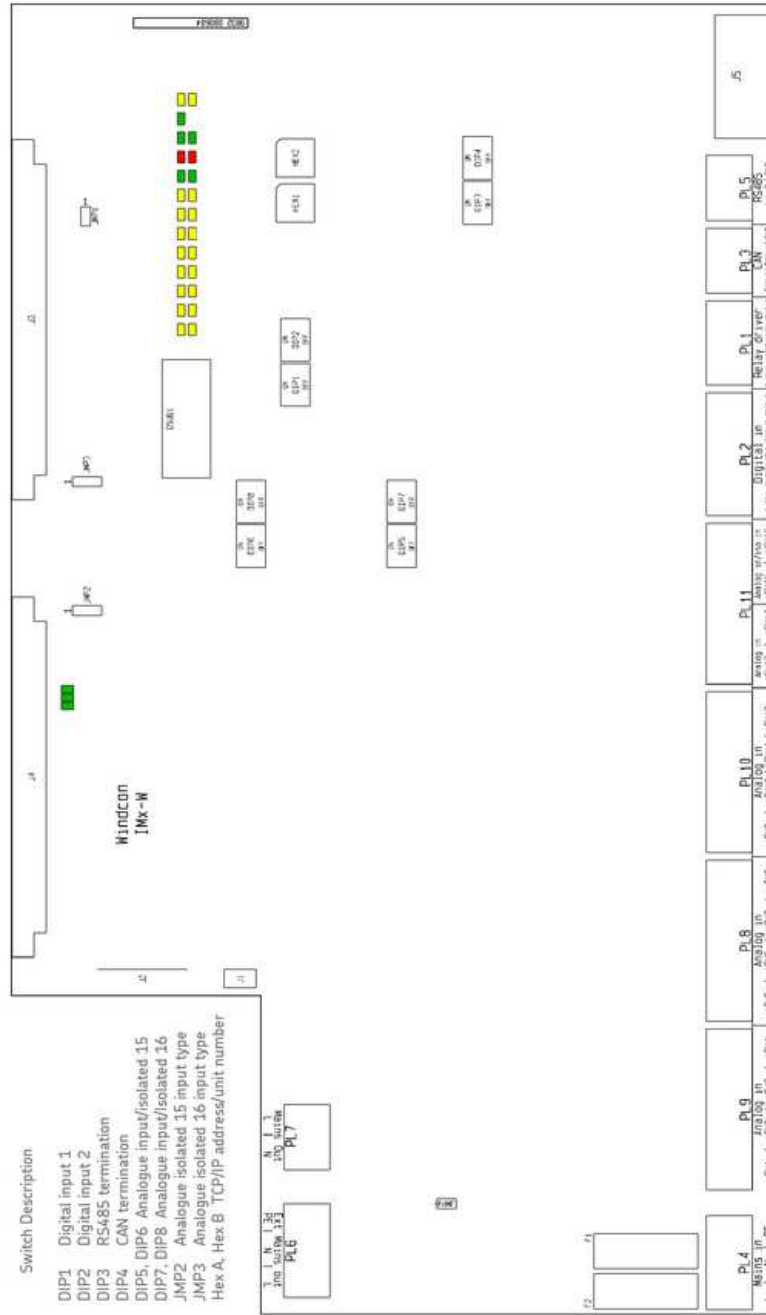
Connectors and Switches Location

Figure 9 - 7.
Connectors and Switches Location.

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 On- line Systems (IMx), 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), 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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