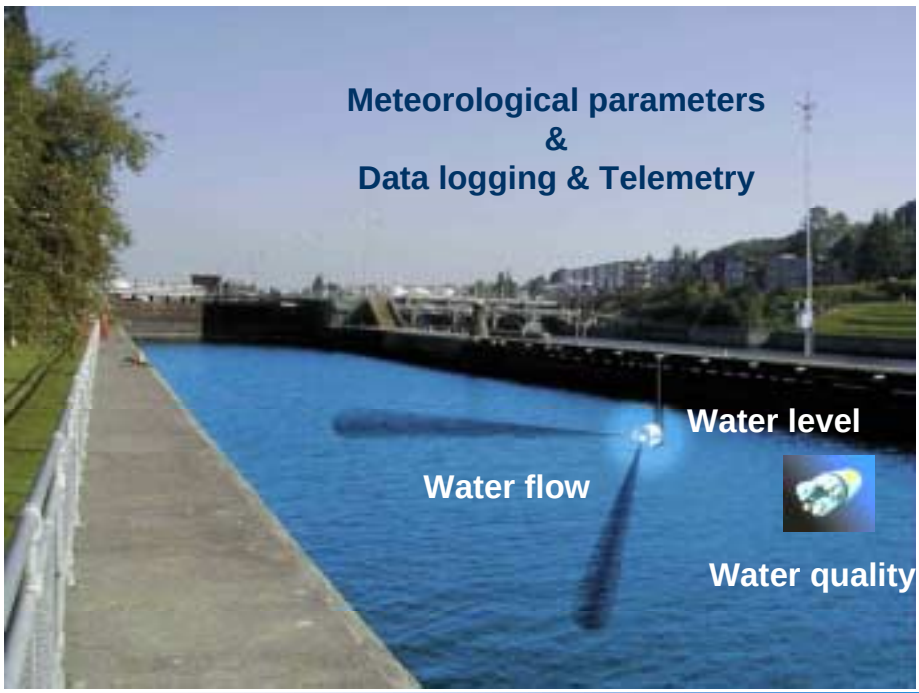
MAWS HydroMet™ Systems for Meteorological and Hydrological Monitoring

TECHNICAL DESCRIPTION

DOC211898-C
November 2004



VAISALA

PUBLISHED BY

Vaisala Oyj
P.O. Box 26
FIN-00421 Helsinki
Finland

Phone (int.): +358 9 8949 1
Fax: +358 9 8949 2227

Visit our Internet pages at http://www.vaisala.com/

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CHAPTER 1

GENERAL INFORMATION

This document give you detailed information on the MAWS HydroMet™ systems, which offer advanced environmental monitoring features integrated into a compact and economical system package. For more details on available sensors and telemetry solutions, please refer to the following technical description documents:

- ***MAWS Systems- Meteorological Sensors (DOC211899)***
- ***MAWS Systems - Hydrological Sensor (DOC211895)***
- ***MAWS Systems - Sensors for Soil Measurements (DOC211896)***
- ***MAWS System - Telemetry (DOC211897)***

Technology

The MAWS HydroMet™ systems integrated around the QML201 Logger are new generation, fully integrated systems especially designed for applications where no commercial power or communication networks are present or are too expensive to be installed. Due to their flexibility and economical design, the MAWS systems are the ideal choice for both meteorological and hydrological applications. The possibility of using the same and standard equipment for various applications lowers the cost of training, spare parts and logistics support – the Total Life Cycle Cost of the network investment. QML201 based systems offer the most economical solution when the total life cycle cost of operating the entire network is fully considered.

The MAWS HydroMet™ Systems are integrated in a compact, ready-to-install package:

- MAWS301 for applications requiring larger back-up batteries and/or multiple telemetry solutions.

The MAWS systems are compact, environmentally robust and low power systems to provide reliable and continuous data on a multitude of meteorological and hydrological parameters. Based on the latest technology both in measurements and communication, MAWS301 can be interfaced with a large choice of telecommunication equipment such as standard PSTN and GSM modems (incl. GPRS packet-switched), CDMA (incl. 1xRTT packet-switched), radio modems and satellite transmitters. The direct connection to the LAN network (via tcp/ip) can easily be made using an economical COM Server module.

The MAWS systems have been designed for applications where only a few sensors are required. However, these systems can easily be upgraded, even in the field, to include a larger set of sensors, including smart sensors such ceilometer, visibility and present weather sensors and multi-parameter water quality sondes and ADCP flow sensors. The same basic system with its options and accessories can cater for all the needs of meteorological and hydrological networks.

MAWS301 Automatic Weather Station Installation

The new Digital I/O module option expands the use of the MAWS system into supervisory and control systems. This allows users to add controlling features such as burglary/vandalism alarms, flood gate controls and optimization of telemetry device power, to name but a few.

Standardization – Economies of Scale and Scope

Information technology, sensor technology, electronics and data communication have developed rapidly in recent years. This has made the automation of meteorological and hydrological networks very economical and attractive to meteorological and hydrological institutes, power corporations and other authorities that need to monitor weather and/or manage water systems such as rivers, lakes, reservoirs and ground water. Hydrometeorological networks, which typically consist of hundreds of automatic monitoring stations, telecommunication systems, databases and application software for users, are installed over wide geographical areas that often include remote areas. The equipment must be able to survive harsh weather conditions while providing information on the prevailing weather, precipitation, water quality and existing water reserves that the authority needs to manage - whether scarce or overabundant - or give timely and accurate forecasts, whether short or long-term.

Meanwhile, demand for meteorological and hydrological data is growing constantly due to new requirements arising from legislation, environmental awareness and the push for efficiency in many of the industries that drive our modern society. Nowcasting, including the forecasting of floods and severe weather events, is creating new requirements for real-time monitoring.

A hydrometeorological network is rarely used on its own and in many cases the same infrastructure is used for other applications as well. Complementary meteorological and climatological observations, or vise versa, are frequently required in order to be able to produce timely and accurate forecasts, warnings, reports and other end products. New forecasting models require more data and more parameters to be monitored - both in meteorology and in hydrology.

If the network is located in a populated area, the hydrometeorological stations can provide accurate real-time weather information to the local community, environmentally hazardous industry, fire brigades, holiday resorts etc, who would not otherwise have accurate meteorological information available. By using the same sensor, data

logger and telecommunication technology the network operator can enjoy the benefits of economies of scale and scope by reducing the cost of network design and maintenance servicing, including spare parts and training. The archived savings in network operation can then be used to further automate the conventional network or otherwise improve hydrometeorological services.

Life Cycle Cost

Although some administrative procedures still favor a “lowest bidder is the winner” policy, the Total Life Cycle Cost (TLCC) is becoming a subject of greater importance. The TLCC is the total cost during the expected lifetime of the meteorological and hydrological equipment. A basic concept of the TLCC contains the following four elements;

$T = P + R + O + C$

Product Cost	P
Resource Cost	R
Operating Cost	O
Contingency Cost	C

An optimum selection would be a combination of a low T and a good overall performance of the equipment to be purchased. We have aimed at a low Life Cycle Cost when designing the MAWS system and when selecting its system components and accessories.

The Product Cost contains, in addition to the basic price quoted, installation, testing and documentation, packaging and transportation, taxis and duties etc.

The Resource Cost includes site preparation works such as site purchasing, access to the site, possible building(s), electricity etc. The MAWS systems are compact, lightweight and easy to install. Frequently they are powered by solar panel and communicate via wireless telemetry, thus minimizing site preparation costs.

When talking about unmanned, automated equipment the major part of the Operating Cost comes from the telecommunication and maintenance costs. In addition, modification and upgrade costs will play a more significant role in future systems. The MAWS systems already have field proven extended Mean Time Between Failure (MTBF) rates. In addition, maintenance is made easy with modular, easy to replace modules and sensors with connectors. A wide range of telemetry options always offer the most economical and reliable alternative for data transmission.

The Contingency Cost primarily contains possible risks in the planned purchase such as a defective product, late delivery, inability to deliver at all, or inability to support the investment with spare parts and upgrades during the life time of the equipment, frequently calculated as 10- 15 years. Vaisala, as the largest manufacturer of meteorological systems, can guarantee timely delivery. In addition, it is Vaisala's policy to support its equipment for its whole lifetime with spare parts, training, upgrades and technical support, incl. HelpDesk functions.

Reliability and Flexibility

Vaisala's HydroMet Station MAWS301 combines Vaisala's and Handar's long term expertise with a new, compact data logger design. The design has been derived from field experience with the MILOS200, MILOS500, QLC50, QLI50 and Handar's 555 systems in synoptic, climatological, hydrological and research applications and in the most demanding industrial use. There are over 25,000 of these pieces of equipment installed in over 70 countries.

MAWS HydroMet systems are an excellent choice for applications requiring ease of installation, low power consumption, automatic operation and interfacing with modern telecommunication options such as satellite transmitters and packed-switched data networks.

The MAWS systems are easy to install and maintain. All connections are pre-wired. The sensors are equipped with ready-made cables and connectors/glands for quick installation. All optional modules such as modems, mains power supplies and surge arrestors are easily mounted on DIN-rails without any special tools.

The MAWS is the most modern HydroMet system including all necessary functions designed on a single printed board logger. Using the latest Surface Mounted Technology the board is very compact and uses little current. It has a very high Mean-Time-Between-Failure (MTBF) value (over 20,000 hours strictly according to MIL-HNDB-217F).

The MAWS HydroMet systems are field proven in various installations around the world. The MAWS stations are already in use in over 65 countries around the world.

For example, the MAWS301 stations are used in the Surface Weather and Airport systems in the SIVAM (Sistema de Vigilancia da Amazonia) in Brazil. Climatological networks in Poland, Romania and Brazil are equipped with the MAWS systems. The Swedish Hydrological and Meteorological Institute (SMHI) automated their whole hydrological network using the MAWS301. In addition, the US Air force's new generation Tactical Meteorological (TACMET) Observation System is based on the same MAWS technology with 300 systems already in field operations. For further details of MAWS references, please see the MAWS Reference List.

Based on Vaisala's continuous product development, the MAWS HydroMet system offers a versatile system concept with a planned upgrade path to meet future customer requirements.

Expandability

MAWS HydroMet systems are already economical in applications, requiring only few sensors. However, they are easily and economically expandable to incorporate a large number of sensors, including intelligent sensors with different types of serial interface. The total number of inputs in the basic data logger is 20 analog inputs (single ended) with the possibility to use them as digital inputs (state), 2 counters and a dedicated input for a Vaisala atmospheric pressure sensor (frequency). Intelligent sensors can be interfaced using the RS-232, RS-485 and SDI-12 serial interfaces, up to 7 ports.

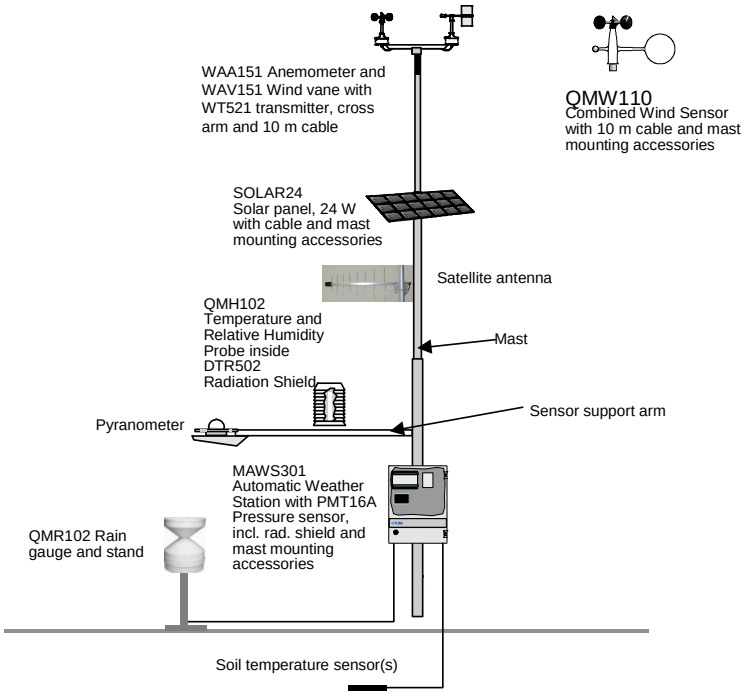
The new optional expansion modules include:

- QMI108 Digital I/O Module with 8 digital inputs and 8 digital outputs for digital measurements and control purposes.

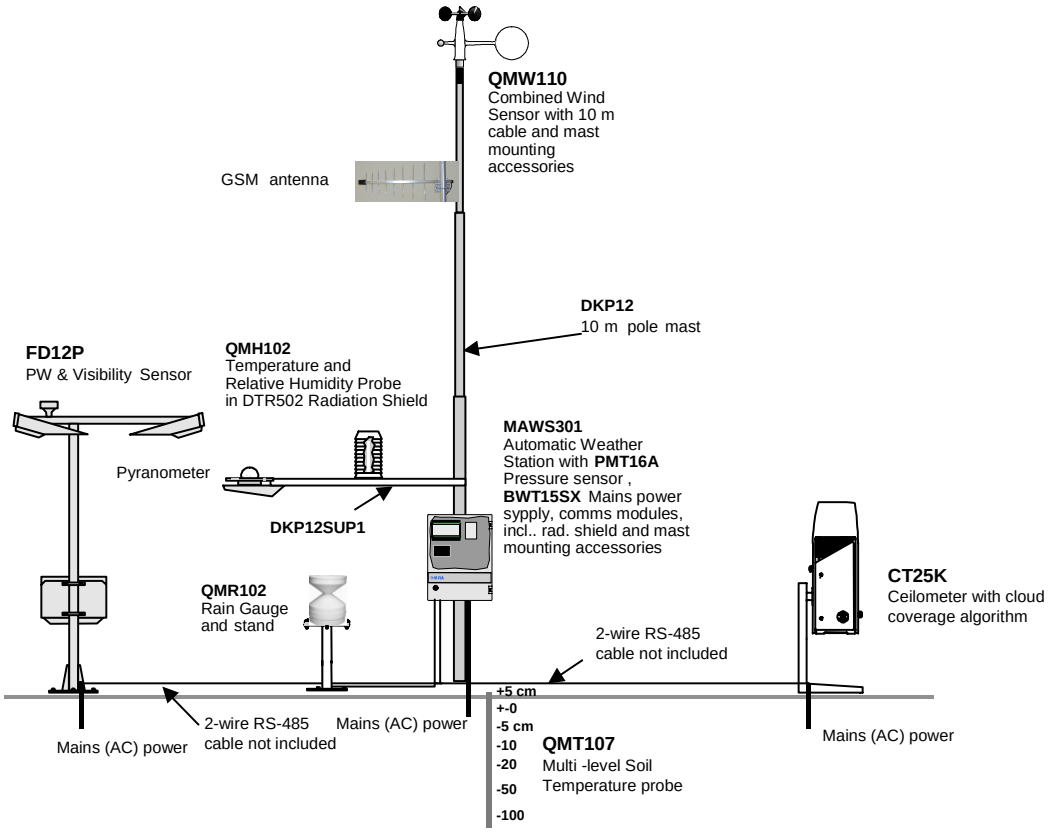
- QMU101 Sensor Multiplexer with additional 20 single ended (10 diff.) analog inputs

Quality Assurance

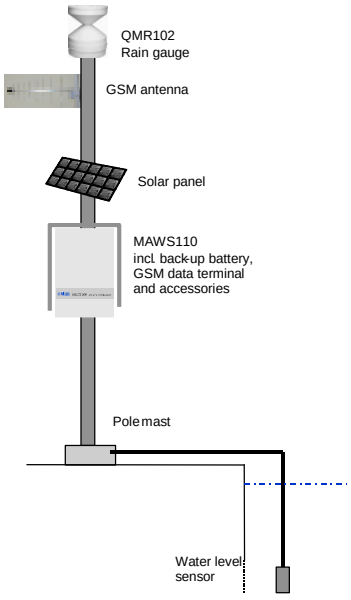
Vaisala's quality management system meets the requirements of the ISO 9001 quality system standard. Vaisala's quality management system has been granted the ISO 9001 Quality System Certificate No. 1413-02 (First issue 1993-03-18) by the Finnish Standardization Organization and the IQNet -The International Certification Network. The Finnish Defense Forces have granted Vaisala a Certificate No.8 for meeting the requirements of AQAP 110 and ISO 9001 since 1.12.1990. More information on Vaisala's Quality Assurance system is available in a separate document.



An Example of a Typical Met. Station Layout



An Example of a Met. Station with an Extended Set of Sensors

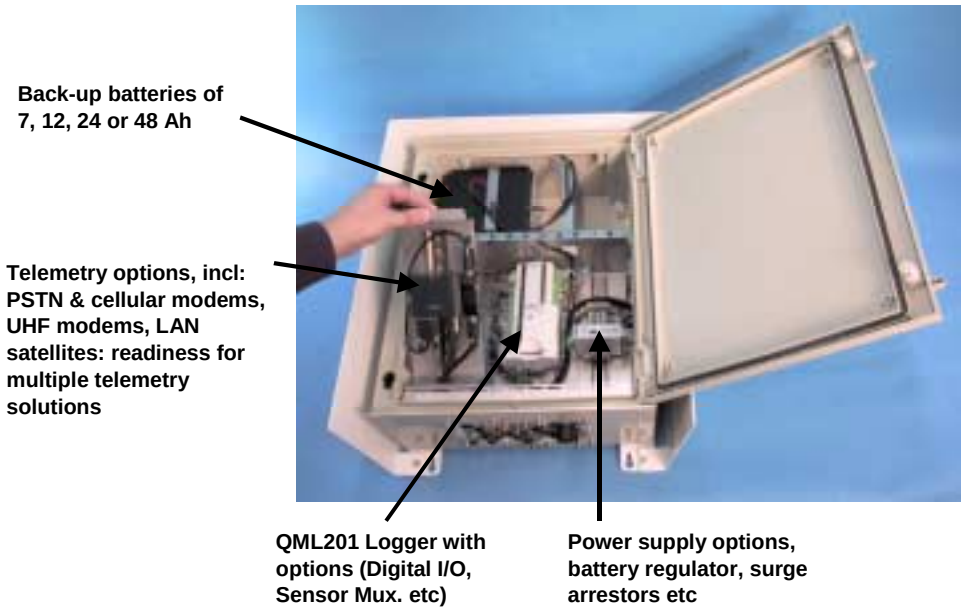


An Example of a Typical Pluviometric / Water Level Station

CHAPTER 2

MAIN COMPONENTS

MAWS HydroMet systems are integrated into the versatile MAWS301. The basic MAWS HydroMet system comprises the following main components.



Main Components (photo of MAWS301 system)

QML201 Logger

The QML201 is a complete data logger with a highly specialized single board computer (CPU) which makes the measurements and calculations, controls all system functions and telemetry devices and logs data. The simplicity of the single board approach reduces the need for excess interconnecting wires and cables. It also greatly enhances reliability and reduces the cost of maintaining a spare part stock. This board contains the 32-bit Motorola CPU for data processing and 10 differential (20 single ended) analog sensor inputs. There are also three (3) frequency sensor interfaces, the 16 bit A/D converter, 1.7 Mbytes of secure Flash memory for data logging, RS-232 and RS-485 serial ports, a real-time-clock and a power supply also providing sensor excitations.

The QML201 has an internal Real-Time-Clock with a resolution of 1 second (internally in milliseconds) and stability better than 20 seconds/month. The RTC is backed up with a lithium battery. There is also the possibility of reading and adjusting the RTC using commands issued via serial ports, both locally and remotely, e.g. from the central data collection software. In addition, the RTC can be synchronized by GPS clock, as an independent device or built-in, e.g. in satellite transmitters.

Optional modules include, for example, a Compact Flash (CF) memory card, various communication modules and a built-in pressure transducer.

QML201 Logger

The printed board uses the latest SMT and CPLD (Complex Programmable Logic Device) technologies and is uniformly coated for better protection and reliability in high humidity environments.

Each sensor input has a varistor (VDR) protection against induced transients. The maintenance terminal connection (RS-232, COM0) also has transzorb diodes in its inputs.

When long signal cables are needed, these will be equipped with optional devices for surge voltage protection. These surge arrestors consist of a combination of VDR, gas-filled discharge tube, transzorb diodes and coils, thus providing excellent protection. These DIN-rail mountable devices are easy to change without any special tools.

Compact Flash Memory Card Option

The QML201 Logger has a place for a standard Compact Flash memory card, the same as is used for example in a digital camera, for logging a large amount of data. CF cards offer logging capacity from 32 Mbytes to hundreds of Mbytes at a very economical cost. CF cards do not need any back-up battery for preserving contents practically indefinitely.

The data is logged into the daily files making it easy to locate any particular data set e.g. for further analysis.

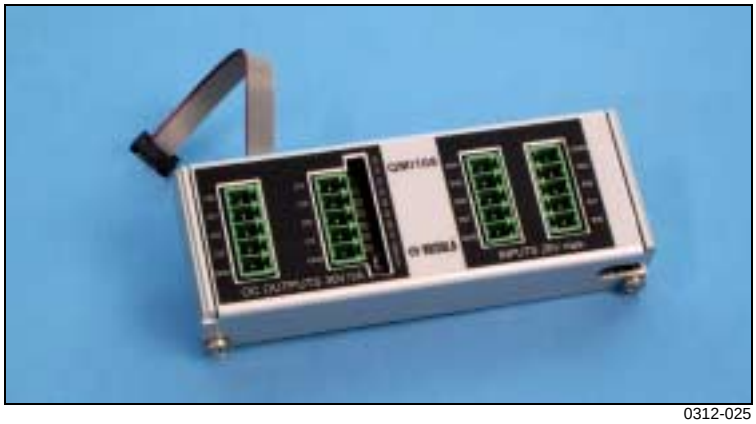
Compact Flash Memory Card Option

These cards can be read directly to the PC. Several different types of readers are commercially available at any PC or camera store; internal PCMCIA (PC-card) readers and external readers connected to the USB or parallel port of a PC.

Compact Flash Memory Card Readers

QMI108 Digital I/O Module

The new QML201 Logger provides the possibility to extend the digital I/O capacity of MAWS with the optional Digital I/O Module QMI108 equipped with eight digital inputs and eight digital outputs.



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Digital I/O Module QMI108

The main characteristics of the QMI108 module are:

- The module interfaces to the logger via the SPI connector, therefore it does not use any RS- channels.
- The module has eight (8) open collector outputs with 30 VDC / 1 A continuous drive capability and LED indicators.
- The eight (8) inputs of the module tolerate voltages from 0 to 25 VDC (the absolute maximum 30 VDC), and they have 40 ms (typical) contact debouncing circuitry.
- The module conforms to the same environmental immunity and emission standards than the logger.
- The module also allows connection of slow pulse inputs, e.g. tipping bucket rain gauges.
- The module is located inside the enclosure beside the logger.

Display and Keyboard Units

The MAWS301 HydroMet systems can be equipped with optional display and keyboard units at installation sites where an operator needs to see data locally and/or insert some own observations or reference data into the system. There are three different models of QMD - display and keyboard units utilizing the same hardware and software technology.

The QMD displays are programmable LCD displays with back light.. They can show several lines of alphanumeric data. The full display size expressed in characters is 20*6 (width * height). The QMD displays include keypad with user-friendly menu, whose content is also configurable by the user. The displayed data is sent as reports to the display. The contents, format and updating intervals of these reports are user configurable. The update interval can be anything between 1 second and 24 hours. The QMD displays are for:

- Viewing data messages whose contents are freely configurable by the user using the MAWS Lizard Setup software.
- Setting up of an extended set of system parameters
- Performing one-point calibration in the field (gain & offset)
- Entering data and/or text messages via the keyboard.

QMD201

The QMD201 unit is mounted on the door of the enclosure. The units can be accessed without opening the enclosure. This unit is mainly for sites, where the enclosure will be installed indoors, e.g. in a "hut" built for a stilling well.

QMD202

The QMD202 unit is mounded on a DIN-rail inside the enclosure. Access is only by opening the enclosure door, which can be firmly locked.

QMD170

The QMD170 handheld unit is attached to the RS-232 port connector at the bottom flange of the enclosure. There is no need to open the door of the enclosure. The QMD170 unit is powered by its own rechargeable battery. Due to its light weight and small size, the QMD170 is easily carried to the installation site in the pocket. The length of the cable is 3 meters.

MAWS Enclosure

ENC542PLM

The ENC542PLM is a polyester enclosure reinforced with fiberglass for the MAWS301 HydroMet system. This robust enclosure has space for the QML201 Logger, multiple communication equipment, battery charger and maintenance free Lead-acid batteries of different sizes with a capacity of up to 48 Ah. Optional devices such as a mains power supply and protective devices for communication lines can also be installed inside the enclosure. All of these devices are installed on easy-to-remove DIN-rails except the back up battery which is installed by means of a screw fixed mounting clamp.

The modular design allows optional devices to be installed on two levels. These installation modules can easily be removed for maintenance or replacement. The installation frame for equipment is made of stainless steel, which also provides excellent protective grounding.

The enclosure material is highly resistant to corrosion, ultra-violet radiation, principal chemicals and atmospheric agents. The door sealing is ensured by using an extruded polyurethane foam gasket. The door has two keyed locks.

The protection rating is min. IP 65 (equiv. NEMA 4X) i.e. dust tight and sealed against water jets. The enclosure material is self-extinguishing.

The ENC542PLM enclosure can be equipped with an optional metal radiation shield, which is painted white. This shield gives additional protection against excessive sun radiation or falling material such as ice, tree branches etc. In addition, as standard there is a white back plate, this gives additional protection against excessive sun radiation.

The enclosure has an optional pressure compensation element installed on the bottom plate. This element compensates for varying degrees of pressure caused by the temperature differences. The element has a GoreTex membrane filter, which prevents moisture sucking in while the enclosure is cooling off, because the element can "breathe". This membrane filter element together with plastic material of high quality and white painted shields significantly reduces water condensation inside the enclosure. Therefore no drying agent, such as silicacel bags, is required inside the enclosure.

In hydrological application where the equipment is frequently installed in small huts built e.g. over the stilling well, the radiation shield is not necessary.

For future needs, the ENC542PLM enclosure has spare space reserved for optional devices.

Bottom View of the ENC542PLM enclosure with extended meteorological configuration, all connectors are labeled

All sensors, power supplies and communication devices are connected to the equipment inside the enclosure via environmentally sealed connectors.

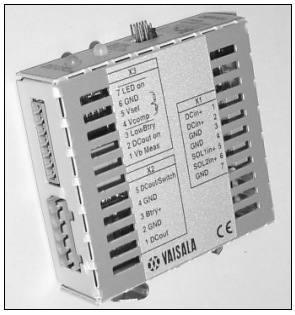
The protection class of all connectors is IP66 as a minimum. Each connector is identified individually with a label. The enclosure used in hydrological systems is normally economized for these applications.

The atmospheric pressure sensor is located on the CPU board of the QML201 Logger. There is a static pressure head for venting out the pressure sensor, thus minimizing the wind effect on the pressure measurement.

There is space for future expansion by installing new sensors and/or communication devices both in the CPU's sensor inputs and in the enclosure.

QBR101B Battery Regulator

The QBR101B Battery Regulator maintains the charging of the integral 12 V battery. The charge/recharge control includes a temperature compensation function as well as deep discharge protection of the battery. QBR101B also allows simultaneous inputs from both a solar panel and mains (AC) power.



QBR101B Battery Regulator

Also included are LED lamps for indicating Battery OK/Low and Charge/Recharge conditions. In order to maximize autonomy time, the lamps are activated only while pressing the ON button.

QBR101B is a rail-mountable unit allowing easy maintenance.

Transient Protection Devices

Each sensor input in the QML201 has varistor (VDR) protection against induced transients. The maintenance terminal I/O port has transzorb diodes in their inputs. A coaxial surge arrestor is used for the RF signal input when radio or satellite equipment is being used.

In case of long signal cables, additional transient protectors can be installed on the DIN-rail. These surge arrestors consist of a combination of VDR, gas discharge, transzorb diodes and coils, thus providing excellent protection.

These are easy to change in the field without tools. In addition, these devices are industry standard and readily available locally, too.

Surge Arrestor for the 230 and 115 VAC Mains Power

Surge Arrestors for RS - serial lines and PT100 sensor

Optional coaxial surge arrestors will be used for UHF / VHF antennas.

Options

In the MAWS enclosures there is space for various types of optional devices, such as:

- Communication equipment (modems, satellite terminals, radio modem).
- Mains power supplies, e.g. for the heating of a rain gauge or wind sensor
- Additional protective devices against over-voltage and electric discharge, e.g. for communication lines or long signal cables.

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CHAPTER 3

SOFTWARE

General Characteristics

The MAWS HydroMet systems utilize Vaisala's field-proven and accurate sensors, which are in extensive use in over 100 countries all over the world from Antarctica to tropical islands. The offered suite of meteorological sensors measures wind direction and speed, pressure, air and surface temperature, relative humidity, precipitation and global solar radiation. There is space for expanding the station with optional sensors such as soil temperature, net radiation, leaf wetness, water level etc. when necessary.

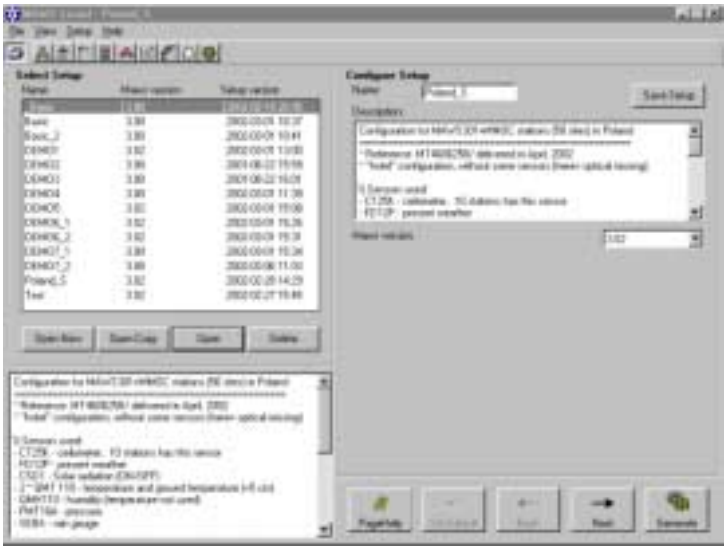
The library of sensors also includes intelligent sensors such as a cloud height ceilometer with cloud cover algorithm, visibility and present weather.

The suite of hydrological sensors includes various types of sensor for measuring water level, water temperature, precipitation and intelligent, multi-parameter water quality sondes and acoustic Doppler profilers for flow and discharge measurements.

The operation of the MAWS systems can be easily set-up and modified with the help of the user-friendly MAWS Lizard Setup program. Using the ready-made templates, this setup software guides the user through the simple set-up routines. Modifications to the system configuration and operation can easily be carried out by the user.

All the configuration settings can be stored in the MAWS Lizard's configuration library where they are easily available for modifications or for creating a new setup based on the old one. In addition, there is an Import/Export function for adding new setup files, or, for example,

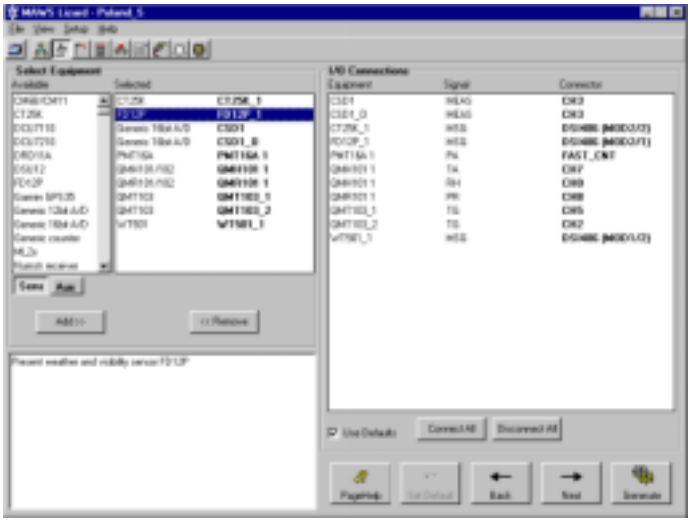
for sending an old file to the Vaisala Helpdesk in case troubleshooting or other assistance is needed.



Lizard Configuration Software

Sensor Library

The MAWS HydroMet systems have a large and continuously updated sensor library. The sensor library includes the default setting for the most common meteorological and hydrological sensors, including Vaisala's optical sensors for cloud height, visibility and present weather.

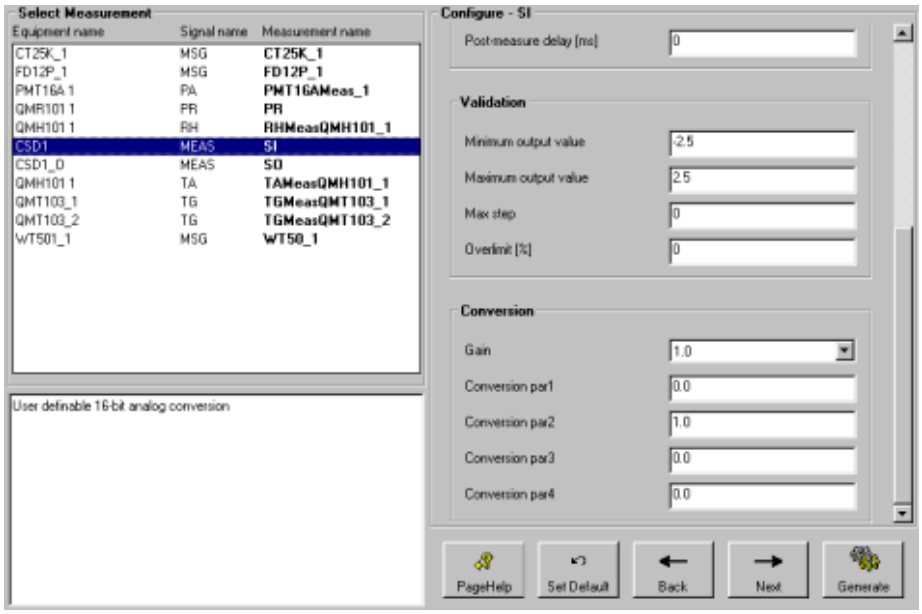


Example of Sensor Setup Template

Generic Sensor Interfaces

In addition to the sensors with default settings, the MAWS Lizard software has options for configuring generic voltage, PT100, counter, frequency, mA and potentiometric inputs as well as numeric string received via serial interface(s).

Each sensor can have user specified validation and conversion/ linearization parameters (up to the 3rd degree factor). This feature enables the interfacing and conditioning of customer's own sensors.



Generic Sensor Interface Setup Template

In the generic numeric receiver, the user can define receiving parameters for a data string via serial port(s). In addition, the SDI-12 interface can be used for interfacing sensors supporting this standard protocol, which is frequently used especially with hydrological sensors.

Digital Input/Output

Basic QML201 Logger

In addition to digital frequency/counter inputs (2 + 1 pcs), analog inputs can be used for monitoring digital state. Furthermore, the state status information can be used for controlling one of the excitation voltages, e.g. as a contact enclosure that can be activated by an event.

Optional QMI108 Digital I/O Module

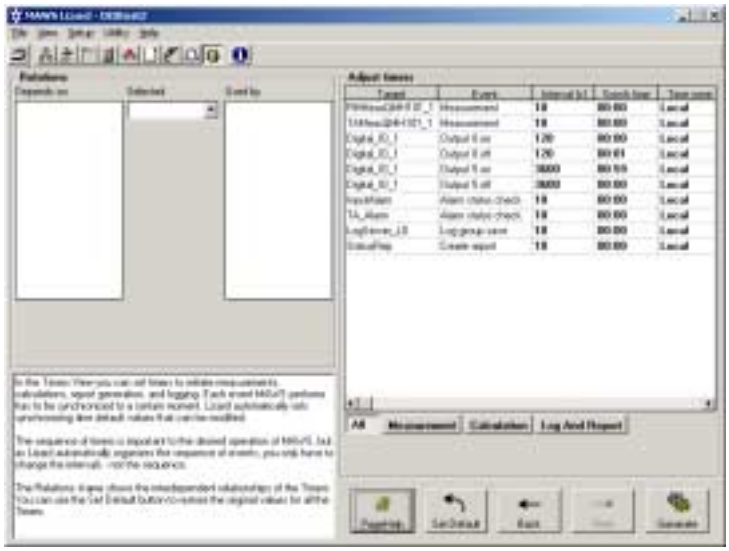
The digital inputs and outputs of QMD108 are freely and individually configurable by the user.

Hardware Setup View: Digital I/O Configuration

The **Hardware Setup** view also provides the possibility to select which outputs are controlled by Timers. The on/off cycle for the selected outputs can then be configured in the **Timers** view. The other possibility to control the outputs is to use alarms, for example, to activate the output signal when the alarm condition is met. The alarm condition is configured in the **Alarms** view.

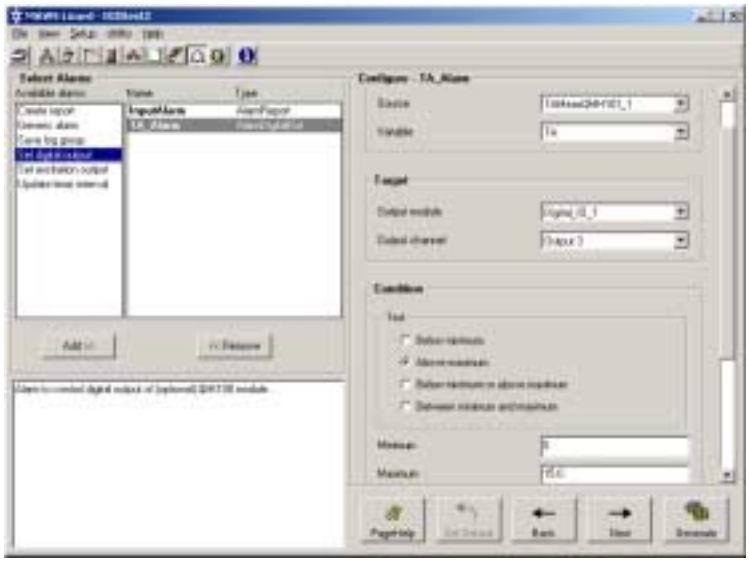
The following template shows an example of the **Timers** view. In the example the configuration is as follows:

- Output 0 toggles between on and off in a one minute cycle.
- Output 5 is on for one minute before each full hour.



Timers View: Timer Configuration for Digital Outputs

The following example shows the **Alarms** view. In the example, the configuration activates output 3 when the air temperature measured by the QMH101 sensor rises above +15 °C.



Alarms View: Controlling Digital Output Using Alarm

The inputs of the QMI108 module can be used as any other application variables, that is for reporting, logging and as alarm inputs.

In the **Reports** view, the input statuses are available as individual variables **IN0** through **IN7** and combined as bits into a single status word **ALL**. The input module **status** is also available as for the sensors.

Reports View: Digital Inputs in the Report

Data Quality Control

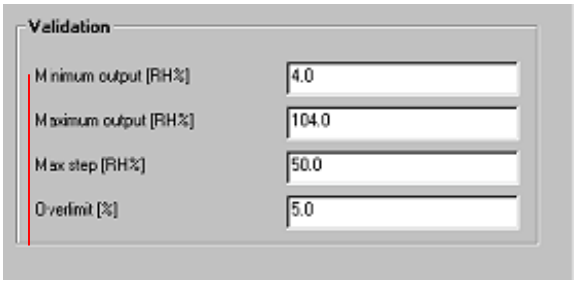
The QML201 Logger has a 32-bit CPU, a 16-bit A/D conversion, and advanced software with data quality control features in order to ensure the continuous accuracy of the measured and calculated data.

Auto-calibration

The MAWS software automatically performs the offset recalibration of the A/D converter and electronics every 15 minutes. In addition, the self-calibration will be initiated automatically whenever there is a temperature change of more than 1° C measured onboard the CPU. The full ADC calibration will be made every 10th calibration time, i.e. at least every 150-min.

Climatological/Measurement Limits Check

The built-in quality control software checks the measured sensor data against the user-set minimum and maximum limit values and step changes between two successive measurements. The user can set these data validation parameters independently for each measured parameter and each site. There is also built-in test software to ensure the reliability of the sensors' measurements.



Data Validation

Sensor Status Information

The MAWS logger provides status values indicating detailed information about the state of the connected sensors. Depending on the sensor, this indication may vary, for example between *ok* and *out of range*, or may provide more accurate diagnostic information. For all sensors, the value is contained in the variable **status**, which can be included in the report(s) and/or monitored in order to produce an alarm, e.g. for maintenance purposes. The following table provides the list of currently available status indications:

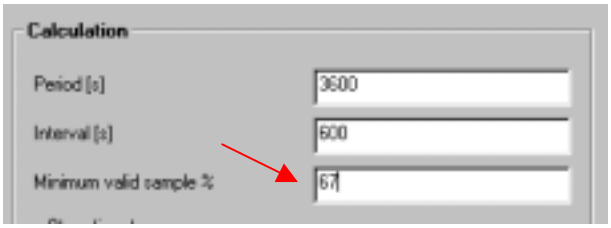
Possible Values for the Status Variable

Value	Meaning	Note
0	The sensor is working properly (OK).	
1	Not measured yet	
2	Interface is not initialized.	1)
3	Communication timeout has occurred.	1)
4	Unknown data is received.	1)
5	Communication is functioning, but sensor reports errors. Use sensor's own service interface to determine cause.	1)
6	Sensor communication is paused because service connection is opened through MAWS.	1)
7	Message sequence numbers are overlapping in the Autotrac satellite transceiver interface.	1)
8..19	Not available	
20	Excitation failure is caused by an overload in the excitation output.	2)
21	The input voltage is out of range or A/D conversion has failed due to an internal error.	2)
22	Sensor is disconnected or connection cables are broken.	2)
23	Sensor output exceeds the min/max limits defined in the **Measurement configuration** view.	2)
24	Change in sensor output has exceeded the maximum step defined in the **Measurement configuration** view.	2)
25	An internal configuration error has occurred.	2)
26	Error in reference measurement, usually caused by damaged sensor/logger or electrical interference.	2)
27	Internal voltage error occurred or the logger is damaged.	2)
28	PMT16 calibration data error.	2)
29	Data invalidated for unspecified reason.	2)
99	Sensor status is not supported.	2)

1) Value is available only for sensors with serial interface.
2) Value is available only for sensors with a conventional, that is analogue or counter/frequency, interface.

Checking Statistical Calculations

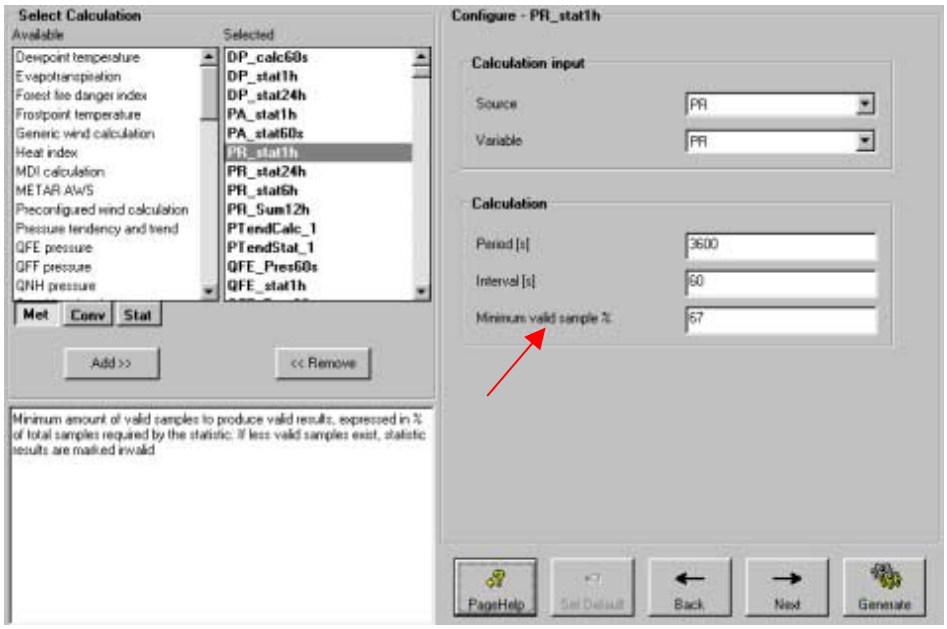
The statistical calculations are made only when the minimum number of valid measurements are available. This number (%) is also a user configurable parameter which can be set individually for each calculation.



Data Quality Control in Statistical Calculations

Calculations

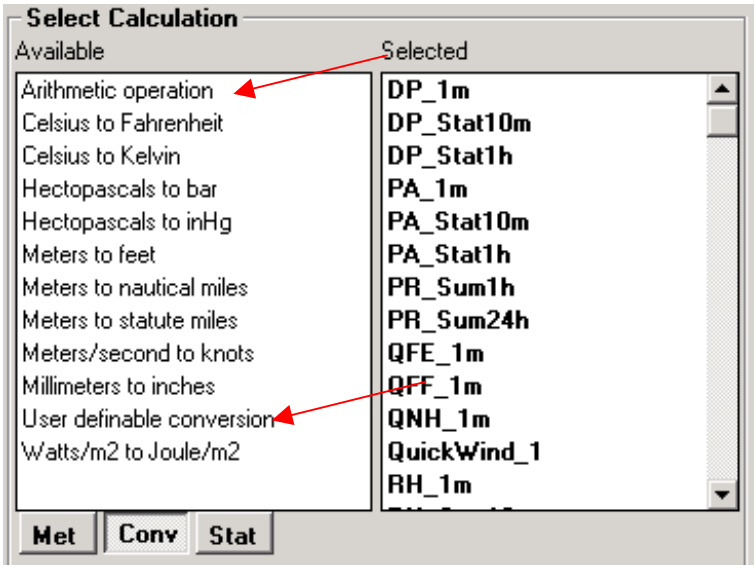
Statistical calculations such as minimum, maximum, averages, standard deviation, and cumulative values, are calculated over user set periods at user set intervals independently for each measured and calculated parameter.



An Example of the Calculations Setup Window

The extreme values can have time stamps accurate to seconds (selectable format hh:mm:ss).

A library of ready made calculations is available in the MAWS software, including, for example, unit conversions, dew point, QNH, QFF, QFE, evapotranspiration, wind chill, heat stress and frost point, MacArthur fire index, rain duration (requires DRD11A sensor) etc. In addition, the sunshine duration can be calculated using the data from the global solar radiation sensor. The CM6B or CM11 global solar radiation sensor is recommended for this purpose.



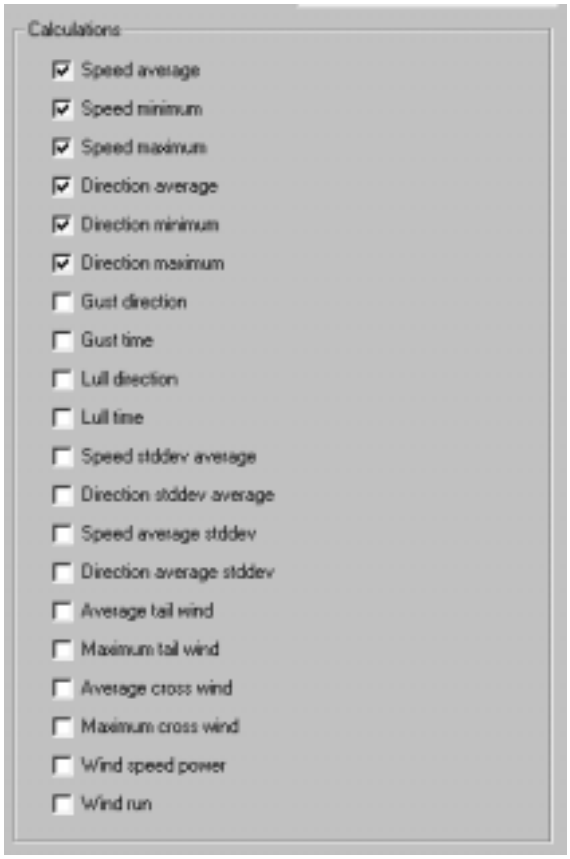
The List of Unit Conversions

The calculation module also offers the possibility to make various arithmetic operation one or two operands, which can be any measured, calculated or manually entered parameters. The operations include:

- Add
- Subtract
- Multiply
- Divide
- Square root
- Power
- Logarithm, lg(A)
- Logarithm10, log(A)
- Exponent
- Absolute
- Sine
- Cosine
- Tangent

An Example of Arithmetic Operation

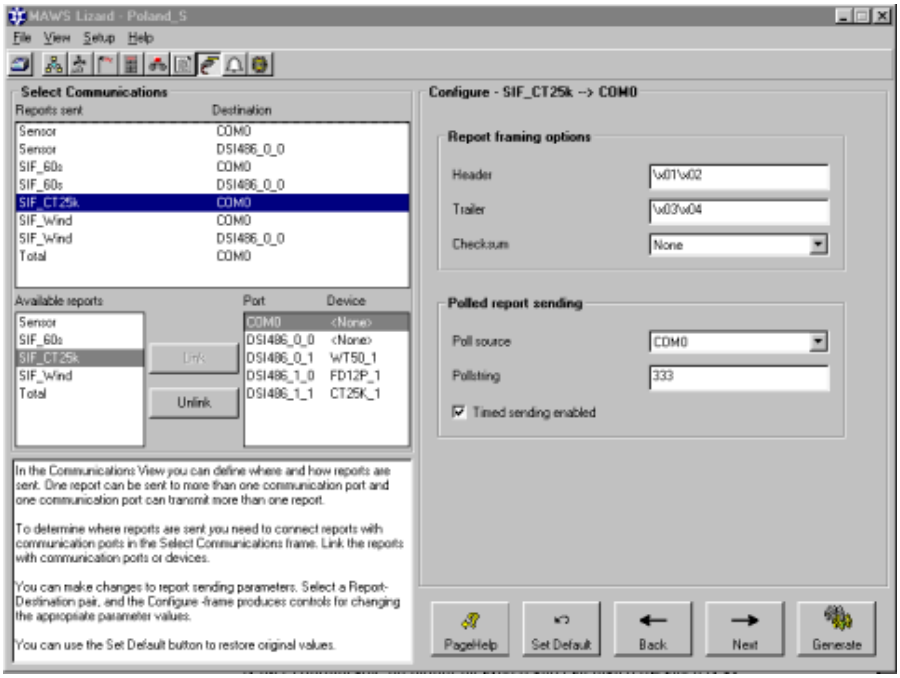
The special Wind Task is for calculating statistical values for wind speed and for wind direction in the vector format. The list of calculations also includes the Sigma-Theta calculation for wind turbulence.



An Example of the Wind Calculation Setup Options (Partial List)

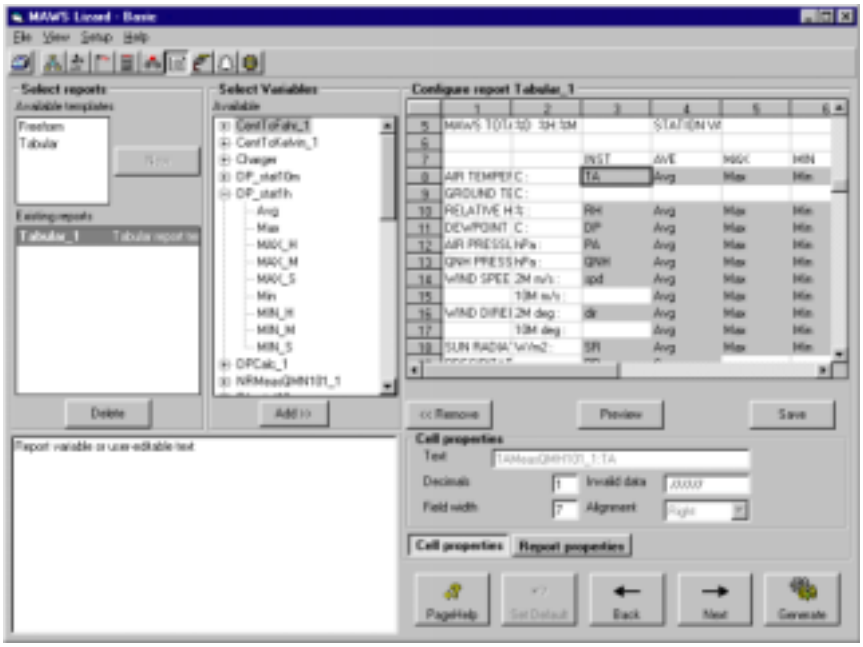
Data Messages and Reports

The formats and contents of the output message are freely configurable by the user(s). MAWS HydroMet systems can be configured to produce several different kinds of fully automated messages to serve various users of the data. The data messages can include measured and calculated data items, complete reports, user inserted data and/or ASCII text. In addition, the data messages can include diagnostics data such as battery voltage, internal temperature, status of the mains power, enclosure door open/close etc.
The formatting of the messages is done using the MAWS Lizard Setup software. The software is fully configurable and therefore there is no need to write new software code and no prior knowledge of programming is needed.



Several Data Messages Can Be Configured to Be Sent to Different Output Ports

In addition, the reports can be easily configured to simulate already existing data formats.



An Example of a Configuration Template for a Tabular Message

Alarms

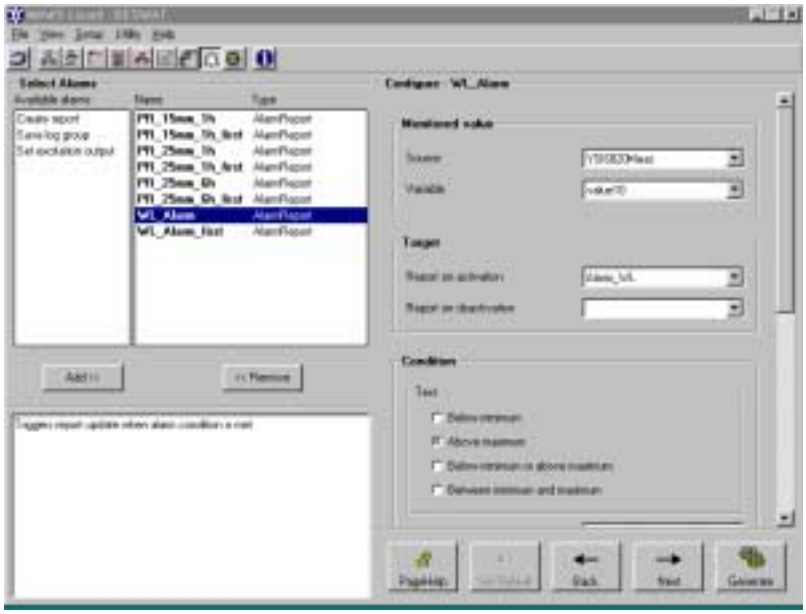
The alarms function is also a completely user configurable feature. Any measured or calculated parameter can be used for testing the user set alarm criteria.

Example: It is possible to combine several alarm criteria (AND or OR - type functions) e.g. to create an alarm when the wind direction is more than 275 degrees and wind speed exceeds 20 m/s.

Whenever an alarm condition has been detected, a user configured alarm message will be automatically sent to the specified communication port(s). Alternatively, triggering an alarm can cause logging of a user defined data group or set an excitation voltage e.g. for controlling a relay. The system supports multiple alarm functions.

There are several alternative triggering functions for alarms such as below minimum, above maximum or a combination of these limits.

In addition, the Alarm module can be used to dynamically adjust the timer functions, such as the report transmission interval or measuring intervals. For a more detailed description, see *the Dynamically Controlled Timer Functions* section.



An Example of the Alarms Setup Window

Data Acquisition

The transmission of the reports can be:

- ***Self-timed***: MAWS sends data at user set interval(s). The interval(s) can be changed remotely on command. The interval is freely configurable between 1 second and 24 hours at 1 second intervals. In addition, these intervals can be changed automatically when a user set parameter exceeds its threshold values. In this way the data can be transmitted more frequently, e.g. when the water level is rising and the development of a potential flood situation requires more real-time data. This feature also allows telecommunication costs to be optimized.

- ***Polled:*** data acquisition system polls MAWS stations whenever data is needed. Polling can retrieve data message(s) or data logged into the station's memory (see Logged Data in Reports below)

- ***ALARM***: based on a measured or calculated parameter exceeding preset threshold value(s).

- ***FTP***: data transfer via FTP (File Transfer Protocol) in GSM, GPRS and PSTN networks. AWS acts as an FTP client placing a file on the FTP Server's hard disk using the central data collection software at a user configurable interval and/or at an ALARM.

Data transmission can include any combination of the above mentioned methods.

Remote Maintenance

Reporting functions can also be efficiently used for remote maintenance by:

- the system monitoring itself with real-time self-diagnostics tasks and providing system alarms in case of system failure,
- providing system maintenance information to the system operators remotely, so that the system status can be analyzed and required maintenance procedures planned in advance prior to maintenance on site, and
- providing a maintenance interface to maintenance technicians on remote sites.

A system status message can include information on internal temperature, available battery capacity and the status of charging, amongst other things. In addition, hardware and software version numbers can be included in these messages. This message can be transmitted e.g. once a day at a set time, typically at midnight.

Logged Data in Reports

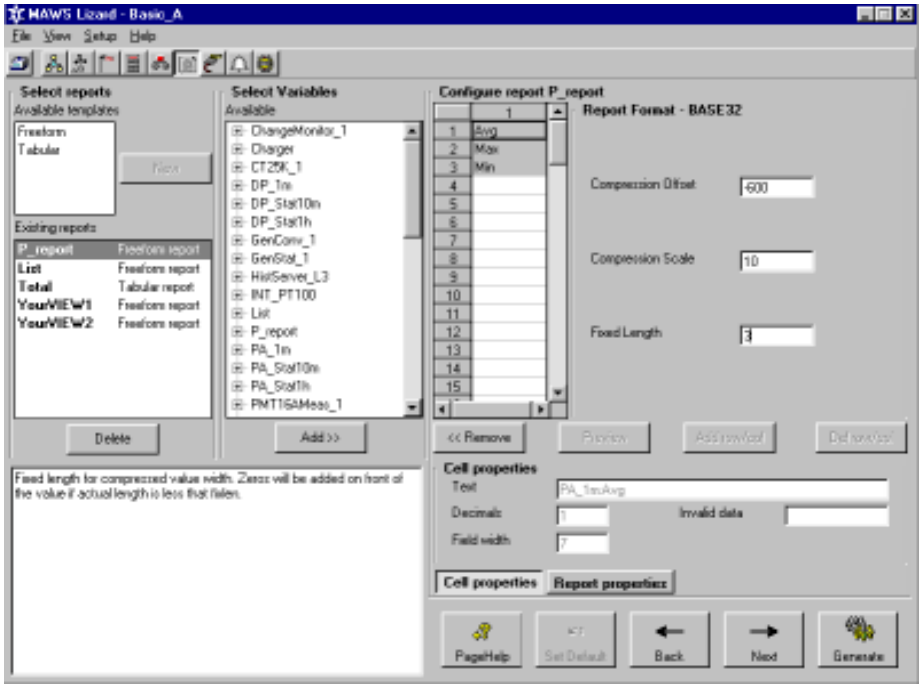
In the MAWS systems, it is possible to format output reports using the data items in logged data files. The user can select the number of records from the logged file to be included in the report. There are two automatically made report formats. When using the SCAN format, the logged data items are organized in columns, in such a way that one column consists of the measurements of one item over a user-set period of records. In the CHANNEL ordered report format, the logged data are organized in rows, with one row consisting of the measurements of one item over a period of records. The data items are by default separated by a space, but the user can also change this parameter.

This option is most convenient when the data is not needed in near-real-time but will be sent e.g. every 3 or 6 hours only.

Data Compression

The cost of telecommunications is often the most significant annual cost in operating the network. In order to lower this cost the MAWS system offers two automatic data compression methods which are user configurable. This function is particularly useful when the data is transferred using methods which are costly or otherwise limit the amount of data to be transferred. Such methods include, for example, satellite systems and SMS (Short Message Service) messages in cellular data transfer.

There are two methods for automatic report formatting: BASE32 and BCD. Depending on the parameters and the length of the message, the data reduction can even be over 50 %.



An Example of the Compression Setup Window

Base32 Compression

The BASE32 report formatting method produces ASCII data and thus printable characters. With this method every measured value is scaled and converted using a radix of 32 instead of 1. The compression ratio is approximately from 30 to 60 %.

Example: temperature value, string presentation:

Original: -18.7 (5bytes)
Offset: -18.7+50=31.3 (if -50 is minimum of measured value)
Scale: 31.3*10=313 (if 0.1 is resolution of measurement)
313 -> BASE32 -> 9P (2bytes)

BCD Compression

The BCD (Binary Coded Decimal) method is a Positional Number System, with a radix of 10 and coefficients expressed in 4-bit binary words. The BCD formatting method produces non-printable binary reports.

Example2:

3 | 1 | 3
8421|8421|8421
0011|0001|0011
313 -> BCD -> 001100010011 (1,5bytes)

Communication

The available telemetry devices are selectable from the list. All equipment has its own default setting which can be modified by the user whenever necessary.

List of Communication Equipment

The MAWS system can have up to 7 serial ports for connecting to telemetry equipment as well as to sensors with serial interface. The communication ports are easily managed using their own setup template:

Communication Ports Setup Template

Multiple telemetry devices can be connected at the same time thus increasing reliability at critical monitoring site(s).

Power Management

The MAWS HydroMet system includes several advanced power management features, which guarantee long term operation during main power failures. In addition to the very low power consumption of the QML201 Logger itself, the following features are included:

- Monitoring of presence of the main power voltage
- Monitoring the voltage level of the back-up battery
- Monitoring the presence of charging for back-up batteries.
- Switching off heater circuits whenever the main power is OFF.
- Controlling powering of the telemetry devices according to the user configured schedule whenever the mains power is OFF

- Controlling powering of the telemetry devices according to the user configured schedule whenever the charging of the back-up batteries from the solar panel is OFF.

- Reducing the telecommunication rate whenever the system works on back-up batteries.

- Reducing the sampling rate whenever the system works on back-up batteries.

The low power monitoring is an intelligent algorithm taking into account the charging state of the back-up batteries and repeated mains power failures.

Power monitoring of telemetry devices

The MAWS station offers intelligent power monitoring features for guaranteeing extended operation. When there is a failure in supplying primary power to a remote station, the MAWS system can be configured to switch off the power from the telemetry device for most of that time. In order to conserve the back-up battery capacity, the power can be switched on at user-defined times for a short period to transmit an alarm or other critical data. Whenever the primary power is recovered, the telemetry device will again be powered normally.

Dynamically Controlled Timer Function

MAWS application execution is mostly controlled by timers, which are configured to fixed intervals using the MAWS Lizard Setup Software.

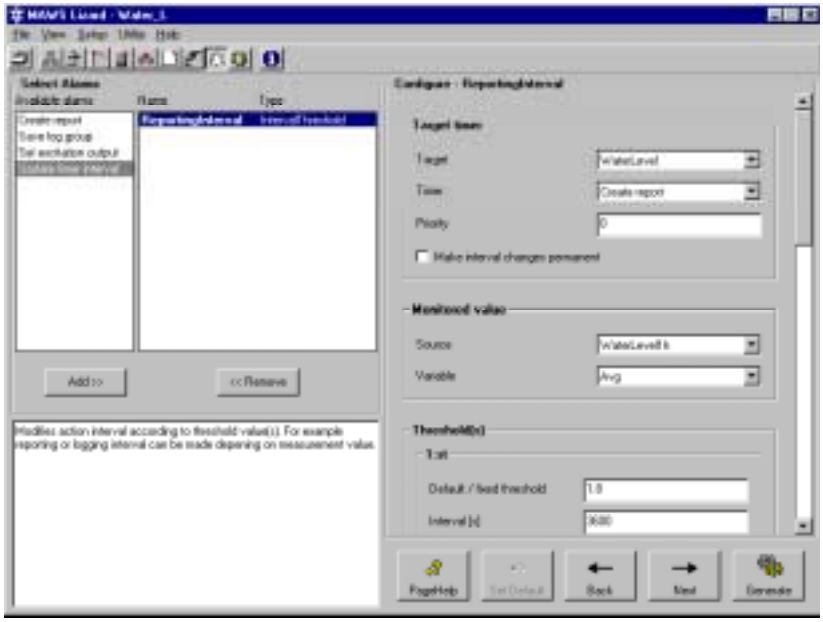
Timer intervals controlled by thresholds provide the means to change these intervals dynamically according to limit values (thresholds) while the system is running. Each measured and/or calculated data item can be configured to be monitored by thresholds.

For example, the following topics can be handled using this control method:

- Power consumption control when operating on backup batteries. MAWS can keep the communication equipment permanently on when external AC-power/solar charging is available, and switch to

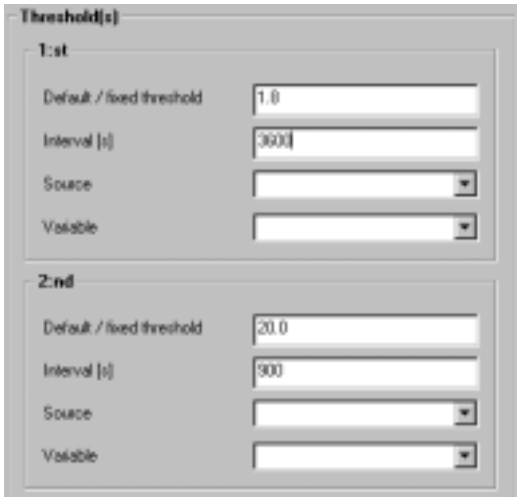
cyclic powered mode (low power mode) when the system is running on back-up batteries.

- Communication cost reduction. When the measured conditions are normal, data messages can be transmitted less frequently, but when preset limits are exceeded by user set parameter(s), the faster transmission cycle can automatically be taken into use.



Interval threshold configuration view

The Interval thresholds are configured in the MAWS Lizard's alarm configuration view. The above picture shows a typical setup for managing transmission intervals for reports. For each timer there can be up to five (5) thresholds configured.



Example of thresholds definition

CHAPTER 4

DATA LOGGING

Internal Flash Memory

The QML201 Logger has 1.7 Megabytes of secure flash memory available for the logging of measured and calculated data. The flash memory does not need any external or internal back-up batteries, and preserves its contents for many years.

There can be several logging schedules where the parameters and logging intervals are user definable. The intervals are configurable from 1 second to 24 hours at 1-second intervals. Data are logged into the daily files, which can be retrieved through the communication channel(s) locally using a laptop PC, or remotely via a modem.

The user can also specify how many days of back-up data is held in the memory. When the memory is full the system will automatically free space by deleting old files, but will always preserve the user specified amount of most recent files in the memory.

The logged files can easily be retrieved e.g. onto a PC's hard disk using the MAWS Terminal software, which is included in the MAWS delivery. The MAWS Terminal automatically converts the binary files into Comma Separated Value (CSV) format used e.g. by Microsoft's Excel software.

In addition, the logged data can be used in data reports that are sent via communication port(s).

External Compact Flash Card

The MAWS system can also log data and reports on a Compact Flash memory card, expanding the memory capacity to hundreds of megabytes.

The external memory card is used for storing data files which have been copied/moved from the internal log directory. The internal log system, file format and operation is not changed, and is operated parallel to the external card. The copy/move is carried out once a day, typically just after midnight. In case the internal memory becomes full earlier, the oldest files are moved to the external log module.

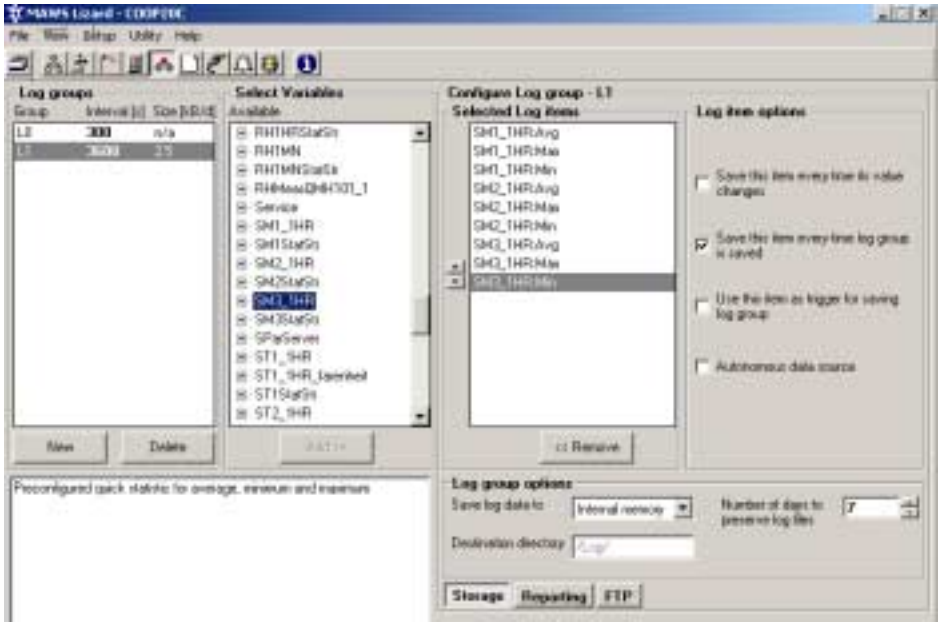
QML201 Logger with a Compact Flash Memory Card

The external log memory card can be hot-swapped with a new card without any command or stopping the logging operation.

The data can be retrieved from the memory card via a terminal connection using Zmodem protocol or by swapping the memory card with empty one. Due to the large amount of data on the card, the contents of the card are most conveniently read directly to a PC. However, it is also possible to retrieve data records or complete files remotely from the CF card.

Memory Card Readers

The file system is compatible with the PC file system, i.e. by inserting the log module into a PC slot or external reader the files can be copied onto the PC. The files are stored in internal log-format, so the MAWS Terminal program can be used to convert the files to CSV format. The files can then be used in various standard software packages, such as MS-Excel, for further analysis.



An Example of the Logging Setup Window

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CHAPTER 5

TELEMETRY AND COMMUNICATION

Telecommunication costs are frequently the major annual cost of operating an observation network. Therefore, it is essential that there are several alternative telecommunication options available to best optimize this function. In addition, the availability of telecommunications is frequently a restrictive factor.

In addition, the availability of data sets requirements for the telecommunication equipment used in the network. When e.g. flood warning is a critical requirement, then near real-time data transmission must be guaranteed. In the MAWS systems there can be two or more redundant communication devices connected at most critical sites, where data availability is of the highest concern.

On the other hand, when data is used for statistical purposes or processes which do not require real-time data, other, often less costly methods, can be used. The MAWS system offers solutions for all these requirements.

Serial I/O Lines

The MAWS system has one (1) RS-232 and one (1) RS-485 port as standard. Two (2) optional plug-in communication modules can be used for enhancing the number of serial I/O channels up to seven (7), including SDI-12 serial sensor interface(s). The high number of serial channels allows the interfacing of intelligent sensors. Redundant communication channels can easily be used for applications and sites where data accessibility is highly important.

The standard RS-232 interface is normally reserved for local use and maintenance tasks such as command interface, updating software, uploading new configurations or downloading logged data files. For

all these tasks the MAWS Terminal Software is included with each system. This terminal software automates many of these tasks using easy to use user interfaces.

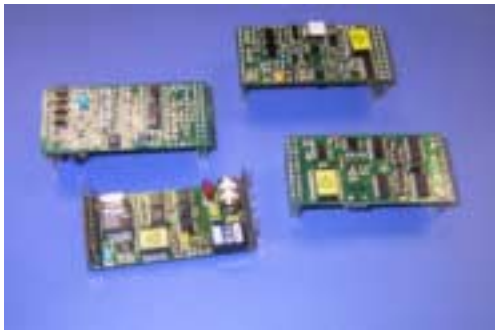
MAWS Terminal Software can be set to automate many tasks

The QML201 Logger with 2 Communication Modules

The optional plug-in communication modules include:

- DSI485 Isolated RS-485 modules for connecting intelligent sensors, terminals and displays up to 1,500 meters away from MAWS.
- DSI486 Dual isolated RS-485 module, also including the SDI-12 interface. The module can be also used as 1 x RS485 and 1 x RS232.
- DSU232 Dual RS-232 module providing an additional two RS-232 channels.

- DMX501 Fixed line modem for connecting other Vaisala devices with a similar interface, max. distance up to 10 km.



Communication Modules

The communication interfaces are freely user configurable in regards to baud rate, stop and start bits, handshaking and ASCII protocol with headers, footers, delimiters, message contents etc.

Hardwire Telemetry

The MAWS system has several options for hardwire telemetry. For more details, see the ***MAWS Systems - Telemetry - Technical Description*** document:

- DXE421 ComServer module for connecting the MAWS directly to a 10- or 100Base-T Ethernet network, making MAWS systems Internet-Enabled devices.

DXE421 ComServer for TCP/IP Network

- DXM421 modem for Public Switched Telephone Networks (PSTN). DMX421 includes both data compression and data correction functions and has a data rate of up to 57.6 Kbits/second.

DXM421 PSTN Modem

- DXL421 is a compact modem for leased line connections of up to 10 kms.

DXL421 Leased Line Modem

Wireless Telemetry

The MAWS system has a large variety of wireless telemetry options. In addition, several of these options can be installed simultaneously as a back up for each other at sites where data availability is of the utmost importance. For more details, see the ***MAWS Systems - Telemetry - Technical Description*** document:

- GSMTC35T-M3 is a dual band (900 and 1800 MHz) GSM Terminal especially designed for demanding professional use.
- GSMMC45-M3 is a GSM terminal for the 1900 MHz network in use e.g. in USA.
- GPRS-M3 is a GSM terminal including a GPRS option, offering a permanent online connection plus fast and cost efficient data transmission.
- CDMA-M3 is a cellular data modem operating both in circuit switched and packed-switched CDMA networks.

GSMTC35T-M3 GSM Data Terminal

- QST101-GOES-M3; GOES Transmitter - transmits at 100 or 300 baud, no internal GPS
- QST102 -GOES-M3; GOES HDR Transmitter - transmits at 100, 300 or 1200 baud, with internal GPS.

GOES transmitters

- QST102-METEOSAT-M3; Meteosat transmitter
- OmniSAT Satellite Communication (AutoTrac); The OmniSat telemetry offers 2-way communication, enabling the sending of polling and other commands to remote MAWS systems.

AutoTrac Satellite Transmitter and Antenna Installed on a Stand at INMET, Brazil

- ORBCOMM Satellite Transmitter; the ORBCOMM system utilizes a Low-Earth-Orbiting (LEO) satellite enabling the use of low power and small antenna in transmitter terminals. The ORBCOMM telemetry offers 2-way communication, enabling the sending of polling and other commands to remote MAWS systems.

ORBCOMM Satellite Transmitter

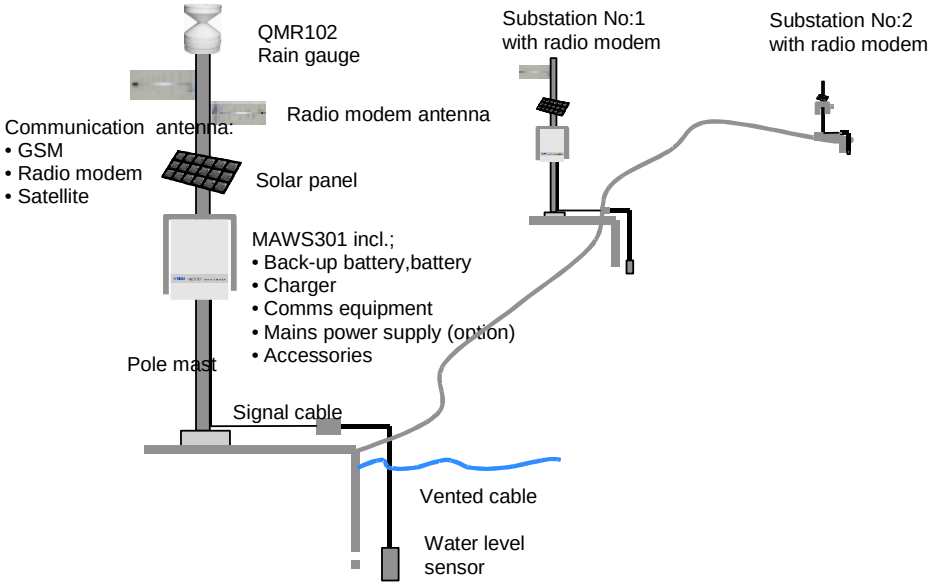
- QSI101-M3; Inmarsat-C Satellite Transmitter; TT-3026LM is a mini-C system comprising transceiver, antenna and 12 channel GPS receiver in one single and compact unit, making installation very easy and simple. The INMARSAT-C telemetry offers 2-way communication, enabling the sending of polling and other commands to remote MAWS systems.

INMARSAT-C Transceiver with Mast Mounting Kit

- SATEL3ASET-M3; high speed UHF radio modem with data transmission of up to 40 kms Line-Of-Sight (LOS). The *Epic* model with its 10 W transmitter power and dual receivers with Diversity Reception operation can have a distance of up to 60+ kms LOS.

Satelline 3AS & Epic Radio modems, with optional display

Message Routing is a built-in feature in SATELLINE-3AS modems, which makes it easier to build up a large radio modem network. Message Routing features a versatile radio protocol, which takes care of routing messages across a radio modem network. Only one radio channel is required even in large networks. Any radio modem in the network can act as a repeater.



CHAPTER 6

POWERING

The MAWS HydroMet systems are low power systems. The basic QML201 Logger consumes less than 5 mA from a 12 V battery with five basic sensors. It can be powered using a small-sized solar panel or optionally using a 110/230 Mains (AC) power supply. The power consumption of the complete MAWS system depends on the connected sensors, telemetry equipment and other options included in the delivery.

Solar Power

The MAWS system is typically powered by SOLAR12, a 12 W solar panel. When e.g. communication equipment with a higher power consumption is used, the system uses SOLAR24, a 24 W solar panel, to guarantee trouble-free and continuous operation. For systems with multiple telemetry options installed and operating simultaneously, there is a 50 W solar panel, SOLAR50.

Solar Panel Mounted to a Pole

The solar power package also includes mast-mounting accessories for a pole mast and a 6-meter cable with connector. The angle of the panel is adjustable.

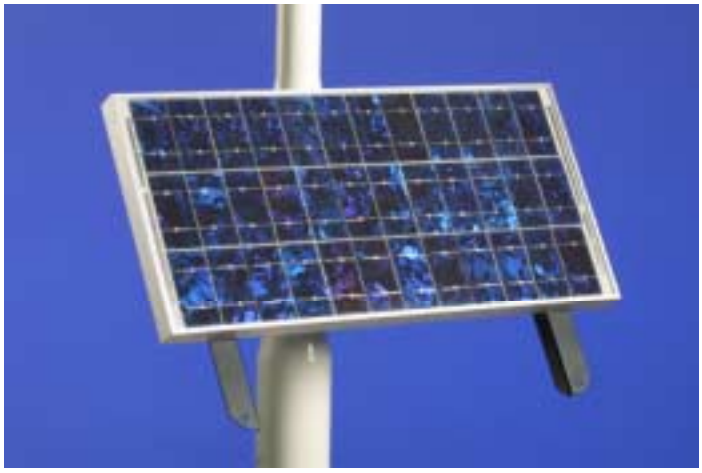
Using a solar panel significantly reduces the risk of electric shocks caused by lightning and induced via long cables when mains (AC) power is used.

SOLAR12-75

SOLAR12-75 solar panels are custom-designed modules incorporating high power efficiency, quality and ruggedness. The 12-Watt panel contains 36 polycrystalline silicon cells in series. The cells are protected from dirt, moisture and mechanical impact by a tough fluoropolymer front film. The solar circuit is laminated using EVA between this film and the durable glass fiberboard back sheet for superior moisture resistance. The SOLAR12-75 modules have lightweight, high power and robust construction.

Solar Panel SOLAR12-75

SOLAR24



Solar Panel SOLAR24

SOLAR24 solar panels are custom-designed modules incorporating high power efficiency and quality. The 24-Watt panel contains 36 polycrystalline silicon cells in series. The cells are protected from dirt, moisture and mechanical impact using a tempered, low iron glass front. The solar circuit is laminated using EVA between tempered glass and a durable, multi-layered polymer back sheet for superior moisture resistance.

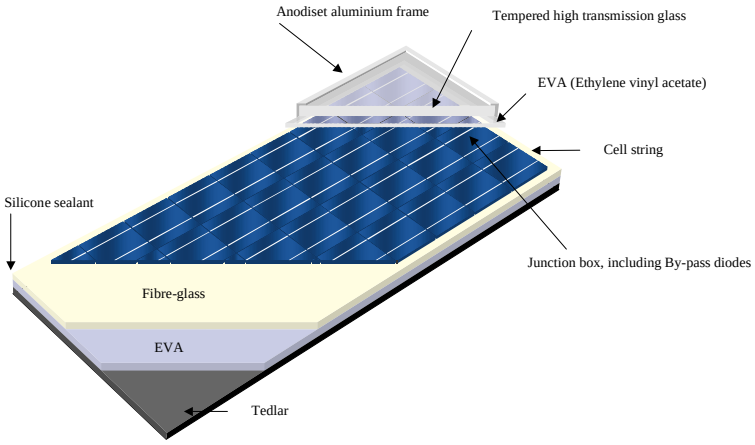


Figure 53 Solar Panel Layers

The mounting frame of the SOLAR24 panel also has space for a 50 W panel (SOLAR50) for applications with higher power consumption or for installation sites where less sunshine will be available e.g. during the winter months.

Backup Batteries

There are four alternative back-up battery sets available with capacities:

QMBATT7;	7 Ah
QMBATT12;	12 Ah
QMBATT26;	26 Ah
QMBATT52:	52 Ah (2x 26 Ah)

The size of the back-up battery depends on the system configuration (options) and the required back-up time. The batteries are charged by solar panel using the QBR101B Battery Regulator. Optionally, the back-up battery can also be charged through the Mains power supply when included in the system.

MAWS can also have its own optional internal backup battery of 1.3 Ah/ 6V, keeping the basic AWS Logger operational for an additional week.

The batteries are sealed lead-acid and maintenance free.

Optional Mains (AC) Power Supply MGP15V-M3

MGP15V Mains

The Mains power supply unit MGP15V is a switching power supply, which operates from the universal mains (AC) input of 85 to 264 VAC and 50/60 Hz. The output voltage is 15 VDC, which is used to power the MAWS system, and as an input to the Battery Regulator QBR101B to charge the back-up battery.

MGP15V is installed inside the MAWS enclosure on a standard DIN-rail enabling easy maintenance of the unit.

Some sensors, such as the heated ultrasonic wind sensor WS425STDH, require higher DC voltage. In these installations, an additional mains power supply MGP36V-M3, a 36 VDC power supply module will be installed.

Power Supply

The mains power supply modules are delivered as packages that also include surge aerators and all internal wiring in the MAWS enclosure:

- MGP15V-230-M3: for 230 VAC mains power
- MGP15V-115-M3: for 115 VAC mains power

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CHAPTER 7

OPERATING ENVIRONMENT

The MAWS HydroMet systems have been especially designed for unattended operation at remote locations. Only minimum maintenance is required annually.

Operating temperature

The MAWS systems have a wide operating temperature of -35° to + 55° C (extended range at request). When installed outside, it is recommended that the enclosure is equipped with a white radiation shield, efficiently protecting the enclosure against excessive sun radiation, falling ice in tower installations etc. The shield also minimizes the temperature differences between day and night, thus preventing condensation inside the enclosure. This, together with the GoreTex membrane filter, guarantees that no extra drying agent bags are required inside the enclose to keep it dry.

Bottom of the Enclosure

ESD/EMI

The ESD/EMI (Electrostatic Discharge/Electromagnetic Impulse) design of the MAWS system is based on Vaisala's over 25 years experience of delivering highly reliable data collection systems for the most demanding environments and industrial conditions, to over 70 countries around the world.

The high reliability is achieved with professional electronic design, protecting the I/O lines and proper grounding of the equipment. All the I/O lines are protected against lightning induced overvoltage surges. When sensors are installed using short, shielded cables, the proper protection is achieved using VDR circuits at inputs. Whenever longer cables are required, additional protective devices - surge arrestors - are installed on those lines.

CHAPTER 8

MASTS

DKP206W & DKP210W - Pole Masts

The Vaisala Tiltable Masts DKP206W (6 m high) and DKP210W (10 m high) are suitable for a wide range of surface weather and climatological applications. The mast tubes are made of anodized aluminum. The remaining parts of the main assembly are made of stainless steel to resist weathering. The mast is painted white. One maintenance person can effortlessly tilt the mast with the optional, easily detached winch to maintain the sensors and other equipment installed on the upper mast assembly. This significantly reduces the costs associated with maintaining the automatic weather station. The basic mast delivery includes the lightning rod with grounding cable, one set of guy wires, the lifting rod and the foundation set. All the components are packed in durable cardboard boxes suitable for airfreight.

The lightning rod protects the sensors and other equipment by means of non-conductive holders and grounding via one of three guy wires totally isolated from the mast. The equipment is always grounded to a separate grounding point. With one standard set of guy wires, the mast can easily withstand winds of up to 50 m/s when the weather station enclosure, solar panel and sensors are installed on it. The optional second guy wire set enables the DKP210W to withstand winds of up to 75 m/s. The foundation set includes all parts needed to construct a steady and correctly oriented base for the mast. The only additional item needed at the installation site is concrete or an existing concrete block.

The air temperature, humidity, and solar radiation sensors will be installed on a sensor cross arm (DKP12SUP1 or DKP12SUP2) typically at a height of 1.5 to 2.0 meters from the ground.

An Example of the 10-m Installation Mast with Accessories

DKP210 Specifications

Property	Description/Value
Height	10 m (32.8 feet)
Diameter Lowest section Highest section	 100 mm (3.94 in) 60 mm (2.36 in)
Maximum wind speed With one set of guy wires With two sets of guy wires	 50 m/s (100 knots) 75 m/s (145 knots)
Weight (DKP210W with winch)	125 kg
Pedestal tube and hinge	Stainless steel
Mast tubes and lifting rod	Aluminum alloy
Guy wires Material Breaking strength Marking	 Stainless steel 28 kN (6 295 lbf) Black and yellow colored cable shrouds to a height of 2 meters from the ground
Threaded anchor bolts	Galvanized steel, thread M20, length 300 mm (11.8 in), with M20 wedge bolts (cast or drilled into concrete using the provided orientation plate)
Other parts, e.g. bolts	Stainless steel

Property	Description/Value
Coating/Painting	
Pedestal tube	Corrosion-resistant powder coating
Aluminum parts	Anodized and painted
Steel parts	Galvanized
Stainless steel parts	Uncoated
Temperature	-50 … +60 °C (-50 ... 140 °F)

DKP102 - 2 m Pole Mast

DKP102 is a 2-m high pole mast designed for installations where normally no wind sensor is required. The diameter of the mast is 60 mm. It is shipped with all necessary installation accessories on a concrete pad.

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CHAPTER 9

AFTER SALES SERVICE

Commitment to Long Term Service

A hydrometeorological network is a long-term investment, which is intended to operate for over a decade. With such a system, special interest should be paid to the manufacturers' capability of providing after sales support to network components. A practical demonstration of a company's commitment to providing long lasting value to its customers is a certified quality system. In the case of Vaisala, the ISO 9001 quality system ensures that the customer can rely on receiving after sales support for Vaisala-made components up to 10 years after the initial delivery.

An important factor in operating a network is its capability to adjust to new requirements and to be expanded economically during its whole operational life. At the time the first system is installed, the operator of the system may decide not to extend the system to cover a certain area or certain variables due to some practical restraining reason. However, it is often found that the system needs be extended after a while and new stations, sensors and/or telemetry must be added to the system. The rapid development of electronics brings new solutions, which must also be easily adapted to existing systems. The system components should be modular so that it is straightforward to expand the system’s features. In the MAWS system all of these factors are already taken care of in the system’s design.

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CHAPTER 10

TECHNICAL DATA

QML201 Logger

QML201 Logger Specifications

Property	Description / Value
Processor	32 bit Motorola
A/D conversion	16 bit
Data logging memory	1.7 Mbytes internal Flash memory Several hundreds Mbytes on optional Compact Flash memory card
Sensor inputs	10 Analog inputs (20 single ended inputs) 2 counter / frequency inputs Internal channel for PMT16A pressure transducer
Typical accuracy across measured temperature range –50 °C ... +80 °C	Better than ± 0.06 °C
Maximum error across measured temperature range –35 °C ... +50 °C	Less than ± 0.12 °C
Maximum error at 0 °C	Less than ± 0.06 °C
Voltage measurement ±2.5V range ±250mV range ±25mV range ±6.5mV range	With factory calibration: Better than 0.04 % reading ± 150 µV Better than 0.04 % reading ± 20 µV Better than 0.04 % reading ± 6 µV Better than 0.12 % reading ± 6 µV
Frequency measurements	0.003 % + resolution 241 nsec (up to 10 kHz)
Common mode range	+5 V / -4 V
Real-time clock Standard With GPS option	 Better than 20 sec/month Configurable, default 5 sec/month
Serial communication Standard Optional	 One RS-232, one RS-485 Two (2) optional plug-in slots for communication modules to increase the number of serial I/O channels up to 7 pcs

Property	Description / Value
Speed Parameters	300 ... 19200 bit/s Configurable speed, start bits, data bits, stop bits, parity, XON/XOFF, and check sum
Voltage (external powering)	8 ... 14 VDC recommended (30 V max.)
Optional internal battery	1.3 Ah/6 V
Power consumption	< 10 mA/6 V (typically with basic 5 sensors)
Solar panel options	12 W/12 V and 24 W/12 V
Back-up battery options	7, 12, 26 or 52 Ah rechargeable sealed lead acid, maintenance free
Mains power	Optional module MGP15V 85 … 264 VAC
Temperature (operating)	-35 ... +55 °C (extended range at request)
Temperature (storage)	-50 ... +70 °C
Humidity	0 ... 100 % RH
Emissions	CISPR 22 class B (EN55022)
ESD immunity	IEC 61000-4-2
RF field immunity	IEC 61000-4-3
EFT immunity	IEC 61000-4-4
Surge (lightning pulse)	IEC 61000-4-5
Conducted RF immunity	IEC 61000-4-6

ENC542PLM Enclosure

ENC542PLM Equipment Enclosure Specifications

Property	Description / Value
Material	Glass fiber reinforced polyester
Protection rating	IP 66, equivalent with NEMA 4X
Dimensions	530 (h) × 430 (w) × 200 (d) mm
Weight	7 kg (without equipment)
Wall mounting	By four M8 × 15-mm screws from rear side
Temperature range	-50 … + 100 ºC
Approved by	UL50
Optional 2 locks with key	PLMLOCKSET

Mains Power Supply Unit MGP15V (Optional)

MGP15V is a switching mains power supply unit, which operates from universal mains (AC) input.

MGP15V Mains Power Supply Specifications

Property	Description / Value
Output power	30 W
Operating principle	SMPS
Input voltage range	85 … 264 VAC
Frequency range	50/60 Hz
Input current on full load: 110 VAC 220 VAC	 0.6 A 0.4 A
Output voltage	+15 V, adjustable ± 10%
Output current	2 A
Efficiency	80 %
Operating temperature range	-40 ... +60 °C
Installation	DIN rail

It is recommended that over voltage protection is used for the main input lines. The following mains power supply packages also include surge arrestors for input lines as well as the necessary wiring inside the MAWS enclosures:

- **MGP15V-230-M3** for 230 VAC lines
- **MGP15V-115-M3** for 115 VAC lines

Battery Regulator QBR101B

QBR101B Battery Regulator Specifications

Property	Description / Value
Maximum input voltage (SMPS and Solar Panel inputs)	30 VDC
Maximum input current (SMPS)	6 A
Solar panel input	55 W max.
Recommended input voltage from SMPS input	16 VDC
Max. load current (backup output)	3.5 A
Recommended battery capacity range	4 … 72 Ah
Battery charge current for 4 Ah battery (selections 0.5 / 1.0 / 2.0 / 2.5 A by jumper)	0.5 A
Max. battery discharge current	3.5 A
Battery charge voltage selection (with external resistor)	13.7 V for stand-by use (mains back-up) 14.4 V for cycling use (solar panels)
Battery charge temp. comp. Coefficient	-20 mV/°C typ.
Load disconnection threshold voltage (with Lo Btry Switch)	10.0 V typ.
Load reconnection threshold voltage	12.0 V typ.
Btry Low signal threshold voltage	11.5 V typ.
Self consumption from battery (with LEDs disconnected)	0.2 mA max. @ + 25 °C
Ground connection	Negative
Reverse voltage protection	Btry, solar panel
Dimensions (in mm)	90 × 80 × 25 (w × d × h)
Weight	0.1 kg
Housing	Anodized aluminum, gray
Wire terminals battery and load wires solar panel, DC input and controls	screw terminals, removable 2.5 mm^2 1.5 mm^2
MTBF (parts stress method, MIL.HDBK 271F ground benign Ta +25 °C)	> 150 000 hours

Solar Panels

SOLAR12 Solar Panel Specifications

Property	Description / Value
Peak power (Pp) @ 1 kW/m^2 @ +25 °C	12 W
Guaranteed min. peak power	10.8 W
Voltage @ peak power (Vpp), typical	16.7 V
Current @ peak power (Ipp), typical	0.72 A
Short-circuit current (Isc), typical	0.8 A
Temperature coefficient of current	0.25 mA/°C
Operating temperature	-40 °C ... +85 °C
Dimensions (in mm)	268 × 540 × 15
Weight	1.5 kg
Output cable	6 m, 2 × 1.55 mm^2, incl.

SOLAR24 Solar Panel Specifications

Property	Description / Value
Peak power (Pp) @ 1 kW/m^2 @ +25 °C	24 W
Guaranteed min. peak power	21.6 W
Voltage @ peak power (Vpp), typical	16.7 V
Current @ peak power (Ipp), typical	1.44 A
Short-circuit current (Isc), typical	1.6 A
Temperature coefficient of current	0.5 mA/°C
Operating temperature	-40 °C ... +85 °C
Dimensions (in mm)	327 × 674 × 34
Weight	3.2 kg
Output cable	6 m, 2 × 1.55 mm^2, incl.

Backup Batteries

QMBATT7 7 Ah Backup Battery Specifications

Property	Description / Value
Type	Sealed. Lead-acid
Nominal voltage	12 V
Nominal capacity	7Ah
Self discharge	3% / month
Expected lifetime	4 … 5 years, temp. dependant
Dimensions	151 (w) × 65 (d) × 97.5 (h) mm
Weight	2.8 kg

QMBATT12 12 Ah Backup Battery Specifications

Property	Description / Value
Type	Sealed. Lead-acid
Nominal voltage	12 V
Nominal capacity	12 Ah
Self discharge	3% / month
Expected lifetime	4 … 5 years, temp. dependant
Dimensions	151 (w) × 98 (d) × 94 (h) mm
Weight	4 kg

QMBATT26 26 Ah Backup Battery Specifications

Property	Description / Value
Type	Sealed. Lead-acid
Nominal voltage	12 V
Nominal capacity	26 Ah
Self discharge	3% / month
Expected lifetime	4 … 5 years, temp. dependant
Dimensions	
Weight	8 kg

The **QMBATT52** battery set includes two pcs of 26 Ah back-up batteries.