

Vaisala HydroMet System MAWS301 in SMHI Hydrological Network *SYSTEM DESCRIPTION*

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

Phone (int.): (+358 9) 894 91
Fax: (+358 9) 8949 2227

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

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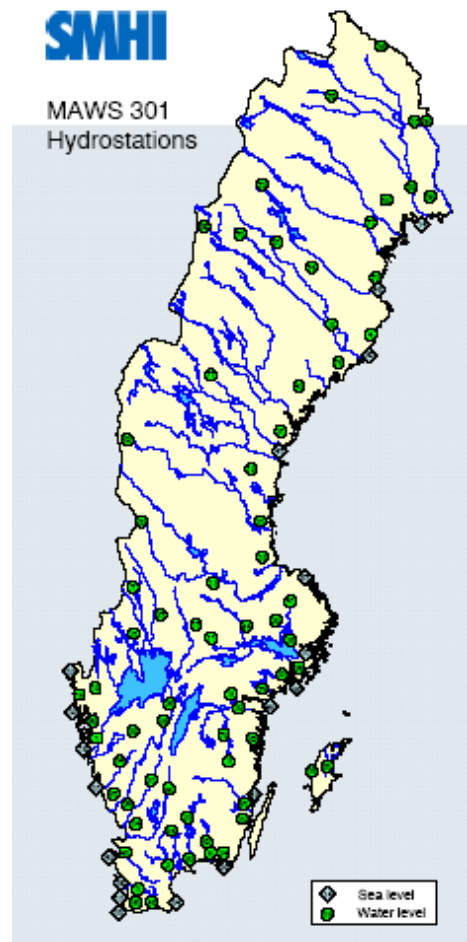
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CHAPTER 1

HYDROLOGICAL NETWORK

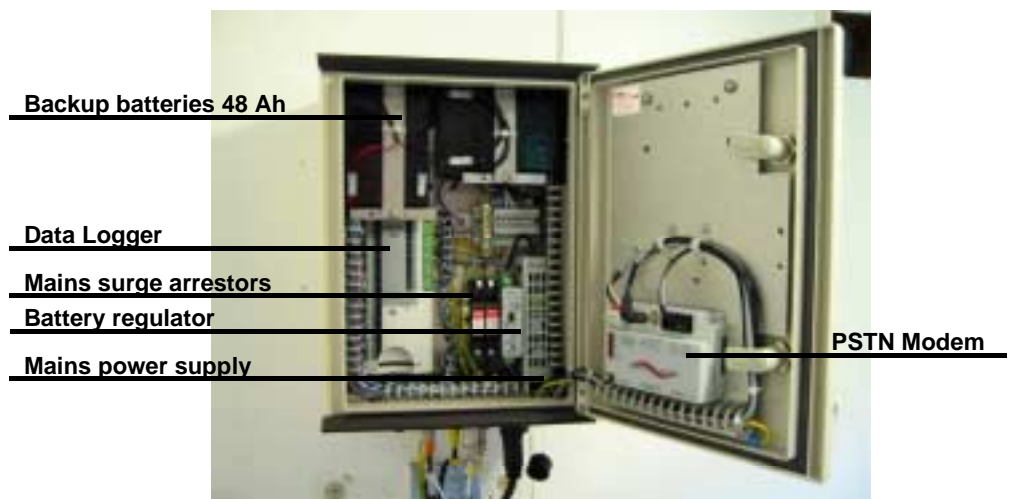
This document describes the application of Vaisala's solutions in the automation of the Swedish Meteorological and Hydrological Institute's (SMHI) hydrological network. The network consists of over 90 stations that measure water levels in inland water systems and coastal sites of Sweden.



CHAPTER 2

MAWS301 SYSTEM

The standard Vaisala HydroMet Systems MAWS301 comprises the following main components installed in the MAWS enclosure:



Sensors

Water level

Water level is measured using the Absolute Shaft Encoder QSE102. The QSE102 absolute shaft encoder uses a multi-polar magnet and 2 reed switches for the accurate and precise measurement of liquid

levels in rivers and reservoirs. It is used in a wide range of applications where distance can be converted to shaft rotation.

The QSE102 uses the SDI-12 Serial Digital Interface at 1200 baud for interfacing with the QML201 Logger. The output is read directly in meters with a resolution of 2.5 mm and an accuracy of greater than 0.01 m.



QSE102 Absolute Shaft Encoder

Alternative water level sensor QSE104

The Vaisala's new QSE104 is a true Absolute Shaft Encoder with a multiturn design based on a reliable high-speed gear with optical scanning and the latest generation of optoasics. The special feature of this shaft encoder is that it assigns a unique, digitally encoded signal to each individual measured increment. This method of transduction prevents erroneous readings caused by either a power failure, or by a transient malfunction. After the encoder is switched on again, or power is restored, the position can be read out. It is not necessary to adjust it to a reference position or insert the reference value, as in case for shaft encoders of the incremental type. QSE104 is not dependent on any backup batteries, thus avoiding the need to change batteries and possible associated malfunctions, including oxidized connections. The design feature of low power optoasics design also allows significant power savings because the power only needs to be on when measuring. In practical terms, the sensor consumes insignificant amount of power because a single measurement takes only a few milliseconds.

The position information is measured to an accuracy of 24 bit resolution (12bits / revolution + 12 bits rev. counter). This method

involves 4096 positions per turn, which converts to the theoretical resolution of 0.092mm with a 375mm float wheel circumference. In addition, the measuring algorithm also takes into account the change in the weight of the measuring tape (different lengths at different water levels) and applies the appropriate correction factor.

High integration density, combined with the new compact gear design, ensures a small mounting depth. This facilitates the installation in existing sites. It also reduces the fitting cost of new installations. The wide operating temperature range of -40°C to $+100^{\circ}\text{C}$ neither limits the selection of optimum installation site for the sensor and the station itself.



QSE104 Absolute Shaft Encoder

QSE104 Encoder Specifications

Property	Description / Value
Sensor type	Optical True Absolute Shaft Encoder
Measuring range	10 m standard, practically unlimited (up to 1536m with 375mm float wheel circumference)
Accuracy	better than 1 mm, including compensation of float tape
Resolution	0.1 mm (4096 positions/turn \Rightarrow 0.092mm with 375mm float wheel circumference)
Max. speed	10,000 rpm / min
Starting torque	< 0.01 Nm
Circumference pulley	375 mm
Float	254 mm (10")
Counterweight	10 oz
Output	RS-485
Operating temperature	-40 to + 60° C
Operating Humidity	0 to 100 %
Power requirements	10 to 32 VDC, 50mA max. when operated
Housing	dia 58 mm, IP67
Shaft	dia 10 mm, IP64
Cable	Serial interface 3 m, extension available, max 100 m
CE Compliance	according to EN 61326+A1+A2: EN 61000-4-2, EN 61000-4-3, EN 61000-4-4, EN 61000-4-5, EN 61000-4-6 and EN 55011 Class B
Vibration	100 m/s (10...2000Hz)
Material	Base and cover aluminum, shaft stainless steel
Mechanical life	1x10 ⁸ revolutions minimum
Dimensions (L x H x D)	245 x 125 x 145 mm (incl. pulley wheel)

Optional sensors

In the MAWS301 systems there is sufficient space to accommodate optional sensors to meet changing project demands, including:

- Water temperature
- Air temperature
- All weather precipitation gauge
- RS-232/RS-485 interface to climatological station nearby
- additional analog and digital inputs for future use



Telemetry

PSTM modem

The data collection system, ADAC2, dials the stations once an hour using the standard PSTM modem connection. The MAWS301 systems use the QMMODEM-M3 PSTN Modem in the SMHI hydro-project. Since then, Vaisala has designed a new PSTN modem with enhanced specifications, including higher speed, lower current consumption and extended operating temperature range.

Updated PSTN modem

The DXM421 modem is an industrial hardened modem for Public Switched Telephone Networks (PSTN). It has been designed for demanding environments. It is rated for - 40 to +60 °C operating temperatures. The modem is mounted on a DIN trail inside the MAWS enclosure. It is DC-powered and has low power consumption. The DMX421 includes both data compression and data correction functions. The maximum data rate is up to 57.6 Kbits/second. The line input is protected by telecom PTC-fuse, sidactors and a heavy duty 350V discharge tube.



DXM421 PSTN Modem

DXM421 PSTN Modem Specifications

Property	Description / Value
Max Data Rate	55.6 kbit/s
Compatibility	ITU V.90, K56flex; ITU-T V.34 enhanced, V.34, V.32bis, V.32, V.22bis, V.22; Bell 212A and 103/113; ITU-T V.29, V.42, V.42bis; ITU-T V.21 & V.23 in int. versions
Data Compression	ITU-T V.42bis and MNP 5
Error Correction	ITU-T V.42 (LAP-M or MNP 3-4)
Line / Phone Jack	RJ11
RS-232 Rate	300 - 57.7 baud
RS-232 Signal Support	TXD, RXD, CTS, RTS, RI/CD, GND
RS-232 Connector	screw terminal
Command Set	Industry standard AT and S register commands
Indicators	+Vin, RI/CD, TxD, RxD
Input Power	5 to 30 VDC, 0.8 W (typical)
Operating Temperature	-40 to + 65 °C
Humidity	0...100 % RH (non-condensing)
Transient protection	Telecom PTC-fuse, sidactors, 350 discharge tube
Mounting	DIN rail
Weight	94 gr.
Dimensions:	25 x 80 x 76 mm

GSM cellular telemetry

Approximately one third of stations use GSM cellular modems for telemetry - both in data call and SMS modes. The GSMTC35T-M3 is a dual band GSM Terminal especially designed for demanding professional use. The data modem is small and has a low power consumption in the stand-by mode. It is especially suitable for environmental monitoring applications with its extended operational temperature range of $-20\text{ }^{\circ}\text{C}$ to $+55\text{ }^{\circ}\text{C}$. The GSM package comes complete with all the necessary RF- and data cables and installation accessories for both the terminal and the antenna.



GSMTC35T-M3 GSM Data Terminal

GSMTC35T-M3 GSM Data Modem Specifications

Property	Description / Value
Sensitivity	-104 dBm
Data transmission	Up to 14.4 kbps
SMS	Included
Tx power	2 W (class 4, EGSM90), 1 W (class 1, GSM1800)
Power consumption	
Transmit mode	300 mA (average)
Idle mode	10 mA
Sleep	3 mA
Power down	0.1 mA
Power supply voltage	8 to 30 V
Temperature range	$-20\text{ }^{\circ}\text{C}$ to $+55\text{ }^{\circ}\text{C}$
Dimensions	65 x 74 x 33 mm
Weight	130 g

GSM Antenna

The GSM antenna is a directional antenna with high gain, enabling data communication even in remote and sparsely populated installation sites where long distances and/or terrain cause unreliable communications.

A directional antenna gives signal strength several times that obtained using a small omnidirectional antenna. In addition to giving a good connection, a strong signal also reduces the power consumption demand on stations.

GSM Antenna Specifications

Property	Description / Value
Frequency	dual band 900/1800 MHz
No. of elements	16
Gain	7.5 dBd
Polarization	Vertical
Weight	420 g
Cable	5 m, included

Voice messages

There was a requirement to be able to dial in to a small number of stations and get the water level readings as spoken messages. This was accomplished by using the DMV51 Voice board interfaced with the MAWS301 through a RS-232 port. The DMV51 board includes its own PSTN modem.

Powering

The stations are mostly powered by the mains (AC) power. Most of the stations are remote and therefore, they have a battery backup (48 Ah) for 30 days independent operation without AC power. In order to guarantee uninterrupted measurements, data collection by the MAWS301 is automatically logged but its telemetry suspended after 24 hours without AC power. The data collection system will collect the missed data from the log memory of the MAWS301 when the mains power resumes. This feature has proved very useful during the severe summer and winter storms experienced in the southern Sweden during last two years. Many of the stations were without AC power for several weeks.

CHAPTER 3

INSTALLATIONS

The MAWS301 systems were installed in existing stage huts and replaced old mechanical instrumentation. At the same time major overhauls also were carried out on the sites.



During the Nordic winter it is necessary to heat the stilling wells in order to keep them free from ice. This is accomplished by using heating lamps and cables.

