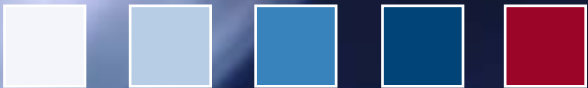


# UMB-Technology

A Passion for Precision



*a passion for precision · passion pour la précision · pasión por la precisión · passione per la precisione ·*



[www.Lufft.com](http://www.Lufft.com)



# Lufft

# UMB TECHNOLOGY

The UMB (Universal Measurement Bus) system is new technology for recording environmental data.

Regardless of whether in the form of a standard weather station or road ice warning equipment, the modular system excels due to easy commissioning, free firmware updates and data transfer over RS232, RS485 or GPRS modem. UMB offers flexibility, modularity and web-based visualization and polling software.

The UMB sensor library provides a comprehensive range of environmental sensors for recording temperature, relative humidity, precipitation, visibility and road conditions. The new WS series compact weather stations, in particular, are outstanding due to their unrivaled price-performance ratio. The top-of-the-range model, WS600-UMB, incorporates sensors for temperature, humidity, precipitation, air pressure, wind direction and wind speed.

The electrical connection for all UMB sensors is made via a standard plug connector system. This keeps installation and service costs to a minimum.

Third party sensors and existing analog sensors can be integrated into the UMB system using the ANACON-UMB module.






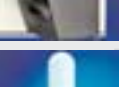







All UMB sensors can be polled by means of a standard protocol. Once data polling has been incorporated for one sensor, additional sensors can be added by way of easy parameterization of the data polling system. Channel-oriented sensor data polling delivers a large number of computed variables in metric and US format. Thus there is no need for conversion by the user. Sensors can be configured, equipment tested and firmware updated with the free configuration software (UMB-Config-Tool).

In addition Lufft offers a variety of software packages from data retrieval from weather stations (COLLECTOR) to web visualization (SmartView3).



Compact design  
Easy commissioning  
RS232 or RS485 data transfer  
Easy software updates  
Free configuration software

# UMB-SENSOR OVERVIEW

	Temperature	Relative humidity	Precipitation type	Precipitation intensity	Air pressure	Wind direction	Wind speed	Visibility	Snow height
 <b>WS600</b>	X	X	X	X	X	X	X		
 <b>WS500</b>	X	X			X	X	X		
 <b>WS400</b>	X	X	X	X	X				
 <b>WS300</b>	X	X			X				
 <b>WS200</b>						X	X		
 <b>VS20</b>								X	
 <b>R2S</b>			X	X					
 <b>8160.TFF10/ANACON</b>	X	X							
 <b>Ultrasonic/ANACON</b>						X	X		
 <b>Windsonic/ANACON</b>						X	X		
 <b>Snow height/ANACON</b>									X
 <b>IRS31</b>	Road conditions, surface temperature, 2 depth temperatures, water film, ice%, freezing temperature								
 <b>IRS21/IRSCON</b>	Road conditions, surface temperature, 2 depth temperatures, water film, freezing temperature								

# PROTOCOL OVERVIEW: DATA OUTPUT STANDARDS

	European measurement units	American measurement units	TLS data types	TLS protocol	NTCIP protocol	XML Asfinag protocol (MKM)	DGT Spanish protocol	Synop protocol
	X	X	X					
	X	X	X	X	X	X	In preparation	In preparation

# WS600-UMB - TEMPERATURE, RELATIVE HUMIDITY, PRECIPITATION, AIR PRESSURE, WIND

From the WS product family of professional intelligent measurement transducers with digital interface for environmental applications.

Integrated design with ventilated radiation protection for measuring:

- Air temperature
- Relative humidity
- Precipitation intensity
- Precipitation type
- Precipitation quantity
- Air pressure
- Wind direction
- Wind speed

Relative humidity is measured by means of a capacitive sensor element; a precision NTC measuring element is used to measure air temperature.

Precipitation is measured by way of a 24 GHz Doppler radar, which measures the drop speed of an individual drop of rain/snow.

Precipitation quantity and intensity are calculated from the correlation between drop size and speed.

The difference in drop speed determines the type of precipitation (rain/snow).

Maintenance-free measurement offers a major advantage over the common tipping spoon and tipping bucket processes.

Ultrasonic sensor technology is used to take wind measurements (WS600 only).

Measurement data are available for further processing in the form of a standard protocol (Lufft-UMB protocol).

Technical Data	Order No.
<b>WS600-UMB Compact weather station</b>	<b>8370.U01</b> EU, USA, Canada
<b>WS600-UMB Compact weather station</b>	<b>8370.U02</b> UK
Dimensions	Ø ca. 150mm, Height ca. 270mm, Weight approx. 1,5kg
<b>Temperature</b>	
Principle	NTC
Measuring range	-30...70°C
Accuracy	±0,2°C
<b>Relative humidity</b>	
Principle	capacitive
Measuring range	0...100 % RH
Accuracy	±2% RH
<b>Precipitation intensity</b>	
Resolution	0,01mm
Measuring range drop size	0,3...5mm
Reproducibility	typ. >90%
<b>Precipitation intensity</b>	Rain/snow
<b>Air Pressure</b>	
Principle	MEMS capacitive
Measuring range	300...1200 hPa
Accuracy	±1,5hPa
<b>Wind direction</b>	
Principle	Ultrasonic
Measuring range	0...360°
Accuracy	± 3°
<b>Wind speed</b>	
Principle	Ultrasonic
Measuring range	0...60m/s
Accuracy	± 0,3m/s or 3% of measurement, highest value applies
Heating	50VA at 24VDC
<b>General information</b>	
Interface	RS485, 2-wire, half-duplex
Operating power consumption	24VDC +/- 10% <3VA
Operating humidity range	0...100%
Operating temperature range	-30...70°C
Heating	25VA at 24VDC
<b>Accessories</b>	
<b>Surge protection</b>	<b>8379.USP</b>



All in One  
 aspirated temperature/  
 humidity measurement  
 maintenance-free operation  
 open communication protocol

# WS500-UMB - TEMPERATURE, RELATIVE HUMIDITY, AIR PRESSURE, WIND

From the WS product family of professional intelligent measurement transducers with digital interface for environmental applications.

Integrated design with ventilated radiation protection for measuring:

- Air temperature
- Relative humidity
- Air pressure
- Wind direction
- Wind speed

Relative humidity is measured by means of a capacitive sensor element; a precision NTC measuring element is used to measure air temperature.

Maintenance-free measurement offers a major advantage over the common tipping spoon and tipping bucket processes.

Measurement data are available for further processing in the form of a standard protocol (Lufft-UMB protocol).

Technical Data	Order No.
<b>WS500-UMB Compact weather station</b>	<b>8373.U01</b>
Dimensions	Ø ca. 140mm, Height ca. 270mm, Weight approx. 1,3kg
<b>Temperature</b>	
Principle	NTC
Measuring range	-30...70°C
Accuracy	±0,2°C
<b>Relative humidity</b>	
Principle	capacitive
Measuring range	0...100 % RH
Accuracy	±2% RH
<b>Air Pressure</b>	
Principle	MEMS capacitive
Measuring range	300...1200 hPa
Accuracy	±1,5hPa
<b>Wind direction</b>	
Principle	Ultrasonic
Measuring range	0...360°
Accuracy	± 3°
<b>Wind speed</b>	
Principle	Ultrasonic
Measuring range	0...60m/s
Accuracy	± 0,3m/s or 3% of measurement, highest value applies
Heating	50VA at 24VDC
<b>General information</b>	
Interface	RS485, 2-wire, half-duplex
Operating power consumption	24VDC +/- 10% <3VA
Operating humidity range	0...100%
Operating temperature range	-30...70°C
Heating	25VA at 24VDC
<b>Accessories</b>	
<b>Surge protection</b>	<b>8379.USP</b>



Ultrasonic wind sensor  
maintenance-free operation  
open communication protocol









# IRS31-UMB - INTELLIGENT ROAD SENSOR

Passive road sensor IRS31 is flush-mounted in the road. The two part housing design allows the combined sensor/electronics unit to be removed for maintenance or calibration at any time.

The following variables are recorded:

- Road surface temperature
- Water film height up to 4 mm
- Freezing temperature for different de-icing materials
- Road condition (dry/damp/wet/ice or snow/residual salt/freezing rain)

Optional:

- 2 additional depth temperatures, e.g. at 5 cm and 30 cm

The sensors are addressable and can therefore be networked.

The measurement data are available for further processing in the form of a standard protocol (Lufft UMB protocol).

Technical Data	Order No.
<b>IRS31-UMB Intelligent road sensor</b>	<b>8510.U050</b>
Measuring range temperatures	-30°C...+70°C
Accuracy temperatures	+/- 0,2°C (-10°C...+10°C), otherwise +/-0,5°C
Measuring range water film height	0..4mm
Accuracy water film height	+/- 0,1mm +20% of measurement value
Freezing temperature graphs	1...10 (Standard: NaCl, CaCl, MgCl)
Measuring range freezing temperature	-20°C...0°C
Accuracy freezing temperature	+/-1°C für t>-10°C
Road conditions	Dry/damp/wet/ice or snow/residual salt/freezing rain
Dimensions	Ø 120mm, installation height 50mm
Weight	approx. 800g
Cable length	50m
Protection type	IP 68
<b>IRS31-UMB with other cable lengths or additional depth temperature sensors:</b>	
2 depth temperature sensors, 50 m cable	<b>8510.U052</b>
100 m cable	<b>8510.U100</b>
2 depth temperature sensors, 100 m cable	<b>8510.U102</b>
Housing road sensor without ext. temperature	<b>8510.G050</b>
Housing road sensor 1 ext. temperature, 50m	<b>8510.G051</b>
Housing road sensor 2 ext. temperature, 50m	<b>8510.G052</b>
Housing road sensor without ext. temperature	<b>8510.G100</b>
Housing road sensor 1 ext. temperature, 100m	<b>8510.G101</b>
Housing road sensor 2 ext. temperature, 100m	<b>8510.G102</b>
<b>Accessories</b>	
<b>UMB interface converter ISOCON</b>	<b>8160.UISO</b>
<b>Road sensor cover (electronics)</b>	<b>8510.DEC</b>
<b>Surge protection</b>	<b>8379.USP</b>



Order NO. 8510.DEC

- Replaceable sensor electronics
- Polling via RS485 interface
- Low energy consumption (solar operation)
- Radar procedure to measure water film



# VS20-UMB - VISIBILITY SENSOR

- Measures visibility up to 2000m
- Ideal for road traffic applications
- Analog output 4...20 mA
- Digital UMB protocol (RS485 interface)
- Calibration device available (optional)

**The VS20 is configured via the software UMB-CFG:**

- Reading / Changing of the current configuration
- Calibration
- Polling of the current measurement values
- The software allows configurations to be loaded and stored

The measurement data are available for further processing in the form of a standard protocol (Lufft UMB protocol).

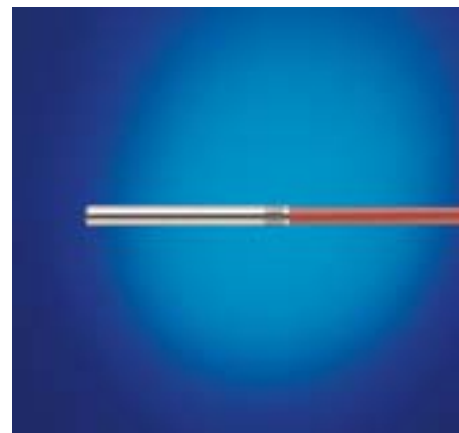
Technical Data	Order No.
<b>VS20-UMB Visibility sensor</b>	<b>8366.U50</b>
with UMB and analog interface (4...20 mA)	
Measuring range	10...2000 m
Accuracy	+/- 10% of measurement value
Firmware update and calibration of the sensor	via RS485
Output signal	4...20mA
Interface	RS485 half-duplex, UMB protocol
Protection type	IP66
Weight	ca. 4kg
Dimensions	360x180x80mm
Operating temperature range	-40...60°C
Power supply	Typical 24VDC (12...28VDC) 3W
Connecting cable	Included in delivery
Accessories	Order No.
<b>UMB interface converter ISOCON</b>	<b>8160.UIISO</b>
<b>Ventilation unit</b>	<b>8366.UBEL</b>
<b>Connecting cable</b>	<b>8366.UKAB10</b>
<b>Calibration kit visibility</b>	<b>8366.UKAL1</b>
<b>Power supply 24V/4A</b>	<b>8366.USV1</b>
<b>Surge protection</b>	<b>8379.USP</b>



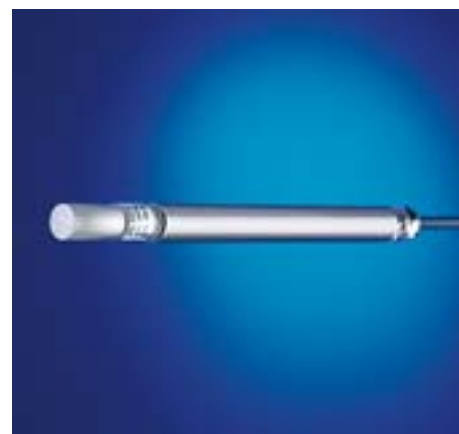
10...2000 m measurement range  
 Calibration kit (optional)  
 Forward light scattering technique

# TEMPERATURE, HUMIDITY, SNOW HEIGHT

Technical Data	Order No.
<b>Temperature probe</b>	<b>8160.TF</b>
Dimensions	Length 50mm, Ø 6mm
Output signal	Resistance
Weight	370g
Cable length	10m
Protection type	IP68
Connector	COMBICON Phoenix
Operating temperature range	-50...150°C
Operating humidity range	0...100% RH
<b>Temperature</b>	
Principle	Pt100
Measuring range	-50...150 °C
Accuracy	±0,2°C (-30...70°C), otherwise ±0,4°C, + 1 Digit



Technical Data	Order No.
<b>Temperature/relative humidity probe</b>	<b>8160.TFF10, 10m cable length</b>
<b>Temperature/relative humidity probe</b>	<b>8160.TFF50, 50m cable length</b>
Dimensions	Length 185mm, Ø 16mm
Output signal	Resistance, frequency
Operating voltage	6...15V
Operating current	approx. 10mA
Weight	400g
Protection type	IP54
Connector	COMBICON Phoenix
Operating temperature	-30...70°C
Operating humidity range	0...100% RH
<b>Relative humidity</b>	
Principle	Capacitive
Measuring range	0...100 % RH / accuracy ±2% RH
<b>Temperature</b>	
Principle	Pt1000
Measuring range	-30...70 °C / accuracy ±0,2°C
<b>Accessories</b>	<b>Order No.</b>
<b>Measuring head for 8160.TFF10 and 8160.TFF50</b>	<b>8160.HC</b>
<b>Radiation shield</b>	<b>8150.SCHUW</b>
<b>Calibration liquid 50%</b>	<b>8151.E50</b>
<b>Calibration kit</b>	<b>8151.KAL</b>



Technical Data	Order No.
<b>Snow height sensor</b>	<b>8365.00</b>
Dimensions	Length 230mm, Ø 80mm
Dimensions	Temperature shield length 120mm, Ø 110mm
Lightning protection	All connections are protected with a discharge capacity of 0.6 kA
Functions	Switchable between distance and height measurement
Weight	2kg
Analogue interface	Distance/snow level (0) 4 ... 20mA (adjustable), 12 bit resolution
Digital interface	Distance/ snow level and air temperature RS232, transmission rate 1200 Bd - 19200 Bd, ASCII various protocols
Power supply	11...15VDC
<b>Snow height</b>	
Principle	Ultrasonic
Measuring range	0 ... 10 m
Accuracy	±0.1% of measuring range
	Resolution 1 mm
<b>Temperature</b>	
Measuring range	-35 ... 60 °C
Resolution	0.1 °C















# MODEM - VIOLA, GPRS

Technical Data	Order No.
Modem for UMB and camera, "dual use"	8160.MOD-VIOLA



Technical Data	Order No.
GPRS Modem	8160.GPRS



Technical Data	Order No.
<b>Tilttable mast, hot-dip galvanized</b>	<b>8357.450</b>
Dimensions	length 450cm
Accessories	Order No.
<b>Plastic cabinet, large</b>	<b>8357.CAS2</b>
Dimensions	600mm high x 400mm wide x 210mm deep
<b>Metal box, small</b>	<b>8357.CAS1</b>
Dimensions	120mm high x 360mm wide x 80mm deep
<b>Lockable tilt device</b>	<b>8357.450V</b>
<b>4 fixed anchor dowel pins</b>	<b>8357.450D</b>

cables between sensors and weather case are "non-visible"



# CONFIGURATION EXAMPLES

## Community Weather Station

Temp / Humidity  
8160.TFF10

Wind speed / direction  
8368.01

Precipitation  
8367.U01

Data collection on polling server

Communication via wireless modem (CDMA/GPRS)



Standard GMA/ARWIS configuration  
Standard ARWIS configuration



UMB modules  
24V power supply  
and GPRS modem

Data collection on site (EAK)

Temperature / Humidity  
8160.TFF10

R2S-UMB  
Precipitation  
8367.U01

Wind speed / direction  
8368.01

VS20-UMB  
Visibility  
8366.U50

IRS31-UMB  
Intelligent road sensor  
8510.U050

IRS31-UMB  
Intelligent road sensor  
8510.U050

Possibility to connect a camera

Wired or wireless data transmission



NTCIP / TLS  
Standard with EAK



EAK (LCOM)



ANACON  
8160.UANA

ISOCON  
8160.UISO

ANACON  
8160.UANA

ISOCON  
8160.UISO

ISOCON  
8160.UISO

ISOCON  
8160.UISO

# UMB CONFIGURATION-SOFTWARE

## UMB configuration-software

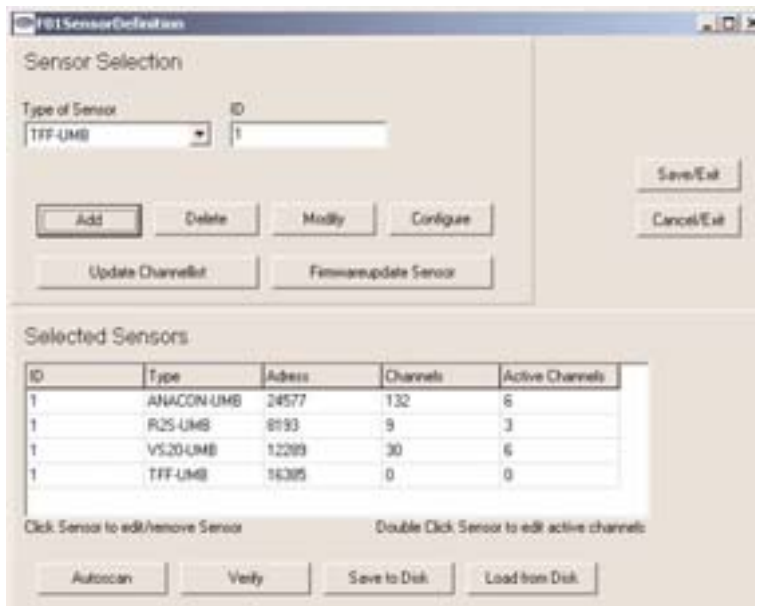
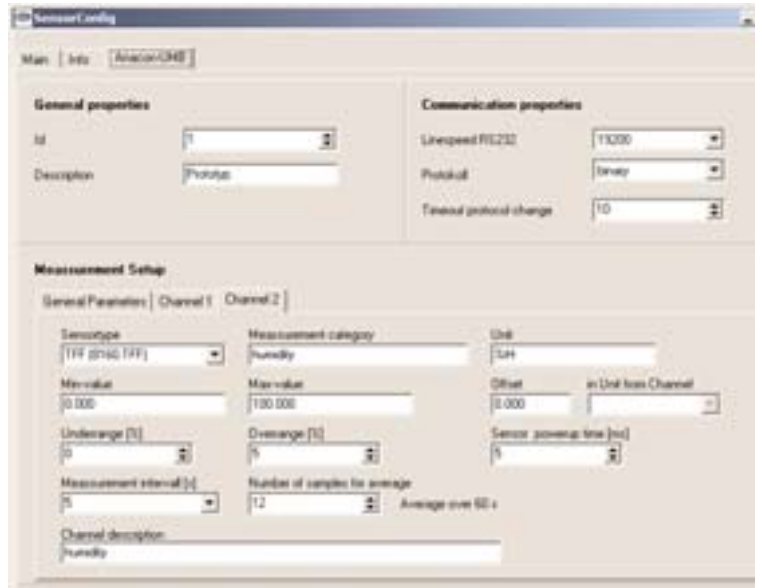
### Functions

- Configuration of sensors
- On-site calibration of sensors
- Indication of current measurement values
- Firmware update for UMB-sensors and UMB-modules

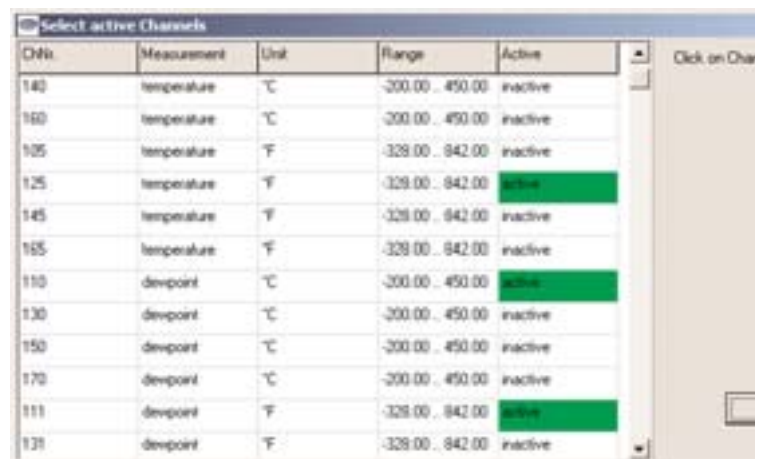
### Coming soon

- Multi lingual user interface
- "trace function", interface recorder

Configuration of analog sensors



Selection list of sensors



Selection list of sensor channels (temporary data request)

# SOFTWARE Collector/SmartView3

## Functions

Web based visualisation and data collection software for Luftt dataloggers/transmitters

Storage of data in database

Flexible export and import functions for integration of external/third party software / data (CSV and XML)

Simultaneous data collection via unlimited communication modules (e.g.modems)

Integration of webcam pictures (via TCP / IP-FTP)

Basis version Collector  
(Collector for up to 5 stations)  
**Order-no: 8160.COLLECT05**

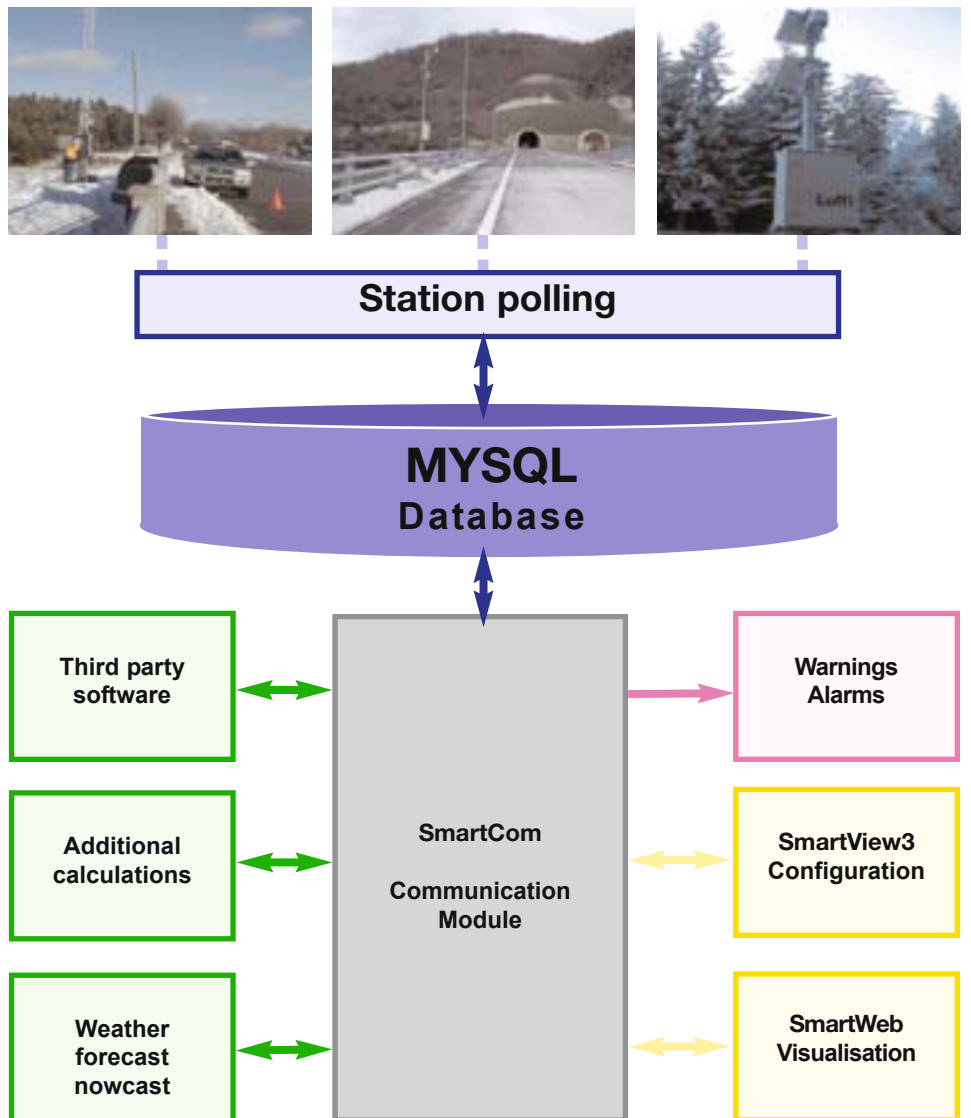
Unlimited version Collector  
(unlimited quantity of stations)  
**Order-no: 8160.COLLECT**

SmartView3 incl. Collector  
up to 5 stations  
**Order-no: 8040.SV05**

SmartView3 incl. Collector  
unlimited  
(Web visualisation)  
**Order-no: 8040.SV300**

## New functions:

- extremely flexible alarming (SMS, email, voicemail)
- 6h forecast module



A screenshot of a configuration window with multiple input fields, checkboxes, and buttons, likely used for setting up the data collection or visualization parameters.



# MEASUREMENTS

Please note:

- Road surface temperature below 0 degrees Celsius and below dew point causes frost.
- Liquid precipitation (rain) on frozen ground causes black ice (subsurface road temperature below 0 degrees Celsius).
- Snow does not remain on the ground when the subsurface is warm but generally turns to water (subsurface road temperature above 0 degrees Celsius). However, melting snow increasingly draws heat from the ground during prolonged snowfall, for this reason snow may remain on the ground later despite above zero ground temperatures.

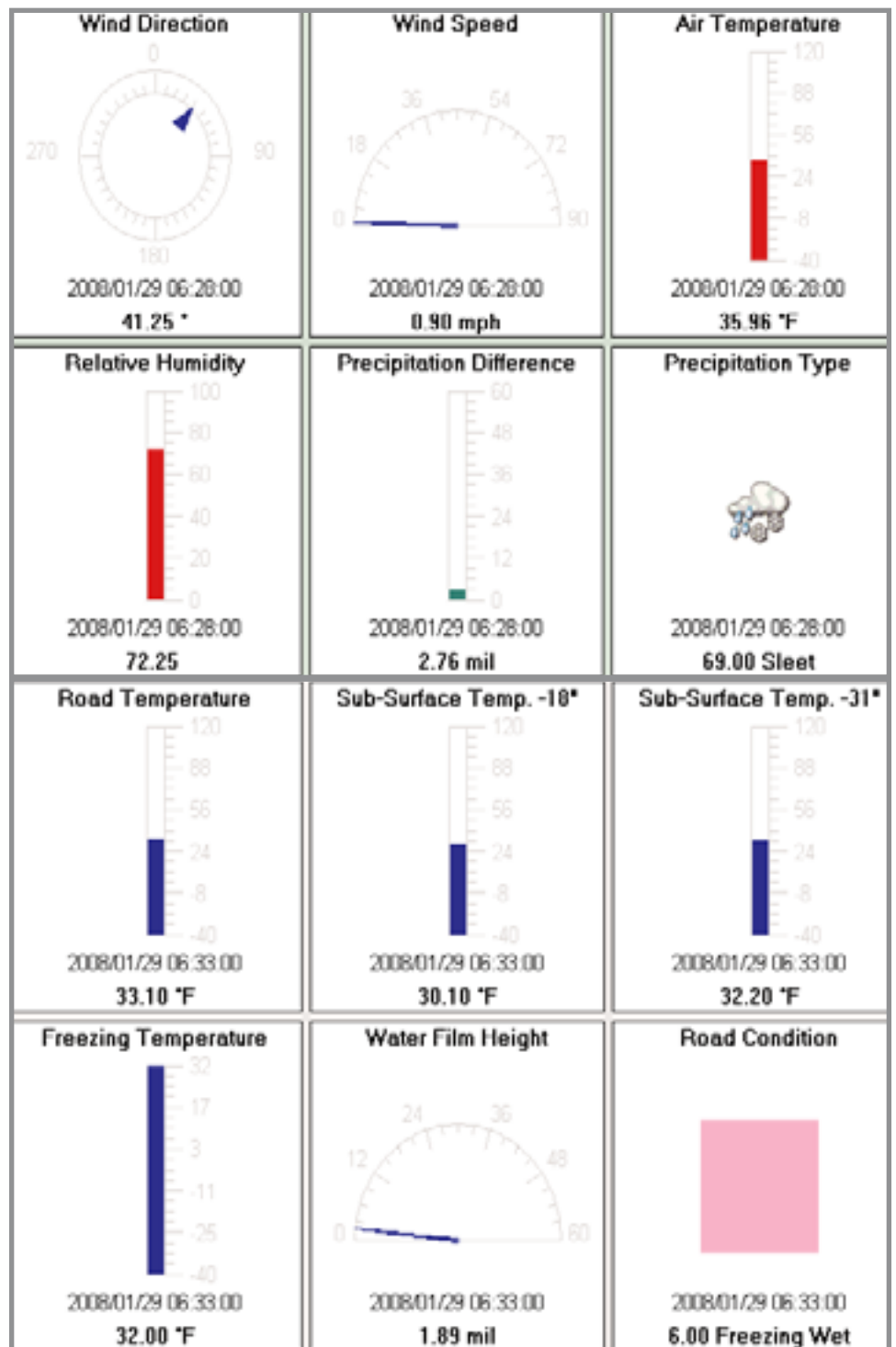


Current measurements displayed in the form of an indicator

Integration of a camera image into the visualization

Graphic displays (day and week charts)

Measurement data in tabular form



# COLLECTOR SmartView3 FUNCTIONS

Functions of SmartView3				
		Basis version	Complete version	SmartView3 with Collector
		Max. 5	Unlimited	Unlimited
<b>Data Transfer</b>	Quantity of weather stations			
	Opus200 (Online and Offline)	x	x	x
	Opus2 (Online and Offline)	x	x	x
	UMB (Online)	x	x	x
	HP100 (Offline)	x	x	x
	Read sensor configurations	All types	All types	All types
	Change sample and storage rate and memory mode (Min/Max/ave)	Opus200	Opus200	Opus200
	Transfer camera picture via FTP	x	x	x
<b>Connections</b>				
	Direct (RS232)	x	x	x
	TCP/IP (Station with COM Server or CDMA/GPRS Modem with fixed IP address or DynDNS support)	x	x	x
	Modem (TAPI)	x	x	x
	PPP (camera picture only)	x	x	x
<b>Intervals</b>				
	Fixed (e.g. every 20 minutes)	x	x	x
	No transfer at special night periods (e.g. not between 10.00 p.m. and 5.00 a.m.)	x	x	x
	Special times	x	x	x
<b>Modem poll</b>				
	Max quantity of modems	Unlimited	Unlimited	Unlimited
	"Modem Pools" (poll stations with dedicated modems)	x	x	x
<b>Recalculation of values</b>				
	Re-scale data before storing in the database	x	x	x
	Mapping of data before storing in the database (e.g. change of road conditions codes)	x	x	x
<b>Clock synchronisation</b>				
	device needs the corresponding software function, device clock can be UTC or local time (with or without summertime adjustment)	x	x	x
<b>Calculation channel</b>				
	Calculation of sensor data as "calculation channel" according to delivered raw data. Immediately: scale of raw data for a configurable coefficient, generation of sum/average/minimum value/maximum value for a specific period of time; mapping of the values	x	x	x
<b>Backup/archive of data</b>				
	Time-controlled automatic backup of full database	x	x	x
	Time-controlled deletion of old data in database (including backup of data before deletion starts)	x	x	x
	Time-controlled compression of data in the database including backup before compression starts (reduction of data down to one value per hour/day)	x	x	x
	Time-controlled deletion of "old" camera pictures in the database (including backup of data before deletion starts)	x	x	x
	Restore of backup-data - including deletion of compressed data before restoring process starts (if the backup is the result of a data compression)	x	x	x
	Automatic transfer of backup-file onto a server via FTP	x	x	x
<b>User access administration</b>				
	Administration of users / functions and user groups	x	x	x
	Admission to functions for users/groups	x	x	x
	Create/delete stations	x	x	x
	Edit/view configuration of a station	x	x	x
	Create/delete website	-	-	x
	Change configuration of website	-	-	x
	Edit/view configuration of website	-	-	x
	Create/change user	x	x	x
	Change configuration data of software	x	x	x
<b>Export/Import</b>				
	Manual export/import	-	-	x
	Automatic export/import	-	-	x
	Export of configurable values of one or more stations in one file			
	Export in "CSV" format incl. parameter settings	-	-	x
	Import in "CSV" format incl. parameter settings	-	-	x
	Export in "XML" format incl. parameter settings	-	-	x
	Scale of data for export (e.g. recalculation of m/s into km/h)	-	-	x
	Mapping of data for export (e.g. recalculation of road conditions codes)	-	-	x
	Scale of import-data before storing the data in the database	-	-	x
	Mapping of import-data before storing the data in the database	-	-	x

# COLLECTOR SmartView3 FUNCTIONS

Calculation channel	Internal calculation of sensor data as "calculation channel" according to imported raw data. Immediately: scale of raw data for a configurable coefficient, generation of sum/average/minimum value/maximum value for a specific period of time; mapping of the	Basis	Voll	SmartView3
		Version	Version	mit Collector
		max. 5	unbegrenzt	
	Dew point calculation with an external program	-	-	x
	Peronospora calculation with an external program	-	-	x
	Venturia calculation with an external program	-	-	x
	Botrytis calculation with an external program	-	-	x
	Oidium calculation with an external program	-	-	x
<b>Control of automatic export/import</b>				
	Export if new data have been stored	-	-	x
	Time-controlled export (e.g. every 5 minutes)	-	-	x
	Flexible definition of time-interval for export based on start-up-time	-	-	x
	Export and execution of a software program	-	-	x
	Export and automatic transfer of a file via FTP	-	-	x
	Export and execution of a software program and import of the calculated result (e.g. disease model calculation)	-	-	x
	FTP transfer of files before import starts	-	-	x
	Time-controlled FTP transfer of files including "Wildcard" support	-	-	x
	Automatic deletion of files transferred via FTP after transfer has been finished	-	-	x
	Import of files including "Wildcard" support	-	-	x
	Automatic deletion of import files after import has been finished	-	-	x
<b>Visualisation of data as "website"</b>				
	Indication of station's status (last data transfer, transfer success) in a table	-	-	x
	Indication of station's status (last data transmission, transfer success) on a static map	-	-	x
	Indication of (selected) sensor data in a "pop-up" window by "scroll over" with the mouse on a station, on the static map	-	-	x
	Indication of status-information and current values of stations on "stations-page" per station	-	-	x
	Indication of camera-picture on "stations-page" of a station	-	-	x
	Graphic indication of the current value on the "station page" in the form of an analog-instrument	-	-	x
	Indication of reports (day/month/year) with sum/average and extreme values during the report period of time, on the "station page"	-	-	x
	Automatic generation of "data pages" to indicate the data in the given time interval, day/week/month/year (diagram and table)	-	-	x
	Selectable "data pages" including current values from sensors of different stations and different storage intervals (day/week/month/year) on one page	-	-	x
	Selectable line and status (bar) diagrams on "data-pages"; line diagrams with up to 4 different Y-axes (units). Scale of line diagrams manually or automatically	-	-	x
	Indication of reports (depending on configured period for the station pages) with average/sum and extreme values on the period of time, on the station page	-	-	x
	Management of "pages-archive" for data pages (historic measurements)	-	-	x
	Automatic transfer of admission rights on to website/webserver (via .htaccess - function has to be active on web-server)	-	-	x
	Automatic erasure of archive pages prior to configured period of time	-	-	x
<b>Warnings/alarms</b>				
	Configuration of high and low threshold per sensor; generation of warnings/alarms if value is out of limits	-	-	x
	Alarm message if station cannot be polled	-	-	x
	Alarm message if import file cannot be used	-	-	x
	In case of alarms, generation of email message (station could not be polled, sensor delivers error, sensor delivers error value/import, sensor delivers error /import, sensor delivers alarm value) to one or more destination addresses	-	-	x

# MEASURING STATIONS - WORLDWIDE

**Road surface temperature:** The sensor measures the "sun temperature" 2 mm below the surface. The most important temperature measurement for ice warning systems.

**Road depth temperature - Depth 1:** The sensor measures at a depth of, for example, 5 cm below the road surface. Typically the road surface temperature graph follows a similar path with a time delay.

**Road depth temperature - Depth 2:** The sensor measures at a depth of, for example, 30 cm below the road surface. Compared to the road surface temperature the measurement only changes very slowly. After a long cold phase the measurement is often below 0°C, so that critical road conditions can arise even when the weather changes from "dry/cold" to "warmer/humid" and the air temperature is above zero.

**Freezing temperature:** The sensor measures the proportion of salt in the water and calculates the freezing temperature from this. This is the value at which the soluble liquid on the surface freezes (icing).

**Water film:** The sensor measures the water film height in micrometers. Aquaplaning usually occurs between measurements from 0.7 mm to (700 micrometers). The higher the water film, the higher must be the concentration of the de-icer in order to prevent freezing. The freezing point is dependent on the concentration of the de-icer and the actual water film height.

**Salt concentration:** The sensor measures the proportion of salt in the water and calculates the freezing temperature from this. The salt concentration is equivalent to the freezing temperature.

**Road condition:** The sensor measures whether the road surface is dry, damp or wet. Dryness, dampness or wetness is determined in accordance with the measured water film height (see above). The sensor also determines critical road conditions (slippery).

**Precipitation quantity:** The sensor measures and recalculates the precipitation quantity every minute. Typically, this is output as "intensity per hour", e.g. 6.8 mm/h = 6.8 [l/m<sup>2</sup>]/h.

hour and the sensor has a very fast response time, the intensity is generally recalculated every 10 minutes.

**Precipitation type:** The sensor differentiates between the following typical types of precipitation (also described as "present weather"):

- Rain
- Snow
- Soft hail
- Hail
- Drizzle
- Sleet

**Air temperature:** The sensor generally measures the air temperature in an air permeable housing, which protects the sensor against direct radiation

and humidity, at a height of 4 m above the road (on the mast). In the event of solar irradiation, the air temperature measurement varies considerably from the road surface temperature.

**Dew point:** Dew point is the calculated temperature at which the ambient air is unable to absorb any further moisture, i.e. the air drops out water in liquid form (mist formation).

A road surface temperature below the dew point leads to the formation of frost (at road surface temperature < 0°C).

**Relative humidity:** The sensor generally measures the humidity in the radiation-protected housing at a height of 4 m above the road (on the mast). The dew point is calculated on the basis of the relative humidity and air temperature.



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G. LUFFT  
Mess-und Regeltechnik GmbH  
Gutenbergstrasse 20  
70736 Fellbach

Postfach 4252  
70719 Fellbach

Tel. +49 (0)711-51822-0  
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[www.lufft.com](http://www.lufft.com)  
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