



# **USER'S MANUAL**

## **DCM-10 INLINE CONCENTRATION MONITOR FOR SEMICON WET CHEMICALS**



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# User's Manual

**WARNING:** If the unit is used in a manner not specified by the manufacturer, the protection provided by the equipment may be impaired.

- The unit is intended for indoor/outdoor use, at an altitude of less than 3000m above sea level, within a temperature range of -0...45°C and a relative humidity range of 0% to 100%. If the instrument is stored outside these ranges, it should be left to stand until it equilibrates to within the above limits.
- Do not operate the unit outside the rated power supply range specified 24VDC +/-10%.
- There are no user accessible or serviceable parts inside the unit. Do not remove or open the unit's casework.
- Before using any cleaning or decontamination method except those recommended by the manufacturer, users should check with the manufacturer that the proposed method will not damage the equipment.
- Ensure the unit is only connected to an earthed supply.

## General safety considerations

This product has been tested for safety. Note the following precautions:

Use personal protection equipment PPE (protective eyewear, clothing, gloves) suitable for the process environment and liquid.

Be aware that the process liquid may transfer heat to the sensor head.

Remove the sensor from the process pipe before any maintenance or service actions are taken.

### Electrical safety

Only licensed or authorized personnel may install or connect electrical components. Follow local and state legislation and regulations.

DCM-10 overvoltage is category I and pollution degree 2.

### High pressure

Always ensure that the process piping and steam/hot water wash lines are un-pressurized and empty of liquid before mounting/removing the inline optical sensor in/from process piping.

### High temperature

In case of hot process liquid, also piping, process connections parts and DCM sensor can be hot. Use Personal Protection Equipment PPE (protective eyewear, clothing, gloves) to avoid burn.

### Bright light source

When looking at bright light sources (e.g. LED), temporary reduction in visual acuity and afterimages can occur, leading to irritation, annoyance, visual impairment, and even accidents, depending on the situation. Avoid looking into the LED and optical measurement window in proximity.

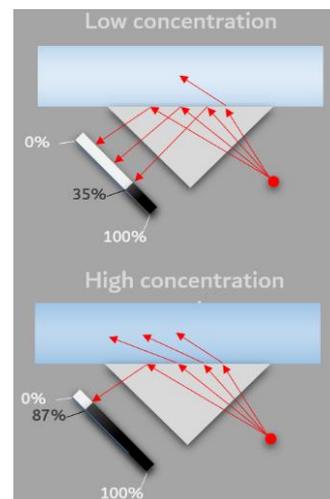


## Introduction

Inline concentration monitor DCM-10 provides real-time measurements in semiconductor wet chemical process applications. The liquid measurement technology is based on refractive index. The refractive index unit RIU is a physical measure of a liquid's dissolved material following the theory of Snell's law. KxS Technologies' refractometers are used in various industries and critical process systems for liquid concentration measurements of liquids and total dissolved solids. The refractometer calibration is performed with NIST traceable standard refractive index liquids and a defined process at KxS Technologies' technology center.

The inline concentration monitor DCM-10 includes an integrated pT-1000 temperature element for process temperature measurement and simultaneous automatic temperature compensation of the concentration measurement.

The instrument integration to process environments and control systems with industrial standard communication protocols is flexible with stand-alone refractometer setups, as well as optional modular connection units and external displays



## 1. Connection

The inline concentration monitor DCM-10 operates with 24VDC input power supply. The communication signal is transferred through either an analog 4-20mA port, or a digital Modbus TCP port. Respective shielded connector port carries a 24VDC input power supply pinout. When the analog output port is chosen, the other digital port is used as a service channel for sensor parameter and diagnostics update in the user interface on a computer web browser, external display, or mobile device. All user interface options can be used simultaneously.

### 1.1 Sensor connectors

Two independent sensor connectors are available. Both shielded connectors are designed with 24VDC power supply pinouts. The analog port is designed with 2x 4-20mA pinouts. The digital port is designed for Modbus TCP communication output and user interface connection (Fig. 1).

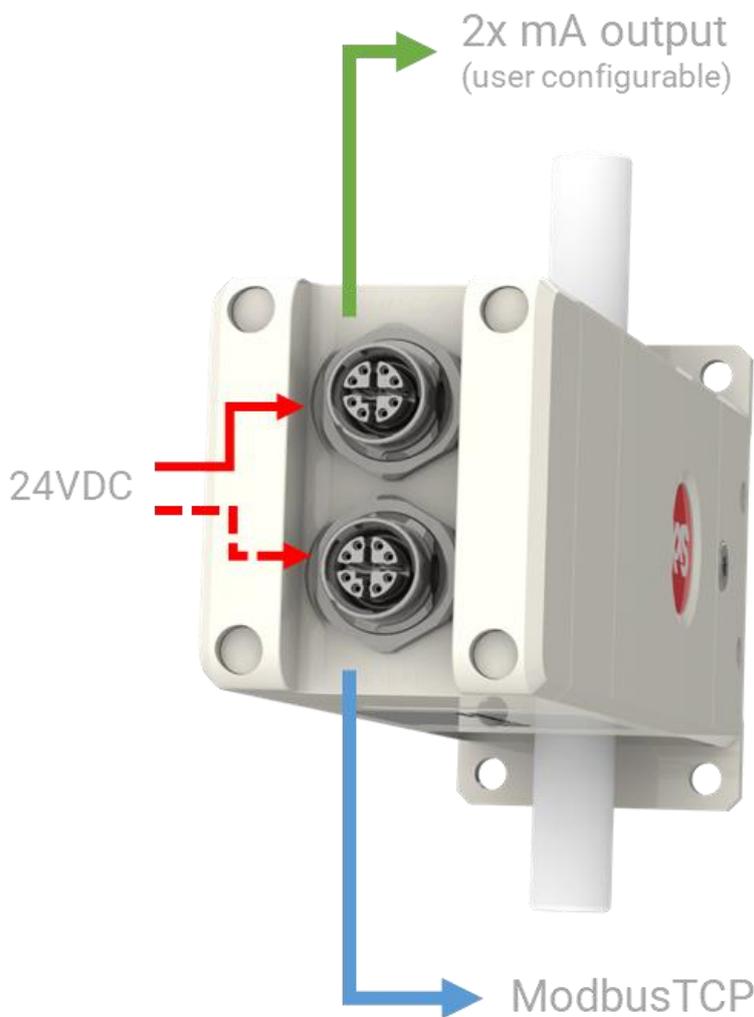


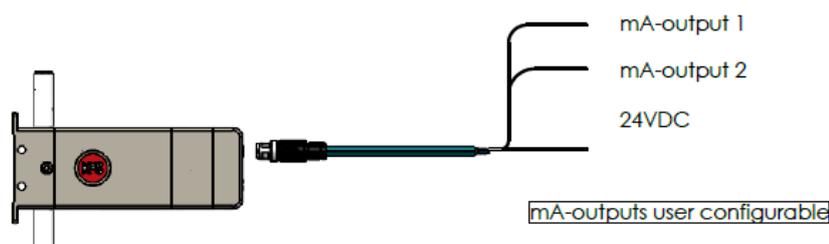
Figure 1 DCM-10 inline concentration monitor connectors.

## 1.2 DCM-10 integration concept

Inline concentration monitor DCM-10 is a stand-alone design with an optical sensor head and flow cell for process pipe connection with industry standard fitting types. The two bodies are independent where the optical construction will remain intact even when removing the flow cell. The critical optical parts are arranged in a solid body to provide a robust measurement in process conditions. The sensor head outer casing is of polypropylene PP to withstand chemical exposure while the wetted part flow cell is of perfluoroalkoxy PFA. The sapphire optical window is inserted in an ethylene chlorotrifluoroethylene ECTFE polymer construction serving as primary sealing in the internal locus of the flow cell. The Kalrez 6375UP o-ring serves as an encapsulated sealing.

The sensor cable connection is with one identical M12 cable model connected either to the sensor analog or digital shielded connector port. Both sensor connectors can receive 24VDC power input. Two identical sensor cables can be connected when the analog output is chosen, and the digital connector serves as access to user interfaces. A connector not in use shall be plugged.

### 1. Analog only (see page 2)



### 2. Digital only (see page 3)



### 3. Analog and Digital (see page 4)

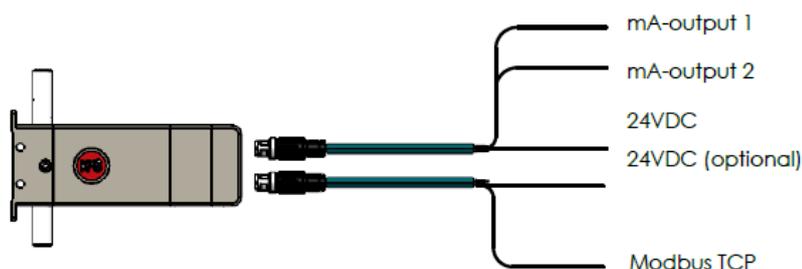


Figure 2 Inline concentration monitor DCM-10 operation concept. DWG No. 10125.

### 1.3 Cable connection with electrical modules

Regardless of analog or digital output port connection, one identical cable model serves both options. The shielded cable is with 24VDC power supply wires, Ethernet CAT 6A communication wires, and analog communications wires for 2x 4-20mA outputs.

The cable provided is with a M12 SPEEDCON male connector (IEC 61076-2-109) attached to the corresponding sensor female connector. The twisted pair cable structure is according to 4x2xAWG26/7; S/FTP. Outer sheath material is polyurethane PUR (Color: water blue RAL 5021). A FEP heat shrink for cable protection is available upon request for aggressive chemical installations.

The cable end is free with 8 wires following given pinout schedules below:

When **sensor analog output** is chosen, the 8 free-end cable wires are connected to the power supply SP-9400 according to Fig. 3. leaving 4 wires for the 2x analog mA signal connections. I.e. cable connections for mA port 1 with Green and White/Brown coloring, and mA port 2 with Orange and Brown coloring.

Analog connector (M12 X-code)

Pin no.	Description	Wire color
1.	Not connected	WH/OG
2.	Current out 2-	OG
3.	Not connected	WH/GN
4.	Current out 1-	GN
5.	Current out 1+	WH/BN
6.	Current out 2+	BN
7.	24VDC+	WH/BU
8.	24VDC-	BU

Figure 3 Wire pinout schedule for analog mA output connection.

Digital connector (M12 X-code)

Pin no.	Description	Wire color
1.	Ethernet Tx+	WH/OG
2.	Ethernet Tx-	OG
3.	Ethernet Rx+	WH/GN
4.	Ethernet Rx-	GN
5.	Not connected	WH/BN
6.	Not connected	BN
7.	24VDC+	WH/BU
8.	24VDC-	BU

Figure 4 Wire pinout for digital Ethernet Modbus TCP output connection.

When **sensor digital output** is chosen, the 8 free-end cable wires are connected to the power supply SP-9400 and RJ-45 connector SP-9310 according to the pinout schedule in Fig. 4. The RJ-45 connector is connected to the industrial ethernet switch SP-9320 with 4+1 available ports. The industrial ethernet switch serves connections of selectable industrial communication protocol converters, user interfaces, external displays, and WLAN modules. When the digital Modbus TCP signal is chosen, an additional module is available for conversion to other industrial protocols, for example Ethernet IP or ProfiNet. See separate third party user's manual for the industrial protocol converter modules.

When the analog output is chosen for measurement values, the digital channel is used for connecting to the user interface on a computer web browser or external display. When connecting the digital port, an identical second cable is connected to the sensor digital M12 connector port and the free-end wires are connected to the RJ-45 connector SP-9310 (Fig.5) in Pin no. 1-4 according to the wiring schedule in Fig. 4. The corresponding color coding is found on the RJ-45 connector SP-9310 in Mode A. An assembled M12 cable with RJ-45 connector is available from KxS Technologies upon request.



Figure 5 Power supply unit (Part No: SP-9400), RJ-45 connector (Part No: SP-9310), Industrial Ethernet Switch with 4+1 ports (Part No: SP-9320), and Universally configurable limit value switch with 1x relay output per switch (Part No: SP-9700).

The inline concentration monitor DCM-10 can be configured with low and high measurement alarms through relays as described in section 3.4.3 and its user interface configuration in section 3.4.4. The universally configurable limit value switch SP-9700 with 1 pcs changeover relay output and plug-in connection technology is used for monitoring analog limit values output from the sensor analog measurements. The limit values are configured with physical DIP switches with one relay per SP-9700 module. Two limit value switches are connected in serial when two relays for both high and low measurement alarms are defined. The 10x physical DIP switches are activated or kept inactivated to follow a defined sensor analog mA limit behavior in the 4-20mA range. See section 3.4.3 for low and high alarm relay function configuration.

## 1.4 System drawing of DCM-10 and Modular Connection Unit

The inline concentration monitor operates with 24VDC input and digital Modbus TCP and/or analog 4-20 mA outputs in a sensor stand-alone setup. In system drawing in Fig.6 optional Modular Connection Unit MCU presented with a set of selectable connection and converter modules, and external panel mounted display. The technical specification of each commercial module presented in section 4. *Technical specification of modules.*

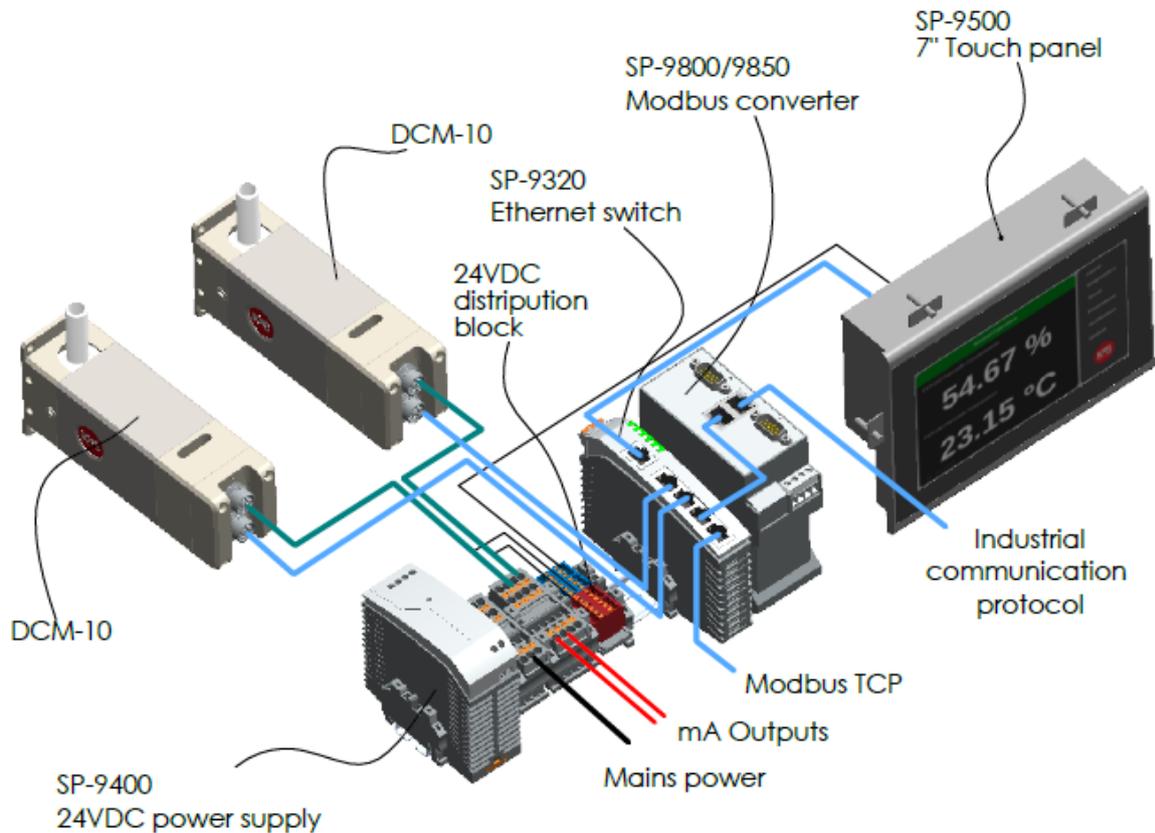


Figure 6 System drawing of inline concentration monitor DCM-10 and Modular Connection Unit MCU. DWG No. 10187.

## 1.5 User interface

Every sensor is delivered with the factory default IP address of 192.168.0.100. The sensor user interface is accessed through the sensor digital port when connecting the sensor to a computer with a web browser, external display, or mobile device. The sensor digital output port carries the Modbus TCP signal and connects to the user interface with a standard RJ-45 connector. The factory set sensor IP address 192.168.0.100. is entered in the address field of a computer web browser, external display, or mobile device. The homepage offers access to displayed measurement values and diagnostics, configure parameters and verify sensor calibrations. KxS Technologies recommends using Google Chrome or Microsoft Edge web browser.

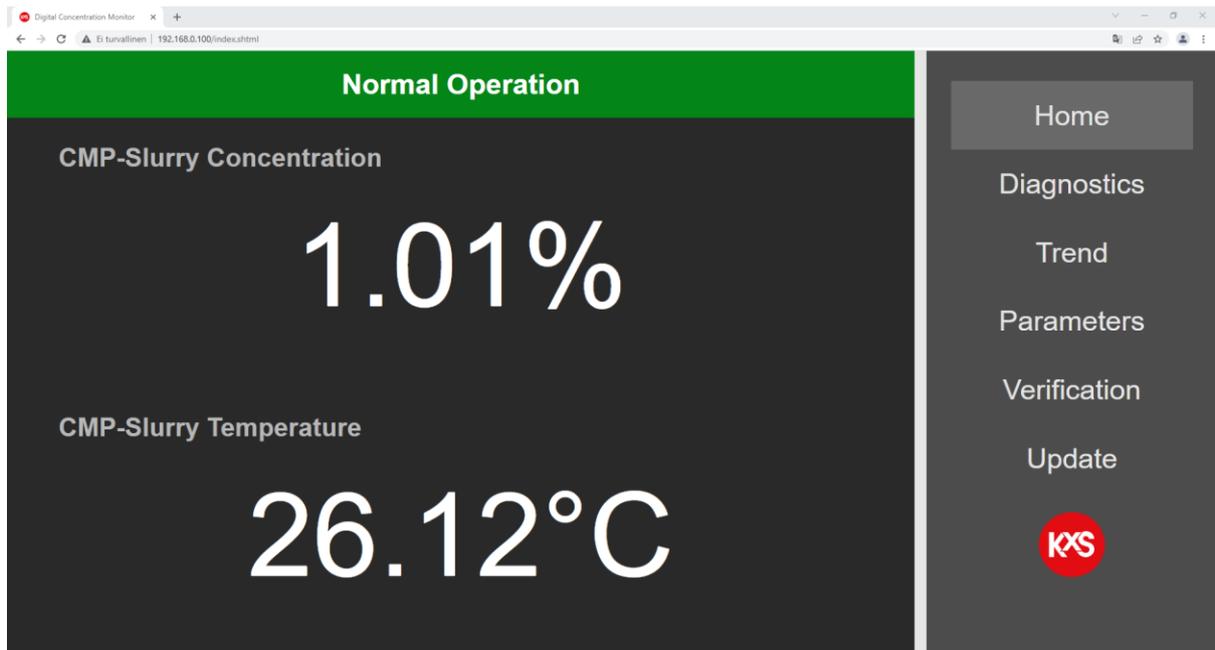


Figure 7 Sensor homepage of user interface on a computer web browser, mobile device or external display SP-9500/SP-9540.

### 1.5.1 Computer setup

Verify in the computer command prompt, (in Windows, press Start button and type *Command Prompt*) by typing *ipconfig*, that the computer IP address is set to the same 192.168.x.y network. The last two digits .x.y on the computer must not be the same as the corresponding for the sensor IP address .0.100.

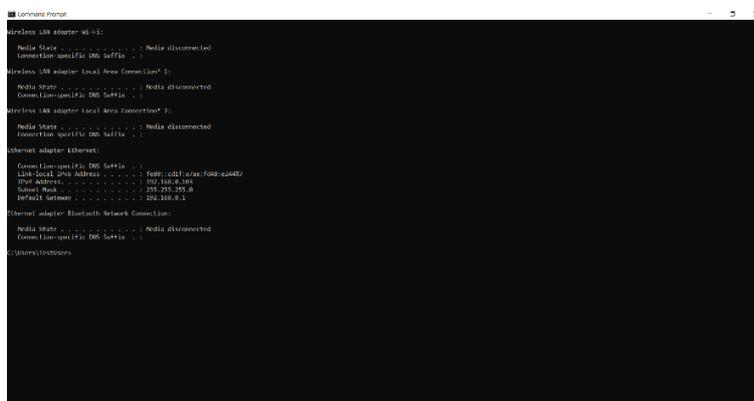
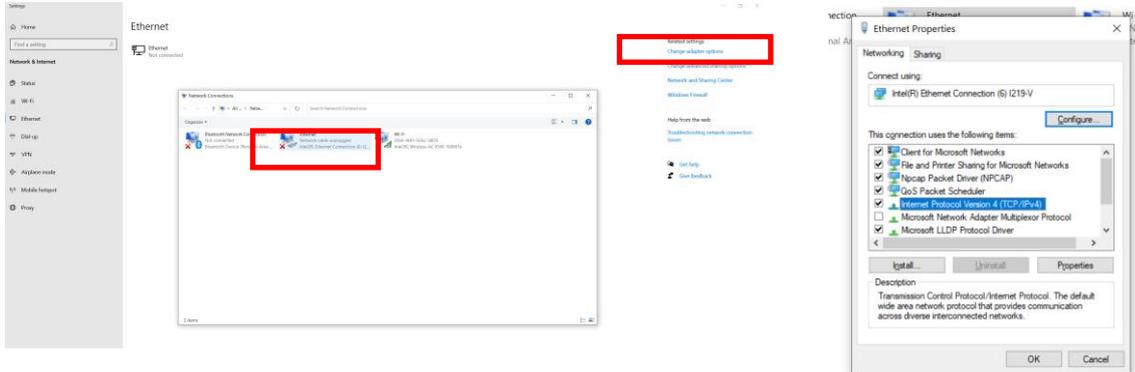
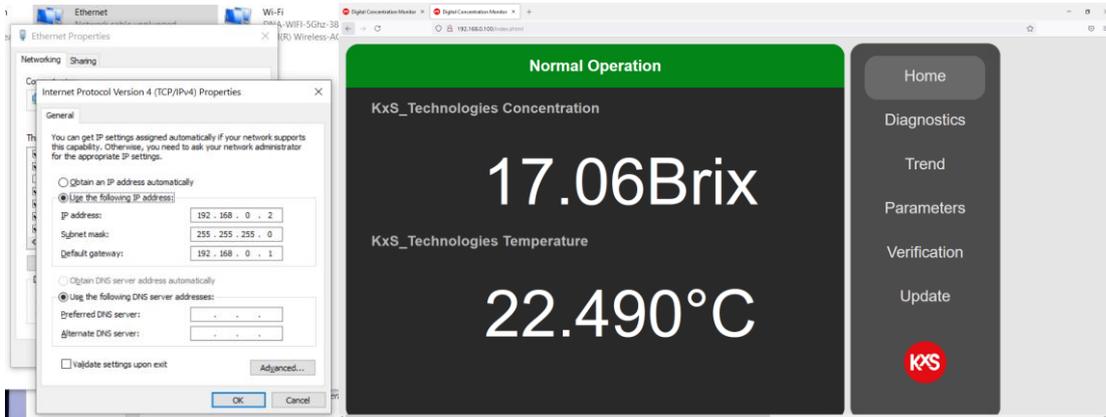


Figure 8 Command prompt on computer for IP address verification.

In the PC Start menu by typing Ethernet, the IP setting window is accessed. By going to *Change adapter settings*, a window will open where *Ethernet* is chosen. A new window for *Ethernet Properties* opens, where *Internet Protocol Version 4 (TCP/IPv4)* is double-clicked.



Unless the PC *obtains the IP address automatically* in the 192.168.x.y domain, the IP settings are changed to *Use the following IP address*. The PC IP address must not be the same as sensor default address. The PC IP address can be for example 192.168.0.2. Subnet mask: 255.255.255.0. Press OK, close, and open a web browser where the sensor IP address is entered in the address field.



### 1.5.2 External display setup

An external industrial display is available with a 7" multi touch panel mount design, or 15" all protected cover design for user interface and measurement reading display purposes. The display is powered with 24VDC. The sensor Ethernet cable is connected to the display with a RJ-45 port shown in Fig 9. When the display is powered up, opt for the configuration page during display start-up.



Figure 9 Cable connections to the external display and activation of configuration page during power up.

To set up the display panel's IP address go to section *Network* and dial in settings as in Fig 10. Select Static IP. IP address with 192.168.x.y where x.y is any other ending than the corresponding for the sensor .0.100. Subnet Mask 255.255.255.0. Confirm by pressing  $\checkmark$ .



Figure 10 Display IP settings in section *Network* and connecting display to sensor IP in section *Web application*.

The touch panel unit can display four sensors by selecting respective sensor IP line 'active' in section *Web application* of the display user interface Fig 10. Confirm by pressing  $\checkmark$ . The settings are applied by pressing the Restart button seen in Fig 11.

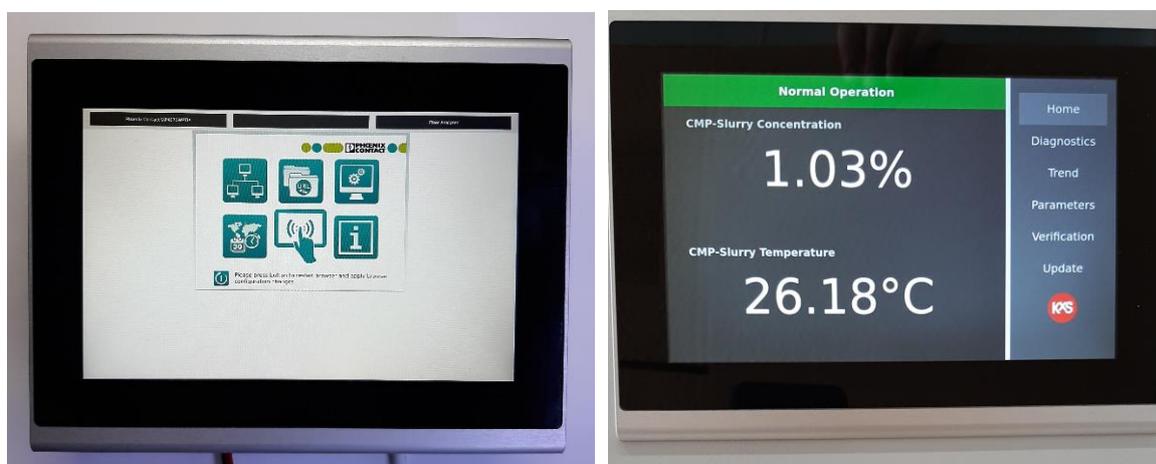


Figure 11 Restart the display by pressing the lower left button on the display to apply configuration settings and changes for activation of the sensor user interface homepage.

### 1.5.3 Mobile device setup

A mobile device can be connected for accessing the user interface. An Ethernet cable from the industrial switch is connected through a standard RJ-45 to a USB-C or other suitable adapter. The adapter is connected to the mobile device. The mobile device is set to Airplane mode. Following the mobile device *Settings* path from left to right in Fig. 12, allows access to the sensor user interface. When the settings are done, open a web browser and type the sensor IP address (default: 192.168.0.100) in the address field. Examples of mobile devices are shown in section 5.2.

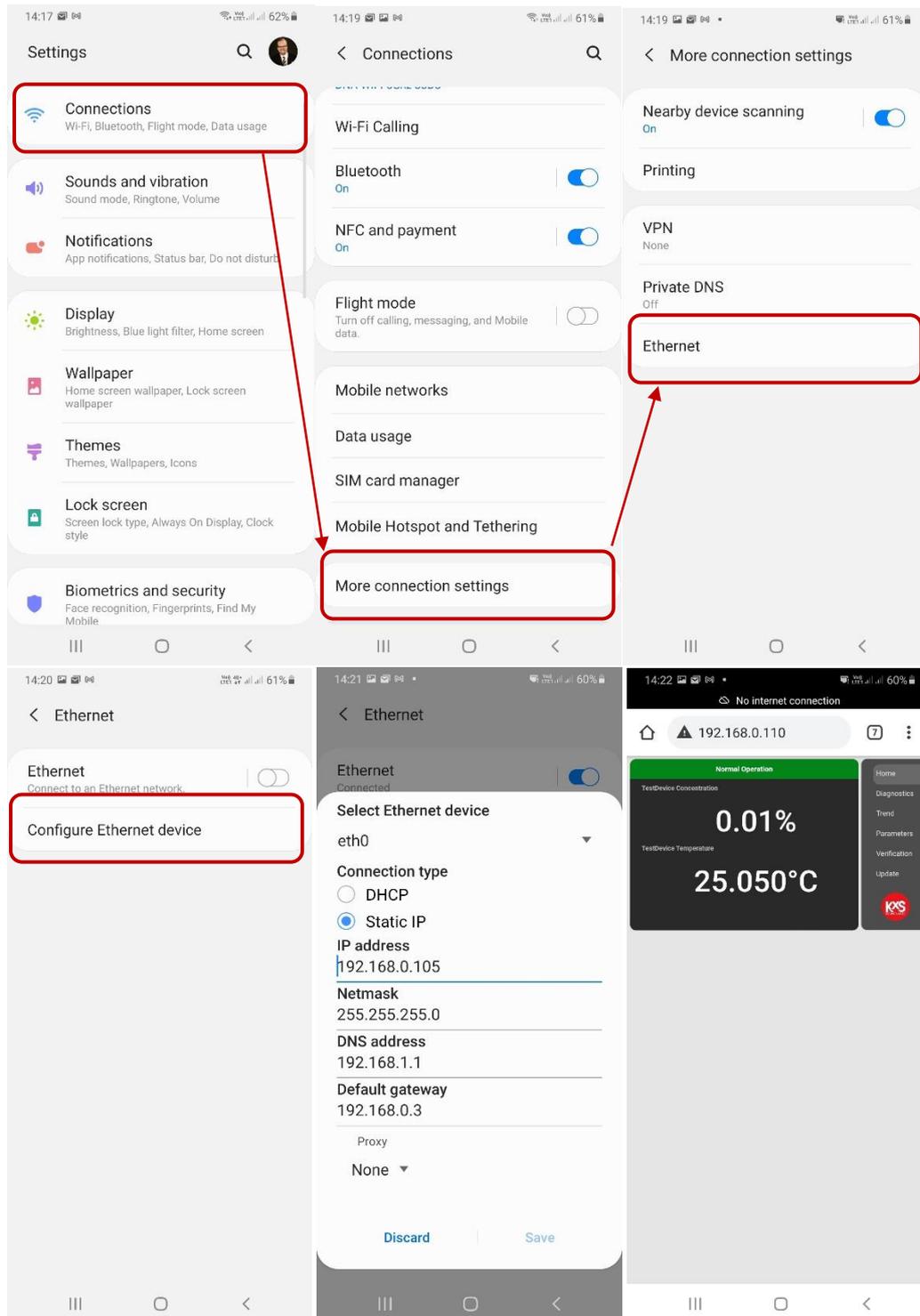


Figure 12 Mobile device settings for IP configuration and access of sensor user interface homepage.

## 2. Inline Concentration Monitor DCM-10 mounting

The inline concentration monitor DCM-10 is mounted straight into process pipe sizes of 1/4", 3/8", 1/2", 3/4" or 1". The recommended sensor mounting location is such where the sensor is accessible for maintenance and cable connection for user interface access. The tube end sensor flow cell allows connection of standard Flare, Pillar type or PrimeLock® fittings. The flow cell casing is designed with a bracket for sensor wall mounting.

### 2.1 Sensor dimensions

The sensor mounting position is either in a vertical or horizontal process pipe section. When a horizontal process pipe section is chosen, the sensor head is recommended in a horizontal orientation, i.e. not on top nor below the process pipe. The recommended flow velocity is 1m/s (3ft/s). That translates to approximately 2 liters per minute LPM in a 1/4" process pipe and 30LPM in a 1" pipe. The sensor dimensions are shown in Fig. 13.

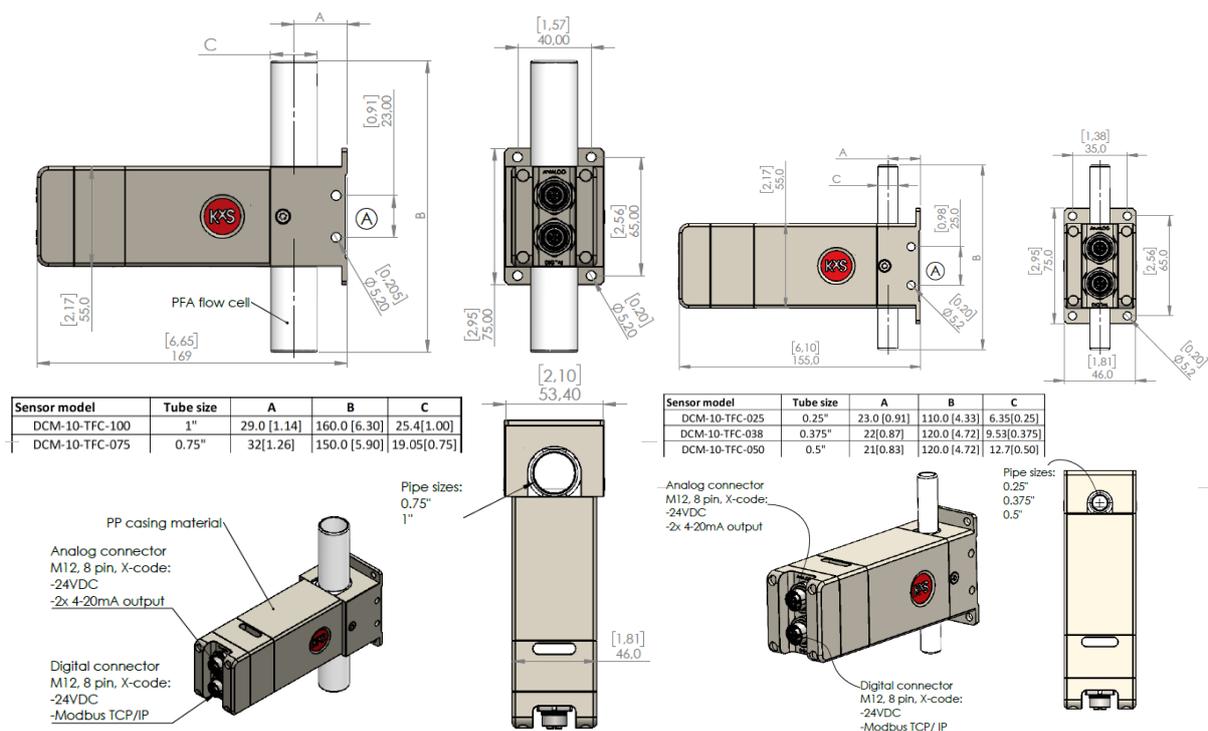


Figure 13 Inline concentration monitor mounted in the main process line. DWG No. 10166 and 10020.

## 2.2 Sensor mounting locations

The inline concentration monitor DCM-10 is mounted in a process line where a fair flow over the sensor is provided. The optical measurement is not limited to a flow velocity, even if the recommended flow is 1m/s. That is typically in the main pipe. The mounting location can be in a slipstream if the recommendation of 1m/s flow over the sensor is maintained. Parallel pipe sections will decrease the flow over the sensor. In CMP slurry applications, the recommendation is to always keep the sensor optical window wetted. Valve isolation of the sensor to keep it wetted can be considered when N<sub>2</sub> purge sequences of the process pipe are designed. The consequence of dried CMP slurry on the optical window is potential of scaling. In clear chemical applications that phenomenon is non-existing. The optical window sapphire material is not harmed whether kept dry or wet.

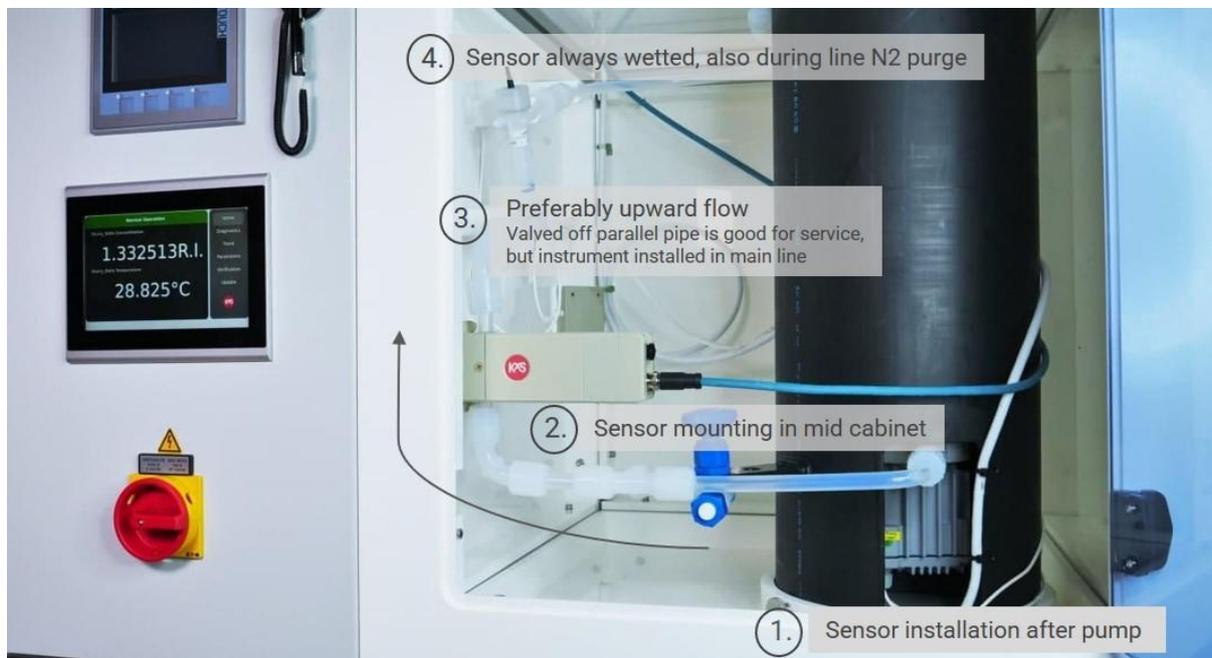


Figure 14 Recommended DCM-10 sensor mounting location.

## 2.3 Wiring drawing of Modular Connection Unit

The wiring drawing consists of all selectable commercial modules for power supply, wiring, control, and converter modules. Components listed from bottom to up: Power supply unit SP-9400, limit value switches with analog mA input and relay output SP-9700, wire connection unit for 100-240V input, analog signal wiring output unit, wire connection unit for 24VDC input and output, patch panel for digital communication 4 wire free-end connection SP-9330, industrial ethernet switch SP-9320, digital communication protocol converter SP-9800,

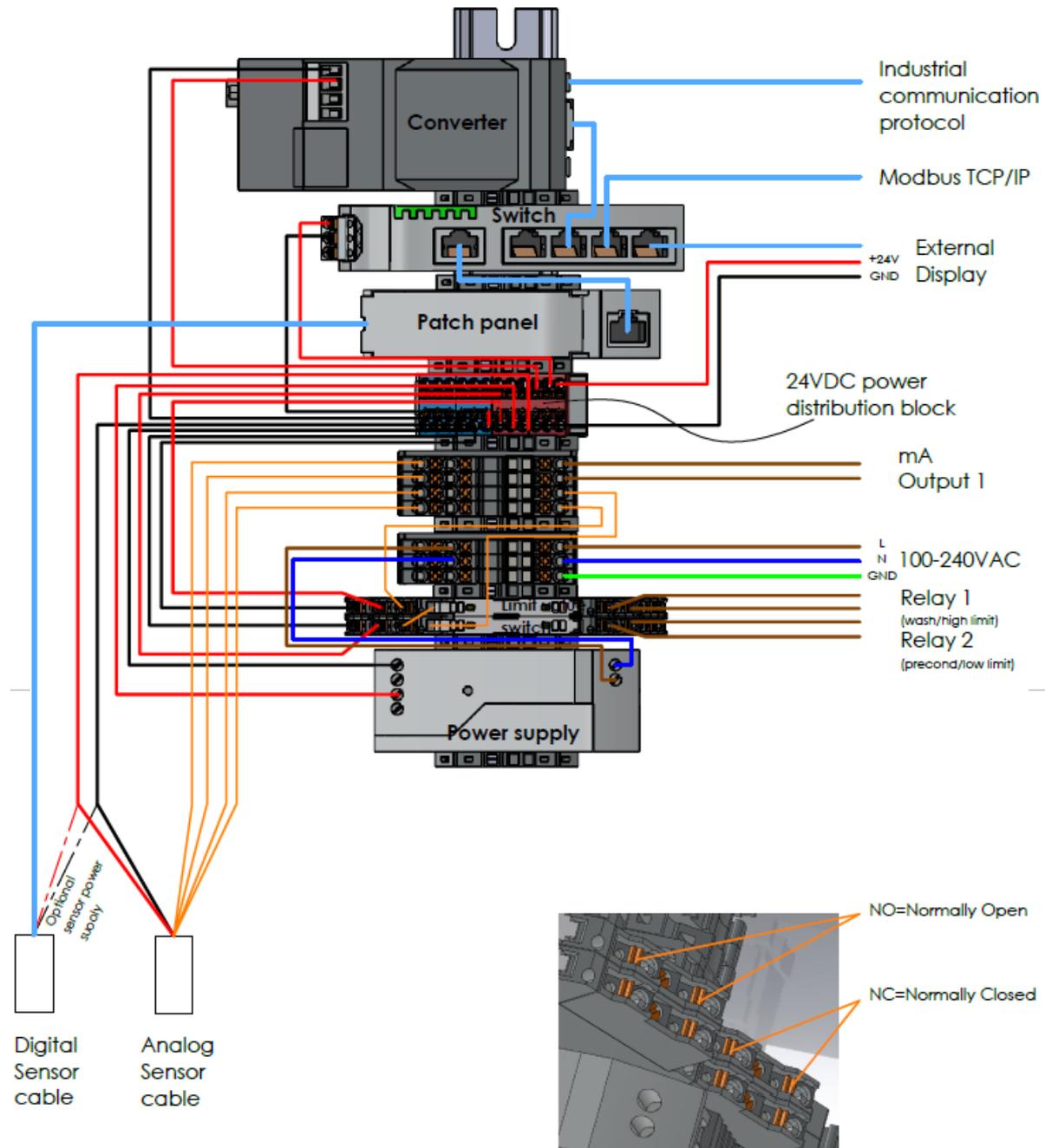


Figure 15 Wiring drawing of modules in MCU. DWG No. 10178.

### 3. Calibration and configuration

The inline concentration monitor DCM-10 is factory calibrated for refractive index units RIU utilizing NIST traceable standard refractive index liquids.

The refractive index units can be converted to output and display concentration %wt or g/cm<sup>3</sup> measurement units. When the chemical is known, the conversion parameters are pre-set in the user interface. In the event a finger-print calibration is required, a defined procedure is followed in lab or field environment while chemical samples are circulated over the sensor optical window. A separate standard operating procedure SOP is available for such work. The refractive index unit RIU and Temperature are used to convert the measurement to given concentration units.

Configuration and calibration parameter changes are defined in the user interface on a web browser on a computer, external display, or mobile device. Access to the user interfaces is described in section 1.4 *User Interface*.

#### 3.1 User interface homepage

The sensor user interface is accessed as described in section 1.4. The homepage displays real time concentration measurement values, process temperature, and sensor serial number. In addition, the sensor status is visible: *Normal Operation* when liquid is in contact with the optical window, *No Sample* when process pipe empty or no liquid on the optical window.

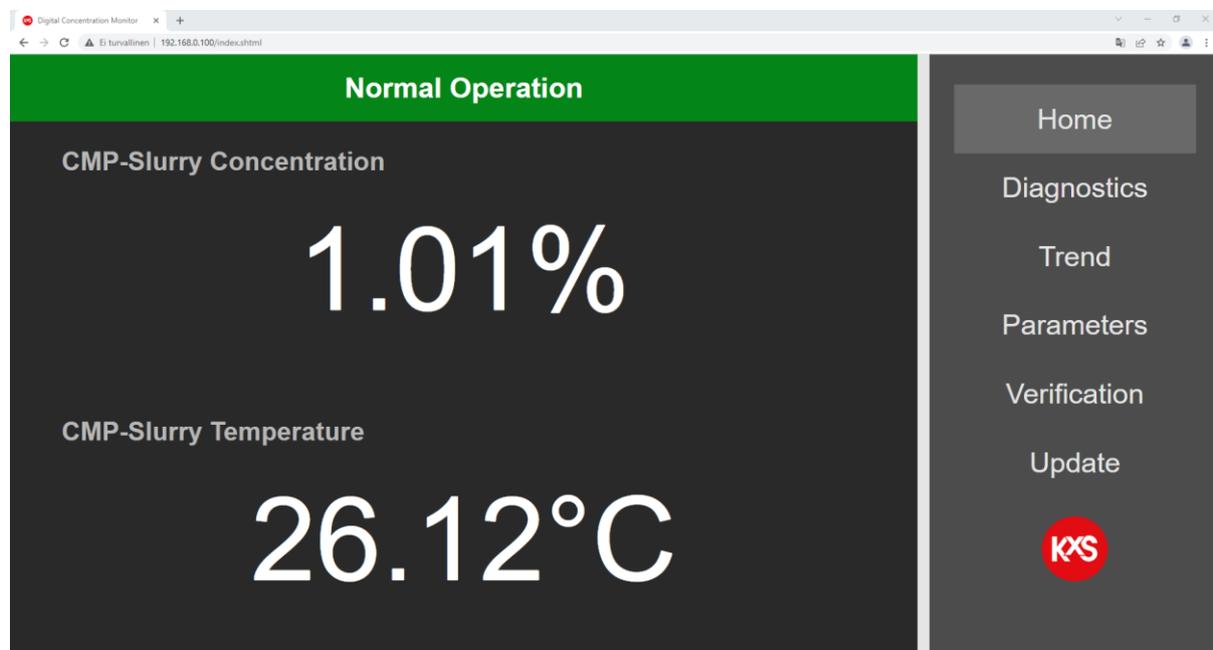


Figure 16 User interface homepage with real-time measurement values.

### 3.2 Diagnostics of measurement and optical image

The optical image, measurements, and sensor internal diagnostics are useful in analyzing the sensor performance and application functionality. During process troubleshooting the optical image is a key indicator of measurement quality.

The 'Field sample' button activates sampling of 10 measurement data points and calculates an average for display.

Prism wash activates an optical window wash if one of the mA outputs have been configured for 'Wash' in section Parameters/Outputs

'Slope image' displays the slope of the optical image border line.

History reset resets the lowest and highest measurement values during the DCM sensor power session.

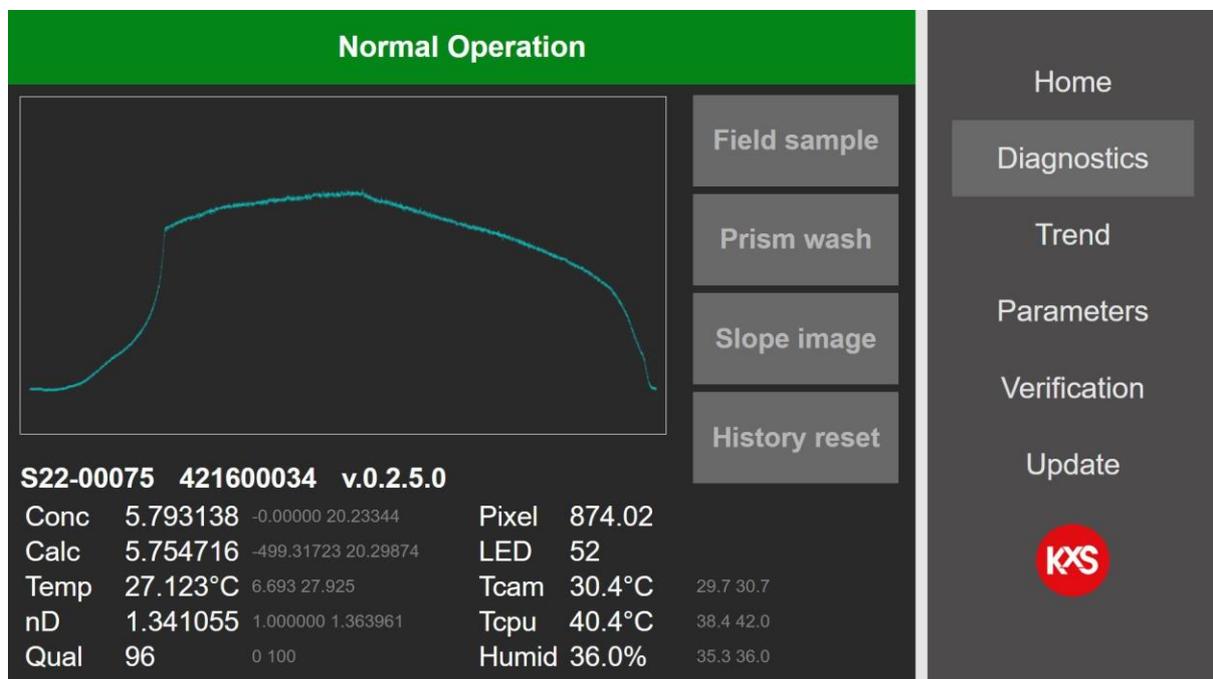


Figure 17 Diagnostics with optical image, measurements, and sensor internal diagnostics.

### 3.3 Trend plots

Realtime trends of user selected two measurement values (e.g., concentration and temperature) are available in page *Trends*. DCM-10 internal memory logs and stores 6000 measurement data points that can be saved in a txt file format. The storage interval is user selectable 1, 10 or 60 seconds. When the memory is full the log continues active, and old measurement points are over written.

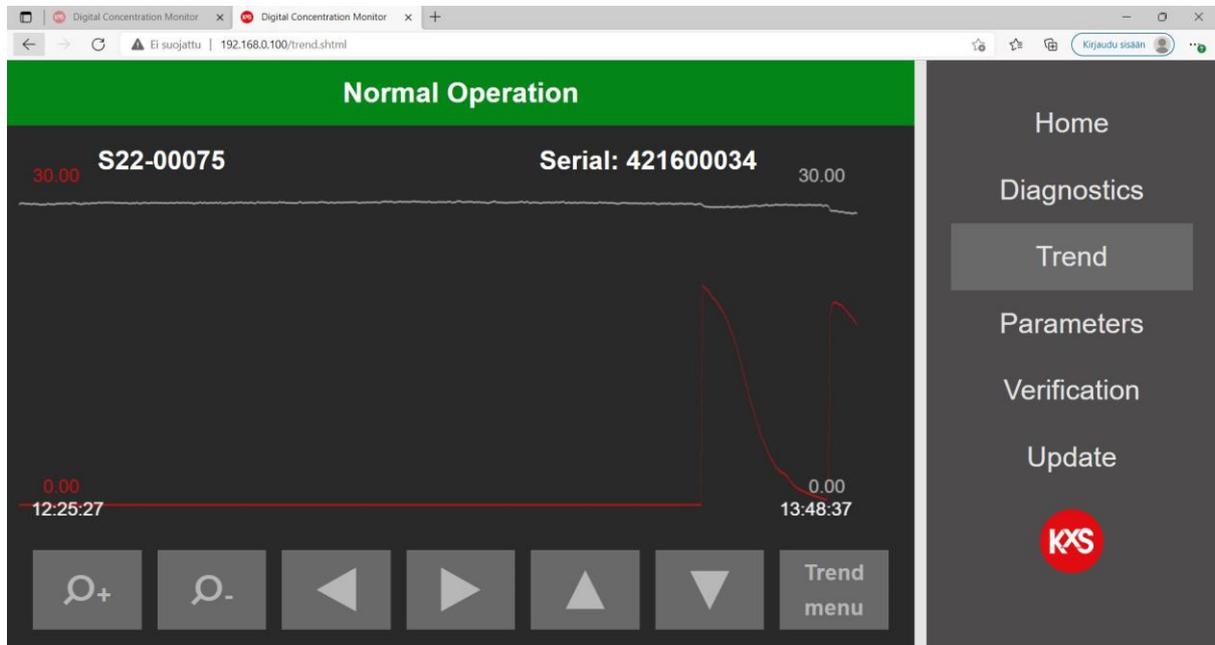


Figure 18 Continuous measurement trend.

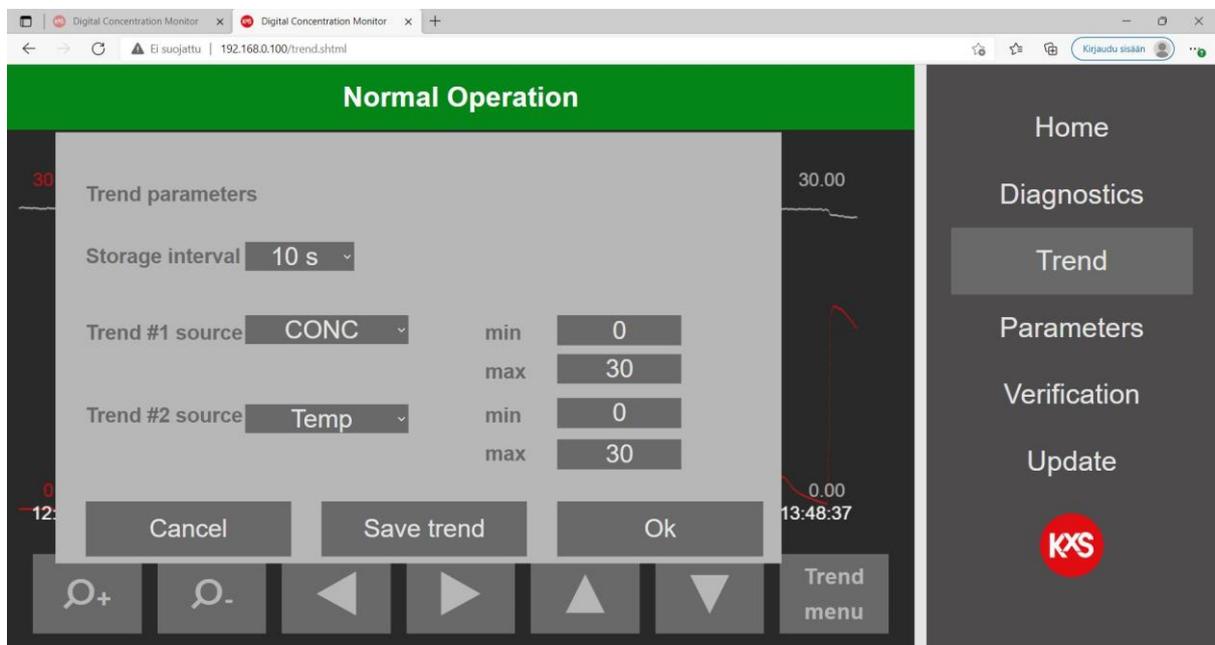


Figure 19 User selectable trend functions



## 3.4 Parameters configuration

### 3.4.1 User interface password

Operating and changing DCM settings and parameters is password protected. The password Login is found in the user interface section Parameters/Special. Please consult KxS Technologies or its authorized local partner for the default password.

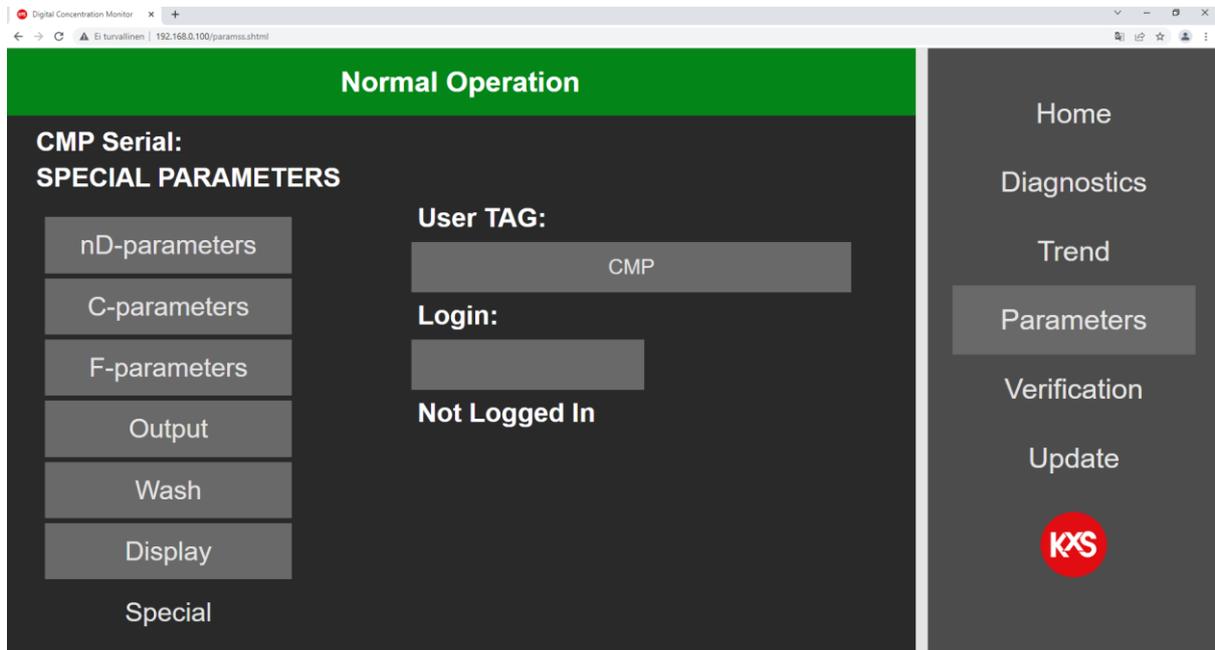


Figure 21 DCM Login with password

After the Login is activated, settings and parameters in the user interface can be changed. Also a user selected password can be configured.

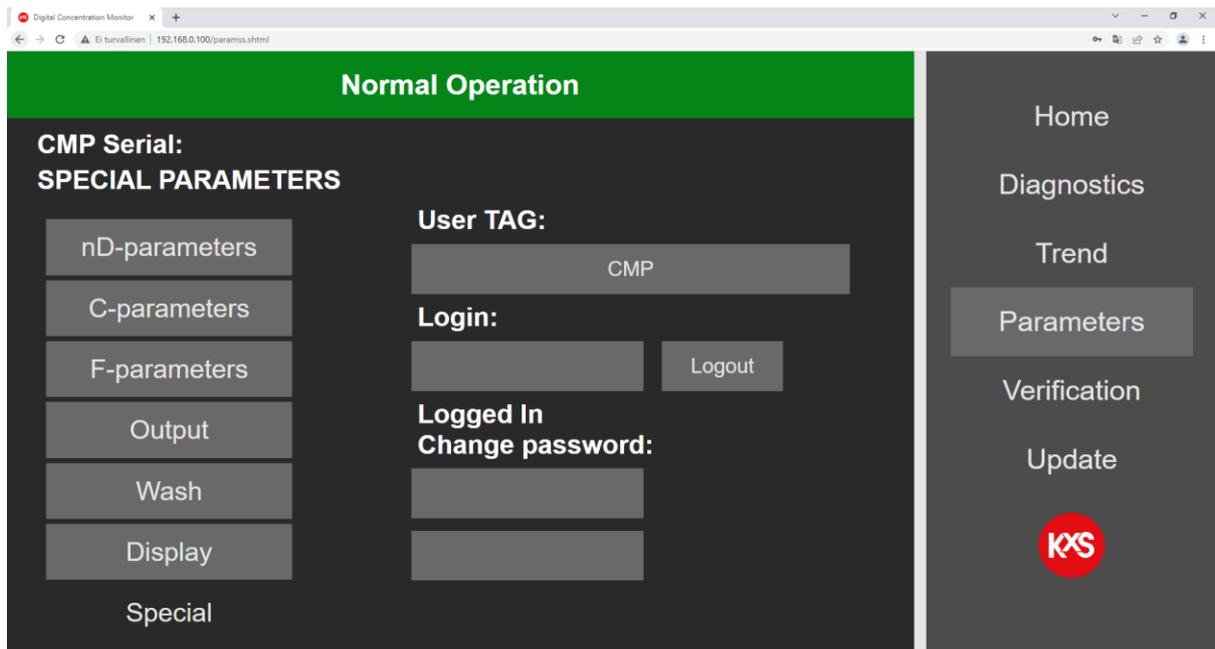


Figure 22 User selectable Password

### 3.4.2 Calibration parameters

In the user interface the mA configuration is found on page *Parameters* and *Output*. The mA-output is user configurable for Brix, Temp, diagnostics, and Wash (for optical window). The range of chosen measurement value is user configurable to correspond the analog 4-20mA range.

The sensor calibration is configured in three layers. Each layer is described by a second degree 3x3 matrix for both concentration and temperature dependency.

The factory camera pixel to refractive index unit RIU calibration is defined in page nD-parameters. The factory set a-parameters are sensor specific and must not be altered unless a sensor RIU calibration is performed.

The Chemical calibration RI to Conc% is set in page C-parameters. The 3x3 matrix describes the non-linear relationship of CONC vs RIU/Temp.

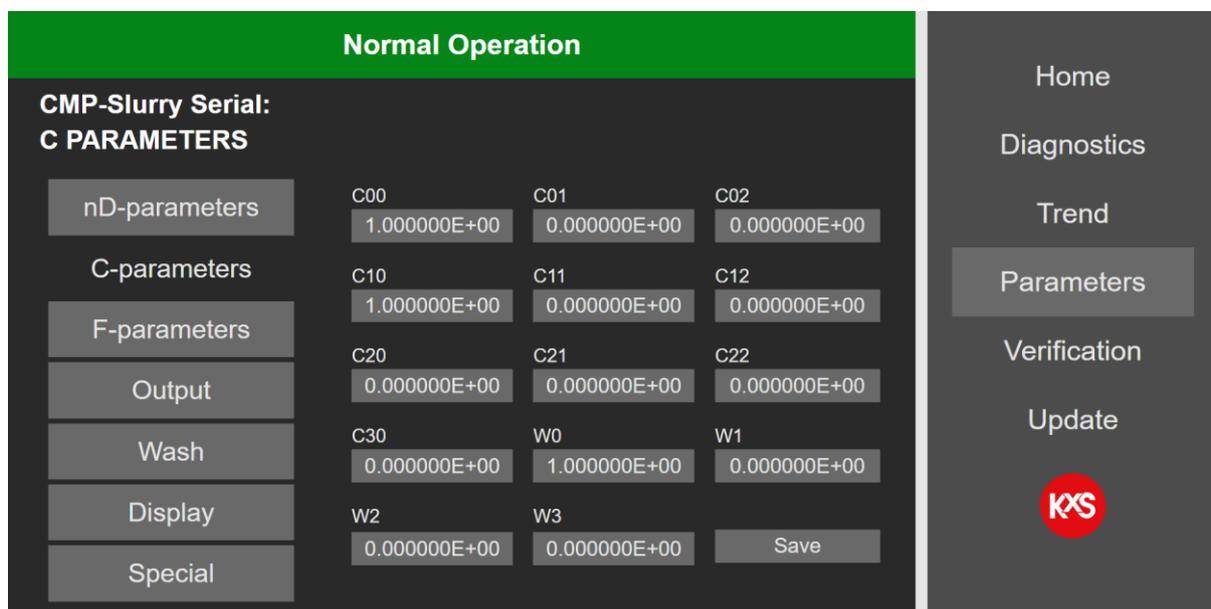


Figure 23 Sensor calibration parameter settings.

The parameter values C00-C30 are dialed by pressing respective cell. In the active cell a new parameter value is entered and confirmed by pressing *Save*.

In the event the output CONC reading needs an adjustment vs. measurement references (laboratory), the sensor reading is adjusted in page F-parameters. The Field adjustment matrix is defined in the F-parameters matrix.

### 3.4.3 Output configuration and analog signal settings

The mA output function is found in the user interface section *Parameters/Output*. Two independent mA ports are available for user configuration. In the drop-down menu the selectable output functions are Concentration, Temperature, Quality of optical image, refractive index unit nD, diagnostics, automatic Wash functions of the optical window, and measurement low/high limit alarms.

The minimum and maximum measurement values are user selectable to correspond with the 4-20mA range. The selection is activated by pressing *Set*. The mA alarm limits are set in *Extras* as described in section 3.4.3

The final CONC (concentration) output signal can be filter with a moving average function in *Damping*. The user selectable damping function is 0-30 sensor measurement points. In fast changing chemical process sequences the recommendation is to keep the Damping moderate 0-10 while in slow changing process a Damping 20-30 will smooth out the CONC measurement noise.

The existing sensor IP address is found in the lower right corner of the *Output* page.

The screenshot displays the 'Normal Operation' page of the Digital Concentration Monitor. The interface is dark-themed with a green header. The main content area shows the following settings:

- Device Info:** S22-00075 Serial: 421600034
- OUTPUT PARAMETERS:**
  - mA output 1:** Function: CONC, Min (4mA): 0.000000, Max (20mA): 100.0000, Extras: ...
  - mA output 2:** Function: Temp, Min (4mA): 0.000000, Max (20mA): 100.0000, Extras: ...
- Damping:** 10 (range 1...30)
- Ethernet IP Address:** 192.168.0.100

On the left side, there are buttons for 'nD-parameters', 'C-parameters', 'F-parameters', 'Output', 'Wash', 'Display', and 'Special'. On the right side, a navigation menu includes 'Home', 'Diagnostics', 'Trend', 'Parameters', 'Verification', and 'Update', along with the KXS logo.

Figure 24 User configurable analog measurement output settings.

### 3.4.4 Configuration of low and high alarms

Low and High alarm limit values are user selectable for measurements or diagnostics. The alarm limit settings are configured in Parameters/Output/Extras.

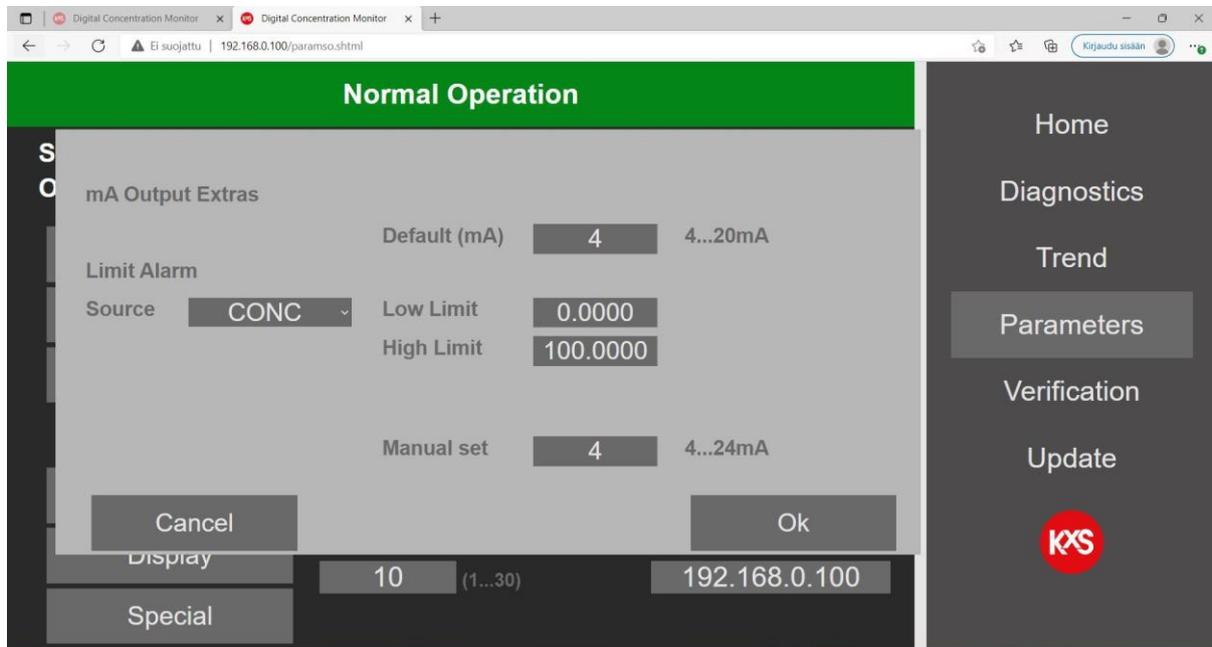


Figure 25 User selectable alarm functions.

Simultaneously corresponding physical DIP switches in the Relay SP-9700 are activated 'ON'. When both low and high alarms are used, two (2) limit value switches SP-9700 are connected in serial per wiring drawing in section 2.3, Fig. 15.

**Low alarm:** Relay module 1 DIP switches **2, 5, 6, 9, 0** activated 'ON'.

**High alarm:** Relay module 2 DIP switches **2, 3, 7, 0** activated 'ON'.

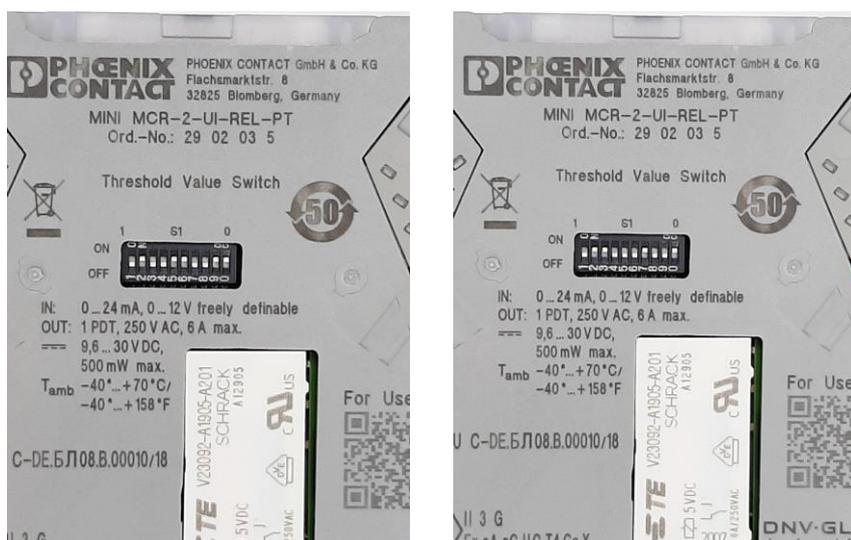


Figure 26 Physical DIP switch configuration of alarm limits

### 3.4.5 Display settings

User selectable engineering units in a drop-down menu are available for display of concentration and temperature. The number of displayed decimals of the final output CONC is user selectable 1-6.

Note! The displayed CONC engineering unit is not connected to the Chemical calibration parameters as described in 3.4.2. The sensor calibration is always correlated with the C-Parameters.

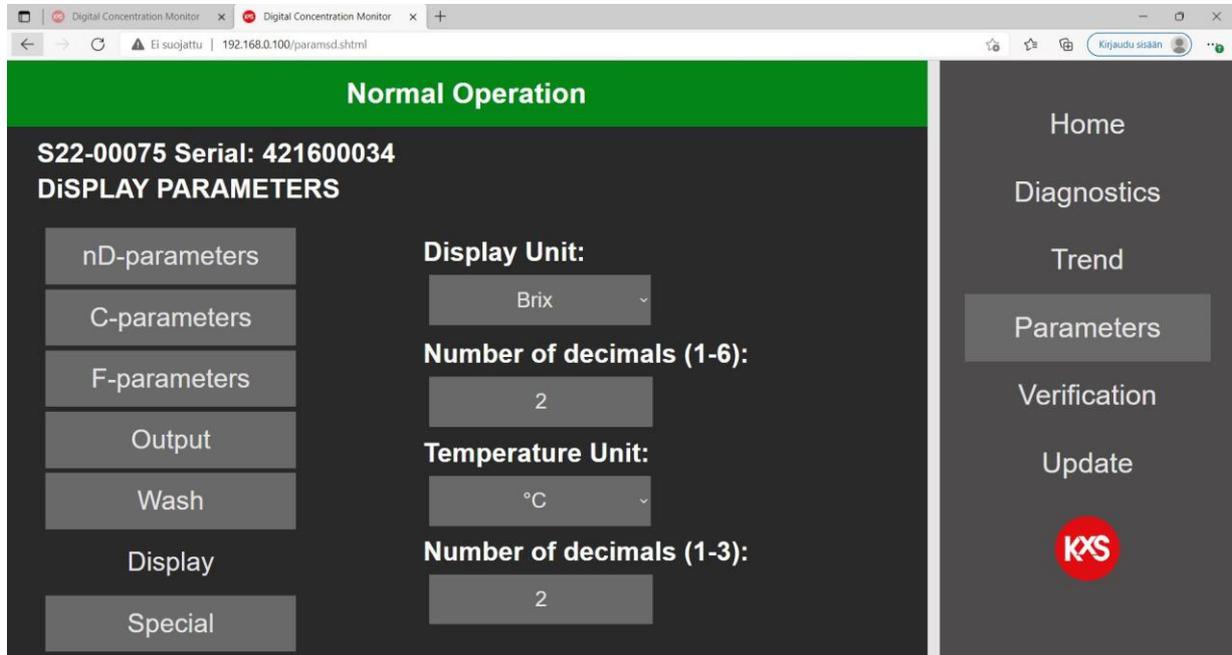


Figure 27 Displayed engineering units for concentration and temperature

### 3.4.6 Software update

Sensor software is updated in the user interface in section Update. To access the sensor update function, the user interface Login must be activated. Login is activated in section Parameters/Special. Please consult KxS Technologies or its authorized distributor partner for login Password. A successful Login will allow a sensor software update function. The user interface status bar is indicated with 'Update allowed'.

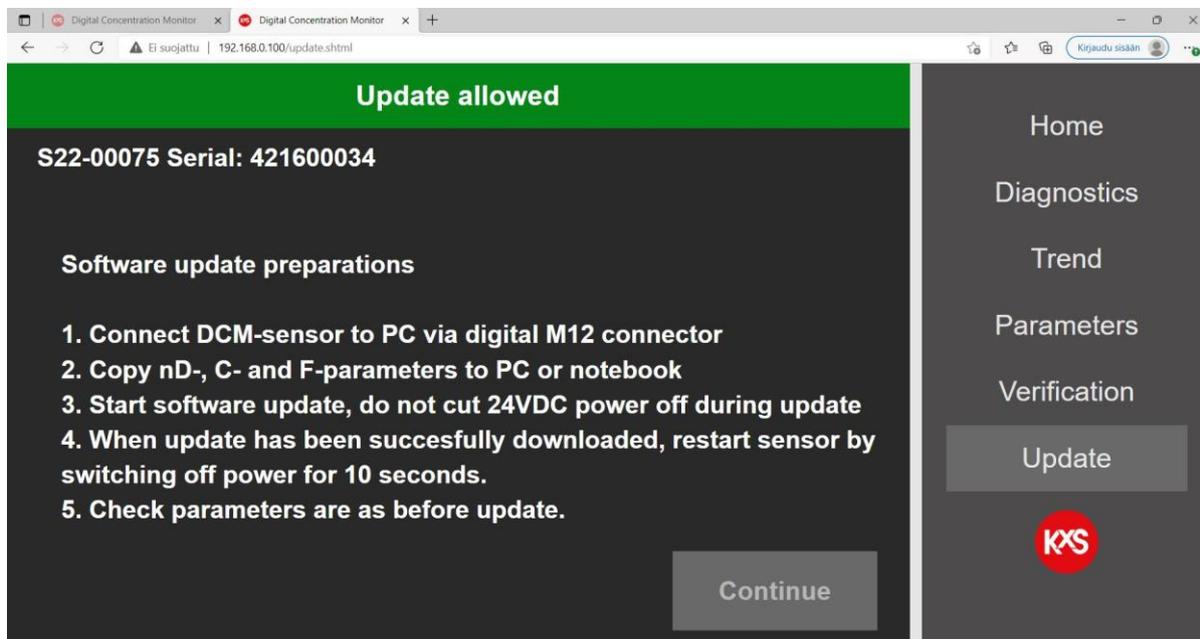


Figure 28 Guided sensor software procedure

The sensor software file is Selected and then activated by pressing 'Update. The update progress is indicated in the status bar. During the update progress the user interface should not be operated nor power to the DCM-10 interrupted. Once the update is successful, there is an indication of allowing for 10 seconds prior to rebooting the sensor through a power cycle. The sensor software version is visible in page Diagnostics.

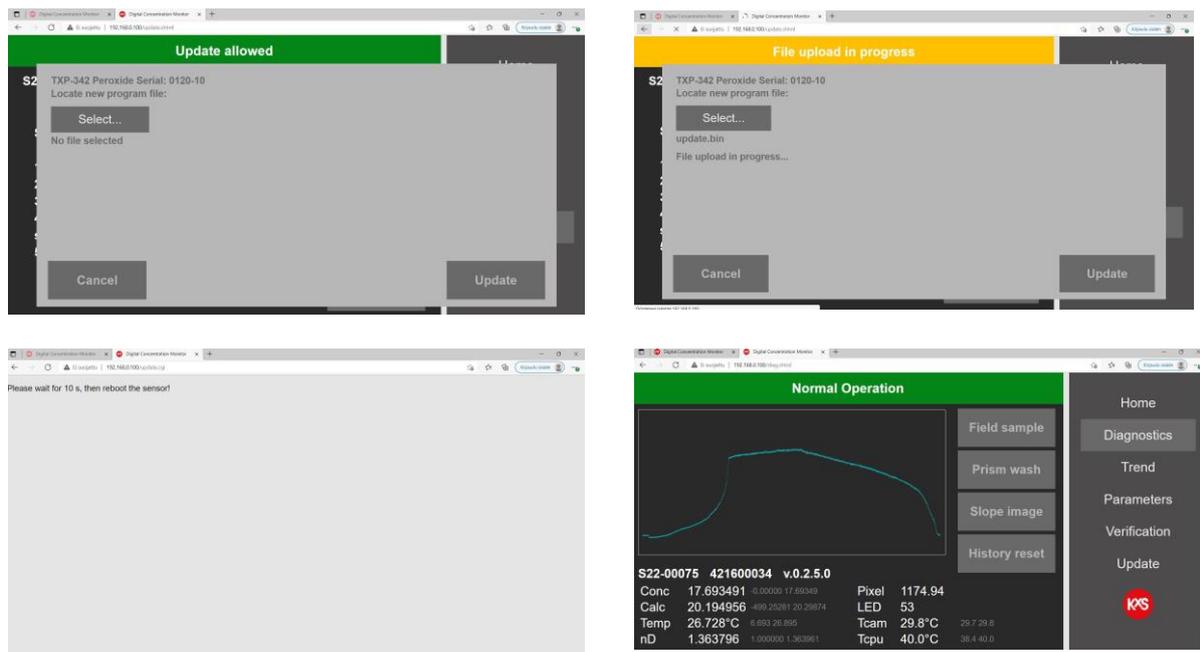


Figure 29 Sensor software update sequence

## 4. Digital Modbus TCP configuration

The DCM-10 digital output signal is designed with Ethernet communication in a Modbus TCP protocol. The protocol uses by default **Port 502** as local port in the server.

When configuring programmable logic controllers PLCs, the DCM-10 measurement quantities are defined in Holding registers. The Holding registers are defined in the Modbus 3xxxx section and sensor specific measurement quantities in register numbers as listed below:

Measurement quantity	Register number	Address	Data type
Status	30001	0	string32
LED	30017	16	ushort
RHsens (sensor relative humidity)	30019	18	float
nD (raw refractive index)	30021	20	float
CONC (final concentration value)	30023	22	float
Temp (process temperature)	30025	24	float
Tsens (sensor internal temperature)	30027	26	float
PIX (Pixel value)	30029	28	float
CALC (calculated concentration)	30031	30	float
Qual (Quality of optical image)	30033	32	float

## 5. Technical specification of modules

### 5.1 Modular Connection Unit MCU

The power and communication modules in the Modular Connection Unit MCU are with DIN rail mounting and can as option be mounted in a stainless-steel enclosure SP-8000 with protection category IP66, NEMA 4X certified by the enclosure manufacturer.

Stainless steel compact enclosures 1.4301 (AISI 304) including mounting plate. The stainless steel door is all-round foamed-in PU seal. Protection category IP 66. The enclosure manufacturer provides an EU Declaration of Conformity and UL Standard(s) for Safety.

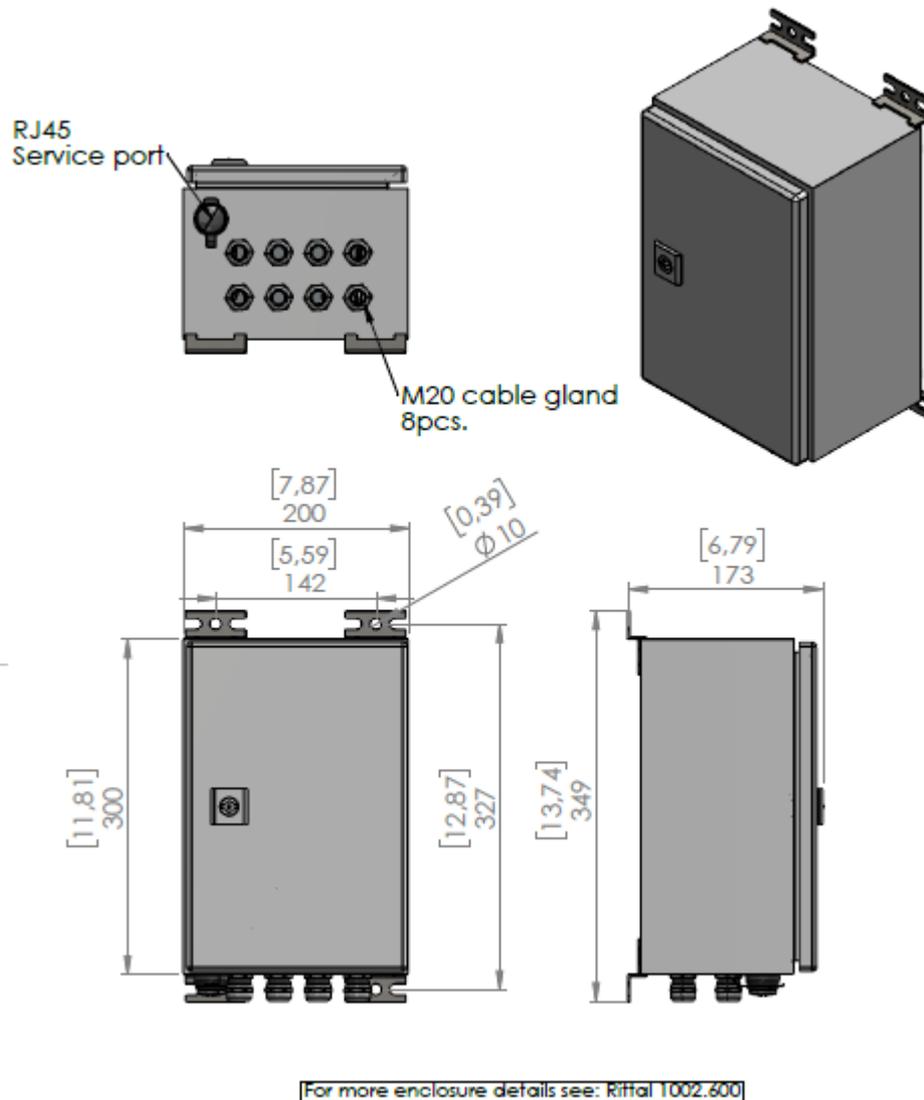


Figure 30 Dimensional drawing of Modular Connection Unit DWG No. 10179.

## 5.2 Display options for User Interface access

KxS Technologies offers options for user interface displays. The user interface features and functions are identical regardless which option is chosen. Product certificates of modules and displays are available per third-party manufacturer.

### 5.2.1 Computer or mobile device with display and RJ45 Ethernet cable

The sensor cable is assembled to an RJ-45 connector according to the color coding given in Section 1.3 Fig.4. The SP-9310 RJ-45 connector is with corresponding color coding. The cable is connected to the computer RJ-45 port, or USB-C port using a RJ-45-to-USB-C adapter. The sensor user interface is accessed as described in section 1.5.

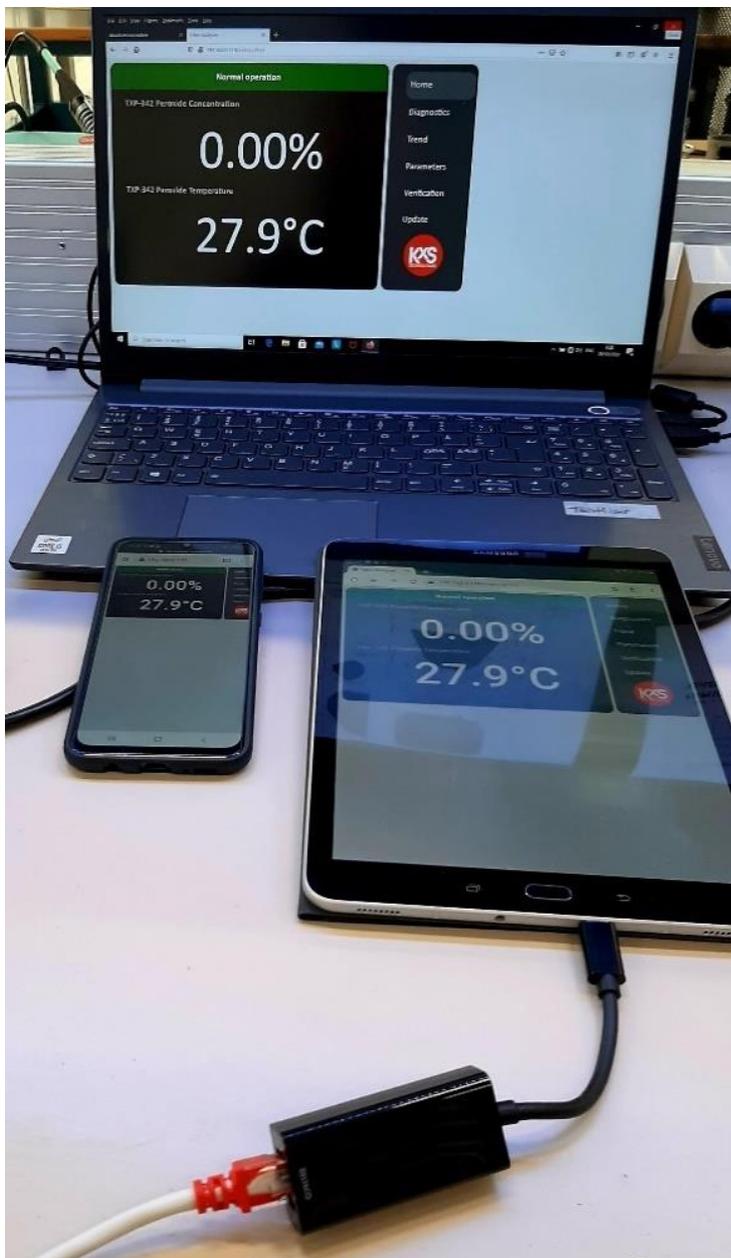


Figure 31 Computer or mobile device used as user interface.

## 5.2.2 WLAN for remote access with Computer or mobile device

The Modular Connection Unit MCU stainless steel enclosure can be equipped with a WLAN wireless module SP-9600 Fig. 25 for wireless connection to a computer or mobile device with corresponding WLAN features. The WLAN wireless module operates with 24VDC power input and holds an RJ-45 port for Ethernet cable connection from the Industrial Ethernet Switch SP-9320 placed inside the MCU enclosure.



Figure 32 WLAN access point, client with two internal antennas (MIMO) for single hole mounting, IP54, WLAN 802.11 a, b, g, n, frequency: 2.4 GHz, 5 GHz (incl. DFS channels), connections: COMBICON 9 ... 32 V DC, RJ45: for LAN, web, http/https, Command Line Interface.

### Dimensions

<b>Width</b>	62.8 mm
<b>Height</b>	36.5 mm
<b>Depth</b>	113.2 mm
<b>Note on dimensions</b>	Outside dimensions

### Ambient conditions

<b>Ambient temperature (operation)</b>	0 °C ... 60 °C
<b>Ambient temperature (storage/transport)</b>	-40 °C ... 85 °C
<b>Permissible humidity (operation)</b>	5 % ... 95 % (non-condensing)
<b>Permissible humidity (storage/transport)</b>	5 % ... 95 % (non-condensing)
<b>Air pressure (operation)</b>	800 hPa ... 1080 hPa (up to 2000 m above sea level)

<b>Air pressure (storage/transport)</b>	660 hPa ... 1080 hPa (up to 3500 m above sea level)
<b>Degree of protection</b>	IP54
<b>Note</b>	Degree of protection when installed

### Wireless interface

<b>Designation</b>	Wireless LAN
<b>Antenna connection method</b>	(Internal)
<b>Wireless standard</b>	IEEE 802.11
	a
	b
	g
	n
<b>Frequency band</b>	2.4 GHz
	5 GHz
<b>Transmission power</b>	max. 20 dBm (EIRP)
<b>Number of wireless interfaces</b>	1 IEEE 802.11 a/b/g/n
<b>Wireless modules that can be connected</b>	10 (In Access Point mode max. 2 SSIDs)

### Functions

<b>Operating modes</b>	Access Point / Client Adapter / Repeater
<b>Configuration</b>	Web-based management, automated CLI
<b>Quality of service (QoS)</b>	Yes
<b>Security</b>	802.11i
	WPA PSK (preshared key)
	WPA2
	AES
	TKIP
	MAC filter
	Supports 802.1X/RADIUS

## Wireless card

<b>Number</b>	1
<b>Type</b>	IEEE 802.11 a/b/g/n 2.4 GHz and 5 GHz to 300 Mbps
<b>Assembly instructions</b>	Permanently installed

## Antenna

<b>Assembly instructions</b>	Internal antenna
<b>Number</b>	2
<b>Connection method</b>	permanently installed
<b>Note on the connection method</b>	MIMO
<b>Gain</b>	5 dBi

## Ethernet interface

<b>Interface</b>	Ethernet (RJ45)
<b>Number of interfaces</b>	1
<b>Connection method</b>	RJ45
<b>Note on the connection method</b>	Auto negotiation and autocrossing
<b>Transmission speed</b>	10/100 Mbps
<b>Transmission physics</b>	Copper
<b>Transmission length</b>	100 m (per segment)

## Power supply for module electronics

<b>Connection technology</b>	COMBICON
<b>Connection method</b>	Push-in spring connection
<b>Designation</b>	1966101 FMC 1,5/ 3-STF-3,5
<b>Number of positions</b>	3
<b>Cross section range AWG</b>	24 ... 16 (Use copper wires rated 75° C (UL))
<b>Note on the connection method</b>	Recommended conductor cross section: 0.75 mm <sup>2</sup>
	Recommended ferrule: connection length 10 mm
	Recommended crimping pliers: trapezoidal or square

<b>Supply voltage</b>	24 V DC (SELV)
<b>Supply voltage range</b>	18 V DC ... 32 V DC (PELV/SELV)
	9 V DC ... 32 V DC (PELV/SELV (as of HW version 05))
<b>Supply current</b>	typ. 120 mA (at 24 V DC)
<b>Current consumption</b>	max. 250 mA (at 18 V DC)
	max. 400 mA (at 9 V DC)

### Connection data

<b>Designation</b>	1966101 FMC 1,5/ 3-STF-3,5
<b>Connection method</b>	Push-in spring connection
<b>Conductor cross section solid min.</b>	0.2 mm <sup>2</sup>
<b>Conductor cross section solid max.</b>	1.5 mm <sup>2</sup>
<b>Conductor cross section flexible min.</b>	0.2 mm <sup>2</sup>
<b>Conductor cross section flexible max.</b>	1.5 mm <sup>2</sup>
<b>Conductor cross section AWG min.</b>	24
<b>Conductor cross section AWG max.</b>	16
<b>Stripping length</b>	10 mm

### General

<b>Housing material</b>	Polycarbonate, PC
<b>Material base plate</b>	Die-cast zinc, nickel-plated
<b>Mounting type</b>	Single-hole mounting
<b>Color</b>	black
<b>Net weight</b>	370.2 g
<b>Degree of pollution</b>	2
<b>Wireless licenses</b>	EU, more countries in e-shop
<b>Wireless licenses</b>	Belgium
	Bulgaria
	Denmark

	Germany
	Estonia
	Finland
	France
	Greece
	Great Britain
	Ireland
	Italy
	Latvia
	Liechtenstein
	Lithuania
	Luxembourg
	Malta
	Netherlands
	Norway
	Austria
	Poland
	Portugal
	Romania
	Sweden
	Switzerland
	Slovakia
	Slovenia
	Spain
	Czech Republic
	Hungary
	Cyprus (rep.)

	China
	Japan
	South Korea
	Thailand
	Brazil
<b>Note</b>	Degree of protection when installed

### Standards and Regulations

<b>Mechanical tests</b>	Shock in acc. with EN 60068-2-27/IEC 60068-2-27 30g, 11 ms half-sine shock pulse
	Vibration resistance in acc. with EN 60068-2-6/IEC 60068-2-6 5g, 10 ... 150 Hz
	Continuous shock according to EN 60068-2-27/IEC 60068-2-27 10g, 16 ms, 6000 shocks
	Broadband noise according to EN 60068-2-64 Category 1, Class A
<b>Standards/regulations</b>	EN 61000-4-2
<b>Contact discharge</b>	± 4 kV
<b>Indirect discharge</b>	± 6 kV
<b>Standards/regulations</b>	EN 61000-4-3
<b>Frequency range</b>	80 MHz ... 1000 MHz
<b>Test field strength</b>	10 V/m
<b>Frequency range</b>	1000 MHz ... 6000 MHz
<b>Test field strength</b>	3 V/m
<b>Standards/regulations</b>	EN 61000-4-4
<b>Comments</b>	±2.2 kV
<b>Standards/regulations</b>	EN 61000-4-5
<b>Signal</b>	± 0.5 kV (symmetrical)
	± 1 kV (asymmetrical)
<b>Standards/regulations</b>	EN 55022
<b>Test result</b>	Class B
<b>Standards/regulations</b>	EN 61000-4-6

<b>Frequency range</b>	0.15 MHz ... 80 MHz
<b>Voltage</b>	10 V
<b>Overvoltage category</b>	none

### Environmental Product Compliance

<b>REACH SVHC</b>	Lead 7439-92-1
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### 5.2.3 Industrial touch panel display specifications

An external industrial display SP-9500 is available with a panel mount design and 7" touch display for user interface and measurement reading purposes with IP20 protection category. The display is powered with 24VDC. The display with a RJ-45 port is used for the sensor Ethernet cable connection.

The touch panel unit can display four sensors by selecting respective sensor URL line 'active' in settings of the display user interface.



*Figure 33 Panel mount external 7" touch display with connectivity of 4 sensors. Touch panel with 17.8 cm/7" TFT-display (Projective-capacitive (PCAP)), 1280 x 800 pixel(s) (WXGA), 16.7 million colors, Arm® Cortex®-A53, 4x 1.2 GHz, 2x USB host 2.0, 1 x Ethernet (10/100 Mbps), RJ45, Yocto/Linux and user software: Chromium Browser. (bus system: without).*

### Dimensions

<b>Outer dimensions: width, height, depth</b>	186 mm x 147 mm x 6 mm (Dimensions of the front plate)
<b>Installation dimensions: width, height, depth</b>	175 mm x 136 mm x 45 mm (Installation cutout)

## Display

<b>Display type</b>	17.8 cm/7" TFT
<b>Screen resolution</b>	1280 x 800 Pixel(s) (WXGA)
<b>Touch technology</b>	Projective-capacitive (PCAP)
<b>Brightness</b>	500 cd/m <sup>2</sup> typical (adjustable)
<b>Backlighting</b>	LED
<b>Display backlight MTBF</b>	50000 h
<b>Colors</b>	16.7 million colors
<b>Reading angle left</b>	85 °
<b>Reading angle right</b>	85 °
<b>Reading angle top</b>	85 °
<b>Reading angle bottom</b>	85 °

## Computer data

<b>Processor</b>	Arm® Cortex®-A53, 4x 1.2 GHz
<b>Operating system</b>	Yocto/Linux
<b>User software</b>	Chromium Browser
<b>RAM</b>	1 GB LPDDR3
<b>Mass storage</b>	Flash eMMC, 8 GB
<b>Network</b>	1 x Ethernet (10/100 Mbps), RJ45
<b>Interfaces</b>	2x USB Host 2.0
<b>Bus system</b>	without
<b>Optional interfaces</b>	Without optional interface
<b>Slots</b>	1x microSD
<b>Realtime clock</b>	Integrated (battery backup)

## General

<b>Material front plate</b>	Aluminum (natural anodized)
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<b>Housing material</b>	Steel sheet, zinc-plated
<b>Mounting type</b>	Front installation
<b>Weight (GRP)</b>	760 g

### Ambient conditions

<b>Degree of protection</b>	IP65 (front), IP20 (back)
<b>Ambient temperature (operation)</b>	0 °C ... 50 °C
<b>Ambient temperature (storage/transport)</b>	-25 °C ... 70 °C
<b>Permissible humidity (operation)</b>	20 % ... 85 % (non-condensing)
<b>Permissible humidity (storage/transport)</b>	20 % ... 85 % (non-condensing)
<b>Vibration (operation)</b>	DIN EN 60068-2-6
<b>Shock</b>	DIN EN 60068-2-27

### Device supply

<b>Supply voltage</b>	24 V DC
<b>Supply voltage range</b>	18 V ... 30 V
<b>Typical current consumption</b>	0.4 A
<b>Power supply unit</b>	24 V DC ±20 %

### Standards and Regulations

<b>Shock</b>	DIN EN 60068-2-27
<b>Vibration (operation)</b>	DIN EN 60068-2-6

### Environmental Product Compliance

<b>REACH SVHC</b>	Lead 7439-92-1
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### 5.2.4 Industrial Panel PC display with IP65 protection

When an enclosure for the display is required, an external industrial 15" display SP-9520 is available with a panel PC of IP65 protection category. The panel PC holds an RJ-45 port for Ethernet cable connection from the Industrial Ethernet Switch SP-9320. When display is powered up, opt for the configuration page during display start-up. On the display URL page set the sensor default IP address 192.168.0.100.



Figure 34 The Designline PPC15M 2000 is a VESA-mounted IP65 industrial PC with a 15-in LED touch screen. Equipped with an Intel® Celeron® 2980U.

#### Note

<b>Utilization restriction</b>	EMC: class A product, see manufacturer's declaration in the download area
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#### Display

<b>Display type</b>	38.1 cm/15" TFT
<b>Screen resolution</b>	1024 x 768 Pixel(s) (XGA)
<b>Touch technology</b>	Projective-capacitive, two-touch control
<b>Brightness</b>	400 cd/m <sup>2</sup> , typical (adjustable)
<b>Backlighting</b>	LED
<b>Display backlight MTBF</b>	> 50000 h
<b>Colors</b>	16.2 million colors

#### Computer data

<b>Processor</b>	Intel® Celeron® 2980U 1.60 GHz
<b>Cooling</b>	passive
<b>Operating system</b>	without operating system

	Windows® 10 IoT Enterprise LTSC 2019 (64-bit), Multi-language
<b>RAM</b>	4 GB DDR3 SODIMM
	8 GB DDR3 SODIMM
	12 GB DDR3 SODIMM
<b>Mass storage</b>	without mass storage
<b>Network</b>	2x Ethernet (10/100/1000 Mbps), RJ45
<b>Interfaces</b>	1x COM (RS-232/422/485)
	4x USB 2.0
	1x USB 3.0
	1x Audio
<b>Monitor output</b>	without
<b>Slots</b>	without slots
<b>Optical drive</b>	without drive
<b>Realtime clock</b>	Yes (battery-backed)
<b>Service life of battery</b>	5 years (typical)

### General

<b>Mounting type</b>	VESA MIS-D, 100
<b>Weight</b>	4.4 kg

### Ambient conditions

<b>Degree of protection</b>	IP65
<b>Ambient temperature (operation)</b>	0 °C ... 45 °C (with HDD)
<b>Vibration (operation)</b>	1g with SSD, 0.5g with HDD, according to EN 60068-2-6
<b>Shock</b>	15g, 11 ms in accordance with IEC 60068-2-27

### Device supply

<b>Power supply unit</b>	24 V DC ±20 %
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## Standards and Regulations

<b>Shock</b>	15g, 11 ms in accordance with IEC 60068-2-27
<b>Vibration (operation)</b>	1g with SSD, 0.5g with HDD, according to EN 60068-2-6

## Environmental Product Compliance

<b>REACH SVHC</b>	Lead 7439-92-1
<b>China RoHS</b>	Environmentally Friendly Use Period = 10;
	For details about hazardous substances go to tab "Downloads", Category "Manufacturer's declaration"

## eCl@ss

<b>eCl@ss 10.0.1</b>	19200103
<b>eCl@ss 11.0</b>	19200103
<b>eCl@ss 8.0</b>	27242301
<b>eCl@ss 9.0</b>	19200103

## ETIM

<b>ETIM 5.0</b>	EC001414
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	0 mA ... 24 mA (can be set via software)
<b>max. input voltage</b>	12 V
<b>Max. input current</b>	24 mA
<b>Input resistance of voltage input</b>	> 120 k $\Omega$
<b>Input resistance current input</b>	approx. 50 $\Omega$ (+ 0.7 V for test diode)

### Switching output

<b>Output name</b>	Relay output
<b>Contact type</b>	1 PDT
<b>Contact material</b>	AgSnO <sub>2</sub> , hard gold-plated
<b>Maximum switching voltage</b>	250 V AC
	30 V DC
	240 V AC (UL)
<b>Limiting continuous current</b>	6 A AC
	4 A DC
<b>Min. switching current</b>	100 mA (12 V DC)
<b>Mechanical service life</b>	2x 10 <sup>7</sup> cycles
<b>Setting range of the response delay</b>	0 s ... 10 s (can be set freely via software)
<b>Internal hysteresis</b>	can be set freely via software
<b>Max. switching current</b>	6 A AC (250 V AC)
	4 A DC (30 V DC)

### Power supply

<b>Nominal voltage</b>	<b>supply</b>	24 V DC
<b>Supply range</b>	<b>voltage</b>	9.6 V DC ... 30 V DC (The DIN rail bus connector (ME 6,2 TBUS-2 1,5/5-ST-3,81 GN, Order No. 2869728) can be used to bridge the supply voltage. It can be snapped onto a 35 mm DIN rail according to EN 60715))
<b>Typical consumption</b>	<b>current</b>	40 mA (12 V DC)
		20 mA (24 V DC)

<b>Power consumption</b>	≤ 0.5 W
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### Connection data

<b>Connection method</b>	Push-in connection
<b>Stripping length</b>	10 mm
<b>Conductor cross section solid</b>	0.2 mm <sup>2</sup> ... 2.5 mm <sup>2</sup> (with ferrule)
	0.14 mm <sup>2</sup> ... 2.5 mm <sup>2</sup> (without ferrule)
<b>Conductor cross section flexible</b>	0.14 mm <sup>2</sup> ... 2.5 mm <sup>2</sup>
<b>Conductor cross section AWG</b>	24 ... 12 (flexible)

### General

<b>No. of channels</b>	1
<b>Maximum transmission error</b>	0.1 % (of final value)
<b>Maximum temperature coefficient</b>	0.01 %/K
<b>Switching point accuracy</b>	< 0.1 %
<b>Status display</b>	Yellow LED (switching output)
<b>Electrical isolation</b>	Reinforced insulation in accordance with IEC 61010-1
<b>Overvoltage category</b>	II
<b>Degree of pollution</b>	2
<b>Rated insulation voltage</b>	300 V (effective)
<b>Test voltage, input/output/supply</b>	3 kV (50 Hz, 1 min.)
<b>Electromagnetic compatibility</b>	Conformance with EMC directive
<b>Noise emission</b>	EN 61000-6-4
<b>Noise immunity</b>	EN 61000-6-2 When being exposed to interference, there may be minimal deviations.
<b>Color</b>	gray
<b>Housing material</b>	PBT
<b>Mounting position</b>	any
<b>Assembly instructions</b>	The T connector can be used to bridge the supply voltage. It can be snapped onto a 35 mm DIN rail according to EN 60715.

<b>Fire protection for rail vehicles (DIN EN 45545-2) R22</b>	HL 1 - HL 2
<b>Fire protection for rail vehicles (DIN EN 45545-2) R23</b>	HL 1 - HL 2
<b>Fire protection for rail vehicles (DIN EN 45545-2) R24</b>	HL 1 - HL 2

### Standards and Regulations

<b>Electromagnetic compatibility</b>	Conformance with EMC directive
<b>Noise emission</b>	EN 61000-6-4
<b>Designation</b>	GB Standard
<b>Standards/regulations</b>	GB 3836.1
	GB 3836.8
<b>Electrical isolation</b>	Reinforced insulation in accordance with IEC 61010-1

### Conformance/approvals

<b>Designation</b>	CE
<b>Identification</b>	CE-compliant
<b>Designation</b>	ATEX
<b>Identification</b>	≡ II 3G Ex ec ic nC IIC T4 Gc
<b>Certificate</b>	BVS 18 ATEX E 071 X
<b>Designation</b>	IECEX
<b>Identification</b>	Ex ec ic nC IIC T4 Gc
<b>Certificate</b>	IECEX BVS 18.0060X
<b>Designation</b>	CCC / China-Ex
<b>Identification</b>	Ex nA ic IIC T4 Gc
<b>Certificate</b>	NEPSI GYJ20.1319X
<b>Designation</b>	UL, USA/Canada
<b>Identification</b>	UL 508 Listed
	Class I, Div. 2, Groups A, B, C, D T4A

	Class I, Zone 2, Group IIC T4A
<b>Designation</b>	Shipbuilding approval
<b>Certificate</b>	DNV GL TAA000021E
<b>Temperature</b>	B
<b>Humidity</b>	B
<b>Vibration</b>	A
<b>EMC</b>	A
<b>Enclosure</b>	Required protection according to the Rules shall be provided upon installation on board

### Environmental Product Compliance

<b>REACH SVHC</b>	Lead 7439-92-1
<b>China RoHS</b>	Environmentally Friendly Use Period = 50 years
	For details about hazardous substances go to tab "Downloads", Category "Manufacturer's declaration"

## 5.4 Sensor network cable specification

### Dimensions

Length of cable	10 m
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### Ambient conditions

Degree of protection	IP65
	IP67
Ambient temperature (operation)	-25 °C ... 90 °C (M12 connector)

### General data

Note	Further products with variable cable type and variable cable length can be found in the accessories section
Rated current at 40°C	0.5 A
Rated voltage	48 V AC
	60 V DC
Number of positions	8
Signal type/category	Ethernet CAT6 <sub>A</sub> , 10 Gbps
	CC-Link IE CAT6 <sub>A</sub> , 10 Gbps
Standards/regulations	M12 connector IEC 61076-2-109
Contact material	CuSn
Contact carrier material	PA
Contact surface material	Ni/Au
Degree of protection	IP65/IP67
Transmission characteristics (category)	CAT6 <sub>A</sub>

### Characteristics head 1

Head type	Plug straight M12 / IP67
No. of positions (pin connector pattern)	8
Coding	X (Data)
Color	black

<b>Material (component)</b>	CuZn (Contact)
	Ni/Au (Contact surface)
	PA (Contact carriers)
	TPU, hardly inflammable, self-extinguishing (Grip)
	Zinc die-cast, nickel-plated (Screw connection)
<b>Insulation resistance</b>	≥ 100 MΩ
<b>Insertion/withdrawal cycles</b>	≥ 100
<b>Torque</b>	0.4 Nm
<b>Ambient temperature (operation)</b>	-25 °C ... 90 °C
<b>Shielded</b>	yes
<b>Outer sheath, material</b>	PUR
<b>External sheath, color</b>	water blue RAL 5021
<b>Type, plug side</b>	Plug straight
<b>Type, socket side</b>	free cable end

### Characteristics head 2

<b>Head type</b>	free cable end
<b>Coding</b>	X (Data)
<b>Color</b>	black
<b>Torque</b>	0.4 Nm
<b>Ambient temperature (operation)</b>	-25 °C ... 90 °C

### Standards and Regulations

<b>Standards/specifications</b>	M12 connector IEC 61076-2-109
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### Cable

<b>Cable type</b>	Ethernet 10 Gbit
<b>Cable type (abbreviation)</b>	94F
<b>UL AWM style</b>	20963 (80°C/30 V)
<b>Signal type/category</b>	Ethernet CAT6A, 10 Gbps

<b>Cable structure</b>	4x2xAWG26/7; S/FTP
<b>Conductor cross section</b>	4x 2x 0.14 mm <sup>2</sup>
<b>AWG signal line</b>	26
<b>Conductor structure signal line</b>	7x 0.16 mm
<b>Core diameter including insulation</b>	1.04 mm
<b>Wire colors</b>	white/blue-blue, white/orange-orange, white/green-green, white/brown-brown
<b>Twisted pairs</b>	2 cores to the pair
<b>Type of pair shielding</b>	Aluminum-lined foil
<b>Overall twist</b>	4 pairs for core
<b>Shielding</b>	Tinned copper braided shield
<b>Optical shield covering</b>	70 %
<b>External sheath, color</b>	water blue RAL 5021
<b>Outer sheath thickness</b>	0.65 mm
<b>External cable diameter D</b>	6.4 mm ±0.2 mm
<b>Minimum bending radius, fixed installation</b>	4 x D
<b>Minimum bending radius, flexible installation</b>	8 x D
<b>Tensile strength GRP</b>	≤ 100 N
<b>Cable weight</b>	42 kg/km
<b>Outer sheath, material</b>	PUR
<b>Material conductor insulation</b>	Foamed PE
<b>Conductor material</b>	Bare Cu litz wires
<b>Insulation resistance</b>	≥ 500 MΩ*km
<b>Loop resistance</b>	≤ 290.00 Ω/km
<b>Cable capacity</b>	47 nF/km
<b>Wave impedance</b>	100 Ω ±5 Ω (at 100 MHz)
<b>Near end crosstalk attenuation (NEXT)</b>	75.3 dB (with 1 MHz)

	66.3 dB (at 4 MHz)
	61.8 dB (at 8 MHz)
	60.3 dB (at 10 MHz)
	57.2 dB (at 16 MHz)
	55.8 dB (at 20 MHz)
	54.3 dB (at 25 MHz)
	52.8 dB (at 31.25 MHz)
	48.4 dB (at 62.5 MHz)
	45.3 dB (at 100 MHz)
	40.8 dB (at 200 MHz)
	39.3 dB (at 250 MHz)
	38.1 dB (at 300 MHz)
	36.3 dB (at 400 MHz)
	34.8 dB (at 500 MHz)
<b>Power-summed near end crosstalk attenuation (PSNEXT)</b>	72.3 dB (with 1 MHz)
	63.3 dB (at 4 MHz)
	58.8 dB (at 8 MHz)
	57.3 dB (at 10 MHz)
	54.2 dB (at 16 MHz)
	52.8 dB (at 20 MHz)
	51.3 dB (at 25 MHz)
	49.9 dB (at 31.25 MHz)
	45.4 dB (at 62.5 MHz)
	42.3 dB (at 100 MHz)
	37.8 dB (at 200 MHz)
	36.3 dB (at 250 MHz)

	35.1 dB (at 300 MHz)
	33.3 dB (at 400 MHz)
	31.8 dB (at 500 MHz)
<b>Attenuation</b>	3.1 dB (with 1 MHz)
	5.7 dB (at 4 MHz)
	8 dB (at 8 MHz)
	8.9 dB (at 10 MHz)
	11.2 dB (at 16 MHz)
	12.6 dB (at 20 MHz)
	14.1 dB (at 25 MHz)
	15.8 dB (at 31.25 MHz)
	22.5 dB (at 62.5 MHz)
	28.7 dB (at 100 MHz)
	41.4 dB (at 200 MHz)
	46.6 dB (at 250 MHz)
	51.4 dB (at 300 MHz)
	60.1 dB (at 400 MHz)
	67.9 dB (at 500 MHz)
<b>Return loss (RL)</b>	20 dB (with 1 MHz)
	23 dB (at 4 MHz)
	24.5 dB (at 8 MHz)
	25 dB (at 10 MHz)
	25 dB (at 16 MHz)
	25 dB (at 20 MHz)
	24.2 dB (at 25 MHz)
	23.3 dB (at 31.25 MHz)
	20.7 dB (at 62.5 MHz)

	19 dB (at 100 MHz)
	16.4 dB (at 200 MHz)
	15.6 dB (at 250 MHz)
	15.6 dB (at 300 MHz)
	15.6 dB (at 400 MHz)
	15.6 dB (at 500 MHz)
<b>Signal runtime</b>	5.13 ns/m
<b>Shield attenuation</b>	≥ 80 dB (at 30 ... 100 MHz)
<b>Nominal voltage, cable</b>	≤ 100 V
<b>Test voltage Core/Core</b>	700 V (50 Hz, 1 min.)
<b>Test voltage Core/Shield</b>	700 V (50 Hz, 1 min.)
<b>Flame resistance</b>	according to IEC 60332-1-2
<b>Halogen-free</b>	according to IEC 60754-1
<b>Resistance to oil</b>	in accordance with DIN EN 60811-2-1
<b>Ambient temperature (operation)</b>	-40 °C ... 80 °C (cable, fixed installation)
	-20 °C ... 80 °C (cable, flexible installation)
<b>Ambient temperature (installation)</b>	-20 °C ... 80 °C
<b>Ambient temperature (storage/transport)</b>	-20 °C ... 80 °C

### Environmental Product Compliance

<b>REACH SVHC</b>	Lead 7439-92-1
<b>China RoHS</b>	Environmentally Friendly Use Period = 50 years
	For details about hazardous substances go to tab "Downloads", Category "Manufacturer's declaration"





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