WIO 200B
Water in oil sensor

User manual Rev. 1.26

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PAJ EMS ApS (branded under ”PAJ Group”) • Ellegårdvej 25P • DK-6400 Sønderborg
CVR: 34591199 • www.paj-group.com • e-mail: paj@paj-group.com

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Introduction

This user manual provides technical data regarding the WIO (water in lubrication oil, gear box oil, diesel oil, hydraulic oil or transformer oil) sensor system. The system consists of a WIO Sensor, terminal box and cables. The WIO Sensor is an insitu sensor which measures water content in lubrication oils on ship engine or similar. The Terminal box connects the sensor to power supply and to the ships surveillance system. The supplied cables are for connection between the WIO Sensor and the Terminal box



Compliance Information

The WIO system complies with:

- EMC Directive 2014/30/EU
- Low Voltage Directive 2014/35/EU
- RoHS Directive 2011/65/EU

A copy of the EU Declaration of Conformity is available upon request.

Safety Advice

For your safety

The WIO200B is designed as a water-in-oil monitoring and advisory system with alarm relay outputs.

Before use please read the user manual and carefully store it in a safe place. Install and operate the device only after reading and comprehending the instruction manual, and after you are familiar with the valid rules on work safety and accident prevention.

Please use the device only as specified. For this purpose please also note the values in section "Technical data".

During transport, storage and operation please adhere to the conditions listed in "Technical data".

IMPORTANT

Only qualified personnel may assemble start-up and maintain the unit when it is in a zero voltage state. Only qualified electricians may work on electrical installations.

The connection and instruction manual contains information that enables the proper and efficient use of the WIO monitoring system. PAJ EMS ApS is not liable for damage caused by improper use of this device. This manual is an integral part of the basic knowledge necessary for proper use of the system.

Rights

PAJ EMS ApS reserves the right to alter its products without prior notice.

Copying and using the instruction manual for other purposes is only allowed with the acceptance from PAJ EMS ApS.

PAJ EMS ApS accepts no responsibility for possible errors and deficiencies in brochures, catalogues and other printed material.

Proper operation of the WIO monitoring system requires installation, connection and use in accordance with this manual and the specified operating conditions.

Safety observations

The comments about safety in this document will not discuss safety observations of individual machine parts where safety devices are applied. Here the respective instruction manuals will be referenced! This document merely describes how to establish a WIO and how to start it up.

WARNING

The monitoring system during machine operation cannot be guaranteed if the system is connected incorrectly or not used as specified. This may lead to fatal injuries. Interventions and changes to the WIO monitoring system are not permitted, unless they are explicitly described in this user manual or be written from PAJ EMS ApS.

The regional legal regulations and conditions of the liability insurance of the employer must be maintained.

Area of application

The WIO monitoring system is usually used in engines where a WIO will monitor the water content in lubrication oil, gear box oil, diesel oil, hydraulic oil or transformer oil.

The advantage of this monitoring system is the simple 4-20 mA interface and the two relays indicating alarms, with digital readout.

Normally the WIO sensor is calibrated against Taro30 lubrication oil, if nothing else is defined from customer.

Function

Short description of the function

PAJ EMS ApS has developed a water in oil (WIO) monitoring system. The fundamental idea of the WIO system is to easily and continuously monitor the water activity (a_w) in oil. The output is converted into a standard 4-20 mA output.

The system also includes two relays indicating when too much water is present in the oil. Default alarm values are set to 0,5 a_w (high alarm) and 0,9 a_w (high high alarm)

By using the WIO-Software it is possible to change HHA and HA levels. Furthermore, you can continuously read out and graph the a_w (or PPM) of water in the oil.

WARNING

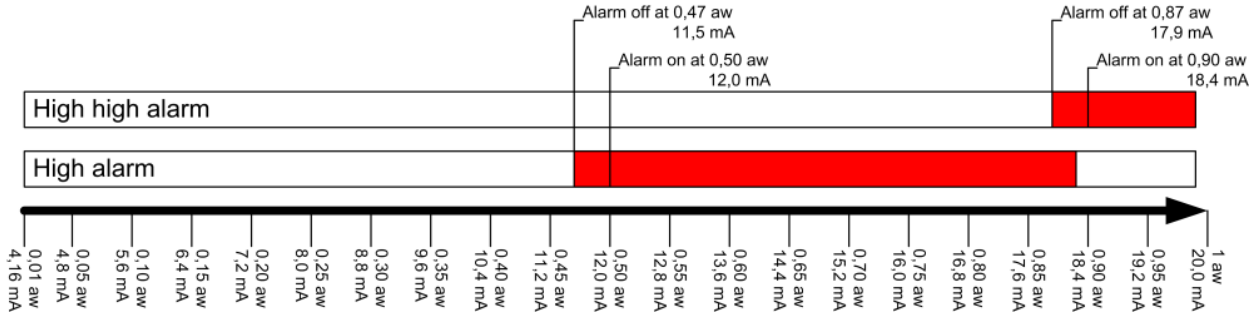
Do not use the sensor or relays to automatically enable/turn on or disable/shut down engine. The decision to enable/turn on or disable/shut down an engine, based on the sensor data, must be taken by proper trained crew personnel, not by the sensor system.

Normal operation

Water activity (a_w) provides the relative availability of water in oil where pure oil has an activity of zero and oil saturated with distilled water has an activity of exactly one. Under normal operation the WIO200B continuously supplies an output analogue signal of 4 to 20 mA corresponding to 0.01 to 1.00 a_w. Alarm indications with 0.03 a_w hysteresis via 2 relays are provided for each sensor. These data can also be read out from the sensor on the RS485 Modbus communication line.

Default alarm values are 0,5 a_w and 0,9 a_w. Assumes these alarm values:

High alarm on at 0,50 a_w (12 mA).
High alarm off at 0,47 a_w (11,5 mA)
High high alarm on at 0,90 a_w (18,4 mA).
High high alarm off at 0,87 a_w (17,9 mA).
High high alarm will disable high alarm, thus only one alarm can be active.



Failure indication

Internal function failure will be indicated by activating both alarm relays at the same time, or indicated as defined in the NAMUR NE43.

Internal failures includes:

- Sensor reading out of range.
- Sensor reading CRC error.
- Unstable Sensor reading.

NAMUR NE43 is a German fault detection standard for 4-20mA analogue signals. It allows the user to know if there is a fault within the instrument, by sending analogue signal below 4mA and/or above 20mA. In accordance with NAMUR NE43, the failure is indicated by:

- Fault indicated by analogue output =<2,0 mA

Self test for alarm functions



On the WIO Sensor there is a button for testing the alarm functions. By pushing the Test button for 5 sec the high alarm relay turns on, and by pushing the Test button for 10 sec the high alarm relay turns off and the high high alarm turns on. When the Test button has been pushed continuously for more than 15 sec, it will be ignored by the software, and the relays return to normal operation.

Test Button	***Mode***	***Output Relay***	***Analogue Output***
Un-pressed	Normal operation and ***no alarm***	Relay 1 Open Relay 2 Open	Normal
Pressed longer than **5 sec**	Test of high alarm	Relay 1 Closed Relay 2 Open	Normal

Pressed longer than **10 sec**	Test of high high alarm	Relay 1 Open Relay 2 Closed	Normal
Pressed longer than **15 sec**	Normal operation	Normal	Normal

Test Button	**Mode**	**Output Relay**	**Analogue Output**
Un-pressed	Normal operation, with ***high alarm active***	Relay 1 Closed Relay 2 Open	Normal
Pressed longer than **5 sec**	Test of high alarm	Relay 1 Closed Relay 2 Open	Normal
Pressed longer than **10 sec**	Test of high high alarm	Relay 1 Open Relay 2 Closed	Normal
Pressed longer than 15 **sec**	Normal operation	Normal	Normal

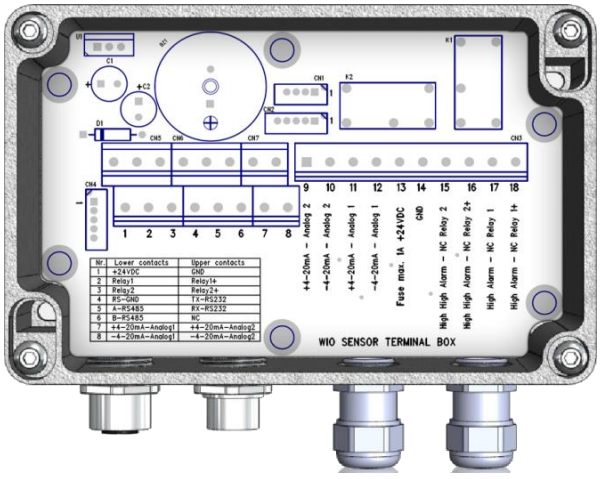
Before installation



IMPORTANT

Only qualified personnel may assemble and maintain the unit. Only qualified personnel may install the unit.

Screw in probe pressure-tight directly in the center of the oil pipe where the measurement is to take place. The threads should be sealed with PTFE tape (TopSeal). The sensor should be mounted with max. torque of 35 Nm. Connect the cables from the WIO sensor to the Terminal box. Use a hexagon wrench size 30.



To sensor Power and Alarms

IMPORTANT

Only qualified personnel may assemble start-up and maintain the terminal box(s) when it is in a zero-voltage state. Only qualified electricians may work on electrical installations.

Install +24 VDC and GND into the terminal box and connect the 4-20 mA to an external device if needed. Connect the relay to external device if needed.

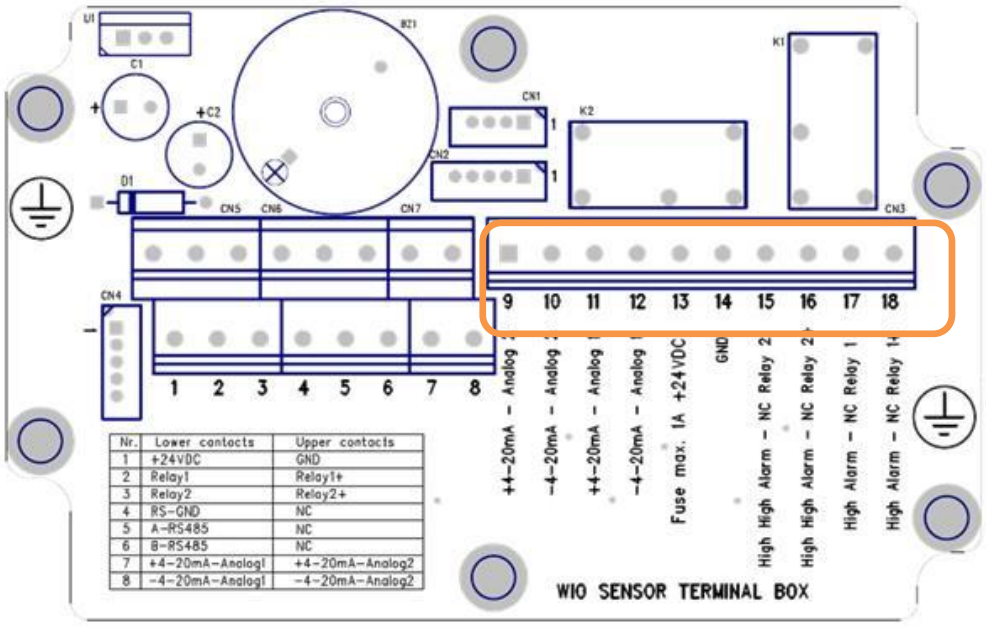
If the terminal box has a (a_w) or PPM display, there must be a short circuit between terminals 11 and 12. This short circuit produces the needed closed loop for mA measurement.

Last connect the cables from the Terminal box to the sensor.

It is allowed (but not necessary) to connect screw terminal 10 and 12 "-4-20 mA" to screw terminal 14 "GND", thus creating common ground for the output and the power.

Terminal boxes with display. Screw terminal pin 11 and 12 or screw terminal pin 9 and 10 can be connected to external equipment, but only in a closed loop for mA measurement.

Terminal Box Connection



Nr.	Lower contacts	Upper contacts
1	+24VDC	GND
2	Relay1	Relay1+
3	Relay2	Relay2+
4	RS-GND	NC
5	A-RS485	NC
6	B-RS485	NC
7	+4-20mA-Analog1	+4-20mA-Analog2
8	-4-20mA-Analog1	-4-20mA-Analog2

Contact Assignment

There is only one connector CN3 for using of the terminal box contacts.

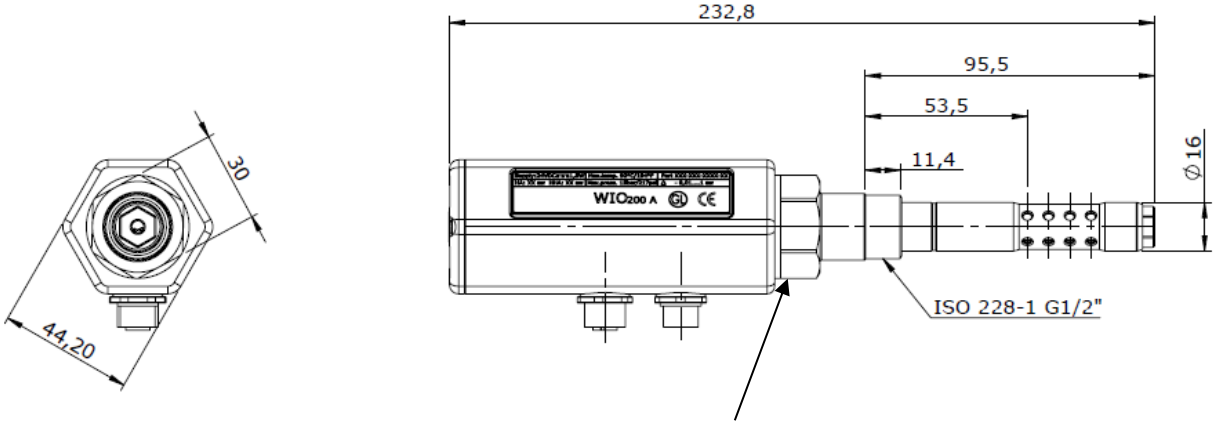
Contact-Number	Description
9	+4 – 20 mA positive analog output signal for indication of temperature in oil. This option is not available for WIO200B **Only for WIO and WIOI 300/400**
10	-4 – 20 mA return analog signal for indication of temperature in oil. This option is not available for WIO200B **Only for WIO and WIOI 300/400**
11	+4 – 20 mA positive analog output signal for indication of a_w or PPM in oil.
12	-4 – 20 mA return analog signal for indication of a_w or PPM in oil.
13	Power supply, 24VDC ±10% and with max. residual voltage ripple 10%
14	Power supply ground terminal contact
15	Relay contact for HH Alarm
16	Relay contact for HH Alarm
17	Relay contact for H Alarm
18	Relay contact for H Alarm

For connection more than one terminal box please refer to:

- Appendix A1
- Appendix A2
- Appendix A3

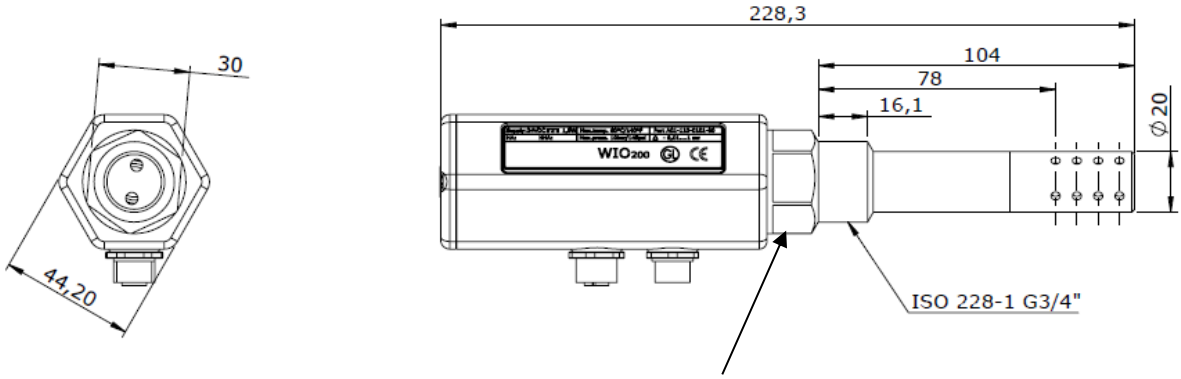
WIO Sensor dimensions in mm

WIO Standard ½" thread Sensor, Short dimensions in mm:



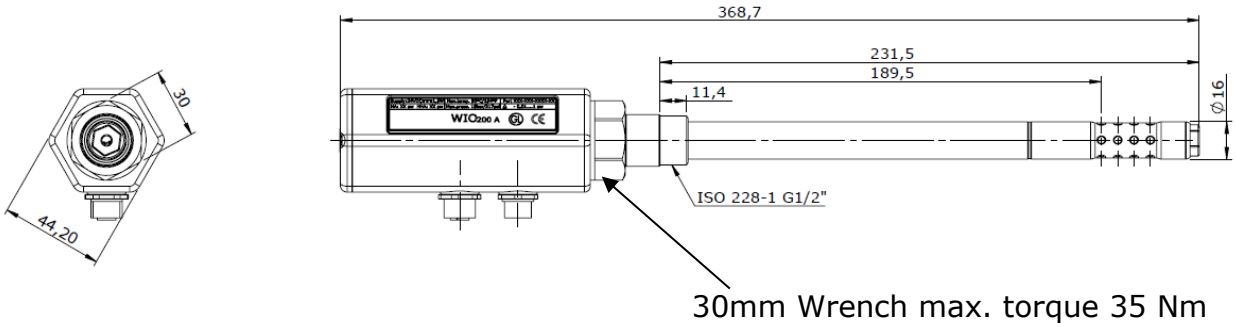
30mm Wrench max. torque 35 Nm

WIO Standard ¾" thread Sensor, Short dimensions in mm:



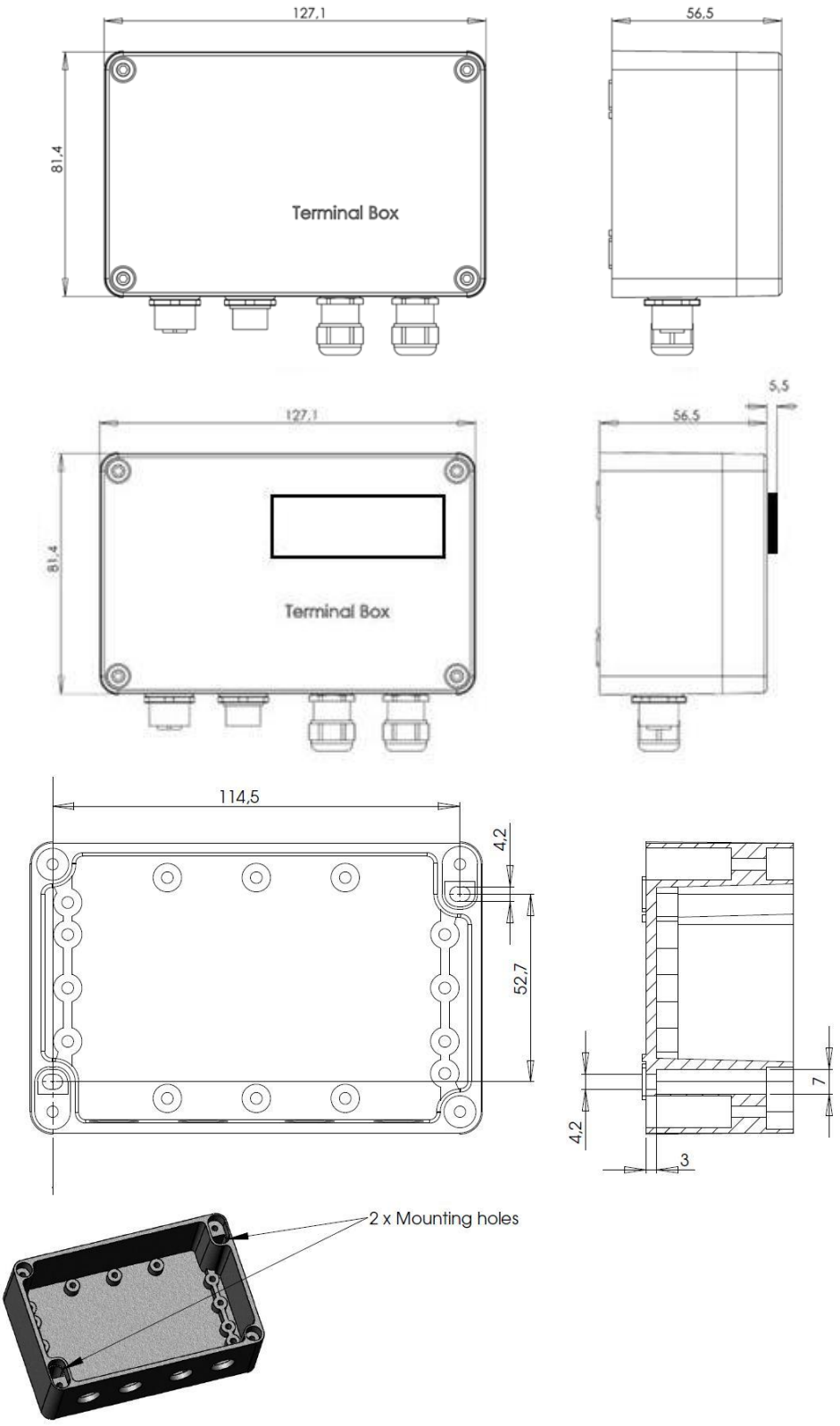
30mm Wrench max. torque 35 Nm

WIO Ball Valve pipe ½" thread Sensor, Long dimensions in mm:



30mm Wrench max. torque 35 Nm

Terminal box dimensions in mm



Technical Data Terminal Display Box



Output	
Analogue output	See the specifications for sensor's analogue output
Digital output	See the specifications for sensor's digital output
Input	
Supply nominal voltage	24V DC ± 10%
Max. residual voltage ripple	10%
Maximum Load current	200 mA
Max. Power input	< 4,8 VA
Relays	
Contact arrangement	2 x Normally Open (NO)
Rated voltage	250 VAC
Max. switching voltage	400VAC
Rated current	2A
Breaking capacity max.	1250VA
Display version - a_w (water activity from 0,01 to 1,00**)**	
Accuracy (0,05-0,95 a_w)	± 0,03 a_w
Resolution	<0,004 a_w
Display version - PPM (H_20)	
Accuracy (0,05-0,95 a_w)	±30%
Resolution	1 PPM
Enclosure	
Weight	650 grams
Connection to sensor (mechanical)	2 x 8-pole connectors, male and female, M12x1 thread
Connection (mechanical)	2 x M20 gland, cable diameter 6 to 12 mm
Enclosure material	Aluminum
Protective type	IP66
Warranty	1 year

FUNCTIONING

Terminal box shall be provided with 24vdc.
Terminal box supply 24vdc on to WIO sensor.
Terminal box measuring mA from the sensor, and convert it to a_w or PPM value.
WIO sensor delivers mA, digital value and relay status to the terminal box.

IMPORTANT

The display is an indication of the water level in the oil. Display can be shipped as PPM or a_w.

Upon ordering a PPM display the customer must specify the water saturation point in PPM of the used oil at the preferred working temperature of the oil. The saturation point is typically between 3000-10000 PPM. Alternatively the customer can ship 10 liters of oil to PAJ EMS ApS for inspection including specification of the working oil temperature.

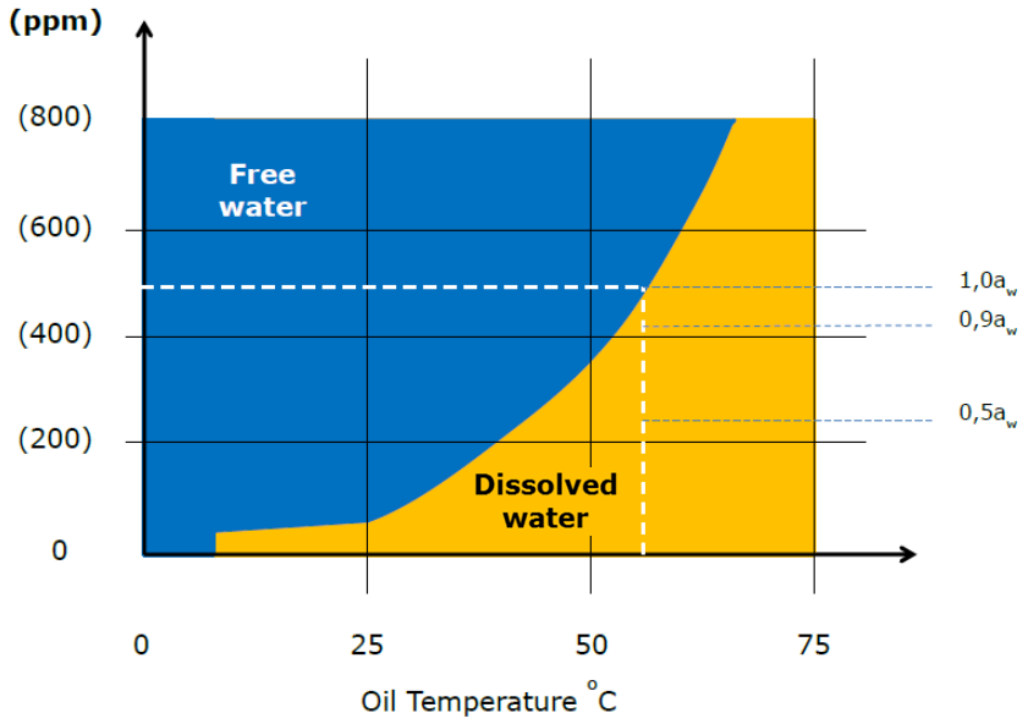
WARNING

All displays will show from positive values when operating properly. There will appear a negative value during start-up, after 5 seconds the value will be in positive measurement range. Otherwise, if a negative value is present the Terminal box might have been installed incorrectly.

NOTE

WIO200B uses 3 different units for the measurement of water in oil:

1) **a_w**: WIO measures humidity in **a_w**. The range is 0.01…1.00 a_w.
2) **%RH** (relative humidity) is identical to the unit a_w multiplied by 100. The range is 1…100 %RH
3) **ppm**: WIO can convert **a_w** to **ppm**. In this case the saturation point, at a given temperature, must be known. Output in ppm is only reliable at this temperature.


(ppm)
(800)
(600)
(400)
(200)
0
Free water
Dissolved water
1,0a$_w$
0,9a$_w$
0,5a$_w$
0
25
50
75
Oil Temperature °C

Technical Data Terminal Box Alarm Buzzer



Output	
Analogue output	See the specifications for sensor's analogue output
Digital output	See the specifications for sensor's digital output
Input	
Supply nominal voltage	24V DC ± 10%
Max. residual voltage ripple	10%
Maximum Load current	200 mA
Max. Power input	< 4,8 VA
Relays	
Contact arrangement	2 x Normally Open (NO)
Rated voltage	250 VAC
Max. switching voltage	400VAC
Rated current	2A
Breaking capacity max.	1250VA
Display version - a_w (water activity from 0,01 to 1,00**)**	
Accuracy (0,05-0,95 a_w)	± 0,03 a_w
Resolution	<0,004 a_w
Display version - PPM (H_20)	
Accuracy (0,05-0,95 a_w)	±30%
Resolution	1 PPM
Buzzer	
Oscillation frequency	3000±500 Hz
Sound pressure level	85db by open housing
Tone	pulsed

FUNCTIONING

Terminal box shall be provided with 24vdc.
Terminal box supply 24vdc on to WIO sensor.
Terminal box measuring mA from the sensor, and convert it to a_w or PPM value.
WIO sensor delivers mA, digital values and relay status to the terminal box.

H-Alarm LED is for indication of the High Alarm relay state from the WIO sensor. When the alarm condition is generated by the WIO sensor, then the High Alarm relay is open and the H-Alarm LED flash red ON/OFF sequence to show the High Alarm state, and the alarm signal buzzer will be switched ON.

HH-Alarm LED is for indication of the High High Alarm relay state from the WIO sensor. When the alarm condition is generated by the WIO sensor, then the High High Alarm relay is open and the HH-Alarm LED flash red ON/OFF sequence to show the High High Alarm state, and the alarm signal buzzer will be switched ON.

The H-Alarm LED or HH-Alarm LED will stay in blinking mode until the H-Alarm or HH-Alarm button is pressed, then the LED constantly turned on.
The alarm signal buzzer will stay on until the H-Alarm or HH-Alarm button is pressed.

Abstract representation of the H-Alarm and HH-Alarm button and LED function:

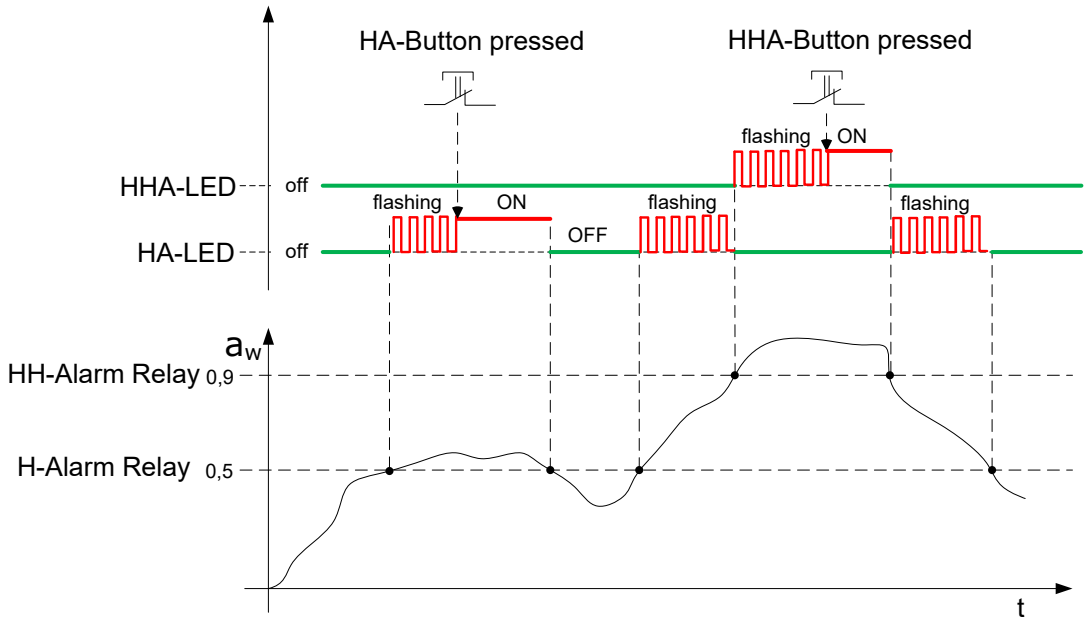
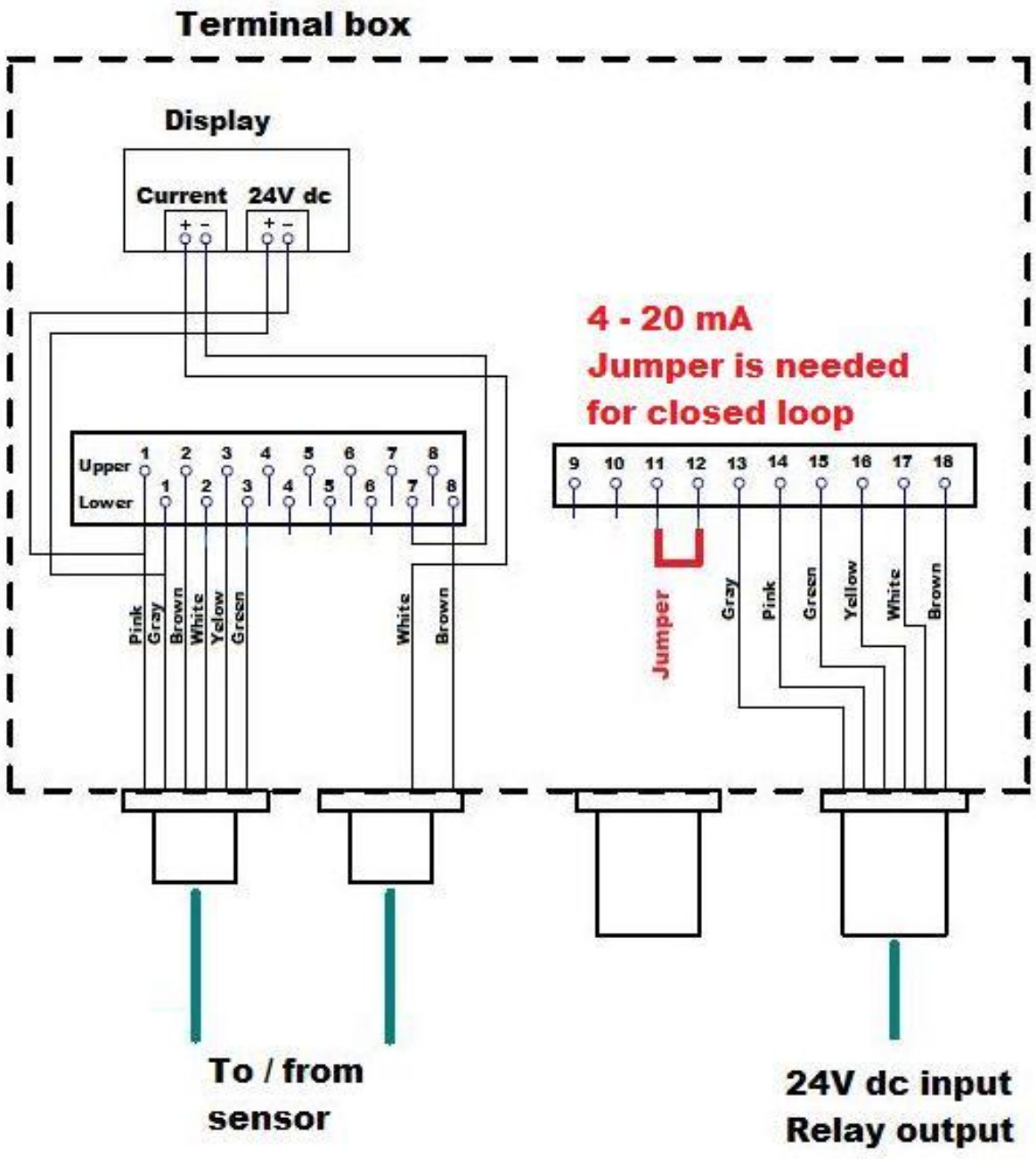
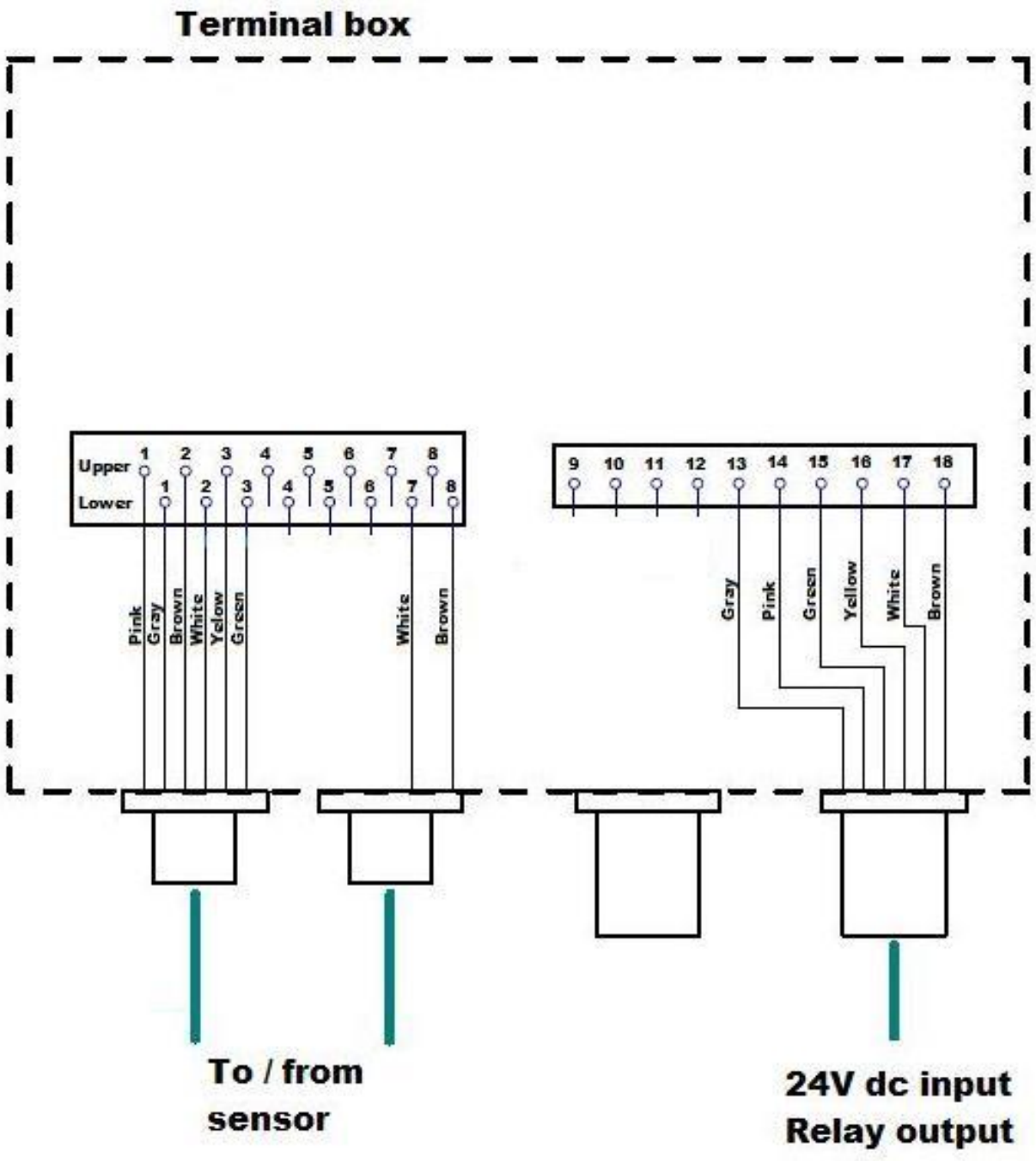


Figure 2: H-Alarm and HH-Alarm button function

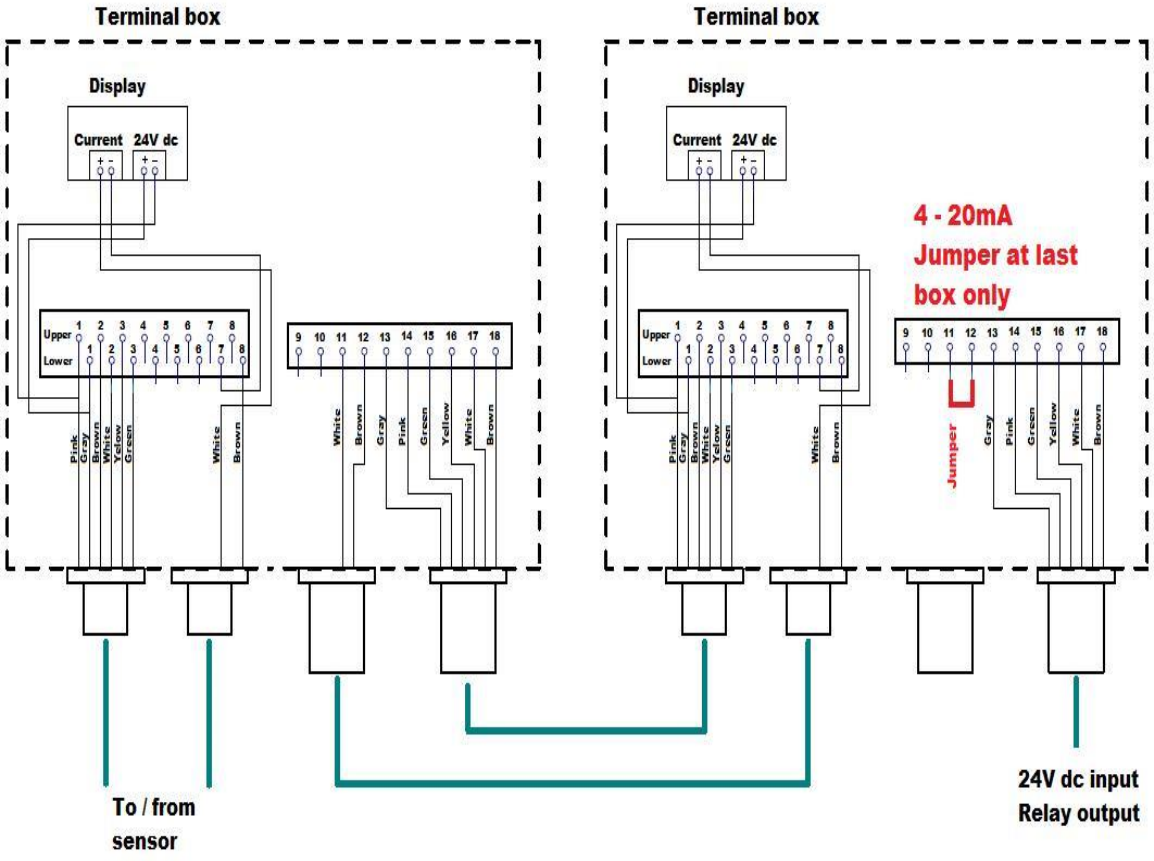
Appendix A1: Install 1 Terminal Box with 1 display



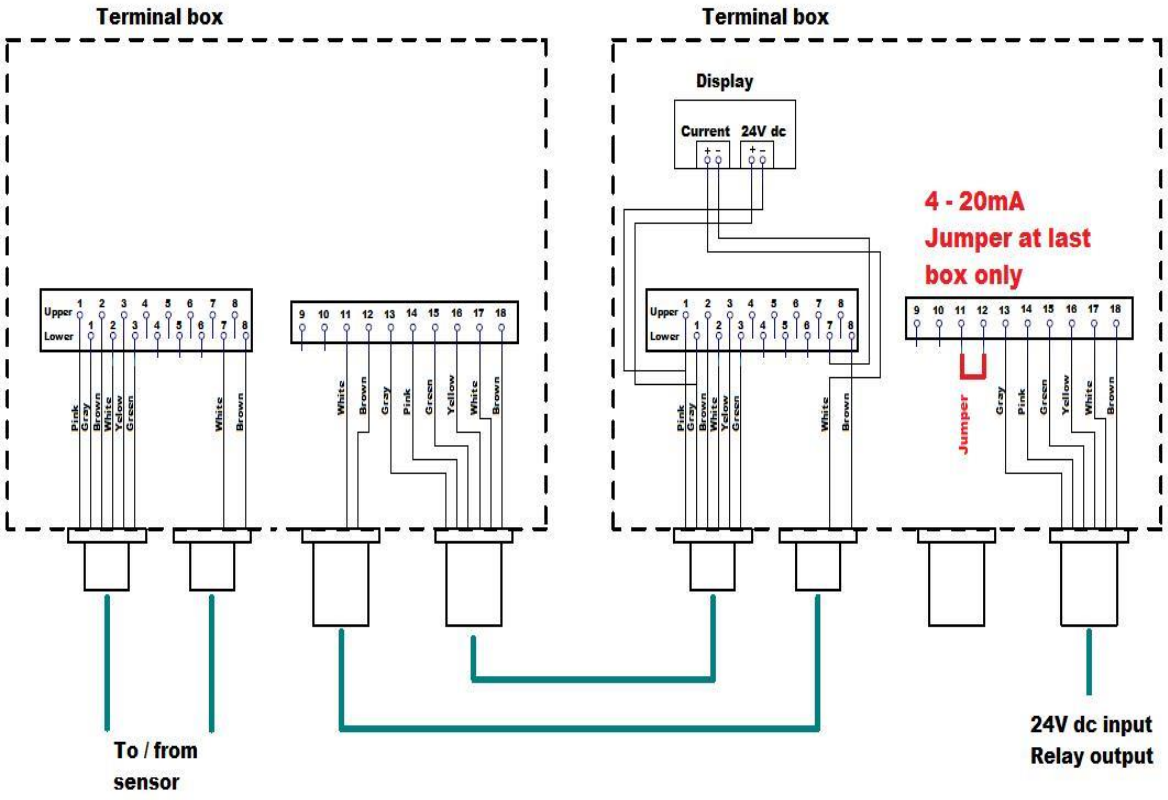
Appendix A2: Install 1 Terminal Box with no display



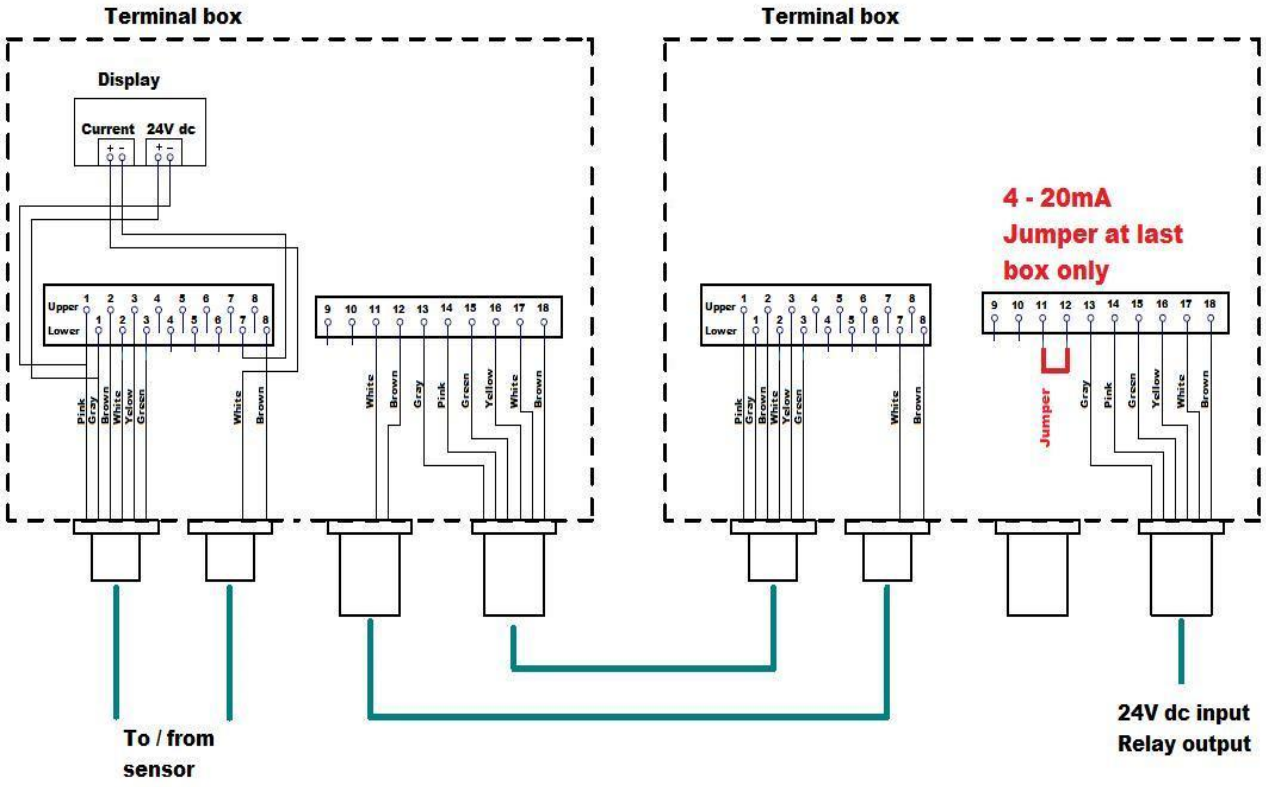
Appendix A3: Install 2 Terminal Boxes with 2 display



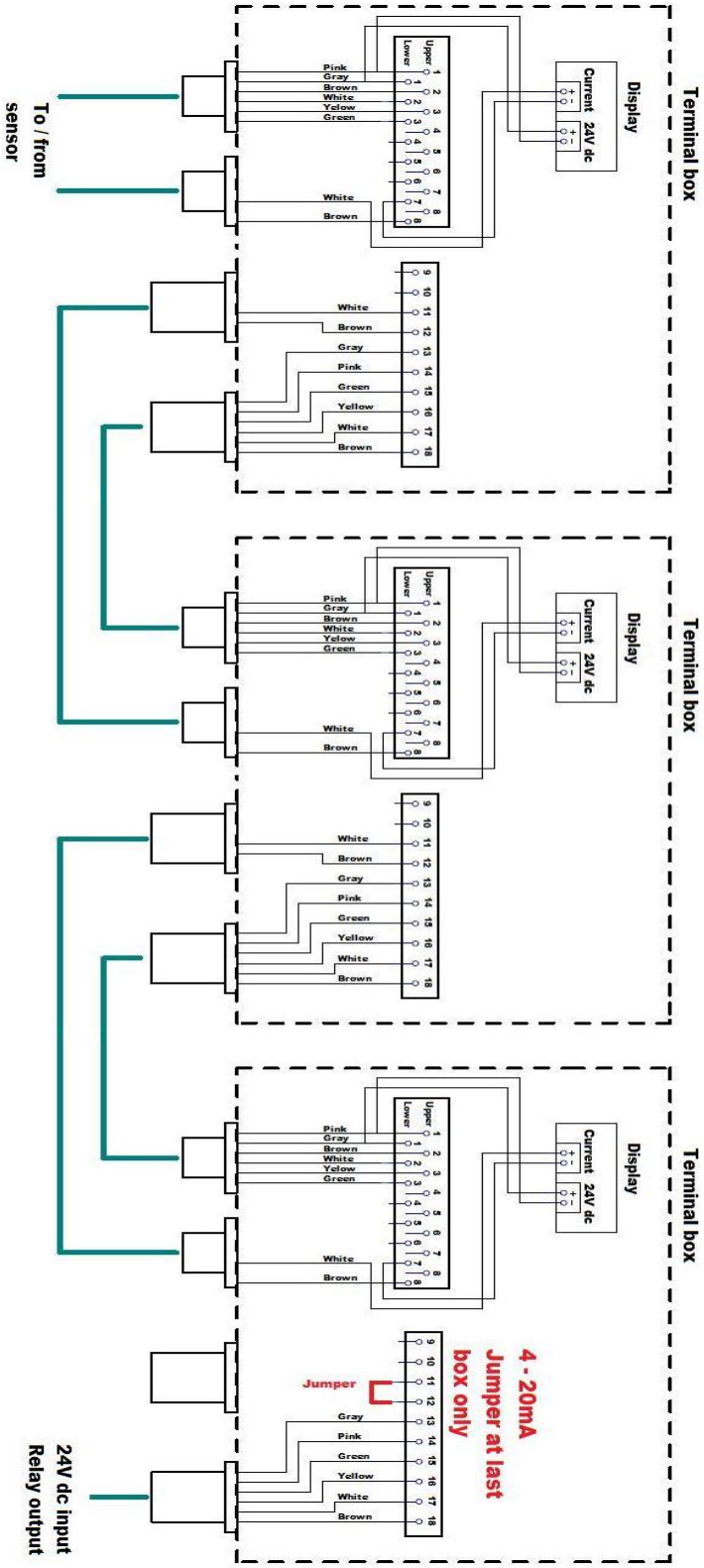
Appendix A4: Install 3 Terminal Boxes with 1 display



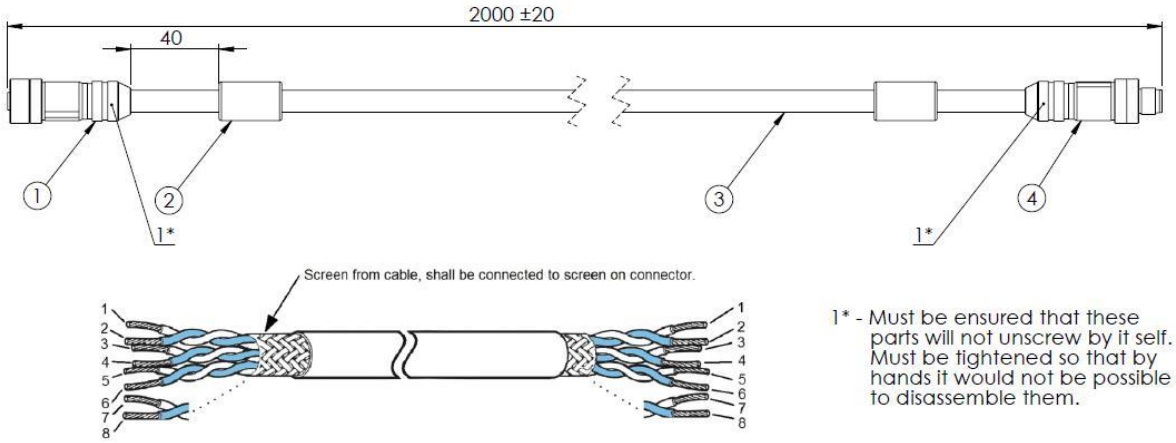
Appendix A5: Install 4 Terminal Boxes with 1 display



Appendix A6: Install 5 Terminal Boxes with 3 display



Appendix A7: Cable specification

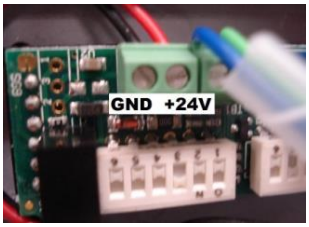
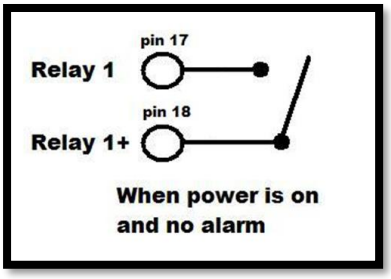
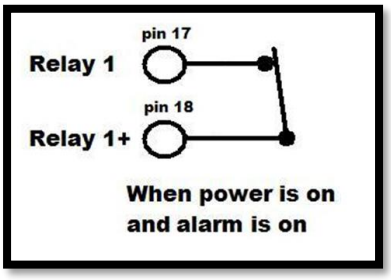
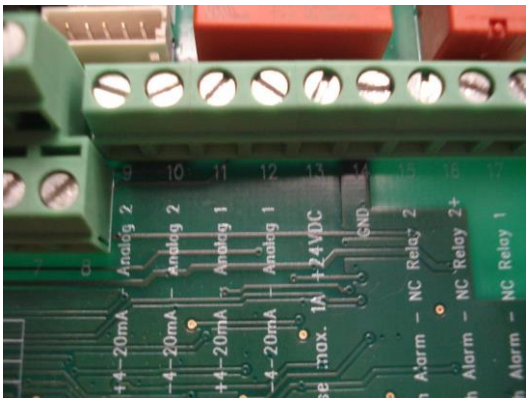


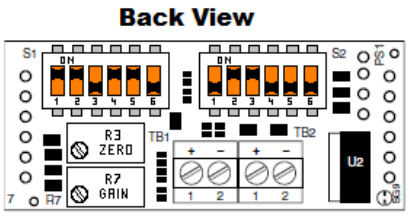
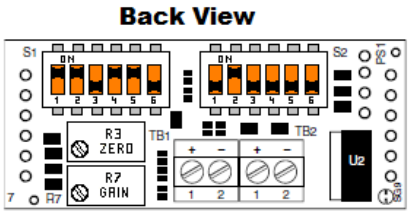
8 pol. Connectors pin layout						
Female				Male		
A	Assignment			B	Assignment	
	Socket	Wire			Plug	Wire
	1	1			1	1
	2	2			2	2
	3	3			3	3
	4	4			4	4
	5	5			5	5
	6	6			6	6
	7	7			7	7
	8	8			8	8

Item No.	Description	Qty.
1	Female Plug	1
4	Ferrite Core	2
2	CL105 4x2x0.75-PO – 2m	1
3	Male Plug	1

Appendix A8: Error / failure FAQ

Failure type	Description	Possible reasons
PPM display failure	Display shows only negative numbers 	1. Sensor is not connected. 2. The error caused by missing jumper in terminal box pin 11 and pin 12. See Appendix A1 3. Check that the jumper is properly installed, it is seen that the jumper has been installed but the jumper had no proper connection 4. The wires are reversed in terminal box pin 7 and pin 8 lower part. After changing and there is no change in the display, then the fault is either 1, 2 or 3.
a_w display failure	Dispay shows only negative numbers 	1. Sensor is not connected. 2. The error caused by missing jumper in terminal box pin 11 and pin 12. See Appendix A1 3. Check that the jumper is properly installed, it is seen that the jumper has been installed but the jumper had no proper connection 4. The wires are reversed in terminal box pin 7 and pin 8 lower part. After changing and there is no change in the display, then the fault is either 1, 2 or 3.

Dead display	Display indicate nothing 	Maybe is 24V dc supply interrupted to the display. There shall be 24V dc at this connector. 
Relay	Relay-state while alarm is on	 
Sensor	How to check the mA output from sensor? 	Remove jumper in pin 11 and pin 12. In order to ensure that there can be measured mA must pin 11 and pin 12 must be screwed. Remember to set the measuring instrument in dc mA and connect test leads correctly in the measuring instrument. Sensor is alright when measuring a value between 4 and 20 mA. Is the result about 2 mA then there is an internal sensor error, so the sensor must be sent for repair. Is the result 0 mA, tjek if the sensor get 24 Vdc power.

Dip Switch a_w	Are the dip switches still positioned correctly?	Correct positions: 
Dip Switch PPM	Are the dip switches still positioned correctly?	Correct positions: 
Broken cables between Sensor and terminal box	No mA will can be measured on: Analog 1: Terminal 11 and 12 and Analog 2: Terminal 9 and 10	