Mounting and operating instructions

Oil condition monitoring sensor

FluidIX Lub-6

ZILA GmbH
Neuer Friedberg 5
98527 Suhl

Phone: +49 (0) 3681 867300
Fax: +49 (0) 03681 8673099

Web: www.zila.de
Email: info@zila.de

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Table of contents

1. Scope of delivery

- Oil condition sensor FluidIX Lub-6
- PIN adapter (plug)
- Mounting and operating instructions

2. General information

Read these installation instructions carefully before using the ZILA oil condition sensor. Follow the instructions. Keep these mounting instructions in a safe place for future use.

2.1. Installation staff

Mounting, commissioning, electrical connection only to be carried out by qualified staff.

Repairs may only be carried out by qualified electricians.

Operate the device only with the specified voltage.

Modifications on the device are not permitted and release ZILA GmbH from any warranty and liability.

3. Product description

The FluidIX Lub-6 is a sensor which is suitable for online monitoring of the oil condition under the mentioned conditions of use and environment. The oil condition is determined using the NDIR *(non-dispersive infrared technology)* optical measuring principle and can be evaluated by digital interfaces and a PC software. The FluidIX Lub 6 is factory-set, depending on the application.

The sensor cell is located in an aluminum housing, and the oil is in contact with an aluminum body and is integrated into the oil circuit via G1/8” screw connections. In addition, the robust design is suitable for direct mounting on the machine and system. The operating voltage is 18...36 V DC.

4. Product features

4.1. Measuring principle

The integrated measuring system consists of a multi-channel infrared measuring cell with related electronics and periphery. Based on the IR absorption, the oil chemistry is measured and processed on individual spectral bands to determine the oil's chemical composition.

Depending on the sensor configuration, up to 6 parameters can be determined simultaneously with one device, in addition to the two reference channels. Which configuration is suitable for your application must be coordinated with our sales department prior to delivery. Currently, the FluidIX Lub-6 is able to measure the following parameters:

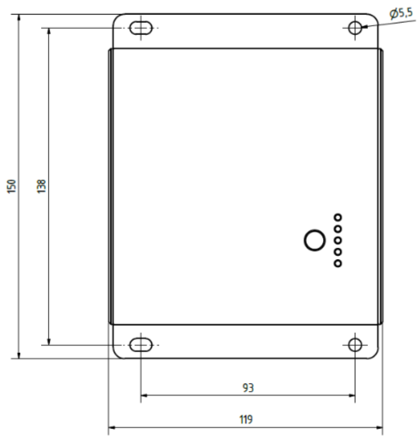
- Water content
- Oxidation
- Reciprocal oxidation
- Nitration
- Sulfation
- Soot content
- Antiwear additive
- ZDDP antiwear additive
- EP/AW additive
- Aminic antioxidant additive

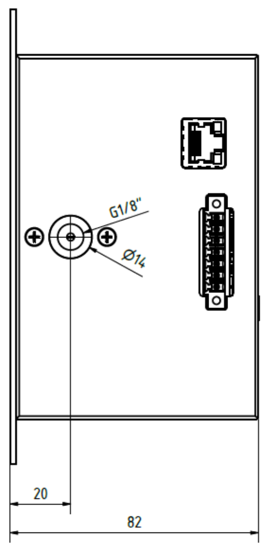
4.2. Technical data

Characteristics	
Operating voltage	18...36 V DC max. current consumption 400 mA @18 V
Housing	Aluminum
Operating conditions	
Operating temperature	0 °C to +70 °C (optionally 0...+90 °C)
Max. operating pressure	10 bar (optionally 30 bar)
Storage temperature	-40 °C to +90 °C
Digital I/O ports	
Digital input	1x Digital In 18...36 V (10 mA max.)
Digital output	4x Digital Out 18...36 V (5 mA max.)
Ethernet port	
10/100 Mbit/s Ethernet with standard RJ-45 LAN 10/100 Base-T connector	

Communication via manufacturer-independent Bus protocol ModBus TCP/IP

4.3. Dimensions*





All figures in mm

*** The dimensions of the latest version vary from those of the older versions**.

5. Communication

There are several ways to communicate with the sensor:

- Web interface
- ModBus TCP/IP
- GSM module (in preparation)
- MQTT (in preparation)

Five minutes after switching on the device, the first measurement is carried out with the standard settings.

If the measurements are to be carried out with a different setup, the configuration can be done within the first five minutes. During this time, the sensor can receive TCP or digital input measurement requests.

However, communication with the device via the web interface or the ModBus TCP/IP is not possible during the measurement time. You have to wait until the measurement is finished.

5.1. Measurement types

The device supports different measurement types. When reading out the measurement data, the respective type is specified for each measurement point.

Type 0: Measurement after defined time interval from web interface

Type 1: First measurement after switching on the device

Type 2: TCP start trigger for starting the measurement, then continued with defined time interval (type 0)

Type 3: TCP trigger measurement to start measurement at any trigger signal (**Attention:** At least 10 minutes are required between two measurements.)

Type 4: Start trigger via digital input signal for starting the measurement, then continued with defined time interval (type 0)

Type 5: Trigger measurement via digital input signal to start a measurement at any trigger signal (**Attention:** At least 10 minutes are required between two measurements.)

Type 6: Hard trigger measurement: If type 3 and type 5 are selected and no trigger signal is applied, the system starts a measurement after two days automatically.

Type 7: Reserved

Type 8: Reserved

Type 9: Due to high oil temperature changes, the measurement is discarded, and, instead, the previous measurement record is duplicated. A new measurement is carried out every 10 minutes until a stable temperature is reached again. After reaching the stable mode the device resumes to its normal operation.

Type 10: Due to an internal device error, the measurement is discarded, and, instead, the previous measurement record is duplicated. A new measurement is carried out every 10 minutes (max. 5 times). If no stable state is reached, the device switches to error mode (red LED is permanently on).

5.2. Configuration via web interface

Sensor configuration and transfer of the measurement data must be done via the web browsers Google Chrome or Mozilla Firefox on a PC. Proceed as follows:

- Set the PC to IP address **192.168.0.100** or another IP address in the same subnet, but not **192.168.0.102**, because it is the default sensor IP address if not changed.
- Connect the Ethernet cable between the sensor and the PC (**note the firewall setting!**).
- Enter the IP address of the sensor in the browser (**192.168.0.102/index.html**).

The following window opens:

Symbols and description:

Symbol	Description
	Device information
	Instrument settings **Device test**
	Measured values and thresholds Set the limit values, then transfer the changes to the device.
	Alarm and modifications
	Imprint
	Device status OK
	New measurement necessary High oil temperature change or internal device error (type 9 or type 10)
	Device status incorrect
	Memory status When the memory is full, the new measurement record will delete the oldest one in the memory, and so on (Ring Buffer structure).
	Device name and description Put in this information, then transfer the changes to the device.
	System time
	User management Create or change password-protected profiles.
	IP configuration Enter the new sensor IP address (192.168.0.x | x=1...254), then transfer the changes.
	Last oil change Update the time or date, then transfer the changes to the device.
	Last measurement
	Measuring interval Set the interval time, then transfer changes to the device.
	Digital I/O configuration (see 5.2.2.) Use the sliders for LED and output testing
	TCP measurement Set the measurement type, then transfer the changes to the device and press “start measurement”.
	Parameter limits Set the thresholds, then transfer changes to the device.
	Oil condition OK
	Oil condition medium
	Oil condition critical

	Transfer the changes to the device
	Save measured values Save the current measurement data in .txt file.
	Load all measurements Measurement results displayed in a graph.
	Delete all measurements

5.2.1. LED status

LED #1	**Sensor status** OFF: No error Flashing slowly: Measurement Flashing quickly: Full memory Red: Device error
LED #2-4	**Output 2-4** - **Parameter monitoring** Red: Threshold value exceeded - **Measurement activity** Red: Measurement active
LED #5	**Power status** Green: Device ON

5.2.2. Digital I/O configuration

Input	- Deactivated - Dedicated event - Start synchronous measurement after start trigger signal (type 4) - Trigger measurement (type 5)

Output 1	Device status (error status)
Output 2-4	- Deactivated - Measurement activity - Monitoring of a single threshold - Monitoring all thresholds
	- Activate Pump (activated 30 minutes before the measurement starts, and it stops when the measurement is done)

5.3. ModBus TCP/IP

The ModBus TCP/IP protocol is based on a master/slave or client/server structure and is part of the IEC 61158 standard. For communication, the device is connected to a PC or a controller via Ethernet cable. The device and PC are located in the same subnet (**192.168.0**.xx).

5.3.1. Supported data types in ModBus TCP/IP

The following data types are supported by the device:

Data Type	Size	Type
Discrete Inputs	1 bit	Read only
Holding Registers	16 bit unsigned	Read/Write (with exceptions)
Input Registers	16 bit signed registers	Read only

5.3.2. Supported functions

The following ModBus TCP/IP functions are supported by the device:

Function Name	Code	Hex
Read Discrete Inputs	02	0x02
Read Holding Registers	03	0x03
Read Input Registers	04	0x04
Write Single Registers	06	0x06
Write Multiple Registers	16	0x10

5.3.3. Supported exception codes

The following ModBus TCP/IP exception codes are supported by the device:

Exception Code	Description
01	**Unknown function.** The received message is not a valid action for the addressed device
02	**Unknown data address.** The address referred to in the "Function-dependent data" section of the message is not valid in the addressed device
03	**Unknown data value.** The value referenced at the addressed device location is not within the valid range
04	**Failure of a slave device.** The addressed device could not process a valid message due to a bad device condition

5.3.4. Registers

Functions that are read or written by the device are mapped as follows to **11** discrete inputs, **48** holding registers and **9** input registers:

Discrete Input Number	Address	Description
Discrete Input 1	0x0000	Measurement status (**0** if no measurement is in progress)
Discrete Input 2	0x0001	Internal memory status (**1** if memory is full, otherwise **0**)
Discrete Input 3	0x0002	**0**: No channel has exceeded the threshold value. **1**: One or more channels have exceeded the threshold values
Discrete Input 4	0x0003	**0**: TP 1.1 threshold not exceeded **1**: TP 1.1 threshold exceeded
Discrete Input 5	0x0004	**0**: TP 1.2 threshold not exceeded **1**: TP 1.2 threshold exceeded
Discrete Input 6	0x0005	**0**: TP 1.3 threshold not exceeded **1**: TP 1.3 threshold exceeded
Discrete Input 7	0x0006	**0**: TP 1.4 threshold not exceeded **1**: TP 1.4 threshold exceeded
Discrete Input 8	0x0007	**0**: TP 2.1 threshold not exceeded **1**: TP 2.1 threshold exceeded
Discrete Input 9	0x0008	**0**: TP 2.2 threshold not exceeded **1**: TP 2.2 threshold exceeded

Discrete Input 10	0x0009	**0**: TP 2.3 threshold not exceeded **1**: TP 2.3 threshold exceeded
Discrete Input 11	0x000A	**0**: TP 2.4 threshold not exceeded **1**: TP 2.4 threshold exceeded

Holding Register Number	**Address**	**Description**
Holding Register 1 *	0x0000	TP 1.1 (raw value 1 / reference value)
Holding Register 2 *	0x0001	TP 1.2 (raw value 2)
Holding Register 3 *	0x0002	TP 1.3 (raw value 3)
Holding Register 4 *	0x0003	TP 1.4 (raw value 4)
Holding Register 5 *	0x0004	TP 2.1 (raw value 5 or reference value)
Holding Register 6 *	0x0005	TP 2.2 (raw value 6)
Holding Register 7 *	0x0006	TP 2.3 (raw value 7)
Holding Register 8 *	0x0007	TP 2.4 (raw value 8)
Holding Register 9 *	0x0008	TP 1.1 (absorbance value)
Holding Register 10 *	0x0009	TP 1.2 (absorbance value)
Holding Register 11 *	0x000A	TP 1.3 (absorbance value)
Holding Register 12 *	0x000B	TP 1.4 (absorbance value)
Holding Register 13 *	0x000C	TP 2.1 (absorbance value)
Holding Register 14 *	0x000D	TP 2.2 (absorbance value)
Holding Register 15 *	0x000E	TP 2.3 (absorbance value)
Holding Register 16 *	0x000F	TP 2.4 (absorbance value)
Holding Register 17 *	0x0010	Measurement type (0 to 10)
Holding Register 18 *	0x0011	Last measurement (year)
Holding Register 19 *	0x0012	Last measurement (month)
Holding Register 20 *	0x0013	Last measurement (day)
Holding Register 21 *	0x0014	Last measurement (hour)
Holding Register 22 *	0x0015	Last measurement (minute)
Holding Register 23 *	0x0016	Last measurement (second)
Holding Register 24	0x0017	Measurement interval
Holding Register 25 *	0x0018	Reserved
Holding Register 26 *	0x0019	Reserved
Holding Register 27 *	0x001A	Reserved
Holding Register 28 *	0x001B	Reserved
Holding Register 29 *	0x001C	Reserved

Holding Register 30 *	0x001D	Reserved
Holding Register 31	0x001E	Last oil change (year)
Holding Register 32	0x001F	Last oil change (month)
Holding Register 33	0x0020	Last oil change (day)
Holding Register 34	0x0021	Last oil change (hour)
Holding Register 35	0x0022	Last oil change (minute)
Holding Register 36	0x0023	Last oil change (second)
Holding Register 37	0x0024	Read/Write TCP measurement **0**: TCP measurement deactivated **1**: Synchronous measurement after TCP start trigger signal **2**: TCP trigger measurement
Holding Register 38 *	0x0025	Serial number
Holding Register 39 *	0x0026	Firmware version
Holding Register 40 *	0x0027	Max Multiplicator value
Holding Register 41	0x0028	TP 1.1 absorbance threshold
Holding Register 42	0x0029	TP 1.2 absorbance threshold
Holding Register 43	0x0030	TP 1.3 absorbance threshold
Holding Register 44	0x0031	TP 1.4 absorbance threshold
Holding Register 45	0x0032	TP 2.1 absorbance threshold
Holding Register 46	0x0033	TP 2.2 absorbance threshold
Holding Register 47	0x0034	TP 2.3 absorbance threshold
Holding Register 48	0x0035	TP 2.4 absorbance threshold

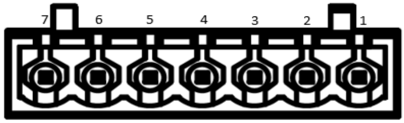
Input Register Number	**Address**	**Description**
Input Register 1	0x0000	NTC_IR1 (temperature optical detector 1 [°C])
Input Register 2	0x0001	NTC_IR2 (temperature optical detector 2 [°C])
Input Register 4	0x0002	Reserved
Input Register 4	0x0003	First Byte IP address
Input Register 5	0x0004	Second Byte IP address
Input Register 6	0x0005	Third Byte IP address
Input Register 7	0x0006	Fourth Byte IP address
Input Register 8	0x0007	Memory usage [%]
Input Register 9	0x0008	Error status **0**: No error **1**: IR-Error **2**: Full memory **3**: Others

Explanations:

- The values of the holding register 1 to 8 should be multiplied by (max multiplicator value) then divided by (65535). For example, if the value of holding register 1 is 45000, and the value of max multiplicator is 5000, this corresponds to a value of 3433.28 for TP1.1.
- The values of Holding Registers 9 to 16 and 41 to 48 should be divided by 1000.
- The values of Holding Register 39 should be divided by 10
- Holding registers with asterisks (*) (holding register 1 to 23 and holding register 38 to 40) are intended to be read-only.
- Holding register 24 is used to set the measurement interval in minutes. The available options are: 10, 20, 30, 60, 120, 180, 240, 360, 480, 600, 720, 1440 min.
- The values of input registers 1-2 should be divided by 10. If the value read by input register 2 is 705, this corresponds to a temperature of NTC_IR2 = 70.5 degrees Celsius.
- ModBus TCP/IP of the device supports a maximum of five active connections simultaneously. A new connection replaces the oldest one.
- The time in (last measurement and last oil change) is in GMT format.
- The values of input register 8 should be divided by 10. If the value read by input register 8 is 327, this corresponds to a memory usage of 32.7%.

6. Electrical connections

Pin assignment:



Connection	Description	PIN
+Vcc	Operating voltage	1
GND	Ground	2
Digital Input	Configurable	3
Digital Output 4	Configurable	4
Digital Output 3	Configurable	5
Digital Output 2	Configurable	6
Digital Output 1	Device status (error status)	7

7. Mounting and commissioning

7.1. Mounting

The sensor should be integrated into the pipe of the oil circuit in the plant. The specified ambient conditions (pressure < 10 (30) bar, temperature < +70 °C) must be observed. For optimum operation, larger temperature fluctuations in the fluid should be avoided during a measurement.

If the plant is later equipped with the sensor system, a pipe must be separated and the sensor installed in between. A bypass connection is recommended for higher volume flows.

Since the sensor represents a narrow point (0.2 x 5 mm over a depth of 30 mm), it must be ensured that the oil flow through the sensor is guaranteed.
In the default settings, a new value is recorded every two hours. This value can also be changed if required. In any case, however, the oil in the measuring pipe must be replaced by the oil flow within this time.

A power supply of 18...36 V must be guaranteed. When the device is connected to the power supply, the user will notice the green power LED is on, and other red LEDs will be on for three seconds. **A data query is only possible via LAN cable**. Therefore, the sensor should be equipped with a LAN cable which is routed to an accessible location.

On the front side of the sensor, holes with a G 1/8” female thread are provided for the process connections. The sensor can be integrated into the process via two screw-in fittings with seals.

7.2. Commissioning

Since the oil condition sensor FluidIX Lub-6 is a sensitive measuring instrument, it is recommended to handle it carefully.

Before installation and commissioning, please check whether the ambient conditions are suitable for use of the device.

Please make sure that the sensor is connected correctly and the power supply is switched on.

8. Maintenance

Thanks to the innovative NDIR technology, the FluidIX Lub-6 oil condition sensor is largely maintenance-free.

In order to ensure permanent operation, care should be taken to ensure that a permanent oil flow takes place in the measuring cell. For this, we recommend to clean the device if the particle and sludge content in the application is too high. Because we have a measuring gap with 0.2 mm, please ensure that the measuring gap is not clogged.

Every oil or every type of oil has its own spectral characteristics. If you switch to a different type of oil, as a consequence, the internal absorption filters may also need to be changed. This means if the oil is changed without prior adjustment, it cannot be guaranteed that the requested aging parameters will continue to be measured reliably. If the new oil is not compatible with the oil sensor, a new oil sensor may have to be purchased.

8.1. Factory reset

A factory reset is possible. If you wish to do so, please contact ZILA GmbH.

9. Equipment and support

The oil sensor is a novel product, which was launched in 2020.

For any questions about this product not given in this manual, please use the following contact details.

Phone: +49 (0) 3681 86 73 00

Email: support@zila.de

ZILA GmbH
Neuer Friedberg 5
98527 Suhl, Germany