The people for Process Analytics

SMART Hydrogen/TCD analyzer

Continuous measurement of percent hydrogen

Manual

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1. Overview

After 30 years of practical application experience and development, SMART Series Intelligent analyzers is qualify to the harsh outdoor surrounding and precise measurement requirements, its unique professional design can be applied in chemical, pharmaceutical, food and health, and the most extreme process physical and chemical environment, to measure percentage hydrogen content of most neutral gases.

The material thermal conductivity of each gas differs, and its thermal conductivity (or thermal conductivity) is related to its molar mass and temperature and has little effect on the gas pressure. When gases with different thermal conductivities are mixed, the thermal conductivity of the mixture depends on the concentration of its components. So the proportion of each component gas can be determined.
The principle of thermal conductivity measurement is particularly applicable when the gases to be measured have significantly different thermal conductivities and one of the following three conditions is fulfilled.
1. the gas mixture contains only two components. For example, the carbon dioxide content in nitrogen or the hydrogen content in nitrogen.
2. the gas mixture contains more than two components, but the concentration of only two components changes.
3. A gas mixture contains more than two components and the background gas contains two or more components but with similar thermal conductivity, which corresponds to two components mixture. For example, when measuring hydrogen or helium in oxygen/nitrogen.

Theory

The sensor chip consists of a silicon frame with 2 silicon-nitride membrane2. Each membrane has a micromechanical heating element at its center, and the chip uses a heating resistor to control heating of the center of the membrane to about 40°C above ambient temperature. The resulting temperature increase of the center is measured by the thermopile. The actual temperature increase depends upon the effective thermal resistance between membrane center and ambient, this is influenced by the thermal resistance of the gas surrounding the sensor. For each binary gas mixture the ratio of temperature increase to heating power is dependent on the mix ratio. The chip determines the thermal conductance between the ambient and the center of the membrane by measuring the temperature elevation of heater, measures the gas composition. For improve accuracy, temperature and humidity sensors are built in for compensation.

2. Features and advantages

Superior performance is proved in the course of SMART series analyzer working.

• Color screen display, magnetic button, ***operation without opening the cover.***

• The instrument has a self-test performance and diagnostic capabilities, alarm function

Measuring principle	Thermal conductivity (TCD)
Display	1.8" industrial color LCD, 160*128Pixel
Language	English Menu
LED Light	Status LED Light(NAMUR NE107)
Keypad	Magnetic keypad
Range	0~100%
Linearity	< 1% F.S.
Repeatability	< 1% F.S.
Sensitivity	0.02% F.S.
Response Time	<1s
T90-time	<1sec at flow rate higher 60l/h
Warm up time	5minute
Diagnosis function	Self-diagnosis, heart beat monitoring
Analog Output	4~20mA
Relay Output	3 Relays, NO, 5A 250VAC/30VDC
Communication	RS485, MODBUS RTU
Power	19 ~ 28V DC Power, 0.5A
Flow rate	40l/h to 150l/h; 60l/h -80l/h recommended
Process Pressure(Max.)	10Bar
Temperature Range	-40 ~ 85℃
Humidity Range	0~95%RH (non-condensing)
Process Connection	G3/8 screw or 6mm tube
Ambient Temperature	-15 ~ 60℃
Electrical protection	EMI / RFI CEI-EN55011 – 05/99
Housing Material	Aluminum and Stainless steel
Explosion-proof	Exd IICT4 Controller optional

3. Application

- Water electrolysis to produce hydrogen
- Hydrogenation unit
- Hydrogen-cooled generator
- University and research
- Metal heat treatment/welding
- Chemicals/Pharmaceuticals
- Air Separation Unit

Depending on the configuration of the measuring point the following device models are used:

- Measuring in the bypass stream using a standard reaction chamber
- Inline measurement in systems with G3/8 thread or vacuum flange KF40

Both the electronics and the sensors are calibrated in our factory with certified calibration gases. The instructed service technician cans readjust via the service tools to a limited extent and therefore adapt to the specific measurement conditions.

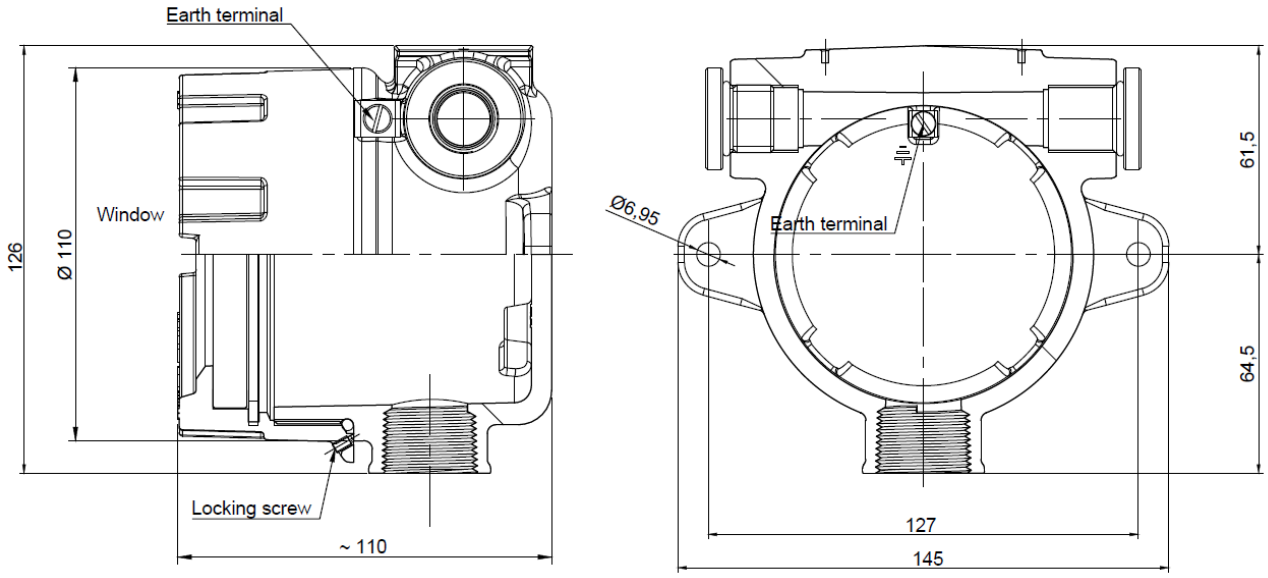
4. Installation

4.1 Front description

- 1- 1.8" industrial color LCD, 160*128Pixel
- 2- Magnetic button (Operation without opening the cover)
- 3- Status LED (Complies with NAMUR NE107)
- 4- Cable gland (M20*1.5, Replaceable Blind plug)
- 5- Blind plug (M20*1.5, Replaceable Cable gland)
- 6- Locking screw (Hexagon socket 1.5)

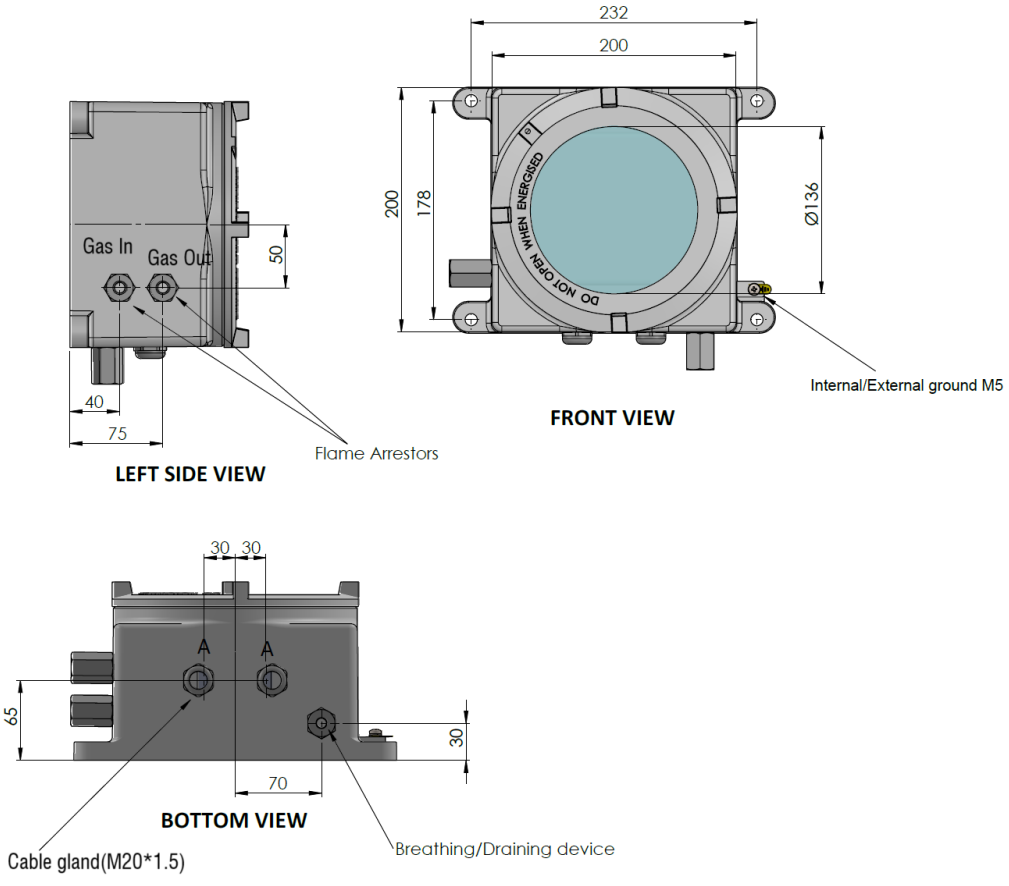
Ex Version is similar.

4.2 Scale drawings



Note：Optional wall mounting available.

Ex Version

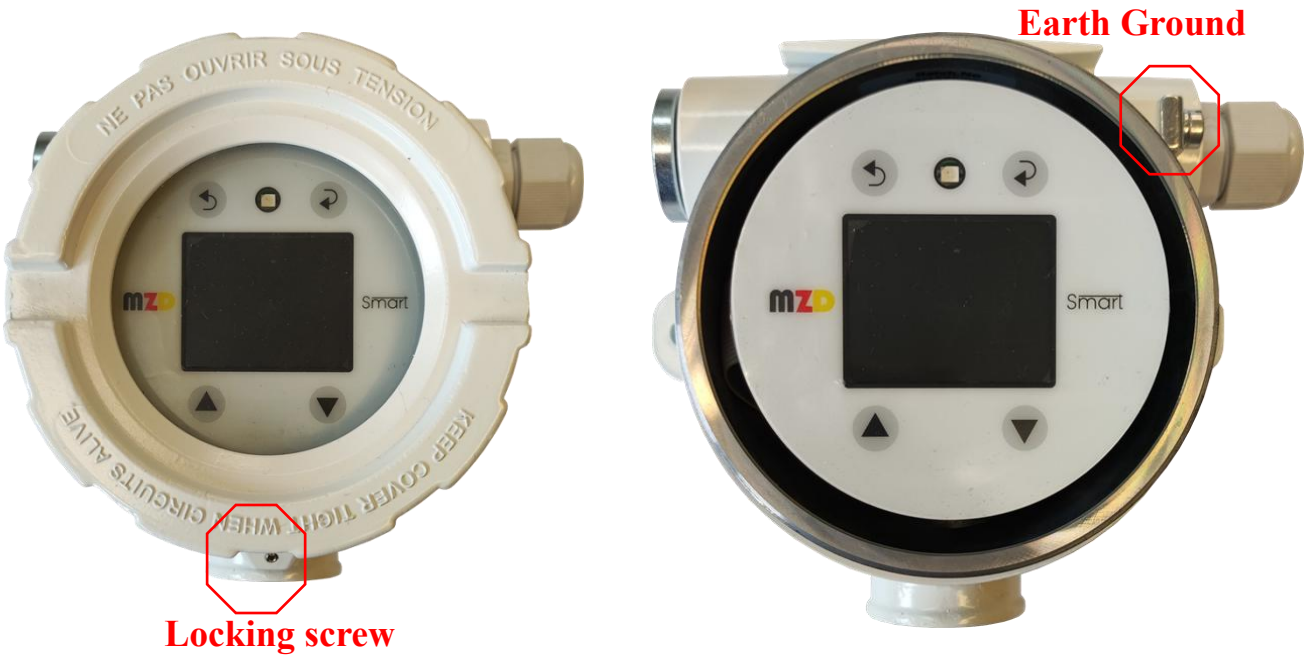


4.3 Wire Connection

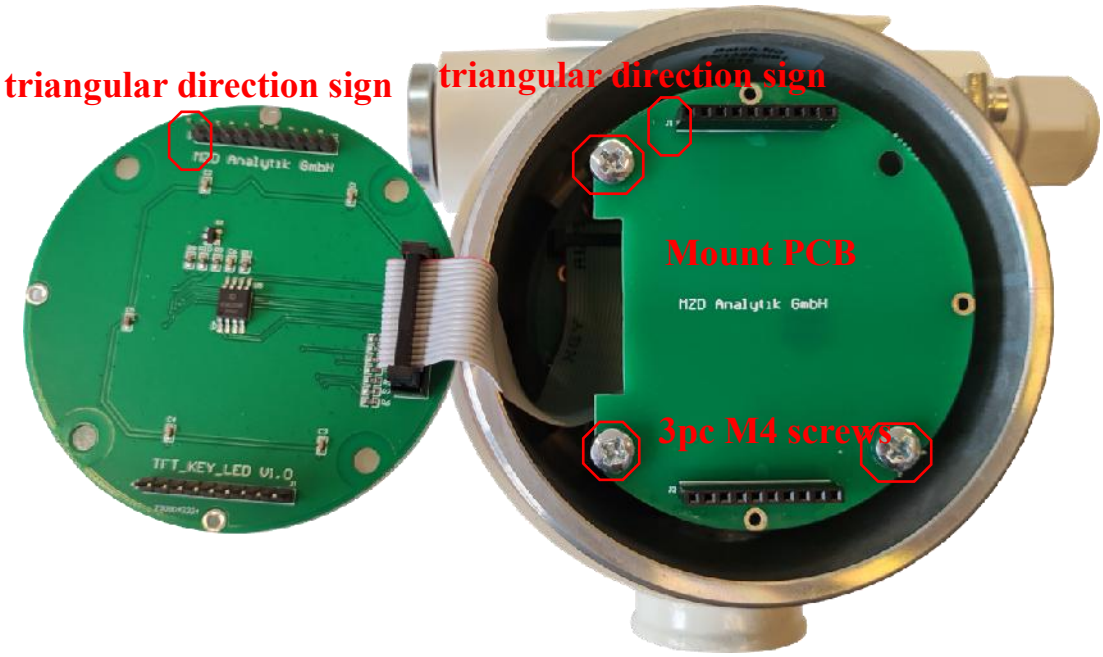
Attention: Explosion-proof area, do not open the cover after power is turned on!

4.3.1 Use tool (Hexagon socket 1.5) to loose Locking screw.

4.3.2 Open the window cover by turning it counterclockwise.

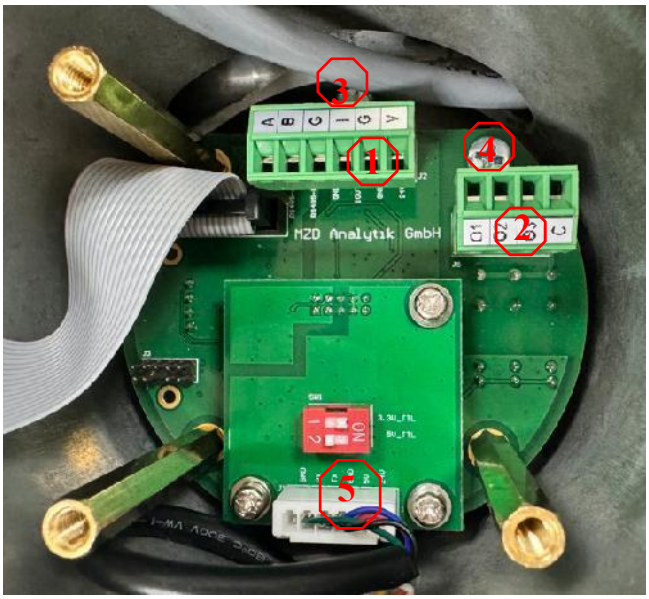


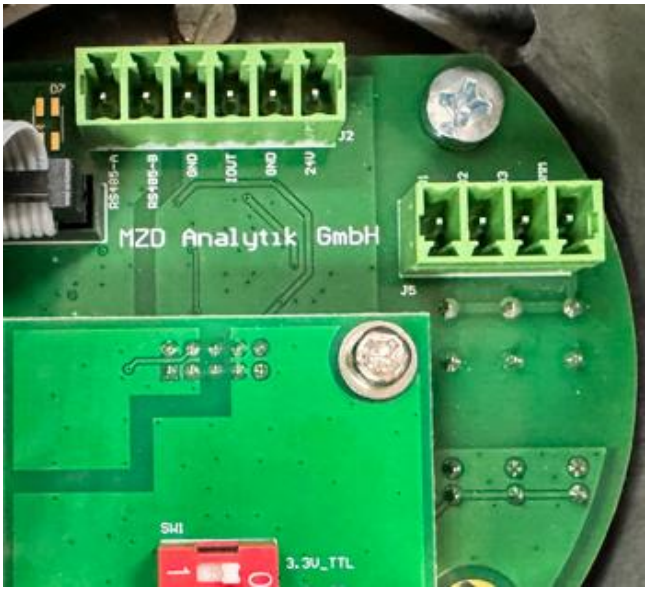
4.3.3 Pull out the LCD module vertically upwards.



Note: After connecting wire, pay attention to the triangular direction mark when installing the LCD module.

4.3.4 Use screwdriver to loose M4 screws and take out the mount PCB.





4.3.5 Wire connection. ***Attention: Incorrect connection will damage the device!***

• 1- Terminal J2

Pin	Description
A / RS-485-A	RS485-A
B / RS-485-B	RS485-B
G / GND	Analogue output GND
I / IOUT	Analogue output (4-20 mA with galvanic isolation Charge max 500 ohm)
G / GND	Power GND
V / 24V	Power +19 … 28V DC

Attention: If the AC/DC power supply is integrated, V/G is connected by factory. The end users need to connect the AC power cable directly to the terminals (AC/N and AC/L) of the AC/DC power.

• 2- Terminal J5 (relays)

Pin	Description
O1 / NO1	Relay Output1(High/Low Alarm)
O2 / NO2	Relay Output2(High/Low Alarm)
O3 / NO3	Relay Output3(System alarm, sensor cleaning failed)
C / COMM	Common ***All relays are designed to operate on the same AC or DC voltage!***

Note：According to the safety design, when the controller fails, or high/low measuring alarm occurs, or analyzer is powered off, relay is open. And measurement is normal, relay is closed.

• 3- Earth ground (Optional connections depending on application)

• 4- Earth ground (M4, Optional connections depending on application)

• 5- Sensor terminal (Factory connection)

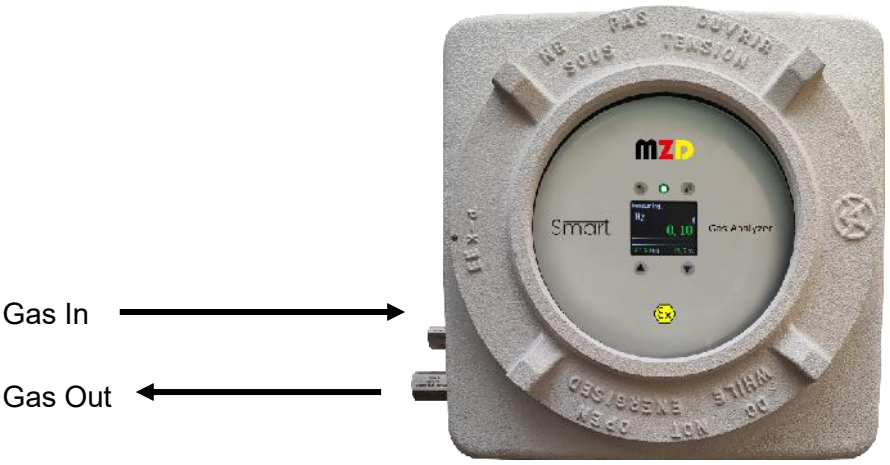
4.3.6 Install the mount PCB, LCD module and window cover.

Note: Ex Version is similar.

4.4 Process connection

Process connection according to the configuration of the measuring point:

- Sensor with flange/screw connection
- Sensor with flow chambe
- Ex Version, Process connection: 1/8NPT



5. Commentary of LED,screen menus and Magnetic button

5.1 Panel description

• 1- 1.8" industrial color LCD, 160*128Pixel

• 2- Status LED (Complies with NAMUR NE107)

• 3- Magnetic button, “Return” 

• 4- Magnetic button, “Enter” 

• 5- Magnetic button, “Up” 

• 6- Magnetic button, ”Down” 

5.2 LED description

No	Color and status	Status	Complies with NAMUR NE107
1	Red	**F**ailure	System fault or Sensor fault
2	Flashing Red	**O**ut of Specification	No coating, Over range (H-High/L-Low alarm)
3	Flashing Green and Red	**M**aintenance required	Poor Calibration curve, Process alarm (High/Low alarm)
4	Flashing Green	**C**heck function	AO simulation, Warming up
5	Green	**N**ormal	Measuring OK

5.3 Magnetic button fuction

The magnetic rod approaches and leaves the button once, which is a button operation.

• 5.3.1 Magnetic button, “Return” 

Return to last menu level.

• 5.3.2 Magnetic button, “Enter” 

Go to operation mode, display Menu

Configuration: Confirm entries, next configuration step.

Calibration: Confirm entries, continue program flow.

• 5.3.3 Magnetic button, “Up” and “Down” 

Menu: Increase/decrease a numeral,

Menu: Selection

Note:

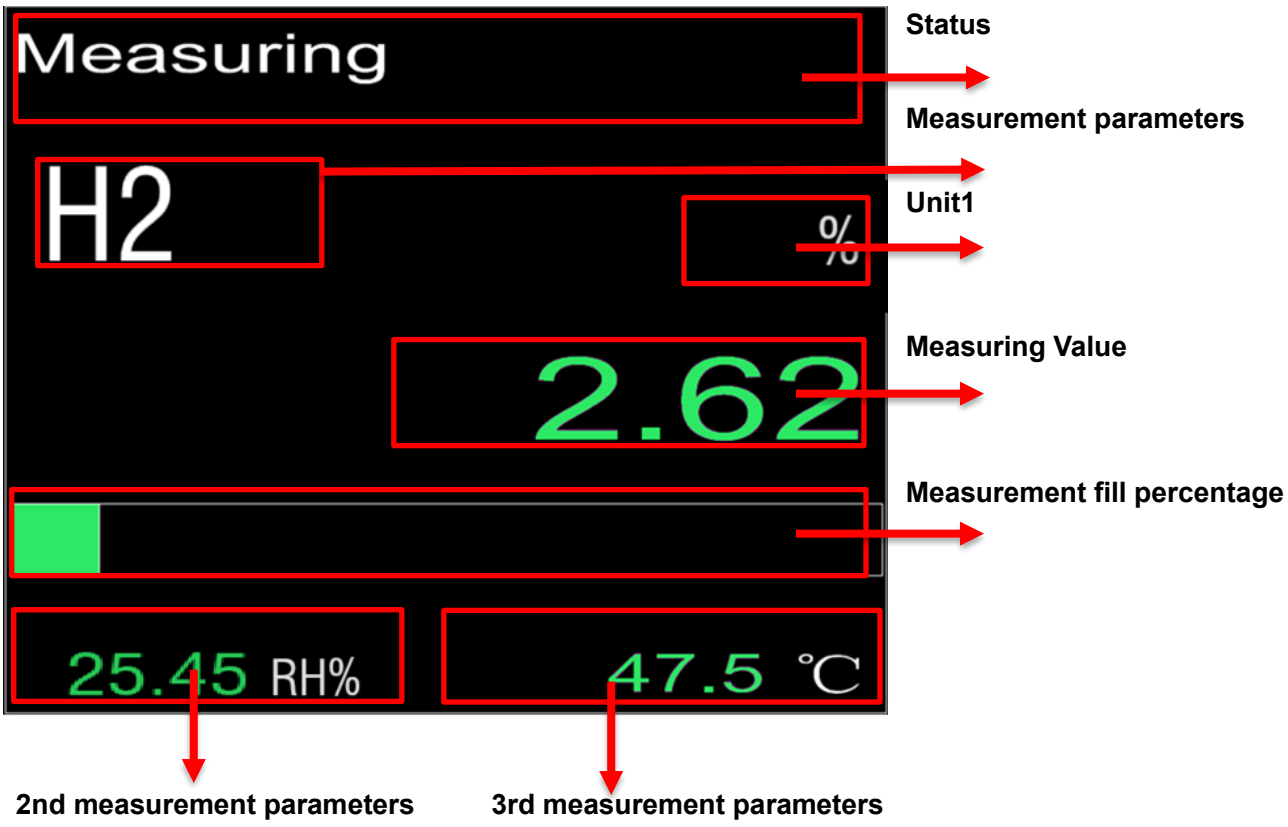
When used for decimal settings. If the magnetic rod does not move after approaching, when the change exceeds 10 digits, the adjustment amount will automatically increase by 10 times.

The magnetic button operation interval cannot be too short, please be greater than 1~2 second! Otherwise it may cause some inexplicable errors.

5.4 Analyzer Initialization

When the analyzer is powered on, the LCD will display MZD logo. If the device initialization is successful, "EE_OK" words in black will be displayed in the upper right corner of the screen, otherwise "EE_ERR" words in red will be displayed.

5.5 LCD Display description



•5.5.1 Status:

No	Display	Description
1	Measuring.	Normal measuring mode
2	Warm up!	Measurement starting up
3	AO.Simul.	Analog output(4~20mA) simulation function is turned on
4	L.Alarm!	Low alarm
5	H.Alarm!	High alarm
6	LL.Alarm!	Low Low alarm
7	HH.Alarm!	High High alarm
8	CheckSensor	Need to check sensor
9	Sen. Fault!	Sensor failure
10	Sys. Fault!	Analyzer system failure
11	R1	Relay1 active (High/Low alarm, red color)
12	R2	Relay2 active (High/Low alarm, red color)
13	R3	Relay3 active (System alarm, red color)

•5.5.2 Measurement parameters:

No	Display	Description
1	H2	Hydrogen measurement (% by volume)

•5.5.3 Unit1:

No	Display	Description
1	%	Hydrogen measurement (% by volume)

•5.5.4 Measuring Value (MV):

•The value is displayed to 2 decimal.

Note: When there has an alarm, the numbers color will change as LED color. (See LED description.)

•5.5.5 Measurement fill percentage:

• Fill percentage = MV / Range *100%

Note: When there has an alarm, the numbers color will change as LED color. (See LED description.)

•5.5.6 2nd measurement parameters:

No	Display	Description
1	RH%	Humidity

•5.5.7 2nd Measuring Value:

•The unit of measurement is RH%, the value is displayed to 2 decimal.

Note: When the temperature humidity/sensor has an alarm, the numbers color will change as LED color.(See LED description.)

•5.5.8 Unit2:

No	Display	Description
1	RH%	Humidity

•5.5.9 3nd measurement parameters:

No	Display	Description
1	℃	Temperature

•5.5.10 3nd Measuring Value:

•The unit of measurement is ℃, the value is displayed to 1 decimal.

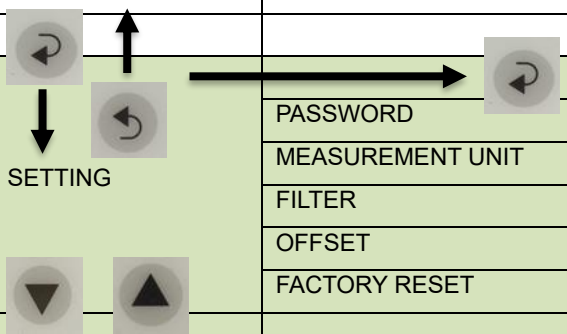
Note: When the temperature humidity/sensor has an alarm, the numbers color will change as LED color.(See LED description.)

•5.5.11 Unit3:

No	Display	Description
1	℃	Temperature

6. Menu and Operation

6.1 Menu Structure of Modes and Functions

NO	MENU	SUBMENU	DESCRIPTION	AUTHORITY
0	Measuring		Measuring Value, alarm and status	
				
1	SETTING		Analyzer Configuration	Engineer, need password
1.1		PASSWORD	Assigning and editing password	
1.2		MEASUREMENT UNIT	Measurement unit	
1.3		FILTER	Measurement digital filter	
1.4		OFFSET	Measurement offset	
1.5		FACTORY RESET	Restore to factory configuration	
2	CURRENT OUT		Current Configuration	
2.1		RANGE/SPAN	Current output(20mA) span	
2.2		ZERO	Current output(4mA) zero	
2.3		FAILED SAFETY	Current output at analyzer failure	
2.4		SIMULATE	Simulate current output	
3	ALARM		Alarm Setting	Operator, no need password
3.1		RELAY1 FUNCTION	Relay1 High/Low alarm	
3.2		RELAY1 SETPOINT	Relay1 alarm setpoint	
3.3		RELAY1 THRESHOLD	Relay1 alarm threshold	
3.4		RELAY2 FUNCTION	Relay2 High/Low alarm	
3.5		RELAY2 SETPOINT	Relay2 alarm setpoint	
3.6		RELAY2 THRESHOLD	Relay2 alarm threshold	
4	CALIBRATION		Calibration	
4.1		1POINT CALIBRATION	1 Point (Span) calibration	
4.2		2POINT CALIBRATION	2 Point (zero and Span) calibration	
4.3		RESTORE CALIBRATION	Restore to factory calibration	
4.4		CALIBRATION STATUS	Calibration Status	
4.5		SENSOR OFFSET	Sensor measurement Offset (High priority)	Specialist, need password
5	COMMUNICATION		MODBUS RTU Slave Configuration	Engineer, need password
5.1		ADDRESS	Device address	
5.2		BUAD RATE	Baud rate	
5.3		PARITY CHECK	Parity check	
5.4		STOP BIT	Stop bit	
6	INFORMATION		Analyzer parameters, status, version and copyright	Operator, no need password

6.2 Menu operate authority

3 level operating authority

0. Free and operator – Alarm configuration, calibration and information check

1. Engineers, need password (Default password is 0) - Includes operator authority, Setting (device configuration), Current output configuration, and communication configuration

2. Specialist, need password – Includes engineer authority, and sensor measurement Offset

Note:

After 60 minutes of inactivity after the engineer or Specialist logs in, the user logs out and screen automatically changes to measuring mode.

If When the operation exceeds the authority, "NO PERMISSION" or "Wrong" will be prompted, otherwise "OK" or "SAVED" will be prompted.

6.3 Operation menu description

DISPLAY	ACTION/SELECT	Display/Operation	REMARK
SETTING			
	PASSWORD		
		0 (default)	Authority login, password change
	MEASUREMENT UNIT		
		% (default)	Hydrogen measurement (% by volume)
	FILTER		
		0 (default)	Digital filter: 0~9, when filter is bigger, the measured value changes smoother.
	OFFSET		
		0 (default)	The calibration curve moves up and down. MV = measured value + offset
	FACTORY RESET		
		NO (default)	
		YES	Restore to factory configuration, includes SETTING, CURRENT OUT, ALARM, COMMUNICATION.
CURRENT OUT			
	RANGE	SPAN 20mA	
		100 (default)	20mA current output, 100%.
	ZERO	ZERO 4mA	
		0 (default)	4mA current output, 0%.
	FAILED SAFETY		When there has system failure or

				sensor not clean, 4-20mA current output value.
		22.5mA (default)		When there has system failure or sensor not clean, 4-20mA current output 22.5mA.
		3.5mA		
	SIMULATE			
		ON/OFF		
			ON	When the analog output (4~20mA) analog function is activated, the current output value is the last analog output before activation.
			OFF (default)	Analog output(4~20mA) simulation function is turned off.
		SIMULATE VALUE		
			4.00mA	Analog output(4~20mA) simulate value.
ALARM				
	RELAY1 FUNCTION			
		LOW ALARM		When Setpoint > ZERO, MV <= Setpoint, alarm active, relay active.
		HIGH ALARM (default)		When Setpoint < SPAN, MV >= Setpoint, alarm active, relay active.
	RELAY1 SETPOINT			
		100 (default)		
	RELAY1 THRESHOLD			
		0.5 (default)		Low alarm, When MV >= Setpoint + threshold, the low alarm is eliminated, relay switch inactive. High alarm, When MV <= Setpoint - threshold, high alarm is eliminated, relay switch inactive.
	RELAY2 FUNCTION			
		LOW ALARM		When Setpoint > ZERO, MV <= Setpoint, alarm active, relay active.
		HIGH ALARM (default)		When Setpoint < SPAN, MV >= Setpoint, alarm active, relay active.
	RELAY2 SETPOINT			
		100 (default)		
	RELAY2 THRESHOLD			
		0.5 (default)		Low alarm, When MV >= Setpoint + threshold, the low alarm is eliminated, relay switch inactive.

			High alarm, When MV <= Setpoint - threshold, high alarm is eliminated, relay switch inactive.
CALIBRATION			*Before calibration, use zero gas to purge for 48 to 72 hours!*
	1POINT CALIBRATION		
		1POINT CALI.	Please switch to the span calibration gas, and wait for the measuring value to stabilize, enter the span calibration gas value and confirm.
		CAL.SAVE	After the calibration is confirmed, it will automatically switch to the calibration curve status check and confirmation. After confirming, the calibration curve will be stored. Otherwise, after 30minutes, the old calibration curve will be restored. *Note: If you want to recalibrate immediately, please restore the factory calibration curve first, and then calibrate again.*
	2POINT CALIBRATION		
		1POINT CALI. 1st	Please switch to the zero calibration gas, and wait for the measuring value to stabilize, enter the span calibration gas value and confirm.
		1POINT CALI. 2nd	Please switch to the span calibration gas, and wait for the measuring value to stabilize, enter the span calibration gas value and confirm.
		CAL.SAVE	After the calibration is confirmed, it will automatically switch to the calibration curve status check and confirmation. After confirming, the calibration curve will be stored. Otherwise, after 30minutes, the old calibration curve will be restored. *Note: If you want to recalibrate immediately, please restore the factory calibration curve first, and then calibrate again.*
	RESTORE		

	CALIBRATION		
		NO (default) YES	Restore factory calibration curve
	CALIBRATION STATUS		Display current user calibration curve base and slope, status. Zero: The base of the calibration curve, the default is 0.00. Slope: The slope of the calibration curve, at least 1.00. Status: good, poor,bad.
	SENSOR OFFSET		For specialist or factory configuration
		0 (default)	
COMMUNICATION			See MODBUS Protocol Specification (https://www.modbus.org/docs/Modbus_Application_Protocol_V1_1b3.pdf s)
	ADDRESS		Slave device address, address range is from 1~240
		1 (default)	
	BUAD RATE		
		4800	
		9600 (default)	
		19200	
		38400	
		57600	
		115200	
	PARTY CHECK		
		NONE (default)	
		ODD	
		EVEN	
	STOP BIT		
		1 (default)	
		2	
INFORMATION			Analyzer information
	INFORMATION_1		Analyzer information page1
		MV	xx.xx (%) For example: 0.28, measured by the sensor
		Humidity	xx.xx (RH%) For example: 25.83, measured by the sensor.
		Temperature	xx.x (℃)

			For example: 25.8, measured by the sensor.
		Transfer	Transfer (V/W)
		Thermocouple	x.xxx (mv) For example: 0.023, thermocouple output of the thermal conductivity sensor.
	INFORMATION_2		Analyzer information page2
		Heater I	x.xx (mA) For example: 0.12, heater current of the sensor.
		Heater V	x.xx (V) For example: 0.75, heater voltage of the sensor.
		AO CURRENT	x.xxx (mA) For example: 4.280, output according measuring value
		REL1 STATUS	ON/OFF ON, relay1 is active, alarm OFF, relay1 is inactive, normal
		REL2 STATUS	ON/OFF ON, relay2 is active, alarm OFF, relay2 is inactive, normal
	INFORMATION_3		Analyzer information page3
		REL3 STATUS	ON/OFF(System alarm or sensor cleaning failed) ON, relay3 is active, alarm OFF, relay3 is inactive, normal
		MEA.STATUS	HH Alarm/LL Alarm/H Alarm L Alarm/Normal HH Alarm: High High Alarm, measuring value > REL1. SETPONT and measuring value > REL2. SETPONT LL Alarm: Low Low Alarm, measuring value < REL1. SETPONT and measuring value < REL2. SETPONT H Alarm: High Alarm, measuring value > REL1. SETPONT or measuring value > REL2. SETPONT L Alarm: Low Alarm, measuring value <

			REL1. SETPONT or measuring value < REL2. SETPONT Normal: Good, no alarm
		SENS.STATUS	NeedCheck / 0 NeedCheck: Need check sensor surface 0: Good, sensor is clean.
		SYS.STATUS	F_Fault / S_Out.S. / M_Mait. / C_Check / N-Normal (Complies with NAMUR NE107) F_Fault: Failure, system fault or Sensor fault S_Out.S.: Out of Specification, Check sensor or Recoating sensor, measuring value over range (High High/Low Low alarm) M_Mait.: Maintenance required, poor calibration curve, process alarm (High/Low alarm) C_Check: Check function,AO simulation active, warming up process N_Normal: Normal, measuring OK
		HEART BEAT	xx For example: 30, changes every second and ranges from 0 to 59
	INFORMATION_4		Analyzer information page4
		MCU TEMP.	xx For example: 28
		DEVICE	TCD_H2
		SERIAL NO	xxxx-xx.xxx For example:2404-24.001
		FIRMWARE	x.xx For example:1.01
	INFORMATION_5		Analyzer information page5
		MZD Analytik GmbH www.mzd-analytik.com	Copyright information

6.4 MODBUS Register address table:

Address	Type	Description
30001~02	32bit float(r)	Measuring Value(% Hydrogen)
30003~04	32bit float(r)	Temperature
30005~06	32bit float(r)	Original Measuring Value
30007~08	32bit float(r)	Original Measuring Temperature Value
300009~10	32bit float(r)	Factory reservation
300011~12	32bit float(r)	Factory reservation
30013~14	32bit float(r)	Factory reservation
30015	16bit Integer(r)	Measuring Value percent (4~20mA, Magnification 100)
30016	16bit Integer(r)	AO current (Magnification 1000)
30017	16bit Integer(r)	Measuring Value percent in trend drawing (Magnification 1000)
30018	16bit Integer(r)	Relay1 status (0 inactive, 1 active)
30019	16bit Integer(r)	Relay2 status (0 inactive, 1 active)
30020	16bit Integer(r)	Relay3 status (System Relay, 0 inactive, 1 active)
30021	16bit Integer(r)	System status (0 Normal, 1 Check function, 2 Maintenance required, 3 Out of Specification, 4 Failure)
30022	16bit Integer(r)	Calibration curve status (0 Good, 1 Poor, 2 Bad)
30023	16bit Integer(r)	Process status (0 Normal, 1 Low alarm, 2 High alarm, 3 Low low alarm, 4 High high alarm)
30024	16bit Integer(r)	Sensor status (0 Normal, 1 Sensor check or Need recoating 2 Not clean)
30025	16bit Integer(r)	System status (0 Normal, 1 Failure)
30026	16bit Integer(r)	Heart Beat (0~59)
30027~28	16bit Integer(r)	Factory reservation
30029	16bit Integer(r)	MCU Chip temperature
30030	16bit Integer(r)	Factory reservation
30031	16bit Integer(r)	Calibration Curve Zero (Magnification 100)
30032	16bit Integer(r)	Calibration Curve Slope (Magnification 100)
30033~43	16bit Integer(r)	Factory reservation
30044~45	16bit Integer(r)	Serial No
30046	16bit Integer(r)	Firmware version
30047~63	8*16bit Integer(r)	name (TCD_H2)

7. FAQ and Maintenance

Measuring instruments has a solid and reliable design in in electrical and mechanical, and very resistant to corrosion and wear.

Checking step when there is a problem:

1. Check the power supply;
2. Switch to nitrogen,or Hydrogen and observe changes in measured values;
3. Depending on the application, calibration is recommended every 1 to 3 months.