KEYENCE

96Mxxxxx

Radar Type Level Sensor
FR Series
Long-range (FR-LM(H)20/LP(H)20/LS20)
Instruction Manual

Details about the FR Series functions and how to use the unit can be found in the "FR Series User's Manual." A copy of the "FR Series User's Manual" can be downloaded off of the KEYENCE website. Alternatively, contact a local KEYENCE representative. KEYENCE website: http://www.keyence.com

Read this manual before using the product in order to achieve maximum performance. Keep this manual in a safe place after reading it so that it can be used at any time.

Symbols

The following symbols alert you to important messages. Be sure to read these messages carefully.

DANGER	**Indicates a hazardous situation which, if not avoided, will result in death or serious injury.**
WARNING	**Indicates a hazardous situation which, if not avoided, could result in death or serious injury.**
CAUTION	**Indicates a hazardous situation which, if not avoided, could result in minor or moderate injury.**
NOTICE	**Indicates a situation which, if not avoided, could result in product damage as well as property damage.**
Important	**Indicates cautions and limitations that must be followed during operation.**
Point	**Indicates additional information on proper operation.**
Reference	Indicates tips for better understanding or useful information.

Safety Precautions

■ General precautions

DANGER	• **Do not use this product for the purpose of protecting a human body or a part of a human body.** • **This product is not intended for use as an explosion-proof product. Do not use this product in a hazardous location and/or potentially explosive atmosphere.** • **Do not use this product in an application that may cause death, serious injury, or serious property damage due to a failure with this product occurring, such as in nuclear power plants; on aircraft, trains, ships, or vehicles; used within medical equipment, playground equipment, roller coasters, and other rides.**
WARNING	• **Do not use the FR-SH01(C) for applications such as beverages, food, and medical services. Also, if using the FR-LP(H)20(L) for applications such as beverages, food, and medical services, be sure to use a ferrule mounting bracket (OP-88888).** • **If the equipment is used in a manner not specified by the manufacturer, the protection provided by the equipment may be impaired.** • **You must perform a sufficient risk assessment for the machine where this product is to be installed prior to installing this product. Provide appropriate protective fail-safe measures on the machine independent from this product in case a failure with this product should occur.**
CAUTION	• **Before starting operation and during operation, verify the functions and performance of the product.** • **In case any failure occurs with the product, take sufficient safety measures to prevent further damage.**
NOTICE	• **The sanitary model (FR-LS20(L)) needs to be cleaned prior to use.** • **If the product is used in combination with other equipment, the functions and performance may not meet expectations depending on the operating condition, environment, and other conditions. Consider these points before using this product.** • **If this product is used for an acid or alkaline medium, or for an application within sanitary environments and electroplating, check the resistance of the sensor materials to the target medium or application beforehand.**

■ Precautions on media

NOTICE	**Measured values may exceed the upper limit if conductive components in the target medium adhere to the bottom of the main unit. In this case, clean the bottom of the main unit to remove the adhered substances.**

■ Precautions on handling

CAUTION	• **When detecting a high-temperature liquid, the temperatures of the metal components of the sensor will also rise, which may cause burns. Do not touch these metal components during operation.** • **Do not touch the thread component of the main unit because it is sharp.**

■ Precautions on installation

CAUTION	**Do not install the sensor in the following locations, as this may result in an accident:** • **A location where the main unit is subject to vibrations or impact greater than its environmental resistance** • **A location whose ambient temperature does not fall within the ambient operating temperature range** • **A location where the humidity surrounding the main unit is not between 35%RH and 85%RH (no condensation)** • **A location subject to sudden changes in temperature** • **A location with any volatile combustibles, solvents, or corrosive gases** • **A location with a strong magnetic or electric field**
NOTICE	**During installation, take the following into account to improve the noise immunity. Otherwise, a malfunction may occur.** • **When using IO-Link, do not use a power cable whose length exceeds 20 m.** • **Mount the sensor as far away as possible from any power lines.** • **Mount the sensor as far away as possible from any equipment generating a high electric or magnetic field (such as solenoids and choppers).** • **Wire input/output signal lines separately from power and high-tension lines.** **Power supply** • **Noise superimposed on the power supply may result in malfunction. Be sure to use a stabilized DC power supply with an isolating transformer.** • **When using a commercially available switching regulator, be sure to ground the frame ground terminal.** • **Failing to abide by the recommended installation conditions in this manual may lead to unstable detection.**

Precautions on Regulations and Standards

■ CE and UKCA marking

Keyence Corporation has confirmed that this product complies with the essential requirements of the applicable EU Directive(s) and UK regulations, based on the following specifications. Be sure to consider the following specifications when using this product in the Member States of European Union and in the United Kingdom.

●RE Directive (CE) and Radio Equipment Regulations (UKCA)

- Operating frequency: 58 to 63 GHz
- Maximum radio output:
  FR-S(H)01(C): -12.81 dBm (0.05 mW)
  FR-LM(H)20/LP(H)20/LS20: -5.89 dBm (0.26 mW)
  FR-LM(H)20L/LP(H)20L/LS20L: -17.36 dBm (0.02 mW)

Remarks: These specifications do not give any guarantee that the end-product with this product incorporated complies with the essential requirements of RE Directive and Radio Equipment Regulations. The manufacturer of the end-product is solely responsible for the compliance of the end-product itself according to RE Directive and Radio Equipment Regulations.

■ CSA certificate

This product complies with the following CSA and UL standards and has been certificated by CSA.

- Applicable standard CAN/CSA C22.2 No.61010-1
  UL61010-1

Be sure to consider the following specifications when using this product as a product certified by CSA.

- Overvoltage category I
- Pollution degree 3 (FR-S(H)01(C)/SA1/SA2/SA1C/SA0/LS20(L))
- Pollution degree 4 (FR-LM(H)20(L)/LP(H)20(L))
- Use this product at an altitude of 5000 m or less.
- Use a CSA/UL certified power supply that provides Class 2 output as defined in the CEC (Canadian Electrical Code) and NEC (National Electrical Code).
- The FR-LM20/LP20 can also be used outdoors. In that situation, use the FR-LMP1 protection cover.
- When using the FR-LM20 outdoors, ensure the ambient temperature is 40°C or lower and select [Turns off when no op.] for "Screen brightness."

■ Precautions on radio communication

- The FR Series uses the 60 GHz band.
- Radio frequency interference slowing or even preventing measurement may occur if this product is used in the vicinity of equipment that uses the same frequency band such as wireless LAN equipment, microwaves, factory-use heaters, and high-frequency medical equipment.
  Industrial, scientific, and medical equipment as well as on-site radio stations (requiring a license) used on factory production lines to identify moving bodies, specified low-power radio stations (not requiring a license), and amateur radio stations (requiring a license) operate in the frequency band used by this device.
- KEYENCE declares that the FR-S(H)01(C)/LS20(L)/LM(H)20(L)/LP(H)20(L) complies with Radio Equipment Directive 2014/53/EU.
- The entirety of this declaration of conformity with this EU directive is available at the following Internet address.
  [www.keyence.com/cedoc]
- 사용자 안내문
  이 기기는 업무용 환경에서 사용할 목적으로 적합성평가를 받은 기기로서 가정용 환경에서 사용하는 경우 전파간섭의 우려가 있습니다.
  본 기기는 통상 이용 상태의 경우 인체(머리, 몸통)와 20cm 초과하는 거리에서 사용되어야 합니다.

■ Precautions on radio communication (FR-S(H)01(C)/LS20L/LM(H)20L/LP(H)20L)

- This device complies with part 15 of the FCC Rules.
- Operation is subject to the following two conditions:
  (1) This device may not cause harmful interference, and
  (2) this device must accept any interference received, including interference that may cause undesired operation.
- FCC CAUTION Changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

Note: This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment.

- This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications.
- Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his own expense.
- This equipment complies with FCC radiation exposure limits set forth for an uncontrolled environment and meets the FCC radio frequency (RF) Exposure Guidelines.
- This equipment should be installed and operated keeping the radiator at least 20cm or more away from person's body.
- This device contains licence-exempt transmitter(s)/receiver(s) that comply with Innovation, Science and Economic Development Canada's licence-exempt RSS(s). Operation is subject to the following two conditions:
  1. This device may not cause interference.
  2. This device must accept any interference, including interference that may cause undesired operation of the device.
- L'émetteur/récepteur exempt de licence contenu dans le présent appareil est conforme aux CNR d'Innovation,
  Sciences et Développement économique Canada applicables aux appareils radio exempts de licence. L'exploitation est autorisée aux deux conditions suivantes :
  1. L'appareil ne doit pas produire de brouillage;
  2. L'appareil doit accepter tout brouillage radioélectrique subi, même si le brouillage est susceptible d'en compromettre le fonctionnement.
- This equipment complies with ISED radiation exposure limits set forth for an uncontrolled environment and meets RSS-102 of the ISED radio frequency (RF) Exposure rules.
- This equipment should be installed and operated keeping the radiator at least 20cm or more away from person's body.
- Cet équipement est conforme aux limites d'exposition aux rayonnements énoncées pour un environnement non contrôlé et respecte les règles d'exposition aux fréquences radioélectriques (RF) CNR-102 de l'ISDE.
- Cet équipement doit être installé et utilisé en gardant une distance de 20 cm ou plus entre le radiateur et le corps humain.
- 取得審驗證明之低功率射頻器材，非經核准，公司、商號或使用者均不得擅自變更頻率、加大功率或變更原設計之特性及功能。
  低功率射頻器材之使用不得影響飛航安全及干擾合法通信；經發現有干擾現象時，應立即停用，並改善至無干擾時方得繼續使用。
  前述合法通信，指依電信管理法規定作業之無線電通信。 低功率射頻器材須忍受合法通信或工業、科學及醫療用電波輻射性電機設備之干擾。

■ Precautions on radio communication (FR- LM(H)20/LP(H)20)

- This equipment should be used outdoors.
- This device complies with part 15 of the FCC Rules.
- Operation is subject to the following two conditions:
  (1) This device may not cause harmful interference, and
  (2) this device must accept any interference received, including interference that may cause undesired operation.
- FCC CAUTION Changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

Note: This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment.

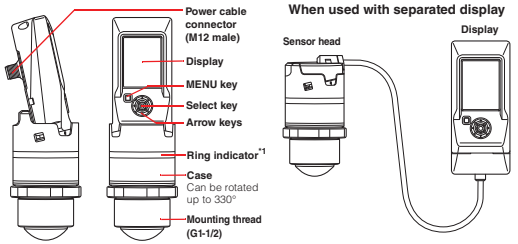
- This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications.
- Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his own expense.
- This equipment complies with FCC radiation exposure limits set forth for an uncontrolled environment and meets the FCC radio frequency (RF) Exposure Guidelines.
- This equipment should be installed and operated keeping the radiator at least 20cm or more away from person's body.

Packaged Items

- Main unit
- Instruction Manual
- Precautions (FR-LP20 only)

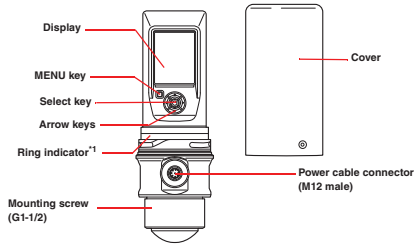
System Configuration Example and Name of Each Component

■ Standard model; chemical model



*1 Lights in red, yellow, or green depending on the indicator pattern setting.

■ Sanitary model



*1 Lights in red, yellow, or green depending on the indicator pattern setting.

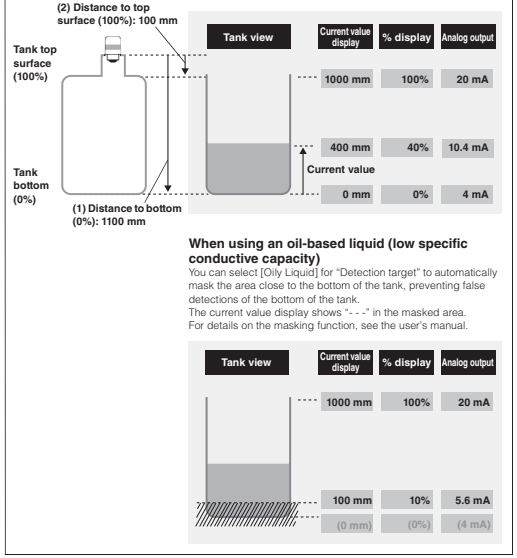
Product Overview

The FR Series allows you to specify the following values.

(1) The distance from the reference surface of the sensor to the bottom of the tank (0%)
(2) The distance from the reference surface of the sensor to the top surface of the tank (100%)

With these values specified, the sensor displays the level of the liquid/powder from the bottom of the tank.

Example) The FR Series is mounted 100 mm above the top surface of a tank whose height (the position at which the tank is filled to 100% capacity) is 1000 mm.



When using an oil-based liquid (low specific conductive capacity)

You can select [Oily Liquid] for "Detection target" to automatically mask the area close to the bottom of the tank, preventing false detections of the bottom of the tank.
The current value display shows "- - -" in the masked area.
For details on the masking function, see the user's manual.

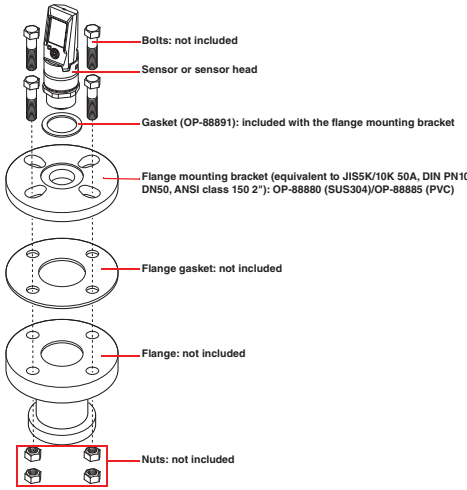
Installation and Mounting

Mounting the sensor

■ Mounting on the flange nozzle

1. **Fit a gasket (included with the flange mounting bracket)[1] on the flange mounting bracket, and then mount the sensor or sensor head on the flange mounting bracket.**
   Recommended tightening torque: 30 N·m for the FR-LM20 and 1.5 N·m for the FR-LP20
2. **Insert a flange gasket[1] between the parts, and then use nuts and bolts to mount the flange mounting bracket on the flange nozzle.**

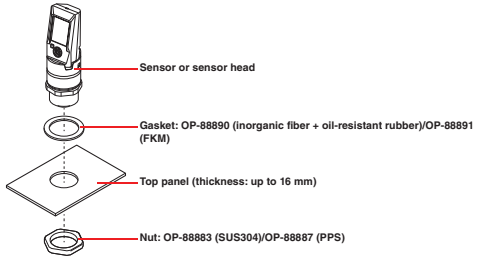
[1] Rubber packing is not required if an airtight seal is not required.



■ Mounting directly on a top panel (mounting with a nut)

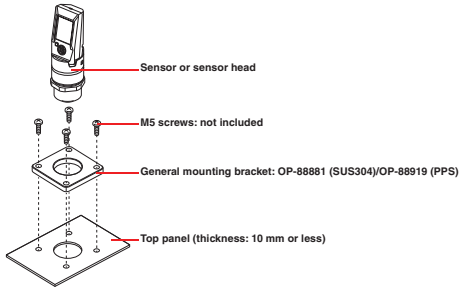
1. **Drill a hole with a diameter of 49 mm in the top panel.**
2. **Fit a gasket[1] on the threads of the sensor or sensor head, and then insert the threads in the hole in the top panel.**
3. **Attach a nut from the bottom of the top panel.**
   Recommended tightening torque: 30 N·m for the FR-LM20 and 1.5 N·m for the FR-LP20

[1] A gasket is not required if an airtight seal is not required.



■ Mounting directly on a top panel (using a mounting bracket, not a nut)

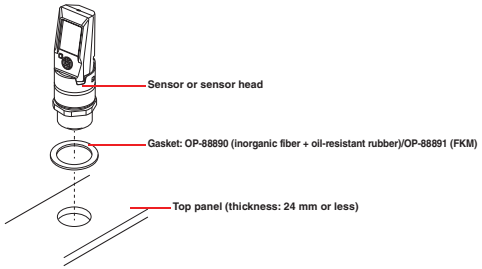
1. **Insert the threads of the sensor or sensor head into a general mounting bracket.**
   Recommended tightening torque: 30 N·m for the FR-LM20 and 1.5 N·m for the FR-LP20
2. **In the top panel, drill a hole with a diameter of 49 mm and four screw holes for securing the general mounting bracket, and then use screws to secure the general mounting bracket on this panel.**



■ Mounting directly on a top panel (screwing in the device)

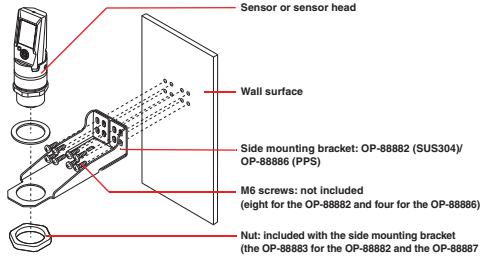
1. **Drill a G1-1/2 screw hole in the top panel.**
2. **Fit a gasket[1] on the threads of the sensor or sensor head, and then screw this device into the top panel.**
   Recommended tightening torque: 30 N·m for the FR-LM20 and 1.5 N·m for the FR-LP20

[1] A gasket is not required if an airtight seal is not required



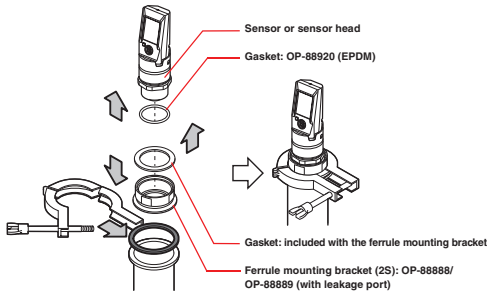
■ Mounting on an inner wall

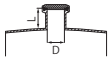
1. **Mount a side mounting bracket on a wall with M6 screws.**
2. **Insert the sensor or sensor head into the bracket, and then attach a nut from the bottom of the bracket.**
   Recommended tightening torque: 30 N·m for the FR-LM20 and 1.5 N·m for the FR-LP20



■ Mounting on a ferrule

1. **Attach the OP-88920 aligned with the sides of the lens unit at the bottom of the sensor.**
2. **Mount the gasket included with the ferrule mounting bracket on the top of this bracket.**
3. **Mount the ferrule mounting bracket on the sensor or sensor head.**
   Recommended tightening torque: 30 N·m for the FR-LM20/LS20 and 1.5 N·m for the FR-LP20
4. **Mount the ferrule gasket on the ferrule, and then mount this assembly on the sensor using a clamp.**

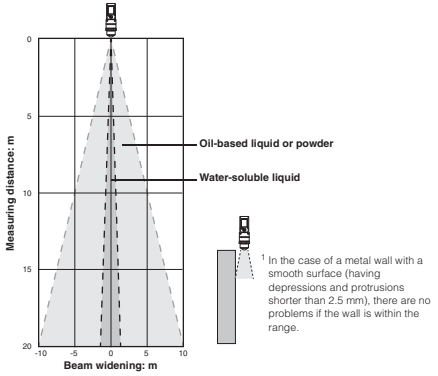




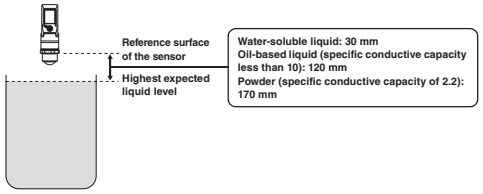
* Mount on a ferrule that meets the following dimensions.
L≤D
L must not exceed 127 mm.

Recommended installation conditions

The FR Series beam widens as follows.
Ensure there are no metal obstacles in the following range.



Detection may be unstable at close distances.
Install the sensor or sensor head at the following recommended distances from the expected upper limit of the liquid level.



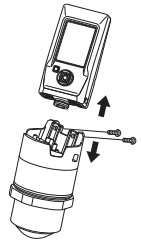
Adjusting the orientation of an installed sensor

The case can be rotated up to approximately 340°. After securing the sensor to a mounting bracket or something similar, rotate the case while holding the hexagon part in place with a wrench to orient the display as desired.

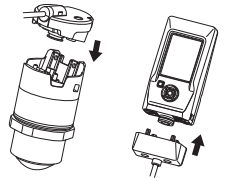
Point **The case of the sanitary model (FR-LS20) does not rotate. Adjust its orientation when mounting the sensor on a ferrule.**

Mounting with separated display (standard model/chemical model)

1. **Remove the two screws (M3 screws for the FR-LM20 and M4 screws for the FR-LP20) from the back, and then pull the display away from the sensor head.**

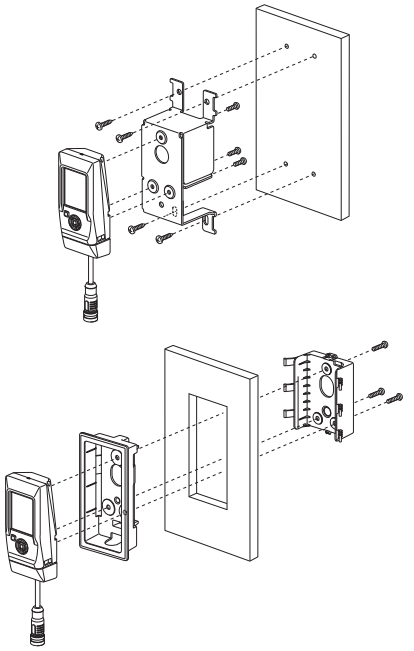


2. **Connect the display and the sensor head with a dedicated cable (FR-LMS5 or FR-LPS5), and then tighten the screws in two locations on the display and sensor head to secure the cable.**
   Recommended tightening torque:
   6.3 N·m (FR-LMS5)/0.2 N·m (FR-LP20)



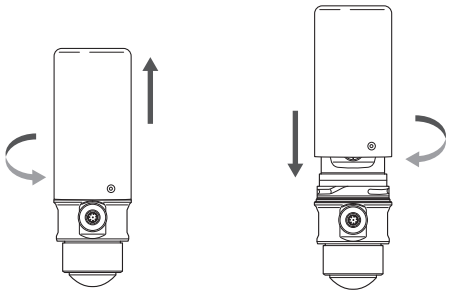
Point **Applying more than the recommended tightening torque may damage the screws.**

3. **Secure the display with the Panel Mounting Bracket FR-LB1 or Rear Mounting Bracket FR-LB2.**



Attaching/removing the cover (sanitary model)

- Removing the cover
  Turn the cover counterclockwise, and then remove it.
- Attaching the cover
  Align the indentation on the cover with the entrance to the groove, and then turn the cover clockwise.



Wiring

■ Pin layout

- **Power cable connector pin layout**

Pin #	Color	Description
1	White	Analog output
2	Brown	Power supply (24 VDC)
3	Green	OUT3
4	Yellow	OUT4
5	Gray	OUT1
6	Pink	OUT2*
7	Blue	0 V
8	Red	OUT5

*IO-Link-compatible wire when connecting an IO-Link device

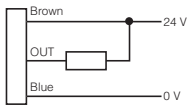
Independently insulate any unused input/output wires.

Load (input device)

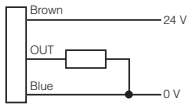
Analog current input device

(1) Control output wiring

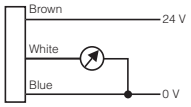
- **NPN**



- **PNP**



(2) Analog output wiring



* It is possible to switch between 4-20 mA and 0-20 mA using settings.

Connecting the Power Cable

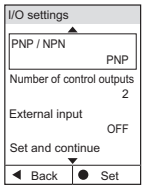
1 Plug the power cable into the power cable connector.

NOTICE	**When connecting the connector, plug it in straight and fix it firmly. If the tightening is not sufficient, the connector may loosen, which may lead to contact failures.**

Initial Setting at First Startup

When the sensor is turned on for the first time, configure the following initial settings.

- Select parameters with the △ and ▽ keys and use the ● Set key to confirm entries.
- To return to the previous screen, press the ◁ key.



Underlined items are initial values

Language	**ENGLISH, 日本語, 中文, DEUTSCH**
PNP/NPN	**PNP, NPN**
Number of control outputs	**0, 1, 2, 3, 4, 5**
Detection target	**Water-soluble liquid, Oily Liquid, Powder**
Distance unit	**mm (millimeters), m (meters)**
Display value scaling	**OFF, ON**
Display value unit*1	**No unit, mL, L, hL, m³, g, kg, t, mm, m, %**
Decimal point position*1	**99999, 9999.9, 999.99, 99.999, 9.9999**
Tank shape*1	**Straight tank, Spherical tank, Cylindrical tank (horizontal placement), Cone base tank, Quadrangular pyramid base tank, Sloped base tank, Multipoint correction**
Distance to bottom	**0 to 25000 mm**
Distance to top surface	**0 to 25000 mm**
Height of base*1, 2	**0 to 25000 mm**
Tank capacity*1	**0 to 99999**
Number of multipoint correction points*1, 3	**2 to 32**
Point 1_Height*1, 3, 4	**0 to 99999**
Point 1_Current value *1, 3, 4	**0 to 99999**
Set value 1*5	**0 to 99999**
Output logic 1*5	**N.O., N.C.**
Indicator pattern*6	**Pattern 1, Pattern 2, Pattern 3, Only green, Always Off**

*1 This item is only displayed when [ON] is selected for "Display value selection."
*2 This item is only displayed when [Cone base tank], [Quadrangular pyramid base tank], or [Sloped base tank] is selected for "Tank shape."
*3 This item is only displayed when [Multipoint correction] is selected for "Tank shape."
*4 Points 2 to 32 are displayed depending on the value selected with Number of multipoint correction points.
*5 Numbers 1 to 5 are displayed depending on the value selected with Control outputs. Nothing is displayed if "0" is selected with Control outputs.
*6 The selectable number of patterns varies depending on the set judgment output count.

- **Number of control outputs**

At most, there are five outputs, one external input, and one analog output.

- Set the number of control outputs to use.
  The set number of control outputs are assigned in order from OUT1.
  You can only use up to four control outputs when you select [ON] for "External input."
- Other functions can be assigned to outputs to which control outputs are not assigned.
  For details on these functions, see the user's manual.
- Each control output can also be changed to area mode.
  For details on area mode, see the user's manual.

Pin #	Color	Name	Control output	Auxiliary output			External input	Analog output	IO-Link
				Error	Stability alarm	Period change	Reset period change		
5	Gray	OUT1	✓	✓	✓	✓	-	-	-
6	Pink	OUT2	✓	✓	✓	✓	-	-	*
3	Green	OUT3	✓	✓	✓	✓	-	-	-
4	Yellow	OUT4	✓	✓	✓	✓	-	-	-
8	Red	OUT5/IN	✓	✓	✓	✓	✓	-	-
1	White	Analog output	-	-	-	-	-	✓	-

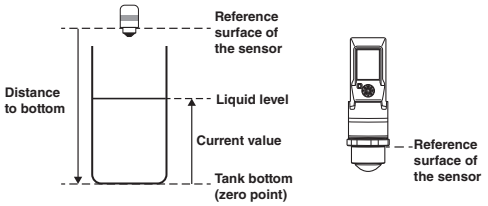
- **Detection target**

Select [Water-soluble liquid] if the specific conductive capacity of the measurement target is 10 or higher, [Oil-based liquid] if the specific conductive capacity of the target is less than 10, and [Powder] if the target is a powder.
If you select [Oil-based liquid], the area from the base to 10% of the height of the tank on the side far from the sensor is masked.
For details, see the user's manual.

Point **Selecting an incorrect detection target may prevent accurate detection of the liquid surface.**

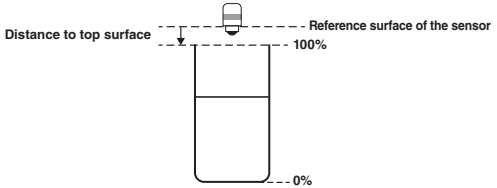
- **Distance to bottom**

Enter the distance from the reference surface of the sensor to the bottom of the tank.
For the position of the reference surface of the sensor when using a mounting bracket, see the dimensions provided in, for example, the catalog.
The height of the liquid surface from the bottom of the tank is displayed as the current value with the position indicated by this distance used as the zero point (0%).



- **Distance to top surface**

Enter the distance from the reference surface of the sensor to the top surface of the tank.
This position is 100% in the % display.



- **Display value selection**

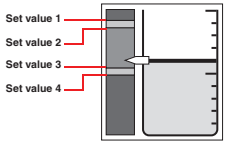
OFF: The height of the liquid level is displayed.
ON : The display value is scaled and converted to volume or weight.
For scaling, you can select the tank shape or enter a conversion table with up to 32 multipoint correction points.
For details on multipoint correction, see the user's manual.

- **Output logic 1**

N.O.: Control output turns on when the current value exceeds one of the set values.
N.C.: Control output turns on when the current value drops below one of the set values.

- **Indicator pattern**

You can select the lighting order of the ring indicator according to the liquid surface position.
The indicator color is also linked to the color bar on the current value screen.

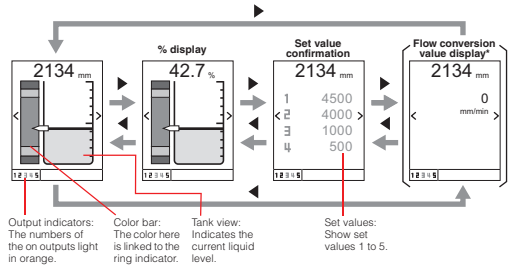


The number of selectable indicator orders varies depending on the number of control outputs. Select the indicator pattern from those shown below.
To use a different pattern, select Custom. For details on how to set custom order, see the user's manual.

Number of control outputs	Order 1	Order 2	Order 3	Only green	Always Off
0				Green	
1	Red Green	Green Red		Green Green	
2	Red Yellow Green	Green Yellow Red	Red Green Red	Green Green Green	
3	Red Yellow Green Red	Red Green Yellow Red	Red Green Green Green	Green Green Green Green	
4	Red Yellow Green Yellow Red	Red Green Green Green Red		Green Green Green Green Green	
5	Red Yellow Green Green Yellow Red	Red Green Green Green Green Red		Green Green Green Green Green Green	

Basic Operation

■ Current value screen

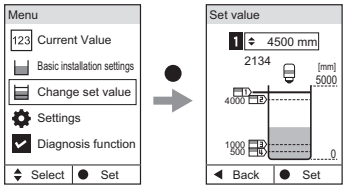


* This item is only displayed when "ON" is selected for Flow conversion mode.

■ Changing set values

Press the MENU key on the current value display to enter the menu, and then select Change set value.
Use the ▲ and ▼ keys to adjust the set value, and then confirm the change with the ● Set key.

Menu screen



■ Key lock

This function prevents operation mistakes by locking/disabling key operations to prevent the settings from being easily changed.
To require a password when canceling the key lock, set “Key lock method” to “With password.”
Enabling/disabling the key lock:
Hold down the ■ MENU key and the ▼ key for 3 seconds or more.
When “Key lock method” is set to “With password,” the password is required when unlocking the keys.

Reference If the password entered is incorrect, an error will occur, and the normal screen will appear with the key lock still enabled.

■ Initializing settings

Press the MODE key on the current value screen to display the menu screen, and then select “Settings” > “Initialize.”

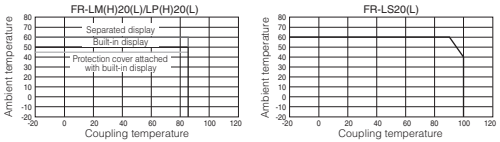
Maintenance

- Clean deposits and foreign substances on the mounting bracket and the bottom of the sensor or sensor head as necessary.
- If using the FR-LS20, it is recommended to replace the gasket (OP-88920) inside the ferrule mounting bracket once a year. At that time, also wipe away any dirt inside the ferrule mounting bracket with a soft cloth.

Specifications

Item		Standard model	Chemical model	Sanitary model
		FR-LM(H)20(L)	FR-LP(H)20(L)	FR-LS20(L)
Measurement range*1		Max. 20 m 65.6 ft		
Displayable range*1		Max. 25 m 82.0 ft		
Specific conductive capacity of target media*2		2 or more		
Resolution		1 mm		
Accuracy*3		0 to 0.5 m: ±5 mm 0.5 to 10 m: ±1 mm 10 m to 20 m: ±2 mm		
Control output response time		0.4 s, 1.5 s, 4 s (default), 10 s		
Tank pressure		-0.1 to 1 MPa	-0.1 to 0.1 MPa	-0.1 to 1 MPa
Material	Inside the tank	Lens: PTFE Internal packing: FKM entering part: SUS304	Lens: PTFE Internal packing: FKM entering part: PPS	Lens: PTFE Ferrule internal packing: EPDM (when using the OP-88920) Ferrule: SUS316L (when using the OP-88888/88889)
	Case	PPS PET PAR	PPS PPSU	SUS304
Connection port		G1-1/2 (40A)	G1-1/2 (40A)	2S ferrule (when using the OP-88888/88889)
Output	Number of control outputs	Max. 5		
	Contro output/ alarm output	NPN/PNP open collector (switchable), 30 VDC max., 50 mA max. for each output, residual voltage: 1.4 V max. (50 mA max.), N.O./N.C. switchable, IO2 also used for IO-Link, IO5 also used for external input		
	Analog output	0-20mA/4 to 20 mA, maximum load resistance: 260 Ω (Response time: 0.2 s after comparator output determined [90% response])		
Network compatibility		IO-Link v1.1/COM2		
Analog output accuracy	Resolution	1 mm		
	Zero accuracy	±0.1 mA (zero = 4 mA)		
	F.S. accuracy	±0.2 mA (F.S. = 20 mA)		
Environmental resistance	Ambient temperature	Built-in and separated display: −20 to +50°C (no freezing)*4, *5 Separated head: −20 to +60°C (no freezing)*4, *5	Built-in and separated display: −10 to +50°C (no freezing)*4, *5 Separated head: −10 to +60°C (no freezing)*4, *5	-20 to +60°C (no freezing)*4, *5
	Ambient humidity	Max. 85%RH (no condensation)		
	Operating coupling temperature*4, *5	-20 to +85°C (no freezing)*4, *5	-10 to +85°C (no freezing)*4, *5	-20 to +100°C (no freezing)*4, *5
	Vibration resistance	10 to 500 Hz; Power spectral density: 0.816 G^2/Hz; X, Y and Z directions		
	Shock resistance	100 m/s^2 (approx. 10 G), 16 ms pulses, 1000 times each for X, Y and Z axes		
Enclosure rating		IP67(IEC60529), Enclosure Type 4X(NEMA250)		IP67(IEC60529), IP69K(ISO20653)
Protection circuit		Protection against reverse power connection, output overcurrent, output surge, and reverse output connection		
Power voltage		24 VDC+25%/-20% including ripple, Class 2/LPS		
Current consumption		56 mA max. (at 20 V)/ 48 mA max. (at 30 V) (excluding load)	75 mA max. (at 20 V)/ 67 mA max. (at 30 V) (excluding load)	56 mA max. (at 20 V)/ 48 mA max. (at 30 V) (excluding load)
Corresponding cable/connector		8-pin M12 connector		

*1 Value guaranteed with water and the recommended mounting method. With water and the recommended mounting method, measurement is possible right up to the lens surface. An undetectable area on the near side occurs due to the relationship between the environment and the measurement medium. Additionally, the maximum measuring distance decreases.
*2 The target shape or the environment may make measurement impossible.
*3 This value is guaranteed by KEYENCE inspection facilities. Errors may occur due to your environment.
*4 The operating temperature range for each model is as follows.



On the FR-LM20/LP20, selecting [Turns off when no op.] for “Screen brightness” can alleviate the ambient temperature regulation by 10°C.
*5 When performing SIP with the FR-LM(H)20(L)/LP(H)20(L)/LS20(L), turn the power supply off, and then perform this operation for 1 hour or less with an ambient temperature of 40°C or less and an internal system temperature of 130°C. Also, be sure to attach a ferrule mounting bracket and an internal gasket, which are optional KEYENCE products.

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