KEYENCE

96M17970

Radar level sensor

FR Series Long Range 2-wire

Explosion-proof Model

(FR-LEX20(L)) Instruction

Manual

For details on the functions of the FR series and specific usage methods, see the "FR Series User's Manual." If you do not have the "FR Series User's Manual," download it from the Keyence website. Alternatively, contact your nearest sales office. <Keyence website> www.keyence.co.jp

Please read this instruction manual before use. After reading, keep it in a safe place for future reference.

How to read the symbols

In this instruction manual, the following symbols are used to make important information clear at a glance. Please be sure to read them.

danger	Failure to follow the instructions described here may result in injury or death. Failure to follow the instructions described here may
caveat	result in injury or death. Failure to follow the instructions described here may result in injury or death. Failure to follow the instructions described here
Note	may result in injury or death. Failure to follow the instructions described here may result in damage to the product itself (your own damage) as well
Notes	as damage to other property.

Important	This indicates caution regarding operations that must be performed.
point	This indicates caution regarding operations that are easy to make mistakes with.
Reference	Indicates matters that will deepen your understanding of the text or information that is useful to know.

For your safety

ÿ General precautions

danger	• Do not use this product to protect the human body or any part of the human body. • When using this product in an explosion-proof area, be sure to follow the precautions in this instruction manual. please. • Please use this product only after determining that there is no risk of corrosion or damage to the equipment. • Do not use this product in applications where the operating condition of the product may cause serious injury to persons or property (power plants, aviation, railways, ships, vehicles, medical equipment, recreational toys, etc.).
caveat	• Do not use the FR-SH01(C) in applications where leaching is a concern (beverages, food, medical use, etc.). When using the FR-LP(H)20(L) in applications where leaching is a concern (beverages, food, medical use, etc.), be sure to use the ferrule attachment tool (OP-88888). • If this product is not used in accordance with our specifications, the product's protection may not function effectively. • When installing this product, perform a risk assessment of the entire system and confirm that appropriate risk reduction has been implemented. To ensure that the entire system operates safely even in the event of an abnormality, provide appropriate protective measures without using this product.
Note	• At the time of starting or operating, the functions and performance of our products are operating normally. Please make sure that it is installed before using it. • In the unlikely event that our product breaks down, please take sufficient safety measures to prevent various damages.
Notes	• Clean the sanitary model (FR-LS20(L)) before use. • When using our products in combination with other equipment, the product may not function and perform to its full potential depending on the usage conditions and environment, so please consider this before use. • When using this product in acidic or alkaline media, in a sanitary environment, or for applications such as electroplating, check the resistance of the sensor material to the media.

ÿ Notes on media

Notes	If conductive components in the medium adhere to the bottom of the unit, the measured value may exceed the upper limit. Clean the bottom of the unit to remove any attached material.

ÿ Handling precautions

Note	• When detecting high-temperature liquid, the metal parts of the product may also become hot and cause burns. Do not touch the metal parts during operation. • Do not touch the threads on the main body as they are sharp.

ÿ Installation precautions

Note	To prevent accidents, avoid installing the product in the following locations: • Locations where the product is subjected to vibrations or shocks that exceed its environmental resistance • Locations where the ambient temperature is outside the range of the ambient temperature for use • Locations where the humidity around the product is not 85% RH or less (no condensation) • Locations with sudden temperature changes • Locations where there are volatile flammable substances, solvents or corrosive gases • Locations where strong magnetic or electric fields are generated
Notes	To improve noise resistance, consider the following points when installing the product. It may cause malfunction. • When using IO-Link, the power cable length should be 20m or less. • Install the product as far away as possible from power lines. • Keep the product away from devices that generate strong electric or magnetic fields (solenoids, choppers, etc.). Please install them as far apart as possible. • Input/output signal lines should be routed separately from power lines and high voltage lines. Power supply • Noise superimposed on the power supply may cause the unit to malfunction. Use a DC stabilized power supply that uses an isolation transformer. If the recommended installation conditions described in this manual are not followed, detection may not be stable. there is.

Notes on regulations and standards ÿ About CE and UKCA

marking We have confirmed that this product meets the essential requirements of EU directives and UK regulations based on the following requirements. If you use this product in EU countries or the UK, please bear in mind the following requirements.

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

•Operating frequency: 58 - 63GHz

•Maximum wireless output: FR-S(H)01(C): -12.81dBm (0.05mW)
FR-LM(H)20/LP(H)20/LS20/LW20/LEX20: -5.89dBm (0.26mW)
FR-LM(H)20L/LP(H)20L/LS20L/LW20L/LEX20L: -17.36dBm (0.018mW) These requirements do not guarantee that the entire machinery incorporating this product satisfies the essential requirements of the RE Directive and the Radio Equipment Regulations. It is the responsibility of the manufacturer of the machinery to verify the conformity of the entire machinery.

ÿ About CSA certification This product complies with the following CSA and UL standards and has been CSA certified. • Applicable standards CAN/CSA C22.2 No.61010-1 UL61010-1 When using this product as a CSA certified product, please note the following requirements. • 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)) • Install at an altitude of 5000m or less. • Install in accordance with the CEC (Canadian Electrical Code), (NEC (National Electrical Code) and other local regulations. In addition, use a CSA/UL Listed certified power supply with Class 2 output as specified in the CEC and NEC.

ÿ Wireless Precautions • The FR series uses the 60 GHz band. • Be sure to use the FR series in accordance with the rules, regulations, and laws of the country or region in which it is used. please.
• When used near devices that use the same frequency band as this unit, such as wireless LAN devices, microwave ovens, industrial heating equipment, and medical high-frequency equipment, radio interference may occur, causing the measurement speed to slow down or making it impossible to make measurements. • In the frequency band used by this unit, in addition to industrial, scientific, and medical equipment, indoor radio stations (radio stations requiring a license) for mobile identification, specific low-power radio stations (radio stations not requiring a license), and amateur radio stations (radio stations requiring a license) are operated, which are used in factory production lines, etc. 1. Before using this unit, make sure that indoor radio stations for mobile identification, specific low-power radio stations, and amateur radio stations are not operating nearby. 2. In the unlikely event that radio interference occurs between this unit and indoor radio stations for mobile identification, immediately change the frequency used or stop emitting radio waves, and contact the following contact information to discuss measures to avoid interference (for example, installing a partition, etc.).
3. If you experience any other problems, such as harmful radio interference caused by this device to specific low-power radio stations for mobile identification or amateur radio stations, please contact the following: Contact: Keyence Corporation Telephone: 06-6379-1151
• Do not disassemble or modify this unit as this is prohibited by the Radio Law.
This device is classified as specific wireless equipment under the Radio Law of Japan, and has been certified for its construction design in accordance with the standards set forth in the Radio Law.

ÿ Explosion-proof precautions Radar level sensor FR-LEX20(L) Insulation barrier FR-LEXB41 Zener barrier FR-LEXB42 Zener barrier with flameproof box and cable gland FR-LEXB43 Zener barrier with flameproof box FR-LEXB44 Optional item Protective cover FR-LEXP1

Cable Gland OP-88908 Before using these products, be sure to read the "Safety Precautions" and "FR Series User's Manual". To get the User's Manual, please visit the KEYENCE website or contact your nearest KEYENCE sales office. Please keep these documents in a safe place so that you can refer to them at any time.

1 Basic Safety Information

1.1 Features and Intended Use The FR-LEX series radar level sensor is designed to measure the level of liquid or powder in a tank using a radar system. This device consists of a radar level sensor (display unit and sensor unit), an insulating barrier, a Zener barrier, a Zener barrier with explosion-proof box and cable gland, a Zener barrier with explosion-proof box, an optional protective cover, and an optional cable gland. Models with "EX" at the end are for explosive atmospheres and are subject to these safety precautions.
1.1.1 Radar Level Sensor The radar level sensor consists of a display and a sensor unit. The display is connected to a barrier*1 (intrinsically safe explosion-proof) that supplies power, and the sensor unit that generates radio waves is connected from the bottom. *1 Suitable barriers include FR-LEXB41, FR-LEXB42, FR-LEXB43, or other barriers with specifications that comply with the parameters required for the location where the product is installed. 1.1.2 Isolation Barrier The isolation barrier is dedicated to the FR-LEX series and is connected to the display of the radar level sensor. It employs insulating components for galvanic isolation, so no earth connection is required. The isolation barrier must be installed in an enclosure suitable for the intended location. The isolation barrier is provided with a 4 to 20 mA signal output port. 1.1.3 Zener Barrier

The Zener barrier is dedicated to the FR-LEX series and is connected to the display of the radar type level sensor. It must be installed in an enclosure suitable for the intended location. An earth connection is required during installation.

1.1.4 Zener barrier with flameproof box and cable gland Zener barrier with flameproof box and cable gland refers to a Zener barrier housed in an Ex d/t enclosure. A cable gland is included for Japan. 1.1.5 Zener barrier with flameproof box Zener barrier with flameproof box refers to a Zener barrier housed in an Ex d/t enclosure. The enclosure is equipped with an NPT 1/2 thread for external connection. 1.1.6 Protective cover The protective cover is an optional accessory designed to protect the radar level sensor from the external environment. 1.1.7 Cable gland The cable gland is an optional part used when the display and sensor are installed in different locations. It is used in place of the cable entry cover (plug cover) that is originally attached.
1.2 Regulatory and Standards Notices 1.2.1 CE Marking 1.2.1.1 ATEX Directive This product complies with the EN standards listed in "Technical Information" (Chapter 4) and is certified by CSA Group Netherlands BV.

1.2.1.2 RE Command Refer to the FR Series User's Manual.
1.2.2 UKCA Marking 1.2.2.1 Equipment and protective systems intended for use in potentially explosive atmospheres This product complies with the BS EN Standards listed in "Technical Documentation" (Chapter 4). 1.2.2.2 Radio Equipment Regulations See the FR Series User's Manual.
1.2.3 North American Regulations 1.2.3.1 CSA Certification This product complies with the UL, FM and CSA standards listed in the Technical Information (Section 4) and is certified by the CSA Group.
1.2.3.2 FCC and ICES Please refer to the FR Series User's Manual. 1.2.4 Specific Terms of Use of Certificates (See Chapter 4)

• Isolation and Zener barriers are open equipment (EN/UL/CSA 61010-1) and associated equipment (EN/UL/CSA 60079-0/-11). Install in a control panel or other enclosure suitable for the intended location. • Radar level sensors have a non-metallic housing.
Minimize the risk of electrostatic discharge. - Control ambient humidity to reduce static electricity generation. - Avoid or protect from direct air currents that can cause charge transfer.

stomach.

- Do not use in locations where there is a risk of static electricity. - If necessary, use an insulator to touch the device. - If necessary, provide a means to continuously discharge static electricity.

• The metal parts, the display screw, and the sensor mounting screw are not grounded (there is no earth potential). The resistance between the metal parts and earth is 1 Gÿ or more when measured at 500 Vdc. The maximum capacitance of each part is as follows.
Display: 5 pF Sensor: 15 pF

2 Installation and Maintenance

2.1 General •
The product must be installed in accordance with the regulations and laws of the location where it is installed.

Examples: • IEC/EN 60079-14
• NFPA 70 (National Electrical Code) • CSA C22.1 (Canadian Electrical Code) • JNIOSH-TR-NO.44

• The product must be inspected and maintained in accordance with IEC/EN60079-17. • Only qualified personnel should work on the product (including installation, maintenance and all other work).
• Modification of the product is not permitted. • Please ensure that there is no risk of corrosion or damage to the equipment before use. • During installation and maintenance, please ensure that there is no explosive atmosphere and/or that the power supply is not damage Make sure there is no voltage on the circuit.
• Both the radar level sensor and the Zener barrier with explosion-proof box must maintain their IP ratings. During installation and maintenance, make sure no dust or water gets inside and that the openings are properly closed before starting operation.

2.2 Installation • External connections (cables) used in intrinsically safe circuits must satisfy the following conditions.
-
The external connections (cables) between the radar level sensor (display) and the insulation barrier, and between the devices inside the radar level sensor (display and sensor section) must be selected taking into account the parameters of the barrier, the radar level sensor and the cable. (For example, the inductance of the cable must be smaller than the difference between Lo (barrier) and Li (radar level sensor). The same applies to the capacitance of the cable.) For product parameters, see Chapter 4.2.1 of this instruction manual.
- External connections (cables) must be protected against electromagnetic or electrostatic induction to prevent induction of currents and voltages that may impair the intrinsic safety performance of this product (for example, by using protective conduits or shielded wires). • Installations that span two different areas (Zones or Divisions) must comply with the regulations and standards applicable to the location where the product is used.
• Take care not to mechanically abrade or damage the flameproof joints of the Zener barrier with flameproof box (surface between the housings, threaded joints of the cable entry port). • A cement-fixed explosion-proof seal is required within 50 mm of the conduit entry port of the Zener barrier with flameproof box (threaded joint of the cable entry port when connecting the conduit).

• If you use cable glands for cable connections to the Zener barrier with flameproof enclosure, select the appropriate flameproof cable gland. • The Zener barrier with flameproof enclosure and cable gland are supplied with a certified Ex d/t cable gland. Use this cable gland for the installation. No other cable glands may be used.

• The cable entry of the Zener barrier with explosion-proof box is firmly attached to the housing. It must be locked in.

2.3 Maintenance • It is recommended that you carry out a regular visual inspection of the goods for mechanical damage and corrosion.
• For troubleshooting, refer to the FR Series User's Manual or contact your nearest Keyence sales office.

3 Repairs

All repairs should be carried out by Keyence. If repairs are required, please contact your nearest Keyence sales office. Please note that repairs may not be possible depending on the model.

4. Technical data

4.1 Explosion protection

4.1.1 IECEx

4.1.1.1 Radar level sensors

Model FR-LEX20(L)
Zone 0/20
Marking: Small explosion-proof device, not marked on product
When used with FR-LEXB41 or other barriers *1
Ex ia ÿ C T4 Ga
Ex ia ÿ C T135 ÿ Da
FR-LEXB42, FR-LEXB43, FR-LEXB44 or other barriers *1
and when used
Ex ia ÿ B T4 Ga
Ex ia ÿ C T135 ÿ Da
-30ÿÿTaÿ60ÿ
-30ÿÿTpÿ85ÿ
IP67
*1 For required parameters, see 4.2 Specifications.
So lame.
Certificates IECEx CSAE 24.0010X
Standards IEC 60079-0: 2017
IEC 60079-11: 2011

4.1.1.2 Isolation Barriers

Model FR-LEXB41
Zone Do not install in explosive atmospheres (associated equipment)
Marking [Ex ia Ga] IIC or [Ex ia Ga] ÿ B
[Ex ia Da] IIIC
Certificates IECEx CSAE 24.0010X
Standards IEC 60079-0: 2017
IEC 60079-11: 2011

4.1.1.3 Zener barrier

Model FR-LEXB42
Zone Do not install in explosive atmospheres (associated equipment)
Marking [Ex ia Ga] ÿ B
[Ex ia Da] ÿ C
Certificates and IECEx CSAE 24.0010X
Standards IEC 60079-0: 2017
IEC 60079-11: 2011

4.1.1.4 Zener barrier and flameproof enclosure with cable glands

Zener Barrier with Explosion Box
Model FR-LEXB43, FR-LEXB44
Zone 1/21
Marking Ex db [ia Ga] ÿ B T4 Gb
Ex tb [ia Da] IIIC T135ÿ Db
-30ÿÿTaÿ60ÿ
IP67ÿ1
Certificates IECEx CSAE 24.0010X
Standards IEC 60079-0: 2017
IEC 60079-1: 2014
IEC 60079-11: 2011
*1 The cable gland included with FR-LEXB43 is IP66.
As stated, FR-LEXB43 (including cable gland)
(including power adapters) are rated IP67 certified by CSA Group
vinegar.

4.1.2 ATEX (EU) and UKEX (UK)

4.1.2.1 Radar level sensors

Model FR-LEX20(L)
Zone 0/20
Marking Small explosion-proof equipment, not indicated on product
When used with FR-LEXB41 or other barriers *1
II 1 G Ex ia II C T4 Ga
II 1 D Ex ia III C T135 ÿ Da
When used with FR-LEXB42, FR-LEXB44 or other barriers *1
II 1 G Ex ia II B T4 Ga
II 1 D Ex ia III C T135 ÿ Da
-30ÿÿTaÿ60ÿ
-30ÿÿTpÿ85ÿ
IP67
*1 For required parameters, see 4.2 Specifications.
So lame.
Certificates CSANe 24ATEX1079X
Standards EN IEC 60079-0: 2018/A11: 2014
EN 60079-11: 2012

4.1.2.2 Isolation Barriers

FR-LEXB41
Model Zone Do not install in explosive atmospheres (related equipment)
Marking II(1)G[Ex ia Ga]IIC or ÿ (1) G [Ex ia Ga] ÿ B
II (1) D [Ex ia Da] IIIC
Certificates CSANe 24ATEX1079X
Standards EN IEC 60079-0: 2018/A11: 2014
EN 60079-11: 2012

4.1.2.3 Zener barrier

Model FR-LEXB42
Zone Do not install in explosive atmospheres (related equipment)
Marking ÿ (1) G [Ex ia Ga] ÿ B
ÿ (1) D [Ex ia Da] ÿ C
Certificates and CSANe 24ATEX1079X
Standards EN IEC 60079-0: 2018/A11: 2014
EN 60079-11: 2012

4.1.2.4 Zener barrier with explosion-proof box

Model FR-LEXB44
Zone 1/21
Marking II 2 (1) G Ex db [ia Ga] II B T4 Gb
II 2 (1) D Ex tb [ia Da] IIIC T135 ÿ Db
-30ÿÿTaÿ60ÿ
Certificates CSANe 24ATEX1079X
Standards EN IEC 60079-0: 2018/A11: 2014
EN 60079-1: 2014/A11: 2024
EN 60079-11: 2012

4.1.3 NRTL/ACO (North America)

4.1.3.1 Radar level sensors

Model FR-LEX20(L)
Zone 0/20
Division 1
Marking Small explosion-proof device, not marked on the body
When used with FR-LEXB41 or other barriers *1
Class I, Zone 0, AEx ia IIC T4 Ga
Zone 20, AEx ia IIIC T135ÿDa
Class I, Division 1, Groups A, B, C, D, T4
Class II, Division 1, Groups E, F, G, T135ÿ
Class III, Division 1
When used with FR-LEXB42, FR-LEXB44 or other barriers *1
Class I, Zone 0, AEx ia IIB T4 Ga
Zone 20, AEx ia IIIC T135ÿDa
Class I, Division 1, Groups C, D, T4
Class II, Division 1, Groups E, F, G, T135ÿ
Class III, Division 1
-30ÿÿTaÿ60ÿ
-30ÿÿTpÿ85ÿ
IP67, Type 4X
*1 For required parameters, see 4.2 Specifications.
So lame.
Certificates 24CA80207446X
Standards UL 60079-0 7th Ed./CSA No.60079-0:19
UL 60079-11 6th Ed./CSA No. 60079-11:14
UL 61010-1 3rd Ed./CSA No.61010-1-12

4.1.3.2 Isolation Barriers

Model FR-LEXB41
Zone Do not install in explosive/hazardous locations
Division locations (related equipment)
Marking [AEx ia Ga] ÿ C or [AEx ia Ga] ÿ B
[AEx ia Da] ÿ C
Intrinsically safe circuit for
Class I, Division 1, Group A, B, C, D or Class ÿ
Division 1, Groups C,D
Class II, Division 1, Groups E, F, G
Class III, Division 1
-30ÿÿTaÿ60ÿ
Certificates 24CA80207446X
Standards UL 60079-0 7th Ed./CSA No.60079-0:19
UL 60079-11 6th Ed./CSA No. 60079-11:14
UL 61010-1 3rd Ed./CSA No.61010-1-12

4.1.3.3 Zener barrier

Model FR-LEXB42
Zone Do not install in explosive atmospheres/hazardous locations (related equipment
Device
Division Locations (Related equipment)
Marking [AEx ia Ga] ÿ B
[AEx ia Da] ÿ C
Intrinsically safe circuit for
Class ÿ Division 1, Groups C, D
Class ÿ , Division 1, Groups E, F, G
Class ÿ Division 1
-30ÿÿTaÿ60ÿ
Certificates and 24CA80207446X
Standards UL 60079-0-7th Ed./CSA No. 60079-0:19
UL 60079-11 6th Ed./CSA No. 60079-11:14
UL 61010-1 3rd Ed./CSA No. 61010-1-12

4.1.3.4 Zener barrier with explosion-proof box

FR-LEXB44
Model 1/21
Zone 1
Division Marking Class I, Zone 1, AEx db [ia Ga] ÿ B T4 Gb
Zone 21, AEx tb [ia Da] IIIC T135ÿ Db
Class I, Division 1, Groups C, D, T4
Class II, Division 1, Groups E, F, G, T135ÿ
Class III, Division 1
-30ÿÿTaÿ60ÿ
IP67, Type 4X
Certificates 24CA80207446X
Standards UL 60079-0 7th Ed./CSA No.60079-0:19
UL 60079-1 7th Ed./CSA No. 60079-1:16
UL 60079-11 6th Ed./CSA No. 60079-11:14
UL 61010-1 3rd Ed./CSA No.61010-1-12
FM3600/CSA No.0
FM3615/CSA No.30

4.1.4 Type Approval of Electrical Equipment for Use in Explosive Atmospheres (Japan)

4.1.4.1 Radar level sensors

Model FR-LEX20(L)
Zone 0/20
Marking: Small explosion-proof device, not marked on product
When used with FR-LEXB41 or other barriers *1
Ex ia ÿ C T4 Ga
Ex ia ÿ C T135 ÿ Da
FR-LEXB42, FR-LEXB43, FR-LEXB44 or other barriers*1
and when used
Ex ia ÿ B T4 Ga
Ex ia ÿ C T135 ÿ Da
-30ÿÿTaÿ60ÿ
-30ÿÿTpÿ85ÿ
IP67
*1 For required parameters, see 4.2 Specifications.
So lame.
Certificate CSAUK 24JPN111X
CSAUK 24JPN112X
standard JNIOSH-TR-46-1
JNIOSH-TR-46-6

4.1.4.2 Isolation Barriers

Model FR-LEXB41
Zone Do not install in explosive atmospheres (related equipment)
marking [Ex ia Ga] IIC or [Ex ia Ga] ÿ B
[Ex ia Da] IIIC
Certificate CSAUK 24JPN113X
standard JNIOSH-TR-46-1
JNIOSH-TR-46-6

4.1.4.3 Zener barrier

Model FR-LEXB42
Zone Do not install in explosive atmospheres (related equipment)
marking [Ex ia Ga] IIB
[Ex ia Da] IIIC
Certificate CSAUK 24JPN113X
standard JNIOSH-TR-46-1
JNIOSH-TR-46-6

4.1.4.4 Zener barrier with explosion-proof box and cable gland

Model FR-LEXB43
Zone 1/21
Marking Ex db [ia Ga] ÿ B T4 Gb
Ex tb [ia Da] IIIC T135ÿ Db
-30ÿÿTaÿ60ÿ
IP67ÿ1
Certificate CSAUK 24JPN111X
CSAUK 24JPN112X
standard JNIOSH-TR-46-1
JNIOSH-TR-46-2
JNIOSH-TR-46-6
*1 The cable gland included with FR-LEXB43 is IP66.
As stated, FR-LEXB43 (including cable gland)
(including power adapters) are rated IP67 certified by the CSA Group
vinegar.

4.2 Specifications

4.2.1 Electrical ratings

4.2.1.1 Radar level sensors

Power supply voltage DC18.3 V to DC35 V
Power consumption: 752.5mW
Ui DC35V
142.4mA
Pi 1000mW
Li 26.2nH
Ci 79 nF

4.2.1.2 Isolation barriers

Power supply voltage DC24V (+25%/-10%)
Power consumption: 3W
Um 250 Vrms
UO DC26.78V
IO 115.307mA
PO 772mW

4.2.1.3 Zener barriers, explosion-proof boxes and Zener bars with cable glands

Rear, Zener barrier with explosion-proof box
Power supply voltage DC20.1V to DC28.0V
Power consumption: 602mW
Um 250 Vrms
UO DC34.33V
IO 112.007mA
PO 961.3mW
LO 1.0mH
CO 0.37ÿF

■ Precautions on radio communication (FR-LEX20L)

- 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.

■ Precautions on radio communication (FR-LEX20)

- 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.
- This equipment should be used outdoors.
- 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 20 cm or more away from person's body.

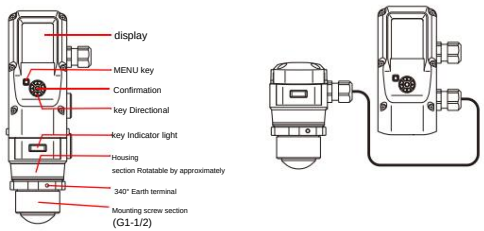
Checking the Package

FR-LEX20(L): •
Main unit • operating instructions • 2 x Cable Glands
FR-LEXB41: •
Isolation barrier • Instructions
FR-LEXB42: •
Zener barrier • operating instructions
FR-LEXB43:
• Zener barrier (in flameproof box with cable gland) • Instruction manual • 2 packings • 2 cable glands • 2 types of labels x 2
FR-LEXB44: •
Zener barrier (in explosion-proof box) • operating instructions

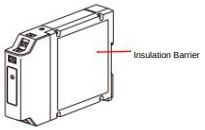
System configuration example and part names

ÿ Explosion-proof model: FR-LEX20

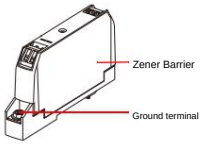
When the display is separated



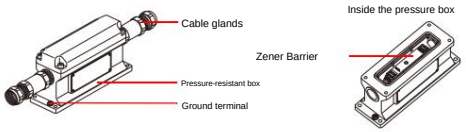
ÿ Insulation barrier: FR-LEXB41



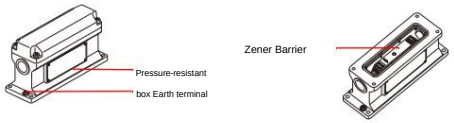
ÿ Zener barrier: FR-LEXB42



ÿ Zener barrier (in a pressure-resistant box with cable gland): FR-LEXB43



ÿ Zener barrier (in pressure-resistant box): FR-LEXB44 Inside the pressure-resistant box



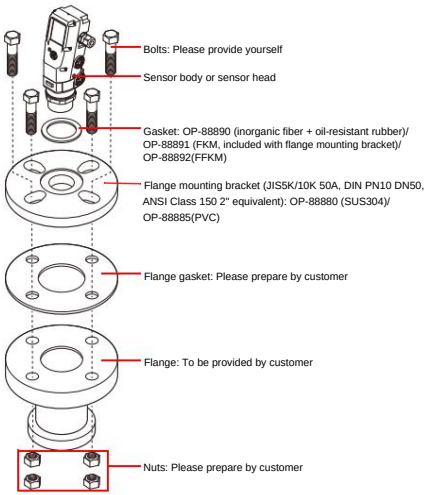
Product Overview

The FR series displays the liquid/powder level from the bottom of the tank by specifying ÿ the distance from the reference surface of the sensor body to the bottom of the tank (0%) and ÿ the distance from the reference surface of the sensor body to the top surface of the tank (100%).

Installation and mounting

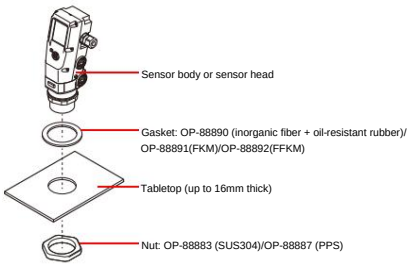
Sensor body and sensor head installation

ÿ Flange nozzle installation **1.** Fit a gasket (included with the flange mounting fixture)* onto the flange mounting fixture, and then install the sensor body or sensor head onto the flange mounting fixture. Recommended tightening torque: FR-LM20(L): 30N•m, FR-LP20(L): 15N•m **2.** Place the flange gasket* between them, and then attach the flange mounting fixture to the flange nozzle with bolts and nuts. * If not sealed, the rubber packing is not necessary.

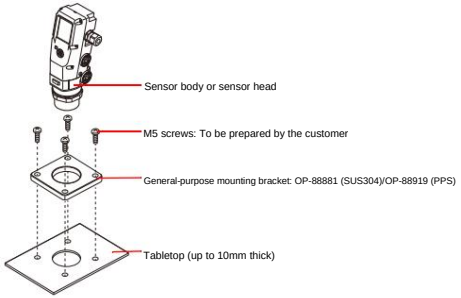


ÿ Direct mounting to the top plate (nut mounting)

1 Drill a ÿ49 hole in the top plate. **2** Fit a gasket* onto the mounting thread of the sensor body or sensor head, and insert the mounting thread of the sensor body or sensor head into the hole in the top plate. **3** Attach the nut from the back of the top plate. Recommended tightening torque: FR-LM20(L): 30 N•m, FR-LP20(L): 15 N•m * If not sealed, the gasket is not necessary.

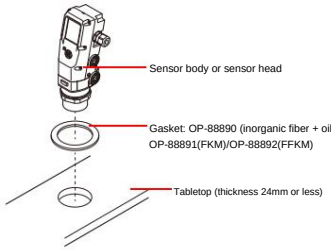


ÿ Direct mounting to the top plate (uses mounting fixture, no nuts required) **1** Attach the mounting screw part of the sensor body or sensor head to the general-purpose mounting fixture. Recommended tightening torque: FR-LM20(L): 30 N•m, FR-LP20(L): 15 N•m **2.** Drill a ÿ49 hole and four screw holes for fastening the mounting fixture in the top plate, and fasten the general-purpose mounting fixture to the top plate with screws.

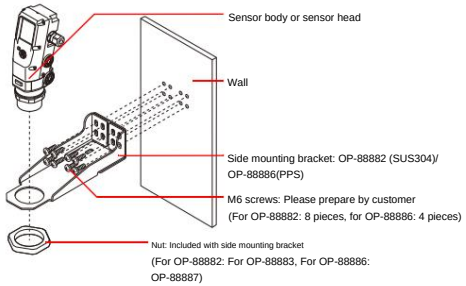


ÿ Direct mounting to the top plate (screw mounting) **1.** Drill a G1-1/2 screw hole in the top plate.

2. Fit a gasket* to the mounting thread of the sensor body or sensor head, and then mount the sensor body or sensor head to the top plate. Recommended tightening torque: FR-LM20(L): 30N•m, FR-LP20(L): 15N•m * If not sealed, the gasket is not required.



ÿ Mounting on an inner wall **1.** Attach the side mounting bracket to the wall with an M6 screw. **2.** Insert the mounting screw part of the sensor body or sensor head into the oblong hole of the side mounting bracket and attach the nut from the back. Recommended tightening torque: FR-LM20(L): 30N•m, FR-LP20(L): 15N•m



ÿ Ferrule installation **1.** Attach

the OP-88920 so that it fits along the side of the lens on the bottom of the sensor body. **2.** Attach the gasket

included with the ferrule installation fixture to the top of the ferrule installation fixture.

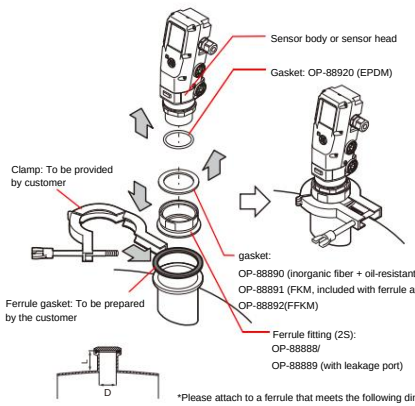
Is included.

3. Attach the ferrule attachment tool to the sensor body or sensor head. Recommended tightening torque:

FR-LM20(L)/LS20(L): 30 N•m, FR-LP20(L): 15 N•m **4.** Attach the ferrule gasket to the ferrule, and

then use the clamp to attach the sensor.

Install the bracket.



*Please attach to a ferrule that meets the following dimensions.

LÿD

L must not exceed 127mm

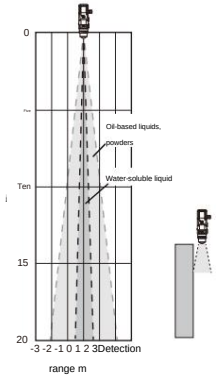
Adjusting the installation direction

The housing can be rotated approximately 340°. After fixing it to a fixture, rotate the housing while fixing the hexagonal part with a wrench, and orient the display in any direction.

Recommended installation conditions

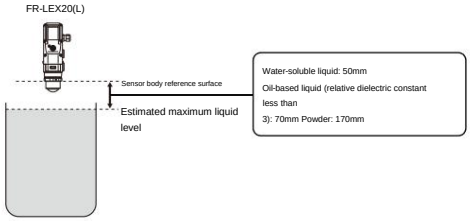
The FR series has the following detection range characteristics, and the range to be considered varies depending on the target

object. Install the sensor so that there are no metal obstacles within the following range. If the above conditions cannot be met, perform the adjustment function. For details on the adjustment function, refer to the FR series user's manual.



*If the wall is made of metal and has few bumps and grooves, there is no problem even if the wall is within the range.

Detection may become unstable if the sensor is placed too close. We recommend that the sensor be placed at the recommended distance below from the expected upper limit of the liquid level. However, if the environment is free of bubbles or adhesions, the sensor may be usable at a closer distance.



wiring

ÿ Preparing the cables ÿ

Cables to be used

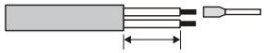
Prepare the following cables to be used.

ϕ6～ϕ12	AWG12～26
ϕ6～ϕ12	AWG16～26

Important We recommend using a shielded power cable.

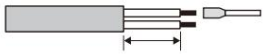
ÿ How to process the cable ends Power cable

Strip the insulation as shown below and use a ferrule terminal with a tip length of 8.0 to 10.0 mm.



Separate cable

Strip the insulation as shown below and use a ferrule terminal with a tip length of 8.0 to 10.0 mm.

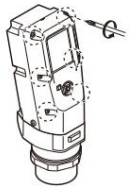


Important At the end of the cable, use a ferrule terminal with a terminal part of 8.0 to 10.0 mm and a total length of 20 mm or less.

ÿ Wiring **1**

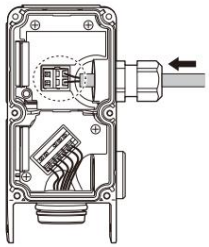
Loosen the 6 screws on the display unit and

Open the face to the left.



2 Pass the power cable through the cable gland on the side of the display unit, and wire it to the upper terminal block. After wiring,

tighten the nut of the cable gland. (Tightening torque: 4.0 N m)

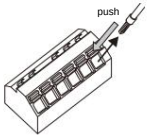


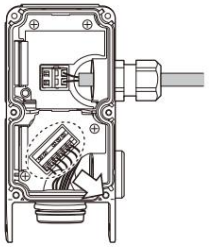
Important
• Push the cables all the way in. • To check that the wiring is correct, gently pull each cable after wiring.
Stretch it and make sure it does not come loose.
• Connect the shield of the shielded cable to earth on the wiring board side.

If you want to use the display separately, go to 3. If you want to use the display as an integrated unit, go to 12.

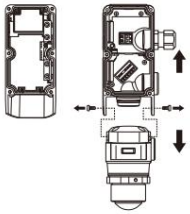
3 Wired to the lower terminal block

Disconnect the six cables.

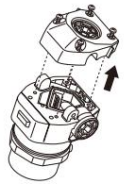




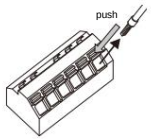
4. Remove the two screws on the side of the display unit and pull out the display unit to separate it.

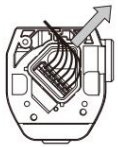


5Loosen the four screws and remove the sensor head cover.

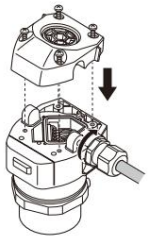


6 Remove the six cables wired to the terminal block.

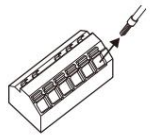


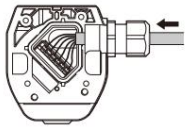


7Remove **the** cable insertion port cover on the side of the head and attach it to the sensor head cover (tightening torque: 2.0 Nÿm). Attach the included cable gland to the side of the sensor head (tightening torque: 4.0 Nÿm).



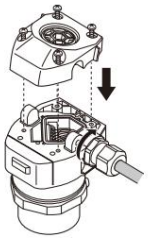
8. Insert the separate cable into the sensor head cable.
Pass the wires through the ground and into the terminal block.



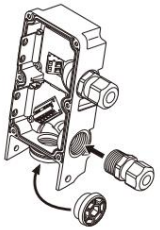


Important • Push the cables all the way in. • After wiring, gently pull each cable to make sure it does not come loose, to check that it is wired correctly.

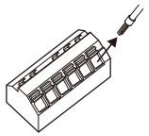
9Tighten the nut of the cable gland (tightening torque: 4.0 Nÿm).
Also, attach the sensor head cover (tightening torque: 0.5 Nÿm).

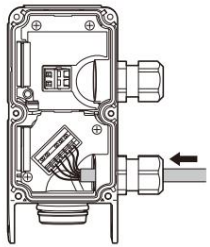


10Remove the cable insertion cover on the side of the display unit.
Remove the cable gland from the base of the display unit and attach it to the bottom of the display unit (tightening torque: 2.0 Nÿm). Attach the included cable gland to the side of the display unit (tightening torque: 4.0 Nÿm).



11 Pass the separate cable through the cable gland on the side of the display unit and wire it to the terminal block. After wiring, tighten the nut of the cable gland. (Tightening torque: 4.0 N m)

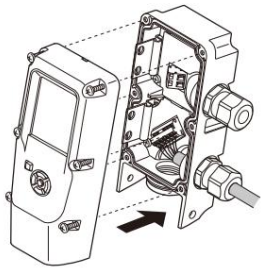




Sensor head side Terminal block terminal number	Display side Terminal block terminal number
1	1
2	2
3	3
4	4
5	5
6	6

Important • Push the cables all the way in. • After wiring, gently pull each cable to make sure it does not come loose, to check that it is wired correctly.

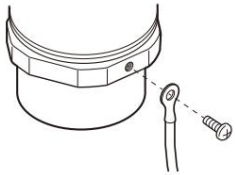
12 Close the front of the display unit and tighten the six screws.
(Recommended tightening torque: 0.5Nÿm)



caveat Please turn off the power when performing wiring work.

Important When closing the case, be careful not to pinch the wires.

13Connect the ground wire to the ground terminal (M4 screw) on the hexagonal part of the sensor head.

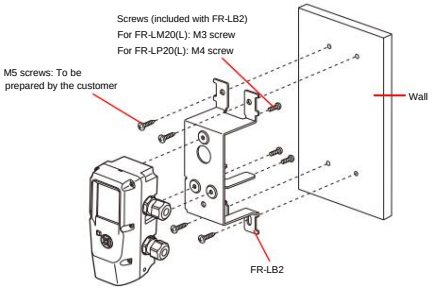


Use a ring terminal with the following dimensions.

• Round terminal compatible dimensions B (outside): 8.5mm or less d (inside): ÿ4.5 or more

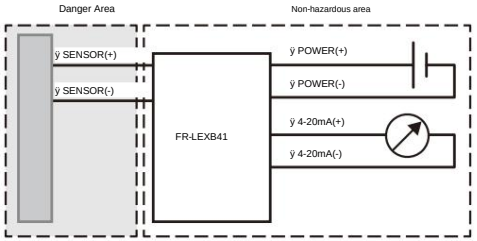
caveat If the earth terminal is not used, the capacitance of the metal parts must comply with the provisions in 1.2.4 on page 2.

ÿ Installing the display (in case of separate display) Fix the display with the rear mounting bracket FR-LB2.

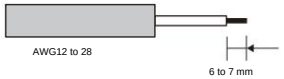


ÿ Wiring to external devices ÿ

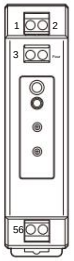
When using an insulation barrier (FR-LEXB41)



Cable End Treatment



FR-LEXB41 Terminal block wiring



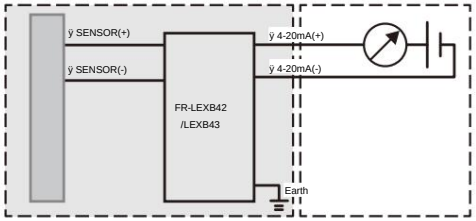
Terminal Number	Function
1	POWER(+)
2	POWER(-)
3	4-20mA(+)
4	4-20mA(-)

Recommended tightening torque for terminal block screws: 0.5N•m

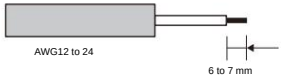
Terminal Number	Function
5	SENSOR(-)
6	SENSOR(+)

caveat Please turn off the power when performing wiring work.

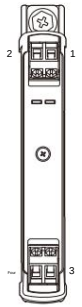
ÿ When using a Zener barrier (FR-LEXB42)



Cable End Treatment



FR-LEXB42 terminal block wiring

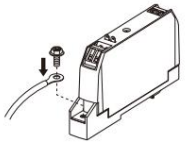


Terminal Number	Function
1	4-20mA(+)
2	4-20mA(-)

Terminal Number	Function
3	SENSOR(+)
4	SENSOR(-)

Recommended tightening torque for terminal block screws: 0.4N•m

Ground Wire Wiring



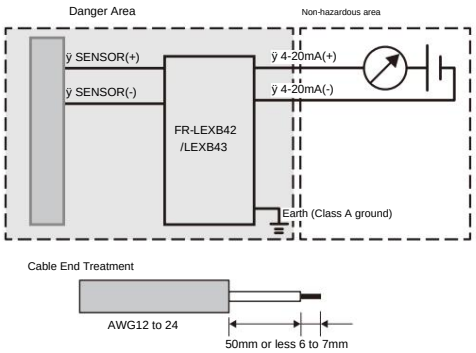
Please use ring terminals with the following dimensions.

• Round terminal compatible dimensions B (outside): 10mm or less d (inside): ÿ4.5 or more

Recommended tightening torque for earth terminal: 1.5N•m

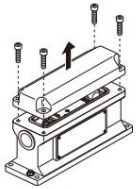
danger
• Use a cable of AWG28 or more and the same or thicker than the power cable.
Please use the round terminals with the dimensions shown for wiring.
• Make sure the resistance of the earth wire is 10 ÿ or less.

ÿ When using a Zener barrier (FR-LEXB43/LEXB44)



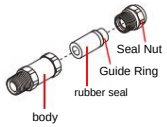
wiring

1 Remove the four screws and remove the lid of the explosion-proof box.
I can open it.



2 Cable gland included with FR-LEXB43
Remove the seal nut and guide ring.
Remove the gasket and packing from the body.

vinegar.



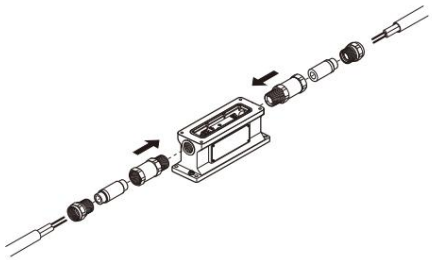
Packing for ÿ11 to ÿ10 is pre-assembled at the time of shipment.
ÿ12 to ÿ11 or
When using a ÿ10 to ÿ9 cable,
Packing according to the outer diameter of the cable used
and add the corresponding label to the body.
Place it over the label attached to the

Packing end face printing

Cable Outer Diameter	End face printing
φ11≤d<φ12	φ12~φ11
φ10≤d<φ11	φ11~φ10
φ9≤d<φ10	φ10~φ9

Important For FR-LEXB44, the customer must prepare the cable gland.

3. Attach the body of the cable gland to the NPT thread of the explosion-proof box.
(Recommended tightening torque: 30N•m)



danger	• Do not use sealing tape. • When using as IP67, use grease and liquid specified for explosion-proof certification. Use a gasket to ensure airtightness.

Wire to **4** Zener barrier.

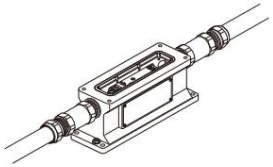
FR-LEXB42/LEXB43/LEXB44 terminal block wiring

ID	function
1	4-20mA(+)
2	4-20mA(-)

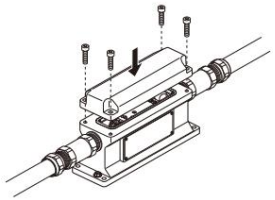
ID	function
3	SENSOR(+)
4	SENSOR(-)

Recommended tightening of terminal block screws
Mounting torque: 0.4N•m

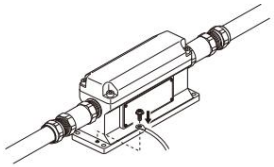
5. Push the packing and guide ring into the body and tighten the seal nut.
(Recommended tightening torque: 30N•m)



6. Close the cover of the explosion-proof box and tighten the four screws.
(Recommended tightening torque: 4.5N•m)

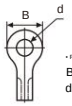


7 Connect the ground wire.



Recommended tightening torque for earth terminal:
1.5N•m

Use the following dimensions for the round terminals.
please.



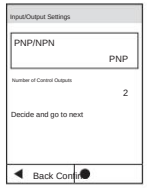
• Round terminal compatible dimensions
B (outer): 10mm or less
d (inside) 4.5 or more

danger	• Use a cable of AWG12 (4 mm2) or more and a round terminal of the above dimensions. Please wire it. • Make sure the resistance of the earth wire is 10 ÿ or less.

danger	Please turn off the power when performing wiring work.

Initial settings at first startup

When starting the program for the first time, please perform the following initial settings. • Use the ÿÿ keys to select each parameter and the • Enter key to confirm. • Press the ÿ key to return to the previous screen.



The underlined values are the initial values.

Language	ENGLISH JAPANESE CHINESE DEUTSCH
Detection target	Water-soluble liquids Oil-based liquids Powders
Distance unit	mm m
Display value scaling OFF ON	
Display unit *1	No unit mL L hL m3 g kg t mm m %
Decimal point *1	99999 9999.9 999.99 99.999 9.9999
Tank shape *1	Straight tank Spherical tank Cylindrical tank (horizontal) Conical bottom tank Square pyramid bottom tank Sloped bottom tank Multi-point compensation
Distance to bottom	0 to 25000mm
Distance to top	0 to 25000mm
Bottom Height *1*2	0 to 25000mm
Tank capacity *1	0 to 99999
Number of multi-point correction points *1 *3 2	
First point _ to 32 Height *1 *3 *4 0 to 99999	
First point _ Current value *1 *3 *4 0 to 99999	
Level interlocking	OFF 2 3 4 5
indicator Indicator pattern	No.1 No.2 No.3 Only green lights off
*6 Indicator setting value 1*5	0 to 99999

*1 Only displayed when "Display value scaling" is set to [ON]. *2 Only displayed when "Tank shape" is set to [Cone bottom tank], [Pyramid bottom tank], or [Sloped bottom tank].
*3 Only displayed when [Multi-point correction] is selected for "Tank shape". *4 Depending on the value selected for "Number of multi-point corrections", points 2 to 32 are displayed. *5 Depending on the value selected for "Level linkage indicator", points 1 to 5 are displayed.
*6 The number of selectable patterns varies depending on the setting of "Level Linked Indicator."

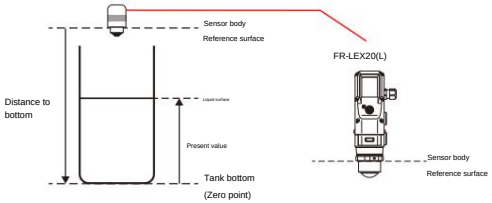
• Detection target

If the dielectric constant of the measurement target is 3 or more, select [Water-soluble liquid]. If it is less than 3, select [Oily liquid]. If it is powder, select [Powder]. If you select [Oily liquid], the area near the bottom of the tank will be automatically masked. For details, refer to the user's manual.

Important note: If the wrong detection target is selected, the liquid level may not be detected correctly.

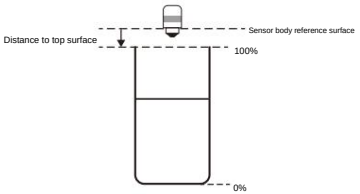
• Distance to bottom

Enter the distance from the sensor's reference surface to the tank's bottom. For the position of the sensor's reference surface when using a mounting bracket, check the external dimensions diagram in the catalog. This position is set as the zero point (0%), and the height from the tank's bottom to the liquid level is displayed as the current value.



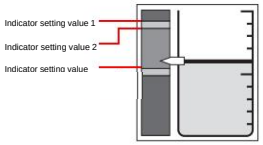
• Distance to top surface

Enter the distance from the reference surface of the sensor body to the top surface of the tank. When displayed in %, this position will be 100%.



• Display value scaling OFF: The liquid level is displayed as height.
ON: The displayed value is scaled and converted to volume or mass for display. Scaling can be performed by selecting the tank shape or by inputting an arbitrary conversion table of up to 32 points with multi-point correction. For details on multi-point correction, refer to the user's manual.

• Indicator Pattern You can select the lighting pattern of the ring indicator according to the liquid level. The color of the indicator also corresponds to the color bar on the current value screen.



* Indicator light setting values 1 to 5 are in no particular order. The order does not have to be Indicator light setting value 1 > Indicator light setting value 2 > ...

The number of indicator light patterns that can be selected varies depending on the level-linked indicator light that has been set, so please select from the following.
If you want a pattern other than these, select Custom. For details on how to set Custom, please refer to the User's Manual.

Level-linked indicator light	Pattern 1 Pattern 2	Pattern 3 Green only			Lights out
OFF				green	
2	red green	green red			
3	red Yellow Green	green Yellow Red	red Green Red		
Four	Red Yellow Green Red	Red Green Yellow Red			
Five	Red Yellow Green Yellow Red				

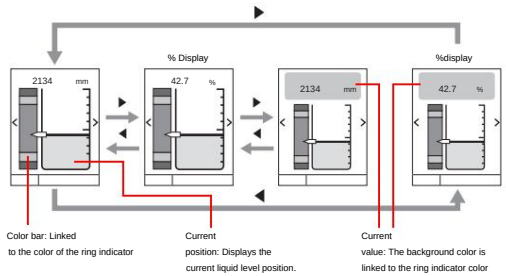
Adjustment Function

After completing the initial settings, we recommend that you perform the adjustment function, which will ensure more stable detection.

Procedure: On the current value screen, press the MENU key to enter the menu screen and select "Adjustment Function".

Reference • For details, refer to the FR series User's Manual. • If [Oil-based liquid] is selected in "Detection target" or if detection is unstable, a screen for executing the adjustment function will be displayed after the initial settings are completed.

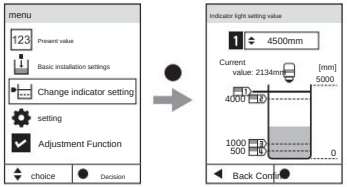
Basic usage ÿ Current value screen



ÿ

ÿ Changing the indicator light setting value On the current value screen, press the MENU key to enter the menu screen and select Change setting value. Use the ÿÿ keys to adjust the setting value and press the • Enter key to confirm.

Menu Screen



ÿ Key lock This function locks key operations to prevent accidental operation. It is useful when you do not want to change settings easily. If you want to require a password to release the key lock, set "Key lock method" to [With PIN code]. How to activate and release the key lock: ÿ Press and hold the MENU key and ÿ key simultaneously for more than 3 seconds. If "Key lock method" is set to [With PIN code], enter the PIN code to release the key lock.

Reference If the PIN code is incorrect, an error will occur and the screen will return to the normal screen with the keys still locked.

ÿ Initialize settings On the current value screen, press the MODE key to enter the menu screen, then select "Settings" > "Initialize".

maintenance

• If necessary, clean any deposits or foreign matter from the mounting bracket, sensor body, or the bottom of the sensor head. Please clean it up.

item		2-wire explosion-proof model	2-wire explosion-proof model (when using an insulating barrier)	2-wire explosion-proof model (when using Zener barrier)	2-wire explosion-proof model (with pressure-resistant explosion-proof box and Zener barrier)
		FR-LEX20(L)	FR-LEXB41	FR-LEXB42 FR-	FR-LEXB43/LEXB44
Measurement range *1		LEX20: ~ 20m FR-LEX20L: ~ 15m			
Display range *2 *1		~ 25m			
Measurable medium relative dielectric constant Resolution		2 or more			
*3 Accuracy		1mm			
		Up to 0.1m: ±10mm 0.1 to 10m: ±1mm 10 to 20m: ±2mm			
Response		1s, 4s (default), 10s, 25s			
time Tank pressure		-0.1 to 1 MPa (depending on temperature)			
Material	Inside the tank	Lens: PTFE Inner packing: FFKM Fastening part: SUS304			
	Chassis	PPS PBT PC PA Internal filler: Epoxy resin	Barrier: PC	Barrier: PC	Explosion-proof box: Aluminum die-cast, NBR Cable Gland: Brass nickel plated, Chloroprene
Connection port size		G1-1/2(40A)			
output	Number of control	-			
	outputs Control output / Auxiliary output	-			
	Analog Output	4-20 mA For maximum load resistance, see separate document (Response time: 0.2 s [90% response] after judgment output is confirmed) *7			
Analog output accuracy *4	Resolution	1mm			
	Zero Accuracy	±0.1mA (zero point = 4mA)			
	FS Accuracy	±0.2mA (full scale = 20mA)			
Environmental resistance	Ambient temperature	-30 to +60ÿ *5 (no freezing)	Barrier: -30 to +60°C (no freezing)		
	Ambient humidity, joint	~ 85% RH (no condensation)			
	temperature, vibration	-30 to +85ÿ (no freezing) *5			
	resistance,	10 to 500Hz Power Spectral Density: 0.816G2 in X, Y, and Z directions			
	impact resistance	100 m/s2 (10G) 16 ms pulse, 1000 times in each of the X, Y and Z directions			
Protective structure		IP67 (IEC60529), Enclosure Type 4X (NEMA250) Power reverse	Barrier: No regulations	Barrier: No regulations	Explosion-proof box: IP67*6
Protection Circuit		polarity protection, power surge protection	Barrier: Reverse power connection protection, power surge protection		
Power-supply voltage		DC 18.3 to 35V Allowable load resistance according to power supply voltage Resistance: see *7	DC 24V +25%/-10%	DC 20.1 to 28V For the allowable load resistance according to the power supply voltage, see separately. *7	
Current consumption (including analog output, excluding load current)		separate page 752.5mW or less	3W or less	602mW or less	
mass		Approx. 920g	Barrier: Approx. 320g	Barrier: approx. 100g	Flameproof box + barrier (without cable gland): Approx. 1,300g

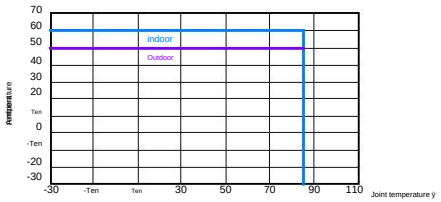
*1 Guaranteed value for water in recommended installation. If the water is static, it is possible to measure up to the edge of the lens. Depending on the environment and the measurement medium, a dead zone may occur on the near side. Also, the maximum measurement distance may be shortened.
I will.

*2 Measurement may not be possible depending on the shape of the object or the environment.

*3 Guaranteed value based on our testing equipment. Errors may occur depending on the customer's environment.

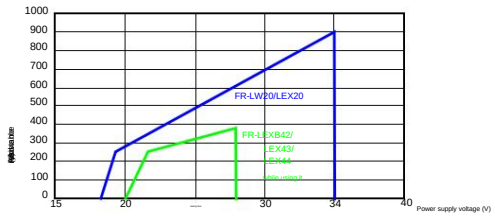
*4 Guaranteed value when load resistance is 250ÿ by our testing equipment. Errors may occur depending on the customer's environment.

*5 Details of the operating temperature range are as follows:



*6 When using as IP67, use grease and liquid gasket specified for explosion-proof certification to ensure airtightness.
If not used, it is IP66.

*7 Details of the allowable load resistance according to the power supply voltage are as follows:



1. Applicable Products

The warranty set forth below applies to products manufactured and sold by our company (hereinafter referred to as "applicable products").
To do.
In addition, consumables such as relays and batteries built into the target products are not covered.
Thank you.

2. Warranty Period

The warranty period for the applicable products is one year after delivery to your designated location.

3. Warranty Coverage

(1) If a failure occurs within the above warranty period for reasons attributable to our company, we will replace the product free of charge.
However, even if it is within the warranty period, the following reasons will apply:
In the event of a malfunction, the product will not be covered by the warranty.
Even if this is done, the starting date of the warranty period will be the original delivery date of the target product.
Masu.

ÿ The following items are not included in the instruction manual, user manual, or separately agreed specifications.
Failures caused by improper external conditions, environment, handling or usage.

ÿFailures caused by anything other than the target product, such as the design of your equipment or software
Obstacle.

3) Malfunctions caused by modifications or repairs made by parties other than our company.

4. Consumable parts listed in the instruction manual, user manual, etc. are properly maintained.
A failure that could have been prevented if it had been replaced.

5) Failure due to reasons that could not have been foreseen with the level of science and technology at the time of shipment by our company.

ÿOther external factors not responsible for the Company, such as disasters such as fires, earthquakes, and floods, and voltage abnormalities.
Failure due to the above cause.

(2) The scope of the warranty is limited to the above (1) and does not cover secondary damage (including damage to equipment,
Any damages incurred due to the use of the product, including damage to equipment, loss of business opportunities, lost profits, etc., are not covered by the warranty.
to come.

4.Applications

Our products are designed and manufactured as general-purpose products for general industry.
Therefore, the following uses are not intended and therefore are not applicable.
I'll enjoy having this.
However, please consult with us in advance and confirm the product specifications at your own responsibility.
After confirming the specifications and performance, you will be asked to take necessary safety measures.
In such cases, the above provisions will be applicable.
In this case, the scope of the warranty will be the same as above.

ÿHuge impacts on human life and property are expected for nuclear power plants, aviation, railways, ships, vehicles, medical equipment, etc.
Facilities to be used

ÿPublic facilities such as electricity, gas, and water

3) Applications that require high levels of consideration and caution regarding safety similar to those listed in 1) and 2) above.

J 1040-1

■お問い合わせ
0120-663-000
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