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# FMCW Radar Level Transmitter

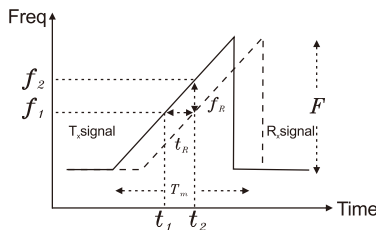


# PRODUCT INTRODUCTION

FMCW Radar level transmitter is a non contact measuring device, which is suitable for high temp., high pressure, and corrosive applications. It is easy to install and free of maintenance, especially for the high accuracy requirement environment.

## PRINCIPLE

FMCW radar adopts a high frequency signal, which is emitted via an antenna and swipes frequency increment by 0.5GHz during the measurement, reflected by the target surface and received at a time delay. The frequency difference, which is calculated from the transmitting frequency and the received frequency, which is directly proportional to the measured distance (or material surface). The frequency difference then is processed by Fast Fourier Transformation (FFT) to identify the signal in Intermedium Frequency (IF). This FMCW radar is innate with signal / noise enhancement and filtering of echo-back via Phase-Lock Loop (PLL) circuit that is the best solution for complex environment and high accuracy measurement.

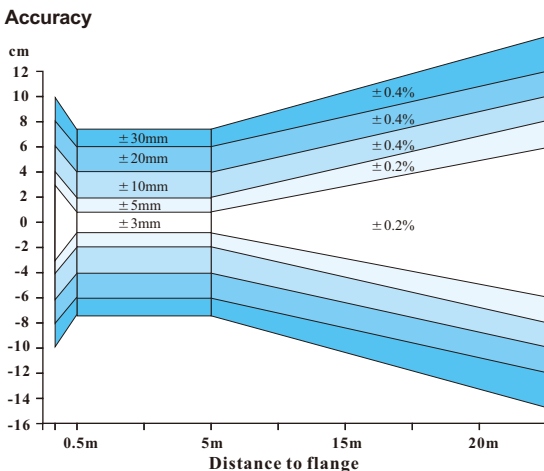


### Design formula

$$\text{Slop} = \frac{F}{T_m} = \frac{f_R}{t_R} = \frac{f_R}{\frac{2R}{c}} \quad t_R = \frac{2R}{c}$$

$$R = \frac{F_R \times c \times T_m}{2F}$$

## LINEARITY DIAGRAM



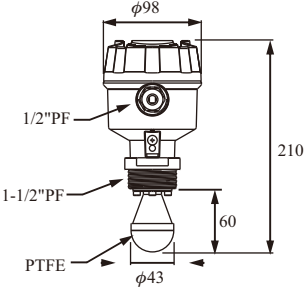
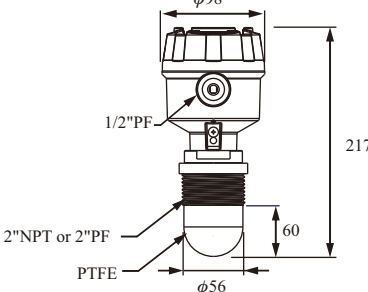
## FEATURES

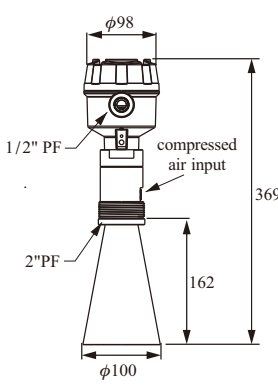
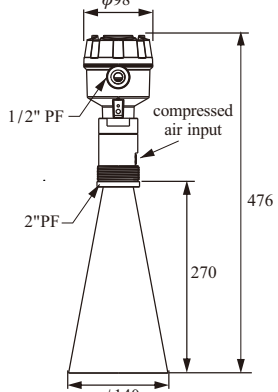
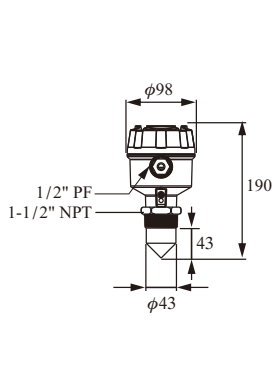
- Non contact measuring
- Corrosive and toxic liquid, hydrocarbons, slurries
- Not affected by specific gravity, pressure, temperature, viscosity, foam
- 5 digits LCM display
- Indicate signal wave inside the silo.
- Selection of Different Measurement unit(m, cm, mm, inch, Ft, %, mA)
- Measuring distance and actual level.
- Language selection of traditional Chinese, simplified Chinese, English.
- 4-20mA / 4 wires / 2 wires
- Modbus RS-485 to enhance isolation and easy for remote control.
- CE standards for isolation(EFT 2000V, B class or better)
- Suitable for mid-range signal
- 4mA, 20mA output
- Isolated circuit design.

## TEST STANDARDS

- High voltage : IEC60947-2
- Isolated resistance : IEC60092-504
- Power supply change : IEC60092-504
- Power supply failure : IEC60092-504
- Electrical burst testing : IEC61000-4-4
- Voltage DIPS : IEC61000-4-11
- Humidity : IEC60068-2-30
- High/Low temperature test : IEC60068-2-38
- IP protection rating : IEC60529

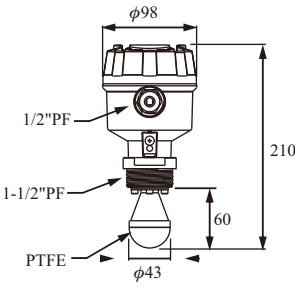
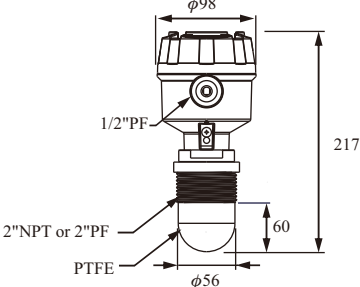
# SPECIFICATION (26GHz 4-wire)

<b>Dimensions (Unit:mm)</b>		
<b>Model</b>	<b>JFR-204</b>	<b>JFR-214</b>
<b>Medium</b>	General liquid and solid	General liquid /suitable for acid and alkaline in liquid
<b>Min. Dielectric constant (solid)</b>	1.5	
<b>Min. Dielectric constant (liquid)</b>	1.4	
<b>Measuring range</b>	Liquid 30m Solid 20m	Liquid 30m
<b>Accuracy</b>	$\pm 3$ mm	
<b>Repeatability</b>	$\pm 1$ mm	
<b>Digital communication</b>	RS485 (Isolated)	
<b>Ambient temperature</b>	-40~80 °C(LCM<75°C)	
<b>Operating temperature</b>	-40~200 °C	
<b>Operating pressure</b>	0~40 bar	
<b>Frequency</b>	K Band	
<b>Analog output</b>	4~20mA / 4 Wire	
<b>Protection rating</b>	IP67	
<b>Power supply</b>	9.5~30Vdc	
<b>Local display</b>	5 digits LCM display	
<b>Housing material</b>	Aluminum	
<b>Antenna type</b>	Horn (43D)	Lens (56D)
<b>Half-power beam width</b>	$\pm 9^\circ$	
<b>Antenna material</b>	SUS316+PTFE	PTFE
<b>Blind distance</b>	500mm	

Dimensions (Unit:mm)			
<b>Model</b>	<b>JFR-224</b>	<b>JFR-234</b>	<b>JFR-244</b>
<b>Medium</b>	General liquid and solid		
<b>Suitable For</b>	Long distance measurement	Super distance measurement	Corrosion type acid and alkaline liquid
<b>Min. Dielectric constant (solid)</b>	1.5		
<b>Min. Dielectric constant (liquid)</b>	1.4		
<b>Measuring range</b>	Liquid 40m Solid 30m	Liquid 70m Solid 50m	Liquid 20m Solid 15m
<b>Accuracy</b>	± 3mm @distance≤30m, ± 0.01% F.S.@distance>30m		± 3 mm
<b>Repeatability</b>	± 1 mm		
<b>Digital communication</b>	RS485 (Isolated)		
<b>Ambient temperature</b>	-40~80 °C(LCM<75°C)		
<b>Operating temperature</b>	-40~200 °C		
<b>Operating pressure</b>	0~40 bar		
<b>Frequency</b>	K Band		
<b>Analog output</b>	4~20mA / 4 Wire		
<b>Protection rating</b>	IP67		
<b>Power supply</b>	9.5~30 Vdc		
<b>Local display</b>	5 digits LCM display		
<b>Housing material</b>	Aluminum		
<b>Antenna type</b>	High gain horn (100)	High gain horn (140)	Lens(43DS)
<b>Half-power beam width</b>	±5°	±3°	±10°
<b>Antenna material</b>	SUS 316		PTFE
<b>Blind distance</b>	500 mm		

P.S. For JFR-224 and JFR-234, customer can connect the compressed air with 1/8"PT thread connector to avoid dust adhered.

# SPECIFICATION (26GHz 2-wire)

<b>Dimensions (Unit:mm)</b>		
<b>Model</b>	<b>JFR-202</b>	<b>JFR-212</b>
<b>Medium</b>	General liquid and solid	General liquid /suitable for acid and alkaline in liquid
<b>Min. Dielectric constant (solid)</b>	1.5	
<b>Min. Dielectric constant (liquid)</b>	1.4	
<b>Measuring range</b>	Liquid 20m Solid 10m	Liquid 20m
<b>Accuracy</b>	± 5mm	
<b>Repeatability</b>	± 3mm	
<b>Digital communication</b>	HART	
<b>Ambient temperature</b>	-40~80°C(LCM<75°C)	
<b>Operating temperature</b>	-40~200°C	
<b>Operating pressure</b>	0~40 bar	
<b>Frequency</b>	K Band	
<b>Analog output</b>	4~20mA	
<b>Protection rating</b>	IP67	
<b>Power supply</b>	24Vdc ± 10%	
<b>Local display</b>	5 digits LCM display	
<b>Housing material</b>	Aluminum	
<b>Antenna type</b>	Horn (43D)	Lens (56D)
<b>Half-power beam width</b>	±9°	
<b>Antenna material</b>	SUS 316 + PTFE	PTFE
<b>Blind distance</b>	500 mm	

<b>Dimensions (Unit:mm)</b>				
	<b>Model</b>	<b>JFR-222</b>	<b>JFR-232</b>	<b>JFR-242</b>
	<b>Medium</b>	General liquid and solid		
	<b>Suitable For</b>	Long distance measurement	Super distance measurement	Corrosion type acid and alkaline liquid
<b>Min. Dielectric constant (solid)</b>	1.5			
<b>Min. Dielectric constant (liquid)</b>	1.4			
<b>Measuring range</b>	Liquid 30m Solid 20m	Liquid 35m Solid 30m	Liquid 15m	
<b>Accuracy</b>	± 5mm @distance≤20m, ± 0.025% F.S.@distance>20m		± 5 mm	
<b>Repeatability</b>	± 3mm			
<b>Digital communication</b>	HART			
<b>Ambient temperature</b>	-40~80°C(LCM<75°C)			
<b>Operating temperature</b>	-40~200°C			
<b>Operating pressure</b>	0~40 bar			
<b>Frequency</b>	K Band			
<b>Analog output</b>	4~20mA			
<b>Protection rating</b>	IP67			
<b>Power supply</b>	24Vdc ± 10%			
<b>Local display</b>	5 digits LCM display			
<b>Housing material</b>	Aluminum			
<b>Antenna type</b>	High gain horn (100D)	High gain horn (140D)	Lens (43DS)	
<b>Half-power beam width</b>	±5°	±3°	±10°	
<b>Antenna material</b>	SUS 316		PTFE	
<b>Blind distance</b>	500 mm			

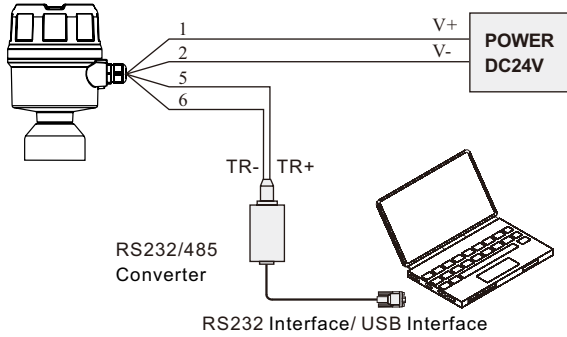
P.s. For JFR-222 and JFR-232, customer can connect the compressed air with 1/8"PT thread connector to avoid dust adhered.



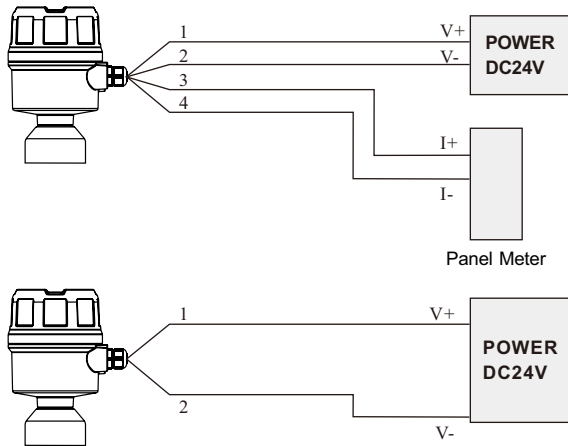
# WIRING/CALIBRATION

## WIRING INFORMATION

RS485 wiring

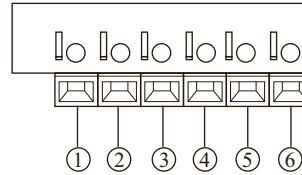


JFR Series and Indicator(External Power)

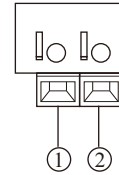


## WIRING DIAGRAM

JFR-2X4



JFR-2X2



- ① Power Supply: V+
- ② Power Supply: V-
- ③ Analog Output: I+ (4~20mA)
- ④ Analog Output: I- (4~20mA)
- ⑤ Communication: TR+ (RS485)
- ⑥ Communication: TR- (RS485)

## CALIBRATION

Two ways to calibrate the JFR Series:

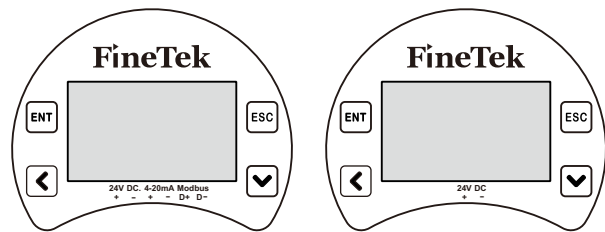
**4-wire:**

1. Display/Adjustment module
2. By pcbased fas soft ware

**2-wire:**

1. Display/Adjustment module
2. HART

Adjustment module is an adjustment tool with 4 buttons to click on. It also has a transparent window to allow display reading.



5 digits LCM display

[ ENT ] Button

- Enter Edit status
- Confirm Edit
- Confirm parameter modification

[ ← ] Button

- Select Edit
- Select parameter
- Parameter

[ ESC ] Button

- Return
- Cancel

[ ▼ ] Button

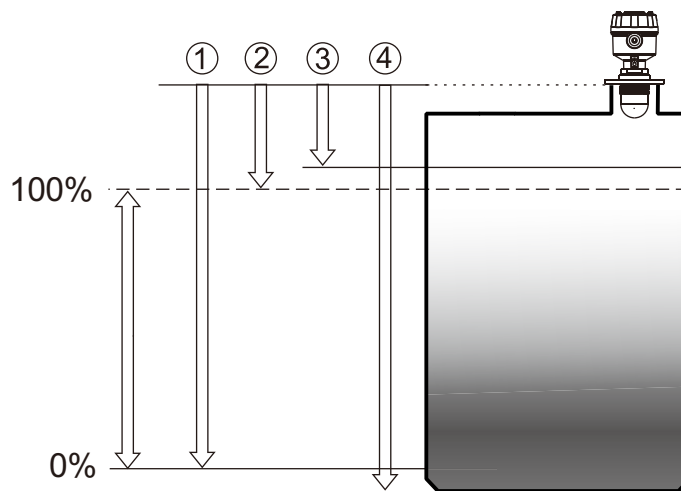
- Increase
- Select

# PARAMETER SETTING

Measurement bench-mark starts at contact surface of connection.

- ① Low level calibration
- ② High level calibration
- ③ Blind Distance
- ④ Measuring Distance Setup

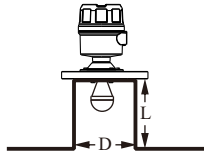
Note: Be aware of blind distance when measuring material high level.(Shown in ③)





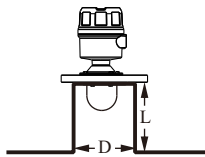
# INSTALLATION

1. JFR-20x can be hidden in the extension tube, the recommendation of the tube diameter D and length L are shown in the table.



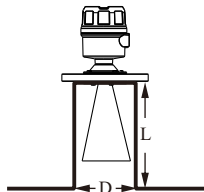
Diameter D (Inch)	Length L (mm)
2"	$L \leq 160$
4"	$L \leq 300$
5"	$L \leq 400$
6"	$L \leq 500$

2. JFR-21x can be hidden in the extension tube, the recommendation of the tube diameter D and length L are shown in the table.



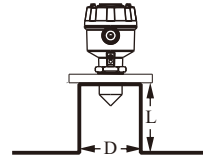
Diameter D (Inch)	Length L (mm)
3"	$L \leq 200$
4"	$L \leq 300$
5"	$L \leq 400$

3. JFR-22X and JFR-23X can be hidden in the extension tube, the recommendation of the tube diameter D and length L are shown in the table.



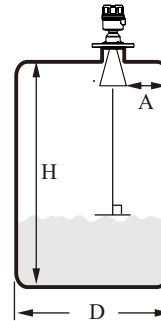
Model	Diameter D (mm)	Length L (mm)
JFR-22X	$D > 100$	$L \leq 150$
JFR-23X	$D > 140$	$L \leq 270$

4. JFR-24x can be hidden in the extension tube, the recommendation of the tube diameter D and length L are shown in the table.

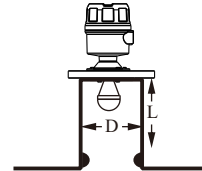


Diameter D (Inch)	Length L (mm)
2"	$L \leq 100$
4"	$L \leq 200$
5"	$L \leq 300$
6"	$L \leq 400$

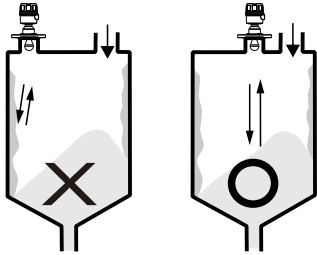
5. Installation recommendations are as follows :
- (1) Antenna installation angle to be perpendicular to the Horizontal.
  - (2) JFR installation position with the drum wall suggestions Are as follows :  
Installation location A should be less than  $1/6D$   
Range with A relation is as follows :  
a.  $H < 10m$ ,  $A > 300mm$   
b.  $10m < H < 20m$ ,  $A > 600mm$   
c.  $H > 20m$ ,  $A > 900mm$



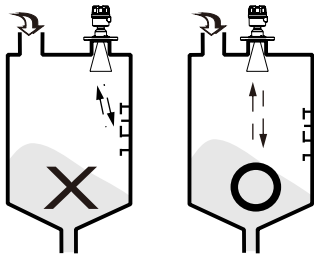
- (3) Extended tube is suggested to do the welding process from outside; welding process from inside, the bulges might affect the signal transmission. The joint part of extended tube cannot be less than "D".



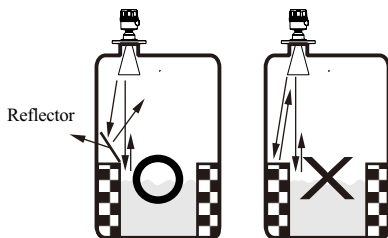
2. Radar installation should not be too close to the drum wall, avoid the drum wall attachment material reflection interference.



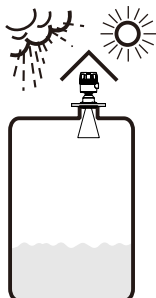
3. Radar installation not too close to the drum bracket to avoid reflection is incorrect



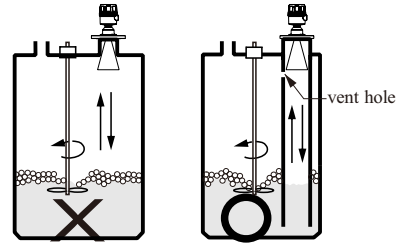
4. When obstructions inside the tank, tank be fitted with effectors, steer clear of the error echo reflected to the receiver, causing radar miscalculation.



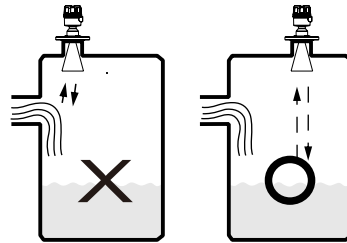
5. Outdoor installation should take shade or rain-proof measures.



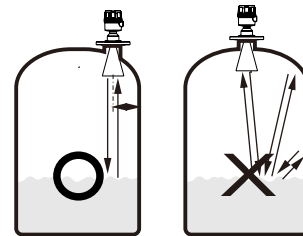
6. If drum internal agitator will have a strong vortex and foam, drum must increase waveguide, the upper waveguide drill vent holes to ensure the correctness of the measured value.



7. Installation should be avoided in the feed inlet position, avoid material interference or obstacles interference.



8. Installation should be avoided in the top center of the arch or round barrel will cause multiple echo reflections.



## MODEL NUMBER / ORDER CODE COMPARISON TABLE

Model Number	Order Code
JFR-204	JFR20000-A1MB
JFR-214	JFR20000-A521
JFR-224	JFR20000-A2
JFR-234	JFR20000-A3MA
JFR-244	JFR20000-A421
JFR-202	JFR20000-A1
JFR-212	JFR20000-A5
JFR-222	JFR20000-A2
JFR-232	JFR20000-A3
JFR-242	JFR20000-A4

# ORDER INFORMATION

JFR 2 0 0 0 0 - <sup>09</sup> <sup>10</sup> <sup>11</sup> <sup>12</sup> <sup>13</sup> <sup>14</sup> <sup>15</sup> <sup>16</sup> <sup>17</sup> <sup>18</sup> <sup>19</sup> <sup>20</sup> <sup>21</sup> <sup>22</sup> A

**<sup>09</sup><sup>10</sup> Antenna type**

- A1: Horn(43D)
- A2: Horn(100D/162L)
- A3: Horn(140D/270L)
- A4: Lens(43DS)
- A5: Lens(56D)
- B1: Horn(100D/126L)
- B2: Horn(140D/202L)

**<sup>11</sup><sup>12</sup> Antenna material**

- MA: SUS 304
- MB: SUS 316
- MC: SUS 316L
- 21: PTFE coating

**Connection**

<sup>13</sup> <sup>14</sup>	<sup>15</sup> <sup>16</sup>	<sup>17</sup> <sup>18</sup>
Flange	B1: 1-1/2"	03: PF male
AK: JIS-FF	B2: 2"	07: NPT male
AN: ANSI-RF	B4: 2-1/2"	40: 5 kg/cm <sup>2</sup>
AS: DIN-FF	B5: 3"	42: 10 kg/cm <sup>2</sup>
	B7: 4"	48: 150 Lbs
Thread	B8: 5"	49: 300 Lbs
AA: JIS	B9: 6"	57: PN10
AC: ANSI	E3: DN65	58: PN16
	E4: DN80	59: PN25
		60: PN40

※ (1) JFR-202,204 thread connection 1-1/2" PF only  
 (2) JFR-212,214 thread connection 2" PF, NPT only  
 (3) JFR-222,224 thread connection 2" PF only  
 (4) JFR 234,232 thread connection 2"PF only  
 (5) JFR 244,242 thread connection 1-1/2"NPT only  
 (6) Please do check Radar antenna can be direct fitted in flange connection and nozzle below is the suggestion  
 (7) 2"Flang is applicable in open area

Type	Opening	Flange size
JFR-21X	56mm	2-1/2"
JFR-22X	100mm	4"
JFR-23X	140mm	6"
JFR-24X	44mm	2"



JFR 2 0 0 0 0 - <sup>09</sup>□ <sup>10</sup>□ <sup>11</sup>□ <sup>12</sup>□ <sup>13</sup>□ <sup>14</sup>□ <sup>15</sup>□ <sup>16</sup>□ <sup>17</sup>□ <sup>18</sup>□ <sup>19</sup>□ <sup>20</sup>□ <sup>21</sup>□ <sup>22</sup>□ A

**⑱⑳ Flange material**

- MA: SUS 304
- MB: SUS 316
- MC: SUS 316L
- MD: SS41 zinc coating
- 18: PP
- 21: PTFE
- 00: None

**㉑ Output**

- A: Loop Power 24 Vdc with HART
- B: 4-Wire 24Vdc 4~20mA with RS-485
- C: Loop Power 24 Vdc, 4~20mA

**㉒ Accuracy**

- A: ± 3mm
- B: ± 5mm
- C: ± 10mm
- D: ± 20mm
- ※2 Wire only option B: ± 5mm or C: ± 10mm

# JFR Radar Level Transmitter

## Customer Information

Prepared by: \_\_\_\_\_ Date: \_\_\_\_\_

Company: \_\_\_\_\_ Industry: \_\_\_\_\_

E-mail: \_\_\_\_\_ Phone Number: \_\_\_\_\_

Address: \_\_\_\_\_

## Application Information

B.1 Measuring Material Information				
Application Description:				
Installation Area:	<input type="checkbox"/> Storage tank	<input type="checkbox"/> Process tank	<input type="checkbox"/> Open-air application	
Material Status :	<input type="checkbox"/> Liquid	<input type="checkbox"/> Slurry/ Sludge/ Paste	<input type="checkbox"/> Solid/ Granulate/Grain	<input type="checkbox"/> Powder
Material Name :		Dielectric Constant	<input type="checkbox"/> 1.4~1.9	<input type="checkbox"/> 4.0~10.0
			<input type="checkbox"/> 2.0~2.5	<input type="checkbox"/> > 10
			<input type="checkbox"/> 2.6~4.0	<input type="checkbox"/> Unknow

### B.2 Power Supply

DC : \_\_\_\_\_  AC : \_\_\_\_\_

### B.3 Output Signal

Analog :  4~20 mA-4 Wire  4~20mA 2-Wire

Digital :  RS-485  HART  Other

### B.4 Measuring range

Measuring range: \_\_\_\_\_ meters

### B.5 Measuring Condition

Operating Temperature

Max: \_\_\_\_\_ °C Min: \_\_\_\_\_ °C

Ambient Temperature

Max: \_\_\_\_\_ °C Min: \_\_\_\_\_ °C

Operating Pressure

Max: \_\_\_\_\_ Bar Min: \_\_\_\_\_ Bar

### B.6 Connection



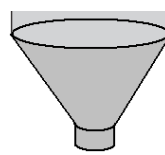
Connection: 9 Threaded

9 Flange

Size and Standard: \_\_\_\_\_

Flange Material: \_\_\_\_\_

## B.7 Tank Information

Tank Shape	<input type="checkbox"/> Vertical Cylinder	<input type="checkbox"/> Horizontal Cylinder	<input type="checkbox"/> Spherical
	<input type="checkbox"/> Cubical/rectangular <input type="checkbox"/> Other: _____		
Tank Material	<input type="checkbox"/> Cubical	<input type="checkbox"/> Plastic	<input type="checkbox"/> Cement <input type="checkbox"/> Other _____
Tank Bottom	<input type="checkbox"/> Metal		
	<input type="checkbox"/> Plastic		
	<input type="checkbox"/> Cement		
	<input type="checkbox"/> Other	_____	

Tank  
 Tank Height (H): \_\_\_\_\_ m  
 Tank Diameter (W): \_\_\_\_\_ m  
 Cone Height (H1): \_\_\_\_\_ m  
 (Ignore cone height with flat/disk bottom )

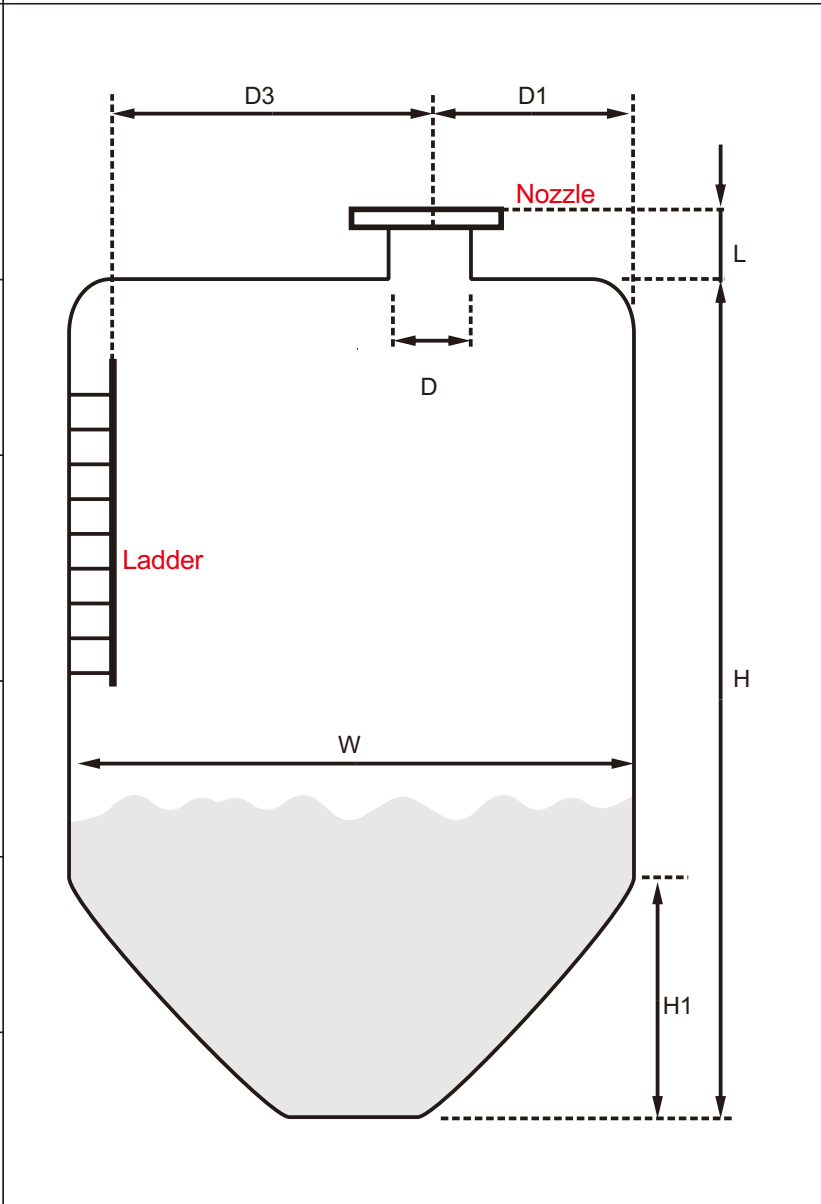
Radars  
 Distance to tank wall(D1): \_\_\_\_\_ m

Nozzle  
 Yes  
 Nozzle Diameter (L): \_\_\_\_\_ m  
 Nozzle Height (D): \_\_\_\_\_ m  
 NO

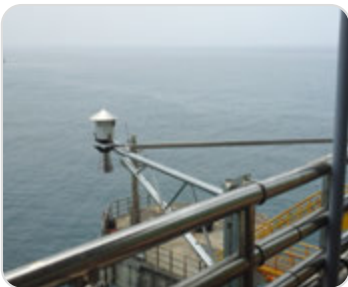
Ladder  
 Yes  
 Distance to rada (D3): \_\_\_\_\_ m  
 NO

Heater  
 Yes  
 NO

Other Internal Obstacles  
 Yes  
 NO







Power plant  
port wave height edtection



Oil Factory  
Process Oil Detection



Government agencies  
flood prevention and control



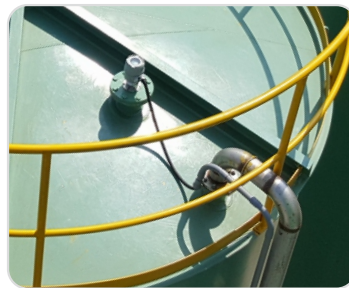
Pharmaceutical Factory  
Boiler Liquid Detection



Feed industry  
butter storage detection



Oil Factory  
Soybean oil level detection

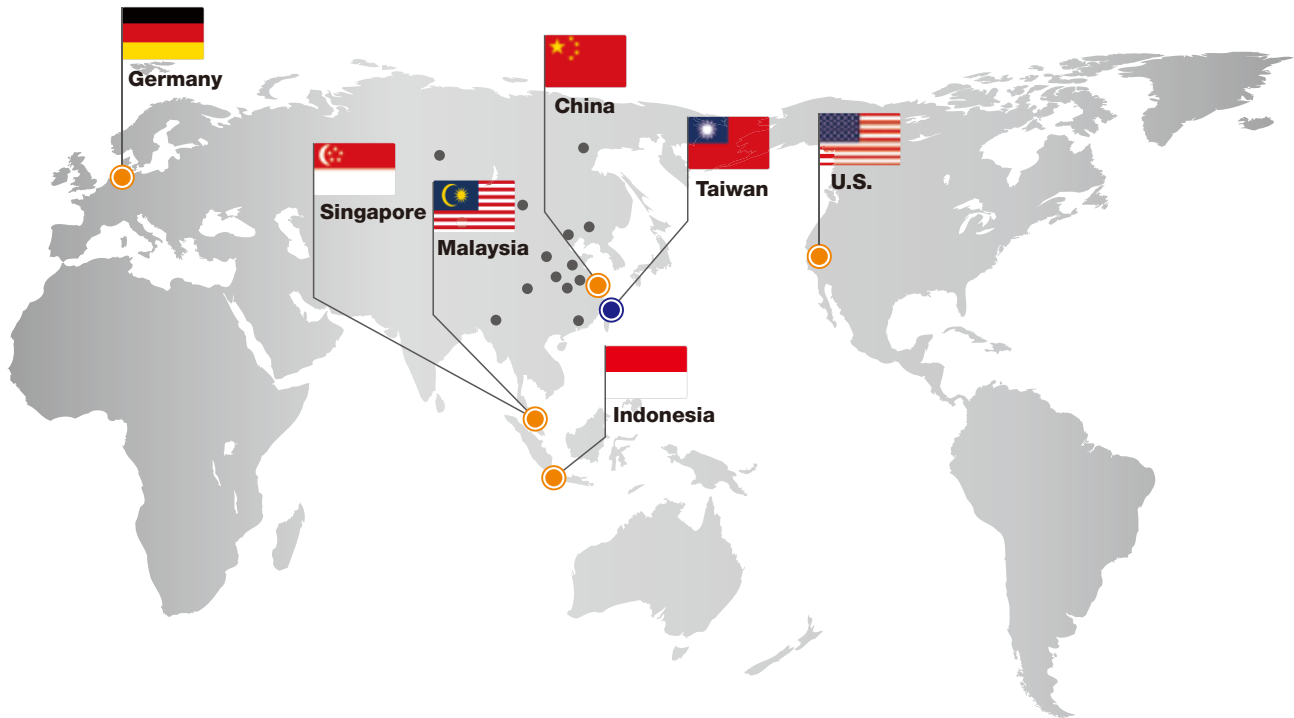


Plastic industry  
chemical detection



Feeding plant  
Corn storage tank detection

# Global Network



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