

**Field-mounted Two-wire Signal Conditioners**
**2-WIRE UNIVERSAL TEMPERATURE TRANSMITTER**  
 (HART® communication, intrinsically safe/explosion-proof)

MODEL

**FRC**
**MODEL & SUFFIX CODE SELECTION**

FRC□□□□A

MODEL \_\_\_\_\_

ENCLOSURE \_\_\_\_\_

0 : None \*1  
 1 : Diecast aluminium  
 2 : Stainless steel casting

SAFETY APPROVAL \_\_\_\_\_

A : None  
 C : CENELEC flameproof (ATEX)  
 E : CENELEC intrinsically safe (ATEX)

LCD DISPLAY \_\_\_\_\_

0 : Without  
 1 : With

WIRING CONDUIT \*2 \_\_\_\_\_

0 : None  
 1 : 1/2 NPT  
 2 : M20 × 1.5  
 3 : PG 13.5

\*1. Choose the suffix code 0 for "Wiring Conduit"

\*2. Confirm selectable combinations of approval and wiring conduit types in the table below.

**SELECTABLE WIRING CONDUITS SPECIFIC TO EACH APPROVAL**

'N' marked combinations are not selectable.

CONDUIT \ APPROVAL	A	C	E
0	Y	N	Y
1	Y	Y	Y
2	Y	Y	Y
3	Y	N	Y

**RELATED PRODUCTS**

- PC Configurator Software
  - HART modem\*  
 MACTek VIATOR RS232 HART® IF recommended
  - Hand-held communicator\*
- \* Consult HART® Communication Foundation (HCF) web site : [www.hartcomm.org](http://www.hartcomm.org)

**GENERAL SPECIFICATIONS**
**Degree of protection :** NEMA 4X, IP66/IP67

**Wiring conduit :** See "Model & Suffix Code".

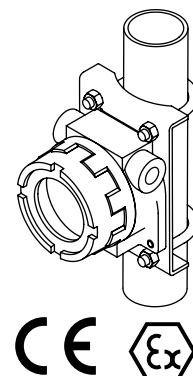
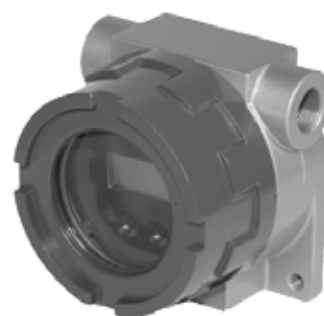
**Electrical connection :** M3.5 screw terminals (torque 0.8 N·m)

**Materials**
**Transmitter housing :** Flame-resistant resin (black)

**Screw terminals :** Nickel-plated brass

**Enclosure :**

Diecast aluminium standard (polyurethane coated) or stainless steel casting (equivalent to type 316, epoxy resin coated).


**Functions & Features**

- Universal input: mV, V, T/C and RTD
- High accuracy
- HART communication
- Intrinsically safe and explosion-proof approval
- CE marking (conforms to ATEX and EMC)
- Optional stainless steel enclosure
- Programming via hand-held communicator or via PC
- A wide variety of T/C and RTD types
- Self diagnostics
- Input-output isolated

**Enclosure color :**
**Body :** Silver

**Cover :** Blue (equivalent to Munsell GPB3.5/10.5)  
 Silver for stainless steel

**Mounting bracket assembly :**

Stainless steel 304

**Applicable pipe :**

1" 1/2 min.; 2" max.

**Isolation :**

Input to output to outdoor enclosure

**User-configurable parameters :**

- Input sensor type
- Number of wires (RTD)
- Input range
- Output range (via HART® only)
- Output calibration
- HART communication mode
- HART network mode

**Burnout (T/C & RTD) :**

Upscale, downscale or no burnout selectable (standard: upscale);

Also detects wire breakdown and overrange input exceeding the electrical design limit for DC input.

**Cold junction compensation (T/C) :**

CJC sensor incorporated

**Damping time :**

0 to 30 sec. (standard : 0)

## LCD DISPLAY (option)

**Features:**

- Indicates and sets input signal, engineering unit and transmitter status.
- Removable while the module is powered.

**Display size:** 36 × 20 mm (1.41" × 0.79")

**Characters:**

**Color:** Black

**Format:** 2 rows of 5 alphanumeric characters;  
Top: 7.4 mm high  
Bottom: 6.5 mm high  
6 status characters, 1.9 mm high

**Display range:**

-99999 to 99999

**Decimal point:**

Top row only; positioned between two characters

**Read rate:** 150 msec.

**Back light:** None

## HART® COMMUNICATION

**Protocol:**

HART® communication protocol

**HART® address range:**

0 – 15 (standard: 0)

**Transmission speed:** 1200 bps

**Digital current:**

Approx. 1mA p-p when communicating

**Character format:**

1 Start Bit, 8 Data Bits, 1 Odd Parity Bit, 1 Stop Bit

**Distance:**

1.5 kilometers (0.9 mile)

**HART® communication mode:**

Master-Slave Mode and Burst Mode (standard: Master-Slave)

**HART® network mode:**

Point-to-Point Mode and Multi-drop Mode; automatically set to Multi-drop Mode when the address is set to other than 0.

## INPUT

The input is factory set for use with 3-wire Pt 100, 0 to 150°C. See Table 1 for the available input type, the minimum span and the maximum range.

### ■ DC mV & V

**Input resistance:** 1MΩ minimum

### ■ THERMOCOUPLE

**Input resistance:** 1MΩ minimum

**Burnout sensing:** 130nA ±10%

### ■ RTD (2-wire, 3-wire or 4-wire)

**Input resistance:** 1MΩ minimum

**Excitation:** 0.2mA ±10%

**Allowable leadwire resistance:** Max. 20Ω per wire

## OUTPUT

**Output range:** 4 – 20mA DC

**Zero adjustment:** 3.8 – 7.2mA (standard: 4mA)

**Span adjustment:** 12.8 – 17.6mA (standard: 16mA)

**Operational range:** 3.8 – 21.6mA

**Load resistance vs. supply voltage:**

Load Resistance (Ω) =  $\frac{\text{Supply Voltage (V)} - 12 \text{ (V)}}{0.024 \text{ (A)}}$   
(including leadwire resistance)

## INSTALLATION

**Supply voltage:**

12 – 42V DC (non-approved)

12 – 28V DC (approved)

**Operating temperature:**

-40 to +85°C Electronics

(See Safety Parameters for use in a hazardous location.)

-30 to +80°C Display (full visibility)

**Operating humidity:**

0 to 95% RH (non-condensing)

**Dimensions:**

See External Dimensions.

**Weight:**

**FRC0:** Approx. 150 g including the LCD

**FRC1:** Approx. 1.3 kg

**FRC2:** Approx. 4.0 kg

## PERFORMANCE

**Accuracy:**

See Table 1 and "Explanation of Terms"

**Cold junction compensation error:** ≤ ±0.5°C

**Temperature coefficient:**

±0.015%/°C of max. range at -5 to +55°C

**T/C and DC mV:** ±0.015%/°C at -40 to +85°C

**Pt 100, span ≥ 100°C:** ±0.015%/°C at -40 to +55°C

±0.03%/°C at 55 to 85°C

**Start-up time:** Approx. 8 seconds

**Response time:**

1 second (0 – 63%) with damping time set to 0 and when not communicating via HART®.

**Supply voltage effect:**

±0.003% × [Output Span] / 1V

**Insulation resistance:**

≥100MΩ with 500V DC (input to output)

**Dielectric strength:**

1500V AC /1 minute (input to output to outdoor enclosure)

## STANDARDS & APPROVALS

**CE conformity:** ATEX Directive (94/9/EC)

Ex ia EN 50020

Ex d EN 60079-1

EMC Directive (2004/108/EC)

EMI EN 61000-6-4

EMS EN 61000-6-2

**Safety approval**

CENELEC: Intrinsically safe (ATEX)

⊗ II 1G, Ex ia IIC; T4, T5 and T6

(EN 50020 : 2002)

CENELEC: Flameproof (ATEX) \*\*

⊗ II 2G, Ex d IIC; T4, T5 and T6

(EN 60079-1 : 2007)

\*\*FRC1 or FRC2

## SAFETY PARAMETERS

**Operating temperature for CENELEC (ATEX):**

T4 -40 to +80°C

T5 -40 to +65°C

T6 -40 to +50°C

**Ex-data:**

Ui	30V DC	Uo	6.4V DC
li	96mA DC	Io	30mA DC
Pi	0.72W	Po	48mW
Ci	0 μF	Co	20 μF
Li	0 mH	Lo	10 mH

## EXPLANATIONS OF TERMS

### ■ ACCURACY

This transmitter's accuracy is theoretically defined as the addition of A/D and D/A conversion errors:

$$\text{Accuracy} = \text{A/D Conversion Error} + \text{D/A Conversion Error}$$

The A/D conversion error means that measured as HART signal which is A/D converted from the analog input signal.

The D/A conversion error of this transmitter is relatively very small so that it does not really affect the unit's overall performance.

The "Accuracies" given in Table 1 therefore equals the A/D conversion error.

The temperature drift (coefficient) or the cold junction compensation error is not included in the "Accuracy."

### ■ CALCULATION EXAMPLES OF OVERALL ACCURACY IN %

#### • DC Voltage

1) 0 – 200mV

$$\begin{aligned} \text{Absolute value accuracy (Table 1): } & 40\mu\text{V} \\ 40\mu\text{V} / 200000\mu\text{V} \times 100 & = 0.02 \% < 0.1\% \end{aligned}$$

⇒ Overall accuracy = ±0.1% of span

2) 0 – 4mV

$$\begin{aligned} \text{Absolute value accuracy (Table 1): } & 10\mu\text{V} \\ 10\mu\text{V} / 4000\mu\text{V} \times 100 & = 0.25 \% > 0.1\% \end{aligned}$$

⇒ Overall accuracy = ±0.25% of span

#### • Thermocouple

1) K thermocouple, 0 – 1000°C

$$\text{Absolute value accuracy (Table 1): } 0.25^\circ\text{C}$$

$$0.1\% \times 1000^\circ\text{C} = 1^\circ\text{C} > 0.25^\circ\text{C}$$

$$\text{CJC error (0.5}^\circ\text{C) added: } 1 + 0.5 = 1.5^\circ\text{C}$$

$$1.5^\circ\text{C} / 1000^\circ\text{C} \times 100 = 0.15 \%$$

⇒ Overall accuracy including CJC error = ±0.15% of span

2) K thermocouple, 50 – 150°C

$$\text{Absolute value accuracy (Table 1): } 0.25^\circ\text{C}$$

$$0.1\% \times (150 - 50)^\circ\text{C} = 0.1^\circ\text{C} < 0.25^\circ\text{C}$$

$$\text{CJC error (0.5}^\circ\text{C) added: } 0.25 + 0.5 = 0.75^\circ\text{C}$$

$$0.75^\circ\text{C} / (150 - 50)^\circ\text{C} \times 100 = 0.75 \%$$

⇒ Overall accuracy including CJC error = ±0.75% of span

#### • RTD

1) Pt 100, -200 – 800°C

$$\text{Absolute value accuracy (Table 1): } 0.15^\circ\text{C}$$

$$0.15^\circ\text{C} / (800 - (-200))^\circ\text{C} \times 100 = 0.015 \% < 0.1\%$$

⇒ Overall accuracy = ±0.1% of span

2) Pt 100, 0 – 100°C

$$\text{Absolute value accuracy (Table 1): } 0.15^\circ\text{C}$$

$$0.15^\circ\text{C} / 100^\circ\text{C} \times 100 = 0.15 \% > 0.1\%$$

⇒ Overall accuracy = ±0.15% of span

## INPUT TYPE, RANGE & ACCURACY

### ■ INPUT TYPE, RANGE & ACCURACY

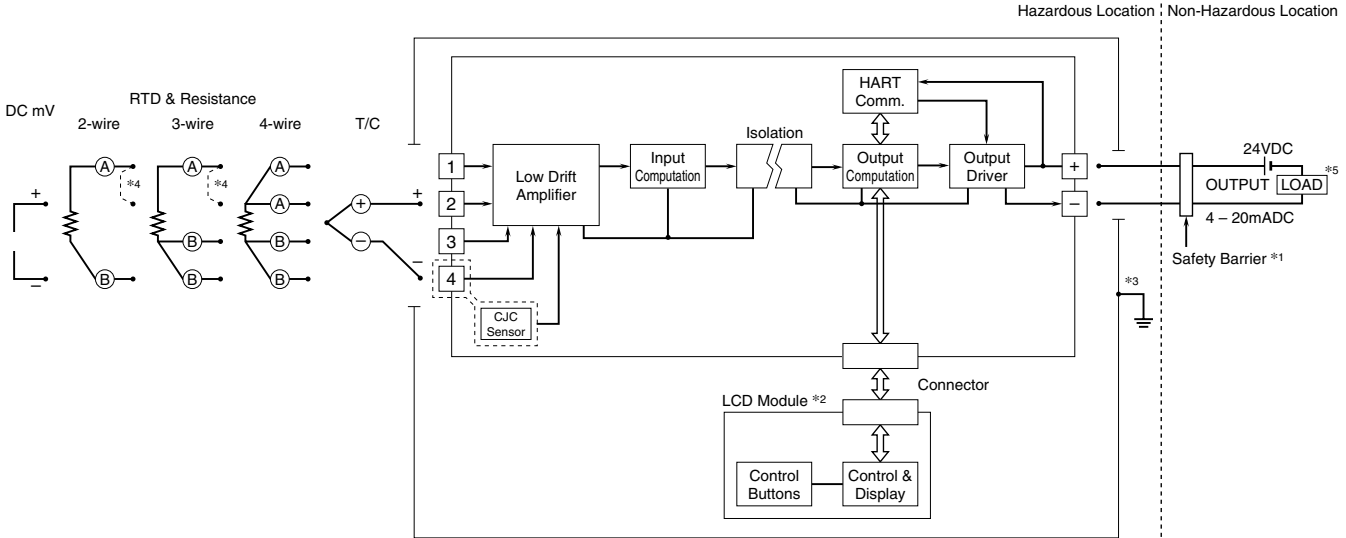
TABLE 1

INPUT TYPE	MIN. SPAN	MAXIMUM RANGE	ACCURACY						
DC mV & V	4mV	-50 to +1000mV	±0.1% or ±10μV, whichever is greater (F.S. input ≤50mV) ±0.1% or ±40μV, whichever is greater (F.S. input ≤200mV) ±0.1% or ±60μV, whichever is greater (F.S. input ≤500mV) ±0.1% or ±80μV, whichever is greater (F.S. input >500mV)						
Thermocouple	°C				°F				
	MIN. SPAN	MAXIMUM RANGE	CONFORMANCE RANGE	ACCURACY *1	MIN. SPAN	MAXIMUM RANGE	CONFORMANCE RANGE	ACCURACY *1	
	(PR)	20	0 to 1760	0 to 1760	±1.00	36	32 to 3200	32 to 3200	±1.80
	K (CA)	20	-270 to +1370	-150 to +1370	±0.25	36	-454 to +2498	-238 to +2498	±0.45
	E (CRC)	20	-270 to +1000	-170 to +1000	±0.20	36	-454 to +1832	-274 to +1832	±0.36
	J (IC)	20	-210 to +1200	-180 to +1200	±0.25	36	-346 to +2192	-292 to +2192	±0.45
	T (CC)	20	-270 to +400	-170 to +400	±0.25	36	-454 to +752	-274 to +752	±0.45
	B (RH)	20	100 to 1820	400 to 1760	±0.75	36	212 to 3308	752 to 3200	±1.35
	R	20	-50 to +1760	200 to 1760	±0.50	36	-58 to 3200	392 to 3200	±0.90
	S	20	-50 to +1760	0 to 1760	±0.50	36	-58 to +3200	32 to 3200	±0.90
	W	20	0 to 2315	0 to 2315	±0.25	36	32 to 4199	32 to 4199	±0.45
	N	20	-270 to +1300	-130 to +1300	±0.30	36	-454 to +2372	-202 to +2372	±0.54
	U	20	-200 to +600	-200 to +600	±0.20	36	-328 to +1112	-328 to +1112	±0.36
	L	20	-200 to +900	-200 to +900	±0.25	36	-328 to +1652	-328 to +1652	±0.45
P (Platinel II)	20	0 to 1395	0 to 1395	±0.25	36	32 to 2543	32 to 2543	±0.45	
RTD	°C				°F				
	MIN. SPAN	MAXIMUM RANGE		ACCURACY *2	MIN. SPAN	MAXIMUM RANGE		ACCURACY *2	
Pt 100 (JIS '97, IEC)	20	-200 to +850		±0.15	36	-328 to +1562		±0.27	

\*1. [Accuracy or ±0.1% of span, whichever is greater] + Cold Junction Compensation Error 0.5°C

\*2. Or ±0.1% of span, whichever is greater. (For 2- or 3-wire RTD, the value is valid by the sensor calibration after the wiring is done.)

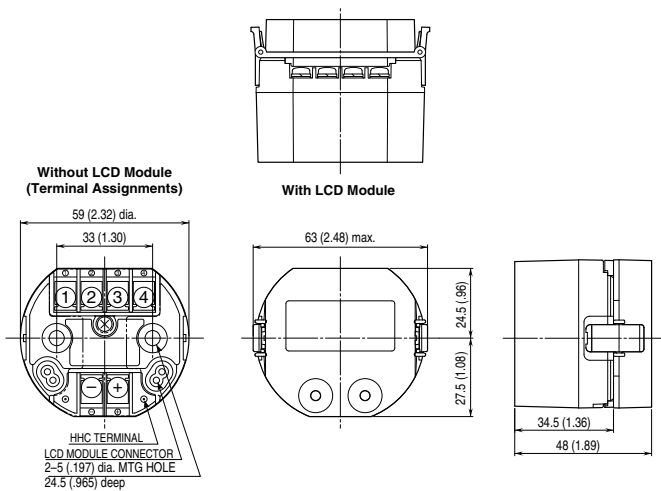
# SCHEMATIC CIRCUITRY & CONNECTION DIAGRAM



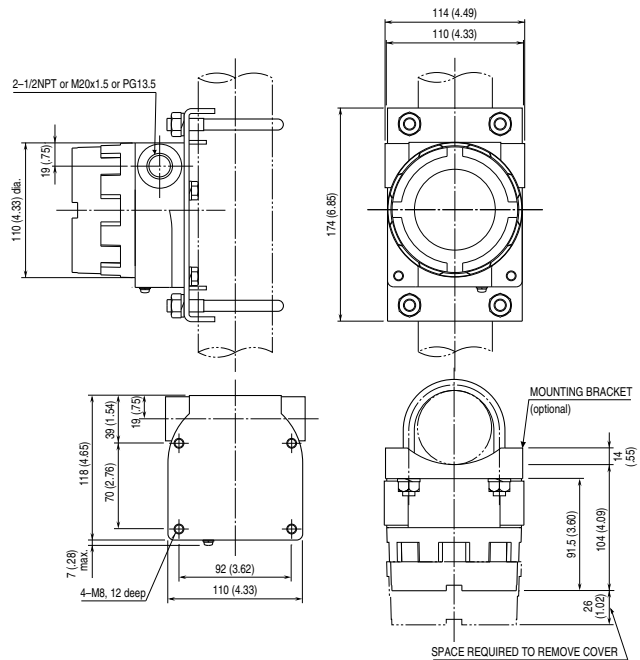
- \*1. A safety barrier must be installed for the intrinsic safety.  
The safety barrier must meet the Ex-data of this unit and must be approved for the hazardous location.
- \*2. Optional
- \*3. Be sure to earth the unit's enclosure to meet the intrinsic safe or explosion-proof (flameproof) requirements.
- \*4. Close across the terminals 1 & 2 for 2-wire/3-wire RTD input.
- \*5. Limited to 250 – 1100Ω for HART communication.

# EXTERNAL DIMENSIONS & MOUNTING REQUIREMENTS unit: mm (inch)

## ■ FRC0



## ■ FRC1, FRC2



# Fuji Electric France S.A.S.

46, Rue Georges Besse - Z I du Brézet  
 63 039 Clermont-Ferrand cedex 2 — FRANCE  
 France : Tél. 04 73 98 26 98 - Fax 04 73 98 26 99  
 International : Tél. (33) 4 7398 2698 - Fax. (33) 4 7398 2699  
 E-mail : sales.dpt@fujielectric.fr

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