

Advanced High Precision Resistometric Transmitter for 3-Wire and 4-Wire Electrical Resistance Probes

FEATURES

- High 18 bits measuring resolution achieves 1nm metal release sensitivity for a 0.5 mm thick exposed element.
- 2 Channel PSD detector for high error signal attenuation.
- Reads ER sensors from 0.7 mohm to 10 mohm.
- Reads 3 and 4 wire probes with access key in fitting or transmitter probe connector port.
- Very low temperature drift for measurement electronic. 0.002% of FS from -10°C to 70°C.
- Very low supply current. 3.6mA at 24 VDC supply voltage.
- Galvanically isolated sensor from supply and comm.
- RS485 Modbus RTU output for easy integration into SCADA systems or data loggers, radios and PLCs.
- Fully welded or O-ring sealed enclosure.
- Small size and weight make it fit on probe shafts directly. No probe cables required.
- Energy flows in and out of the device are restricted for use in hazardous areas. Explosion proof enclosure.
- Resistance ratio or thickness output. Corrosion rate output with connected logger online.

APPLICATIONS

- **Online Corrosion Monitoring with ER Probes**
- **Corrosion Monitoring with Logger or Wireless**
- **Erosion Monitoring with Cylindrical Probes**
- **Underwater Applications (depth max 500m)**
- **General Corrosion Testing/Monitoring with Sensors on short Cables.**

DESCRIPTION

The **ERT01** transmitter is specifically designed to detect metal release (caused by corrosion or erosion) from electrical resistance probes (sensors) in three or four wire configuration.

The **ERT01** transmitter operating principal is based on the resistometric technique outlined in the copper sensor data sheet **DS FMRS06**. The three channel **FMRT01** PSD detector for the **FMRT01** transmitter has been reduced to 2 channels without the reference element temperature measurement and gradient detector for the two sensing elements in the sensor. A four cycle gain offset and drift compensation technique allows for stable and reproducible ratios over a large instrument temperature range. Additionally a basic AI algorithm based on linear regression further improve accuracy and precision for the collected ratio-metric measurement samples.

The **ERT01** transmitter preferably uses Solenics type cylindrical and strip shaped metal elements as reference and sensing elements (resistors). Other standard ER probes can also be used if their resistances do not exceed 10 mohm but in most cases with much lower performance.

An internal flat reference element is used for both Solenics types of sensors to compensate for the temperature dependent resistance of the element material. The wall thickness for the exposed cylinder and strip type Solenics sensors is 0.5 mm (0.02").

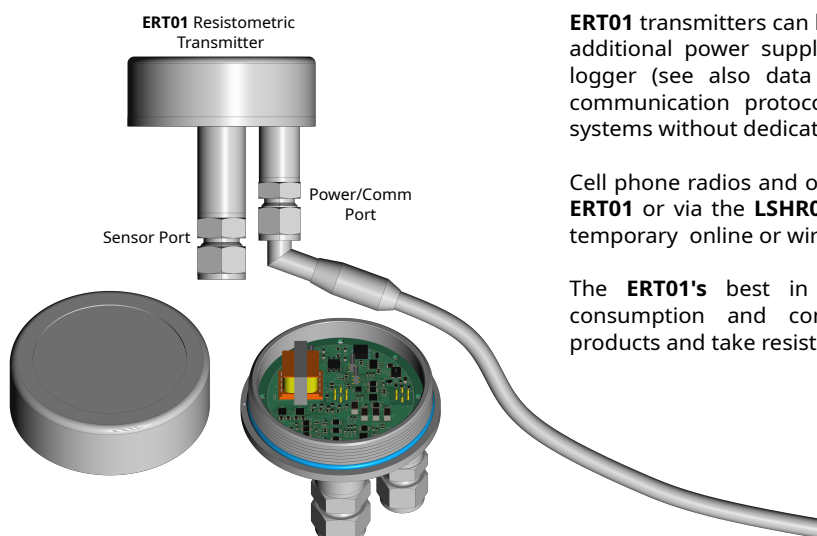
The **TCR** (Temperature Coefficient of Resistance) of the two elements (reference and exposed) is within or better than ± 2 **RRU** for a 1°C change in element material temperature at 18 bits of resolution. 18 bits of resolution result in 262144 RRU (Resistance Ratio Units). The loss of half the wall thickness for the exposed cylinder or strip is a full scale reading of 262144 RRU or 254 000 nm for a 0.5mm thick cylinder or strip wall (**1 RRU = ~ 1nm**).

The **ERT01** power and communication side is **galvanically isolated** from the sensing elements in the sensor (probe). Sensor output signals are proximity signal corrected for Solenics and other standard ER sensors/probes.

ERT01 transmitters can be directly read with a rugged **Tablet PC** without an additional power supply. It can also be connected to the **LSHR01** data logger (see also data sheet **DS-LSHR01**). The standard **Modbus RTU** communication protocol allows for easy integration into plant SCADA systems without dedicated additional computers.

Cell phone radios and other wireless gear can be directly connected to the **ERT01** or via the **LSHR01** data logger. The Tablet PC can also be used for temporary online or wireless communication.

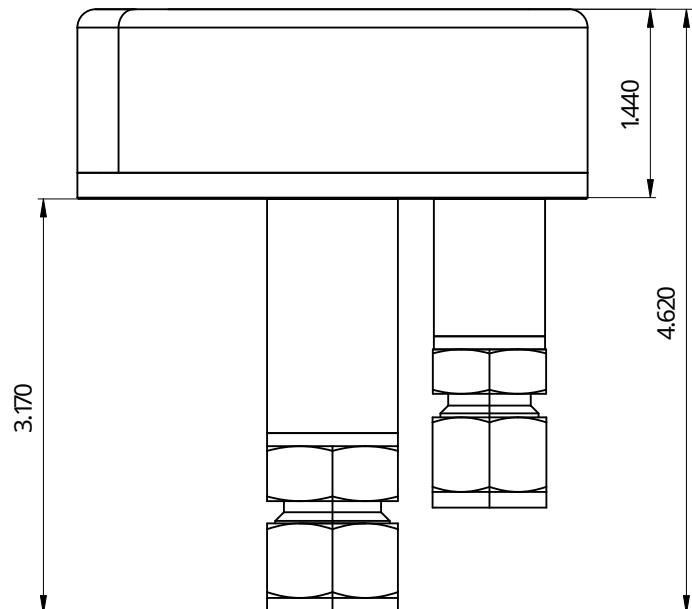
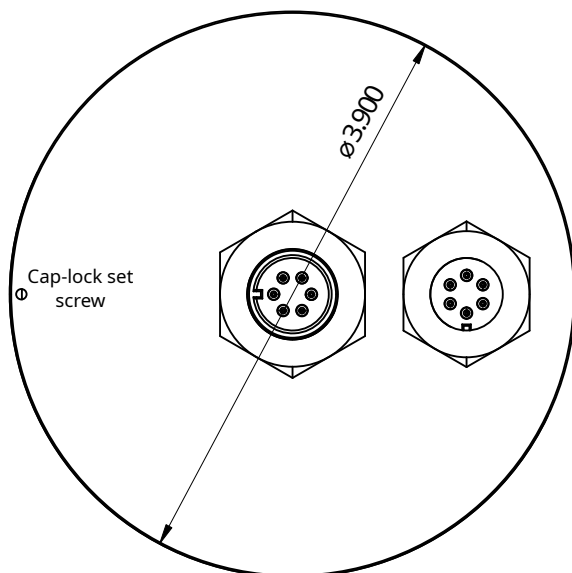
The **ERT01's** best in class precision, repeatability, very low power consumption and communication flexibility outperform competitive products and take resistometric metal release monitoring to the next level.



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ERT-01 Transmitter Specifications

Enclosure	Stainless Steel with Swagelok Port entries.	For other enclosure options please contact SOLENICS
Connectors/Cables	6 pin glass sealed connector ports/over-molded wire armored instrumentation cables	For custom connections and cables please contact Solenics
Measurement Method	Ratio-metric Electrical Resistance	Modified Wheatstone Bridge
Signal Conditioning	2 Channel PSD	Phase Sensitive Demodulation
Resolution	18 bits	262144 points FS
Sensor Resistance Range	0.7 mohm to 10 mohm	Transmitter can be adapted to other resistance ranges.
Channels	2	
Power Supply	6 to 24 VDC	
Current Consumption	3.6 mA at 24 VDC	
Communication	RS485 Solenics or Modbus RTU	For other Comm options please contact SOLENICS
Output Values	2	
Value 1	Sensor Ratio 0 to 262144 RRU	RRU = Resistance Ratio Units
Value2	Transmitter PCB temperature -40 to 80 °C.	Circuit board body Temperature
Sensor Element Material	C1010 Low Carbon Steel	For other materials please contact SOLENICS
Sensitivity to thickness loss	1nm for 0.5 mm wall thickness	
Precision	+/- 5 RRU for 0.7 mohm SR better for higher resistances	Depends also on the rate of temperature change in the exposed environment.
Transmitter Temperature Drift	0.002% of FS from -10 to 70 °C	
Permanent Operating Temperature Range	-20 to 70 °C	
Excitation Output	28 Hz Sinusoidal	
Max Excitation Current	100mA	
Max Excitation Output Amplitude	40 mVpp	Terminal voltage for a disconnected sensor



Dimensions are in inches

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Tel + 52 993 3149556 Cell +521 993 1175107 e-mail: et@solenics.com
Prolong. de Zaragoza #1017-C Col. Centro C.P. 86000
Villahermosa, Tabasco. MEXICO

Detection Prinziple for the ERT01 Resistometric Transmitter

The **ERT01** resistometric detection principle is comprised of a modified Wheatstone Bridge, where one bridge leg is the sensor and the other is replaced by two lock-in amplifiers. Circuit drift and offsets over its operating temperature range are compensated for by rotating **Ch A** and **Ch B**. The resulting four cycle measurement generates two zero ratios and two sensor resistance ratios and the actual sensor ratio is calculated as:

$$Sensor_{Ratio} = \frac{(SR_{cycle2} - ZR_{cycle1}) + (SR_{cycle4} - ZR_{cycle3})}{2}$$

The lock-in method rejects signal noise and extracts the real part of the sensor's impedance. Lock-in amplifiers were invented in the 1930's and commercialized in the mid-20th century as electrical instruments capable of extracting signal amplitudes and phases in extremely noisy environments.

Over decades of development, researchers have found many different ways to use lock-in amplifiers but as with most powerful tools, only a solid understanding of the working principles and features enables the user to get the most out of it and successfully design applications. The lock-in amplifier used in the **ERT01** transmitter (**Fig.1**) employs a homodyne detection scheme and low-pass filtering to measure the ER-sensor signal's amplitude and phase relative to the square wave reference, extracting signals around the reference frequency while efficiently rejecting other frequency components.

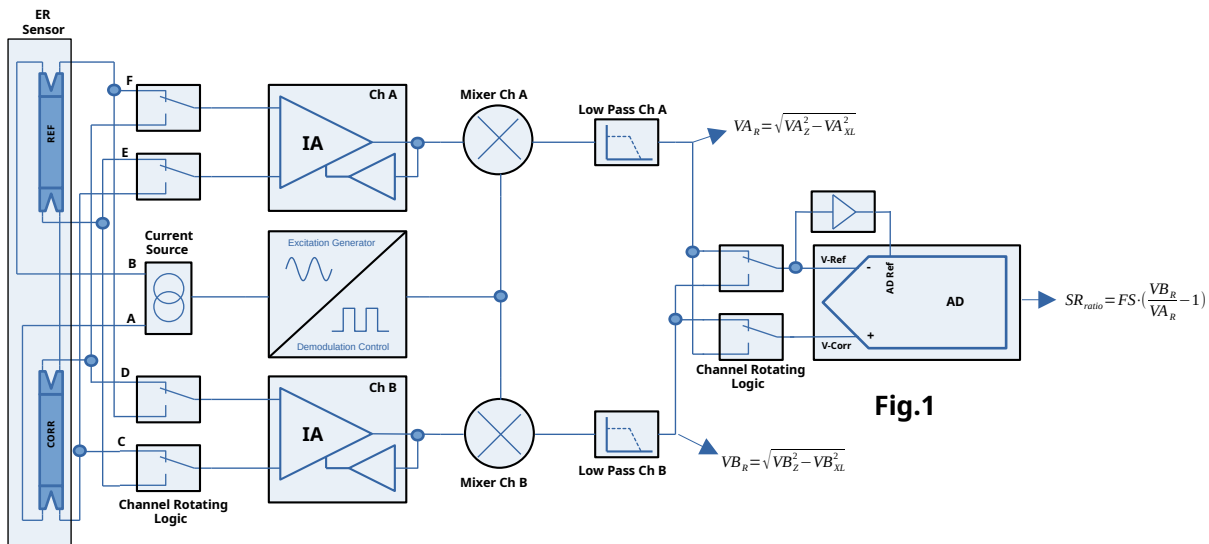


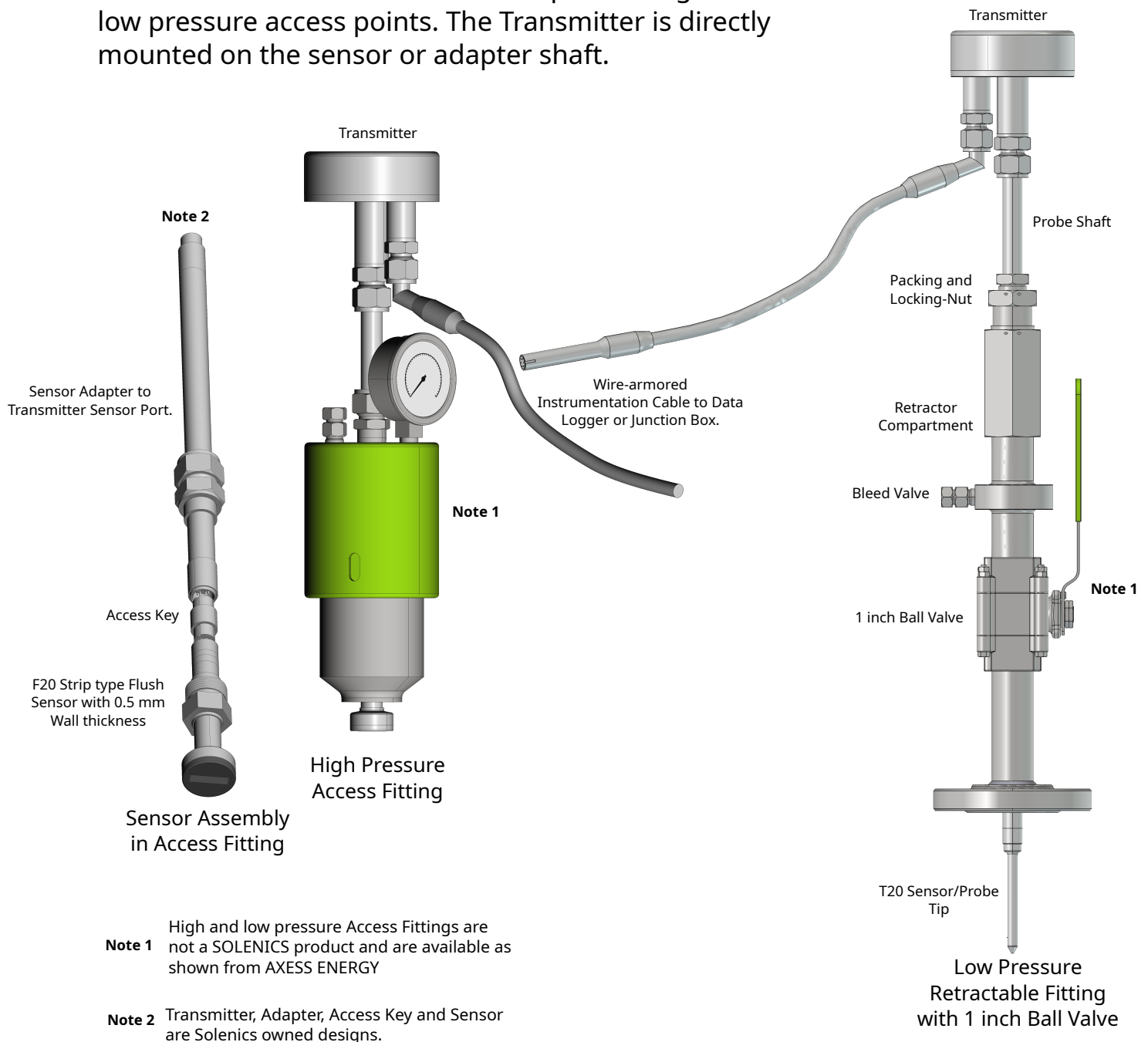
Fig.1

ERT01 Transmitter Serial Interface Modbus RTU Mapping for 32 bit Floating Point numbers

Serial Interface IO Mapping				Protocol:		RS485			
				Comm Protocol		Modbus RTU (Master)			
				PLC Address:					
				Baud Rate:		1200			
				Start Bit:		1			
Project:	Stop Bit:		1						
End User:	Parity:		None						
Doc No:	PLC Data Type:		Holding Register						
Rev. No / Date:									
Serial Device Type:									
Remote IO Device Address	IO Card Slot Number	Ch. No.	Field Tag Name	Description	Remote Register Address	PLC to DCS Register Address	Access Type	Data Type	Remark
1		CH1	ER 0001	ER Corrosion Sensor	40001	40001	Read	IEEE Floating Point	32 Bit Floating Point Number (DCBA)
2		CH2	ER 0002	ER Corrosion Sensor	40001	40003	Read	IEEE Floating Point	32 Bit Floating Point Number (DCBA)

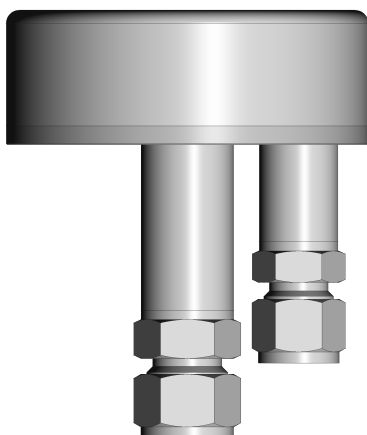
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ERT01 Transmitter installation examples for high and low pressure access points. The Transmitter is directly mounted on the sensor or adapter shaft.



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Fully welded hermetically sealed enclosure version



ERT01 Transmitter enclosure composition for fully welded and o-ring sealed version.

O-ring sealed enclosure version



Threaded enclosure cap



Double sided instrument PCB



Threaded base plate with o-ring

Glass sealed sensor connector

Hermetically sealed sensor connector port



Glass sealed power/comm connector

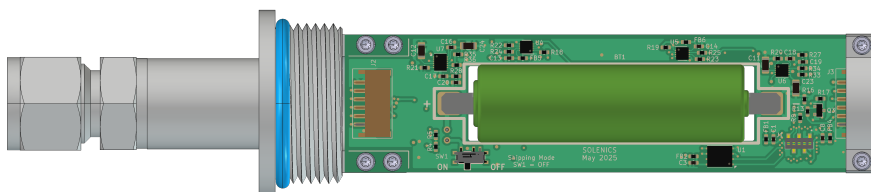
Hermetically sealed power/comm connector port



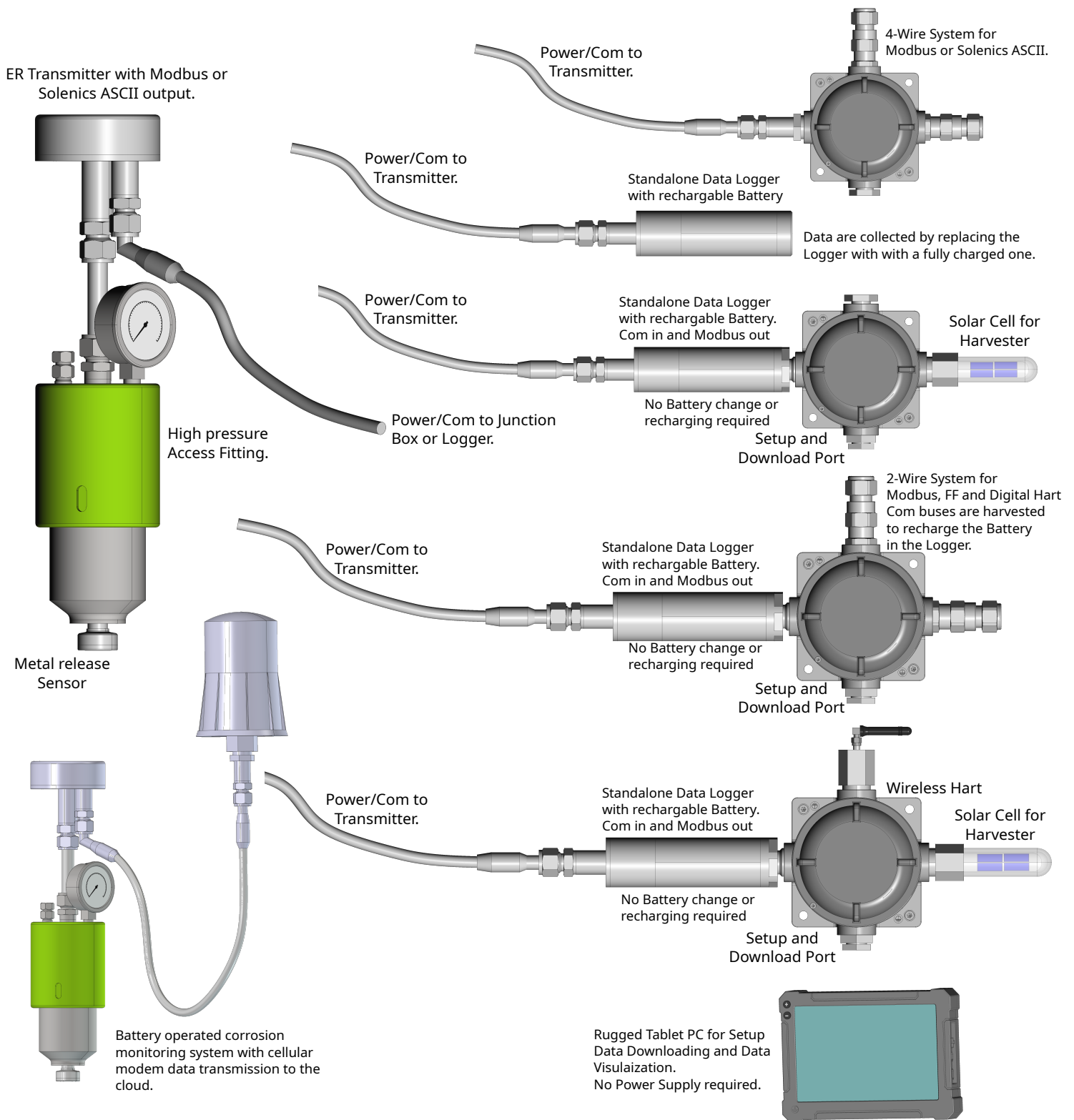
1/2" gas and pressure tight SWAGELOK entry

7/8" gas and pressure tight SWAGELOK entry

Standalone Data Logger with Cap open



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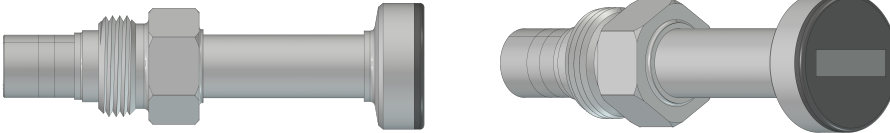


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Solenics Type Electrical Resistance Sensors

SOL-F20-RI

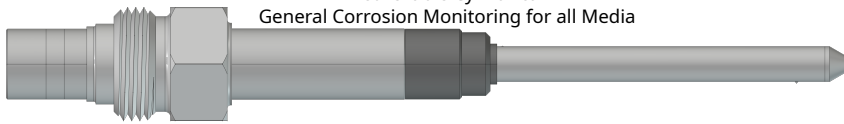
Retrievable Flush
General Corrosion Monitoring for all Media



Sensor Style: **Retrievable**
Element Style: **Strip**
Element Material: **C1010 Carbon Steel**
Element Thickness: **0.02"**
Body Material: **SS 316**
Connector Style: **6 pin Glass Sealed**

SOL-T20-RI

Retrievable Cylindrical
General Corrosion Monitoring for all Media



Sensor Style: **Retrievable**
Element Style: **Cylindrical**
Element Material: **C1010 Carbon Steel**
Element Thickness: **0.02"**
Body Material: **SS 316**
Connector Style: **6 pin Glass Sealed**

SOL-T20-RA

Retractable Cylindrical
General Corrosion Monitoring for all Media



SOL-ST28-RI

Retrievable Cylindrical
General Erosion/Sand Monitoring for all Media



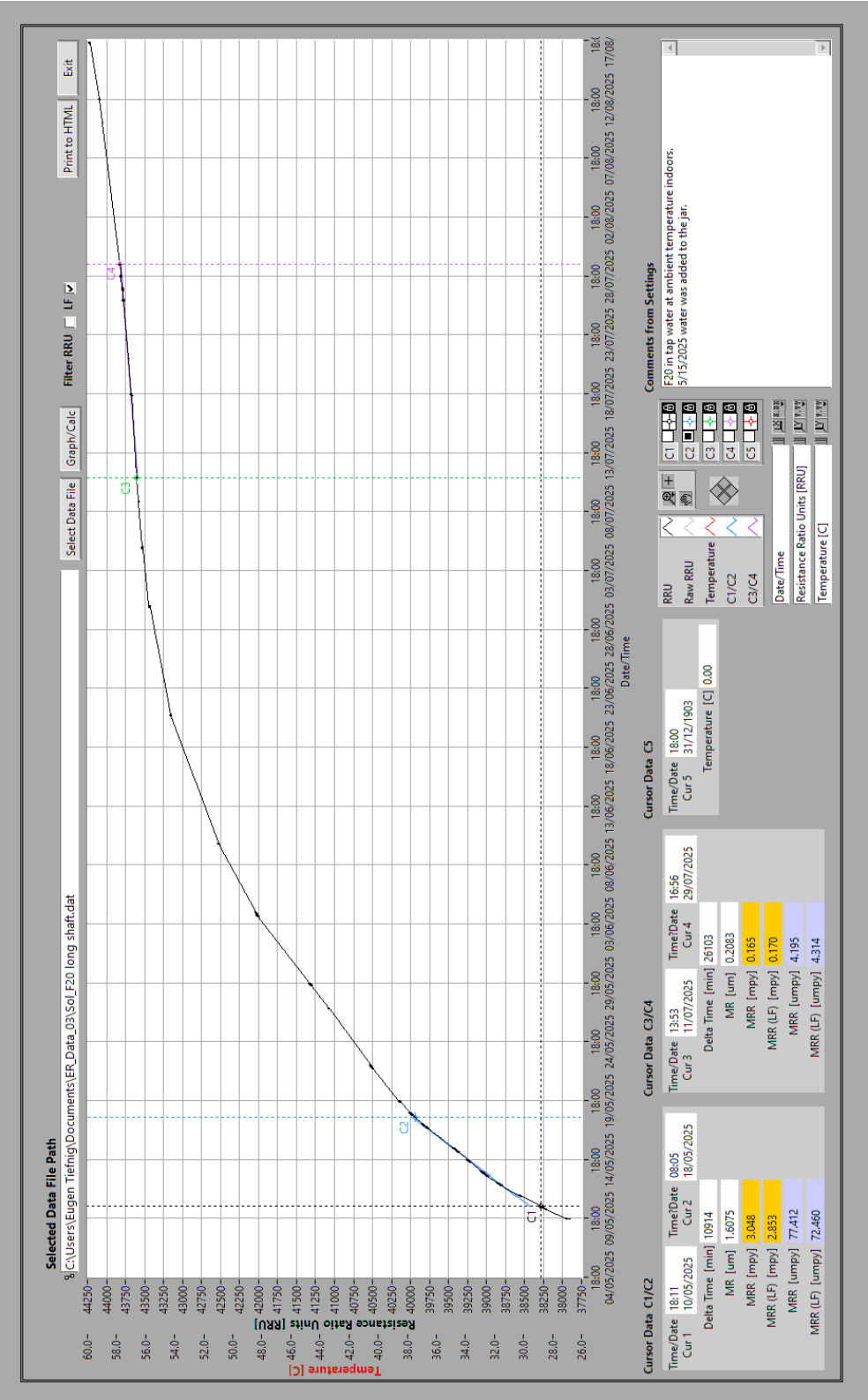
Sensor Style: **Retrievable**
Element Style: **Cylindrical**
Element Material: **Inconel 600**
Element Thickness: **0.028"**
Body Material: **Inconel 600 or SS 316**
Connector Style: **6 pin Glass Sealed**

For Pressure and Temperature Ratings Please Contact Solenics

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Metal Release Test in Tap Water.



MR = Metal Release (Thickness Loss)

MRR = Metal Release Rate (Thickness Loss per Year)

MRR (LF) = Metal Release Rate with Slope

Determined by Linear Regression.

um = [micro meter]

umpy = [micro meter per year]

mpy = [mils per year]

Test Conditions:

Instrument: ERT01

Sensor: Flush 20 (0.5 mm thick).

Exposed Material: C1010 9low carbon steel).

Medium: Tap water in glass jar indoors no stirring.

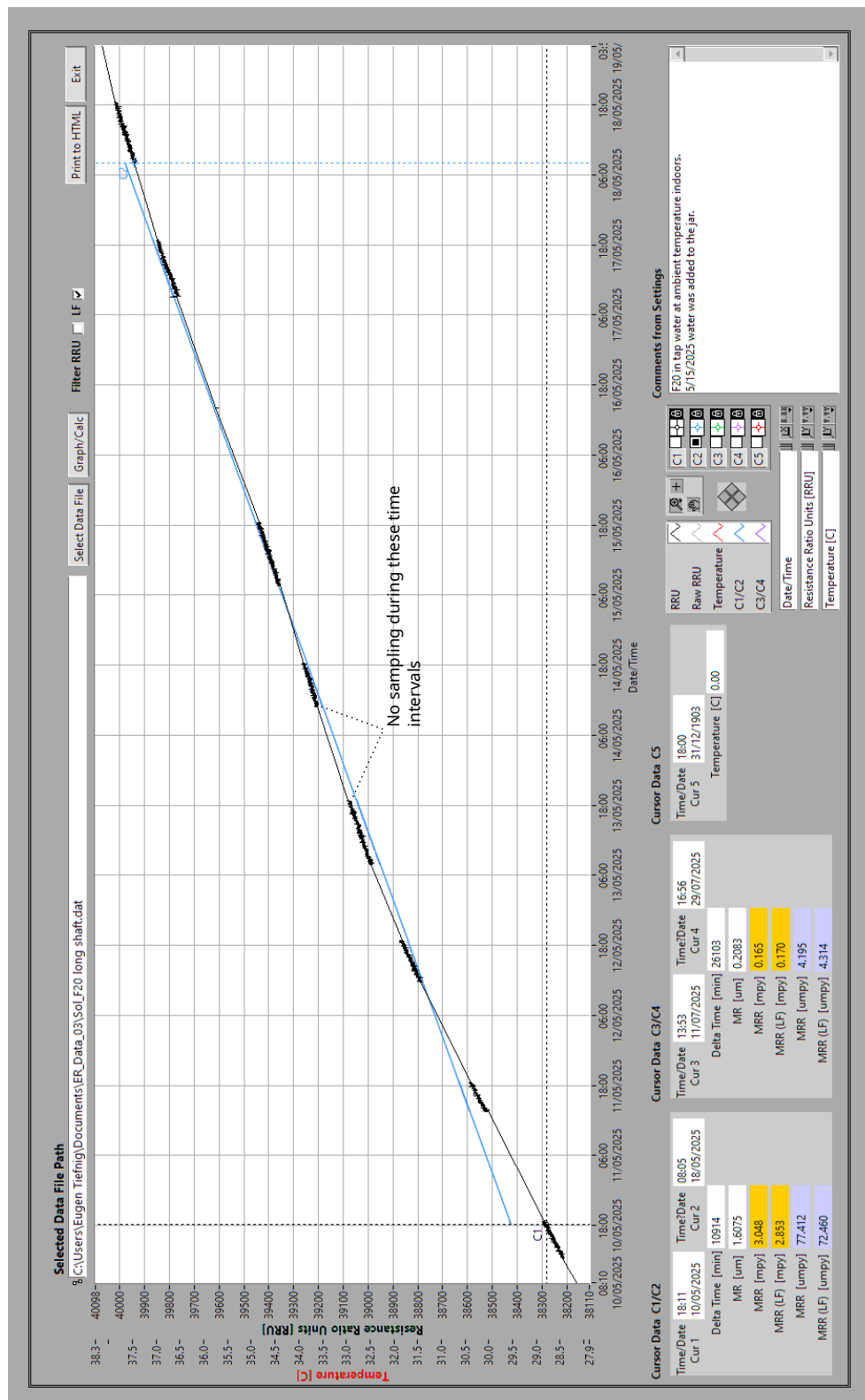
Temperature: min 26 °C max 35 °C.

Sampling: Discontinuous.

Duration: 90 days.

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Acknowledgments

This application, development and the device **ERT01** with its associated components are wholly owned and financed by **Solenics** with all rights reserved.

Components not part of this development are marked as such with directions regarding their origin.

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