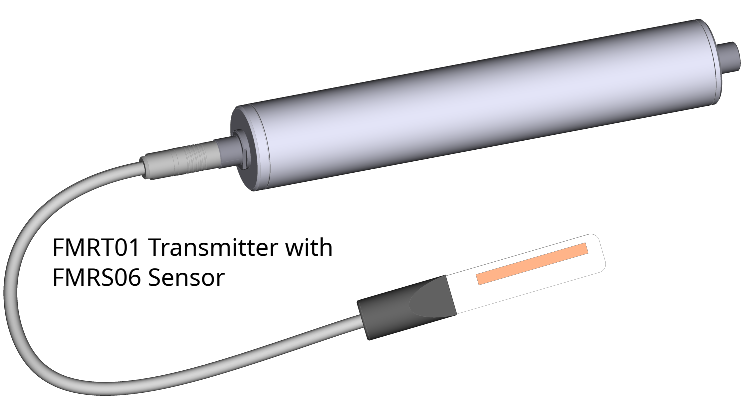
High Precision Ratio-Metric Resistance Transmitter for Electrical Resistance Sensors or Probes used to detect Metal Release.

FEATURES

- High measuring resolution 18bits (262144 points).
- 3 Channel PSD for error signal attenuation.
- Reads ER sensor from 1mΩ to 20mΩ.
- 5 output values if further processing of resistance ratio is desirable.
- Low temperature drift. 5 points from -10 ºC to 80 ºC.
- Low supply current (4.2mA at 24VDC supply voltage.
- Can be adapted to most ratio-metric ER probes.
- RS485/Modbus Com output. Easy to integrate into SCADA or battery operated wireless systems.
- High permanent operating temperature of 70ºC
- Temperature output from sensor reference element and gradient compensation optional.
- Multiple enclosure material options (Plastic, Aluminum, Stainless Steel).
- Small form factor allows integration into tubes.

APPLICATIONS

- **Transformer Oil Monitoring and Testing**
- **Engine Oil Monitoring and Testing**
- **Grease Testing**
- **Fuel Storage Monitoring**
- **Nuclear Repository and Waste Storage Container Monitoring and Testing**
- **Laboratory Corrosion Testing**



FMRT01 Transmitter with
FMRS06 Sensor

DESCRIPTION

ER (Electrical Resistance) sensors or probes have usually a very low bulk resistance value in the order of milliohms. High resolution measurements are therefore difficult to realize.

To ensure precise resistance measurements, a ratio-metric three channel lock-in technique is used for the **FMRT01** transmitter to attenuate error signals and DC offsets through phase-sensitive detection (**PSD**). Phase sensitive-detection (synchronous demodulation) derives the real part from the ER sensors impedance. ER sensors comprise two thin metal elements in close proximity and are exited with a low frequency sinusoidal current waveform. The AC waveform is used to mask out thermal EMF which can otherwise saturate the input amplifiers and attenuate noise signals. An ER sensors impedance can be substantially increased by the proximity effect which depends on the excitation frequency and the sensors material and geometry. Alternating currents through a conductor (ER element) induce eddy currents in its neighboring conductor (Proximity Effect) which causes current crowding in the conductor and in turn leads to uneven current distribution in the ER elements. The faster the rise time of the excitation signal the larger the eddy currents. ER sensors contain two in series connected sandwiched or in plane strips of metal where the excitation current enters on one element and exits at the second.

In such a configuration the proximity effect increases the current density on the element sides facing each other and decreases the current density on the sides facing away from each other subsequently decreasing the effective cross section of the sensing elements.

DC excitation does not eliminate the proximity problem because in order to compensate for thermal EMF the excitation current would have to be turned on and off several times per second. The fast on/off transitions generate large eddy currents in the sensing elements which dissipate slow. There is also little attenuation to noise signals using a DC technique. The

FMRT01 transmitter circuit accommodates a modified Wheatstone Bridge where one bridge leg is the ER sensor and the other is replaced by two subtractors in the transmitter. The output of this bridge after AD conversion is the resistance ratio between the sensors internal reference and exposed element. To compensate for temperature gradient affected ratios a third channel compares the sensors reference and exposed element simultaneously with the **FMRT01** internal reference to either derive the absolute temperature of the reference element in the sensor or detect a temperature gradient between the two elements in the sensor. A temperature difference between the two elements in the sensor is predicted by measuring the rate of resistance change caused by increasing or decreasing temperature for the two elements in the measuring period of 15 seconds. During this 15 seconds it is assumed that no metal release takes place. See also **FMRT01** block diagram **Fig. 1.**

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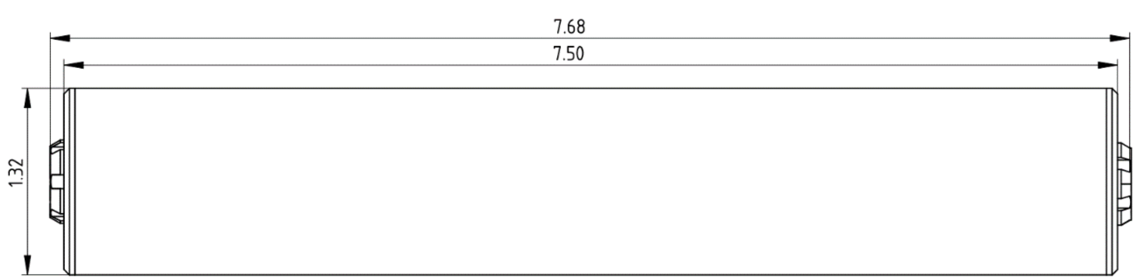
FM000 Transmitter Specifications

Enclosure	Tubular	For enclosure materials please contact SOLENICS
Connectors	Fisher, Material: brass	For other connections please contact SOLENICS
Measurement Method	Ratio-Metric-Resistance	Modified Wheatstone Bridge
Signal Conditioning	PSD (Phase Sensitive Detection)	
Resolution	18bits 262144 points	
Sensor Resistance Range	1 mΩ to 20 mΩ	For other sensor resistances please contact Solenics
Channels	3	
Power Supply	6 to 40 VDC	
Current Consumption	4.2mA at 24VDC	
Communication	RS485/Modbus	For other Com options please contact Solenics
Output Values	5	
Value 1 *	Sensor Ratio 0 to 262144 RRU	RRU = Ratio Resistance Units
Value 2 *	Sensor REF Element Ratio 0 to 262144 RRU	Sensor REF element ratio used to derive the sensor temperature.
Value 3 *	Slope of Value 1	Rate of RRU change in 15sec
Value 4 *	Slope of Reference Element	Rate of RRU change for REF Element in 15sec
Value 5 *	Slope of Exposed Element	Rate of RRU change for CORR Element in 15sec
Transmitter Temperature Drift	5 RRU from -10 ºC to 80 ºC	
Permanent Operating Temperature	-20 ºC to 70 ºC	
Enclosure Seals	O-Rings	For indoor lab applications a plastic enclosure without O-rings is sufficient
Excitation Output	23 Hz Sine Wave	Used for FMRS06 Cu Sensors
Max Excitation Current Output	200mA	
Max Excitation Output Amplitude	40mVpp	

***Value 1:** Can be used as is or further processed in acquisition software.
***Value 2:** Can be further processed to absolute sensor temperature in acquisition software.
***Value 3:** Indicates a temperature gradient problem.
***Value 3,4,5:** Used to adjust temperature gradient affected RRU readings (Value 1) in acquisition software.
Value 2,3,4,5 are not required if no further processing of Value 1 is satisfactorily.



Dimensions are in inches

FMRT01 Signal Conditioner Block Diagram

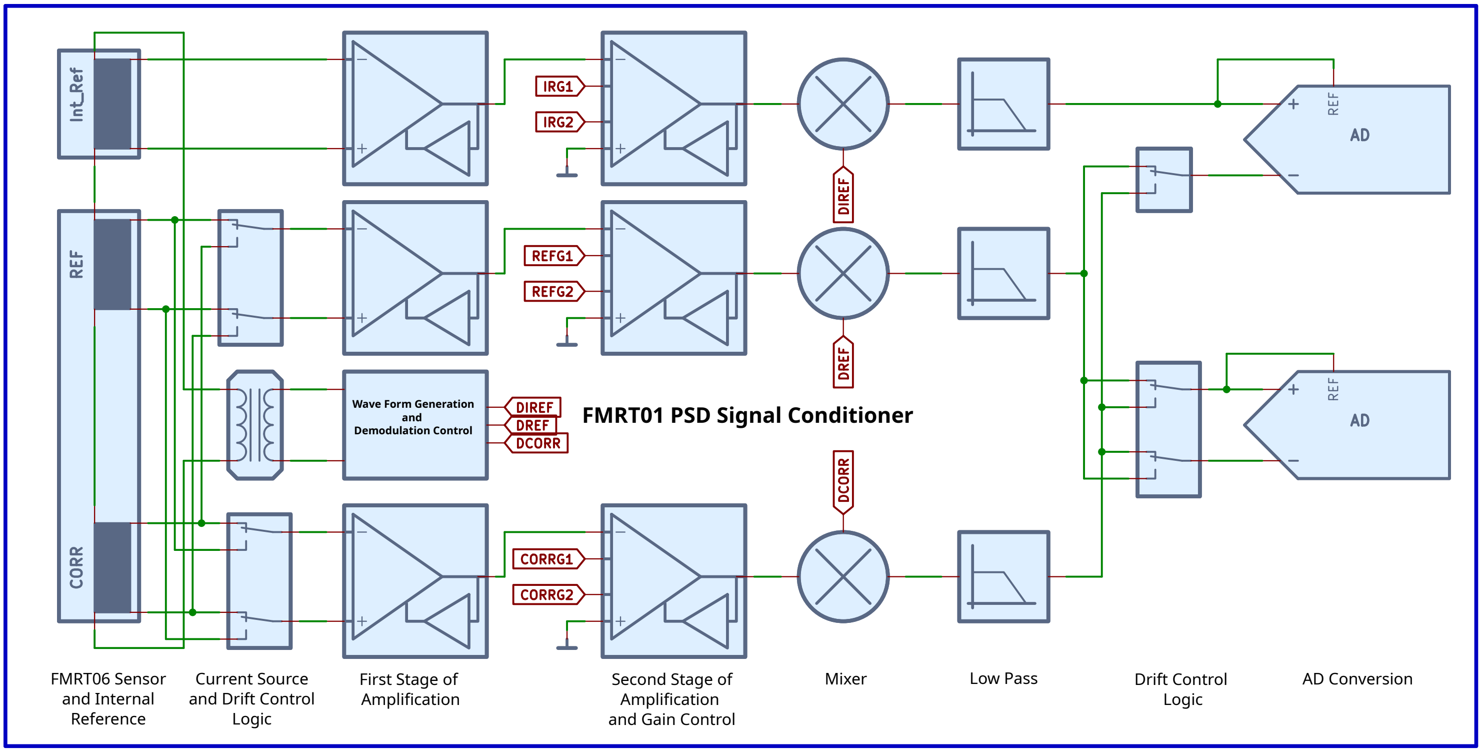


Fig. 1

The 3 channel **FMRT01** PSD signal conditioner does not require a special instrument setup or programming except for the instrument channel number required for Modbus.

To compensate for the increase in sensor impedance caused by the proximity effect synchronous demodulation in phase with the excitation signal is used for the **FMRT01** transmitter.

This does not solve for the uneven current distribution in the sensor elements itself but the reactive signal component is for an in plane copper sensor design like the **FMRS06** very small.

The reactive signal part is highest for ferromagnetic materials in a cylindrical ER sensor design.
The reactive signal part also decreases with increasing element temperature causing eddy currents in the sensing elements to decrease with increasing material resistance.

All calculations to further improve the resistance ratio information are performed external in the acquisition software. If no further processing of RRU values is required, the values 2,3,4,5 can be ignored or simply not read.

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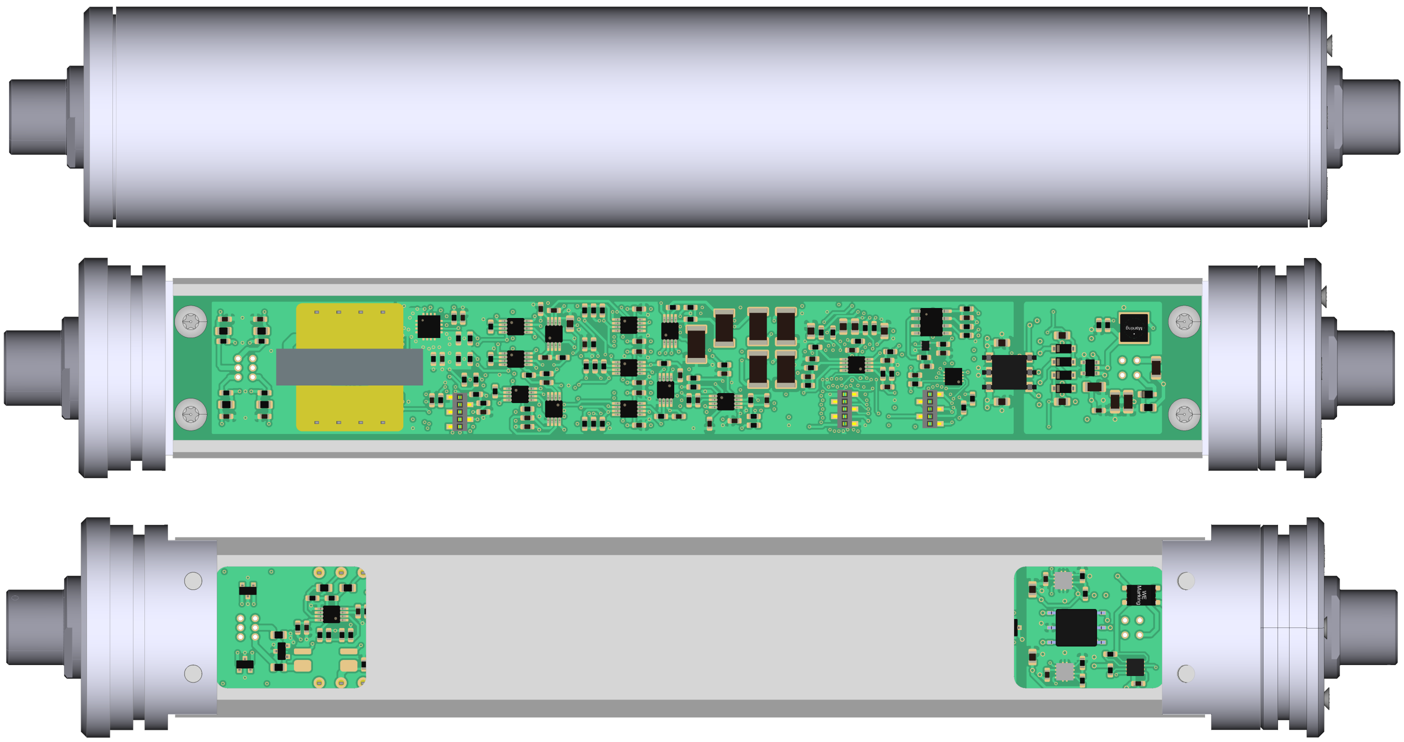
FMRT01 Transmitter for Ratio-Metric Metal Release Sensors **FMRS06**.



Transmitter enclosure is hermetically sealed and available in plastic, aluminum and stainless steel.

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