MS2801L

LPR RS-485 Transmitter

Operator's Manual

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I. Introduction

A. General Description

The model MS2801L **CorrTran** MV transmitter is designed to measure general corrosion, localized corrosion and conductance in a wide range of industries. The instrument measures the corrosion rate and pitting factor, giving the output in mil/year or a 0-1 pitting factor respectively. It also provides conductance measurement. The corrosion (corrosion rate) data from a Linear Polarization Resistance (LPR) probe can be transmitted to a plant control system or other recording device. The MS2801L **CorrTran** transmitter utilizes RS-485 communication which allows multiple units to be daisy-chained, simplifying installation and reducing associated costs. The use of the RS-485 protocol also allows the transmitter to be placed great distances from the control system or recorder while maintaining good noise rejection. Practical distances can be up to 3000 feet. Additionally, the MS2801L **CorrTran** transmitter offers user selectable RTU or ASCII communication protocols making it highly versatile.

The MS2801L **CorrTran** transmitter is compatible with 3 electrode elements of Metal Samples LPR probes.

The MS2801L **CorrTran** transmitter is available as direct-mount or remote-mount. The direct-mount version is mounted directly to the LPR probe. This option offers the simplest installation and minimizes noise problems. The remote-mount option allows the MS2801L **CorrTran** transmitter to be mounted independently from (but in close proximity to) the LPR probe. It is then connected to the probe via a short probe cable. (See pages 5 and 6 for mounting diagrams and specifications.)

B. Principles of Operation

The MS2801L **CorrTran** transmitter operates on the Linear Polarization Resistance (LPR) technique and is used in conjunction with an LPR probe. The instrument measures the current required to polarize the electrodes of a probe to a known potential. From the polarization potential and the measured current, polarization resistance can be calculated. Then, using Faraday's law, the instantaneous corrosion rate can be calculated from polarization resistance.

The MS2801L **CorrTran** MV utilizes state-of-the-art algorithms and data analysis techniques to accurately measure general corrosion rate and pitting. Harmonic distortion analysis (HDA) is applied to improve the performance of the industry-accepted linear polarization resistance (LPR) technique used to measure corrosion rate.

To further enhance the performance, an application-specific Stern-Geary variable (B value) is calculated and updated every measuring cycle. There is no need to manually update the B value because of process changes. During the measurement cycle, **CorrTran** MV also performs an automated electrochemical noise (ECN) measurement, which in combination with the corrosion rate data can provide a measurement of localized corrosion (pitting).

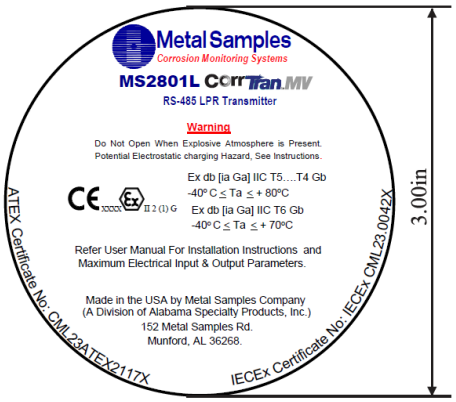
The MS2801L **CorrTran** MV works with Metal Samples three-electrode **CorrTran** style probes and electrodes. Probes are available in a variety of mounting types and materials to suit almost any type of installation.

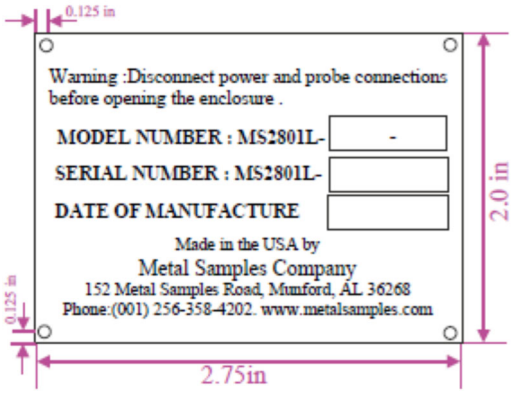
C. Disclaimer

Metal Samples has no power, nor does it undertake to police or enforce, compliance with the contents of this manual or observance of the safety precautions set forth herein. Metal Samples does not certify, test, or inspect the installations of MS2801L **CorrTran** MV for safety or other purposes. Metal Samples disclaims liability for any personal injury, property, or other damages of any nature whatsoever, whether special, indirect, consequential, or compensatory, directly or indirectly resulting from the publication, use of, or reliance upon this manual. Metal Samples makes no guaranty or warranty, express or implied, as to the accuracy or completeness of any information published in this manual, and disclaims and makes no warranty that the information in this manual will fulfill any particular purposes or needs. Metal Samples' only warranty is set forth in the written Limited Warranty specifically provided by Metal Samples in connection with the purchase of the MS2801L **CorrTran** MV.

D. Device Identification

Name Plates



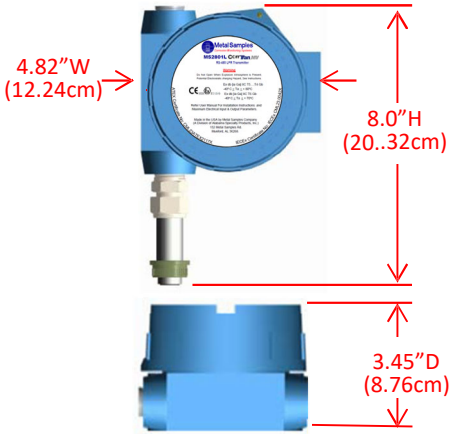


Model Number

Transmitter Model			
MS2801L-	CorrTran MV Transmitter – RS-485 Modbus		
	Mounting Type		
	00	Direct Mount	
	06	Remote Mount with 6’ (1.8m) Cable	
	12	Remote Mount with 12’ (3.6m) Cable	
	XX	Special (Remote Mount with XX’ of Cable)	
		Enclosure Type	
		00	Copper Free Aluminum
		01	Stainless Steel 316
MS2801L-	**06**	**00**	**Example of Ordering #**

E. Technical Specifications

Model MS2801L CorrTran LPR RS-485 Modbus Transmitter



Physical Data

Instrument Weight:	3.70 lb. (1.68 Kg) Total
Weight w/ Accessories:	5.76 lb. (2.61 Kg)
Instrument Dimensions:	8.0"H x 4.82"W x 3.45"D
	(20.32cm x 12.24cm x 8.76cm)
Operating Temperature:	-40° to 158°F (-40° to 70°C)
Storage Temperature:	-40° to 176°F (-40° to 80°C)
Enclosure Material:	Cast Aluminum (Copper-Free) / Stainless Steel 316
Mounting Specifications:	Direct probe mount or Remote mount (Up to a 2.5" (6.35cm) Dia. pole)

Measurement Data

Measurement Type:	LPR measurement
Probe Type:	3-Electrode LPR
Measurement Type:	General Corrosion; Range: 0 -40 mpy Localized corrosion; Range: 0.0 to 1.0 Conductance; Range: 5 to 333333 uS
Factory Settings:	B Value (Stern Geary Value): 25.6 mV
Cycle Time:	4 to 21 minutes (Depends on Configuration)

Electrical Data

Power Requirements:	11 to 30 VDC
Maximum Probe Cable Distance:	12 ft (3.6 m)
Output Specifications:	RS-485 Modbus, RTU or ASCII Protocol (Switch Selectable) 2400 / 4800 / 9600 / 19.2K Selectable Baud 32 Maximum Units (Addresses 1 to 32)

Hazardous Location Certifications – Transmitter

Europe and Worldwide (ATEX and IECEx)	Ex db [ia Ga] IIC T5….T4 Gb - 40°C ≤ Ta ≤ + 80°C Ex db [ia Ga] IIC T6 Gb - 40°C ≤ Ta ≤ + 70°C ATEX Certificate No: **CML23ATEX2117X** IECEx Certificate No: **IECEx CML23.0042X**

X - see Special Conditions (page 11)

Hazardous Location Certifications – Enclosure

Case Specifications:	Explosion Proof (FM, CSA, CENELEC, UL) IP 66, NEMA 4X, 7BCD, 9EFG

Included Accessories (Direct-Mount Model)

Meter Prover, Operations Manual

Included Accessories (Remote-Mount Model)

Meter Prover, Operations Manual, Probe Cable, Mounting Hardware Kit

II. Installation and Operation

A. Receiving the MS2801L CorrTran Transmitter

Check the **CorrTran** Transmitter for any shipping damage when it is first received. When the unit is unpacked, verify that the following items are included:

- Transmitter
- Meter Prover
- User's Manual
- Probe Cable (for remote-mount only)
- Mounting Hardware (for remote-mount only)

In the event of shipping damage, quantity shortage, or missing items, it is recommended that the event is documented immediately and that digital photographs are taken. Any shortages or missing items should be reported to Metal Samples immediately. In the event of shipping damage, a claim should be opened with the responsible carrier.

B. Installation

CAUTION: *Using this product in any way other than that specified within this manual may impair the intrinsic safety protection.*

Installation of the MS2801L **CorrTran** transmitter involves the following steps:

1. Physical Mounting
2. Electrical Connection
3. Setup and Programming

1. Physical Mounting and Probe Connection

When selecting a location to mount the **CorrTran** transmitter it is important to consider the surrounding environment. To ensure proper operation:

- Do not mount the transmitter in a location that exceeds its operating temperature.
- Avoid mounting the transmitter near sources of strong electrical noise.
- Ensure that there is sufficient clearance for installation and to open the transmitter cover afterwards.

a. Direct-Probe Mounting

The **CorrTran** transmitter is designed for direct-probe mounting which eliminates the need for additional hardware and transmitter-to-probe cabling. This greatly simplifies installation, reduces costs, and minimizes electrical noise that can be coupled onto probe cabling from nearby electrical equipment.

Before mounting the **CorrTran** transmitter, first ensure that the probe is installed properly and securely. During installation it is important that you do not apply excessive force on the probe or seals, as doing so could break the seal and result in system leakage.
To mount the **CorrTran** transmitter:

1. Align the keyways of the transmitter and probe connectors.
2. Insert the transmitter connector plug fully into the probe connector receptacle.
3. Secure the transmitter to the top of the probe by tightening the coupling nut.

NOTE: Hand-tight is sufficient. Do not over-tighten the coupling nut.

NOTE: Never force the connectors to mate. If there is resistance, stop and check for bent pins on the probe and for foreign material in the female sockets of the transmitter connector. Gently straighten any bent pins and clear any foreign material that may be found.

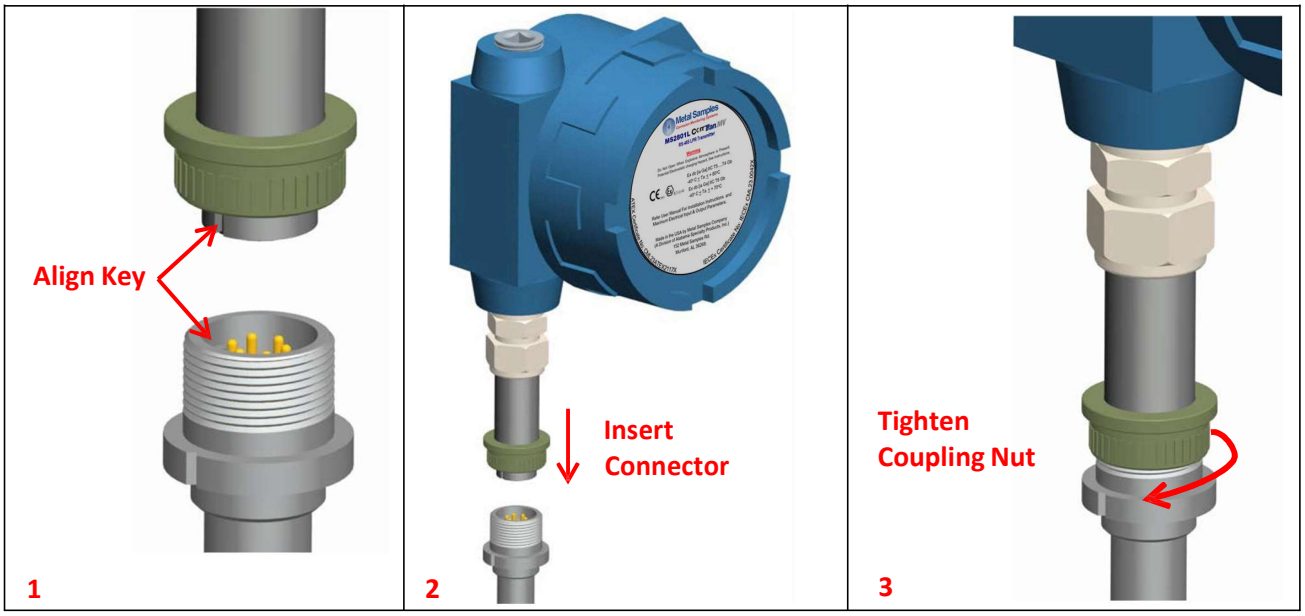


Figure 1. Direct Mount Installation

b. Remote Mounting

When it is not practical to direct-probe mount the **CorrTran** transmitter, the unit can be remote mounted instead. In this case the instrument is mounted to a separate mounting pole using the optional Remote Mounting Hardware Kit. The transmitter is then connected to the LPR probe via the probe extension cable.

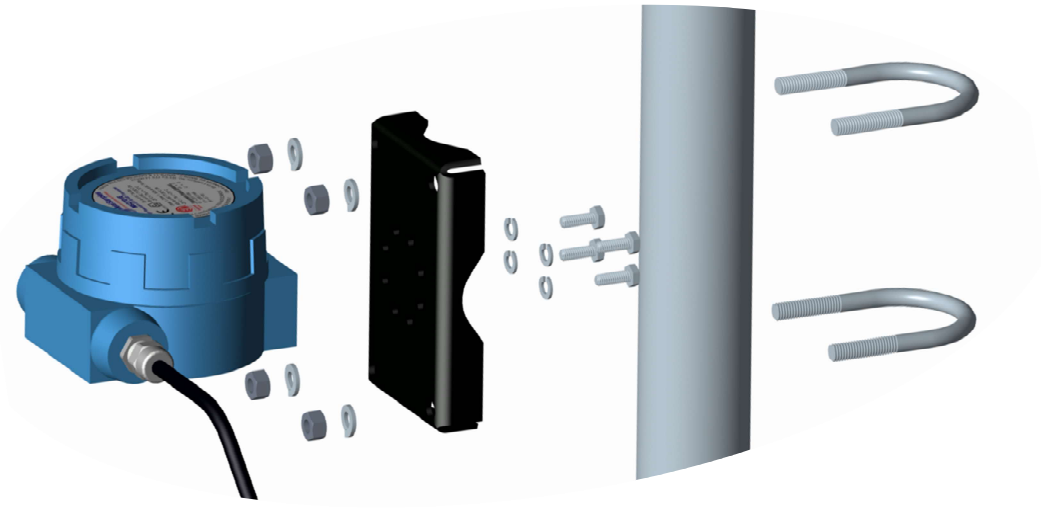


Figure 2. Remote Mount Installation

C. Probe Specifications

CorrTran Style Epoxy Adjustable Probe

The CorrTran Style epoxy adjustable probe (Figure 3) consists of a glass epoxy probe with a ¾" NPT nylon compression fitting for insertion into the system. The studs for mounting the electrodes and the six-pin connector are held in place by the epoxy fill material. This probe is available in 127 mm and 280 mm (5" and 11") lengths only. This probe is only available with the remote mounting option.

Electrodes shown in the picture are ordered separately.

Specifications	
Probe Body	Glass epoxy
Endcap Seal	Epoxy
Fill Material	Epoxy
Process Temperature	-50…65 °C (-58…149 °F)
Pressure Rating	7 bar (100 psi)
Mounting	3/4" NPT nylon fitting
Standard Lengths	280 mm (11")
Custom Lengths	N/A
Insertion Length	Adjustable, Max = probe length - 89 mm (3.5") + EL

*EL = 32 mm (1.25") for finger and 0 mm (0") for flush electrodes

Figure 3. Epoxy Adjustable Probe

CorrTran Style Adjustable Probe

The CorrTran Style adjustable probe (Figure 4) is an adjustable probe commonly used in many field applications. The assembly consists of a ¾" NPT compression fitting, an insertion rod with a hermetically sealed three- electrode end cap, and a six-pin connector welded in place. The insertion length is adjustable using the compression fitting. This probe is only available with both the remote and direct mounting options.

Electrodes shown in the picture are ordered separately.

Specifications	
Probe Body	1.4435, 316L SS; Hastelloy C
Endcap Seal	Glass
Fill Material	Epoxy
Process Temperature	Direct mount: -50…121 °C (-58…250 °F) Remote mount: -50…260 °C (-58…500 °F)
Pressure Rating	102 bar (1500 psi)
Mounting	3/4" NPT fitting
Standard Lengths	153, 204, 305, 457 mm (6, 8, 12, 18")
Custom Lengths	Lengths available in increments of 10 mm (0.5"). Min: 170 mm (7"), Max: 762 mm (30")
Insertion Length	Adjustable, Max = probe length - 51mm (2.0") + EL

*EL = 32 mm (1.25") for finger and 0 mm (0") for flush electrodes

Figure 4. Adjustable Probe

CorrTran Style Fixed Flange Probe

The CorrTran Style fixed flange probe (Figure 5) is a fixed-length probe. The probe assembly consists of a specified flange that is welded in place, an insertion rod with a three-electrode end cap, a hermetically sealed connector, and a six-pin connector welded in place. The insertion length (I. L.) is calculated to the end of the electrode and must be specified by the customer. This probe is only available with both the remote and direct mounting options.

Electrodes shown in the picture are ordered separately.

Specifications	
Probe Body	1.4435, 316L SS; Hastelloy C
Endcap Seal	Glass
Fill Material	Epoxy
Process Temperature	Direct mount: -50…121 °C (-58…250 °F) Remote mount: -50…260 °C (-58…500 °F)
Pressure Rating	206 bar (3000 psi)
Mounting	Flange connection
Standard Lengths	305, 457, 610 mm (12, 18, 24”)
Custom Lengths	Lengths available in increments of 10 mm (0.5”). Min: 170 mm (7”), Max: 762 mm (30”)
Insertion Length	Fixed, Max = probe length - flange thickness - 50.4 mm (2.0”) + EL, Length specified in 5 mm (0.2”) increments.

*EL = 32 mm (1.25”) for finger and 0 mm (0”) for flush electrodes

Figure 5. Fixed Flange Probe

CorrTran Style Retractable Probe

The CorrTran Style retractable probe (Figure 6) is an adjustable-length probe. A specially designed packing gland is used with the probe for insertion into or retraction from a pressurized system without a process shutdown. The packing gland is designed to mount easily on a 1” piping system with a ball valve, but it can be modified for your specific mounting requirements. The probe assembly consists of a packing gland, an insertion rod with a hermetically sealed three-electrode end cap, and a six-pin connector welded in place. A safety chain is also provided to prevent blowout. The insertion length (I. L.) is calculated to the end of the electrode and can be specified by the customer. This probe is only available with the remote mounting option.

Electrodes shown in the picture are ordered separately.

Specifications	
Probe Body	1.4435, 316L SS; Hastelloy C
Endcap Seal	Glass
Fill Material	Epoxy
Process Temperature	Remote mount: -50…260 °C (-58…500 °F)
Pressure Rating	102 bar (1500 psi)
Mounting	3/4” NPT fitting
Standard Lengths	610, 762, 914, 1066 mm (24, 30, 36, 42”)
Custom Lengths	Lengths available in increments of 10 mm (0.5”). Min: 170 mm (7”), Max: 762 mm (30”)
Insertion Length	Adjustable, Max = probe length - 165 mm (6.5”) + EL

*EL = 32 mm (1.25”) for finger and 0 mm (0”) for flush electrodes

Figure 6. Retractable Probe

CorrTran Style Retrievable Probe

The CorrTran Style retrievable probe (Figure 7) is a fixed-length probe. It is designed to be used with HP™ and MH™ high-pressure access systems. The probe assembly consists of an insertion rod with a hermetically sealed three-electrode end cap, a hollow plug nut, and a standard six-pin connector, which are all welded in place. The hollow plug nut on the probe screws into the hollow plug of the access system. This allows the probe to be installed in the process, using a retrieval tool and service valve, without process shutdown. The insertion length (I. L.) is calculated using one of the formulas below and must be specified by the customer. This probe is only available with the remote mounting option.

Electrodes shown in the picture are ordered separately.

Specifications	
Probe Body	1.4435, 316L SS; Hastelloy C
Endcap Seal	Glass
Fill Material	Epoxy
Process Temperature	Direct mount: -50…121 °C (-58…250 °F)
	Remote mount: -50…260 °C (-58…500 °F)
Pressure Rating	245 bar (3600 psi)
Mounting	UNS 1-14, 1″ left-handed thread
Standard Lengths	Length dependent on insertion length
Insertion Length Finger Electrodes	Top-of-the-line: I.L. = PD + WT + 44.5 mm (1.75″) Middle-of-the-line: I.L. = PD + WT + 22.25 mm (.875″) Bottom-of-the-line: I.L. = PD +WT
Insertion Length Flush Electrodes	I.L. = PD + WT + 44.5 mm (1.75″)

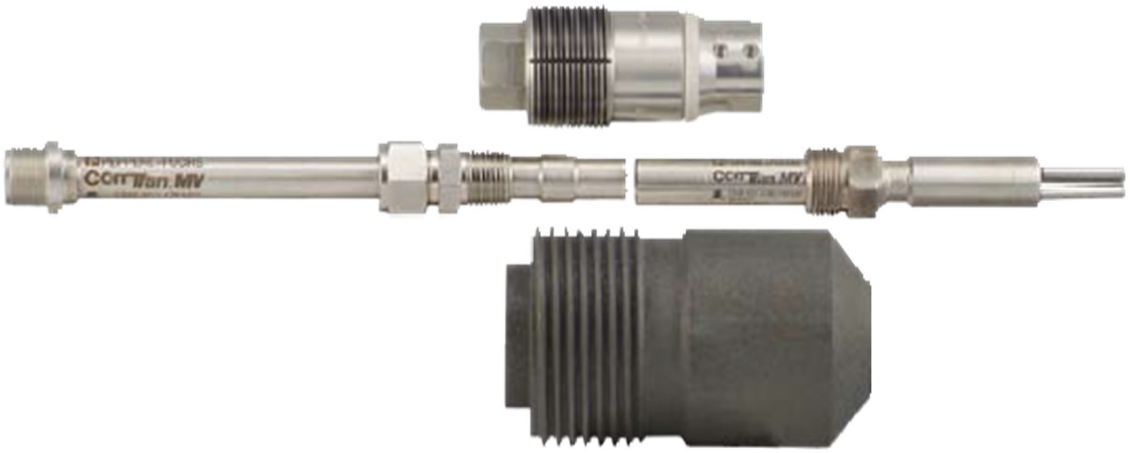
*EL = 32 mm (1.25″) for finger and 0 mm (0″) for flush

*PD = Penetration depth, for flush mount PD = 0

*WT = Wall thickness

Figure 7. Retrievable Probe

Hollow plug and access fitting are ordered separately.



2. Power and Data Connections

a. Making Connections

The RS-485 field wiring enters the transmitter through the 3/4" female NPT conduit port shown in Figure 8 below.

CAUTION: *When used in a hazardous area, the conduit or cable connections must be made in such a way that all hazardous area requirements are met.*

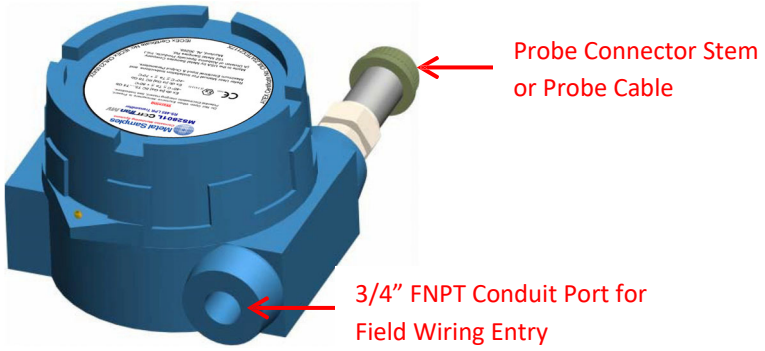


Figure 8. RS-485 Connector

Electrical connections are made to the main PCB via the terminal block J1 as shown in Figure 10. NOTE: Do not connect cable shielding to the Transmitter. The shield must remain floating at the Transmitter.

The RS-485 protocol allows up to 32 transmitters to be daisy-chained which simplifies installation and reduces costs. Figure 9 shows an example of a typical arrangement.

CAUTION: *Be sure to observe the appropriate gas group rating listed on page 3 for stand-alone or multi-drop operation.*

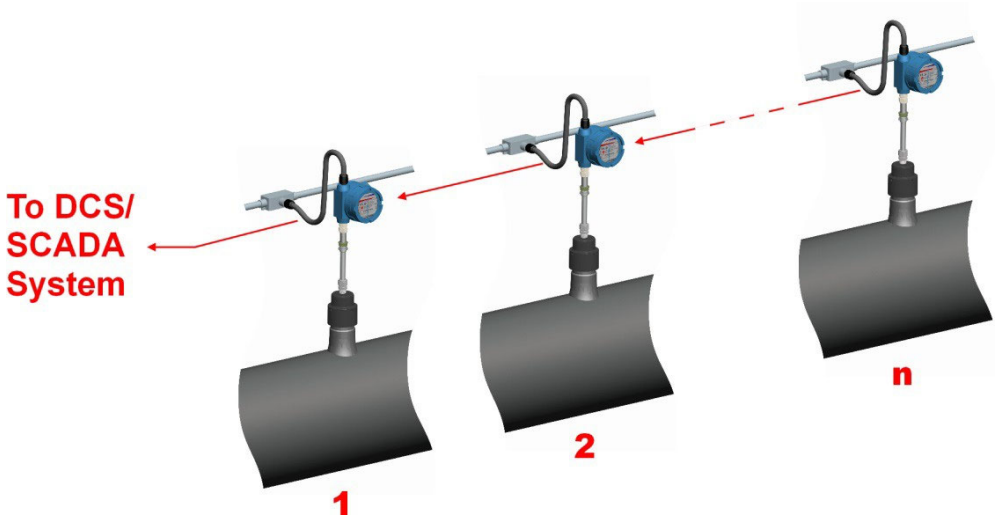


Figure 9. Typical daisy-chain arrangement, where 'n' is the number of the last transmitter.

The maximum permissible length of the field wiring between the **CorrTran** transmitter and the control system is determined by the control system supply voltage, the electrical resistance of the cable and the load of the control system input. If the Transmitter is to be installed in a safe area, refer to section *c. Safe Area Installation* for details. If the Transmitter is to be installed in a hazardous area, refer to section *d. Hazardous Area Installation*.

b. Grounding

The **CorrTran** transmitter enclosure is grounded internally through the wiring harness, but an additional, external grounding terminal is provided as well. The enclosure should be grounded properly using the external grounding terminal to ensure safe operation.

c. Safe Area Installation

The **CorrTran** transmitter is approved for use in hazardous areas, but can be used in non-hazardous areas as well.

CAUTION: *When used in non-hazardous areas, equipment must be supplied with a pre-approved power supply unit or approved equipment which meets the entity parameters shown below.*

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d. Hazardous Area Installation

CAUTION: *This section provides general guidelines for hazardous area wiring. However, regardless of anything stated here, the* **CorrTran** transmitter *must be installed in full compliance with the control drawing located on page 30 and all of the local area requirements.*

CAUTION: *When used in Hazardous areas, equipment must be supplied with a pre-approved power supply unit or approved equipment via a certified intrinsically safe barrier or a galvanically isolated barrier) with the following* ***entity parameters****.*

Input supply terminal (J1)

Um = 30.0V DC

Probe Connector (J3)

Uo =8.6 V
Io = 0.038 A
Po = 0.083 W
$C_i = 0$
$L_i = 0$

Special Conditions

1. *The MS2801L* **CorrTran** *MV RS-485 LPR Transmitter shall only be powered from a supply with a maximum output voltage of 30V and which complies with one of the following:*
   - *Is a SELV or PELV system*
   - *A safety isolating transformer complying with the requirements of IEC 61558-2-6 or technically equivalent standard*
   - *Apparatus complying with the IEC60950 series, IEC61010-1, or a technically equivalent standard*
   - *Fed directly from cells or batteries*
2. *All versions of the enclosure are manufactured from aluminium. In rare cases, ignition sources due to impact and friction sparks could occur. This shall be considered during installation, particularly if the equipment is installed in a zone 0 location.*
3. *The MS2801L* **CorrTran** *MV RS-485 LPR Transmitter have non-metallic parts incorporated in the enclosure of this equipment which may generate an ignition-capable level of electrostatic charge, under certain extreme circumstances. Therefore, the equipment shall not be installed in a location where the external conditions are conducive to the build-up of electrostatic charge on such surfaces. This is particularly important if the equipment is installed in a zone 0 location. In addition, the equipment shall only be cleaned with a damp cloth.*
4. *The MS2801L* **CorrTran** *MV RS-485 LPR Transmitter is not capable of withstanding the 500V insulation test required by Clause 6.3.12 of IEC 60079-11. This shall be taken into account when installing the equipment.*
5. *Only sensors that are classified as simple apparatus can be used with this equipment.*

CAUTION: *For hazardous area installations, the maximum inductance and capacitance of the field wiring between the connected equipment and the transmitter cannot exceed the entity parameters.*

CAUTION: *Non-Metallic Hazardous area label on the instrument may pose a potential electrostatic hazard. Following precautions may help to reduce risk during maintenance / handling the equipment. The static charge can be dissipated by following simple steps*

a. *Use dampened cloth to clean the label surface before handling it.*
b. *Body can be grounded by using ground/anti-static wrist bands or by other means before handling.*

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3. Setup and Operation

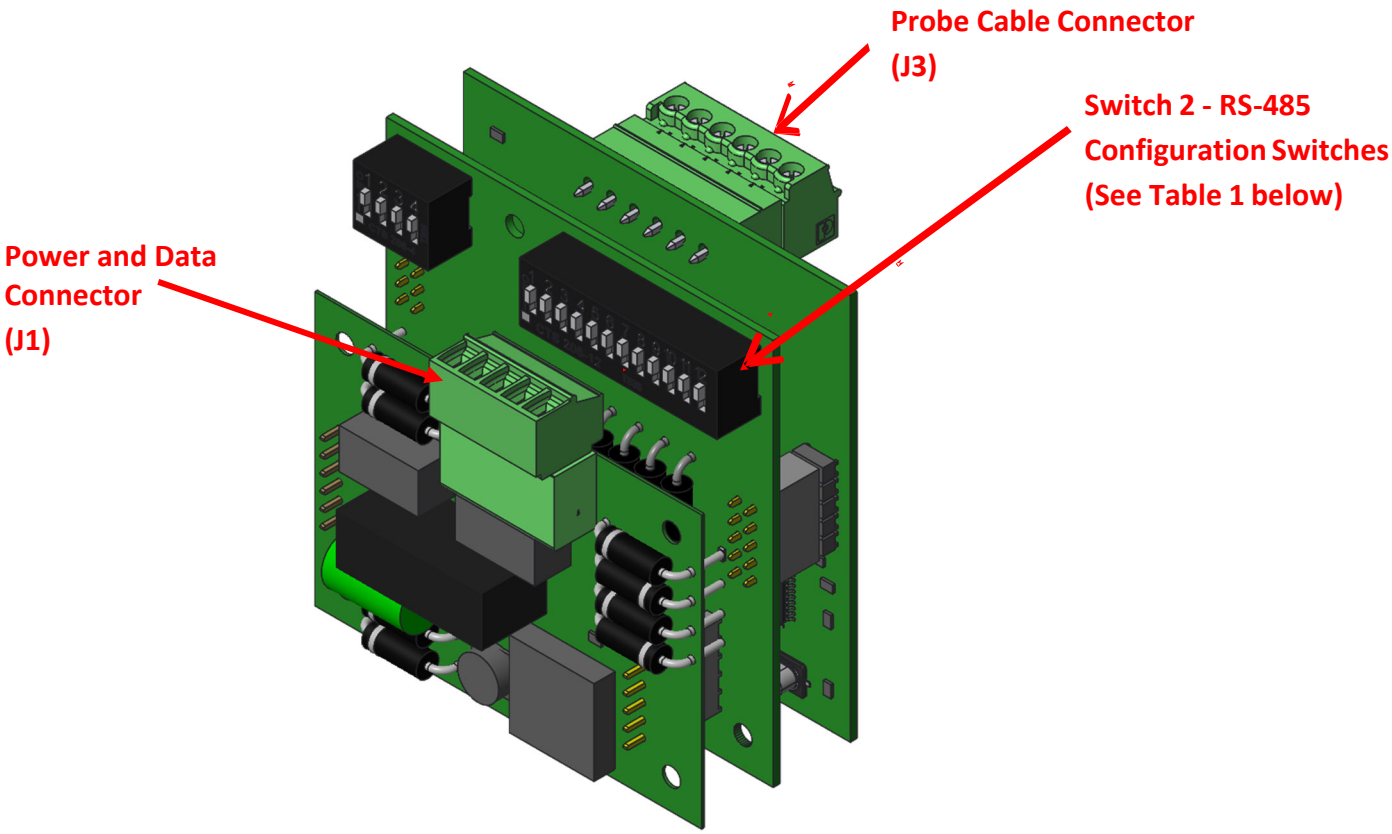
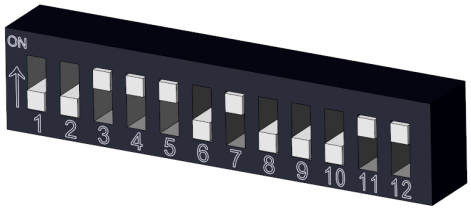


Figure 10. Connector and Switch Details

a. RS-485 Communication Settings

The RS-485 configuration switches are located on the top right corner of the main board as illustrated in Figure 10. These are used to set the instrument address, baud rate, communication protocol, and to enable the termination resistor. Table 1 gives the switch settings for each of these parameters, and they are explained in more detail below.



Switch 2 (12 Positions)

Baud Rate	Position 1	Position 2
2400	Off (↓)	Off (↓)
4800	Off (↓)	On (↑)
9600	On (↑)	Off (↓)
19200	On (↑)	On (↑)

Communication Protocol	Position 8	Position 9
Modbus ASCII	On (↑)	Off (↓)
Modbus RTU	Off (↓)	Off (↓)
Serial ASCII	On / Off	On (↑)

Termination Resistor	Position 12
Active	On (↑)
Inactive	Off (↓)

Spare	Position 10 & 11

Device Address	Position 3	4	5	6	7
1	Off (↓)	Off (↓)	Off (↓)	Off (↓)	Off (↓)
2	On (↑)	Off (↓)	Off (↓)	Off (↓)	Off (↓)
3	Off (↓)	On (↑)	Off (↓)	Off (↓)	Off (↓)
4	On (↑)	On (↑)	Off (↓)	Off (↓)	Off (↓)
5	Off (↓)	Off (↓)	On (↑)	Off (↓)	Off (↓)
6	On (↑)	Off (↓)	On (↑)	Off (↓)	Off (↓)
7	Off (↓)	On (↑)	On (↑)	Off (↓)	Off (↓)
8	On (↑)	On (↑)	On (↑)	Off (↓)	Off (↓)
9	Off (↓)	Off (↓)	Off (↓)	On (↑)	Off (↓)
10	On (↑)	Off (↓)	Off (↓)	On (↑)	Off (↓)
11	Off (↓)	On (↑)	Off (↓)	On (↑)	Off (↓)
12	On (↑)	On (↑)	Off (↓)	On (↑)	Off (↓)
13	Off (↓)	Off (↓)	On (↑)	On (↑)	Off (↓)
14	On (↑)	Off (↓)	On (↑)	On (↑)	Off (↓)
15	Off (↓)	On (↑)	On (↑)	On (↑)	Off (↓)
16	On (↑)	On (↑)	On (↑)	On (↑)	Off (↓)
17	Off (↓)	Off (↓)	Off (↓)	Off (↓)	On (↑)
18	On (↑)	Off (↓)	Off (↓)	Off (↓)	On (↑)
19	Off (↓)	On (↑)	Off (↓)	Off (↓)	On (↑)
20	On (↑)	On (↑)	Off (↓)	Off (↓)	On (↑)
21	Off (↓)	Off (↓)	On (↑)	Off (↓)	On (↑)
22	On (↑)	Off (↓)	On (↑)	Off (↓)	On (↑)
23	Off (↓)	On (↑)	On (↑)	Off (↓)	On (↑)
24	On (↑)	On (↑)	On (↑)	Off (↓)	On (↑)
25	Off (↓)	Off (↓)	Off (↓)	On (↑)	On (↑)
26	On (↑)	Off (↓)	Off (↓)	On (↑)	On (↑)
27	Off (↓)	On (↑)	Off (↓)	On (↑)	On (↑)
28	On (↑)	On (↑)	Off (↓)	On (↑)	On (↑)
29	Off (↓)	Off (↓)	On (↑)	On (↑)	On (↑)
30	On (↑)	Off (↓)	On (↑)	On (↑)	On (↑)
31	Off (↓)	On (↑)	On (↑)	On (↑)	On (↑)
32	On (↑)	On (↑)	On (↑)	On (↑)	On (↑)

Table 1. RS-485 Configuration Switch Settings

i. Baud Rate and Default Communication Parameters

The default communication parameters for the **CorrTran** transmitter are provided in Table 2 below. If necessary, the baud rate can be changed using Positions 1 and 2 of Switch 2, as illustrated in Table 1.

	Modbus RTU	Modbus ASCII	Serial ASCII
Parameter	**Value**	**Value**	**Value**
Baud Rate	19200	19200	2400
Data Bits	8	7	8
Parity	Even	Even	Even
Stop Bits	1	1	1
Response Time Out	3000 mS	3000 mS	3000 mS
Polling Interval	1 min	1 min	1 min
RTS Toggle	Active	Active	Active
RTS Disable Delay	1 mS	1 mS	1 mS

Table 2. Default Communication Parameters

ii. Device Address

Up to 32 **CorrTran** transmitters may be connected in a multi-drop network ("daisy-chained") using a single cable run. However, each transmitter must be set to a unique device address to avoid conflicts. This is done using Positions 3 through 7 of Switch 2, as illustrated in Table 1.

CAUTION: *Be sure to observe the appropriate gas group rating listed on page 3 for stand-alone or multi-drop operation.*

iii. Communication Protocols

The **CorrTran** transmitter offers user-selectable RTU or ASCII communication protocols, giving the unit a broader range of compatibility. The communication protocol is set using Position 8 of Switch 2, as illustrated in Table 1.

iv. Termination Resistor

To ensure proper operation, the RS-485 network must be terminated properly with a termination resistor. To facilitate this, each **CorrTran** transmitter has a built-in 120Ω termination resistor that can be switched on or off using Position 12 of Switch 2. Once all units have been installed, be sure to enable the termination resistor of the last unit in the network. The termination resistors of all other transmitters should be turned off.

b. Setup Variables (Read/ Write)

No	Register Address	Description	Data Type
1	40113	GC measurement Unit	Unsigned Integer
2	40114	Measurement Mode	Unsigned Integer
3	40115	Measurement Configuration	Unsigned Integer
4	40116	Channel Number	Unsigned Integer
5	40119	B Value	Float single precision
6	40121	K value	Float single precision
7	40123	A Value	Float single precision

Table 3. Setup Data Registers

i. GC measurement unit. (Read / Write)
Data Value
0 = mils per year (Default)
1 = mm per year

ii. Measurement mode. (Read/ Write)
(This determines the way the general corrosion calculation performed)
Data Value
0 = LPR Mode. A user defined Stern-Geary voltage (B user) is used for all LPR corrosion rate calculations. This is the Default setting on MS2801L.
1 = Dynamic mode. A process specific Stern-Geary Voltage (B Value) is calculated with every measurement cycle through Harmonic Distortion Analysis. This B value is dynamically implemented in the LPR corrosion rate calculation resulting in a highly accurate self-adjusting, process specific corrosion rate calculation.

iii. Measurement Configuration. (Read/ Write)
Data Value
0 (GC+Con) = General Corrosion + Conductance. (Default Value)
1 (GC+LC+Cond.) = General Corrosion + Localized corrosion+ Conductance.
2 (LC+Cond.) = Localized corrosion+ Conductance.

iv. Channel Number. (Read/ Write)
Data Value
1 = One measurement channel output (Default)
X = Future use

v. B User Value. (Read/ Write)
Data Value
25.6 mV = B Value or Stern-Geary voltage. (Default)
* This is relevant in LPR mode only. This value does not normally need to be changed.

vi. A Electrode area. (Read/Write)
Data Value
4.75 cm2 = Electrode area (Default for EL400 electrodes.)

vii. K probe Constant. (Read/Write)
Data Value
11597.63 = K probe constant or corrosion constant (Default – G10180)
*This value is dependent on the electrode material's properties. Refer to appendix for other values.

c. Output Data Registers (Read only)

No	Register Address	Description	Data Type
1	40201	Measurement Counter	Unsigned Long
2	40203	Conductance	Single Precision Float
3	40205	Calculated B Value	Single Precision Float
4	40207	i_{Corr}	Single Precision Float
5	40209	General Corrosion	Single Precision Float
6	40211	Localized Corrosion	Single Precision Float
7	40213	Average Localized Corrosion	Single Precision Float
8	40215	Solution Resistance	Single Precision Float

Table 4. output Data Registers

i. 40201-Measurement Counter. (Read)
Number of corrosion measurement cycles completed since the device rest/power on. This counter resets automatically after reaching the value 99999.

ii. 40203-Conductance
Current solution Conductance value in Siemens

iii. 40205 **Calculated B Value**
Current measured Stern-Geary value (Bharm) in mV.

iv. 40207 I Corr
I Corr value in mA

v. 40209 - General Corrosion
Current General Corrosion in mpy.

vi. 40211- Local Corrosion
Current Local corrosion. 0 or 1.

vii. 40213- Average Local Corrosion
The average localized corrosion value. This value is averaged until the cycles/AVG is reset or the CorrTran instrument is reset to factory default.

viii. 40215- Solution Resistance
Solution resistance in ohms.

d. Status Registers (Read only)

No	Register Address	Description
1	40001	Device Status
2	40002	Device Address
3	40003	Baud Rate

Table 5. Status Data Registers

i. 40001-Device Status
0 = Device in Error State
1 = Device in normal operation.

ii. 40002-Device Address
Shows active device address. 1-32.

iii. 40003- **Baud Rate**
Displays the current Baud rate. 2400/4800/9600/19200

iv. 40004- **Error**
Displays the current error information.
1 – High Localized corrosion detected
2 – Bvalue from Harm. Out of range.
4 – Conductance out of range
8 – Cell Offset Voltage overflow
16 – Corrosion rate calculation not possible.
32 – Electrode balance out of range
64 – Harmonics out of range
128 – internal Failure
256 - ADC Failure
512 - Memory Failure

Note: Sum of all error values displays if multiple error presents on the unit.

e. Calibration and Testing

I. <u>Calibration</u>
The **CorrTran** transmitter is fully calibrated when shipped from the factory. The calibration settings are fixed to avoid accidental change which could result in erroneous data. No field calibration is required. However, it is important to test the unit upon installation, and during periodic maintenance inspections, to ensure the unit is operating properly.

II. Testing the CorrTran transmitter with the Meter Prover

A Meter Prover is provided to allow routine checks of the **CorrTran** transmitter. It is not a calibration device and cannot be used to scale the corrosion process data.

1) Disconnect power.
2) Disconnect the **CorrTran** transmitter from the probe (or if the unit is remote-mounted, disconnect the probe extension cable from the probe.)
3) Connect the Meter Prover to the probe connector stem (or to the probe extension cable if the **CorrTran** transmitter is remote-mounted.)
4) Loosen the Enclosure Lock Screw.
5) Unthread and remove the transmitter cover.
7) Reconnect power and allow the instrument to measure for several minutes to stabilize.
8) After several minutes observe the transmitter output. The output should closely match the value printed on the Meter Prover label.

Using the MS2801L Config/Datalog Tool set **CorrTran** parameter as follows.

Device Mode = LPR Mode

B Value = 25.6 mV

Allow the MS2801L **CorrTran** MV to complete one whole sampling cycle.

From the Config/Datalog tool collect the following data:

A Elect Area

K Probe Const Calculated B Value

From the Config/Datalog tool Main screen read the corrosion rate in mil/yr.

For A Elect Area = 4.75cm^2 (finger style electrodes) use Equation 1

For A Elect Area = 0.316cm^2 (flush style electrodes) use Equation 2

Equation 1: CRcalc = B/12695 x (K-7)

Equation 2: CRcalc = B/846 x (K+1.4)

Where:

CRcalc is the calculated corrosion rate in mil/yr, B is the Calculate B value, and K is the K probe constant.

If the CRcalc is +/- 1% of the corrosion rate obtained from the Cofig/Datalog **CorrTran** MV Online Parameters screen, then **CorrTran** MV is operating within factory specifications. At this point remove the Meter Prover and reattach the transmitter to the probe or the remote mount cable.

If the transmitter output matches the calculated CR Value, you may reconnect the **CorrTran** transmitter to the probe. If the transmitter output shows a significant difference compared to the Meter Prover value, further troubleshooting may be required. Refer to page 16 for troubleshooting or contact the factory for further assistance.

Be sure to reinstall the enclosure cover and tighten the Lock Screw when putting the **CorrTran** transmitter back into service.

f. Commissioning

Once the **CorrTran** transmitter has been installed, tested, and properly configured for the probe in use, it can then be closed and put into service. First, perform one last visual inspection to ensure that all electrical connections are secure and that the enclosure O-ring is in place and is in good condition. Then thread the enclosure lid onto the base fully. Once the lid has been threaded into place, tighten the Lock Screw to prevent unauthorized tampering.

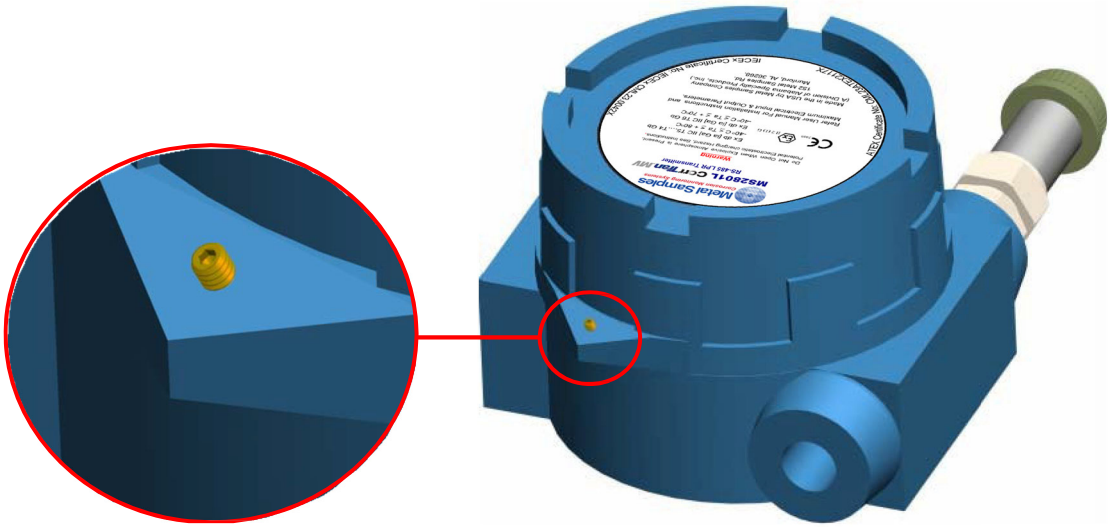


Figure 11. Enclosure Lock Screw

CAUTION: *The Lock Screw on the instrument base must be tightened securely to prevent unauthorized personnel from opening the* **CorrTran** *transmitter, and ensure that the intrinsic safety is not violated. Only qualified personnel should be allowed to install, operate, and maintenance the* **CorrTran** *transmitter.*

4. Maintenance

Once installed, the **CorrTran** transmitter requires little maintenance. However, it is important to verify the following items periodically to ensure continued safe operation.

CAUTION: *Before performing any tests or maintenance on the* **CorrTran** *transmitter, ensure that all hazardous area requirements are met.*

Inspection Item	Frequency
Inspect the enclosure o-ring for any signs of damage. Replace as necessary.	Annually
Inspect the probe connector o-ring for any signs of damage. Replace as necessary.	Annually
Inspect all electrical connections for signs of corrosion, mechanical damage, or foreign matter that could cause improper operation or cause an electrical short. Clean as necessary.	Annually
Ensure that the locking screw is in place and is secure.	Annually
Inspect the enclosure for any signs of corrosion or paint damage.	Annually
Check for any signs of moisture ingress within the enclosure.	Annually

Contact Metal Samples for replacement parts or if instrument repair is necessary.

5. Troubleshooting

If the **CorrTran** transmitter does not seem to perform as expected, check the following items:

CAUTION: *Before performing any tests or maintenance on the* **CorrTran** *transmitter, ensure that all hazardous area requirements are met.*

CAUTION: *If the* **CorrTran** *transmitter shows any signs of damage, remove it from service immediately and consult the factory.*

1 . Bais Trouble shooting guide.

SYMPTOM	CAUSE / PROCEDURE	SOLUTION
No Response	a. Check voltage. Nominal voltage: 24 V DC. b. Check polarity. c. Ensure that all electrical cables and wiring are in good condition. d. Ensure that all electrical contacts are secure and free of corrosion.	Connect the correct voltage. Connect correct polarity.
No communication to the computer/PLC/DCS	a. Check communication cable between the instrument and DCS/PLC. b. Check the baud rate setting switch on the instrument and set the same rate on communication unit. c. Ensure Number of bits, parity and stop bits. 8 bits Even parity one stop bit	Replace the communication cable and try. Set RS485 communication parameters as below and try. Baud Rate: 19200 Data bits: 8 Parity: Even Stop Bit = One
No Data	Check and ensure the probe connections and electrode condition.	Replace probe cable and check. Replace electrodes and check.

2. If there is insufficient supply voltage on the power connector, check the safety barrier (if applicable) for a blown fuse or any other failure.
3. Test the **CorrTran** transmitter using the supplied Meter Prover (see page 19.)
4. Check the instrument status from register value 40001 which shows whether the device is in good state or error state.
   a. 40001 = 0 (Device is in normal operation)
   b. 40001 = 1 (Device in Error state)
5. Device error is further classified, and the details of the issue can be derived from the register value 40004. Basic Troubleshooting table is shown below with respect to the error codes. The value of this register may be sum of all faults if multiple faults exist on the unit.

REG. DATA	DEVICE STATUS	DESCRIPTION	TROUBLE SHOOTING
1	High Localized corrosion detected	The localized corrosion rate is above 0.3	This is Information only. It is not an error.
2	B Value from Harmonics out of range	The calculated B Value based on the HAD is out of the range. (10mV<B<62.5mV)	In some rare occasions the HAD calculation might not give a plausible result. Switch to LPR only mode if this status persists to stay on.
4	Conductance out of range	The measured solution conductance is lower than 4 uS. This equals a conductivity of approximately 1 uS/cm for finger electrodes.	**CorrTran** MV RS485 transmitter needs at least 4 uS of solution conductance or solution conductivity of 1 uS/cm for full accuracy. This can also be an indication that there is too much buildup on the surface of the electrodes, and they may need to be cleaned or they may not be fully immersed in the process fluid.
8	Cell Offset voltage overflow	Detected a voltage difference between the three electrodes which is too high to compensate	Typically, this is an indication that there is too much build up on the surface of the electrodes and they need to be cleaned or that they have exceeded their useful life and should be replaced.
16	Corrosion rate calculation not possible	Not able to get any useful data	Check the electrodes for debris, check the other flags, and make sure that the electrodes are fully immersed.
32	Electrode balance out of range	Due to an extremely high unbalanced potential (voltage difference) of the electrodes, the instrument is drawing more power.	This occurs only at very rare circumstances where the corrosion rate is very small but at the same time there is a huge potential difference between the electrodes. This can indicate contamination of one or more electrodes, corrosion masking effects of buildup, or that one electrode is bent or missing from the probe.
64	Harmonics out of range	The HDA (Harmonic Distortion Analysis) did not provide any valid results	In some rare occasions the HAD calculation might not give a plausible result. Switch to LPR only mode if this status persists to stay on.
128	Internal Failure	Hardware Failure detected	Replace Transmitter
256	ADC failure	ADC failure detected	Replace Transmitter
512	Memory Failure	Memory Failure detected	Replace Transmitter

These basic checks should indicate the source of any problem (probe, power supply, wiring, etc.). If it is determined that the **CorrTran** transmitter is malfunctioning, or if you need further assistance in troubleshooting, contact Metal Samples Technical Support.

6. Measuring Principle

General corrosion

Linear Polarization Resistance (LPR) is based on the fact that in a corroding electrode the relationship between i_{corr} and the polarization resistance is given by the following equation:

$i_{corr} = \frac{B}{R_P}$,where $R_P = \frac{\Delta E}{\Delta I}$ with ΔE being the applied voltage and ΔI the resulting current.

Harmonic Distortion Analysis (HDA) allows CorrTran MV to determine i_{corr} without using the Tafel slopes (ba, bc). This is typically done by applying a low frequency sinusoidal voltage and determining the distance of the resulting current.

CorrTran MV accurately measures the general corrosion rate by implementing Harmonic Distortion Analysis (HDA) to improve the performance of Linear Polarization Resistance (LPR). A process-specific Stern-Geary voltage (Bharm) is calculated with every measurement cycle through HDA. This value is then implemented in the LPR corrosion rate calculation resulting in a highly accurate self adjusting, process specific corrosion rate calculation. CorrTran MV can measure the general corrosion rate from 0 … 1000 mpy (0 …25 mmpy).

Localized Corrosion (Pitting)

Electrochemical Noise (ECN) is the method of monitoring spontaneous fluctuations generated at the interface of the corroding metal and process solution. As localized corrosion occurs, these fluctuations increase.

The CorrTran MV monitors for these fluctuations on the electrode surfaces for 17 minutes. It then performs a statistical analysis resulting in a unitless pitting factor value between 0 and 1. A pitting factor of nearly 0 represents no localized corrosion activity and a pitting factor of 1 represents high localized corrosion activity. Independent studies have revealed that a sustained pitting factor of greater than 0.3 is cause for concern and you should investigate the source of the elevated Localized Corrosion rate.

Conductance

Solution resistance is a measure of how easily electricity flows along a certain path through an electrical element. The reciprocal of the solution resistance is solution conductance.

The CorrTran MV measures solution resistance in order to more accurately calculate the general corrosion rates. As an added feature CorrTran MV provides you with the solution conductance in units of Siemens as the tertiary variable that is not scalable. CorrTran MV requires a minimum solution conductance of 4 µS in order to provide reliable corrosion data.

The solution conductance value that CorrTran MV provides can be used to approximate solution conductivity by this relationship:

$$Conductivity\ \left(\frac{S}{cm}\right) = \frac{Conductance(S)}{19}$$

Solution conductivity is a function of distance. As the electrodes corrode, their sizes and geometry change causing this correlation to deteriorate. The CorrTran MV should not be considered as a replacement for standard conductivity meters.

III. Service and Warranty Information

A. Warranty

Metal Samples warrants that any part of the model MS2801L **CorrTran** transmitter and accessories which proves to be defective in material or workmanship within one year of the date of original shipment to Purchaser will be repaired or replaced, at Metal Samples option, free of charge. This warranty does not cover (1) probe assemblies, (2) items expendable in nature, or (3) items subject to damage from normal wear, misuse or abuse, or failure to follow use and care instructions.

All damaged items are to be shipped at Purchaser's expense to and from Metal Samples which shall have the right to final determination as to the existence and cause of a defect.

The foregoing shall constitute the sole and exclusive remedy of any purchaser of Metal Samples products for breach of warranty and IS EXCLUSIVE AND IN LIEU OF ALL OTHER WARRANTIES, EXPRESSED, IMPLIED OR STATUTORY, INCLUDING THE IMPLIED WARRANTIES OR MERCHANTABILITY AND FITNESS. IN NO EVENT SHALL METAL SAMPLES BE LIABLE FOR SPECIAL OR CONSEQUENTIAL DAMAGES, OR FOR ANY DELAY IN THE PERFORMANCE OF THIS WARRANTY DUE TO CAUSES BEYOND ITS CONTROL.

The technical information and suggestions contained herein are believed to be reliable, but they are not to be construed as warranties since conditions of use are beyond our control.

B. Obtaining Service and Returning the Instrument for Repair

If you experience problems with your instrument please contact the factory at 256-358-4202 and ask for customer support for instrumentation. Our customer support department will assist you in troubleshooting your instrument.

Most issues can be resolved over the phone, but in some cases it may be necessary to return your instrument for further evaluation and repair. In this case, please obtain a Return Materials Authorization (RMA) number from the sales person or support technician. This RMA number will ensure that your instrument is routed to the correct department when it is received at the factory.

After receipt of an RMA number you may pack your instrument for return. Be sure to pack your instrument in a sturdy box and to pad it sufficiently to avoid damage during transit. Also be sure to complete the "Instrument Repair Form" on the next page and include a copy with your repair. This will ensure that the repair department has sufficient information regarding the problems you are experiencing with your instrument, as well as the billing, contact, and return shipping details for the repair.

Once you have obtained an RMA number, completed the "Instrument Repair Form", and packed your instrument securely, please ship it prepaid to the following address:

Metal Samples
152 Metal Samples Road
Munford, AL 36268
ATTN: RMA# _ _ _ _ _

NOTE: Be sure to list your RMA number in the attention line (shown as blanks in the example above.)

C. Instrument Repair Form

This form may be photocopied for use when returning an instrument to Metal Samples for repair. Please fill in all known information and enclose a copy of the completed form with the instrument.

General Information

Model Number		**Serial Number**	
RMA Number		**Date of Purchase***	

**If known.*

Contact Information for Repair

Contact Name		**Company**	
Phone Number		**E-mail Address**	

Return Shipping Information

Recipient Name*		**Company***	
Return Address			

**If different than above.*

Reason for Return. (Provide as much detail as possible. Attach additional pages if required.)

Invoice Instructions (For non-warranty repairs)

☐ **Invoice me for the repair** → **Reference PO#**
(Requires an open account with Metal samples.)

☐ **Contact me for credit card information.**

Appendix A: Revision History

Revision	Date	Changes
0	07/11/2023	Initial Draft
A	01/21/2024	Data registers updated

Appendix B: Electrode Material

Electrode Material	K-Value	UNS Number
Aluminum		
1100	10940.96	A91100
2024	11400.51	A92024
7075		A97075
Carbon Steel & Alloys		
1010	11486.66	G10100
1018	11597.63	G10180
1020	11401.49	G10200
C4130	11283.76	G41300
A53 Grade B	11583.07	K03005
ASTM A105	11298.74	K03504
A36	11368.92	K02600
A285 Grade C	11359.95	K02801
Pipe Steel & API		
A106 Grade B	11342.61	K03006
API 5L Grade B	11441.28	–
API 52X-65	11440.94	–
API 5L X52 (STE 360.7)	11443.31	–
API 5L X60	11444.4	–
API 5L Grd A	11443.89	–
API 5L X42	11429.12	–
Stainless Steel		
304	11334.57	S30400
304L	11342.8	S30403
316	11513.39	S31600
316L	11519.53	S31603
316 Ti	11382.15	S31635
317L	11400.62	S31703
904L	11287.19	N08904
254SMO	11306.19	–
Copper Alloys		
CDA715 (Cu/Ni 70/30)	11337.86	C71500
CDA110ETP (99.9 Cu)	11686.71	C11000
CDA706 (Cu/Ni 90/10)	11513.44	C70600
CDA687 (aluminum brass)	12411.53	C68700
CDA443 (ARS AD.Brass)	12324.74	C44300
CDA220 Bronze		C22000
Super Alloys		
Hastelloy C-276	11666.48	N10276
Zinc Alloys		
Zinc		Z15001

Appendix C: Hazardous Area Certification Details

Metal Samples	MS2801L Hazardous Area Certification Details	Doc.Number	EXDOC-000034
		Revision	0
		Date	06/13/2023
		Page	1 of 1

Worldwide and Europe

Ex db [ia Ga] IIC T5 & T4 Gb
-40°C ≤ Ta ≤ +80°C
Ex db [ia Ga] IIC T6 Gb
-40°C ≤ Ta ≤ +70°C
ATEX Cert. No: CML23ATEX2117X
IECEx Cert. No: IECEx CML 23.0042X
X – See special Conditions below

Entity Parameters

J1: Input Terminals (common for all models)

Um: 30 V DC

J3: Probe Connector (common for all models)

Uo: 8.6V
Io: 0.038A
Po: 0.083W
Ci: 0
Li: 0

Special Conditions

i. The MS2801L CorrTran MV RS-485 LPR Transmitter shall only be powered from a supply with a maximum output voltage of 30V and which complies with one of the following:
   - Is a SELV or PELV system
   - A safety isolating transformer complying with the requirements of IEC 61558-2-6 or technically equivalent standard
   - Apparatus complying with the IEC60950 series, IEC61010-1, or a technically equivalent standard
   - Fed directly from cells or batteries

ii. All versions of the enclosure are manufactured from aluminium. In rare cases, ignition sources due to impact and friction sparks could occur. This shall be considered during installation, particularly if the equipment is installed in a zone 0 location.

iii. The MS2801L CorrTran MV RS-485 LPR Transmitter have non-metallic parts incorporated in the enclosure of this equipment which may generate an ignition-capable level of electrostatic charge, under certain extreme circumstances. Therefore, the equipment shall not be installed in a location where the external conditions are conducive to the build-up of electrostatic charge on such surfaces. This is particularly important if the equipment is installed in a zone 0 location. In addition, the equipment shall only be cleaned with a damp cloth.

iv. The MS2801L CorrTran MV RS-485 LPR Transmitter is not capable of withstanding the 500V insulation test required by Clause 6.3.12 of IEC 60079-11. This shall be taken into account when installing the equipment.

v. Only sensors that are classified as simple apparatus can be used with this equipment.

Appendix D: Control Drawing