

Serial Number _____

**MODEL 9020 & 9020-OEM
CORRATER[®] TRANSMITTER
USER MANUAL**

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Chapter 1 Introduction

The Model 9020 CORRATER[®] Transmitter and 9020-OEM Transmitter Module are two-wire CORRATER transmitters which are designed to be directly connected to an industrial plant Distributed Control System (DCS) or other 4-20 milliamp receiver for the purpose of monitoring corrosion rates and imbalance currents from 2-electrode CORRATER probes mounted in water systems. Please note that the Model 9020 has no temperature measurement capability and therefore should not be used with CORROTEMP[®] CORRATER probes.

The Model 9020-OEM (Figure 1) is a complete transmitter module for mounting in a customer provided secondary enclosure while the Model 9020 (Figure 2) consists of the transmitter module mounted in a NEMA-4X (IP-66) weatherproof enclosure suitable for field mounting. Either is supplied with a five-foot cable with connector which is compatible with any CORRATER probe.

The transmitter module is capable of monitoring corrosion rate or imbalance current using a single loop, or both measurements can be made by powering both transmitter loops.

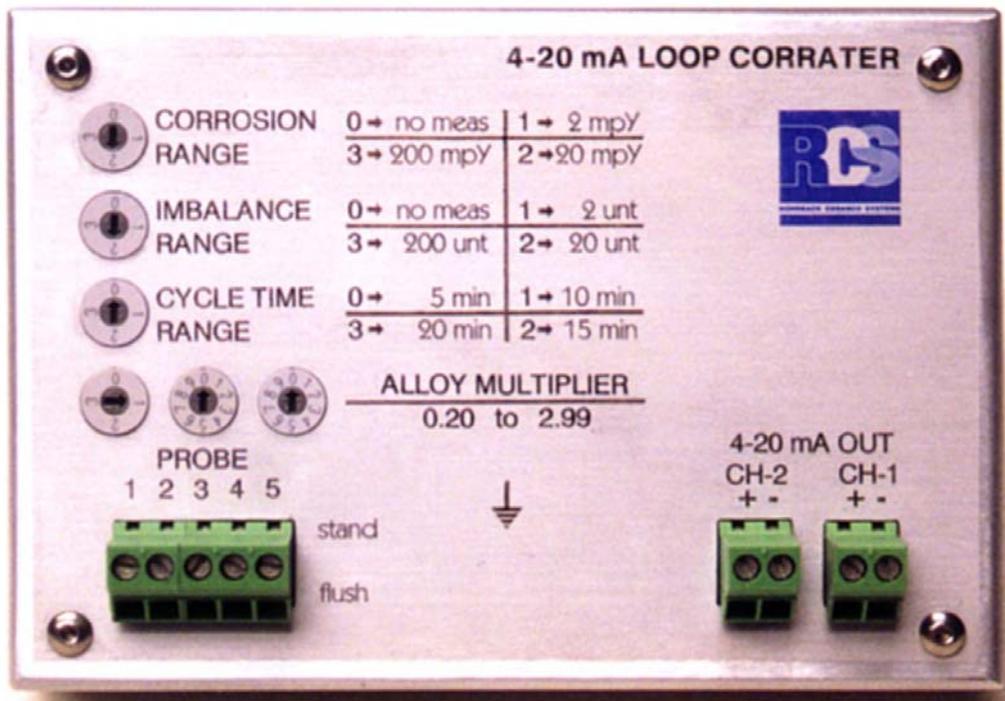


Figure 1 - 9020-OEM Transmitter Module

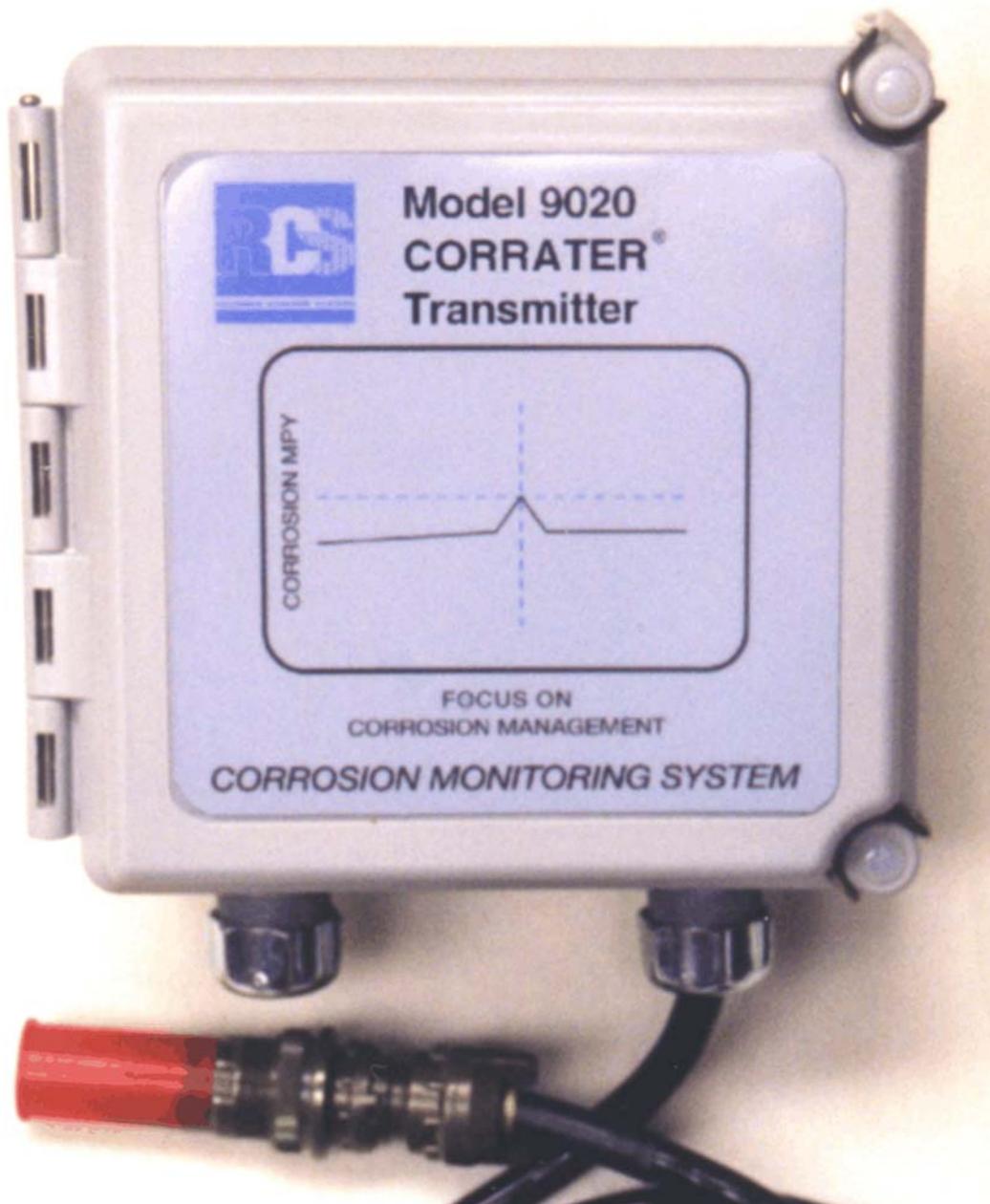


Figure 2 - 9020 Transmitter Installed in Enclosure

Connection to the CORRATER probe to be monitored is made with the six-foot (two-meter) cable supplied with the instrument. A 5 MPY (mil per year) test probe is provided with the instrument for the purpose of verifying proper instrument operation.

Chapter 2 Specifications

ELECTRICAL:

#Corrosion Rate Ranges:	0-2, 0-20 and 0-200 MPY
#Imbalance Ranges:	0-2, 0-20 and 0-200 Imbalance Units
#Measurement Cycle Time:	5, 10, 15 and 20 minutes
#Resolution:	0.1% of Full Scale
#Alloy Multiplier Range:	0.2 to 2.99
#Ambient Temperature Range:	-18EC to +60EC
#Supply Voltage Range:	16-32 VDC at 20 mA.

MECHANICAL:

#Enclosure:	Model 9020-OEM	16 Ga. Aluminum Box
	Model 9020	NEMA 4X, IP66
#Weight:		2 lbs. (1 Kg.)
#Cable:		Six-foot (Two-meter) with Type B connector

MISCELLANEOUS:

#Compatibility:	All 2-electrode and 3-electrode CORRATER® probes
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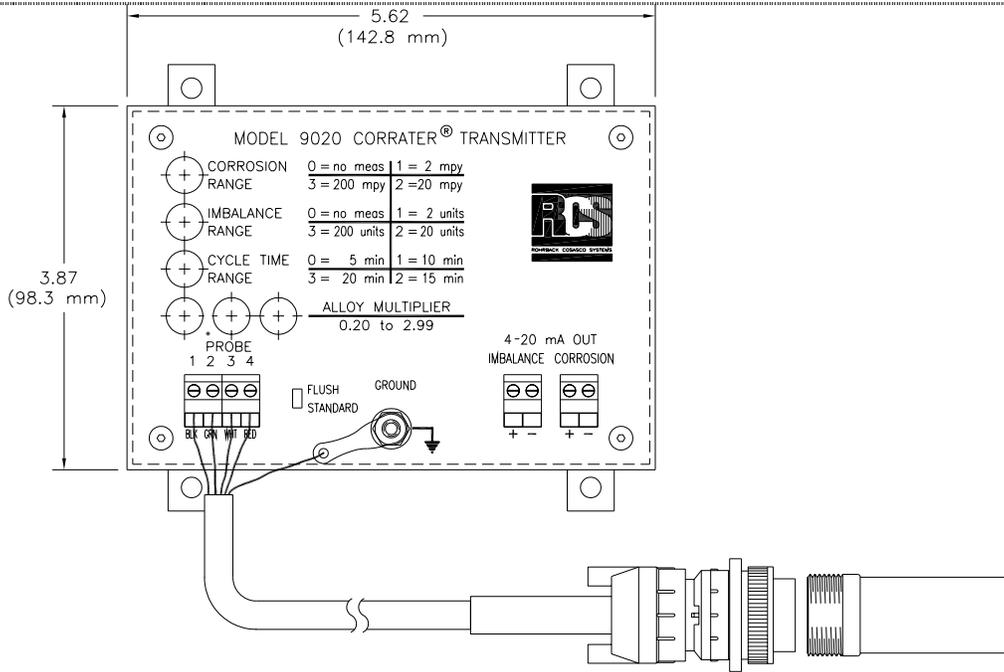


Figure 3 - Dimensions of 9020-OEM

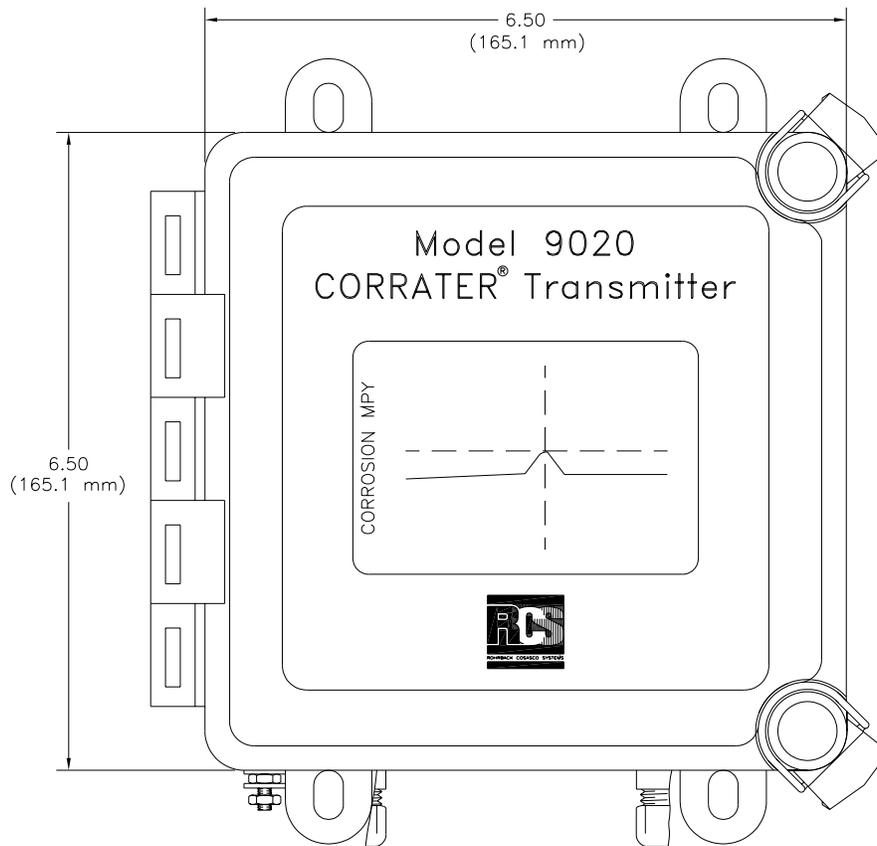


Figure 4 - Dimensions of 9020 NEMA Enclosure

Chapter 3 Installation

Unpacking

Check to make sure that the package contains the following items:

- # Model 9020-OEM or Model 9020 CORRATER® transmitter
- # Six-foot probe-to-instrument cable with Type B connector
- # P/N 710920 Test Probe (to verify 9020 instrument operation only)
- # User Manual

Note: All 9020-OEM and 9020 system components are carefully tested, inspected and packaged prior to shipment. Before proceeding with the installation of the instrument, please inspect all items for shipping damage and retain any damaged materials to support any claim against the freight carrier should this become necessary.

Installation Procedure

Installation of the 9020-OEM and 9020 consists of three tasks:

- # Mechanical mounting of the transmitter
- # Electrical connections to the transmitter and probe
- # Verification of instrument operation
- # Selection of parameters for corrosion rate monitoring

Mechanical Mounting

The Model 9020-OEM is intended to be mounted in a customer supplied secondary enclosure using four #10 machine screws through the mounting feet. Dimensions for the mounting holes are shown in Figure 5.

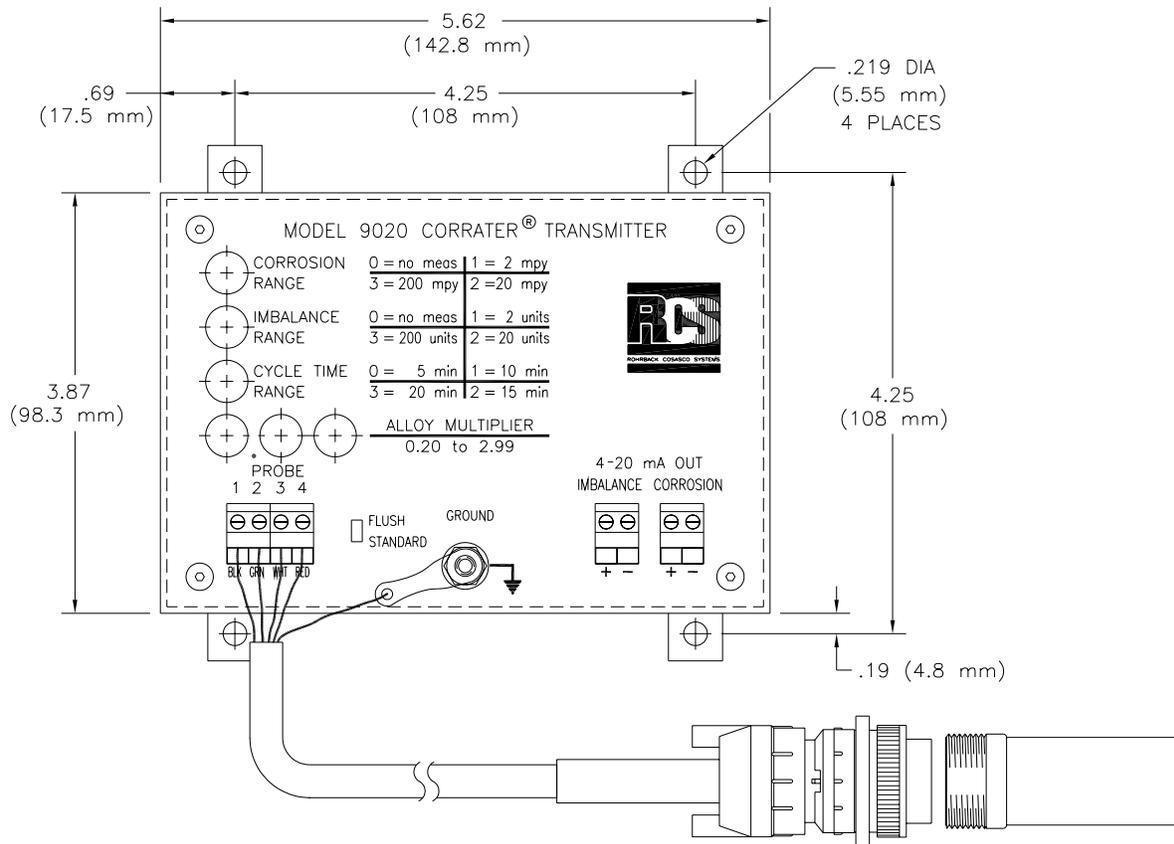


Figure 5 - Mounting hole dimensions on transmitter.

The Model 9020 is intended to be field mounted on a panel, wall or other vertical surface. The NEMA 4X enclosure is mounted using four #1/4" machine screws through the mounting feet. Dimensions for the mounting holes are shown in Figure 6.

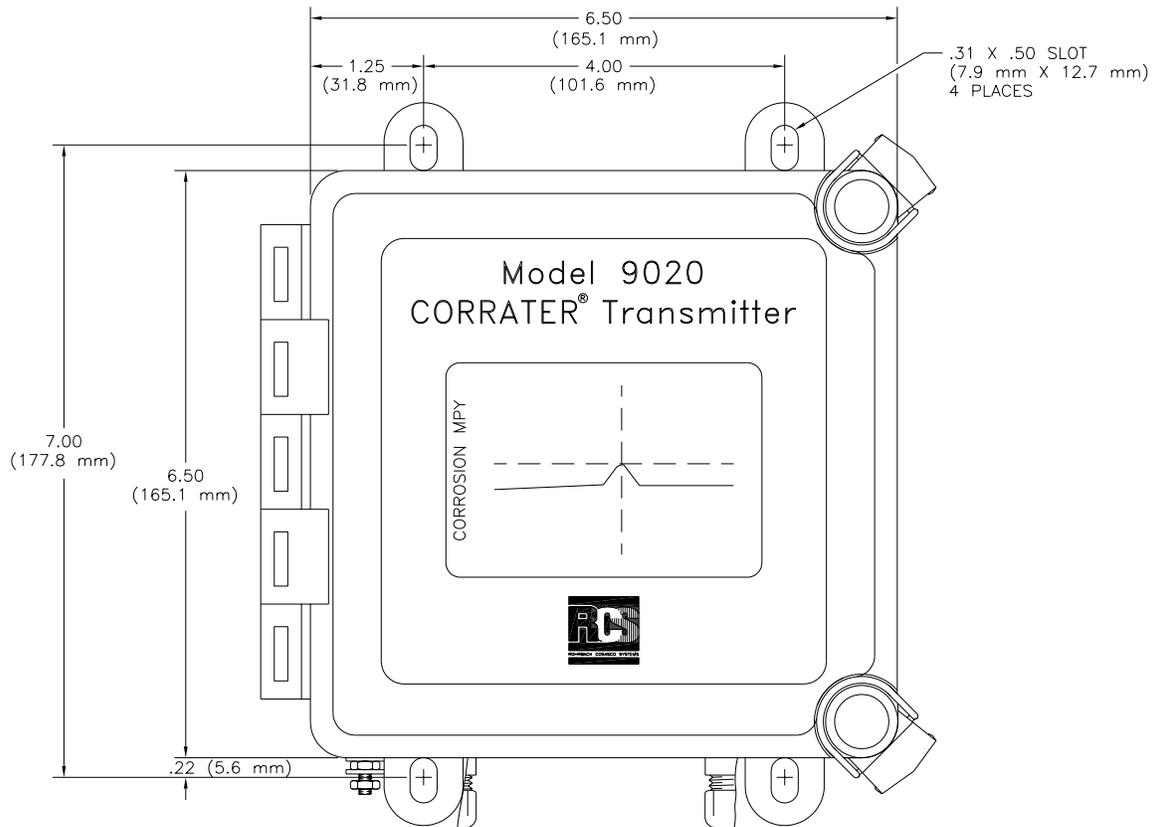


Figure 6 - Mounting hole dimensions on enclosure.

Electrical Connections

The electrical connections are the same for either the 9020-OEM or the 9020 with the exception that the probe and 4-20 mA. loop cables enter the 9020 enclosure through sealing glands.

Both the 9020-OEM and the 9020 are provided with six-foot CORRATER probe-to-instrument cables which are already terminated on the instrument. If for some reason the cable must be removed and reconnected, the individual conductors in the cable should be terminated to the instrument in accordance with Figure 7.

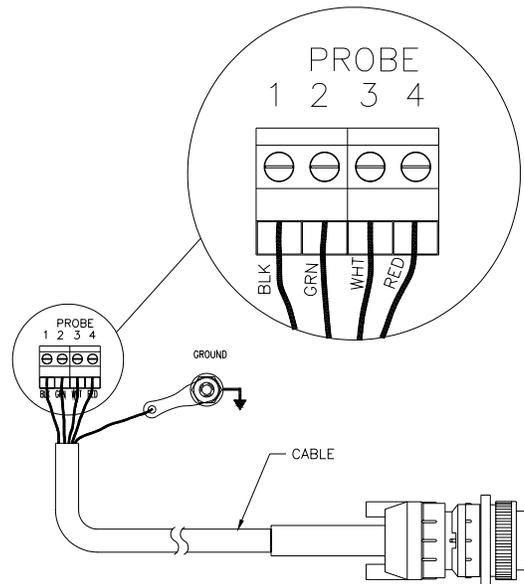


Figure 7 - Drawing showing termination of cable to Probe terminal lug including wire colors and termination of shield to the ground lug.

If possible, the 9020-OEM and 9020 should be grounded to the system ground in order to maximize noise immunity. For the 9020-OEM, the ground lead should be connected to the SHIELD stud where the cable shield is terminated. For the 9020, a separate ground stud is located directly adjacent to the probe cable gland on the bottom of the enclosure.

A two-conductor cable with shield is recommended for wiring to the 4-20 mA. connections. If only corrosion rate measurement is required, the connections are made to the two-position terminal strip labeled CORROSION. If only imbalance measurements are required, the connections are made to the two-position terminal strip labeled IMBALANCE. If both measurements are required, connect to both two-position terminal strips as described above.

It is recommended that the shield for the 4-20 mA. loop(s) be grounded at the receiving end, but left un-terminated at the transmitter end.

Verification of Instrument Operation

To verify the proper operation of the 9020-OEM or 9020 instrument, the P/N 710920 Test Probe is used. The test probe should be connected to the connector on the end of the probe cable and the switches on the transmitter set in accordance with the following:

<u>Switch</u>	<u>Position</u>	<u>Value</u>
CORROSION RANGE	2	20 MPY
IMBALANCE RANGE	2	20 Imbalance Units
CYCLE TIME RANGE	0	5 Minutes
ALLOY MULTIPLIER	1,0,0	1.00
STANDARD/FLUSH	STANDARD	

Apply power to the 4-20 mA. loop and observe the loop current after the measurement cycle has been completed (approximately 5 minutes). The CORROSION RATE loop current should be 8.00 ± 0.25 mA. and/or the IMBALANCE loop current should be 4.00 ± 0.1 mA.

Note that the above settings include the switch settings for the transmitter used for monitoring both CORROSION RATE and IMBALANCE, however it is not necessary to power the second loop in order to complete the verification testing.

Selection of Parameters for Corrosion Rate Monitoring

To place the transmitter into operation, disconnect the Test Probe and connect the cable to the CORRATER[®] probe to be monitored.

Set the CORROSION RANGE switch to the position that exceeds the maximum corrosion rate to be expected, i.e. Position 2 (20 MPY) if the maximum expected rate is 12 MPY. Set the IMBALANCE RANGE to 0 (No Measurement) if this function is not used.

Set the IMBALANCE RANGE switch to the position that exceeds the maximum imbalance reading that is expected. The scale factor for this measurement is 0.5 microamperes (Φ A.) per square centimeter of electrode area. Standard electrodes are 5 square centimeters in surface area, therefore one imbalance unit is 2.5 Φ A.

Set the CYCLE TIME RANGE for the desired measurement cycle time. For water with conductivities greater than 100 Φ S., any cycle time of 5 minutes or more should be satisfactory. For lower conductivity water, or when filming type inhibitors are in use, it is recommended that the 20 minute cycle time be selected first. After consistent readings are

obtained, then a shorter time cycle can be selected as long as the readings do not increase substantially (>5%) over the readings taken with a 20 minute cycle.

Set the ALLOY MULTIPLIER switches to the appropriate multiplier value for the metal or alloy of the electrodes as shown in the chart of Appendix 1. The switches represent the three digits of the multiplier with the left-hand switch selecting the units value (0, 1 or 2); the center switch selecting the 1/10's value (0.0-0.9); and the right-hand switch selecting the 1/100's value 0.00-0.09).

Set the STANDARD/FLUSH toggle switch for STANDARD if using a probe with protruding 5.0 square centimeter electrodes or select FLUSH if using a probe with flush 0.5 square centimeter electrodes.

Enable the power to the loop and after the initial measurement cycle has been completed, the loop current will be continuously updated to the new value at the end of each measurement cycle.

Chapter 4 Operation

After the initial measurement cycle is completed, the transmitter will update the loop current at the completion of each measurement cycle. If logging this data, it is not necessary to sample the loop current more often than once each measurement cycle.

To convert the 4-20 mA. signal into CORROSION RATE in mils per year (MPY), the conversion formula is as follows:

$$\text{CORROSION RATE (MPY)} = \{(I_L - 4)/16\} \times \text{CORROSION RANGE (selected)}$$

To convert the 4-20 mA. Signal into IMBALANCE UNITS, the conversion formula is as follows:

$$\text{IMBALANCE (2.5 } \mu\text{A./unit)} = \{(I_L - 4)/16\} \times \text{IMBALANCE RANGE (selected)}$$

The constant of 2.5 $\mu\text{A.}$ per IMBALANCE UNIT is equivalent to a current density of 0.5 $\mu\text{A.}$ per square centimeter of electrode area and has been determined empirically so that the magnitude of the imbalance measurement can be compared with the corrosion rate in mils per year. For a more detailed description of the imbalance measurement function, please refer to Appendix B.

Appendix A

Alloy Multipliers

NOTE: These factors are recommended for use with the 9020 instrument when setting the MULTIPLIER value, as described in Chapter 3. They are based upon use of CORRATER[®] electrodes which have surface areas of 5cm² for "standard" probes and 0.5 cm² for "flush" probes.

UNS Code	Material	Multiplier
K03005	Pipe Grade Carbon Steel	1.00
A91100	Aluminum 1100-0	0.94
A92024	Aluminum 2024	0.88
C11000	Copper 110 ETP Comm. Pure	2.00
C44300	CDA 443 Arsenical Admiralty	1.67
C44500	CDA 445 Phosphorized Adm.	1.68
C64200	CDA 642 A1 Silicon Bronze	1.48
C68700	CDA 687 Alum. Brass Arsenical	1.62
C70610	CDA 706 90/10 Copper/Nickel	1.80
C71500	CDA 715 70/30 Copper/Nickel	1.50
G41300	AISI 4130 Alloy Steel	1.00
L50045	Lead	2.57
N04400	Monel 400 Nickel	1.13
N05500	Monel K-500 Nickel	1.04
N06022	Hastelloy C22	0.85
N06600	Inconel 600 Nickel	0.95
N08020	Carpenter 20 CB3 SST	0.98

UNS Code	Material	Multiplier
N08800	Incolloy 800	0.89
N08825	Incolloy 825	0.88
N10276	Hastelloy C276	0.86
R50400	ASTM B-348 Grades 2-4 Titanium	0.75
S30400	AISI 304 Stainless Steel	0.89
S31600	AISI 316 Stainless Steel	0.90
S31603	AISI 316L Stainless Steel	0.90
S31803	2205 Duplex Stainless Steel	0.89
S32750	2507 Duplex Stainless Steel	0.88
Z17001	Grades 1A, 1, 2, 3, or 5 Zinc	1.29

Appendix B

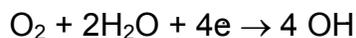
IMBALANCE MEASUREMENT FUNCTION OF CORRATER® INSTRUMENTS

Metal surfaces, no matter how uniform they may appear, have numerous microscopic imperfections. Metals such as iron alloys are crystalline in structure and surface imperfections such as small intergranular cavities will tend to grow, especially in liquids that have large concentrations of dissolved oxygen.

The corrosion processes (iron oxidation) for iron alloys can be described by the following anodic reaction:



which, in an oxygen rich environment can be "driven" by the following cathodic reaction:



When large amounts of oxygen are available at a portion of a metal surface, oxygen not only maintains this cathodic reaction, but it promotes the reaction. At other locations on the metal surface where oxygen is less available, the anodic reaction proceeds to balance the cathodic reaction.

A small intergranular cavity would represent an excellent site for the anodic reaction to take place because there is less available oxygen. In the case of an iron alloy, the reaction causes the rapid localized conversion of iron atoms to ferrous ions since a small anodic area can be supported by the larger cathodic area. As this iron oxidation proceeds, the small cavity grows which in turn exposes a larger iron surface that is essentially void of oxygen causing it to be a very active anode. This process which has the natural tendency to accelerate describes the growth of a corrosion pit.

Since susceptible pitting sites tend to be randomly distributed and generally are not too numerous on a metal surface, there is a high probability that on two seemingly identical metal electrodes, one of the electrodes will have a greater number of susceptible pitting sites than the other electrode. If these two electrodes are the electrodes of a two-electrode CORRATER® probe and they are submersed in a conductive solution which tends to promote pitting, one electrode will exhibit a more positive corrosion potential (E_{corr}) than the other. The polarity of the open-circuit potential difference (E_{oc}) will indicate which electrode has the greater pitting tendency. That electrode will be the more negative of the two.

If these electrodes are electrically connected through a zero-resistance ammeter (ZRA), the measured short-circuit current is a measure of the pitting tendency of the electrode

material in the aqueous environment. This is the measurement technique that it is utilized in CORRATER[®] instruments to provide a qualitative measure of pitting tendency.

In CORRATER[®] instruments, the imbalance (or pitting) units have been established to be 2.5 microamperes ($\mu\text{a.}$) which scales to a current density of $0.5\mu\text{a./cm}^2$ (the CORRATER[®] electrode surface area is 5 cm^2).

The scale factor above was established from empirical data so that the relative magnitudes of corrosion rates in mils per year (MPY) and imbalance readings could be compared. At this scale factor, the dominant corrosion mechanism is the one which exhibits the greater magnitude (i.e. corrosion rate > imbalance indicates more general corrosion and imbalance > corrosion rate indicates more pitting activity).