MS1500E
Data Logger

(Version 2.4)

Table of Contents

I. Introduction

A. General Description

The MS1500E is a battery-powered, hand-held corrosion meter
that enables you to directly take measurements from an electrical
resistance probe, store the data, and upload directly to a computer.
The unit features an easy-to-use Main Menu that will permit even
an operator who is unfamiliar with the unit to take readings with
ease.

Corrosion rate measurements are made using the electrical resis-
tance method. The electrical resistance method has a wide range
of applications since it can be used in conductive or nonconductive
environments including oil and gas. The unit measures the change
in resistance of the probe element as metal loss occurs. The rate of
change is directly proportional to the corrosion rate.

After taking and storing a reading, the operator can display the
metal loss in mils and the corrosion rate in mils per year (mpy). All
measurements made with the unit are automatically time and date
stamped with the MS1500E internal real time clock. If the
MS1500E detects a probe with an internal leak or damaged ele-
ment, a CHECK FAILED message occurs. The unit can take up to
3100 readings and can be used with up to 150 probes. All stored
readings are protected by a lithium back-up battery to prevent loss.

Data may be selectively deleted from memory to accommodate
additional information once the 3100 reading capacity is reached.
Alternatively, information may be downloaded to a PC as a comma
delimited ASCII file for import into any of the standard data handling
and analysis programs (e.g., EXCEL®).

The MS1500E may also be used as a data collection and transfer terminal for the MS3500E remote data logger. Accumulated data from several MS3500E field-based units may be locally down-loaded to the MS1500E hand-held terminal, and then transferred to a PC for further analysis.

The MS1500E offers seven operating modes:
• Select Probe ID
• Make Measurements
• Compute
• Recall
• Delete Readings
• Communicate
• Set Time and Date

All electrical resistance probe types can be used with this unit, including wire loop, tube loop, cylindrical element, surface strip, and flush mount probes.

B. Ports and Battery Replacement

Use this cable to connect the MS1500E to a computer via serial port or USB port.

COILED DATA CABLE

MS1500 SERIAL
PORT ADAPTER

SERIAL TO USB
ADAPTER (OPTIONAL)

TO
COMPUTER
SERIAL
PORT

TO
COMPUTER
USB
PORT
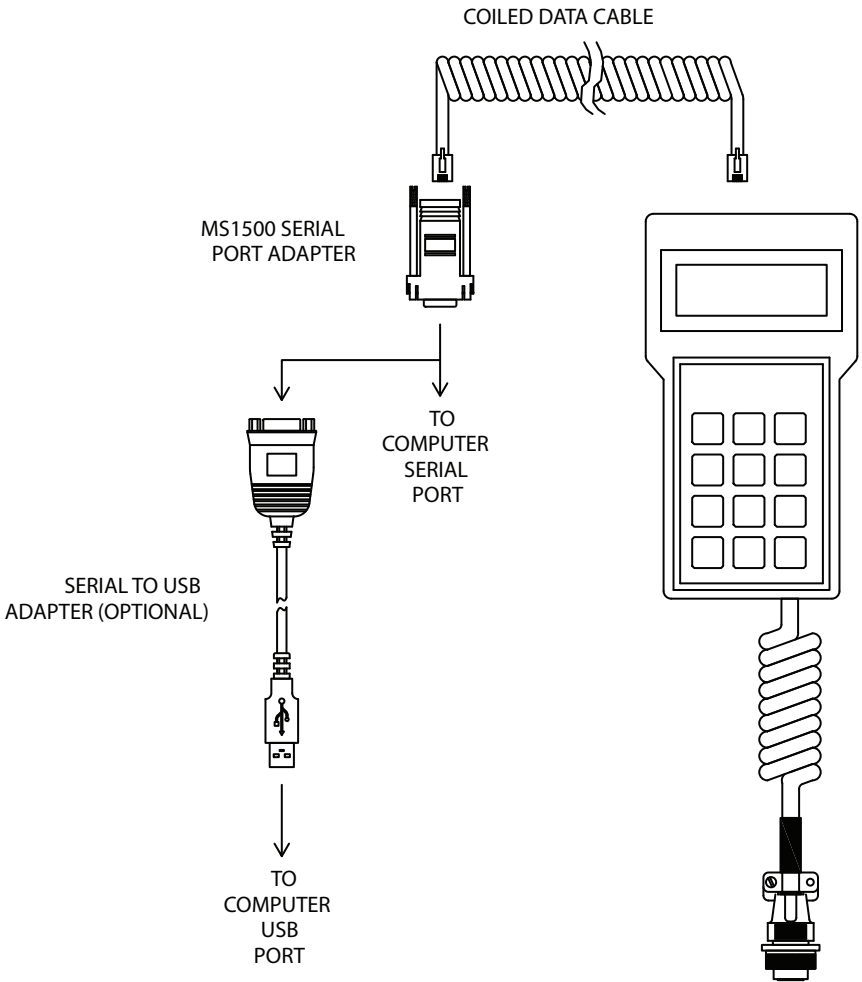
Use the port on top of the MS1500E for connecting to a computer (with the cable provided) or to the MS3500E (with the Opti-link cable.)
See **Communications** (p. 16) for more information.
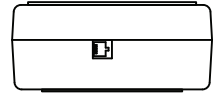
The battery compartment is accessed by removing the "slip-fit" cover on the rear of the instrument. Three 1.5VDC, AA size, dry cell batteries are placed in the spring loaded holders, following the plus/minus orientation indicated on the battery holder as illustrated below.

FRONT   BACK

"SLIP-FIT" BATTERY COVER

POWER SWITCH

3 X 'AA' ALKALINE BATTERIES
(DURACEL MN1500 OR PC1500
REQUIRED FOR INTRINSIC SAFETY.)

PROBE CONNECTOR
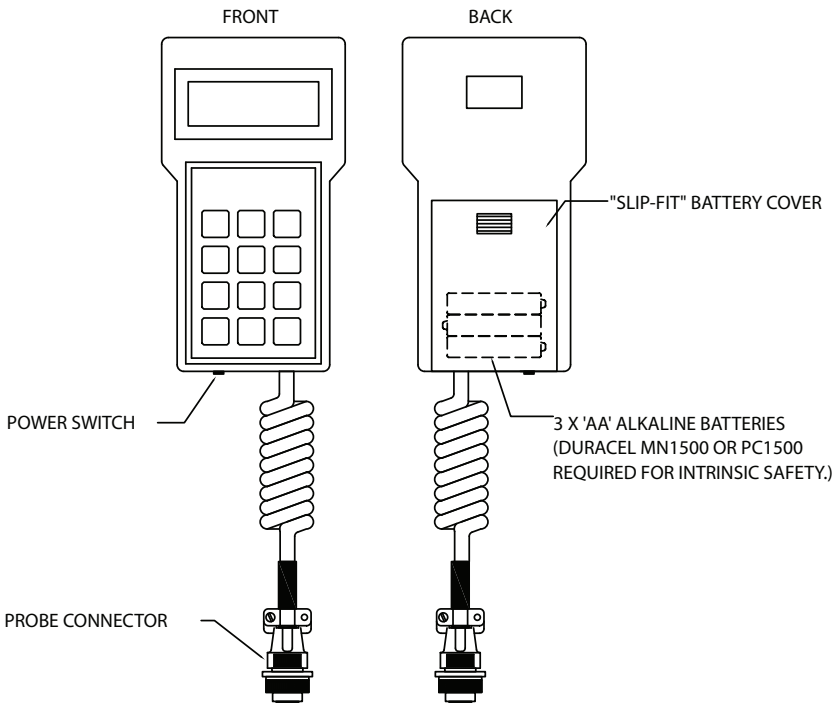
C. Specifications

Model
MS1500E - Handheld ER Corrosion Data Logger (Ordering # IN1500)

Physical Data
Instrument Weight:	1.4 lb. (0.64 Kg)
Total Weight w/ Carrying Case and Accessories:	5.26 lb. (2.39 Kg)
Instrument Dimensions:	7.63"H x 4.15"W x 2.0"D (19.38cm x 10.54cm x 5.08cm)
Carrying Case Dimensions:	10"H x 11.75"W x 5.4"D (25.40cm x 29.85cm x13.72cm)
Operating Temperature:	32° to 122°F (0° to 50°C)
Storage Temperature:	-4° to 158°F (-20° to 70°C)

Performance Data
Measurement Type:	ER measurement using any standard ER probe type (Wire Loop, Tube Loop, Cylindrical, Flush, Strip, etc.)
Range:	0-1000 digits representing 0-100% of probe life
Resolution:	1 digit

Electrical Data
Power Requirements:	Three 1.5V AA Batteries
Maximum Probe Cable Distance:	6 ft (1.83 m)
Output Specifications:	RS-232 Output in Comma-Delimited ASCII Text Format

Special Features
• Microprocessor-based electronics
• Data storage capacity of 3100 readings on 150 different probes, with battery backup
• Menu-driven interface using a 12-key keypad and a 4-line LCD display
• Low-battery detection
• Portable

Accessory Items
Carrying Case, 6' Probe Cable (attached), Meter Prover,
Communications Cable and Connector,
Operation Manual

II. Operation

The MS1500E allows you to measure metal loss and corrosion rate. Review this section which describes the functions that display on the Main Menu:

- Select probe ID
- Make measurement
- Compute MIL/MPY
- Recall readings
- Delete readings
- Communications
- Set time & date
- Test mode

When you power up the MS1500E, the start-up screen confirms these checks:
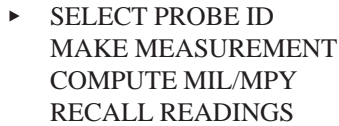
- the software version currently running
- free storage available (see **Storage capacity** in margin)
- system test pass

The last display of the start-up screen looks like this:

```
METAL SAMPLES
MS1500E VX.X
SYSTEM TEST : PASS
```

Storage capacity

The MS1500E allows a maximum of 3,100 readings with up to 150 probes.

To increase your free storage, which displays in the start-up screen, select from the Main Menu:

- DELETE READINGS

or

- SELECT PROBE ID
  and then
  DELETE PROBE
  or
  ENTER NEW PROBE

If you want to know how much storage is currently available, carefully watch the start-up screen which displays this information quickly before SYSTEM TEST PASS; then the Main Menu displays.

Screen 1 of the Main Menu looks like this:

```
▶    SELECT PROBE ID
     MAKE MEASUREMENT
     COMPUTE MIL/MPY
     RECALL READINGS
```

Screen 2 of the Main Menu looks like this:

```
▶    DELETE READINGS
     COMMUNICATIONS
     SET TIME & DATE
     TEST MODES
```

To run a function, select it by using the up or down arrow and pressing ENTER. While in the Main Menu, pressing EXIT will return the selector icon to the first item of the Main Menu.

A. Select Probe ID

The SELECT PROBE ID function allows you three options:

- select a probe already in memory for which you wish to run any other feature of the MS1500E (Make Measure ment, Compute mil/mpy, Recall Readings, or Delete Readings);
- enter into memory the identification of a new probe
- delete from memory the identification of a probe

To run any of these three options, choose SELECT PROBE ID from the Main Menu.

```
‣   SELECT PROBE ID
    MAKE MEASUREMENT
    COMPUTE MIL/MPY
    RECALL READINGS
```

The next screen allows you to choose the functions to ENTER or DELETE a probe ID or to select a probe ID from those already in memory for which you wish to make measurements.

Select a probe before you run a function

In order for you to make measurements, compute mil/mpy or recall or delete readings, you must select a probe that is currently in memory.

The MS1500E provides you with a list of probes in memory; use the arrow key to select one and press enter. Now you're ready to run any other function.

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To assist you with selecting a probe ID, the screen displays a list of all probe IDs currently in memory.

Select from the list of probes in memory the probe for which you wish to run a function (Make Measurement, Compute mil/mpy, Recall Readings, Delete Readings).

```
   ENTER NEW PROBE
   DELETE PROBE
 ▶ 1234 WIRE 40
   4567 FLUSH 20
```

1. Press the arrow key to select a probe ID.
2. Press ENTER.

To enter the ID of a new probe, select ENTER NEW PROBE; the next screen allows you to enter the ID number and the type.

1. Enter the probe ID - use the number keys (press the DOWN arrow if you make an error).
2. Press the UP arrow when   you've entered the correct ID number.
3. Enter probe TYPE (see margin).
4. Press ENTER.

Entering information
To enter a number, type it using the keypad numbers.

If you make an error, press the down arrow - this allows you to type the number again.

Pressing the up arrow retains the ID number you typed in.

Entering probe type
The MS1500E has a list of probe types in memory. Select one by pressing the arrow keys. (See **Appendix B** *for a list of probe types supported by the MS1500E.)*

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```
PROBE ID:  5385
PROBE TYPE: WIRE 40

USE ARROW KEYS
```

Deleting probes

It's necessary to delete a probe when you replace one. Note that when you delete a probe, you also delete all the readings for that probe.

You might want to transfer the readings to a computer before deleting them by using the COMMUNICATIONS *option in the Main Menu. (See* **Communications***, p. 16.)*

It is occasionally necessary to re-move the ID of a probe from memory, for example:

- when the memory bank is full
- when a probe is no longer used

To delete the ID of a probe in memory, select DELETE PROBE.

```
DELETE PROBE
PROBE ID:

UP ARROW WHEN DONE
```

1. Enter the probe ID - use the number keys (press the DOWN arrow if you make an error).
2. Press the UP arrow when you've entered the correct ID number.

The instrument will confirm your choice of probe ID before deleting it from memory.

B. Make Measurement

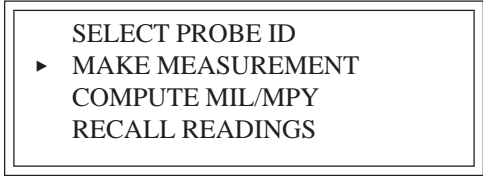To take measurements from probes in memory, select MAKE MEASUREMENT from the Main Menu:

```
    SELECT PROBE ID
►   MAKE MEASUREMENT
    COMPUTE MIL/MPY
    RECALL READINGS
```

The next screen displays the Probe ID that you selected earlier from the Main Menu item
SELECT PROBE ID.

```
    PROBE ID: 1234


    PRESS ENTER TO START
```
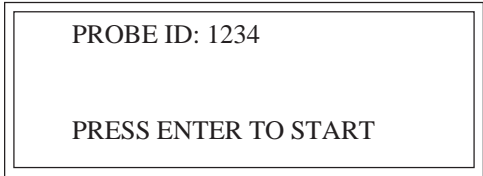
When you press ENTER, the MS1500E checks the probe for correct operation. The next screen then displays the results of that check as PASSED or FAILED.

If the probe failed the test, this screen displays:

```
PROBE ID: 1234
PROBE CHECK FAILED

PRESS EXIT
```

Check failed = bad probe
When a probe fails this test and the screen displays CHECK FAILED, *it means the probe may have either a damaged element or an internal leak.*

Press EXIT to return to the Main Menu.

If the probe passed, this screen displays:

```
PROBE ID: 1234
PROBE CHECK PASSED
CHECK READING: 123
PRESS ENTER TO READ
```

Press ENTER to view the reading:

```
PROBE ID: 1234
READING: 124
CHECK READING: 123
PRESS ENTER TO SAVE
```

Press ENTER to save the reading in memory. Saved readings also include the date.

Press EXIT to return to the Main Menu.

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C. Compute MIL/MPY

Select COMPUTE MIL/MPY to review data from the last reading on a probe. The MS1500E calculates these data from a comparison between the last reading and the first reading on the probe:

```
20/01/98 TO 20/02/98
MET LOSS: 0.05 MIL
COR RATE: 0.59 MPY
PRESS EXIT
```

Press EXIT to return to the Main Menu.

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D. Recall Readings

Select RECALL READINGS to look at data from different dates. Use the arrow keys to choose the reading number. Or press ENTER to type in the number on the keypad.

```
READING #: 2
DATE: 20/02/98
READING: 124
DOWN/UP/EXIT/ENTER
```

Press EXIT to return to the Main Menu.

E. Delete Readings

Select DELETE READINGS to erase a reading from memory. Periodically delete readings to create more free storage area in memory.

```
    DELETE READINGS
#1  20/01/98  125
#2  20/02/98  125
    ENTER TO DELETE
```

Press EXIT to return to the Main Menu.

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F. Communications

The MS1500E Data Logger has the ability to store readings as they are taken. These readings can later be transferred to your PC via serial port or USB port. To transfer data to a PC it is necessary to install the Corrosion Data Management Software.

Installing the Software
To run the Corrosion Data Management Software, you need a PC that meets the following requirements:

- Pentium® class processor
- Windows® 95 or higher operating system
- 16 MB of RAM
- 10 MB of available hard-disk space
- VGA monitor with 800 600 or greater resolution
- Mouse or pointing device recommended
- Available 9-pin serial port or USB port
- CD-ROM drive for software installation

To install the Corrosion Data Management Software:

1. Insert the setup disk provided in your accessory kit.

2. You will be prompted to close any open programs. After you have done so, click *OK* to continue.

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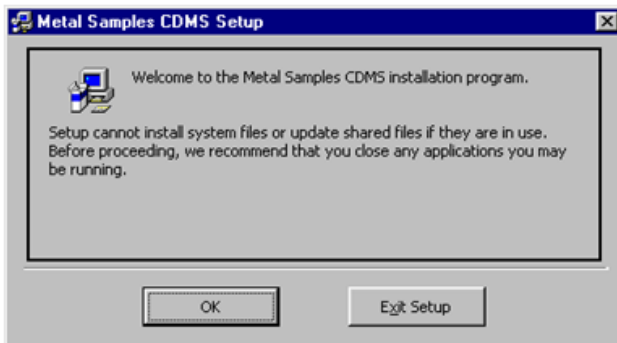
3. Click the install button to begin installation. Note, it is recommended that you install the software in the default directory.
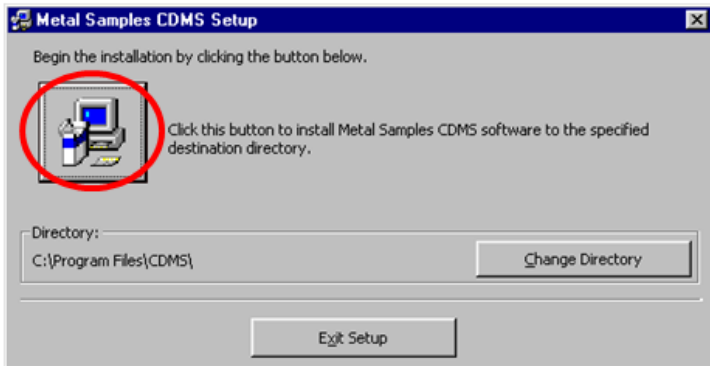
4. After clicking the install button, the software will be installed on your PC.

5. When the software installation is complete you should remove the setup disk, then reboot your computer.

Instrument Download Center

The Instrument Download Center is a simple tool for retrieving data from Metal Samples ER and LPR data logger instruments.
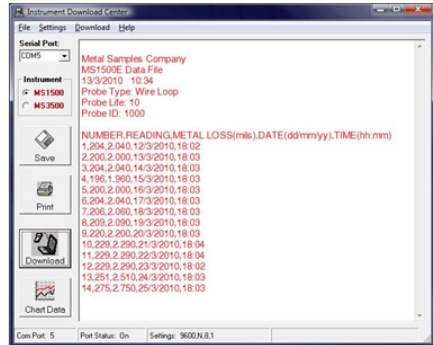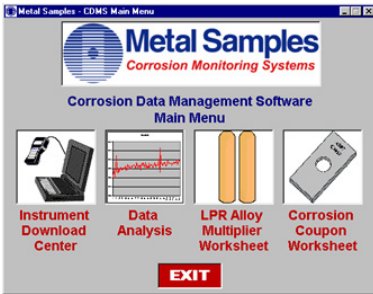

To download data from an instrument:

- Connect the instrument to an available PC serial port or USB port (see page 3.)
- Turn the MS1500E on.
- Run the Corrosion Data Management Software
- Open the Instrument Download Center
- Select the serial port and instrument
- Click the *Download* button (ensure that Part Status toggles to "On").
- From the main menu of the instrument, go to the Select Probe I.D. menu and select the probe data you wish to download.
- From the main menu of the instrument, go to the Communications menu and select Computer Upload.

Data will begin to transfer from the instrument to the PC, and will appear in the data window of the Instrument Download Center as shown above. If the data appears garbled, the wrong instrument type has been selected. Select another instrument type and try again. If data does not appear in the data window at all, verify that:

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- The instrument is connected to a valid serial or USB port
- All cables are securely connected
- The message "Port Status: On" appears in the status bar
- There are no errors on the instrument
- If using a USB adapter, ensure that the device drivers have been installed.

Selecting a Serial Port

Use the *Serial Port* selection box to select the port to which the instrument is connected. If the COM port number is unknown, it can be found in Windows Device Manager under "Ports (COM & LPT)".

Selecting an Instrument

Use the *Instrument* option box to select the model of Metal Samples instrument being downloaded. This sets the appropriate communication parameters, which will be displayed in the status bar at the bottom of the window ("*9600,N,8,1*" for an MS1500, "*2400,N,8,1*" for an MS3500).

Downloading Data

To toggle the selected port on and off, click the *Download* button. Toggling the port on and off will also clear the data window.

Once a valid serial port and instrument have been selected, click the *Download* button to turn the port on and enable the computer to receive data. If a valid serial port has been selected, the status bar at the bottom of the window will display the message "Port Status: On". If an invalid serial port has been selected, an error message will appear, and the status bar will display the message "Port Status: Off". If this happens, another serial port should be selected.

Saving Data

To save the data in the data window, click the *Save* button. The data is comma-delimited ASCII text. It can be saved to a standard text (.txt) file, or it can be saved to a comma-separated values (.csv) file, which greatly simplifies the process of importing the data into some spreadsheet programs such as Excel® or Quattro Pro®.

Printing Data

To print the contents of the data window, click the *Print* button. A print dialog box will be displayed to allow printer selection and setup.

Charting Data

To chart the contents of the data window, click the *Chart Data* button. If the data has not yet been saved, the user will be prompted to do so before the charting process begins. For more information on charting data, see the Data Analysis section.

Data Analysis

The Data Analysis utility is a convenient tool for charting data from Metal Samples ER and LPR data logger instruments. The Data Analysis utility can be opened from the Main Menu, or it can be opened directly from the Instrument Download Center.

If the Data Analysis utility is opened from the Instrument Download Center, the contents of the data window will be loaded into the chart. However, if the Data Analysis utility is opened directly from the Main Menu, a valid data file must be loaded. The *Select File* box will open to allow selection of a data file.

Loading a Data File

After selecting a data file (or clicking the *Chart Data* button from the Instrument Download Center) a status window will display the progress of the file being opened, along with the Instrument Type, Probe Type, and Probe ID for the data file.
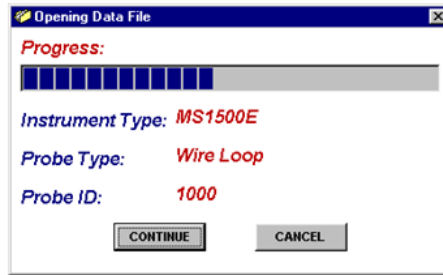
Data Table

After a file has been successfully loaded, the data will be displayed in the Data Table for review. By default, all data points will be included in the chart. However, data points can be turned off, or excluded, from the chart. If the "Excluded" flag appears in the status column for a data point, that data point will not appear in the chart. To toggle the exclude/include status of a data point, double-click the data point, or select the data point and click *Exclude/Include* in the *Options* menu.

READING #	METAL LOSS (mils)	DATE (dd/mm/yy)	PROBE ID	PROBE TYPE	STATUS
1	2.040	12/3/2001	1000	Wire Loop	
2	2.000	13/3/2001	1000	Wire Loop	
3	2.040	14/3/2001	1000	Wire Loop	
4	1.960	15/3/2001	1000	Wire Loop	
5	2.000	16/3/2001	1000	Wire Loop	
6	2.040	17/3/2001	1000	Wire Loop	
7	2.060	18/3/2001	1000	Wire Loop	
8	2.090	19/3/2001	1000	Wire Loop	
9	2.200	20/3/2001	1000	Wire Loop	
10	2.290	21/3/2001	1000	Wire Loop	
11	2.290	22/3/2001	1000	Wire Loop	Excluded
12	2.290	23/3/2001	1000	Wire Loop	Excluded
13	2.510	24/3/2001	1000	Wire Loop	Excluded

Printing Data

The data table can be printed by clicking *Print* in the *Options* menu. A print dialog box will be displayed to allow printer selection and setup.

Creating A Chart

To chart the selected data, click the *Chart Data* button, or select *Chart Data* from the *Options* menu. The chart will be displayed in a new window.

Printing a Chart

A chart can be printed using the *Print Chart* option in the *File* menu. A print dialog box will be displayed to allow printer selection and setup.

Exporting a Chart

A chart can be exported to other applications using the *Copy Chart* option in the *File* menu. This will copy both the chart and the raw data to the Windows® Clipboard. The chart can then be inserted into other applications using the *Paste* function. Note: In some applications, using the *Paste* function will insert the raw data instead of the chart. In this case, use the *Paste Special* function, then select *Picture* to insert the chart.

Chart Tools

- **Statistical Data**

  The *Statistical Data* tab at the bottom of the Data Chart window will display a page with statistical information about the chart data. If the Statistical Data page is visible, this information can be printed by clicking *Print Statistical Data* in the *File* menu.

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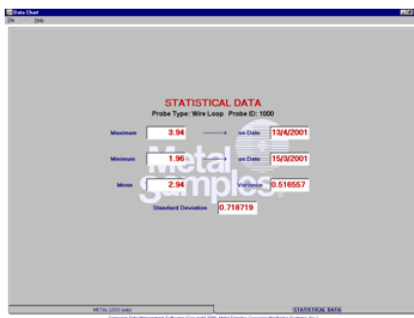
- **Finding A Data Points Value**

  While viewing the chart, the value of any data point can be determined by simply clicking it. The value will be displayed in the charts tool-tip box (a small text box that is displayed near the mouse pointer). If the tool-tip box does not appear immediately after clicking the data point, hold the mouse pointer stationary over the chart background for a moment.

- **The Tools Menu**

  The *Tools* menu contains a collection of utilities for viewing and manipulating the chart. The *Tools* menu can be accessed by clicking *Tools* on the menu bar, or by right-clicking anywhere on the chart.

Hide **D**ata Markers	Ctrl+D
Show **M**ean Value	Ctrl+M
Show **T**rend Line	Ctrl+T
Title/**F**ootnote Setup	Ctrl+F
Pl**o**t Setup	Ctrl+O
Data Series Co**l**or	Ctrl+L
Zoom **I**n	F5
Zoom **O**ut	F6
Calculate Corrosion Rate	F7

  o **Data Markers**

  Show Data Markers toggles the data markers on and off.

  o **Mean Value**

  Show Mean Value toggles the mean value line on and off.

  o **Trend Line**

  Show Trend Line toggles the trend line on and off.

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- **Title/Footnote Setup**

  Title/Footnote Setup displays a window that allows the chart title and footnotes to be toggled on and off, and to be modified.

- **Plot Setup**

  Plot Setup displays a window that allows configuration of Y-axis scaling, and of the chart type.

  The Y-axis can be scaled to default values by checking the *Auto Scaling* option box. The Y-axis can be scaled to manual values by un-checking the *Auto Scaling* box, then entering the desired values in the *Minimum* and *Maximum* fields.

  The chart type can be set to *Line Chart*, *Bar Chart*, or *Area Chart* by selecting the appropriate button in the *Chart Type* box. The default chart type is *Line Chart*.

- **Data Series Color**

  Data Series Color displays a color selection box, which allows the user to select the brush color for the plot line. The default color for the plot line is Blue.

- **Zoom In**

  Zoom In allows a region of the chart to be enlarged so that it may be viewed in greater detail. To enlarge a region of the chart, click on the two data points that define the left and right boundaries of the region.

  In zoom mode, the mouse pointer will change to a cross-hair. When zoom mode ends, the mouse pointer will return to its normal state.

  To cancel zoom mode, click *Cancel Zoom In* from the *Tools* menu, or simply press the *Esc* key.

o **Zoom Out**

   Zoom Out restores the initial view of the chart, which displays the full data set.

o **Calculate Corrosion Rate**

   If the chart contains ER data, the *Calculate Corrosion Rate* option will become available under the *Tools* menu. This option allows the corrosion rate to be calculated between any two data points on the chart. To calculate the corrosion rate click *Calculate Corrosion Rate*, then click two data points. The corrosion rate between those two data points will be displayed.
   In calculate mode, the mouse pointer will change to an arrow/question mark. When calculate mode ends, the mouse pointer will return to its normal state.

   To cancel a calculation, click *Cancel Calculate* from the *Tools* menu, or simply press the *Esc* key.

G. Set Time and Date

When you need to set the internal clock, select SET TIME & DATE.
In order for information in memory to be useful and accurate, be sure the time and date are accurate.

```
SET TIME & DATE
11:46 AM 20/02/98

ENTER TO ACCEPT
```

Use the numbers on the keypad and the arrow keys to make changes to the time and date.

NOTE: The MS1500E uses the international date format (DD/MM/YY). Be sure to enter the date in this format to prevent errors in data handling and calculations.

Press ENTER to confirm your changes and to return to the Main Menu, or press EXIT to discard your changes.

H. Test Mode

This function of the instrument is used by authorized factory personnel for servicing or upgrading the MS1500E.

```
E2939  O153R1364 O151
G57           RATIO 0.4641
READING: 122        #105
PROBE: 1234-WIRE 40
```

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III. Theory of Operation

A. Measurement Theory

The reduction in cross-sectional area of an element of metal or alloy as it corrodes is accompanied by a corresponding increase in the electrical resistance of the element.

The relationship is given by

$$R = \rho \ x \ L/A \ ....(1)$$

R = element resistance
ρ = specific resistivity of the element alloy
A = element cross-sectional area
L = element length

Consequently, periodic resistance measurements of a metal/alloy element that is continuously exposed to a corrosive environment, will provide data on the rate and extent of corrosion for that alloy/ environment combination.

In practice, resistance is also a function of temperature. Therefore, electrical resistance corrosion sensors need some means to compensate for the effects of temperature change. This is achieved by constructing the sensors such that the sensing element has an exposed portion that freely corrodes and a protected portion that is within the body of the sensor and not subject to corrosion. Such a construction is illustrated in Figure 1.
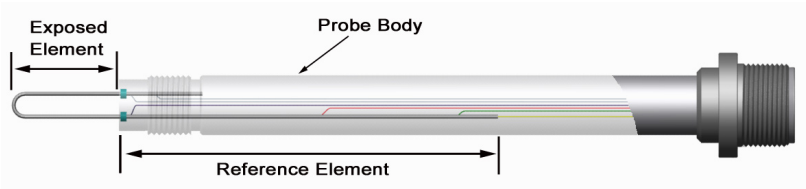

Figure 1: Temperature compensated element

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The resistance of both the exposed (R_E) and protected (R_T) portions of the sensors are equally influenced by temperature. Consequently, the resistance ratio of the exposed to protected elements is a function only of the loss in metal thickness on the exposed element, and therefore of corrosion.

This resistance ratio (R_E/R_T) is measured either periodically with a portable instrument, or continuously with a variety of continuous, automatic recording/data logging instruments and read as percentage thickness loss. Thus, total metal loss versus time is directly available, and corrosion rate is indirectly available as the slope of the line for metal loss versus time.
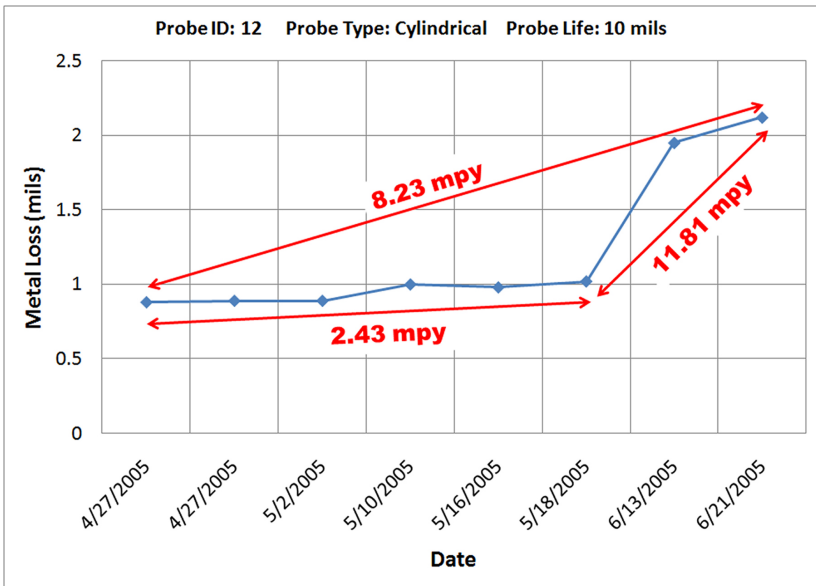

Figure 2: Typical data

B. ER Sensing Elements

Electrical resistance probe elements are offered in a variety of thicknesses and geometries. The most common are illustrated below:

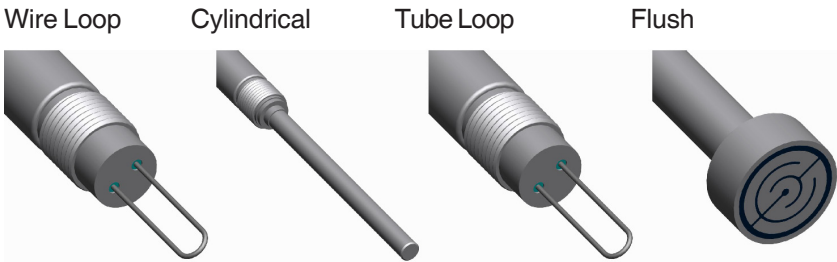Wire Loop   Cylindrical   Tube Loop   Flush

Figure 3: Element styles

Tubular loop elements are constructed from thin-walled tubing. Their small cross-section allows fast response at low corrosion rates.

Wire loop elements, constructed of solid wire, provide a good compromise between sensitivity and long life. They are typically used for systems exhibiting moderate corrosion rates (5-20 mpy).

Cylindrical elements are made from hollow cylinders and are extremely robust. They are widely used in high temperatures and high flow rate conditions. They tend to be sensitive to noise and somewhat sluggish in response. Consequently, they are only recommended for moderate to high corrosion rates (20-50 mpy).

Flush elements are designed to be located flush with the corroding surface of the vessel/pipe, consequently, most closely simulating true corrosion rates. The flush element is useful in high flow regimens and operating conditions where internal obstructions are not permissible, e.g. pigged pipelines.

The mechanism for sealing elements into probe bodies varies. For example, the cylindrical type elements are sealed with an all metal weld, whereas flush elements are sealed with an epoxy seal.

The sealing mechanism of the element is a primary factor in determining the temperature and pressure rating of an ER probe.

Table 1 provides a guide to temperature and pressure limitations for various element designs.

Element Form	Thickness	Element ID	Pressure Rating PSI	Temperature Rating °F / °C
tubular loop glass sealed	4 mil 8 mil	TU04 TU08	1500	500 / 260
wire loop glass sealed	40 mil 80 mil	WR40 WR80	1500	500 / 260
cylindrical element all metal	10 mil 20 mil	CT10 CT20	1500	500 / 260
flush element epoxy seal	5 mil 10 mil	FM5 FM10	1500	400 / 204

Table 1: Element temperature and pressure ratings

The temperature and pressure limitations given above may be subject to modification according to the probe body design. This is discussed later in this manual.

A final issue with respect to sensing elements is material of construction. Generally, this should be selected to most nearly match that of the plant or equipment under consideration.

Almost any geometric configuration and thickness of element can be made in any commercially available alloy. However, some alloys, particularly in the glass sealed loop version, may be costly and have a considerable delivery time.

C. ER Element Performance

The basic ER measurement gives percentage of metal thickness loss and is a function of the original element thickness. Essentially, total metal loss and corrosion rate are given by the following functions:

$$M_L = \frac{X \; x \; K}{1000} \quad \text{.. (2)}$$

$$C_R = \frac{(X2 - X1) \; x \; K \; x \; 365}{1000 \; t} \quad \text{................... (3)}$$

M_L = METAL LOSS IN MILS
X = INSTRUMENT READING AT ANY GIVEN TIME
X_2 = INSTRUMENT READING AT TIME t_2
X_1 = INSTRUMENT READING AT TIME t_1
t = TIME LAPSE (DAYS) BETWEEN READINGS X_1 AND X_2
C_R = CORROSION RATE IN MILS PER YEAR
K = PROBE CONSTANT

The probe constant K is a function of the element thickness and geometry. Table 2 lists the K factors for various common elements.

ELEMENT GEOMETRY	K FACTOR
TU04	2
TU08	4
WR40	10
WR80	20
CT10	5
CT20	10
FM5	2.5
FM10	5
FM20	10
FM40	20

Table 2: K factors

Some of the newer instruments, the MS1500E in particular, perform metal loss and corrosion rate calculations automatically and display these as a direct reading.

Two key performance characteristics for a particular element style are element life and response time. The element life is directly proportional to its thickness, whereas response time, which is the time required to obtain a significant reading change at a given corrosion rate, is inversely proportional to element thickness. Thus, the user must make some compromise between life and response time when selecting a sensing element. Figures 4 and 5 provide a general guide for selecting optimum life and response time combinations.
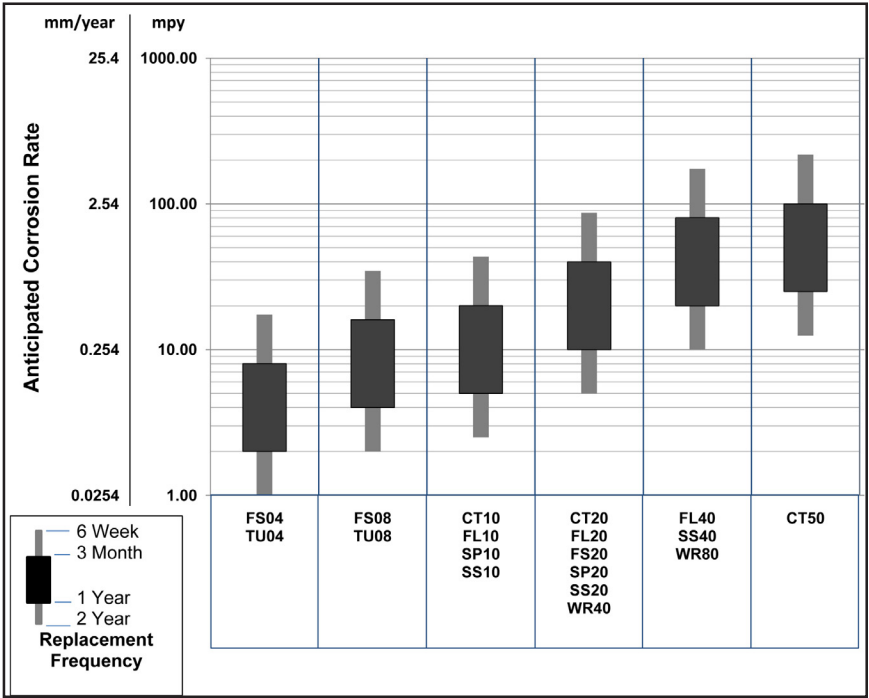
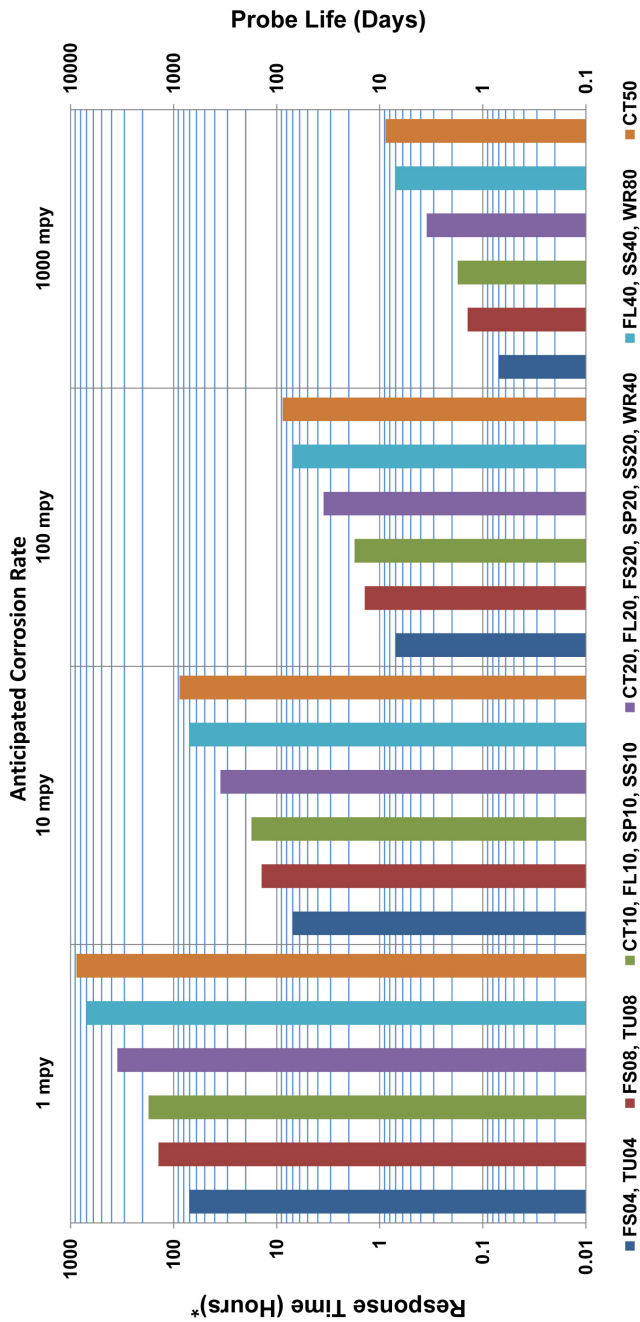Figure 4: Element selection guide (element life)

Figure 5: Element selection guide (response time)

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The other major performance characteristic related to element geometry is measurement reproducibility. Under ideal circumstances the measurement reproducibility will match the instrument resolution, which is ±0.1% for most commercially available units. However, low resistance elements (i.e., CT20, WR80) in systems exhibiting frequent (30-60 minute cycle), and comparatively large (±10-15°F), temperature fluctuation may only achieve a reproducibility of ±0.5%. Such low resistance elements should be avoided when temperature instability is anticipated, unless high corrosion rates are expected (20+ mpy).

D. ER Probe Body Design

ER probe bodies may be made in almost any design and material. Metal Samples frequently supplies custom probe designs for atypical applications. However, a standard range of designs are available that will cover the majority of uses. These standard designs are discussed in the following paragraphs.

1. Fixed Length ER Probe

The fixed length probe, which has a body constructed in 316L stainless steel, is a general purpose probe construction. The probe is comprised of a NPT pipe plug entry or welded flange on a cylindrical shaft. The probe is available in a variety of insertion lengths, although no length adjustment is available; hence the name "fixed-length" probe.

This probe is available in all element styles. The wire loop and cylindrical elements can use threaded ports as small as 3/4" NPT. The flush mount elements require at least a 1½" NPT opening. Pressure and temperature ratings are 3000PSI and 500°F for pipe plug entries, whereas flanged entries are controlled by the flange rating. The major limitation of this design is that the system needs depressurization prior to insertion or removal of the probe.
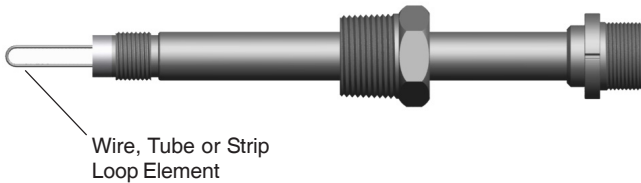
Wire, Tube or Strip
Loop Element

Figure 6: Fixed Length ER Probe

2. Retractable ER Probes

Retractable probes are the industry standard in refinery and petro-chemical plants. The probe body is constructed in 316L stainless steel and compromises a one inch FNPT packing gland with a cylindrical probe shaft. Four basic probe lengths are available: 18", 24", 30", and 36".

However, the insertion is adjustable through the packing gland to provide any desired insertion. The retractable probe is inserted into the system through a customer supplied ball valve and can be inserted or removed from pressurized systems without shutdown.

Retractable probes can be operated at pressures to 1500 psi and 500°F. Metal Samples' Easy Tool is recommended for probe insertion or retraction in systems with pressure over 150 pounds.

All element configurations are available for retractable probes and most can be accommodated through a 1" full-port valve. Flush element probes, however, require a 1½" full-port valve.
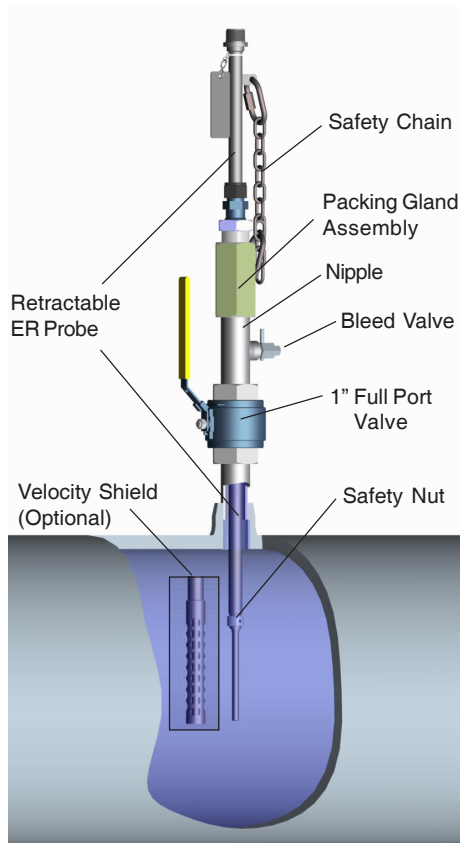

Figure 7: Retractable ER Probe

3. High Pressure Retrievable ER Probe

The high pressure retrievable probe is widely used in the oil and gas production and transmission industry and is part of a specially designed insertion/retraction system. The probe is mounted on a specially designed plug and inserted through a welded or flanged access fitting as shown in Figure 8.

The retrievable probe, which is normally constructed in AISI316L stainless steel, can be inserted and removed from systems operating up to 3600 psi without system shutdown. This is achieved by using a portable valve and retrieval tool that can be moved from probe location to probe location as insertion or removal is required.
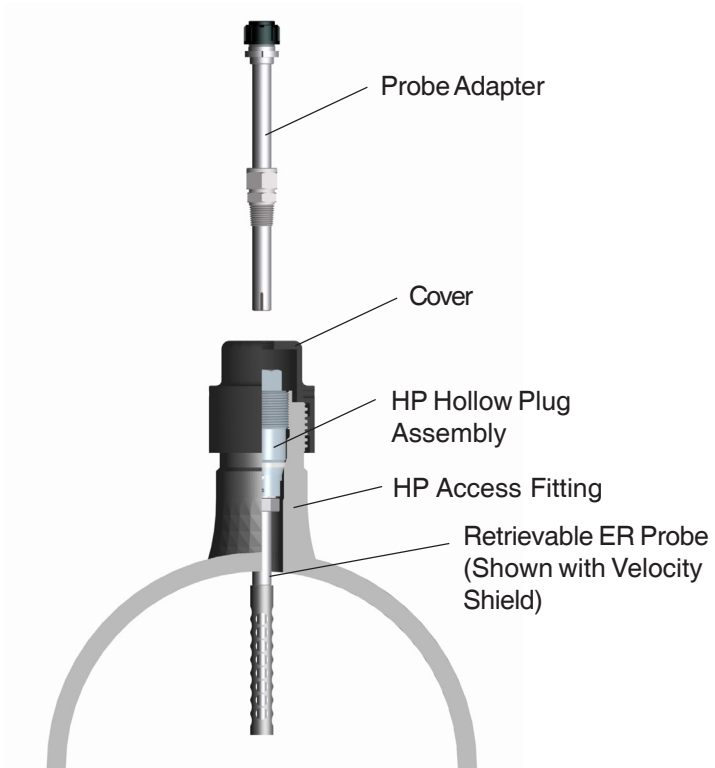
Probe Adapter

Cover

HP Hollow Plug Assembly

HP Access Fitting

Retrievable ER Probe (Shown with Velocity Shield)

Figure 8: Retrievable ER Probe

IV. Testing the MS1500E with the ER Meter Prover

An ER Meter Prover is provided to allow routine checks of the MS1500E instrument. The ER Meter Prover simulates a Wire Loop type ER probe at a fixed value which is printed on the Meter Prover label (as shown below.)
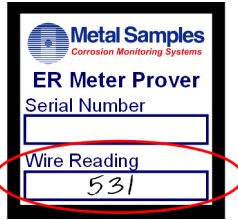
To test the MS1500E with the Meter Prover:

1) Enter a new Probe ID in the MS1500E menu with the probe type Wire 40 (see "ENTER NEW PROBE" on page 10.) This Probe ID can be used for future checks with the Meter Prover.

2) Connect the ER Meter Prover to the MS1500E probe connector as shown to the right.

3) Perform a measurement by selecting "MAKE MEASUREMENT" from the main menu (see page 12.)

4) Allow the measurement to finish. The measured value should be close the value printed on the ER Meter Prover label (+/- 10 probe units is typical, but may vary more depending on ambient conditions at the time.) If the reading shows a *significant* difference compared to the Meter Prover value, further troubleshooting may be required.

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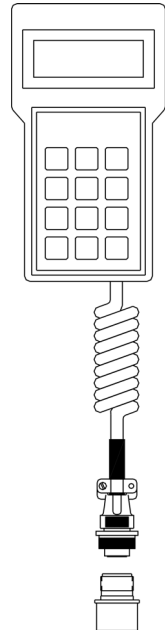
It is important to note that the ER Meter Prover is only a check probe used to verify general instrument operation. It is not a calibration standard. The measured value may differ from the listed value as explained in step 3 above.

It is also important to note that each ER Meter Prover is serialized to match the instrument it is shipped with, and its measured value may differ if it is used with another meter. If it is necessary to use an ER Meter Prover with another meter, it is recommended that you establish a baseline value for the ER Meter Prover with the other meter.

V. Returning an Instrument for Repair

If it is necessary to return any Metal Samples instrument for repair, the following procedure is recommended to ensure the fastest possible repair and return cycle. You may contact Metal Samples to verify that returning the instrument is necessary.

1. If possible, pack the instrument in the original shipping carton. If the original carton is not available, pack the instrument in a rigid cardboard or wood carton. Surround the instrument with a minimum of three inches of resilient packing material such as foam rubber or shredded newspaper.

2. Ship the instrument prepaid via air freight or air express to:

   Metal Samples
   152 Metal Samples Rd
   Munford, AL 36268

3. Contact Metal Samples by telephone (256) 358-4202, fax (256) 358-4515, or e-mail msc@alspi.com and tell them:

   a. the name of the airline carrying the instrument

   b. the flight number

   c. the estimated time of arrival

   d. the waybill number and delivery instructions

4. When the instrument is packed, include a copy of the form on the next page, filled in as required to expedite the repairs.

Copy this form when you need to return an instrument. Send a copy of this form filled in as completely as possible.

1. Check one:

   _____ Repair this instrument under warranty.

   _____ Repair this instrument regardless of problem or cost of repair.

   _____ Inspect this instrument and advise customer of approximate cost of repairs if instrument is not covered under warranty (Note: This may delay return of instrument to customer.)

2. Instrument Model # _____

   Serial # _____

   Date of purchase _____

   Customer's original purchase order # _____

3. Return this instrument to:

   Company _____

   City/State/Zip _____

   _____

   Telephone _____ Fax _____

4. Describe problem fully - this may shorten repair time.

   _____

   _____

   _____

5. Urgency of repairs _____

VI. Warranty

Metal Samples warrants that any part of Metal Samples corrosion rate instruments 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 the option of Metal Samples, 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. Metal Samples shall have the right to final determination as to the existence and cause of the 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.

Orders or requests for additional information should be addressed to:

Metal Samples
152 Metal Samples Rd
Munford, AL 36268
Phone: (256) 358-4202
Fax: (256) 358-4515
E-mail: msc@alspi.com

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.