GE Infrastructure

Sensing

Kaye Intelligent RTD Probe

User's Manual

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Intelligent RTD Probe
Kaye Temperature Measuring Device

User's Manual
M2845-6, Rev. 3
May 2005

The Intelligent RTD Probe is a GE Kaye product. GE Kaye has joined other GE high-technology sensing businesses under a new name—GE Infrastructure Sensing.

Warranty

Each instrument manufactured by GE Infrastructure Sensing, Inc. is warranted to be free from defects in material and workmanship. Liability under this warranty is limited to restoring the instrument to normal operation or replacing the instrument, at the sole discretion of GE Infrastructure Sensing, Inc. Fuses and batteries are specifically excluded from any liability. This warranty is effective from the date of delivery to the original purchaser. If GE Infrastructure Sensing, Inc. determines that the equipment was defective, the warranty period is:

- one year from delivery for electronic or mechanical failures

- one year from delivery for sensor shelf life

If GE Infrastructure Sensing, Inc. determines that the equipment was damaged by misuse, improper installation, the use of unauthorized replacement parts, or operating conditions outside the guidelines specified by GE Infrastructure Sensing, Inc., the repairs are not covered under this warranty.

The warranties set forth herein are exclusive and are in lieu of all other warranties whether statutory, express or implied (including warranties or merchantability and fitness for a particular purpose, and warranties arising from course of dealing or usage or trade).

Return Policy

If a GE Infrastructure Sensing, Inc. instrument malfunctions within the warranty period, the following procedure must be completed:

1. Notify GE Infrastructure Sensing, Inc., giving full details of the problem, and provide the model number and serial number of the instrument. If the nature of the problem indicates the need for factory service, GE Infrastructure Sensing, Inc. will issue a RETURN AUTHORIZATION NUMBER (RAN), and shipping instructions for the return of the instrument to a service center will be provided.

2. If GE Infrastructure Sensing, Inc. instructs you to send your instrument to a service center, it must be shipped prepaid to the authorized repair station indicated in the shipping instructions.

3. Upon receipt, GE Infrastructure Sensing, Inc. will evaluate the instrument to determine the cause of the malfunction.

Then, one of the following courses of action will then be taken:

- If the damage <u>is</u> covered under the terms of the warranty, the instrument will be repaired at no cost to the owner and returned.

- If GE Infrastructure Sensing, Inc. determines that the damage <u>is</u> <u>not</u> covered under the terms of the warranty, or if the warranty has expired, an estimate for the cost of the repairs at standard rates will be provided. Upon receipt of the owner's approval to proceed, the instrument will be repaired and returned.

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Chapter 1

Introduction

The Intelligent RTD Probe is a self-contained precision temperature measuring device, with onboard analog/digital conversion electronics. With this probe, you get a direct digital output of a measured value, which can be displayed on a hand-held or bench top instrument or interfaced to a PC for analysis or plotting. By eliminating the need for separate readout instrumentation and manual conversion calculations, the probe greatly improves measurement accuracy.

Inside the probe, lead wires extend from the platinum sensing element in the tip to the A/D converter in the grip. The converter measures sensor resistance 30 times per second.

The microcomputer takes the resistance measurement, corrects it according to calibration coefficients stored in nonvolatile memory, and converts it to temperature readings.

There is one Intelligent RTD Probe model: the IRTD 400 (X0855), with an operating range of -196°C to 420°C and accuracy of ±0.025°C.

The Intelligent RTD Probe is manufactured and tested with highly sophisticated, automated techniques to provide years of reliable service. The probe is factory calibrated for resistance measurement, using precision resistors, and then independently calibrated for temperature measurement by the comparison method.

Temperature Calibration

Temperature calibration is done according to IPTS-68 (International Practical Temperature Scale of 1968), but built-in conversion firmware lets you read temperature according to:

- IPTS-48

- IPTS-68

- ITS-90 (International Temperature Scale of 1990)

Figure 1-1 below shows an Intelligent RTD Probe used for calibration with a high temperature reference.

Figure 1-1: Intelligent RTD Probe used for Calibration with GE Kaye High Temperature Reference

Communicating with the Probe

The Intelligent RTD Probe has its own operating system and applications program resident in firmware. As soon as power is applied, it runs by itself, ready to send data to a CRT, VDU or computer. You can communicate with the probe using any RS-232C interface device that can send and receive ASCII characters.

With a CRT or VDU, you enter data requests (i.e., commands) one at a time. The probe answers within a few milliseconds.

If you are working with a PC, you can use the software supplied with the probe. This software, which is written in BASIC, lets you display several parameters on screen at once, for example, or plot up to 2750 measurements. *The programs are included only as a convenience, and as samples of the type of program you can write yourself. Warranties are neither expressed nor implied.*

Some commercially available data acquisition programs may look for a transmission terminator character at the end of the probe's reply to a data request. You can use the xt (Write Transmission Terminator) command to append one of nine common transmission terminators (see Chapter 5).

Networking Multiple Probes

The Intelligent RTD Probe's digital communications interface is capable of high-speed multi-drop operation up to 1,000 feet, letting you connect multiple probes to the same 4-wire cable. The cable consists of one ground wire, one power supply wire, and separate wires for communication transmit and receive. It is important to note that the cable does not have to be shielded or twisted. Digital communication noise margin is extremely good since the signal swings by the amount of the power supply. This LAN capability is especially useful in manufacturing and process applications.

PC Network Environment

If your PC is connected to a network, probe operation may be affected adversely. For example, the network controller may interrupt communications by seizing control of your CPU while the probe is sending an answer to a request for data.

Probe Labels

The probe has three separate electronic labels. The first (LB, lb) contains the model and serial number. If it is changed, it will be reset when you send it to the factory or lab for service or recalibration. The calibration label (CL, cl) stores the calibration site and date. The user label (UL, ul) can be programmed with information relevant to your application. For example, you could give a probe the tag "Ice Bath."

About the Manual

Chapter 2 of this *User's Manual* itemizes the accessories shipped with the probe, and tells you how to connect a single, complete Intelligent Probe System and a multiple probe network.

Chapter 3 tells you in a few paragraphs how to set up communications.

Chapter 4 describes the types of probe commands and command format.

Chapter 5 is a Command Dictionary.

Chapter 6 describes the software shipped with the probe.

Chapter 7 is a technical description of the probe design and operation.

Chapter 2

Installation

The probe is carefully packaged to prevent mechanical stress and shock during shipping. Save the packing materials in case you need to ship the instrument for recalibration.

When you remove the probe from its protective packaging, handle it only by the grip. Avoid touching the hollow sheath of the instrument in order to safeguard the sensor at the tip of the sheath. Make sure when you place the probe on the bench that it is secure against accidentally rolling off onto the floor.

Complete Intelligent RTD Probe System

The Intelligent RTD Probe (M2801, shown in Figure 2-1 below) is shipped with utilities software on a 3.5-inch disk, the *User's Manual*, and a Certificate of Calibration. The serial number on the certificate matches the serial number on the red ring at the top of the probe grip.
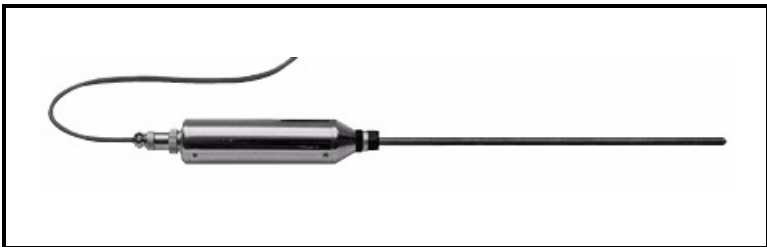
Figure 2-1: M2801 Intelligent RTD Probe

Complete Intelligent RTD Probe System (cont.)

The shipment also includes the following required accessories:

One cable (Model M2810, shown in Figure 2-2 below) to connect the probe to the calibration interface. The cable has a probe connector on one end and an RJ11/4 telephone-type plug on the other. Table 2-1 below shows the cable pin assignments.

Figure 2-2: M2810 Cable

Table 2-1: M2810 Cable Pin Assignments

Conductor	Probe Pin	Signal
Yellow	1	+ DC Voltage
Green	2	Probe Transmit
Red	3	RS-232C Transmit
Black	4	Ground & common

GE Kaye Calibration Interface (Model X1715). The Calibration Interface is used with the Portable Validator and Digi product line.

Note: *If you are using Validator KL or Validator 2000 hardware, do not use the Calibration Interface box; all connections are made at the rear of each unit.*

The Calibration Interface lets you communicate with up to three probes and a high temperature reference on the same COM port. The probes, the power cable and the HTR can be plugged into any of the RJ11 connectors.

Complete Intelligent RTD Probe System (cont.)

Plug your terminal or computer into the PC port on the Calibration Interface. A 9 to 9-pin female RS-232 cable is included with the Calibration Interface.

Note: *Make sure that Pins 1 and 7 on your computer's serial port and your calibration block or salt bath are all properly grounded, otherwise you may get incorrect or erratic readings.*

One AC adapter (**Model M2831** for 110 VAC or **M2835** for 220 VAC).
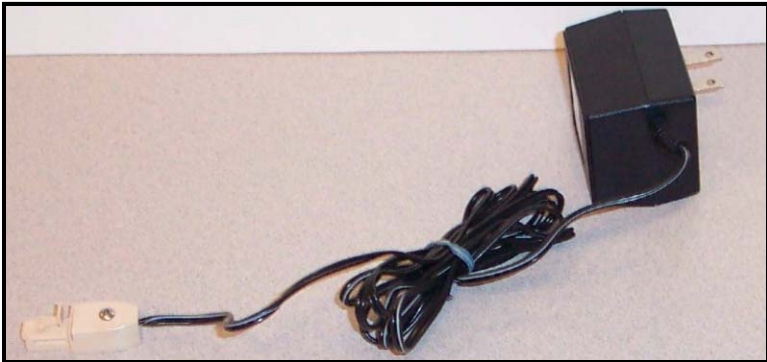
Figure 2-3: M2831 AC Adapter

The AC adapter supplies DC power to the Calibration Interface, and can support up to 4 probes. (To power more than 4 probes in a single network, consult factory.) The power can be unregulated DC in the range from 10 to 25 volts.

Note: *Do not use the AC adapter with the Validator KL or the Validator 2000, damage may result. The power is provided internally.*

Each Intelligent RTD Probe has its own regulated power supply and is protected against spikes and supply reversals. Since each probe consumes only about 650 milliwatts at 10 to 25 volts, and the contact rating of the gold-plated RJ11/4 connectors is 1.5 A, interconnection is safe, reliable and economical.

Complete Intelligent RTD Probe System (cont.)

To communicate with the Intelligent RTD Probe system, you need an RS-232C interface device: a CRT, hand-held terminal, or computer. The device must be able to send and receive ASCII characters.

With a personal computer, you can run the Probe software from DOS or, if you want to modify the programs, from BASIC. The software is supplied in both executable and BASIC file format.

Optional Accessories

To increase the distance between any component of the network, use a 25-foot extension cable (Model M2855) with an RJ11/4 connector on each end, or a 25-foot M2810-25 cable.

Making the Hardware Connections
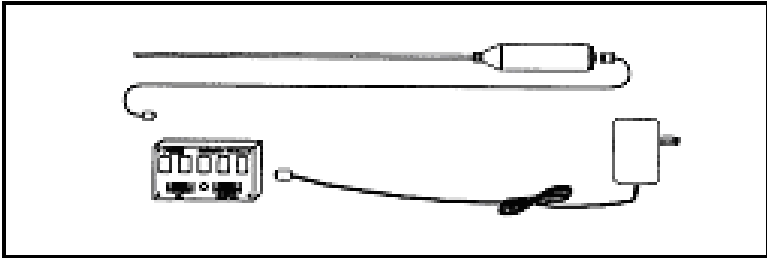
Figure 2-4: Complete Intelligent RTD Probe System

Using Figure 2-4 above as a guide, follow these steps:

1. Attach the cable to the probe.

2. Plug the RJ11 connector on the cable into one of the sockets on the Calibration Interface. Do not use the Calibration Interface box with the Validator KL or the Validator 2000; connections are made at the rear of each unit.

3. Plug the RJ11 connector on the AC adapter cable into an RJ11 socket on the Calibration Interface. Do not use the AC adapter with the Validator KL or the Validator 2000; power is provided internally.

4. If your computer has a 25-pin RS-232 port, attach a 9 to 25-pin adapter to the 9 to 9-pin cable supplied with the Calibration Interface.

5. Connect the Calibration Interface to your computer with the supplied RS-232 cable.

6. Plug the AC adapter into a wall outlet.

7. Turn on your CRT, hand-held terminal or computer.

Note: *To set up a multi-drop network, see Figure 2-5 on the next page.*

Making the Hardware Connections (cont.)
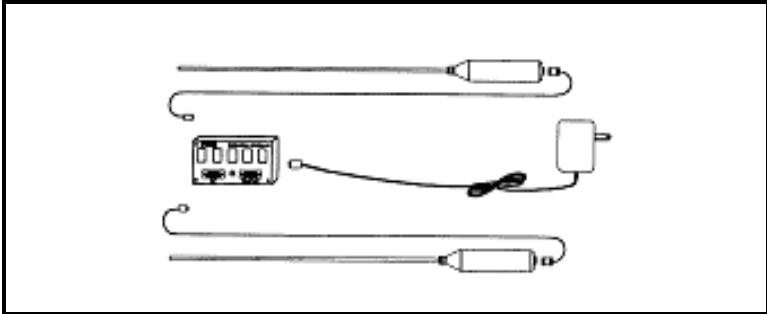
Figure 2-5: Intelligent RTD Probe Multi-drop Network

Caution!
To prevent mechanical shock to the probe when
immersing it in a new temperature environment,
ensure that the immersion process takes place over
a 30-second interval.

Chapter 3

Quick Start

Setting the RS-232C Interface

If you are using a CRT or VDU, follow the manufacturer's instructions to set the baud rate to 9600, the parity to N (none) and the word length to 8 bits. Make sure that a carriage return (CR) character is sent out from your terminal every time you press RETURN or ENTER.

To test the communications link, enter the command:

```
#01VC
```

The temperature of the probe will be displayed on your screen in degrees Celsius. (Commands are explained in detail in Chapter 4.)

Communicating with a Computer

You can run the software supplied with your probe directly from MS-DOS® or, if you want to modify the files, from GW-BASIC®, BASICA or QBASIC™. The programs are written in GW-BASIC and saved as ASCII files.

From DOS:

At the C:> prompt, insert the Intelligent RTD Probe disk in Drive A and enter

```
A:PROBE
```

Communicating with a Computer (cont.)

With GW-BASIC or BASICA:

Load BASIC. At the "OK" prompt, insert the Intelligent RTD Probe disk in Drive A, press F3 (LOAD), and enter:

```
A:PROBE
```

Press F2 (RUN).

With QBASIC:

Load QBASIC. Select **F**ile, then **O**pen. At the prompt, insert the Intelligent RTD Probe disk in Drive A and enter:

```
A:PROBE
```

Press F5 (RUN).

Next, with DOS and all versions of BASIC,

At the Probe Setup screen, follow the prompts to enter the probe baud rate, the port number, and the highest probe address in the network.

At the Probe Menu, select the desired function.

The software is described in detail in Chapter 6.

Chapter 4

Commands

While the Intelligent RTD Probe automatically takes temperature measurements, calibrates them and converts them into the temperature scale you select, you need to send a command in order to get data from the probe.

The master-slave communication protocol between your terminal and the probe prevents the probe from sending data except in response to a command. This protocol lets you connect several probes to one RS-232C device; since each probe has a different address, and every command includes the probe address, there is no conflict in communication.

Types and Classes

There are two types of commands: Read and Write. Read commands get data from the probe, and Write commands send data to the probe. Certain Write commands, such as calibration changes, are password protected. Write commands do not get a response from the probe; you must issue a Read command for the changed parameter in order to check the data.

Commands are divided into three classes: Data, Calibration, and System.

Data Commands

Data commands let you read the sensor temperature, grip temperature, filter amount, filter band, and temperature scale. You can read temperature in °C, °F or K, and the resistance in ohms.

Types and Classes (cont.)

The filter amount, filter band and temperature scale are factory-set to the parameters shown in Table 4-1 below. However, you can write different filter parameters and select another temperature scale.

Table 4-1: Probe Factory Defaults

Parameter	Command	Value
Sensor Filter Amount	FA, fa	8
Sensor Filter Band	FB, fb	100
Temperature Scale	TS, ts	IPTS-68
Sensor R0 (Ohms)	R0, r0	+1.999069E+02
Sensor Alpha	AL, al	+3.853789E-03
Sensor Delta	DE, de	+1.487160E+00
Sensor A4	A4, a4	-7.217805E-05
Sensor C4	C4, c4	+5.748184E-13
A/D R-Span Coefficient	RS, rs	+5.675126E-04
A/D R-Zero Coefficient	RZ, rz	-4.040144E-03
A/D C-Span Coefficient	CS, cs	-2.462295E-04
A/D C-Zero Coefficient	CZ, cz	+1.362949E+02
A/D Temp. Coefficient	TC, tc	+1.148474E-05
A/D Ratio Coefficient	RA, ra	3
Line Frequency (Hz)	LF	60
Probe Address	AD, ad	01
Baud Rate	BR, br	9600
Error Flag	EF	O.K.
Probe Identifier	ID	X2001V3.E
Label	LB, lb	100/60-KI1019
Probe Password (Key)	ky	CODE
Transmission Terminator	XT, xt	0

Note: *Calibration values and label are unique to each probe.*

Calibration Commands

Calibration commands let you read existing calibration data. The factory-set calibration parameters are shown in Table 4-1 on the previous page. The sensor Alpha, Delta, A4 and C4 parameters are based on IPTS-68.

To write new calibration coefficients, you need to include the system password in your command.

System Commands

System commands let you read existing system configuration parameters (probe address, baud rate, etc.) and write new parameters, including a password. The defaults are shown in Table 4-1 on the previous page.

Command Format

All commands start with # (pound sign), followed by the two-digit probe address (01 to 99).

Next comes the two-letter mnemonic for the parameter. For example, VC is the command for reading the Value Celsius of the sensor, and BR is the command for reading the Baud Rate of the probe.

Read commands consist of two upper case letters, while Write commands are two lower case letters. For example, FA is the command for reading the sensor Filter Amount, while fa is the command for writing a new Filter Amount.

Let's look at examples: three classes of Read commands, a Write command and a password-protected Write command.

Read Commands

Read commands get measurement, calibration or system configuration data from the probe.

Format: $\#A_1A_2C_1C_2$

Where:

$\#$ = command lead-in

A_1A_2 = probe address

C_1C_2 = mnemonic for the parameter to be read

Example 1: Read value in °C.

To read the temperature in °C (VC for Value Celsius) from Probe 01, enter:

#01VC

The Intelligent RTD Probe responds with a value, such as:

VC = +22.388

This indicates that the sensor temperature is 22.388°C.

Note: *The response to all Data Read commands is a 12-character string. The first 3 characters are the two upper case letters of the command plus an equal sign (=). The remaining 9 characters indicate the value. A blank is a character.*

Example 2: Read C4 Calibration parameter.

To read the Sensor C4 parameter (C4) from Probe 03, enter:

#03C4

The probe responds with a value, such as:

C4 = +8.690607E-13

Read Commands (cont.)

Note: *The response to all Calibration Read commands is a 16-character string. The first 3 characters are the two upper case letters of the command plus an equal sign (=). The remaining 13 characters indicate the value. A blank is a character.*

Example 3: Read Probe Baud Rate

To read the Baud Rate (BR) at Probe 01, enter:

> #01BR

The probe responds with a value, such as:

> BR = 9600

Note: *The response to all System Configuration Read commands is a 16-character string. The first 3 characters are the two upper case letters of the command plus an equal sign (=). The remaining 13 characters indicate the value. A blank is a character.*

Write Commands

Write commands send system configuration data to nonvolatile memory.

Format: $\#A_1A_2c_1c_2X_1...X_2$

Where:

> $\# =$ command lead-in

> $A_1A_2 =$ probe address

> $c_1c_2 =$ mnemonic for the parameter to be written

> $X_1...X_2 =$ alphanumeric value of the parameter

Write Commands (cont.)

Example 4: Write Temperature Scale selection

To write the Temperature Scale (ts) selection IPTS-68 to Probe 05, enter:

> #05ts68

Subsequent temperature readings from Probe 05 will be calibrated according to IPTS-68. There is no response to this command. You can check it by sending a Read Temperature Scale (TS) command to Probe 05.

Protected Write Commands

All commands that write new calibration data to a probe are protected with a password. You also need the password to change the probe label (for example, to enter a recalibration date) or enter a new password.

The Intelligent RTD Probe's mnemonic for password is "KY" (for Key). The default password is "CODE." You cannot read the password, and you must enter the current password in order to write a new one.

Format: $\#A_1A_2c_1c_2KKKKX_1 \ldots X_2$

Where:

> # = command lead-in
>
> A_1A_2 = probe address
>
> c_1c_2 = mnemonic for the parameter to be written
>
> KKKK = four password (key) characters
>
> $X_1 \ldots X_2$ = value of the parameter

Protected Write Commands (cont.)

For example, to write a calibration value of Alpha (al) to Probe 02, using the default password "CODE," enter:

#02alCODE3.848062E-03

There is no response to a Protected Write command. To verify the parameter, send a Read command for the Alpha parameter (AL) to Probe 02.

If you forget the password, enter the Hex Dump (HD) command and call GE Infrastructure Sensing Customer Service. One of our representatives will unscramble the hex code and tell you the password. Be sure to read the hex code exactly as it appears on your screen, specifying upper and lower case characters.

Entering Commands

To check your command entry for a possible error, enter the Error Flag (EF) command. You get a response of up to 13 characters indicating the type of error. For example, if you enter a Read command in the wrong format, the Error Flag says "INVALID QUERY." Or if you enter the wrong password, the Error Flag says "INVALID KEY."

If you are using the GE Kaye software and you enter an invalid baud rate when you are setting up communications, you get an error message. Just re-enter the correct baud rate.

If you try to enter an out-of-range value, the Intelligent RTD Probe either leaves the existing value or writes the default value. For example, if you try to change the filter amount from 07 to 00, the probe leaves the value at 07.

Some terminals have programmable function keys that let you send an entire command by pressing just one key. If you have this type of terminal, you could program one key with the sensor Value °C command, one with sensor Value °F, and a third with sensor Value Kelvin. Then you can read the temperature in °C, °F or K at the touch of a key.

Chapter 5

Command Dictionary

Table 5-1: Commands and Page References

Parameter	Read (pg)	Write (pg)	Protected Write (pg)
Sensor Value, °C	VC (5-26)		
Sensor Value, °F	VF (5-26)		
Sensor Value, K	VK (5-27)		
Sensor Value, Ohms	VO (5-27)		
Sensor Filter Amount	FA (5-13)	fa (5-13)	
Sensor Filter Band	FB (5-14)	fb (5-14)	
Grip Temperature, °C	GT (5-15)		
Temperature Scale	TS (5-24)	ts (5-24)	
Sensor R0	R0 (5-22)		r0 (5-22)
Sensor Alpha	AL (5-3)		al (5-4)
Sensor Delta	DE (5-10)		de (5-11)
Sensor A4	A4 (5-4)		a4 (5-5)
Sensor C4	C4 (5-9)		c4 (5-10)
A/D RSPAN	RS (5-20)		rs (5-20)
A/D RZERO	RZ (5-21)		rz (5-21)
A/D CSPAN	CS (5-7)		cs (5-8)
A/D CZERO	CZ (5-8)		cz (5-9)
A/D TC	TC (5-23)		tc (5-23)
A/D RATIO	RA (5-19)		ra (5-19)
Line Frequency	LF (5-18)		

Table 5-1: Commands and Page References (Continued)

Parameter	Read (pg)	Write (pg)	Protected Write (pg)
Address	AD (5-2)	ad (5-3)	
Baud Rate	BR (5-5)	br (5-6)	
Identity	ID (5-16)		
Label	LB (5-17)		lb (5-17)
Calibration Label	CL (5-6)		cl (5-7)
User Label	UL (5-25)		ul (5-25)
Transmission Terminator	XT (5-28)		xt (5-29)
Error Flag	EF (5-12)		
Hex Dump	HD (5-15)		
Key (Password)			ky (5-16)

AD: Read Probe Address

Format: $\#A_1A_2AD$

Where:

> \# = command lead-in
> A_1A_2 = probe address 01-99
> AD = command for reading the probe address

For example, to read (verify) the address at Probe 04, enter:
> #04AD

The RTD Intelligent Probe responds with a value, such as:
> AD = 04

Command Dictionary

ad: Write Probe Address

Format: #A_1A_2adNN

Where:

> # = command lead-in
> A_1A_2 = probe address 01-99
> ad = command for writing an address to the probe
> NN = Two digit address 01-99

For example, to write the address 78 to Probe 41, enter:
> #41ad78

Note: *When you write a new address to a probe, be sure to change the address in your software programs. Otherwise, you will not be able to communicate with the probe.*

AL: Read Sensor Alpha Calibration Value

Format: #A_1A_2AL

Where:

> # = command lead-in
> A_1A_2 = probe address 01-99
> AL = command for reading the Alpha calibration value

For example, to read the Alpha calibration value at Probe 43, enter:
> #43AL

The RTD Intelligent Probe responds with a value, such as:
> AL = +3.920145E-03

al: Write Sensor Alpha Calibration Value (Password Protected)

Format: $\#A_1A_2alKKKKsNdNNNNNNEsNN$

Where:

> $\#$ = command lead-in
> A_1A_2 = probe address 01-99
> al = command for writing the Alpha calibration value
> KKKK = password
> sNdNNNNNNEsNN = value of Alpha in scientific
> notation where:
> > s = sign (+ or -)
> > N = numeral 0-9
> > d = decimal point

For example, to write the Alpha calibration value 0.003920145 to Probe 21, enter:
> #21alCODE+3.920145E-03

A4: Read Sensor A4 Calibration Value

Format: $\#A_1A_2A4$

Where:

> $\#$ = command lead-in
> A_1A_2 = probe address 01-99
> A4 = command for reading the sensor A4 calibration value

For example, to read the A4 calibration value from Probe 43, enter:
> #43A4

The RTD Intelligent Probe responds with a value, such as:
> A4 = -3.866756E-05

a4: Write Sensor A4 Calibration Value (Password Protected)

Format: #A$_1$A$_2$a4KKKKsNdNNNNNNNEsNN

Where:

>   # = command lead-in
>   A$_1$A$_2$ = probe address 01-99
>   a4 = command for writing a new A4 calibration
>   parameter to the sensor
>   KKKK = password
>   sNdNNNNNNNEsNN = value of A4 in scientific notation
>   where:
>   s = sign (+ or -)
>   N = numeral 0-9
>   d = decimal point

For example, to write the A4 calibration value -0.00003866756 to Probe 08, enter:
      #08a4CODE-3.866756E-05

The password is "CODE." There is no response to this command.

BR: Read Probe Baud Rate

Format: #A$_1$A$_2$BR

Where:
>   # = command lead-in
>   A$_1$A$_2$ = probe address 01-99
>   BR = command for reading the probe baud rate

For example, to read the baud rate of Probe 03, enter:
      #03BR

The RTD Intelligent Probe responds with a value, such as:
      BR = 9600

br: Write Probe Baud Rate

Format: #A_1A_2brNNNN

Where:

> # = command lead-in
> A_1A_2 = probe address 01-99
> br = command for writing the baud rate to the probe
> NNNN = four digit baud rate: 9600, 4800, 2400, 1200, 0600 or 0300

For example, to write a baud rate of 2400 to Probe 53, enter:
    #53br2400

Note: *When you write a new baud rate to a probe, be sure to change the baud rate at the terminal or computer. Otherwise, you will not be able to communicate with the probe.*

CL: Read Calibration Label

Format: #A_1A_2CL

Where:
> # = command lead-in
> A_1A_2 = probe address 01-99
> CL = command for reading the probe calibration label. By default, this label shows the calibration lab and date of calibration.

For example, to read the calibration label at Probe 02, enter:
    #02CL

The RTD Intelligent Probe responds with a value, such as:
    CL=XSYS20-OCT-93

cl: Write Calibration Label (Password Protected)

Format: $\#A_1A_2clKKKKC_1 \ldots C_{13}$

Where:

> $\#$ = command lead-in
> A_1A_2 = probe address 01-99
> cl = command for writing a calibration label to the probe
> KKKK = password
> $C_1 \ldots C_{13}$ = up to 13 alphanumeric characters

Caution!
Do not use the "#" character in your label.

For example, to write the calibration label ABCD15-NOV-93 to Probe 38, enter:
> #38clCODEABCD15-NOV-93

The password is "CODE."

CS: Read A/D CSpan Calibration Value

Format: $\#A_1A_2CS$

Where:
> $\#$ = command lead-in
> A_1A_2 = probe address 01-99
> CS = command for reading the A/D CSpan calibration value

For example, to read the A/D CSpan calibration value from Probe 02, enter:
> #02CS

The RTD Intelligent Probe responds with a value, such as:
> CS = -2.810012E-04

cs: Write A/D CSpan Calibration Value (Password Protected)

Format: #A_1A_2csKKKKsNdNNNNNNEsNN

Where:

> \# = command lead-in
> A_1A_2 = probe address 01-99
> cs = command for writing an A/D CSpan calibration value to the probe
> KKKK= password
> sNdNNNNNNEsNN=value of CSpan in scientific notation where:
> > s = sign (+ or -)
> > N = numeral 0-9
> > d = decimal point

For example, to write the A/D CSpan calibration value -0.0002810012 to Probe 02, enter:
> #02csCODE-2.810012E-04

The password is "CODE." There is no response to this command.

CZ: Read A/D CZero Calibration Value

Format: #A_1A_2CZ

Where:

> \# = command lead-in
> A_1A_2 = probe address 01-99
> CZ = command for reading the A/D CZero calibration value

For example, to read the A/D CZero calibration value from Probe 04, enter:
> #04CZ

The RTD Intelligent Probe responds with a value, such as:
> CZ = +1.719167E+02

cz: Write A/D CZero Calibration Value (Password Protected)

Format: #A_1A_2czKKKKsNdNNNNNNEsNN

Where:
    # = command lead-in
    A_1A_2 = probe address 01-99
    cz = command for writing an A/D CZero calibration value to the probe
    KKKK = password
    sNdNNNNNNEsNN = value of CZero in scientific notation where:
        s = sign (+ or -)
        N = numeral 0-9
        d = decimal point

For example, to write the A/D CZero calibration value +171.9167 to Probe 18, enter:
    #18czCODE+1.719167E+02

The password is "CODE." There is no response to this command.

C4: Read Sensor C4 Calibration Value

Format: #A_1A_2C4

Where:
    # = command lead-in
    A_1A_2 = probe address 01-99
    C4 = command for reading the sensor C4 calibration value

For example, to read the C4 calibration value from Probe 03, enter:
    #03C4

The RTD Intelligent Probe responds with a value, such as:
    C4 = -2.712589E-12

c4: Write Sensor C4 Calibration Value (Password Protected)

Format: $\#A_1A_2$c4KKKKsNdNNNNNNEsNN

Where:

      # = command lead-in
      A_1A_2 = probe address 01-99
      c4 = command for writing a new sensor C4 calibration value to the sensor
      KKKK = password
      sNdNNNNNNEsNN = value of C4 in scientific notation where:

          s = sign (+ or -)
          N = numeral 0-9
          d = decimal point

For example, to write the C4 calibration value -0.000000000002712589 to Probe 03, enter:
      #03c4CODE-2.712589E-12

The password is "CODE." There is no response to this command.

DE: Read Sensor Delta Calibration Value

Format: $\#A_1A_2$DE

Where:

      # = command lead-in
      A_1A_2 = probe address 01-99
      DE = command for reading the Delta calibration value of the sensor

For example, to read the Delta calibration value from Probe 15, enter:
      #15DE

The RTD Intelligent Probe responds with a value, such as:
      DE = +1.435356E+00

de: Write Delta Calibration Value (Password Protected)

Format: #A_1A_2deKKKKsNdNNNNNNEsNN

Where:

> \# = command lead-in
> A_1A_2 = probe address 01-99
> de = command for writing a new Delta calibration value
> to the sensor
> KKKK = password
> sNdNNNNNNEsNN = value of Delta in scientific
> notation where:
> > s = sign (+ or -)
> > N= numeral 0-9
> > d = decimal point

For example, to write the Delta calibration value 1.435456 to Probe 15, enter:
> #15deCODE+1.435456E+00

The password is "CODE." There is no response to this command.

EF: Read Error Flag

Format: $\#A_1A_2EF$

Where:

 # = command lead-in
 A_1A_2 = probe address 01-99
 EF = command for reading the Error Flag at the probe

For example, to read the Error Flag at Probe 56, enter:
 #56EF

Possible responses are:

	Condition
`EF=O.K.`	No error
`EF=INVALID COMMD`	Incorrect command
`EF=INVALID ENTRY`	Parameter out of range
`EF=INVALID QUERY`	Incorrect Read command
`EF=INVALID KEY`	Wrong password (key)
`EF=!!HI LIMIT!!`	Reading overrange
`EF=!!LOW LIMIT!!`	Reading underrange
`EF=*RAM ERROR`	System RAM error
`EF=*EEPROM ERROR`	System EEPROM error

FA: Read Sensor Filter Amount

Format: #A_1A_2FA

Where:

> \# = command lead-in
>
> A_1A_2 = probe address 01-99
>
> FA = command for reading filter amount (filter coefficient) applied to all sensor readings: VC, VF, VK, VO

For example, to read the filter amount at Probe 04, enter:

> #04FA

The RTD Intelligent Probe responds with a value, such as:

> FA =   9

fa: Write Sensor Filter Amount

Format: #A_1A_2faNN

Where:

> \# = command lead-in
>
> A_1A_2 = probe address 01-99
>
> fa = command for writing a new filter amount
>
> NN = two digits 01-13 representing filter amount, where:

01 = 1 (off)	08 = 128
02 = 2	09 = 256
03 = 4	10 = 512
04 = 8	11 = 1024
05 = 16	12 = 2048
06 = 32	13 = 4096
07 = 64	

For example, to write a filter amount of 6 to Probe 03, enter:

> #03fa06

The value at Probe 3 is then filtered to 1/32 of the current reading.

FB: Read Sensor Filter Band

Format: #A_1A_2FB

Where:

> \# = command lead-in
> A_1A_2 = probe address 01-99
> FB = command for reading the width of the filter band
> applied to all sensor readings: VC, VF, VK, VO

For example, to read the filter band at Probe 07, enter:
> #07FB

The RTD Intelligent Probe responds with a value, such as:
> FB =   50

fb: Write Sensor Filter Band

Format: #A_1A_2fbNNNN

Where:

> \# = command lead-in
> A_1A_2 = probe address 01-99
> fb = command for writing a new filter band in mK
> NNNN = four digits 0000-9999 representing the width of
> the filter band

For example, to write a 50mK filter band to Probe 14, enter:
> #14fb0050

If a reading is outside the filter band, no filtering takes place; if a reading is within the band, the value is filtered by the amount selected with the fa command. Note that when a temperature is rising or dropping rapidly, your readings may jump outside the band. Filtering automatically stops, the new instantaneous value is recorded, and the temperature plot displays a staircase pattern. To prevent this from happening, decrease the filter amount.

GT: Read Probe Grip Temperature

Format: $\#A_1A_2GT$

Where:

$\#$ = command lead-in

A_1A_2 = probe address 01-99

GT = command for reading the grip temperature in °C

For example, to read the grip temperature at Probe 15, enter:
    #15GT

The RTD Intelligent Probe responds with a value, such as:
    GT = 27.1

The grip temperature can range from 0-60°C.

The Read Grip Temperature command is useful in high temperature ambient environments. The reading is used internally to compensate for the temperature coefficient of the A/D converter.

HD: Read Hex Dump

Format: $\#A_1A_2HD$

Where:

$\#$ = command lead-in

A_1A_2 = probe address 01-99

HD = command for reading area of non-volatile memory of probe

For example, to initiate a hex dump at Probe 05, enter:
    #05HD

The RTD Intelligent Probe responds with a value, such as:
    HD=JV=hIZ01jTC=p

Use this command if you forget your password. Call the factory and read the response to a Customer Service representative, who will descramble the hex code for you. Be sure to note whether characters are upper or lower case.

ID: Read Probe Identity

Format: #A_1A_2ID

Where:

> # = command lead-in
> A_1A_2 = probe address 01-99
> ID = command for reading probe identity, which includes the software revision level

For example, to read the identity of Probe 09, enter:
> #09ID

The RTD Intelligent Probe responds with a value, such as:
> ID =   X2001V3.E

ky: Write Probe Key (Password Protected Command)

Format: #A_1A_2kyKKKKCCCC

Where:

> # = command lead-in
> A_1A_2 = probe address 01-99
> ky = command for writing new key (password) to probe
> KKKK = current password
> CCCC = new 4-digit password

Caution!
Do not use the character "#" in your password.

For example, to write the key (password) "Mary" to Probe 02, enter:
> #02kyCODEMary

"CODE" is the old password, which is deleted.

You cannot read the password. If you forget it, issue the Hex Dump command and call GE Infrastructure Sensing Customer Service for assistance in descrambling the code.

LB: Read Probe Label

Format: $\#A_1A_2LB$

Where:

$\# $ = command lead-in
A_1A_2 = probe address 01-99
LB = command for reading the probe label. By default, the label shows the model and serial number.

For example, to read the label at Probe 02, enter:
#02LB

The RTD Intelligent Probe responds with a value, such as:
LB = KL25/60-30123

This is a sample model and serial number.

lb: Write Probe Label (Password Protected)

Format: $\#A_1A_2lbKKKKC_1 \ldots C_{13}$

Where:

$\# $ = command lead-in
A_1A_2 = probe address 01-99
lb = command for writing a label to the probe
KKKK = password
C1 . . . C13 = up to 13 alphanumeric characters

Caution!
Do not use the "#" character in your label.

If you write a different label to the probe, the original model and serial number will be reset when the probe is returned to the factory for service or recalibration. To give the probe a tag, use the **ul** (Write User Label) command.

LF: Read Line Frequency Calibration Value

The line frequency of the probe is factory set at 60 Hz.

Caution!
Do not change this setting, or you will invalidate the calibration. Operating the probe at a 60 Hz setting in a 50 Hz environment will not cause errors.

Format: $\#A_1A_2LF$

Where:

$\#$ = command lead-in

A_1A_2 = probe address 01-99

LF = command for reading the Line Frequency calibration value

For example, to read the Line Frequency calibration value at Probe 34, enter:

#34LF

The RTD Intelligent Probe responds:

LF = 60

RA: Read A/D Ratio Calibration Value

Format: $\#A_1A_2RA$

Where:

> $\#$ = command lead-in
> A_1A_2 = probe address 01-99
> RA = command for reading the A/D Ratio calibration value

For example, to read the A/D Ratio calibration value from Probe 03, enter:

> $\#03RA$

The RTD Intelligent Probe responds with a value, such as
> RA =   12

This means that there are 12 A/D sensor measurement cycles for each A/D autocalibration cycle.

ra: Write A/D Ratio Calibration Value (Password Protected)

Format: $\#A_1A_2raKKKKNN$

Where:

> $\#$ = command lead-in
> A_1A_2 = probe address 01-99
> ra = command for writing a new A/D Ratio calibration value
> KKKK = password
> NN = value 01-99 specifying the number of A/D sensor measurement cycles before an A/D autocalibration cycle

For example, to write an A/D Ratio calibration value of 12 to Probe 05, enter:

> $\#5raCODE12$

The password is "CODE." There is no response to this command.

RS: Read A/D RSpan Calibration Value

Format: #A_1A_2RS

Where:

> \# = command lead-in
> A_1A_2 = probe address 01-99
> RS = command for reading the A/D RSpan calibration value

For example, to read the A/D RSpan calibration value from Probe 13, enter:

> #13RS

The RTD Intelligent Probe responds with a value, such as:

> RS = +6.749778E-04

rs: Write A/D RSpan Calibration Value (Password Protected)

Format: #A_1A_2rsKKKKsNdNNNNNNEsNN

Where:

> \# = command lead-in
> A_1A_2 = probe address 01-99
> rs = command for writing a new A/D RSpan value
> KKKK = password
> sNdNNNNNNEsNN = value of RSpan in scientific notation where:
> > s = sign (+ or -)
> > N = numeral 0-9
> > d = decimal point

For example, to write the RSpan calibration value 0.0006749778 to Probe 06, enter:

> #06rsCODE+6.749778E-04

The password is "CODE." There is no response to this command.

RZ: Read A/D RZero Calibration Value

Format: #A_1A_2RZ

Where:

$#$ = command lead-in
A_1A_2 = probe address 01-99
RZ = command for reading the A/D RZero calibration value

For example, to read the A/D RZero calibration value from Probe 13, enter:
#13RZ

The RTD Intelligent Probe responds with a value, such as:
RZ = -2.211312E-02

rz: Write A/D RZero Calibration Value (Password Protected)

Format: #A_1A_2rzKKKKsNdNNNNNNEsNN

Where:

$#$ = command lead-in
A_1A_2 = probe address 01-99
rz = command for writing a new A/D RZero value
KKKK = password
sNdNNNNNNEsNN = value of RZero in scientific notation where:
s = sign (+ or -)
N = numeral 0-9
d = decimal point

For example, to write the RZero calibration value -0.02211312 to Probe 06, enter:
#06rzCODE-2.211312E-02

The password is "CODE." There is no response to this command.

R0: Read Sensor R0 Calibration Value

Format: $\#A_1A_2R0$

Where:

> $\#$ = command lead-in
> A_1A_2 = probe address 01-99
> R0 = command for reading the sensor R0 calibration
> value

For example, to read the sensor R0 calibration value from Probe 04, enter:
> #04R0

The RTD Intelligent Probe responds with a value, such as:
> R0 = +1.001267E+02

r0: Write Sensor R0 Calibration Value (Password Protected)

Format: $\#A_1A_2r0KKKKsNdNNNNNNEsNN$

Where:

> $\#$ = command lead-in
> A_1A_2 = probe address 01-99
> r0 = command for writing a new sensor R0 value
> KKKK = password
> sNdNNNNNNEsNN = value of R0 in scientific notation
> where:
> > s = sign (+ or -)
> > N = numeral 0-9
> > d = decimal point

For example, to write the R0 calibration value 100.1267 to Probe 04, enter:
> #04r0CODE+1.001267E+02

The password is "CODE." There is no response to this command.

TC: Read A/D TC Calibration Value

Format: $\#A_1A_2TC$

Where:

> $\#$ = command lead-in
> A_1A_2 = probe address 01-99
> TC = command for reading the A/D TC calibration value

For example, to read the A/D TC calibration value from Probe 17, enter:
> #17TC

The RTD Intelligent Probe responds with a value, such as:
> TC = +1.256723E-05

tc: Write A/D TC Calibration Value (Password Protected)

Format: $\#A_1A_2tcKKKKsNdNNNNNNEsNN$

Where:

> $\#$ = command lead-in
> A_1A_2 = probe address 01-99
> tc = command for writing a new A/D TC calibration value
> KKKK = password
> sNdNNNNNNEsNN = value of A/D TC in scientific notation where:
>> s = sign (+ or -)
>> N = numeral 0-9
>> d = decimal point

For example, to write the A/D TC calibration value 0.00001256723 to Probe 19, enter:
> #19tcCODE+1.256723E-05

The password is "CODE." There is no response to this command.

TS: Read Temperature Scale

Format: $\#A_1A_2TS$

Where:

      # = command lead-in
      A_1A_2 = probe address 01-99
      TS = command for reading the Temperature Scale

For example, to read the Temperature Scale at Probe 03, enter:
      #03TS

The RTD Intelligent Probe responds with a value, such as:
      TS =   IPTS-68

ts: Write Temperature Scale

Format: $\#A_1A_2tsNN$

Where:

      # = command lead-in
      A_1A_2 = probe address 01-99
      ts = command for writing the temperature scale to the
      probe
      NN = two digits representing temperature scale:
      48 = IPTS-48
      68 = IPTS-68
      90 = TS-90

For example, to write the IPTS-68 Temperature Scale to Probe 41, enter:
      #41ts68

Subsequent temperature readings (°C, °F or K) will be calibrated according to the selected temperature scale.

UL: Read User Label

Format: #A_1A_2UL

Where:

> \# = command lead-in
> A_1A_2 = probe address 01-99
> UL = command for reading the probe user label. You can enter any information that is relevant to your application.

For example, to read the user label at Probe 02, enter:
>   #02UL

The RTD Intelligent Probe responds with a value, such as:
>   UL = TestProbe123

ul: Write User Label (Password Protected)

Format: #A_1A_2ulKKKK$C_1 \ldots C_{13}$

Where:

> \# = command lead-in
> A_1A_2 = probe address 01-99
> ul = command for writing a user label to the probe
> KKKK = password
> $C_1 \ldots C_{13}$ = up to 13 alphanumeric characters

Caution!
Do not use the "#" character in your user label.

For example, to write the user label TestProbe123 to Probe 38, enter:
>   #38ulCODETestProbe123

The password is "CODE."

VC: Read Sensor Value °C

Format: $\#A_1A_2VC$

Where:

> \# = command lead-in
> A_1A_2 = probe address 01-99
> VC = command for reading the sensor Value in °C

For example, to read the sensor Value in °C at Probe 35, enter:
> #35VC

The RTD Intelligent Probe responds with a value, such as:
> VC = +320.138

VF: Read Sensor Value °F

Format: $\#A_1A_2VF$

Where:

> \# = command lead-in
> A_1A_2 = probe address 01-99
> VF = command for reading the sensor Value in °F

For example, to read the sensor Value in °F at Probe 62, enter:
> #62VF

The RTD Intelligent Probe responds with a value, such as:
> VF = -157.375

VK: Read Sensor Value, Kelvin

Format: #A$_1$A$_2$VK

Where:

    # = command lead-in
    A$_1$A$_2$ = probe address 01-99
    VK = command for reading the sensor Value in Kelvins

For example, to read the sensor Value in Kelvins at Probe 99, enter:

    #99VK

The RTD Intelligent Probe responds with a value, such as:

    VK = +119.876

VO: Read Sensor Value, Ohms

Format: #A$_1$A$_2$VO

Where:

    # = command lead-in
    A$_1$A$_2$ = probe address 01-99
    VO = command for reading the sensor resistance in ohms

For example, to read the sensor resistance value in ohms at Probe 35, enter:

    #35VO

The RTD Intelligent Probe responds with a value, such as:

    VO = +250.2745

XT: Read Transmission Terminator Character

Format: #A_1A_2XT

Where:

> # = command lead-in
> A_1A_2 = probe address 01-99
> XT = command for reading the transmission terminator
> character. By default, the terminator character is 0,
> indicating that the probe will transmit its responses
> without a terminating character.

For example, to read the transmission terminator character at
Probe 02, enter:
> #02XT

The RTD Intelligent Probe responds with a value, such as:
> XT=ASCII(DEC: 0)

xt: Write Transmission Terminator (Password Protected)

Format: $\#A_1A_2xtKKKKC_1C_2$

Where:

> $\#$ = command lead-in
> A_1A_2 = probe address 01-99
> xt = command for writing a transmission terminator character to the probe
> KKKK = password
> C_1C_2 = 2-digit transmission character

For example, to write the transmission terminator "Carriage Return" to Probe 38, enter:
> #38xtCODE13

The allowable terminator characters are:

00	None	03	ETX	04	EOT	09	Tab	10	LF
13	CR	23	ETB	30	RS	44	Comma	59	Semicolon

All probes on a network must have the same transmission terminator. If you have a mixture of new (after August 1993) and older models, set terminator for the new models to 0.

Chapter 6

Software Utilities

The software programs supplied with your probe let you display
probe parameters on screen in text or graphic form, and handle all
probe functions, including recalibration. The programs are called
PROBE and CPROBE. CPROBE is identical to PROBE, except
that it is in color.

The Intelligent RTD Probe disk has two versions of each
program, an executable file and a GW-BASIC file saved in
ASCII format. You can run the programs from DOS or, if you
want to modify the files to suit your own requirements, from GW-
BASIC, BASICA or QBASIC.

The software is shipped in 3.5-inch disk format. The programs
are not copy protected. They are provided as a convenience for
customers; warranties are neither expressed nor implied. You
may prefer to write your own programs.

Running The Software

From DOS:

1. At the C:> prompt, insert the Intelligent RTD Probe disk in a
   floppy drive.

2. Enter the drive and the program name. For example,
   A: PROBE

The Probe Setup screen appears.

With GW-BASIC or BASICA:

1. Load BASIC. At the OK prompt, insert the Intelligent RTD
   Probe disk in a floppy drive, press F3 (LOAD), and enter the
   drive and the program name. For example,
   A: PROBE

2. At the OK prompt, press F2 (RUN) for the Probe Setup
   screen.

With QBASIC:

1. Load QBASIC. Press Alt-F for **F**ile, then select **O**pen. At the
   File Name prompt, insert the Intelligent RTD Probe disk in a
   floppy drive and enter the drive and the program name. For
   example,
   A: PROBE

2. Press F5 (RUN) for the Probe Setup screen.

The PROBE Program

At the Setup screen (shown in Figure 6-1 below), follow the
prompts to enter the probe baud rate, the port number, and the
highest probe address in the network.
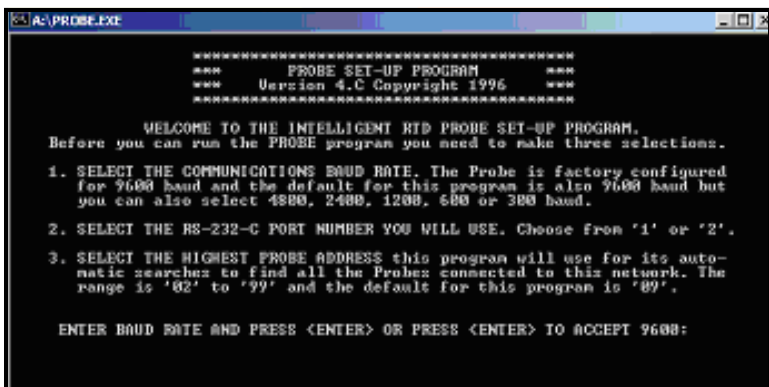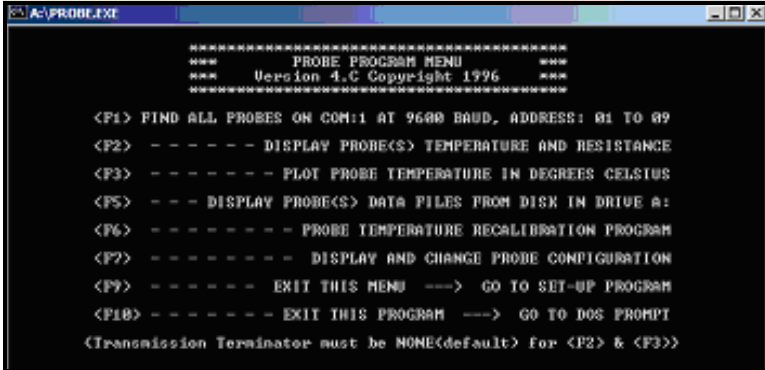
Figure 6-1: PROBE Setup Screen

Note: *These parameters apply to the entire probe network.*

The PROBE Program (cont.)

At the Probe Program Menu (shown in Figure 6-2 below), select functions with F1 through F7.

Figure 6-2: PROBE Program Menu

If you are running the program from BASIC, press CTRL-BREAK to stop. To restart, press F2 (GW-BASIC and BASICA) or F5 (QBASIC).

The functions are explained below.

F1 - Identify Probes

The F1 selection (shown in Figure 6-3 below) finds the address and software version of all probes in the network at the baud rate you selected and up to the highest address you selected. Press F10 to return to the menu.

Figure 6-3: PROBE Identification Screen

F2 - Display Temperature and Resistance

This selection (shown in Figure 6-4 below) lets you monitor multiple probes. It automatically finds up to 10 probes, numbers them sequentially with the lowest address becoming Probe 1, and displays addresses, labels, temperature in °C and °F and resistance.

Figure 6-4: PROBE Data Display Screen

Press F1 through F6 to write the displayed data to Drive A for later retrieval and analysis. F1 writes data to File #1, F2 writes data to File #2, and so on.

Note: *You must press* all *the function keys F1 - F6 in order to set up six files on the Drive A disk, even though some of the files may be unnecessary. Otherwise, when you try to retrieve the files, you will get the error message, "Cannot find end of files."*

These data files can be used in the calibration program if at least one of the probes is a calibrated reference probe. All probes must be immersed in the same medium.

Press F10 to return to the menu.

F3 - Plot Temperature

This function (illustrated in Figure 6-5 below) plots real time probe output in °C with a resolution of 0.001°C to 1°C. It plots 5 lines of 550 data points each, then clears the screen and repeats. The value of the Y coordinate (plot line) is determined by the value of the first data point on the line. The Y scale is the selected resolution.
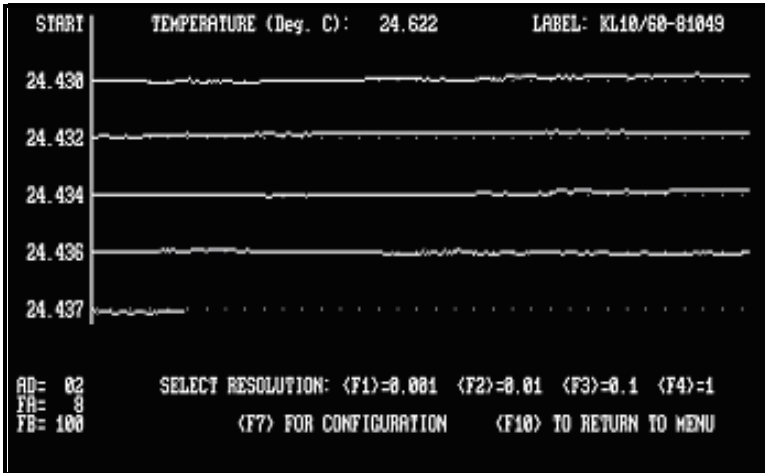
Figure 6-5: Typical Temperature Plot

The screen also displays the probe label, address, filter amount and filter band. You can reset the resolution at any time with F1, F2, F3 or F4.

Press F10 to return to the menu.

F5 - Display Data Files

This function reads six data files from the disk in Drive A into memory and displays File #1 on screen. To view one of the other files, press F2 to F6.

Each data file is identified by number (1-6), date and time the data was recorded, unit number of the probe in the sequence in which it was automatically located on the network, label, temperature in °C and °F, and sensor resistance.

F5 - Display Data Files (cont.)

From a data file display, press F9 to return to the Probe Temperature and Resistance display (F2 selection on the main menu). Here you can update (rewrite) the files. Press F9 at the Probe Temperature and Resistance display to view the updated data files.

To print a data file, press PRINT SCREEN. To exit, press F10.

F6 - Temperature Recalibration

Use this function to find the IPTS-68 coefficients R0, Alpha, Delta, A4 and C4 for recalibrating your probe.

The function requires four IPTS-68 or ITS-90 reference temperatures, one below 0°C, together with four sensor resistance readings from your probe. It then computes and displays the probe's coefficients. This function does not communicate with the probe; to write the coefficients to the probe, select F7 - Display and Change Probe Configuration.

At the prompt, key in the below 0°C reference temperature, a comma, and the corresponding probe resistance reading. Press ENTER. Follow the prompts to enter the remaining sets of data.

Check your entries for accuracy and correct any errors before you press ENTER. If you make an incorrect entry, exit PROBE. Reload and run the program, select Temperature Recalibration again and enter the correct value.

F7 - Display and Change Configuration

This function (shown in Figure 6-6 on the next page) displays all probe data in real time on your screen. It continually updates the screen as fast as your computer processes the data from the probe.

To change any parameter, press F1 and enter a Write command, using the command formats in Chapter 5 without the pound sign (#) and probe address.

F7 - Display and Change Configuration (cont.)

Figure 6-6: Configuration Display Screen

This function lets you communicate continuously with the probe even after you change the probe address. However, it cannot continue communicating once you change the probe baud rate, because this change affects the entire network.

After you change the baud rate, stop the program. Go to the Setup screen and change the baud rate for the probe network. Press <F7> to return to this function.

CPROBE

CPROBE is identical to PROBE except that it is in color. It has a blue background and yellow foreground. The temperature and resistance plots are in high intensity white.

The program requires a Screen 9 mode capability and runs in color on VGA adapters at a 640 x 350 pixel resolution.

Writing Your Own Programs

If you write your own BASIC programs, remember to:

- Send a carriage return after each command.

- Allow adequate time (about 300 ms) for the EEPROM write cycle and automatic reload, so that under computer controlled downloading, you are not sending Write commands too rapidly.

- Build in a delay after each command, to allow the probe to respond.

The responses to all Data Read commands are 12 characters; responses to Calibration and System Read commands are 16 characters. You can easily parse these strings with BASIC commands.

Chapter 7

Technical Description

The Intelligent RTD Probe's very high precision, wirewound platinum temperature sensing element is in the tip of the 18" stem, as shown in Figure 7-1 on the next page. Wires lead from the element to the grip, where they connect to the A/D converter.

The resistance of the element is a nonlinear function of temperature. This resistance is measured by monitoring the voltage drop across the element with a 4-wire ratiometric Kelvin sensing configuration.

Electronic Circuitry

The A/D converter is designed to allow direct interfacing to the sensing element without prior signal conditioning or amplification. The converter, a high-speed, ratiometric offset dual-slope design, resolves the resistance of the temperature sensing element to better than the equivalent of 0.001°C more than 30 times per second over a range of -200°C to 600°C. Controlled by the microcomputer, the converter is corrected for its own long-term zero drift, measures its own ambient temperature, and corrects itself for its own temperature-induced zero and span drift. Additionally, the converter corrects itself for any linearity errors.

The microcomputer consists of a CPU, RAM, ROM, EEPROM and an application-specific integrated circuit (ASIC) that interfaces the CPU to the A/D converter. All calibration data and characteristic coefficients of the sensing element, together with the probe's address and communication parameters, are stored in nonvolatile EEPROM. Certain sections of this memory require a password, ensuring security of calibration constants and other parameters.

Connector for digital
communication and power

A/D circuit board
with power supply

Microcomputer
circuit board
with ASIC

Inconel
sheath

Temperature
sensing
element
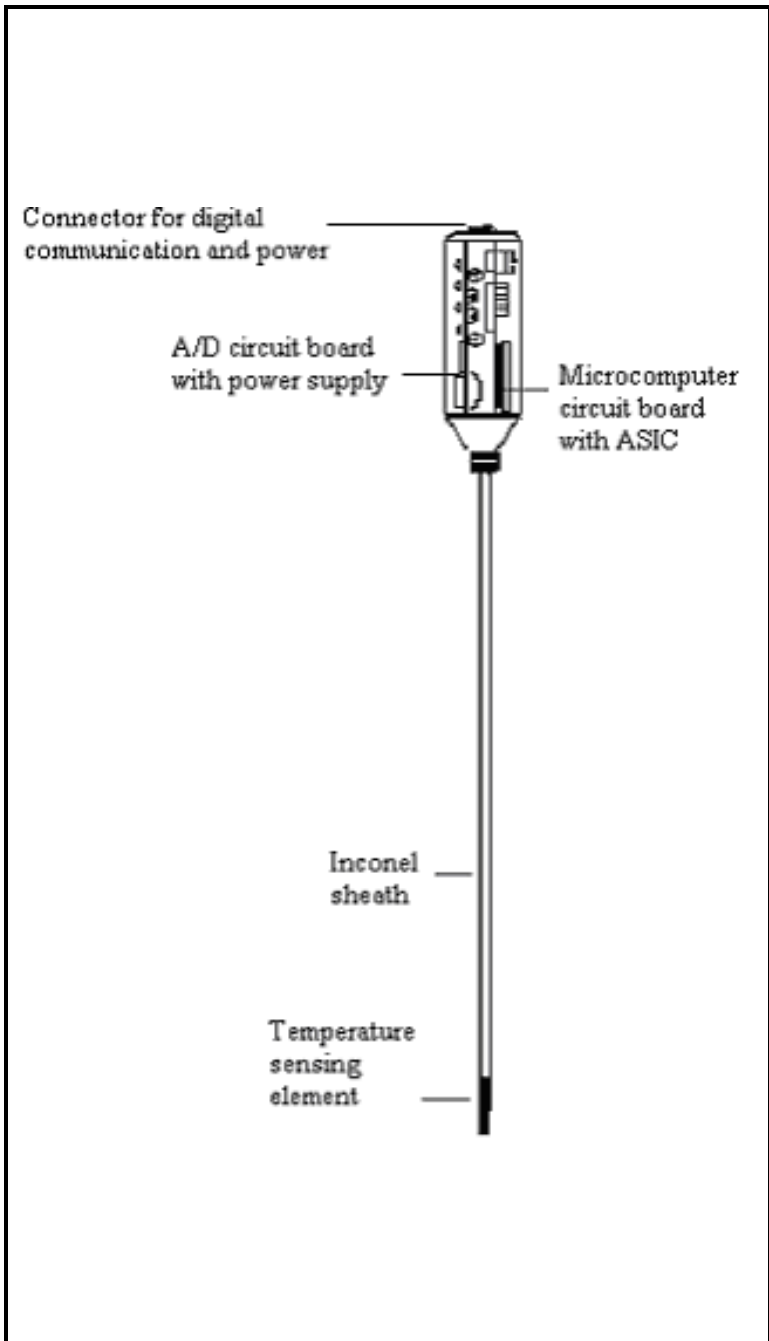
Figure 7-1: Intelligent RTD Probe Sectional View

Electronic Circuitry (cont.)

The analog and digital electronic circuitry requires very low power, which is provided by a switching regulator power supply in the grip. This means that the probe can be used with inexpensive, wall-mounted AC power supplies that do not need highly filtered or regulated outputs. In daisy chain applications where one source powers up to five probes, supply reversals or voltage drops caused by lead wire resistance have no effect on the integrity of the digital output data.

Sequence of Operation

The microcomputer instructs the A/D converter to obtain the next measurement of sensor element resistance. This measurement might take 30 ms to make, since the A/D is optimized to reject line power interference.

During this time, the microcomputer processes the data from the previous measurement so that the algorithmic execution of the firmware is optimally interlaced with the data conversion timing of the A/D.

The first stage in the processing calibrates the resistance measurement. There are five steps:

1. Correction of data for A/D zero and span coefficients, using previously calibrated and stored coefficients.

2. Correction of data for long-term A/D zero drift. This is carried out by an interlaced measurement cycle whereby the A/D measures its own drift, filters it appropriately, and stores that value in memory.

3. Correction of data for ambient temperature effects on the A/D parameters of zero and span. This is accomplished by an interlaced measurement cycle of a temperature sensor mounted in the grip of the Intelligent RTD Probe and located optimally to critical analog components. Under microcomputer control, the A/D measures this sensor, determines the equivalent ambient temperature, and corrects the data according to previously calibrated and stored values.

Sequence of Operation (cont.)

4. Correction of data for A/D linearity errors according to previously calibrated and stored characteristic A/D parameters.

5. Digital filtering of the data so that it appears smooth and stable. You can select the magnitude of the "capture band" (outside of which filtering will not take place) and the amount of filtering to be applied once the data value falls inside the capture band.

At this point, the processed data accurately represents the value of resistance of the temperature sensing element. This resistance value is continuously stored so that it can be transmitted on request.

In the next stage in the processing, the microcomputer, using the stored IPTS-68 temperature calibration coefficients, converts resistance data to temperature data according to the selected temperature scale. The default is the IPTS-68 scale, but you can select the IPTS-48 or the new ITS-90 scale. The microcomputer uses the exact equations specified by the selected temperature scale.

The temperature is simultaneously converted into °F, °C, and Kelvins, so you can request a value in any measurement unit without having to wait for further processing.

The value is stored in local memory and updated with each new measurement. Upon request, the Intelligent RTD Probe transmits the most recent value within a few milliseconds.

Appendix A

Specifications

IRTD 400

Temperature Range

-195 to 420°C

Accuracy Over Range

±0.025°C

Resolution

0.001°C

Sensor Element

200 Ohm Platinum sensor

Sheath Material

Inconel™ 600

Immersion Depth (Minimum)

101.6 mm (4")

Dimensions

Overall length:	603 mm (23.75")
Grip:	89 mm x 32 mm (3.5" x 1.25")
Sensor sheath:	457 mm x 6.35 mm (18" x 0.25")

Calibration

Traceable to NIST or PTB;
Recommended calibration period: 1 year

User-Selectable Parameters

IPTS-48, IPTS-68 or ITS-90Temperature units:
°C, °F, or KSensor resistance in ohms;
grip temperature in °C

Power to Probe

Unregulated DC, 10 to 25V;
first probe: 850 mW at 15 V;
each additional probe: 550 mW

Power Supply

Adapter: 110 VAC U.S. style or 220 VAC VDE-approved*
Powers up to 4 probes on a single network*

User-Programmable Functions (Stored in EEPROM)

Probe address and label, baud rate
Calibration constants, sensor and A/D
Password, filtering coefficients for filter band and filter
magnitude

Communications

RS-232C interface, Command/Response protocol with baud rates
of 300, 600, 1200, 2400, 4800 or 9600; 30 readings per second

Environmental

Ambient temperature: 0 to 60°C (32 to 140°F)
Humidity: 0-95% non-condensing

Warranty

12 months parts and labor

*For power supply requirements other than those listed, or to
power more than 4 probes in a network, consult factory or local
representative.

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The Intelligent IRT Probe is a GE Kaye product. GE Kaye has joined other GE high-technology sensing businesses under a new name—GE Infrastructure Sensing.

M2845-6