

HYDRA

2625A DATA LOGGER
2620A DATA ACQUISITION UNIT

USERS MANUAL

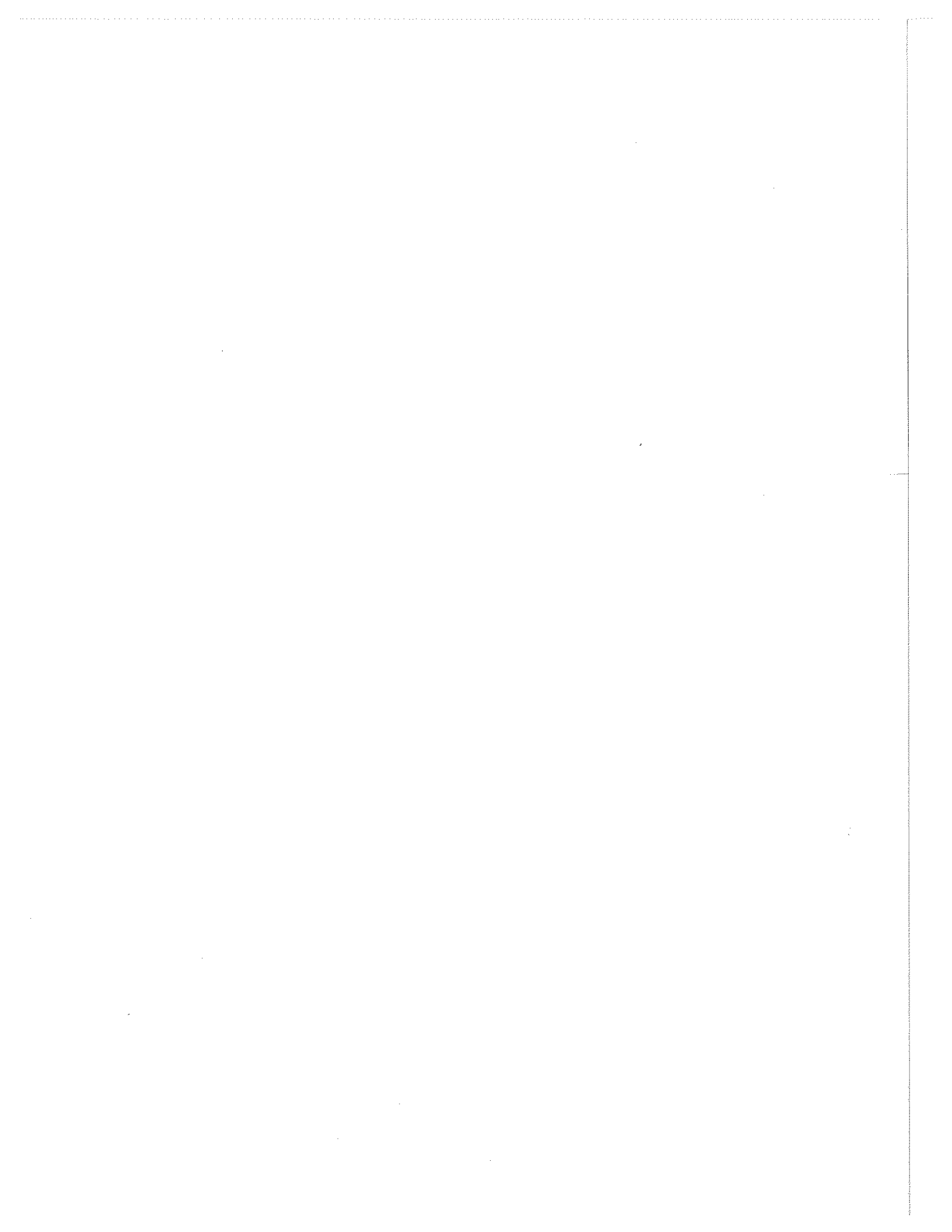
*For a quick introduction,
read pages with this tab:*

GETTING STARTED

PN 885988
OCTOBER 1990
Rev. 4, 10/93

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CAUTION

THIS IS AN IEC SAFETY CLASS 1 PRODUCT. BEFORE USING, THE GROUND WIRE IN THE LINE CORD OR THE REAR PANEL BINDING POST MUST BE CONNECTED FOR SAFETY.

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Fluke Corporation

GETTING STARTED

This section will have you operating Hydra in a matter of minutes. All basic operating information is covered in this short Getting Started guide. Subsequent sections of the manual cover the instrument in more detail.

NOTE

This manual contains information and warnings that must be followed to ensure safe operation and retain the instrument in safe condition.

THE BASICS

Hydra has 21 input channels: channel 0 is on the front panel, and channels 1 through 20 are on the rear input module.

There are two ways Hydra takes measurements (these can be used separately or together):

- A Scan function, which measures all channels at a specified scan interval.
- A Monitor function, which repeatedly measures any one channel.

The instrument has three different modes of operation:

- Active Mode - when the Scan and/or Monitor functions are on.
- Configuration Mode -when any of the setup parameters are being changed.
- Inactive Mode - when the instrument is powered up, and sitting idle. (i.e., not in Active Mode or Configuration Mode).

TURNING ON THE INSTRUMENT




Press **POWER** ON. The entire display lights up as the instrument steps through a series of self tests. (Refer to Section 6 if any error messages are displayed during this self-test sequence.) When the self-tests are finished, the instrument resumes whatever mode it was in the last time power went off.

Normally it will go to Inactive Mode, and sit idle with a channel number on the right-hand display. You can change the displayed channel with **▲** and **▼**. Other annunciators are lit dimly to provide a summary description of the selected channel's setup.







The initial setup for all channels should be "off": as you scroll through the channels with **▲** or **▼**, the "OFF" annunciator should be on dimly. If any of the channels are set up otherwise, or if the instrument immediately starts taking measurements after the self-test sequence, then it still contains the previous user's setup. You can quickly get the instrument back to the initial setup by performing a "Configuration Reset".

To perform a Configuration Reset, press **POWER** OFF. Then hold **CANCEL** in, while pressing **POWER** ON; keep **CANCEL** pressed until the self-test sequence is finished and the instrument beeps one time.

SETTING UP A CHANNEL










1. Press ,  to select a channel to modify. For this example, start with channel 0.
2. Press  to access the function setup menu.

The “SET” and “FUNC” annunciators come on, and the instrument goes into Configuration Mode. The present function for this channel is also highlighted (for this example, “OFF” is lit if you’re working with channel 0, and have already performed the Configuration Reset).

3. Press ,  to cycle through the choices for measurement function. For now, select “V AC”, to set up the channel for AC voltage measurements.
4. Press  to confirm your choice. The instrument then offers a choice of measurement ranges for this function, starting with “Auto” for autoranging.
5. Press ,  to cycle through the choices for range. Select the 300V range. (300V is available only on channels 0, 1 and 11.)
6. Press  to confirm your choice.







This completes setting up channel 0 to measure AC voltage. The instrument returns to Inactive Mode, and the new setup for channel 0 is shown dimly on the display.

The sequence for setting up a channel to measure DC Voltage, Frequency or Resistance is very similar:

1. Press ,  to select a channel to set up.
2. Press  to access the function setup menu.
3. Press ,  to cycle through the choices for measurement function, then press .
4. Press ,  to cycle through the choices for range, then press . This completes the setup for the channel and the instrument returns to Inactive Mode.

When you set up a channel to measure resistance, the instrument also lets you choose 2-Terminal or 4-Terminal measurements (“2T” or “4T”) before returning to Inactive Mode. Note that 4-terminal measurements are supported only on channels 1 - 10.

The sequence for setting up a channel to measure temperature is similar:

1. Press ,  to select a channel to set up.
2. Press  to access the function setup menu.
3. Press ,  to select “°C” (or “°F”) from the list of measurement functions, then press . (Section 3 of the manual explains how to change temperature measurement units.)

- The instrument then offers a choice of 9 different thermocouple types, as well as "Pt" for platinum RTD's.

Press Δ , ∇ to select a thermocouple type, then press ENTER. This completes the setup for the channel and the instrument returns to Inactive Mode.

When setting up a channel to measure RTD's, the instrument also prompts for 2-Terminal vs 4-Terminal measurements, and then allows you to specify a value for R0. (Note that channel 0 cannot be set up to measure thermocouples or 4-terminal RTD's.)

Subsequent sections of the manual explain how to set up alarm values and Mx+B linear scaling for each channel.

TAKING MEASUREMENTS

Before taking any measurements, you might want to set up a few more channels... set up three additional channels, as described below. (Remember, use Δ or ∇ when in Inactive Mode to select a channel, and then press FUNC.)

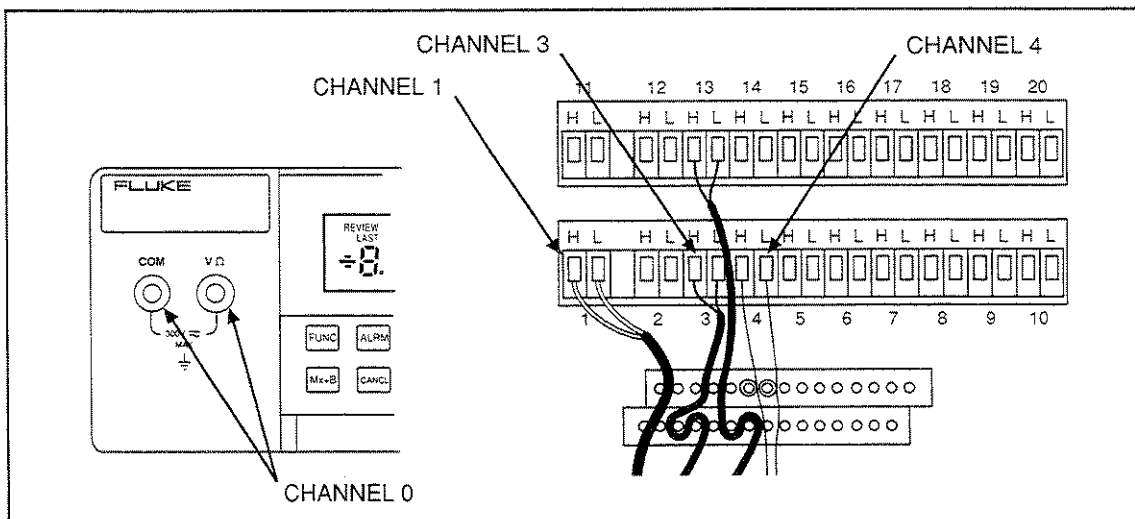
| Channel | Function |
|---------|---|
| 0 | V AC, 300V range |
| 1 | V DC, 30V range |
| 2 | (leave set up as "OFF") |
| 3 | Resistance, 3 M Ω range |
| 4 | Thermocouple Temperature ("°C" or "°F") |
| 5 .. 20 | (leave set up as "OFF") |

WARNING

INPUTS MAY BE CONNECTED TO LIVE VOLTAGES. TO AVOID ELECTRIC SHOCK REMOVE INPUTS FROM LIVE VOLTAGES BEFORE OPENING THIS MODULE.

You need to connect wires to these channels before taking measurements. Insert a pair of test leads into the jacks on the front panel for channel 0. For channels on the rear input module, proceed as follows:

- Remove the Input Module from the rear panel.
- Loosen the two large screws on top and open the module.
- Connect wires to the pairs of terminals for channels 1 and 3. We've enclosed some thermocouple wire for you to connect to channel 4; the thermocouple's red lead must be connected to the "low" input terminal, labeled "L". (Note that the enclosed thermocouple is for demonstration purposes only. Measurements taken with it may be off by 1 - 2 degrees.) Refer to Table 3-14 in Section 3 to identify the type of thermocouple by positive lead color. This table also shows the appropriate usable temperature range.
- Thread the wires through the strain-relief pins and out the back of the module.



5. Close the cover, secure the screws, and insert the module back in the instrument.

The instrument is now ready to take measurements. Start with the Monitor function, which takes repeated measurements on a channel.

Press Δ , ∇ to select a channel to monitor.

Press MON to activate the Monitor function.

NOTE

You cannot activate the Monitor function if the selected channel is set up as OFF; the instrument gives a long beep and ignores your request.

The "MON" annunciator comes on, and the instrument starts taking measurements on the selected channel. If you haven't connected the input leads to a signal, the instrument simply displays a nominal noise reading; on channels set up to measure resistance, "OL" is displayed for overload. (The instrument also displays "OL", or "otc" for open thermocouple, when attempting to measure temperatures on channels to which no sensor has been connected.)

Press Δ , ∇ to scroll through other channels and take additional measurements. Note that the instrument automatically skips over channels that are not set up (i.e., those channels still set to "OFF").

Press MON to deactivate the Monitor function when you're through. (MON toggles the Monitor function on and off.)

Next, press SCAN to activate the Scan function. The "SCAN" annunciator comes on, and the instrument begins taking measurements on all the channels you've set up.

When the scan completes, the instrument normally then counts down the time interval remaining until the next scan is due. (The countdown appears on the right display.) However, if you performed a Configuration Reset, then the scan interval has been set back to 0:00:00. Under this condition, the instrument performs continuous scanning. Subsequent sections of the manual explain how to change the scan interval.

Even with the Scan function on, you can still use the Monitor function to watch a channel:

Press **MON** to activate the Monitor function.

Press **▲**, **▼** to change the monitor channel, as desired. (The instrument continues to take scan measurements in the background.)

Press **MON** to deactivate the Monitor function when you are through.

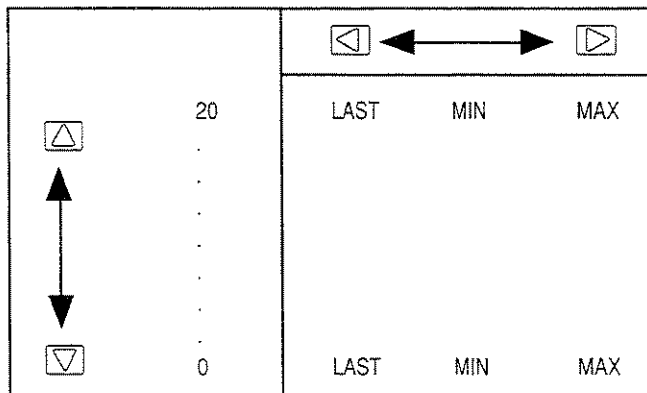
Similarly, press **SCAN** to deactivate the Scan function when you are through.

LOOKING AT DATA

While taking scan measurements, the instrument also collects Minimum, Maximum and Last values for each channel. These values are stored in the "Review Array." You can examine the data in the Review array when the instrument is in Active Mode or Inactive Mode. If you are in Active Mode, (i.e. the Scan and/or Monitor functions are on), the instrument will continue to take measurements in the background while you examine the Review data.

Press **REVIEW** to call up the Review array onto the display.

Use the four arrow buttons to examine different entries in the Review array. The arrow buttons move around in the Review array, as illustrated below.



Press **REVIEW** or **CANCEL** to remove the Review data from the display when you're through.

The remainder of this manual covers all aspects of using Hydra. Glance over the Table of Contents; you'll find that each section presents an additional layer of information. You can use as little as (or as much as) you need for your Hydra application.

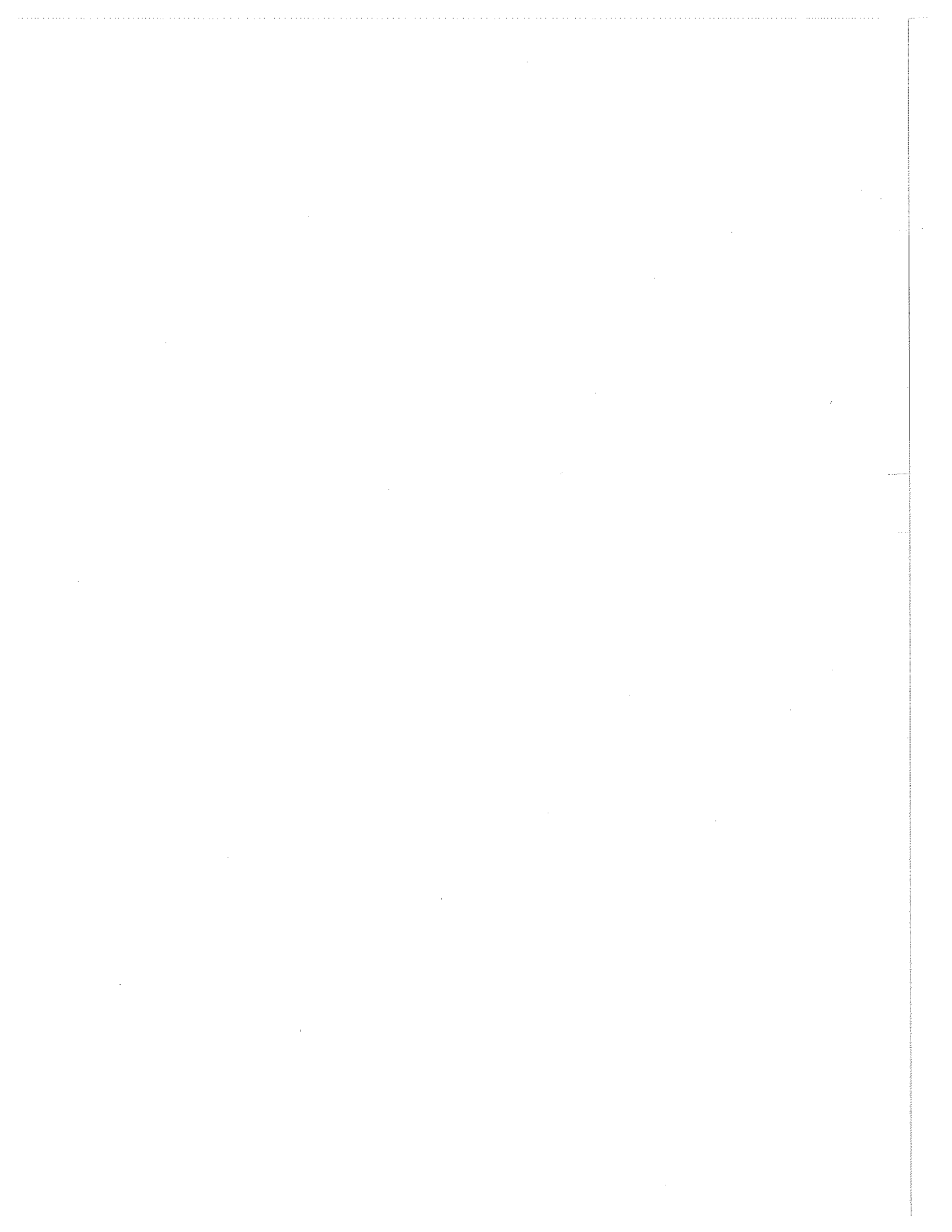


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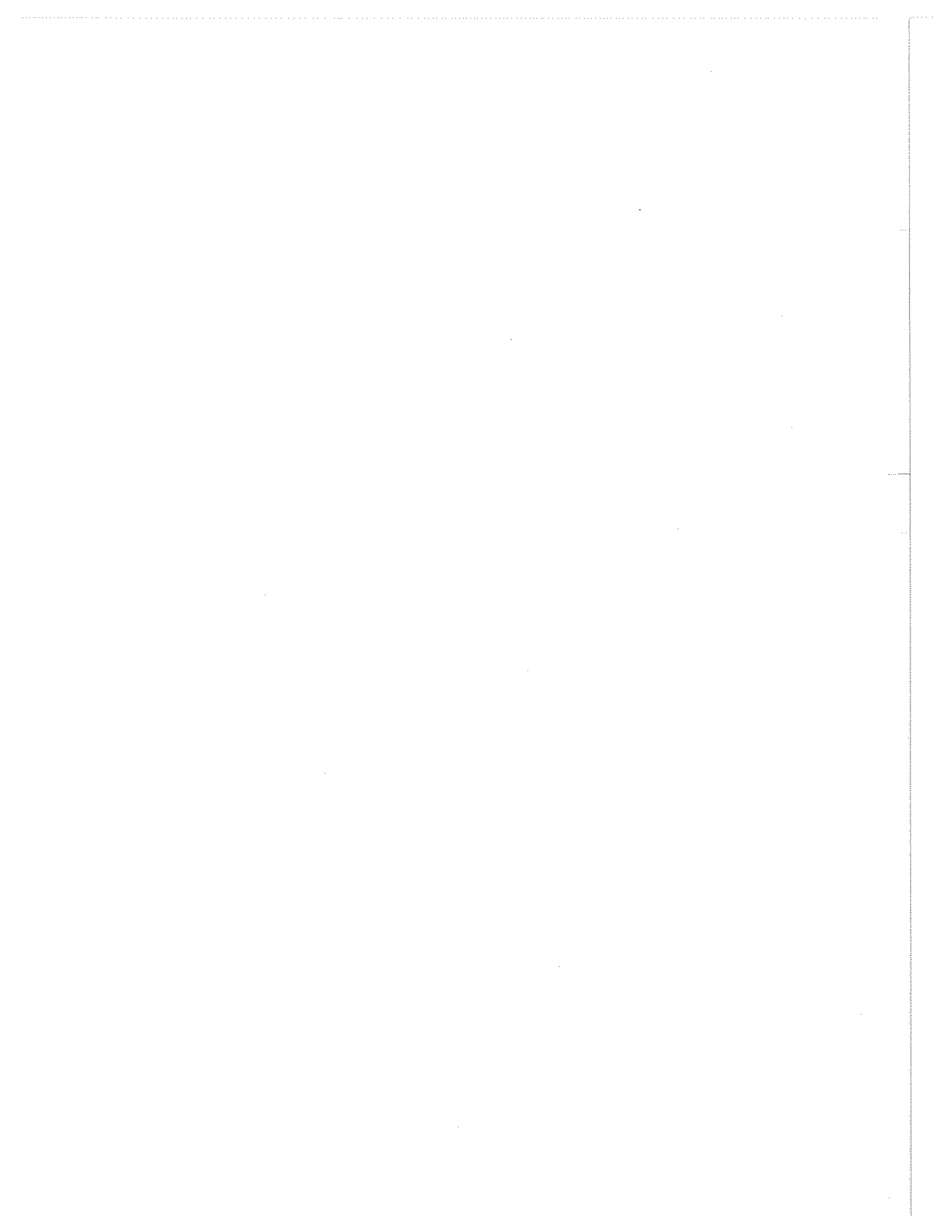
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Section 1

Introduction

NOTE

This manual contains information and warnings that must be followed to ensure safe operation and retain the instrument in safe condition.

THE HYDRA DATA ACQUISITION UNIT

The Hydra Data Acquisition Unit (Model 2620A) is a multi-channel data acquisition unit able to measure ac and dc voltages, temperature via thermocouples and RTDs, resistance, and frequency. It features 21 measurement channels, 8 digital input/output lines, a Totalizer input, and 4 alarm output lines. The Data Acquisition Unit is easily carried by hand and can be ac or dc powered. The user can choose communications with a host computer over an RS-232 (standard) or IEEE-488 (2620A/05) computer interface. Refer to Table 1-1 for a list of operating features.

THE HYDRA DATA LOGGER

The Hydra Data Logger (Model 2625A) combines data logging memory with the features of the Data Acquisition Unit. The RS-232 computer interface is standard (IEEE-488 capability is not available.)

OPTIONS AND ACCESSORIES

Applications Software

The following software packages are available for the instrument:

- Hydra Starter Package (included with instrument)

Allows for communication from an IBM-compatible personal computer through the RS-232 interface, emphasizing transfer of measurement and configuration settings to and from the instrument.

Table 1-1. Hydra Features

| |
|--|
| <ul style="list-style-type: none">• Channel Scanning Can be continuous scanning, scanning at an interval time, single scans, or triggered (internal or external) scans.• Channel Monitoring Make measurements on a single channel and view these measurements on the display.• Channel Scanning and Monitoring View measurements made for the monitor channel while scanning of all active channels continues.• Multi-Function Display Left (numeric) display shows measurement readings; also used when setting numeric parameters. Right (alphanumeric) display used for numeric entries, channel number selection and display, status information, and operator prompts.• Front-Panel Operation Almost all operations can be readily controlled with the buttons on the front panel.• Measurement Input Function and Range Volts dc (VDC), volts ac (VAC), frequency (Hz), and resistance (Ω) inputs can be specified in a fixed measurement range. Autoranging, which allows the instrument to use the measurement range providing the optimum resolution, can also be selected.• Temperature Measurement Thermocouple types J, K, E, T, N, R, S, and B, and Hoskins Engineering Co. type C are supported. Also, DIN/IEC 751 Platinum RTDs are supported.• Totalize Events on the Totalizing Input• Alarm Limits and Digital Output Alarm Indication• 4-Terminal Resistance Measurements (Channels 1 through 10 only)• RS-232 Computer Interface Operation• Measurement Rate Selection• Nonvolatile Memory Storage of minimum, maximum, and most recent measurements for all scanned channels Storage of Computer Interface setup, channel configurations, and calibration values. Storage of measurement data: storage for 2047 scans of up to 21 channels, representing up to 42,987 readings (Hydra Data Logger only). |
|--|

- Hydra Data Logger Package 2620A-901 (order separately)

Allows for full instrument control from an IBM-compatible personal computer through either the RS-232 or IEEE-488 interface. Up to two instruments can be controlled at the same time, and measurement data can be displayed in text or graphics mode.

IEEE-488 Interface Assembly

Model 2620A/05 includes an IEEE-488 Interface. Commands for the IEEE-488 interface are virtually identical to those used with the RS-232 Interface.

If your Hydra Data Acquisition Unit does not have an IEEE-488 Interface, a field-installable kit (2620A-05K) is available. The Hydra Data Logger cannot be equipped with an IEEE-488 Interface.

Connector Set (2620A-100)

The 2620A-100 is a complete set of input connectors (one Input Module and two Digital I/O Connectors). These connectors allow for additional wiring setups so that a single Hydra Data Acquisition Unit or Data Logger can then be moved among multiple installations.

Accessories

Accessories available for the instrument are described in Table 1-2.

WHERE TO GO FROM HERE

You might want take a minute to familiarize yourself with this manual. Glance through the table of contents at the front to see the overall layout of the manual and the major parts of the instrument. If you have questions about specific topics, the Index at the end of the manual will be useful. Or, just fan through the headers at the top of each page; each header reveals the section number and the chief subject for that page.

The sections are summarized below:

GETTING STARTED

Provides a quick introduction to instrument setup and operation.

SECTION 1. INTRODUCTION

Describes standard features, options, and accessories for the Fluke Hydra Data Acquisition Unit and Hydra Data Logger. Also, this section discusses the organization and intended uses of this manual.

Table 1-2. Accessories

| MODEL | DESCRIPTION |
|---------------------|--|
| 80i-410 80i-1010 | Clamp-On DC/AC Current Probes. |
| 80J-10 | Current Shunt. |
| 2620A-05K | Field-installable IEEE-488 Option kit (Hydra Data Acquisition Unit only). |
| 2620A-901 | Hydra Data Logger Applications Package. |
| C40 | Soft carrying case. Provides padded protection for the instrument. Includes a pocket for the manual and pouch for the line cord. |
| M00-200-634 | Rackmount Kit. Provides standard 19-inch rack mounting for one instrument (right or left side). |
| PM 8922 | Switchable x1, x10 passive probe. |
| RS40 | Shielded RS-232 terminal interface cable. Connects the instrument to any terminal or printer with properly configured DTE connector (DB-25 socket), including an IBM PC®, IBM PC/XT® or IBM PS/2 (models 25, 30, 50, P60, 70, and 80). |
| RS41 | Shielded RS-232 modem cable. Connects the instrument to a modem with properly configured DB-25 male pin connector. Use an RS40 and an RS41 cable in series to connect with an IBM PC/AT®. |
| RS42 | Serial printer cable. Contact Fluke for list of compatible printers. |
| TL20 | Industrial test lead set. |
| TL70 | Test lead set. |
| Y8021 | Shielded IEEE-488 one-meter (39.4 inches) cable, with plug and jack at each end. |
| Y8022 | Shielded IEEE-488 two-meter (78.8 inches) cable, with plug and jack at each end. |
| Y8023 | Shielded IEEE-488 four-meter (13 feet) cable, with plug and jack at each end. |
| Y9109 | Binding post to BNC plug. |
| Fluke PN 268789 | 10Ω Precision Resistor, metal film, +/- 1%, 1/8 watt, 100 ppm. For use with 4 - 20 mA signals. |

SECTION 2. OVERVIEW

Brings the instrument from its shipping container to operating status. This section provides brief descriptions and a quick walk-through of instrument operation. Read this section to gain a feel for instrument use. But please don't avoid reading Section 3 (for in-depth operation from the front panel) and Section 4 (for computer interface operation); the instrument is far more powerful than suggested in Section 2.

SECTION 3. OPERATING THE INSTRUMENT FROM THE FRONT PANEL

Describes all capabilities available through front panel control. The features introduced in Section 2 are described more fully, including descriptions for setting up and using each type of measurement input (dc volts, thermocouple, etc.) and digital input (Totalizer, etc.) or output (such as alarms). Other features of the Hydra Data Acquisition Unit and the Hydra Data Logger are also more fully explained.

SECTION 4. USING THE COMPUTER INTERFACE

Describes connecting the instrument to a terminal or host computer and operating the instrument over the RS-232 Interface. For the Hydra Data Acquisition Unit only, use of the optional IEEE-488 Interface is also described here. This section is detailed and requires a good knowledge of instrument operation via the front panel (see Sections 2 and 3).

SECTION 5. ADDITIONAL CONSIDERATIONS

Provides detailed operating information not provided elsewhere. This section also describes instrument operation for the advanced user. This section is written with the assumption that you have full knowledge of instrument operation from the front panel (Section 3).

SECTION 6. MAINTENANCE

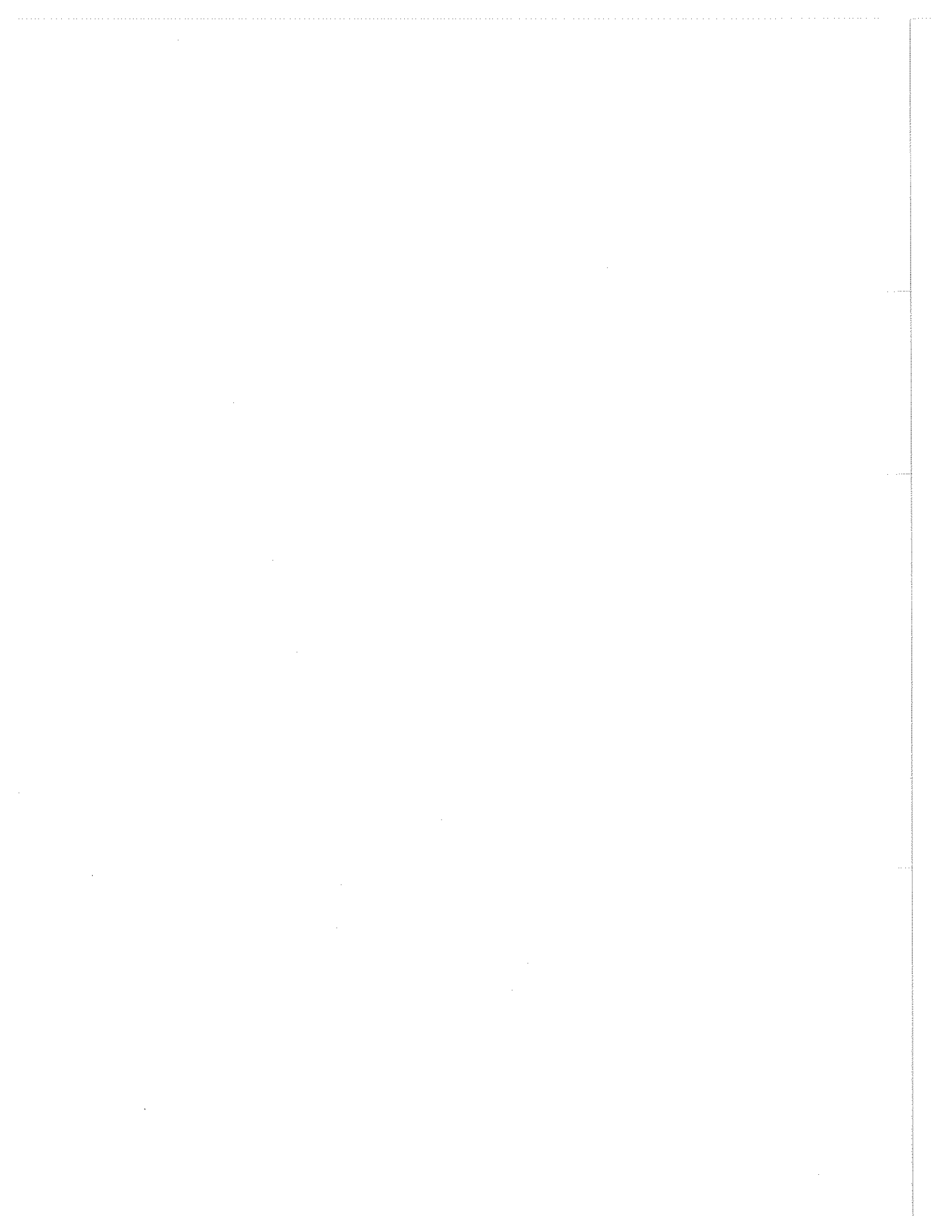
Provides performance tests (suitable as acceptance testing procedures) and routine maintenance information. Refer to this section for explanation of error codes encountered during instrument operation. Also, this section provides parts ordering information for such commonly used items as fuses, accessories, and publications.

Refer to the "Hydra Service Manual" (P/N 889589) for complete service, repair, and parts ordering information.

APPENDICES

- A. Specifications
- B. ASCII/IEEE-488 Bus Codes
- C. IEEE-488.2 Device Documentation Requirements
- D. Service Centers
- E. Making Mixed Measurements

INDEX



Section 2 Overview

INTRODUCTION

Section 2 provides an overview of the major features of the instrument. Comprehensive details on all instrument features are found in Section 3 (for front panel operation) and Section 4 (for computer interface operation.)

SETTING UP THE INSTRUMENT

Unpacking and Inspecting the Instrument

The following items are included in the shipping container:

- This manual
- Applications Software (text and disks)
- Quick Reference Card
- Hydra Data Acquisition Unit (2620A) or Hydra Data Logger (2625A)
- Input Module
- Digital I/O and Alarms Connector
- Test leads
- Line cord

Carefully remove the instrument from its shipping container and inspect it for possible damage or missing items. If the instrument is damaged or something is missing, contact the place of purchase immediately. Save the container and packing material in case you have to return the instrument.

Rotate the rear feet 180 degrees so that their support pads extend slightly below the bottom of the case.

Adjusting the Handle

The handle can be positioned to four angles: one for carrying, two for viewing, and one for handle removal. To change the angle, simultaneously pull both handle ends outward to hard stops (about $\frac{1}{4}$ inch on each side) and then rotate the handle to one of the four stop positions shown in Figure 2-1. With the handle in the straight-up removal position (4 in Figure 2-1), you can disengage and free one handle side at a time.

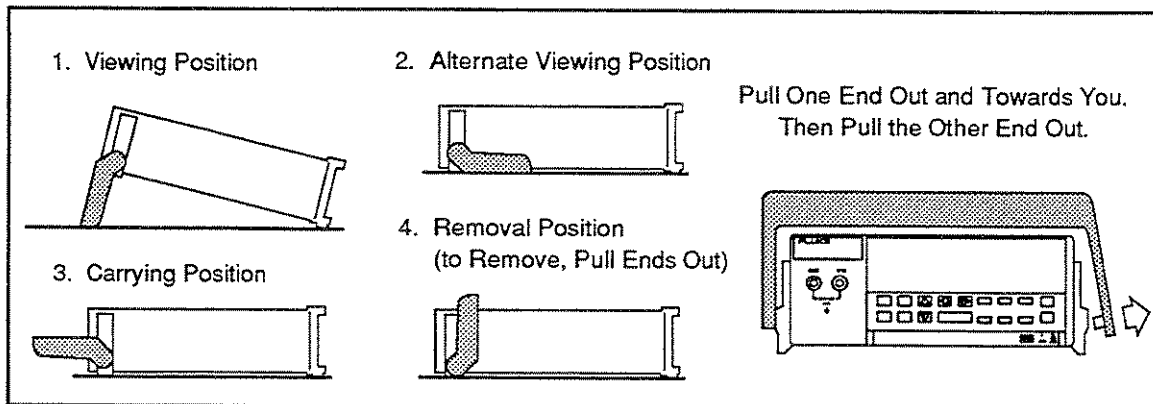


Figure 2-1. Adjusting Handle

Line Power

WARNING

TO AVOID SHOCK HAZARD, CONNECT THE INSTRUMENT POWER CORD TO A POWER RECEPTACLE WITH EARTH GROUND.

Plug the line cord into the connector on the rear of the instrument. The instrument operates on any line voltage between 90 and 264V ac without adjustment, and at any frequency between 45 and 440 Hz. However, the instrument is warranted to meet published specifications only at 50/60 Hz.

Front/Rear Panel Features

The Front Panel (shown in Figure 2-2) provides a two-terminal input for channel 0, a multipurpose display, and a set of control buttons. The display includes the following elements:

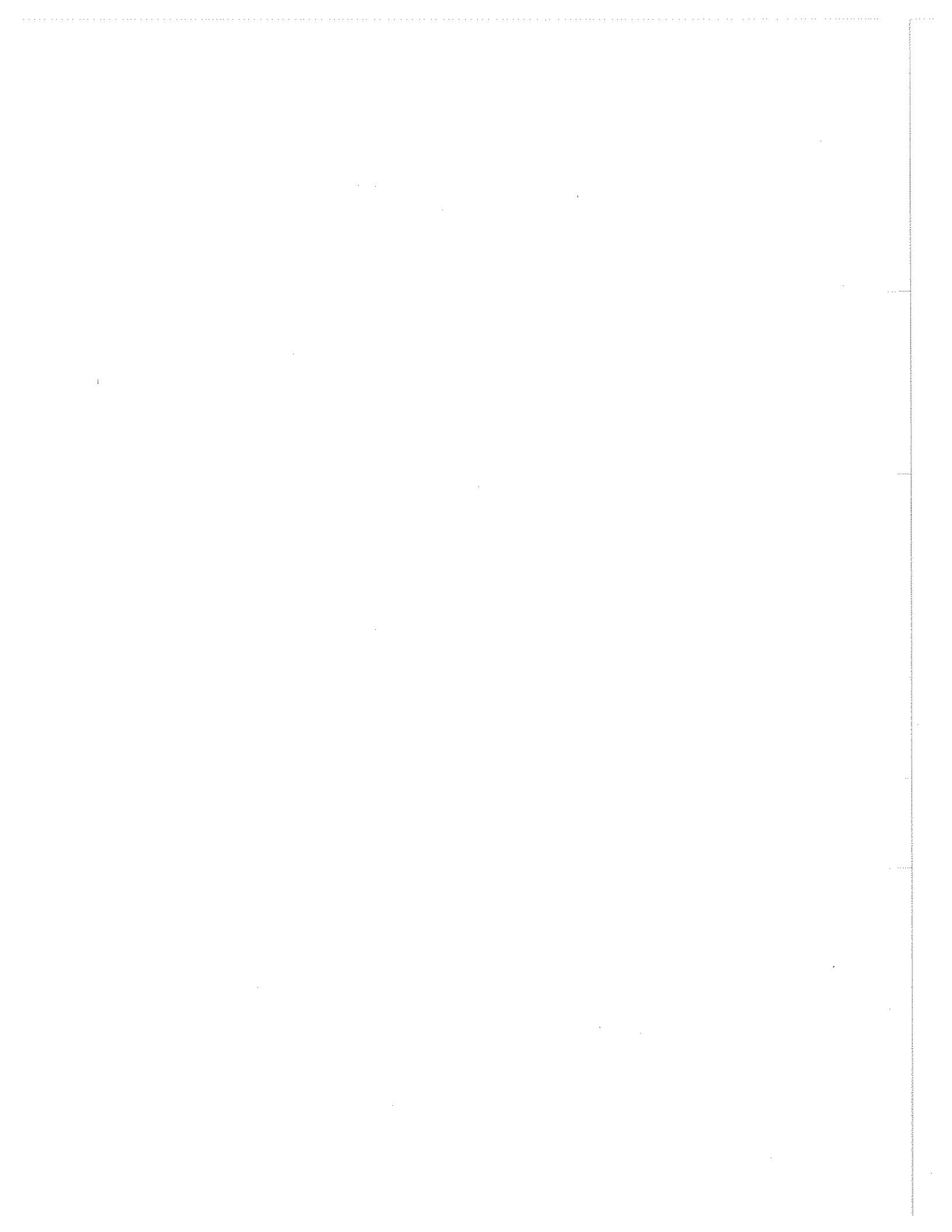
- A major numeric section (called the Left Display). See Figure 2-3.
- An auxiliary alphanumeric section (called the Right Display). See Figure 2-4.
- A set of Display Annunciators. See Figure 2-5 and Table 2-1.

The buttons control all instrument operations: channel configuration, instrument configuration, measurement functions, and print/communications selections. The buttons are introduced in this section, with a more detailed description following in Section 3.

The Rear Panel (shown in Figure 2-6) provides input and output connections: power input, measurement input, digital input/output, Totalizer input, alarm output, and computer interface connections. These connections are introduced in this section and explained in greater detail in subsequent sections of this manual. Inputs and outputs are described with their related functions (Measuring DC Voltage, Totalizing, etc.) in Section 3. RS-232 and IEEE-488 Computer Interface connections are detailed in Section 4.

LIST OF FIGURES

| FIGURE | TITLE | PAGE |
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| 2-3. | Left Display | 2-4 |
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SAFETY TERMS IN THIS MANUAL

This instrument has been designed and tested in accordance with IEC Publication 1010, Safety Requirements for Electrical Measuring, Control and Laboratory Equipment. This User Manual contains information, warnings, and cautions that must be followed to ensure safe operation and to maintain the instrument in a safe condition. Use of this equipment in a manner not specified herein may impair the protection provided by the equipment.

The meter is designed for IEC 664, Installation Category II use. It is not designed for use in circuits rated over 4800VA.

WARNING statements identify conditions or practices that could result in personal injury or loss of life.

CAUTION statements identify conditions or practices that could result in damage to equipment.

SYMBOLS MARKED ON EQUIPMENT



DANGER — High voltage.



Ground (earth) terminal.



Protective ground (earth) terminal. Must be connected to safety earth ground when the power cord is not used. See Section 2.



Attention — refer to the manual. This symbol indicates that information about usage of a feature is contained in the manual. This symbol appears in the following two places on the instrument rear panel:

1. Ground Binding Post (left of line power connector). Refer to 'Using External DC Power' in Section 2.
2. Alarm Outputs/Digital I/O Connectors. Refer to Appendix A, Specifications.

AC POWER SOURCE

The instrument is intended to operate from an ac power source that will not apply more than 264V ac rms between the supply conductors or between either supply conductor and ground. A protective ground connection by way of the grounding conductor in the power cord is required for safe operation.

SAFETY

DC POWER SOURCE

The instrument may also be operated from a 9 to 16V dc power source when either the rear panel ground binding post or the power cord grounding conductor is properly connected.

USE THE PROPER FUSE

To avoid fire hazard, use only a fuse identical in type, voltage rating, and current rating as specified on the rear panel fuse rating label.

GROUNDING THE INSTRUMENT

The instrument utilizes controlled overvoltage techniques that require the instrument to be grounded whenever normal mode or common mode ac voltages or transient voltages may occur. The enclosure must be grounded through the grounding conductor of the power cord, or if operated on battery with the power cord unplugged, through the rear panel ground binding post.

USE THE PROPER POWER CORD

Use only the power cord and connector appropriate for the voltage and plug configuration in your country.

Use only a power cord that is in good condition.

Refer cord and connector changes to qualified service personnel.

DO NOT OPERATE IN EXPLOSIVE ATMOSPHERES

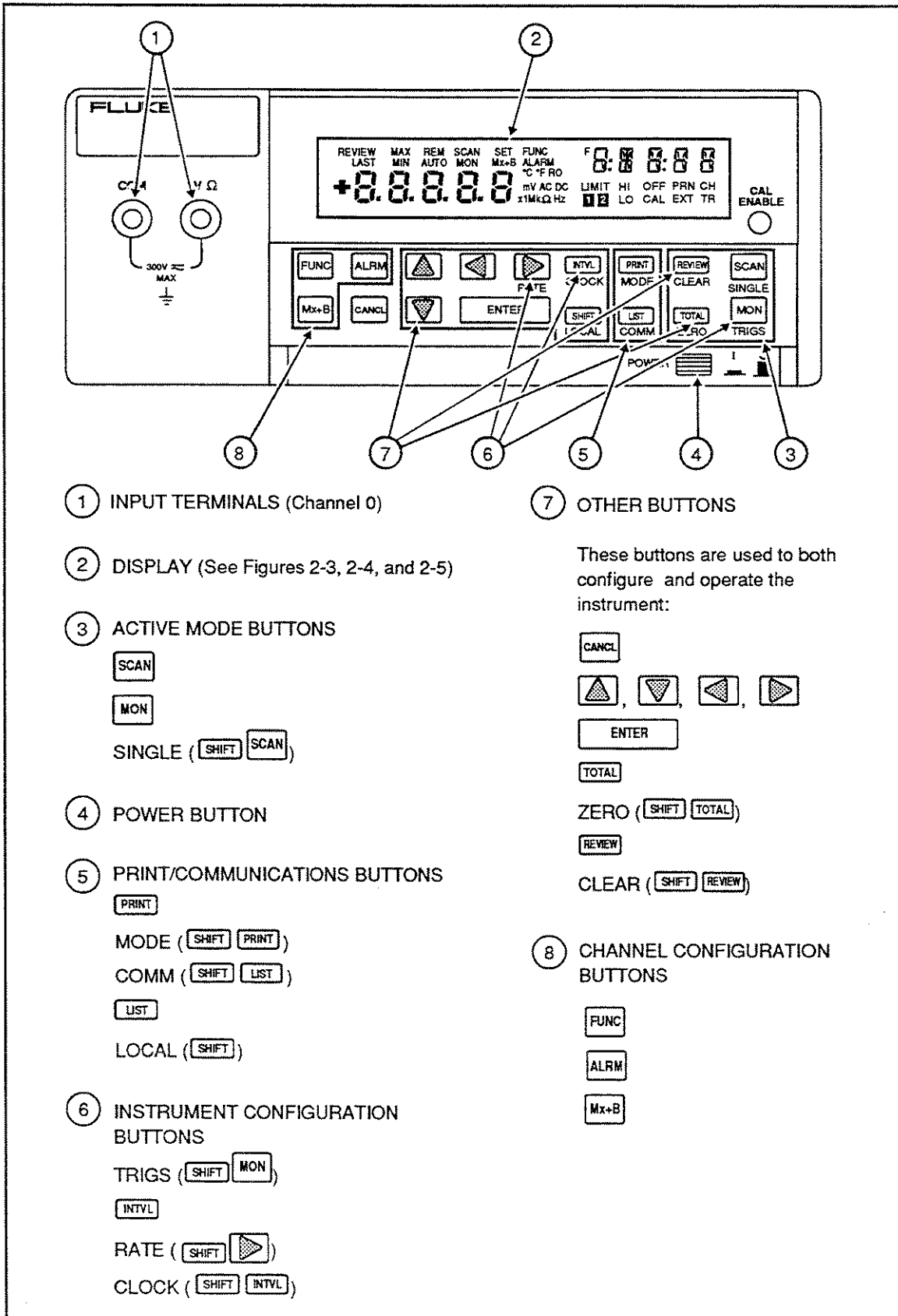
To avoid explosion, do not operate the instrument in an atmosphere of explosive gas.

DO NOT REMOVE COVER

To avoid personal injury or death, do not remove the instrument cover. Do not operate the instrument without the cover properly installed. Normal calibration is accomplished with the cover closed, and there are no user-serviceable parts inside the instrument, so there is no need for the operator to ever remove the cover. Access procedures and the warnings for such procedures are contained in the Service Manual. Service procedures are for qualified service personnel only.

DO NOT ATTEMPT TO OPERATE IF PROTECTION MAY BE IMPAIRED

If the instrument appears damaged or operates abnormally, protection may be impaired. Do not attempt to operate it. When in doubt, have the instrument serviced.



① INPUT TERMINALS (Channel 0)

⑦ OTHER BUTTONS

② DISPLAY (See Figures 2-3, 2-4, and 2-5)

These buttons are used to both configure and operate the instrument:

③ ACTIVE MODE BUTTONS

- SCAN
- MON
- SINGLE (SHIFT SCAN)

- CANCL
- ▲, ▼, ◀, ▶
- ENTER
- TOTAL
- ZERO (SHIFT TOTAL)
- REVIEW
- CLEAR (SHIFT REVIEW)

④ POWER BUTTON

⑤ PRINT/COMMUNICATIONS BUTTONS

- PRINT
- MODE (SHIFT PRINT)
- COMM (SHIFT LIST)
- LIST
- LOCAL (SHIFT)

⑧ CHANNEL CONFIGURATION BUTTONS

- FUNC
- ALARM
- Mx+B

⑥ INSTRUMENT CONFIGURATION BUTTONS

- TRIGS (SHIFT MON)
- INTVL
- RATE (SHIFT ▶)
- CLOCK (SHIFT INTVL)

Figure 2-2. Front Panel

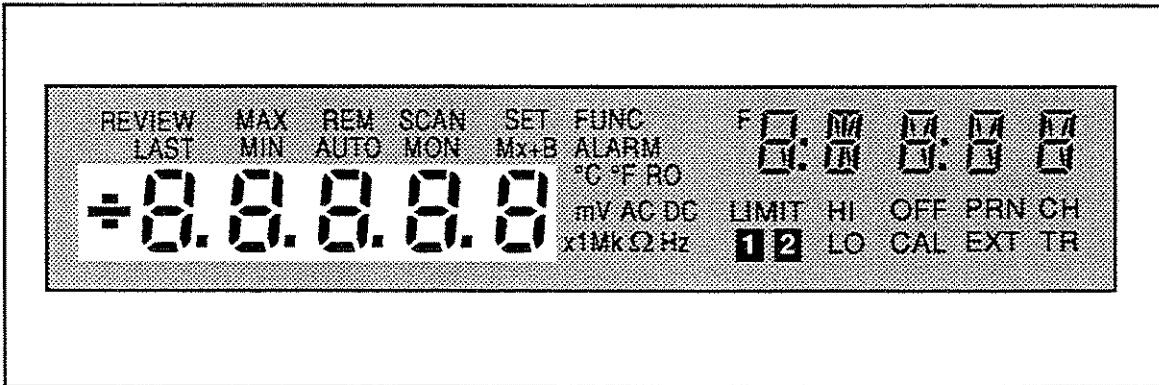


Figure 2-3. Left Display

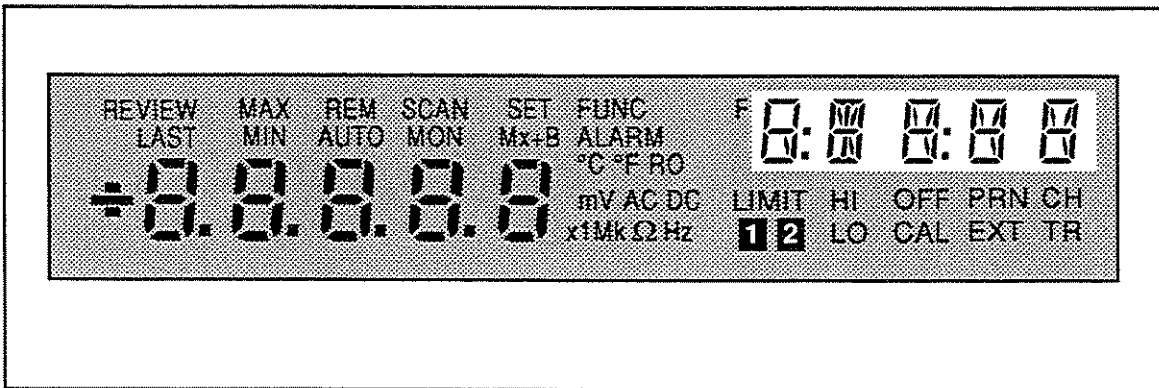


Figure 2-4. Right Display

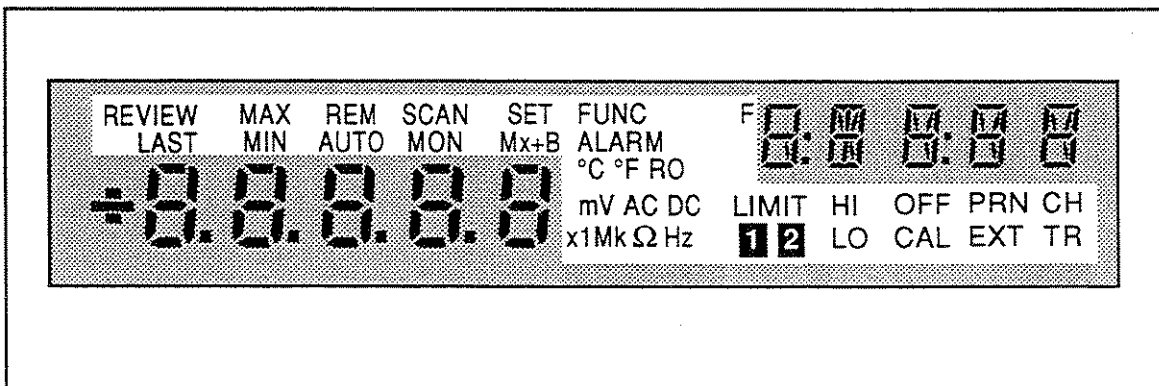


Figure 2-5. Annunciators

Table 2-1. Display Annunciators



| | |
|--------------------|---|
| MON | Indicates that the Monitor function is enabled. |
| SCAN | Indicates that the Scan function is enabled. Scanning can be enabled as a single scan (SINGLE  ) , with a scan interval, with an alarm-triggered scan, or as an externally triggered scan. |
| CH | Indicates that the channel number is displayed immediately above, in the right display. |
| SET | Lit when the instrument is in Configuration Mode. |
| Mx+B | Lit while Mx+B scaling is being defined and when a measurement on the display has been scaled with an M value other than 1 and/or a B value other than 0. Also dimly lit when in the Inactive Mode to indicate that an M value other than 1 and/or a B value other than 0 has been defined for this channel. |
| FUNC | Lit when a measurement function is being defined for this channel. |
| ALARM | Lit when alarm values are being defined for this channel or when an alarm limit has been exceeded while measuring. |
| V | Indicates that the measurement function is volts for this channel (used with the AC or DC annunciator). |
| DC | Indicates that the measurement function is dc voltage for this channel. |
| AC | Indicates that the measurement function is ac voltage for this channel. |
| Ω | Indicates that the measurement function is resistance for this channel. |
| Hz | Indicates that the measurement function is frequency for this channel. |
| $^{\circ}\text{C}$ | Indicates that the measurement function is temperature for this channel and that the degree unit is Celsius. |
| $^{\circ}\text{F}$ | Indicates that the measurement function is temperature for this channel and that the degree unit is Fahrenheit. |
| m | (milli) a multiplier for the displayed value, e.g., mV for millivolts. Also used when defining alarm and Mx+B values. |
| x1 | (times 1) a multiplier for the displayed value. Used when defining alarm and Mx+B values. |
| k | (kilo) a multiplier for the displayed value, e.g., kHz for kilohertz. Also used when defining alarm and Mx+B values. |
| M | (mega) a multiplier for the displayed value, e.g., M Ω for megohms. Also used when defining alarm and Mx+B values. |
| R0 | Lit when the ice point resistance is being defined for RTD measurements on the displayed channel. |

Table 2-1. Display Annunciators (cont)

| | |
|----------|---|
| OFF | Indicates there is no measurement function defined for the displayed channel; OFF channels are skipped over when scanning. OFF is also used when defining an alarm value to indicate that the alarm limit is to be ignored. |
| AUTO | Indicates that autoranging is enabled for the displayed channel. |
| LIMIT | Used with the 1 and 2 annunciators when you are setting an alarm limit value. Also lit when displaying a measurement value (LAST, Monitor) which has exceeded an alarm limit. |
| 1 | Lit when alarm limit 1 is being defined. Also lit when displaying a measurement value (LAST, Monitor) which has exceeded alarm limit 1. |
| 2 | Lit when alarm limit 2 is being defined. Also lit when displaying a measurement value (LAST, Monitor) which has exceeded alarm limit 2. |
| HI, LO | Identifies alarm limit sensing (high or low) during channel configuration. At other times, identifies an alarm condition. |
| REVIEW | Indicates that review data is being displayed (used in conjunction with the MIN, MAX, and LAST annunciators). |
| MIN, MAX | Indicates that the displayed value is the minimum (maximum) value measured on this channel. |
| LAST | Indicates that the displayed value is the most recent scan measurement taken on this channel. |
| PRN | Indicates that the autoprint function is enabled (to send readings to a printer) or the memory storage function is on (to store readings in internal memory.) Internal memory is available with Hydra Data Logger only. |
| F | Bright when memory storage is full, dim when memory storage is nearly full. Hydra Data Logger only. |
| EXT | Indicates that external triggering (on the rear panel) is enabled. |
| TR | Indicates that internal triggering (from the monitor alarm) is enabled. Also used with EXT when external triggering is enabled. |
| REM | Indicates that the instrument is under the remote control of one of the computer interfaces. |
| CAL | Indicates that the instrument's internal calibration constants have been corrupted. |

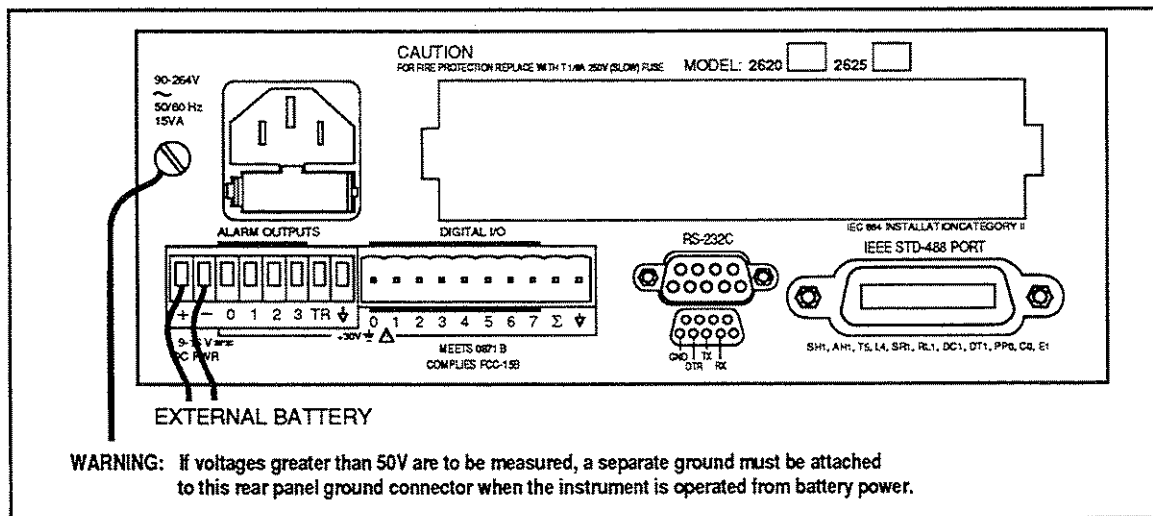


Figure 2-6. Rear View

Input Channels

The instrument provides one input (channel 0) on the front panel and 20 inputs (channels 1 .. 20) through a connector on the rear panel. Channels 0, 1, and 11 can measure a maximum of 300V; all other channels can measure a maximum of 150V.

CAUTION

The maximum input that can be applied between any terminal of channels 2..10 and 12..20 is 150V dc or ac rms. The maximum input that can be applied between any terminal of channels 0, 1, and 11 and ground is 300V dc or ac rms. The maximum common mode input that can be applied is 300V dc or ac rms.

OPERATING MODES

The instrument provides three modes of operation:

- Active Mode

The instrument is in Active Mode whenever the Monitor and/or Scan functions are enabled. Scans are activated by the interval timer, an external trigger, an alarm trigger, or a single scan (SINGLE) command. When in Active Mode, the MON and/or SCAN annunciators are lighted.

- Configuration Mode

The instrument is in Configuration Mode whenever settings (channel function, alarm values, Mx+B scaling values, scan interval, trigger type, etc.) are being examined or changed. When in the Configuration Mode, the SET annunciator is on, along with other annunciators indicating the parameter(s) being set.

- Inactive Mode

The instrument is in Inactive Mode when no measurement functions are enabled and no instrument settings are being examined or changed. This is a quiescent state; only summary channel information is displayed.

TURNING THE INSTRUMENT ON

Turn the instrument on by pressing **POWER** on the lower right of the front panel. Initially, the entire display lights while the instrument conducts several internal self tests.

NOTE

*You can familiarize yourself with the instrument by holding the display fully lit. Press and hold **SHIFT**, then press **POWER** ON and wait a moment for the instrument to beep. Then release **SHIFT**. The entire display will now stay on until you press any button; the power-up sequence then resumes.*



A deviation in mainframe software Version 5.5 will not allow the display to remain ON. Versions 5.4 and below will allow the display to remain ON.

Any error conditions are momentarily displayed during this test sequence. Even in the presence of an error, the instrument still attempts to complete the self-test sequence and begin normal operation. However, if you encounter an error, note the number and refer to Self Test Diagnostics and Error Codes in Section 6 for additional information.

Once the self tests are completed, the instrument enters Inactive or Active Mode, depending on the following circumstances:

- Active Mode if this mode was in effect prior to the cycling of power. Scanning, monitoring, or combined scanning/monitoring is resumed.
- Inactive Mode if the instrument was in Inactive Mode or Configuration Mode prior to cycling of power.

When in Inactive Mode, the instrument shows configuration information for the displayed channel. The channel number appears in the right display, and other annunciators are dimly lit to show the present setup for this channel. For example, if the channel is set up to measure $k\Omega$, the “k” and “ Ω ” annunciators are dimly lit. Alternatively, if this channel has not been set up to measure anything, the “OFF” annunciator is lit dimly.

You can change the channel by pressing  or .

FRONT PANEL DISPLAY

Full descriptions of the display annunciators are presented in Table 2-1.

READING THE DISPLAY

The instrument display uses both alphanumeric characters and fixed annunciators. When in Configuration Mode, these features are used to provide user prompting. In Inactive Mode, they provide status information. In Active Mode, they provide both status information and measurement data.

Information is presented on the display during both front panel control and computer interface control. If the instrument is being controlled through a computer interface, the display shows the results of computer-interface initiated actions (even if the front panel controls have been disabled.)

The remainder of Section 2 (as well as Section 3) relates to front panel control of the instrument. Refer to Section 4 for additional information about computer interface operation.

Left Display

The left display has five large numeric characters to show measurement results, “otc” when an open thermocouple is detected, or “OL” when a measurement is over range.

During Configuration Mode, the left display is also used to display the numeric values and instrument parameters being chosen.

Right Display

The right display has five small alphanumeric characters to show the channel number, display prompting information during setups, or to count down the scan interval.



Specific Annunciators

The rest of the display is devoted to specific annunciators, combinations of which are used to describe the operating mode, the type of measurement being displayed, or the type of setup information to be entered. These annunciators are described in Table 2-1 and shown in Figure 2-5.

FRONT PANEL BUTTONS

Go ahead and press any front panel button. The instrument always provides an audible response to each button press. Valid entries yield a short beep; incorrect entries yield a longer beep. Don't worry if you press an inappropriate button and get a long beep; you can't damage the instrument. It will discard the button entry and wait for another entry.

Selecting a Channel

The channel number appears in the right display. Press  or  to select a channel. You can change the channel when in Inactive Mode, when looking at data in the Review array, or when the Monitor function is on.

Using the Buttons

Table 2-2 presents a summary of the control buttons.

Special button sequences cause a total instrument Configuration Reset or change the temperature units between °C and °F.



- Holding  down while turning the power on causes the instrument to perform a Configuration Reset. Hold the button down until the instrument beeps, indicating that the action has been taken. All channels will be reset OFF. All alarm and scaling values will be reset. Scanning and monitoring will be turned off.
- Holding  down while cycling POWER ON toggles the degree unit used with temperature measurements (°C or °F). Again, the instrument will beep and display °C or °F when this action is complete.

Table 2-2. Front Panel Pushbuttons




















| | |
|---|---|
|  | Calls up the menu to set the function for the channel. |
|  | Calls up the menu to set alarm limits 1 and 2 for the channel. |
|  | Calls up the menu to set scaling on the channel. |
|  | Used to change the channel number and to step through choices in any of the setup menus. These arrow buttons have an automatic repeat action when held down for more than 1 second. |
|  |  generates a service request when the instrument is under remote control without local lockout (REMS). |
|  | Used to accept a selection just made in any setup menu. |
|  | Used to exit setup menu and return to Inactive Mode, without saving settings you've selected thus far. Exceptions exist under the following two conditions: <ul style="list-style-type: none"> • If you cancel out of the alarm menu part way through defining alarm limit 2, any just-made entries for alarm limit 1 will still take effect. • If you cancel out of the Mx+B menu partway through defining the B value, any just-made changes to the M value will still take effect. <p>This button also provides a handy way to remove the Totalizer value or Review data from the display.</p> |
|  | Turns the Scan function on or off. |
|  |  triggers a single scan when the instrument is under remote control without lockout (REMS). |
|  | Turns the Monitor function on or off. |
|  | Allows you to change the scan interval. Scanning becomes continuous when the interval is set to 0:00:00. |
|  | Enables/disables logging measurements to the printer (Autoprint - RS-232 only) or to internal data memory (Memory Storage). Only the Hydra Data Logger provides internal Memory Storage. |
|  | Calls up the Review array of MIN, MAX and LAST values to the display. |
|  | Calls up the present Totalizer count to the display. |
|  | (RS-232 only) Prints out the Last values of the Review array (2620A and 2625A) or Data Logger memory (2625A only) via the RS-232 interface. |
|  | Accesses secondary functions under various keys, as described below. When this button is pressed, "SHIFT" appears on the right display, but automatically disappears if you have not made a selection within 5 seconds or if you press  . |

Table 2-2. Front Panel Pushbuttons (cont)

| |
|---|
| LOCAL (SHIFT) |
| When under remote control without lockout (REMS), this returns control to the front panel. |
| RATE (SHIFT) (▶) |
| Allows you to change the scanning speed: "SLO" for highest accuracy, or "FAST" for highest throughput. |
| CLOCK (SHIFT) (INTVL) |
| Allows you to set the internal day/date clock. |
| MODE (SHIFT) (PRINT) |
| Allows you to select the conditions for which scan measurements will be automatically printed or logged. |
| CLEAR (SHIFT) (REVIEW) |
| This button sequence clears the entire contents of the Review array. Review data must be presently shown on the display to clear the array. |
| COMM (SHIFT) (LIST) |
| Allows you to set up a computer interface port. |
| ZERO (SHIFT) (TOTAL) |
| While the Totalizer count is displayed, resets the Totalizer to 0. |
| SINGLE (SHIFT) (SCAN) |
| Forces an immediate scan of all defined channels. If a scan is presently in progress, this new request is ignored. Once begun, the full scan is completed. Configuration changes are not allowed while a scan is in progress. |
| TRIGS (SHIFT) (MON) |
| Allows you to set up the auxiliary scan trigger mechanisms. |

SETTING UP A CHANNEL

Channel set ups are made in Configuration Mode, which must be entered from Inactive Mode. If the instrument is in Active Mode, turn the Scan and/or Monitor function off before proceeding.

Follow the steps below to change the channel setup. More detailed instructions for setting all instrument parameters are provided in Section 3.

During the following steps, note that some items on the display are brightly lit, and others are dimly lit. The bright item is intended to focus your attention on the choice the instrument is offering you at that moment.

NOTE

Changing the channel function causes any alarm limits and scaling values to be automatically cleared. Therefore, you must set a channel's function before setting alarm limits and/or scaling values for that channel.

NOTE

Press to exit the channel setup menu at any time, leaving the old setup unchanged.

1. Select a channel to set up:

Look for the desired channel number in the right display.

2. Press the following buttons to change the setup:

SET and FUNC come on bright, along with the present setting for measurement function.

Cycle through the choices for measurement function.

Accept your choice of measurement function.

For resistance measurements, continue on with steps 3 and 4. For temperature measurements, skip to step 5.

3. For dc volts, ac volts, resistance, or frequency, the instrument now provides a choice of measurement ranges. Press the buttons as follows:

Cycle through the choices.

Accept your choice.

For dc volts, ac volts, or frequency, the configuration is now complete for this channel. The instrument returns to Inactive Mode.

4. For resistance measurements, one more step is required to specify 2-terminal (2T) or 4-terminal (4T) measurements. Since 4-terminal measurements require two channels, 4-terminal measurements can be set up on channels 1-10 only. For each 4-terminal channel, a corresponding channel (11-20) ten numbers higher is reserved for the additional two connections required. Press the buttons as follows:

Choose between two terminals (2T) and four terminals (4T).

Accept your choice. The instrument returns to Inactive Mode.

5. If you've specified temperature measurements, the instrument provides a choice of thermocouple types or Platinum RTD. Press the buttons as follows:

Cycle through the thermocouple choices. "Pt" is the RTD choice.

Accept your choice.

If you selected one of the thermocouple types, channel configuration is complete; the instrument returns to Inactive Mode.

6. If you selected “Pt” (for RTD-based measurements), use the following buttons to specify 2-terminal (2T) or 4-terminal (4T) measurements and the R0 value.

Since 4T measurements require two channels, 4-terminal measurements can be set up on channels 1-10 only. For each 4T channel, a corresponding channel (11-20) ten numbers higher is reserved for the additional two connections required.

Choose between two terminals (2T) and four terminals (4T).

Accept your choice.

Now choose the R0 (ice point) value (preset to 100.00). Use or to move between digits. Use or to select a value for each digit.

Accept your choice. Channel configuration is complete; the instrument returns to Configuration Mode.

NOTE

Any old alarm status/limits, Review array values, or scaling parameters are automatically cleared whenever you change a channel's function.

SETTING ALARM LIMITS AND Mx+B SCALING VALUES

Alarm limits and Mx+B scaling values are set in a manner very similar to that used for the channel function. Begin by pressing either of the following buttons:

To begin alarm limits settings for this channel.

To begin scaling value settings for this channel.

The setup sequences are briefly discussed below. Refer to Section 3 for more details about these and other instrument parameters.

Alarm Limits

The menu for setting alarm limits allows you to set up both setpoints (**1** and **2**). After choosing a setpoint, the following settings must be made:

- The alarm sense HI, LO or OFF.
- The limit value (sign and number).
- The decimal point location.
- The value multiplier (m, x1, k, M).

Use , , and to cycle through the selections at each setting. Then press to accept your choice and move on to the next setting.

For example, to set a high limit of +5.35 for alarm **1** on channel 7, do the following:

1. Select channel 7 by pressing or .

2. Press **ALRM** to begin alarm setting for channel 7. "LIMIT" and **1** (for alarm limit 1) now appear in the display. Press **ENTER** to accept that you are setting up alarm limit 1.
3. Use the arrow buttons to select "HI". Then press **ENTER**.
4. Now use the arrow buttons again to set "+53500". Press **▶** or **◀** to move between digits. Press **▲** or **▼** to select the value for each digit. (Ignore the decimal point). Press **ENTER** to accept these digits.
5. Use the arrow buttons to select the decimal point position ("+5.3500"). Then press **ENTER** to accept this position.
6. Next, use the arrow buttons again to select the multiplier ("x1"). Press **ENTER** to accept this multiplier and save alarm limit 1.
7. Limit **1** for channel 7 is now set for a high value of +5.35. Continue pressing **ENTER** to step through alarm limit 2 and return to the Inactive Mode. Or, press **CANCL** to immediately return to the Inactive Mode.

Pressing **CANCL** while partway through setting limit **1** undoes any changes entered thus far for limit **1**, returning the instrument to Inactive Mode. Pressing **CANCL** while partway through setting limit **2** cancels entries made thus far for limit **2**, but does not affect any changes already made to limit **1**.

Mx+B Scaling

The menu for setting Mx+B scaling values takes you through the following steps:

- Set the M value (sign and number).
- Set the decimal point location for the M value.
- Set the multiplier for the M value (m, x1, k, M).
- Set the B value (sign and number).
- Set the decimal point location for the B value.
- Set the multiplier for the B value (m, x1, k, M).

Use **▲**, **▼**, **◀** and **▶** to cycle through the selections at each step. Then press **ENTER** to accept your choice and advance to the next step.

For example, to set an M value of 1.8 and a B value of 32 for channel 7, do the following:

1. Select channel 7 by pressing **▲** or **▼**.
2. Press **Mx+B** to begin Mx+B scaling setting for channel 7.
3. Use the arrow buttons to select "+18000". Press **▶** or **◀** to move between digits. Press **▲** or **▼** to select the value for each digit. (Ignore the decimal point). Press **ENTER** to accept these digits.

4. Use the arrow buttons to select the decimal point position (“+1.8000”). Then press to accept this position.
5. Next, use the arrow buttons again to select the multiplier (“x1”). Press to accept this multiplier.
6. Use the arrow buttons to select +00320. Then press .
7. Use the arrow buttons to select the decimal point position (“+0032.0”). Then press to accept this position.
8. Next, use the arrow buttons again to select the multiplier (“x1”). Press to accept this multiplier as the multiplier for the B value.

Mx+B scaling is now set at $1.8x+32$ for channel 7.

Pressing while partway through setting the M value undoes all changes entered thus far, returning the instrument to Inactive Mode. Pressing while partway through setting the B value cancels entries made thus far for the B value, but does not affect any changes already made to the M value.

SETTING THE SCAN INTERVAL

Press to set the scan interval. The latest value appears on the right display. The format of the display is H:MM:SS. Use and to move between digits. Use and to select the new value for a digit. Values ranging from 0:00:00 to 9:99:99 are allowed. Press to accept the displayed value.

Set the interval to 0:00:00 for continuous scanning. If you set the interval to a value shorter than the time required to measure all channels, scanning effectively becomes continuous.

USING THE MONITOR FUNCTION

The Monitor function repeatedly measures the displayed channel. Press to activate the Monitor function. Use and to change the monitored channel; undefined channels (those set to OFF) are automatically skipped over.

Since the instrument cannot take measurements on a channel that has not been set up, it responds with a long beep if you try to activate the Monitor function on a channel that is defined as OFF. Press or to find a channel that has been set up, then activate the Monitor function. If all channels are defined as OFF, you must first set up one or more channels before activating the Monitor function.

NOTE

The Monitor function does not update data in the Review array, an Autoprint listing, or data memory (2625A). These values are updated only with measurements taken by the Scan function.

USING THE SCAN FUNCTION

The Scan function takes measurements at the specified interval on all defined channels. Pressing **SCAN** to activate the Scan function causes all defined channels to be measured in sequence. This cycle repeats at the specified scan interval. When **SCAN** is pressed a second time, the Scan function is turned off, and the instrument returns to the Inactive Mode.

NOTE

During a scan, a channel set up with autoranging will momentarily slow the scanning rate whenever the correct range must be determined. This will occur during the initial scan; the instrument remembers the range for subsequent scans. Scans then occur at the normal measurement rate. If the input signal later changes sufficiently, the scanning rate will again slow momentarily while the instrument determines the new range.

If scanning is deactivated while the instrument is actually taking scan measurements, the display changes immediately, but the full scan is still completed. The instrument always completes a scan in progress.

You can also trigger a single scan of all defined channels. Select SINGLE (**SHIFT** **SCAN**) to scan all the defined channels once.

REVIEWING CHANNEL DATA

The instrument automatically stores minimum, maximum, and last-scanned values for each defined channel. These values are stored in the Review array and are updated with each set of scan measurements. Measurements taken by the Monitor function are not included in the Review array.

The contents of the Review array can be called up to the display when in Active or Inactive Mode by pressing **REVIEW**. The displayed channel must be defined (i.e., not OFF) to call up Review array data from Inactive Mode; otherwise, a long beep results.

You can move around in the Review array using the arrow buttons. The access scheme is shown in Table 2-3. Either the Review array or the Totalizer count can be displayed at one time; you must deactivate one before activating the other.

To remove the Review data from the display and restore the previous display, press **REVIEW** again, or press **CANCEL**.

To clear out the contents of the Review array, press **REVIEW** to call the review data up to the display, and then select CLEAR (**SHIFT** **REVIEW**). The entire array is then cleared. All array values, including the displayed value, are changed to "-----". If a scan is occurring when a review clear is requested, new review values are taken from the next scan. If the Scan function is not active, "-----" continues to be shown for all values.

Alarms are shown with the LAST review values. Refer to Alarm Indications in Section 3 for a description of alarm annunciation.

VIEWING THE TOTALIZER COUNT

The Totalizer continuously samples the Totalizer input on the rear panel. The present count can be called up to the display when in Active or Inactive Mode by pressing **TOTAL**. The word "totAL" appears on the right display, and the present Totalizer count appears on the left display.

The maximum count is 65535, after which "OL" is displayed. To reset the Totalizer to zero, press **TOTAL** to call the Totalizer value to the display, and then select ZERO (**SHIFT** **TOTAL**).

To remove the Totalizer value from the display and restore the previous display, press **TOTAL** again, or press **CANCL**.

Note that either the Review array or the Totalizer count can be displayed at one time; you must deactivate one before activating the other.

USING EXTERNAL DC POWER

The instrument can be powered from an external 9 to 16V dc source. Refer to Appendix A, Specifications, for additional information about dc power requirements.

Terminals for positive, negative, and ground connections are provided on the instrument rear panel. Figure 2-6 shows connection locations.








WARNING

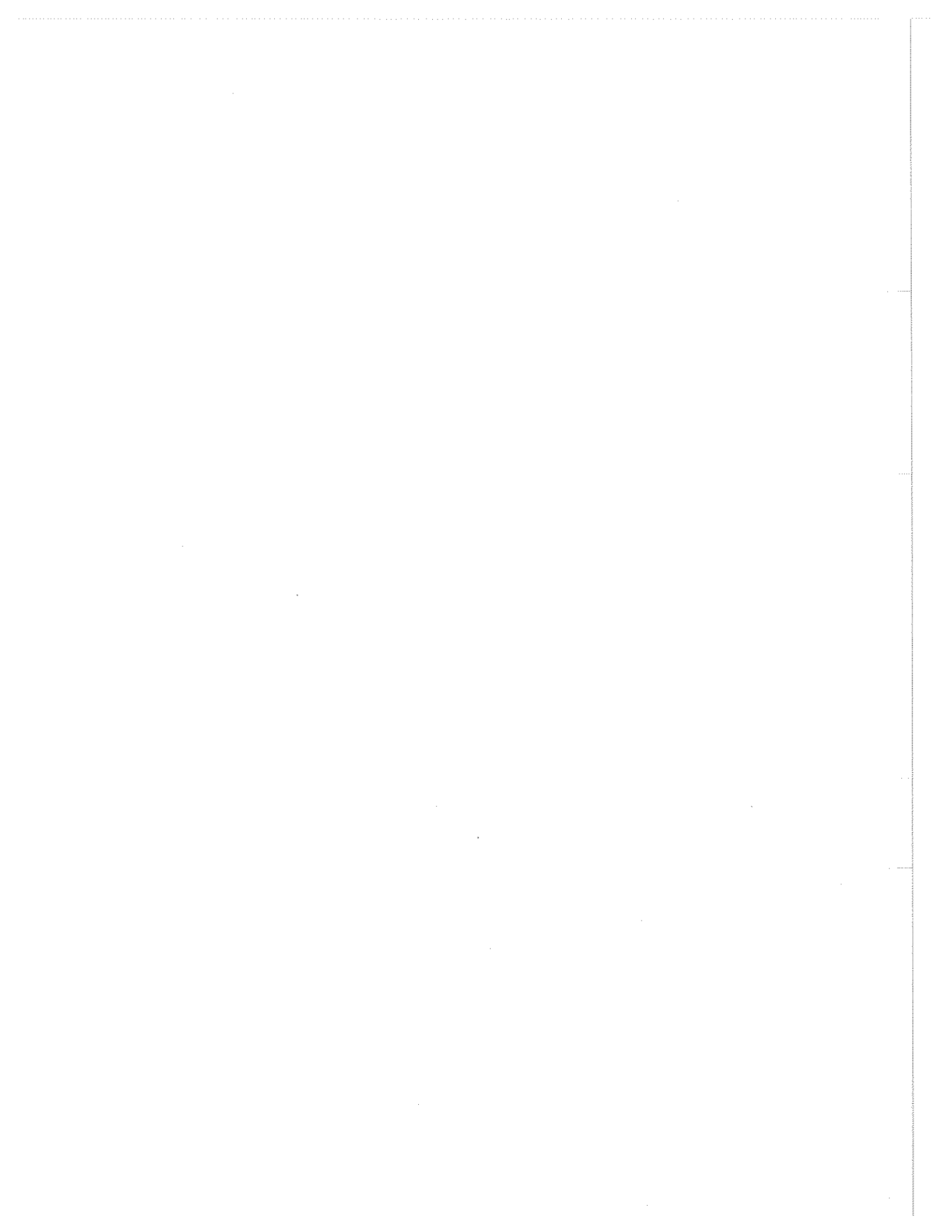
IF VOLTAGES GREATER THAN 50V ARE TO BE MEASURED, A SAFETY GROUND MUST BE ATTACHED TO THE REAR PANEL GROUND CONNECTOR WHEN THE INSTRUMENT IS OPERATED FROM BATTERY POWER.

USING THE RACK MOUNT KIT

Use the M00-200-634 Rack Mount Kit to mount the instrument in a standard 19-inch rack. First, rotate the two bottom feet on the instrument 180 degrees so that the support pads point up. Then install the instrument per the instructions provided with the Rack Mount Kit.

Table 2-3. Review Array

| ACTIVATE | REVIEW POINTS | DEACTIVATE |
|--|---|--|
|   20  0 |  ← →  LAST MIN MAX LAST MIN MAX |  or  |



Section 3

Operating the Instrument From the Front Panel

INTRODUCTION

Section 3 describes how to use the instrument features that were introduced in Section 2. The introductory information in Section 2 is designed to give you a feel for the instrument's controls and display. The information presented here in Section 3 adds more detail about connecting and operating the instrument.

OPERATING MODES

The instrument has three modes of operation. These modes are summarized as follows:

- Active Mode

The instrument is in Active Mode whenever the Monitor and/or Scan functions are enabled; "MON" and/or "SCAN" annunciators are lighted, as appropriate. Note that the Scan function can be activated by the scan interval timer, external trigger, alarm trigger, or a single scan command.

- Configuration Mode

The instrument is in Configuration Mode whenever any of the settings are being examined or changed. Examples of Configuration Mode are: channel function selection, alarm value setting, Mx+B scaling value setting, scan interval setting, and trigger type selection. During Configuration Mode, the "SET" annunciator is on, along with other annunciators indicating the parameter being set. Configuration Mode is summarized in Figure 3-1.

- Inactive Mode

The instrument is in Inactive Mode when no measurement functions are enabled and no instrument settings are being changed. This is a quiescent mode, from which Active or Configuration Mode can be entered. The display presents summary information, identifying the channel number (brightly lit, right display) and its present function (dimly lit annunciator).

OTHER DISPLAYED DATA

An array of "MIN", "MAX", and "LAST" values for each channel is updated whenever scan measurements are taken. This Review array can be displayed from Active or Inactive (but not Configuration) Mode by pressing **REVIEW**.

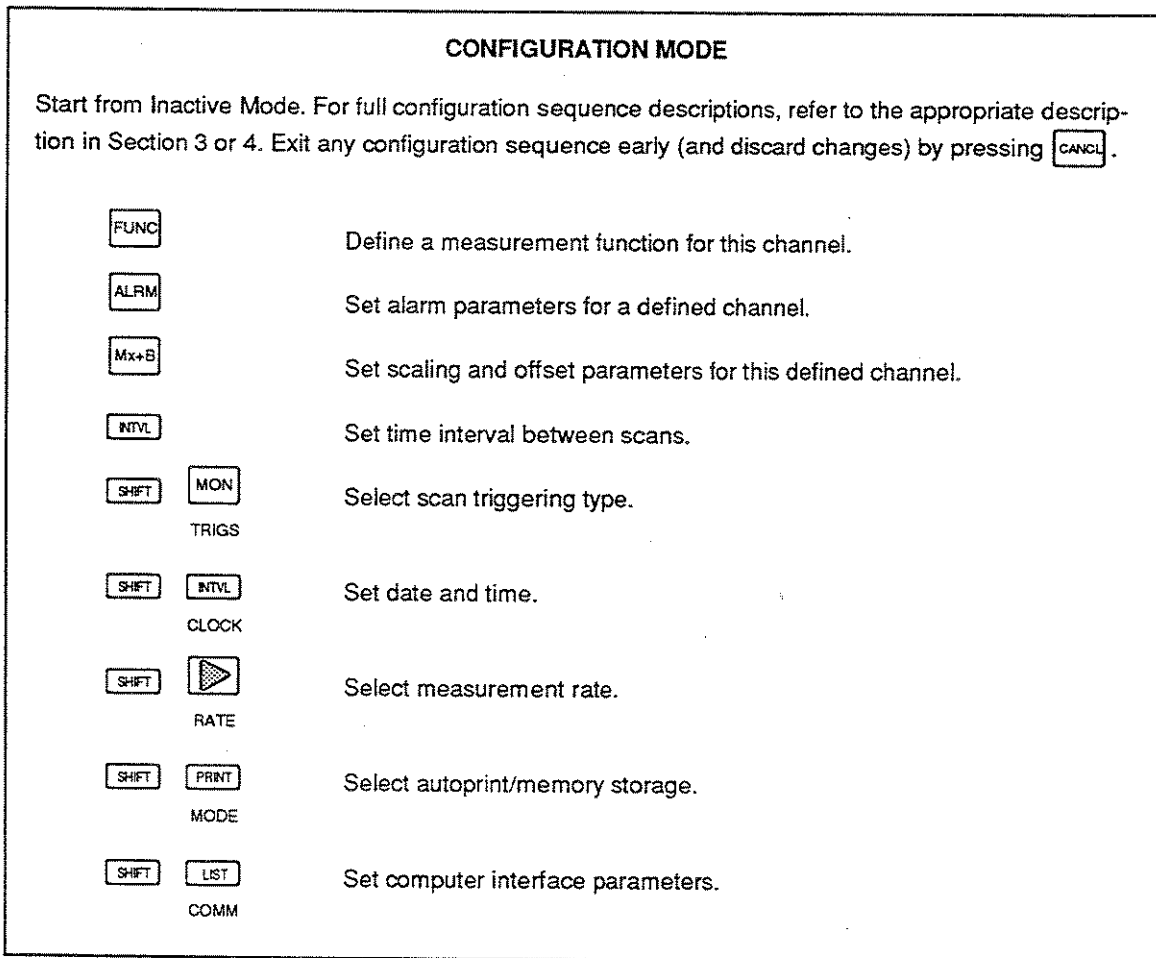


Figure 3-1. Configuration Mode

The constantly updated Totalizer count can also be displayed (Active or Inactive Mode only) by pressing **TOTAL**.

Note that either the Review array or the Totalizer count can be displayed at one time; you must deactivate one before activating the other. Deactivate the Review array by pressing **REVIEW** a second time. Deactivate the Totalizer display by pressing **TOTAL** a second time. Pressing **CANCL** also deactivates either function.

WHAT IS THE PRESENT CONFIGURATION?

If Power is Interrupted

All configuration settings (function, range, scan interval, etc.) are stored in nonvolatile memory. If power is interrupted (**POWER** pressed off or due to power loss), these settings are retained. When turned on, the instrument first executes a self test, then resumes the state it was in prior to interruption of power. This feature is handy for applications where power may be inadvertently lost; the instrument automatically resumes taking measurements, as originally configured, once power is restored.

If the Configuration is Reset

You can perform a Configuration Reset in either of two ways:

- From the front panel, press and hold when cycling POWER ON.
- Through the computer interface, send the *RST command.

Refer to Table 3-1 for the configuration reset settings.

CHANNEL CONFIGURATION

Configuration Mode involves selecting an entry from a list of choices (and may involve setting number values.) Measurements are not taken when the instrument is in Configuration Mode. Configuration Mode is discussed throughout this section; it is used whenever a parameter for a channel or for the whole instrument needs to be set.

Table 3-1. Configuration Reset Settings

| | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|------------------|----|----|---|---|----------------------|---|---|---|---|--|---|---|----|----|--|----|----|----|----|--|----|----|----|----|--|----|--|--|--|
| Perform a Configuration Reset to restore these conditions by pressing and holding <input type="button" value="CANCEL"/> while cycling POWER ON. | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Channels 0 - 20: | OFF. | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Measurement rate: | Slow. | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Scaling (M): | 1 (all channels) | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| (B): | 0 (all channels) | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Alarm parameters: | Limit-1 and Limit-2 OFF. All limit values 0. | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Alarm assignments: | Channels 0-3 assigned to outputs 0-3, respectively. Channels 4-20 assigned to digital I/O lines 4-7, as follows (appropriate channels are OR'ed to drive each I/O line): | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | <table border="1"> <tr> <td>DIGITAL I/O LINE</td> <td>4</td> <td>5</td> <td>6</td> <td>7</td> </tr> <tr> <td>ASSIGNED TO CHANNELS</td> <td>4</td> <td>5</td> <td>6</td> <td>7</td> </tr> <tr> <td></td> <td>8</td> <td>9</td> <td>10</td> <td>11</td> </tr> <tr> <td></td> <td>12</td> <td>13</td> <td>14</td> <td>15</td> </tr> <tr> <td></td> <td>16</td> <td>17</td> <td>18</td> <td>19</td> </tr> <tr> <td></td> <td>20</td> <td></td> <td></td> <td></td> </tr> </table> | DIGITAL I/O LINE | 4 | 5 | 6 | 7 | ASSIGNED TO CHANNELS | 4 | 5 | 6 | 7 | | 8 | 9 | 10 | 11 | | 12 | 13 | 14 | 15 | | 16 | 17 | 18 | 19 | | 20 | | | |
| DIGITAL I/O LINE | 4 | 5 | 6 | 7 | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| ASSIGNED TO CHANNELS | 4 | 5 | 6 | 7 | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | 8 | 9 | 10 | 11 | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | 12 | 13 | 14 | 15 | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | 16 | 17 | 18 | 19 | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | 20 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Scan interval time: | 0:00:00 (continuous) | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Review values (MIN, MAX, LAST): | cleared for all channels. | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Digital I/O lines: | set high (non-alarm) | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Totalizer: | 0, with debounce disabled. | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Autoprint: | OFF. | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Memory Storage (2625A only): | OFF, empty | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| RTD R0 parameter: | 100.00 (all channels) | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Open Thermocouple Detection (OTC): | enabled. | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |

Selecting Channel, Function, and Range

Steps necessary for setting each type of measurement function are shown in the following tables:

- DC Voltage Measurement (Table 3-2)
- AC Voltage Measurement (Table 3-2)
- Resistance Measurement (Table 3-3)
- Frequency Measurement (Table 3-4)
- Temperature Measurement Using Thermocouples (Table 3-5)
- Temperature Measurement Using RTDs (Table 3-6)

Additional channel configuration steps (alarms, scaling, etc) are discussed later in this section.

NOTE

During a scan, a channel set up with autoranging will momentarily slow the scanning rate whenever the correct range must be determined. This will occur during the initial scan, with the instrument remembering the range for subsequent scans. Scans then occur at the normal measurement rate. If the input signal later changes sufficiently, the scanning rate will again slow momentarily while the instrument determines the new range.

AC voltage measurements can be made over a wide range of frequencies. The instrument's true rms converter insures accuracy for both sine wave and non-sine wave signals. Refer to Section 5 for additional information about true rms measurements.

Resistance measurements can be made to determine either resistance or the value of another directly related parameter. Slide wire potentiometers, thermistors, and other sensors with variable resistance outputs are often used to indicate temperature, position, and other physical parameters. The instrument measures resistance by passing a current through both a known resistance and the sensed resistance. The resulting voltages are measured and appropriate conversions are applied to the measurement, yielding a displayed output in ohms.

Frequency is measured by counting cycles for a known time period. The measurement represents the frequency observed during the sampling time. The instrument can measure a wide range of frequency inputs. Test applications might include measuring line voltage sine wave signals or measuring the output of a voltage-to-frequency converter used in a servo system.

Thermocouple temperature measurements can be made using linearizations for the following nine standard thermocouples: J, K, E, T, N, R, S, B, C. You specify what type of thermocouple is connected to the channel. The reference temperature sensor is built into the Input Module. The instrument applies compensation automatically for thermocouple channels. Open thermocouple detection is indicated by "otc" in the left display. The thermocouples are further described in Table 3-14.

Table 3-2. DC Voltage, AC Voltage
















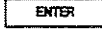








| CHANNEL | | FUNCTION (DC or AC) | | RANGE (Note) | |
|--|--|---|--|--|---|
| PRESS THESE BUTTONS: |   |    |   |   |  |
| TO SELECT FROM THESE CHOICES: | 0 1 . . 20 | OFF V DC V AC Ω Hz °C or °F | Auto 300.00 mV 3.0000V 30.000V 150.00°V | (Completes Selection and returns to Inactive Mode) | |
| * 300.00 CH 0, 1, and 11 | | | | | |
| <p>Note: Determine the highest ac or dc voltage value anticipated for this channel. Then select a range large enough to accommodate this value. If the highest voltage cannot be anticipated, select "Auto".</p> | | | | | |

Table 3-3. Resistance

| CHANNEL | | FUNCTION | | RANGE (Note 1) | | TERMINALS (Note 2) | |
|--|--|---|--|--|--|--|---|
| PRESS THESE BUTTONS: |   |    |   |   |   |   |  |
| TO SELECT FROM THESE CHOICES: | 0 1 . . 20 | OFF V DC V AC Ω Hz °C or °F | Auto 300.00 Ω 3.0000 kΩ 30.000 kΩ 300.00 kΩ 3.0000 MΩ 10.000 MΩ | 2T 4T | (Completes selection and returns to Inactive Mode) | | |
| <p>Note 1. Determine the highest resistance value anticipated for this channel. Then select a range large enough to accommodate this value. If the highest resistance cannot be anticipated, select "Auto".</p> <p>Note 2. "4T" allowed on channels 1 through 10 only. For each 4T channel, an additional channel (10 channels higher) is reserved to provide the third and fourth terminals. Channels 11 through 20 are available for this purpose. Any channel so reserved cannot be used for other definitions.</p> | | | | | | | |

3/FRONT PANEL OPERATION

Table 3-4. Frequency










| | CHANNEL | FUNCTION | | RANGE (Note) | |
|---|--|---|--|---|---|
| PRESS THESE BUTTONS: |   |  |   |  |    |
| TO SELECT THESE CHOICES: | 0 1 . . 20 | OFF V DC V AC Ω Hz $^{\circ}\text{C}$ or $^{\circ}\text{F}$ | | Auto 900.00 Hz 9.0000 k Hz 90.000 k Hz 900.00 k Hz 1.0000 M Hz | (Completes selection and returns to Inactive Mode) |
| <p><i>Note: Determine the highest frequency anticipated for this channel. Then select a range large enough to accommodate this value. If the highest frequency cannot be anticipated, select "Auto". "Auto" does not cause any delays for frequency measurements.</i></p> | | | | | |

Table 3-5. Thermocouple Temperature










| | CHANNEL | FUNCTION | | TYPE (Note) | |
|--|--|---|--|---|---|
| PRESS THESE BUTTONS: |   |  |   |  |    |
| TO SELECT THESE CHOICES: | 1 . . 20 | OFF V DC V AC Ω Hz $^{\circ}\text{C}$ or $^{\circ}\text{F}$ | | J K E T N R S b C Pt | (Completes selection and returns to Inactive Mode) |
| <p><i>Note: The nine thermocouple choices and related temperature measurement ranges are:</i></p> <ul style="list-style-type: none"> "J" Type J (-210 to 760 $^{\circ}\text{C}$) "K" Type K (-270 to 1372 $^{\circ}\text{C}$) "E" Type E (-270 to 1000 $^{\circ}\text{C}$) "T" Type T (-270 to 400 $^{\circ}\text{C}$) "N" Type N (-270 to 1300 $^{\circ}\text{C}$) "R" Type R (0 to 1767 $^{\circ}\text{C}$) "S" Type S (0 to 1767 $^{\circ}\text{C}$) "b" Type B (0 to 1820 $^{\circ}\text{C}$) "C" Type C (0 to 2316 $^{\circ}\text{C}$)* (Tungsten - 5% Rhenium vs. Tungsten - 26% Rhenium) <p>"Pt" selects RTD temperature measurement (DIN/IEC 751). See Table 3-6.</p> <p>* Hoskins Engineering Co.</p> | | | | | |

Table 3-6. RTD Temperature

| | CHANNEL | FUNCTION | TYPE (Note 1) | TERMINALS (Note 2) | R0 (Ice Point) (Note 3) |
|--|---------|--------------|------------------|-----------------------|---|
| PRESS THESE BUTTONS: | | FUNC | | | |
| | | | | | |
| | | ENTER | | ENTER | ENTER |
| | | | | | ENTER |
| | | | | | |
| TO SELECT FROM THESE CHOICES: | 0 | OFF | J | 2T | 100.00 |
| | 1 | V DC | K | 4T | <i>(Completes selection and returns to Inactive Mode)</i> |
| | . | V AC | E | | |
| | . | Ω | T | | |
| | . | Hz | N | | |
| | 20 | °C or °F | R | | |
| | | | S | | |
| | | | b | | |
| | | | C | | |
| | | | Pt | | |
| <p>Note 1. Pt* selects RTD temperature measurement (DIN/IEC 751). See Table 3-5 for J, K, E, T, N, R, S, b, and C thermocouple selections.</p> <p>Note 2. 4T not available on channels 0 and 11 through 20.</p> <p>Note 3. R0 default is 100.00Ω. A unique R0 value can be set for each channel.</p> | | | | | |

NOTE

Temperature units can be displayed in degrees Celsius (°C) or Fahrenheit (°F). To switch this setting between °C and °F, start with the instrument powered off, then press and hold while pressing POWER ON. The setting can also be changed through the Computer Interface with the TEMP_CONFIG command (refer to Section 4.)

RTD temperature measurement uses a resistance-temperature detector (RTD). RTDs, while usually larger and more expensive than thermocouples, are frequently used where accuracy, stability, and repeatability are important. The resistance of an RTD varies directly with the sensor temperature. Passing a current through this resistance generates a proportional voltage that can be accurately translated into a temperature reading. The instrument supports the DIN/IEC 751 RTD type.

Setting Alarms

ALARM LIMITS



























NOTE

If you press for a channel that is OFF, an error beep will result. Therefore, for a new channel, use to define the channel's measurement function before selecting .

3/FRONT PANEL OPERATION

Two alarm limits (**1** and **2**) can be defined for each analog input channel. An alarm occurs when the measured value on the channel moves above the HI value or below the LO value. With the desired channel already selected from Inactive Mode, verify or change these limits using the procedure shown in Table 3-7. If necessary, refer to “Entering and Changing Numeric Values” for a more detailed description of the number changing technique used here.

Table 3-7. Alarm Selection

| CHANNEL | | ALARM | | | | |
|--|--|--|--|--|---|--|
| PRESS THESE BUTTONS |   |  |   |  | Complete Alarm Parameters (Below)  | |
| TO SELECT FROM THESE CHOICES: | 0 1 • • 20 | 1 or 2 | | | | |
| ALARM PARAMETERS | | | | | | |
| | ALARM LIMIT (Note 1) | SIGN, VALUE | DECIMAL POINT POSITION | MULTIPLIER (Note 2) | | |
| PRESS THESE BUTTONS: |     |     |     |     |    | |
| TO SELECT FROM THESE CHOICES: | OFF HI LO | ±00000 | 0.0000 00.000 000.00 0000.0 | m x1 k M | | |
| <p>Note 1. Alarm limit can be cycled through HI, LO, and OFF without resetting the alarm value.</p> <p>Note 2. Multiplier definitions (available for each decimal point position):</p> <p style="margin-left: 100px;">m .001 x1 1.0 k 1000 M 1000000</p> | | | | | | |

Alarm evaluation is not carried out for a channel if:

- The limit sense is changed to “OFF”. Alarm checking and the alarm limit values are re-enabled by setting limit sense to “HI” or “LO”.
- An open thermocouple has been detected on that channel (thermocouple temperature function only).

ALARM INDICATIONS

Generally, the ALARM annunciator is dimly lit whenever the last measurement on any channel was found to be in alarm. When the displayed channel is in alarm during review, the ALARM annunciator flashes, LIMIT is lit, and additional annunciators show the alarm limit as **1** and/or **2** and the alarm sense as “HI” or “LO”.

Alarm annunciation is disabled when the instrument is in Inactive or Configuration Mode.

ALARM annunciation and evaluation follow these rules:

1. When any channel reading from the latest scan is in alarm (but the presently displayed channel is not in alarm or a scan interval countdown is in progress):

“ALARM” annunciator is dimly lit.
2. If the presently displayed channel (i.e., the Monitor or the Review array Last channel) is in alarm:

“ALARM” annunciator flashes. **1** and/or **2** limit annunciator on brightly. “HI” and/or “LO” sense annunciator on brightly. “LIMIT” annunciator on brightly.
3. If the present channel is in alarm with a value of “OL” displayed:

“OL” means that a very large positive number is used for alarm evaluation.

“-OL” means that a very large negative number is used for alarm evaluation.
4. If the present channel shows a value of “otc”:

Alarm limit checking is no longer occurring for that channel. Alarm status remains as it was prior to the “otc” condition.
5. If no channels are in alarm:

All alarm-related annunciators (“ALARM”, **1**, **2**, “HI”, “LO”, “LIMIT”) are off.

Alarms encountered during scan measurements can generate a low level on an assigned output. An IEEE-488.1 SRQ can also be generated when an alarm condition is set or cleared.

RESETTING ALARM CONDITIONS

When review values are cleared, all alarm status is also removed. This action occurs in the following instances:

- A channel function is changed or set to OFF.
- A channel range is changed.
- CLEAR (**SHIFT** **REVIEW**) is selected while Review array data is being examined.
- Configuration Reset occurs (power up **CANCL** or *RST)

Changing an alarm definition clears the alarm status for the changed alarm limit.

Using the Digital I/O Lines

The rear panel Digital I/O Connector provides eight lines (numbered 0 through 7) that are individually usable as inputs or outputs. No preconfiguring for the use of these lines is necessary; an input low signifies that the line is an input, and an output low signifies that the line is an output. Output low conditions take precedence over input low conditions.

Both alarm limits **1** and **2** for channels 0 through 3 are permanently assigned to alarm outputs 0 through 3, respectively, on the rear panel Alarm Output Connector.

At any Configuration Reset (power up **CANCL** or computer interface *RST), alarm limits on channels 4 through 20 are assigned to Digital I/O lines 4 through 7 in the "ORed" pattern shown in Table 3-8. These assignments can be changed via the Computer Interface. Each limit (**1** or **2**) for a channel can be assigned to any one digital output.

Table 3-8. Initial Alarm Assignments, Digital I/O Lines 4 Through 7

| | | | | |
|----------------------|----|----|----|----|
| DIGITAL I/O LINE | 4 | 5 | 6 | 7 |
| ASSIGNED TO CHANNELS | 4 | 5 | 6 | 7 |
| | 8 | 9 | 10 | 11 |
| | 12 | 13 | 14 | 15 |
| | 16 | 17 | 18 | 19 |
| | 20 | | | |

(Appropriate channels are OR'ed to drive each I/O line.)

All Digital I/O lines are set high (non-active) whenever power is cycled. These lines remain high until a new scan detects an alarm condition on an assigned limit or until a new Computer Interface command is received.

NOTE

Measurements taken with the Monitor function do not affect the digital outputs.

At the completion of a scan, an alarm condition sets the assigned digital output to a logic 0 (low) state. The digital output returns to a logic 1 (high) state when all assigned alarm conditions are cleared. Note that digital outputs for alarms are updated only at the end of each scan. This technique prevents unnecessary toggling of the digital lines during a scan.

Mx+B Scaling

Any analog input channel (0 through 20) can be assigned scaling ("M" and "B") values that are applied to subsequent measurements of that channel. Scaling values can be set via the front panel or over a computer interface.

The "M" value is used as a multiplier of the actual reading; the "B" value is then added in the same units as the resultant. If no scaling values are specified for a channel, the Configuration Reset values of 1 ("M") and 0 ("B") are used, leaving the measurement reading unaltered.

In the Inactive Mode, the "Mx+B" annunciator lights to indicate that an M value other than 1 and/or a B value other than 0 has been specified for the displayed channel. When a measurement is displayed for a channel so configured, no measurement units ("Ω", "V", etc.) are shown.

NOTE

If you press for a channel that is OFF, an error beep will result. Always use to define the channel's measurement function before using to define the scaling values.

You can familiarize yourself with the Mx+B setup procedure by pressing . Then press a few times to cycle through the elements of the scaling values. If only is pressed, no changes are introduced. Note that the scaling value element that can be changed at any point is brightly lit (solid for digits, flashing for other annunciators); all other elements are dimly lit at this time. Table 3-9 presents a full description of the Mx+B configuration sequence.

If you press while setting the "M" value (anytime prior to showing the "B" value), no changes entered thus far are stored. If you press while setting the "B" value, changes to M are stored and changes to "B" are discarded. In either case, the instrument returns to Inactive Mode.



































The final press shown in Table 3-9 stores all changes and returns the instrument to Inactive Mode.

NOTE

Once Mx+B scaling values are defined for a channel, the instrument uses the range chosen for the B value as the display range for the resulting scaled value. If the result is larger than the display range chosen, an overload ("OL") is displayed.

3/FRONT PANEL OPERATION

Table 3-9. Mx+B Selection

| | CHANNEL | SIGN, M VALUE | DECIMAL POINT POSITION | MULTIPLIER (Note 1) |
|--|--|---|---|---|
| PRESS THESE BUTTONS: |   |     |     |     |
| | |  |  |  |
| TO SELECT FROM THESE CHOICES: | 0 1 . . 20 | ±00000 | 0000.0 000.00 00.000 0.0000 | m x1 k M (Continue to B value below) |
| | | SIGN, B VALUE | DECIMAL POINT POSITON | MULTIPLIER (Note 1) |
| PRESS THESE BUTTONS: | |     |     |     |
| | |  |  |  |
| TO SELECT FROM THESE CHOICES: | | ±00000 | 0000.0 000.00 00.000 0.0000 | m x1 k M |
| <i>Note 1. Multiplier definitions:</i> | | | | |
| | <i>m</i> | <i>.001</i> | | |
| | <i>x1</i> | <i>1.0</i> | | |
| | <i>k</i> | <i>1000</i> | | |
| | <i>M</i> | <i>1000000</i> | | |
| <i>Note 2. If you press  while setting the "M" value (anytime prior to showing the "B" value), no changes entered thus far are stored. If you press  while setting the "B" value, changes to M are stored and changes to "B" are discarded. In either case, the instrument returns to Inactive Mode.</i> | | | | |

For example, you could monitor the output of a high-pressure pump by using Mx+B scaling to convert the millivolt output of a pressure transducer to PSI. Such a transducer might output 0 to 30 mV, corresponding to pressure of 0 to 5000 PSI. The scaling values to convert the transducer millivolts to PSI would be $M = 166.67 \text{ PSI/V}$ and $B = 0 \text{ PSI}$, calculated as follows:

$$M = \frac{\text{Max Display Value} - \text{Min Display Value}}{\text{Max Transducer Output} - \text{Min Transducer Output}} = \frac{5000}{30} = 166.67$$

$$B = \text{Min Display Value} - (M * \text{Min Transducer Output}) = 0 - 166.67 * 0 = 0$$

When a channel that has had scaling values entered is scanned or monitored, the resulting scaled value is displayed without the underlying function annunciation. The decimal point location and scale factor for the result is fixed by the "B" value entered. If the scaled value is too small to be represented in 5 digits given this scaling, zero is displayed. If the scaled value is too large, "OL" (overload) is displayed (even if the underlying measurement was on scale.) "OL" is also displayed if the measurement is in overload.

If scanning or monitoring a scaled channel gives unexpected results (like zero or overload), make the following checks:

1. Verify that the values and scale factors of "M" and "B" are set as intended.
2. Verify that the desired values are the correct values: calculate the result for a few measured values using the entered "M" and "B".
3. Temporarily set "M" to 1 and "B" to 0; verify that the measurements are returning values in the expected range. Unexpected measurements could result from a wiring error or the wrong range/function being selected.

INSTRUMENT CONFIGURATION

Entering and Changing Numeric Values

Use the arrow buttons to enter or change a numeric value. Use \leftarrow and \rightarrow to select the digit to change. (The selected digit is brightly lit.) Use \uparrow and \downarrow to change the value for that digit.

Setting the scan interval provides a good example of entering a numeric value. Press $\boxed{\text{INTVL}}$ to set the scan interval. Now try pressing \leftarrow and \rightarrow a few times to select different digits. (The selected digit is always brightly lit.) For any digit, press \uparrow or \downarrow to change the value. Refer to Table 3-10 for details of setting the scan interval.

This number editing technique occurs during Configuration Mode operations whenever you are setting a numeric value. Instances of number editing include the following:

- R0 (RTD) Table 3-6
- Alarms Table 3-7
- Mx+B Scaling Table 3-9
- Scan Interval Time Table 3-10
- Time/Date Table 3-13

Selecting Scan Interval

The scan interval is the period between starts of measurement scans. The resolution of the scan interval is one second; the maximum scan interval is 9 hours: 99 minutes: 99 seconds. The format of the scan interval is x:xx:xx; 1:30:45 translates to 1 hour, 30 minutes and 45 seconds.

If scan interval of "0:00:00" is specified, continuous scanning will occur when the Scan function is activated. If more than a few seconds are required to scan all defined channels, a short scan interval (a few seconds) effectively becomes continuous scanning.

If the Monitor function is turned on when the instrument is continuously scanning, a Monitor channel measurement is still taken between each scan.

Table 3-10 illustrates the button sequence used for setting scan interval. If necessary, refer to "Entering and Changing Numeric Values" for a more detailed description of the number editing technique used here.

Table 3-10. Scan Interval

| | HOUR | MINUTE | | | SECOND | |
|--------------------------------|---|---------|---------|---------|---------|---------|
| PRESS THESE BUTTONS: | | | | | | |
| TO CHANGE THE INDICATED DIGIT: | 0:00:00 | 0:00:00 | 0:00:00 | 0:00:00 | 0:00:00 | 0:00:00 |
| Note: | Go backward (from SECOND to MINUTE to HOUR) by pressing . Press at any time to accept the displayed scan interval and exit scan interval selection. Press at any time to exit interval selection without storing any changes. | | | | | |

Selecting the Measurement Rate

The slow measurement rate provides the highest accuracy and resolution. A fast rate can be selected, but keep in mind that fast rate provides one less digit of resolution than does slow rate. Measurement rate selection is illustrated in Table 3-11.




Table 3-11. Measurement Rate Selection

| | | | |
|-------------------------------|----------|-------------|--|
| PRESS THESE BUTTONS: | RATE () | | |
| TO SELECT FROM THESE CHOICES: | | SLO FAST | (Completes selection and returns to Inactive Mode) |

Triggering

To set the scan triggering type from the front panel, use the procedure shown in Table 3-12.



Table 3-12. Trigger Type Selection

| | | | |
|---|-------------------|---|--|
| PRESS THESE BUTTONS: | TRIGS (SHIFT MON) |  |  |
| TO SELECT FROM THESE CHOICES: | |  | |
| | | OFF | |
| | | On | |
| | | ALAr | |
| <p><i>Note: The three trigger types signify:</i></p> <p>"OFF" External triggering is disabled. Scan trigger is controlled by scan interval.</p> <p>"On" External triggering is enabled. A low input on the rear-panel TR terminal affects scanning as follows:</p> <p><i>If the instrument is in Inactive Mode, or just the Monitor Function is on, the low input enables scanning. When the signal on the TR terminal returns to high, scanning is disabled.</i></p> <p><i>If scanning is already enabled, the external trigger initiates a single scan. If a scan is already in progress, this request is ignored.</i></p> <p>"ALAr" An alarm condition on the monitor channel automatically triggers a scan. (External triggering is disabled.)</p> | | | |

External Triggering

The external trigger setting offers additional control of scan starts through a separate trigger line on the rear panel. Refer to Section 5 for an in-depth discussion of external triggering.

Changing the Temperature Unit















The displayed temperature unit can be degrees Celsius (°C) or Fahrenheit (°F). To switch this setting, start with the instrument powered off, then press and hold  while pressing POWER ON. After the instrument beeps and the new temperature unit is shown in the display, release .

The units setting can also be changed through the Computer Interface with the TEMP_CONFIG command (refer to Section 4.)

Setting Date and Time of Day

The instrument features a built-in, battery-maintained clock and calendar. Verify or change the settings using the steps shown in Table 3-13. If necessary, refer to “Entering and Changing Numeric Values” for a more detailed description of the number changing technique used here.

Table 3-13. Date/Time Selection

| | YEAR “YEAR” | MONTH.DAY “Mn.dY” | HOUR.MINUTE “Hr.nn” |
|---|---|---|---|
| PRESS THESE BUTTONS: | CLOCK (SHIFT INTVL)  |  |  |
| |  |  |  |
| |  |  |  |
| |  |  |  |
| | | ENTER | ENTER |
| | | | ENTER |
| TO SELECT FROM THESE RANGES: | 00-99 | 01-12.01-31 | 00-23.00-59 |
| <p>Note: The last  press completes clock and calendar setting and returns the instrument to Inactive Mode.</p> <p>Pressing  during this sequence also returns the instrument to Inactive Mode; all entries to this point are discarded, and the clock/calendar settings are left unchanged.</p> | | | |

MEASUREMENT CONNECTIONS

DC Volts, AC Volts, Frequency, and Thermocouples

Any analog input channel (0 through 20) can be used to measure dc volts, ac volts, or frequency. For channel 0, use the two terminals on the front panel. For channels 1 through 20, use the H (high) and L (low) inputs on the rear panel Input Module.

NOTE

The terminals for channel 0 on the front panel do not support thermocouple measurements.

Front panel channel 0 and Input Module channels 1 and 11 accept a maximum input of 300V dc or ac rms. All other channels (2 through 10 and 12 through 20) accept a maximum of 150V dc or ac rms.

Use the following procedure for connections to the Input Module:

1. Remove the Input Module from the rear panel.
2. Loosen the two large screws on top and open the module.

3. Connect wires to H (high) and L (low) terminals for each channel.
4. Thread these wires through the strain-relief pins and out the back of the module. Refer to Figure 3-2.
5. Close the module cover, secure the screws, and put the module back in the instrument.

Resistance and RTD

For all channels (0 through 20), 2-terminal resistance or RTD measurements are allowed. Four-terminal measurements can be made on channels 1 through 10 only. Refer to Figure 3-3.

For each channel configured for 4-terminal measurements (channels 1-10 only), a second channel (numbered 10 higher than the first) becomes unavailable for any other type of measurement. For example, using channel 7 to make 4-terminal resistance measurements requires the use of input terminals for both channels 7 and 17. Channel 17 cannot be used to take any other measurements as long as channel 7 remains configured for 4-terminal measurements.

Table 3-14. Thermocouple Ranges

| POSITIVE LEAD | | POSITIVE LEAD COLOR | | NEGATIVE LEAD* MATERIAL | USABLE RANGE (°C) |
|---------------|---------------------------|---------------------|--------|----------------------------|----------------------|
| TYPE | MATERIAL | (ANSI) | (IEC) | | |
| J | Iron | WHITE | BLACK | Constantan | -210 to 760 |
| K | Chromel | YELLOW | GREEN | Alumel | -270 to 1372 |
| E | Chromel | PURPLE | VIOLET | Constantan | -270 to 1000 |
| T | Copper | BLUE | BROWN | Constantan | -270 to 400 |
| N | NISIL-NICROSIL | | | | -270 to 1300 |
| R | Platinum | BLACK | ORANGE | Platinum (13% Rhodium) | 0 to 1767 |
| S | Platinum | BLACK | ORANGE | Platinum (10% Rhodium) | 0 to 1767 |
| B | Platinum (30% Rhodium) | GRAY | | Platinum (6% Rhodium) | 0 to 1820 |
| C** | Tungsten (5% Rhenium) | WHITE | | Tungsten (26% Rhenium) | 0 to 2316 |

*ANSI negative lead always RED, IEC negative lead always WHITE
 **Hoskins Engineering Co.

3/FRONT PANEL OPERATION

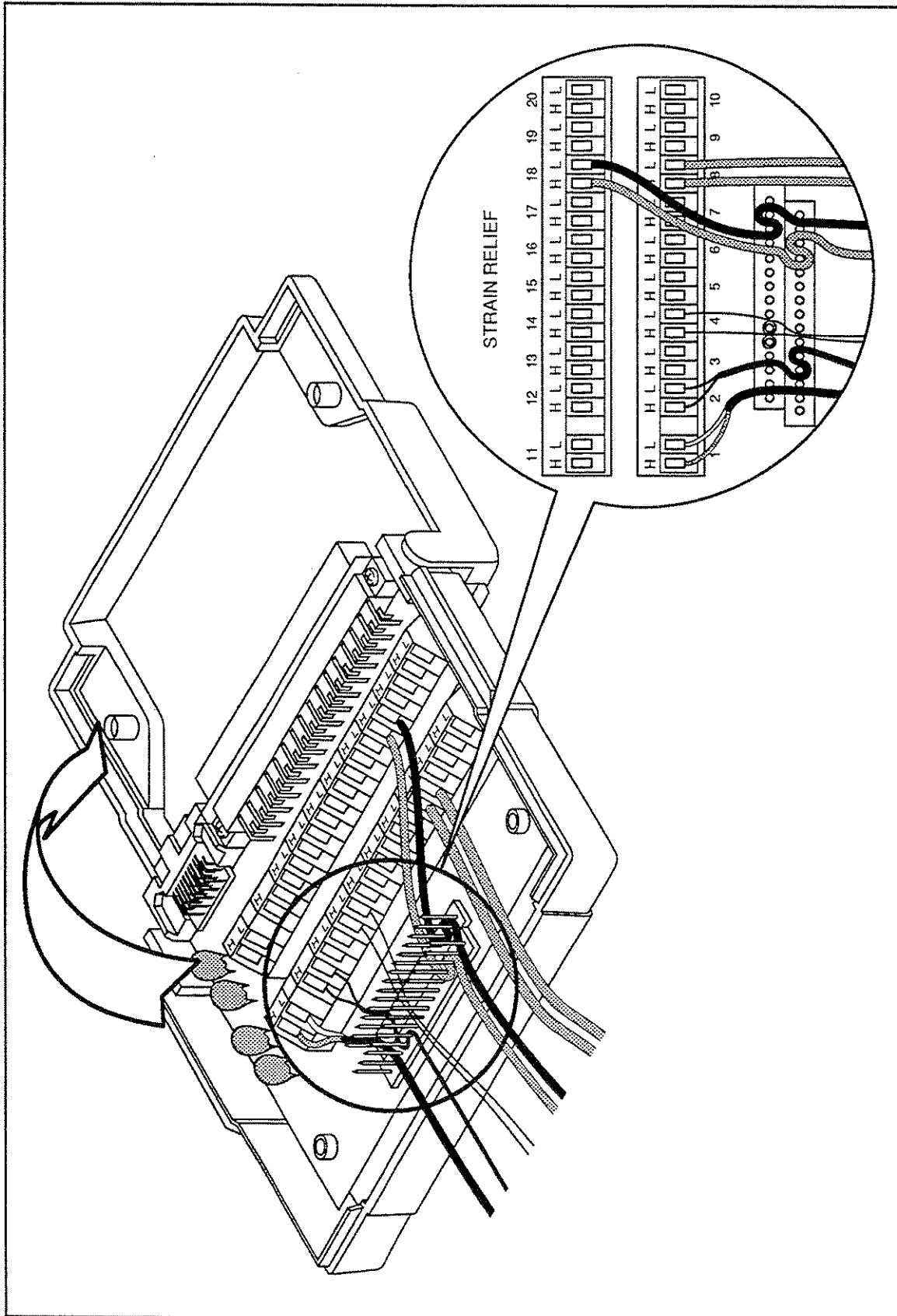
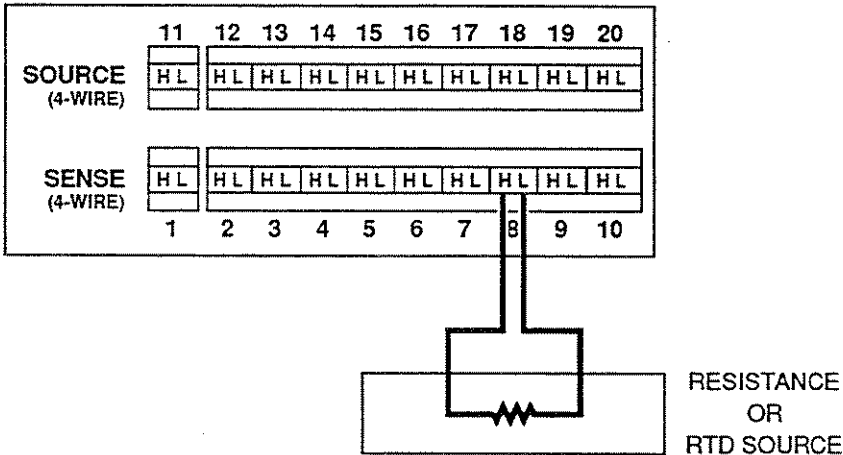


Figure 3-2. 2620A-100 Input Module

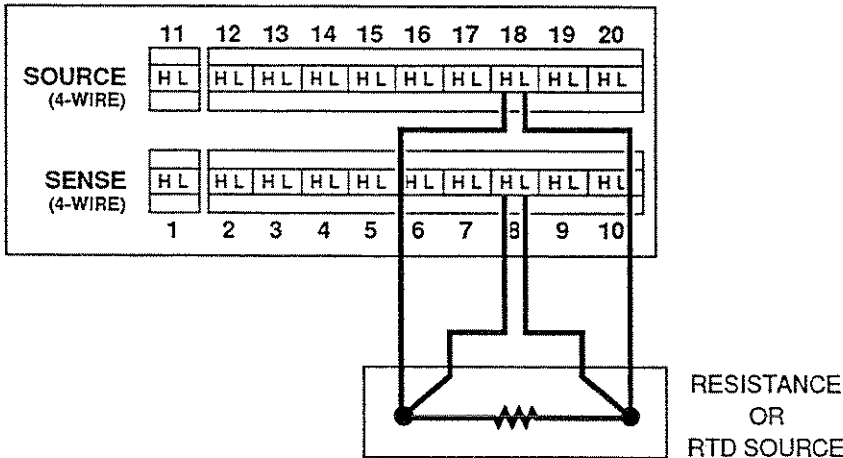
2-WIRE (2T) CONNECTION



USE H AND L TERMINALS FOR ANY CHANNEL.

- CHANNEL 0 ON FRONT PANEL
- CHANNELS 1 THROUGH 20 ON REAR PANEL INPUT MODULE (CHANNEL 8 SHOWN HERE).

4-WIRE (4T) CONNECTION



USE H AND L TERMINALS FOR TWO CHANNELS ON REAR PANEL INPUT MODULE. CONNECTIONS FOR CHANNEL 8 SHOWN HERE WITH CHANNEL 18 PROVIDING ADDITIONAL TWO CONNECTIONS.

FOR EACH 4-WIRE CONNECTION, ONE SENSE CHANNEL (1 THROUGH 10) AND ONE SOURCE CHANNEL (SENSE CHANNEL NUMBER +10 = 11 THROUGH 20) ARE USED.

Figure 3-3. 2T and 4T Connections

3/FRONT PANEL OPERATION

Use the following procedure for resistance or RTD measurement connections to the Input Module:

1. Remove the Input Module from the rear panel.
2. Loosen the two large screws on top and open the module.
3. Connect wires to H (high) and L (low) terminals for each channel (channel 7 for 2-terminal configuration or channels 7 and 17 for 4-terminal configuration, in this example.)
4. Thread these wires through the strain-relief pins and out the back of the module. Refer to Figure 3-2.
5. Close the module cover, secure the screws, and put the module back in the instrument.

TOTALIZING

General

Event counting (totalizing) is commonly used on production lines for counting items. The instrument counts events by detecting low-to-high voltage transitions; each low-to-high transition increments the totalizer value by one. The maximum count is 65535; "OL" (for "overload") is displayed when the count exceeds this limit.

Connections

The totalizing input is made at the input labeled " Σ " (sigma) on the rear panel Digital I/O Connector (see Figure 3-4). This input accepts a minimum input of 2.0V pk, which translates to 1.4V rms for a sinewave or 1V rms for a square wave. If the input is a contact-closure type, input debouncing of 300 Hz (1.67 ms) is available. A maximum rate of 5 kHz can be accommodated through the totalizing input, but only if the input debouncing is disabled. Input debounce settings are available only through the computer interface (see Section 4.)

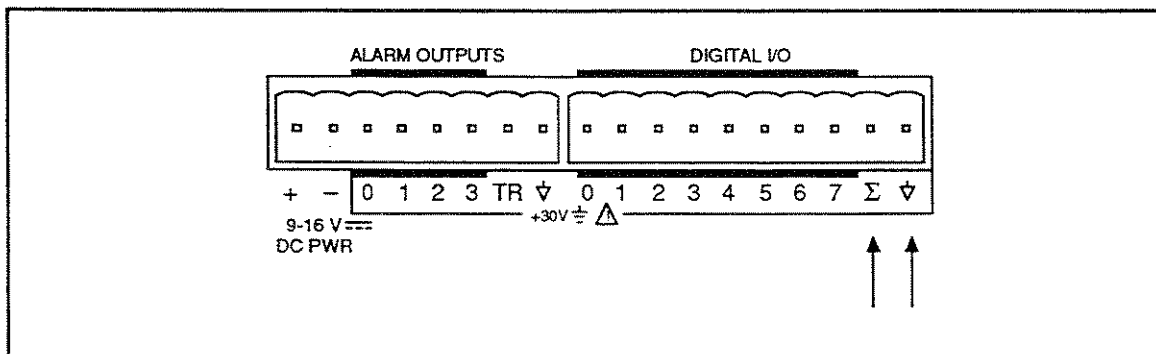


Figure 3-4. Totalizing Connection

REVIEW ARRAY





Readings from every scan are checked for minimum and maximum values. These values, along with the last value measured, are stored in the Review array and can be recalled by pressing **REVIEW**. To cycle through the three values for the displayed channel, press **▶** or **◀**. If no value has been stored, or if the value has just been cleared, the display shows dashes ("-----").

These values are updated by all scans (scan intervals, continuous scans, single scans, or scans initiated with an external trigger input.) Measurements taken with the Monitor function do not update these values.

Note that either the Review array or the Totalizer count can be displayed at one time; you must deactivate one before activating the other. Press **REVIEW** a second time (or press **CANCL**) to remove Review data from the display.

Table 3-15 illustrates how to examine the Review array contents.

Table 3-15. Review Array

| ACTIVATE (Note 1) | REVIEW POINTS (Note 2) | DEACTIVATE (Note 3) |
|--|--|--|
| <p>REVIEW</p> <p style="text-align: center;">  20  0 </p> | <p style="text-align: center;">  ← →  </p> <p style="text-align: center;">LAST MIN MAX</p> <p style="text-align: center;">LAST MIN MAX</p> | <p style="text-align: center;">REVIEW</p> <p style="text-align: center;">or</p> <p style="text-align: center;">CANCL</p> |
| <p><i>Note 1. Review array can be entered only from a channel that is defined for some type of measurement ("VDC", "VAC", etc.). Review array cannot be entered from a channel that is OFF.</i></p> <p><i>Note 2. All review values (MIN, MAX, LAST for all channels) can be cleared (to "-----") by pressing:</i></p> <p style="margin-left: 40px;">CLEAR SHIFT REVIEW</p> <p style="margin-left: 40px;"><i>This clearing action can be initiated only while viewing the Review values. Any scan in progress is completed before a requested Review clear is carried out.</i></p> <p style="margin-left: 40px;"><i>Review values are cleared when any channel configuration is changed.</i></p> <p style="margin-left: 40px;"><i>Review values are not cleared automatically at the start of a new scan.</i></p> <p><i>Note 3. When returning to Inactive Mode, the instrument returns to the last channel examined in the Review array. This may not be the same channel from which you started viewing the Review array.</i></p> <p><i>Note 4. Alarms are shown with the LAST Review values. See Alarm Indications for a description of alarm annunciation.</i></p> | | |

3/FRONT PANEL OPERATION

All review values for all channels are cleared with any of the following actions:

- CLEAR (SHIFT REVIEW) is selected. This must be done while review data is on the display; otherwise, an error beep results.
- Function or number of terminals for any channel is changed.
- Range or thermocouple/RTD type for any channel is changed.
- The M and/or B scaling value for any channel is changed.
- The RTD R0 value for any channel is changed.
- The temperature unit is changed.
- The measurement rate is changed.

LIST BUTTON FUNCTIONS

If the RS-232 interface is active, you can print out the Last values from the Review array (2620A and 2625A) or all values from Data Logger memory (2625A only). This procedure is described in Table 3-16.

In the LAST printout, channels that are defined as OFF are not included. Following is a sample LAST printout:

```
07:41:37 02/09/91
CH  LAST VALUE      MAX VALUE      MIN VALUE
1:  097.32 mVDC     098.51 mVDC     096.10 mVDC
2:  0.0973 VDC      0.0985 VDC      0.0961 VDC
3:  00.097 VDC      00.099 VDC      00.096 VDC
4:  000.10 VDC      000.10 VDC      000.10 VDC
5:  OL mVAC         OL mVAC         OL mVAC
6:  OL VAC          OL VAC          OL VAC
7:  05.511 VAC      05.582 VAC      05.414 VAC
8:  005.51 VAC      005.58 VAC      005.41 VAC
9:  OL OHMS         OL OHMS         OL OHMS
10: OL kOHMS        OL kOHMS        OL kOHMS
11: 08.276 kOHMS    08.374 kOHMS    08.231 kOHMS
12: 008.28 kOHMS    008.37 kOHMS    008.23 kOHMS
13: 0.0083 MOHMS    0.0084 MOHMS    0.0082 MOHMS
14: 00.008 MOHMS    00.008 MOHMS    00.008 MOHMS
15: OL HZ           OL HZ           OL HZ
16: 9.7193 kHz      9.7239 kHz      9.6771 kHz
17: 09.719 kHz      09.724 kHz      09.677 kHz
18: 009.72 kHz      009.72 kHz      009.68 kHz
19: 0.0097 MHz      0.0097 MHz      0.0097 MHz
```

With the Hydra Data Logger (2625A), a sample Store printout of stored values for three scans would be as follows:






```
07:41:52 02/09/91
5: -3.2345 mTX+B      12: 123.87 kOHMS      17: 31.268 VAC
ALM:15 DIO:255 TOTAL:0

07:41:53 02/09/91
5: -3.2345 mTX+B      12: 123.87 kOHMS      17: 31.268 VAC
ALM:15 DIO:255 TOTAL:0



07:41:54 02/09/91
5: -3.2345 mTX+B      12: 123.87 kOHMS      17: 31.268 VAC
ALM:15 DIO:255 TOTAL:0
```

The Hydra Data Logger can hold 2047 scans, with each scan containing 21 channels of data.

Table 3-16. List Button Operation



| | (Note 1) | (Note 2) | (Note 3) |
|---|---|--|---|
| PRESS THESE BUTTONS: |  |   |  |
| TO SELECT FROM THESE CHOICES: | | LASt StorE | |
| <p><i>Note 1. RS-232 computer interface must be active. If the IEEE-488 interface is active, an error results.</i></p> <p><i>Note 2. "LASt" prints out all values in the Review array. Review array values are not affected. An error results if Review array data has been cleared.</i></p> <p><i>"StorE" prints out logged scan data from the Hydra Data Logger (2620A) memory. Logged data is not affected. An error results if there is no logged data.</i></p> <p><i>Note 3. Press  to abort a printout while it is occurring</i></p> | | | |

AUTOPRINT

The front panel setup procedure is summarized in Table 3-17. Begin this procedure by selecting MODE ( ). Select the scan data destination ("dEST" in right display) as "Print" (left display). For the Hydra Data Logger, a destination of "both" can also be selected, allowing for simultaneous printing and storage. (For the Hydra Data Acquisition Unit, "Print" is the only possible selection.) Then select the mode ("MOde" in right display) from "ALL", "ALAr", or "trAnS" (left display).

With the Autoprint function defined, press  to enable or disable Autoprint. The "PRN" annunciator lights when Autoprint is enabled.

MEMORY STORAGE

Memory Storage is only available with the Hydra Data Logger. Initiate the Memory Storage setup by selecting MODE ( ).

Now refer to Table 3-17. Select the scan data destination ("dEST" in right display) as "StorE" for memory storage only or "both" for simultaneous storage and printing. Then select the mode ("MOde" in right display) from "ALL", "ALAr", or "trAnS" (left display).

Once the destination and mode have been set, enable Memory Storage by pressing:









The "PRN" annunciator lights to indicate that Memory Storage is enabled.

Front panel controls allow you to send memory contents over the RS-232 computer interface to a printer. Retrieval can also be made through the RS-232 computer interface for data storage that has been accomplished either from the front panel or through the computer interface.

3/FRONT PANEL OPERATION

Table 3-17. Autoprint/Memory Storage Selection

| | | DESTINATION ("dESt") (Note 1) | | MODE ("MOdE") (Note 2) | |
|-------------------------------|--------------------|---|--|---|---|
| PRESS THESE BUTTONS: | MODE (SHIFT PRINT) |  |  |  |  |
| | |  | |  | |
| TO SELECT FROM THESE CHOICES: | | Print StorE both | | ALL ALAr trAnS | |
| Note 1. | "Print" | Sends data to be printed through the RS-232 interface. | | | |
| | "StorE" | Sends data to be stored in memory (Hydra Data Logger only). | | | |
| | "both" | Sends data to be stored and printed (Hydra Data Logger only) | | | |
| Note 2. | "ALL" | Measurements for all defined channels are printed/stored when a scan occurs. | | | |
| | "ALAr" | Measurements for all defined channels are printed/stored when a scan occurs and at least one channel is in alarm. | | | |
| | "trAnS" | Measurements for all defined channels are printed/stored when a scan occurs and at least one channel has transitioned into or out of alarm since the last scan. | | | |









For memory clearing, refer to Table 3-18. You can clear scan data memory by holding  pressed while momentarily pressing  and answering "YES" in the left display as "CLEAR" appears in the right display. The instrument must be in Active or Inactive Mode; you cannot clear memory from Configuration Mode.

Table 3-18. Clearing Memory Storage

| TO INITIATE | TO CONFIRM | TO ACTIVATE |
|--|---|---|
| Hold  , and press  | "no" to exit without clearing |  |
| |   | |
| "CLEAR" appears in right display | "YES" | |
| |  to exit without clearing | |



The F annunciator is dimly lit when the logging storage is nearly full (more than 1800 scans have been stored). The F annunciator is brightly lit when the logging storage is full (2047 scans). Storing additional scans causes the oldest scans to be overwritten.

FRONT PANEL LOCKOUT FUNCTIONS

Various methods are available to prevent accidental use of the front panel buttons. These actions can be initiated from either the front panel or the computer interface.

Front Panel Review Only Function

Access the Review Array (press , REVIEW annunciator comes on)

Press  and  simultaneously to activate the Review Only function (REM annunciator becomes dim).

▶, ◀, ▲, and ▼ can now be used to view the various elements of the Review Array. All other front panel buttons are locked out, yielding a long beep when pressed. Press both FUNC and Mx+B again to deactivate the Review Only function and return the instrument to normal front panel button operation (regular Review Array display.)

Front Panel Monitor Only Function

First place the instrument in the Monitor Function (press MON, MON annunciator comes on). Then press FUNC and Mx+B simultaneously to activate the Monitor Only Function (REM annunciator comes on).

▲ and ▼ can now be used to change the monitored channel. All other front panel buttons are locked out; a long beep results from their use. Press both FUNC and Mx+B again to deactivate the Monitor Only function and return the instrument to normal front panel button operation (regular Monitor Function on.)

Computer Interface-Initiated Lockouts

Front Panel lockout can also be specified over the Computer Interface with the following commands.

- REMS (RS-232 only): four front panel buttons remain active (SCAN, ▲, SHIFT, and POWER).
- RWLS (RS-232 only): only the POWER button remains active.
- LOCK 1 ▶, ◀, ▲, and ▼ can now be used to view the various elements of the Review Array. All other front panel buttons are locked out, yielding a long beep when pressed. Press both FUNC and Mx+B again to deactivate the Review Only function and return the instrument to normal front panel button operation (regular Review Array display.)
- LOCK 2 ▲ and ▼ can now be used to change the monitored channel. All other front panel buttons are locked out; a long beep results from their use.

Refer to Section 4 for additional information on these commands.

REM ANNUNCIATOR

The front panel REM annunciator identifies the status of both computer interface control and front panel lockout. REM may be lit due to actions taken from the computer interface or the front panel; it can be off, dim, or bright as shown in Table 3-19.

Table 3-19. REM Annunciation

| REMOTE | LOCK | REM ANNUNCIATION |
|--------|-------|------------------|
| False | False | Off |
| False | True | Dim |
| True | False | Bright |
| True | True | Dim |

CALIBRATION

Refer to Section 6 (Maintenance) of this manual for a general discussion of instrument calibration. Refer to the Hydra Service Manual (P/N 889589) for complete calibration procedures.

The CAL ENABLE control point is located in the lower-right corner of the display. When the instrument is correctly calibrated, this control should be covered with a calibration decal; removing the decal voids assurance of correct calibration.

NOTE

Do not press CAL ENABLE unless you have a copy of the Service Manual and intend to calibrate the instrument. If you have accidentally activated Calibration and wish to exit immediately, press CAL ENABLE (until CAL disappears from the display) or turn power OFF.

Section 4

Using the Computer Interface

INTRODUCTION

The instrument can be operated from a host via commands sent through the rear panel computer interface. The host can be a terminal, controller, PC, or other computer.

This section describes how to set up and operate the instrument via the RS-232 interface (standard with Hydra Data Acquisition Unit and Hydra Data Logger) or the IEEE-488 computer interface (optional with Hydra Data Acquisition Unit only.) The RS-232 interface can also be connected to a serial printer for direct output of data in printed format.

With the IEEE-488 computer interface installed in the Hydra Data Acquisition Unit, the instrument is fully programmable for use on the IEEE Standard 488.1 interface bus (1987). The instrument is also designed in compliance with supplemental IEEE Std. 488.2-1987.

This section assumes you are familiar with the basics of data communication, the RS-232 interface, and/or the IEEE-488 bus. For an introduction to the IEEE-488 interface, request Fluke Application Bulletin AB-36, "IEEE Standard 488-1978 Digital Interface for Programmable Instrumentation."

An annotated sample program, illustrating the use of the RS-232 computer interface, is provided at the end of this section. Calibration procedures using the computer interface are provided in the Hydra Service Manual (P/N 889589).

Front Panel and Computer Interface Operations

When the instrument is operated from the front panel, it is said to be under front panel control. When the instrument is operated from a host, it is said to be operating under computer interface control.

Most operations that can be performed from the front panel can also be performed over the computer interface. Some operations, like setting communications parameters for the RS-232 interface and selecting the instrument address for IEEE-488 operations, can only be performed from the front panel.

Types of Computer Interface

Only one interface can be selected or used at a time.

The optional IEEE-488 interface is contained on a single printed circuit assembly and can be selected if it is installed in the Hydra Data Acquisition Unit. The IEEE-488 interface cannot be used with the Hydra Data Logger. Of course, the RS-232 interface can be re-selected even if the IEEE-488 interface is installed.

If you are going to use the RS-232 interface, continue reading. If you are going to use the IEEE-488 interface, skip to "USING THE IEEE-488 INTERFACE" later in this section.

NOTE

To determine which computer interface is enabled, select COMM (SHIFT LIST). If "IEEE" appears on the display, the IEEE-488 interface is enabled. Otherwise, if a baud rate appears, the RS-232 interface is enabled.

USING THE RS-232 COMPUTER INTERFACE

The RS-232 interface allows ASCII, asynchronous, serial communication between the instrument and a host, a serial printer, or a terminal.

Setting Communication Parameters (RS-232)

Baud rate ("bAUd"), parity ("PAR"), and echo ("Echo") parameters can be set directly by the user; number of data bits and number of stop bits cannot be set. Refer to Figure 4-1.

For the instrument and host to communicate via the RS-232 interface, the communication parameters of the instrument must match those of the host. RS-232 communication parameters can be set only from the front panel. If the communication parameters of the host and the instrument do not match, proceed as follows to select the appropriate baud rate and parity parameters for the instrument (summarized in Table 4-1):

1. Select COMM (SHIFT LIST).

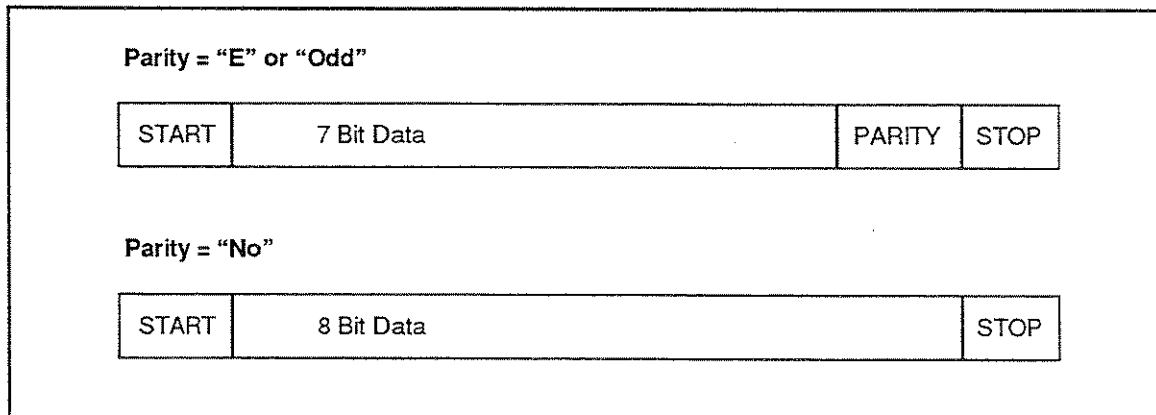





















Figure 4-1. Data/Stop Bits

Table 4-1. RS-232 Setup

| | BAUD (NOTE) | PARITY | ECHO |
|---|---|---|---|
| PRESS THESE BUTTONS: | COMM (SHIFT LIST)   |   |   |
| |  |  |  |
| TO SELECT FROM THESE CHOICES: | IEEE 300 600 1200 2400 4800 9600 | Odd E no | OFF On |
| <i>Note: If "IEEE" is selected here (2620A only), the RS-232 setup sequence is exited and the IEEE setup sequence is begun. Refer to Table 4-3.</i> | | | |

- The baud rate presently selected is now shown in the left display, and "bAUd" is shown in the right display. If "IEEE" appears, press  until a baud number appears.
- Press  or  to scroll to the desired baud (9600, 4800, etc., but not "IEEE".) Press  to select the displayed baud rate.
- "PAR" appears in the right display. The parity selection ("Odd", "E", or "no") is now shown in the left display.
- Press  or  to scroll to odd, even, or no parity, respectively. Press  to select the displayed parity.
- "Echo" now appears in the right display, with "On" or "OFF" appearing on the left display.

When Echo is "On", each character sent to the instrument over the RS-232 interface is "echoed" back to the host. If Echo is "OFF", commands are not echoed.

Press  or  to select echo "On" or "OFF". Then press  to accept the displayed setting.

Autoprint and Memory Storage (RS-232)

Instrument measurements can be automatically sent to a printer (Autoprint) or to internal Memory Storage. Both the Hydra Data Acquisition Unit and the Hydra Data Logger have the Autoprint function; only the Hydra Data Logger has internal Memory Storage.

NOTE

During Autoprint operations, consider setting the instrument echo mode to "OFF". Although Autoprint does operate when echo mode is "on", the "OFF" setting prevents mixing of echoed command characters with autoprinted data.

Autoprint can be controlled from the front panel or over the RS-232 interface. Setting up storage into (and retrieving data from) memory in the Hydra Data Logger can be controlled either from the front panel or over the RS-232 interface. Refer to Section 3 for front panel operation. The stored data cannot be viewed from the front panel; data must be requested through the RS-232 computer interface or listed on a printer.

Here are some rules to follow when using Autoprint and Memory Storage:

1. The RS-232 interface must be enabled before Autoprint can be enabled. (RS-232 is always enabled on the Hydra Data Logger.)
2. Since the instrument does not print over the IEEE-488 interface, Autoprint is automatically turned off when you enable the IEEE-488 interface (Hydra Data Acquisition Unit only.)
3. If you have selected Memory Storage (Hydra Data Logger only), verify that the RS-232 interface is configured correctly before you upload the memory contents to a PC or printer.

AUTOPRINT: COMPUTER INTERFACE CONTROL

Autoprint can be controlled from the front panel or over the RS-232 interface. Refer to Section 3 for front panel operation.

Through the RS-232 interface, the PRINT_TYPE command can be used to set up Autoprint, and the PRINT command can be used to enable Autoprint. These commands follow a structure paralleling the front panel procedure. PRINT_TYPE selects destination (0 for Print Scans, 1 for Store Scans, or 2 for both) and type (0 for ALL, 1 for ALAr, or 2 for trAnS.) PRINT sets printing on (1) or off (0).

AUTOPRINT: OUTPUT FORMAT

The first line of an autoprint printout contains time and date values that identify when the scan was started. Time values include Hour:Minute:Seconds, and date values include Month/Year/Day. As an example, the following line is a valid start-of-scan time:

10:33:45 5/11/90

Lines following the time and date contain measurement data for channels that have been set up for this session. The last line of the printout contains the Totalizer count and the status of the digital I/O lines.

Channel data is formatted to fit three readings onto an 80-column line. Each reading provides the following information:

- Channel number, followed by a colon and a space (4 characters)
- space or minus sign (1 character)
- Digits and decimal point. Measurements taken at the fast rate use 5 characters (4 digits plus a decimal point.) Measurements taken at the slow rate use 6 characters (5 digits plus a decimal point.)
- Space (1 character)
- Measurement multiplier - 'm' for X0.001, space for X1, 'k' for X1,000, 'M' for X1,000,000
- Measurement units - VDC, VAC, OHMS, HZ, C, F, Mx+B (4 characters, left justified)
- Space (1 character)
- Alarm indication for Limit-1 (H=High, L=Low, R=Return) (1 character); a blank space = no alarm limit is used, or alarm inactive.
- Slash (/) used as a separator when either alarm indicator is shown (1 character)
- Alarm indication for Limit-2 (H, L, R); space = no alarm limit is used, or alarm inactive.
- Two spaces between channel measurements (2 characters)

The following example illustrates this format:

```
07:42:01 02/09/91
5: -3.2345 Mx+B H/R 12: 123.87 kOHMS /L 17: 31.268 VAC
ALM:15 DID:204 TOTAL:0
```

MEMORY STORAGE: COMPUTER INTERFACE CONTROL

Memory Storage can be controlled from the front panel or over the RS-232 interface. Refer to Section 3 for front panel operation.

Through the RS-232 interface, the PRINT_TYPE and PRINT commands can be used to set up and enable Memory Storage. PRINT_TYPE selects the destination (0 for printer, 1 for Memory Storage, and 2 for both) and the mode used to select the scans to store (0 for ALL, 1 for ALAr, or 2 for trAnS.) PRINT sets storage on (1) or off (0)

The PRINT_TYPE? and PRINT? queries can be used to determine present settings for the PRINT_TYPE (destination, type) and PRINT commands, respectively.

MEMORY RETRIEVAL

NOTE

The LOG? query does not return channel numbers with scan data. Therefore, if you add or delete defined channels, you may want to clear the memory contents so that subsequent LOG? queries return only data for the new set of scanned channels.

Data for the oldest set of scan readings in Hydra Data Logger memory can be retrieved with the LOG? query. Each set of scan readings is cleared from memory when read with LOG?. The LOG? query returns the following information:

- Date and time at the start of the logged scan. Date and time are returned as integer values in the same format as used with the TIME_DATE? query (hours 0-23, minutes 0-59, seconds 0-59, month 1-12, day 1-31, year 00-99.)
- Values for the channels measured. This measurement data is returned as a list of values in scientific notation format.

- State of the Digital I/O lines and totalize count at the time the channels were scanned. The state of the digital I/O lines may reflect evaluation of alarms for this set of scan measurements. Alarm outputs and digital I/O values are returned as integer values. The Totalizer value is returned as a scientific notation value.

Data for a specific scan can be retrieved with the LOGGED? <index> query. The <index> parameter can be 1 through 2047, signifying the number of the scan. Scan data is not removed from memory with this query.

The number of stored scans can be retrieved with LOG_COUNT?

MEMORY FULL OPERATION

If Data Logger memory is full, two methods of handling additional scan data are available. With the LOG_MODE 0 command, older scans are written over by newer scans on a first-in, first-out basis. Therefore, the instrument can continue to make scans until a certain event occurs, and storage of all data leading up to the event is assured.

With the LOG_MODE 1 command, new scans are stored only when memory is available. All data following a specific event (e.g., an alarm) can thereby be saved. Memory can be made available in one of the following two ways:

- LOG? command clears each scan as it is read.
- Memory Clear (Front Panel or LOG_CLR) removes all scans.

The LOG_MODE setting is non-volatile and cannot be changed from the instrument front panel.

CLEARING MEMORY

Memory clearing is available with the Hydra Data Logger (2625A) only. With the RS-232 interface active, use the LOG_CLR command to clear all stored Data Logger memory values. Refer to Section 3 for the front panel version of memory clearing.

Cabling the Instrument to a Host or Printer (RS-232)

Communications with a host are handled through a DB-9 interface connector on the rear panel of the instrument. Pin usage is diagrammed on the instrument's rear panel and shown in Figure 2-6.

Connect the instrument to the host (or terminal) using a cable appropriate to your application. Usually, total cable length should not exceed 50 feet (15 meters). Longer cables are permitted if the load capacitance measured at the interface point (including the signal terminator) does not exceed 2500 picofarads.

To connect the instrument to an IBM PC/AT (DB-9 connector), use RS40 and RS41 cables connected in series, or use any other cable designed for interconnecting two IBM PC/ATs. The RS40 and RS41 cables are described in Section 1.

To connect the instrument to a specific brand of RS-232 printer, use the cable that would be used to connect that printer to an RS-232 port on an IBM PC/AT (DB-9 connector). The RS42 cable is compatible with most serial printers; contact Fluke for printer compatibility information.

Once the cable is connected, turn the instrument back on. You are now ready to operate the instrument over the RS-232 interface.

Installation Test

The procedure below demonstrates the instrument processing a computer interface command and, at the same time, confirms that the instrument has been properly set up and cabled for computer interface operations:

1. Ask for the instrument identification by sending the following query:

```
*IDN? <CR>
```

2. Verify that the instrument sends either of the following responses:

```
FLUKE,2620A,0,Mn.n An.n Dn.n  
=>
```

```
FLUKE,2625A,0,Mn.n An.n Dn.n  
=>
```

Mn.n identifies the main software version.

An.n identifies the A/D software version.

Dn.n identifies the display software version.

The RS-232 prompt => means that the command has been executed and the instrument is ready to accept another command.

RS-232 Information

CHARACTER ECHOING

With the RS-232 interface, characters sent to the instrument can be automatically echoed back to the host. When Echo is set "On", characters sent to the instrument are echoed back to the host. With Echo "OFF", characters are not echoed back. To set the Echo parameter, refer to the procedure earlier in this section under "Setting Communication Parameters (RS-232)".

CHARACTER DELETION

Characters sent directly from a host to the instrument can be deleted by pressing the <DELETE> or <BACKSPACE> key. Backspaces are echoed to the host if Echo is "On".

DEVICE CLEAR USING CTRL C

CTRL C is the RS-232 equivalent of IEEE-488 DC1 (device clear), causing the output sequence:

```
=> <CR> carriage return <LF> line feed.
```

Use of CTRL C clears the RS-232 input buffer.

RS-232 PROMPTS

The instrument parses and executes, in turn, each command received from the host over the RS-232 interface. The instrument returns one of the following three response prompts to indicate the results of command execution:

- => No errors; the command was successfully parsed and executed.
- ?> The command was not understood. Used when an IEEE-488.2 Command Error or Query Error was generated by the command.
- !> The command was successfully parsed but could not be executed for some reason. Used when an IEEE-488.2 Execution Error or Device Dependent Error was generated for the command. An example of this would be trying to execute a calibration command when calibration mode is not enabled.

Sample Program Using the RS-232 Computer Interface

Figure 4-2 presents a sample program for controlling the instrument over the RS-232 interface. This program is written in BASIC and is compatible with IBM PC, PC/AT, or equivalent personal computers.

USING THE IEEE-488 INTERFACE

IEEE-488 Operating Limitations

The following limitations govern the IEEE-488 interface:

- A maximum of 15 devices can be connected to a single IEEE-488 bus system.
- The maximum length of an IEEE-488 cable used in one IEEE-488 system must be the lesser of 20 meters or 2 meters times the number of devices in the system.

With an IEEE-488 interface installed and active, the instrument (2620A/05 or Hydra with 2620A-05K) supports the IEEE-488 capabilities shown in Table 4-2.

Installing the IEEE-488 Interface

The following instructions pertain to the 2620A/05 Data Acquisition Unit or a Hydra Data Acquisition Unit equipped with a 2620A-05K IEEE-488 kit. A standard IEEE-488 cable attaches to the instrument rear panel. The following cables are available from Fluke: Y8021 (1-meter), Y8022 (2-meter), and Y8023 (4-meter).

Select COMM () to check the interface setting. If "IEEE" is displayed, the IEEE-488 interface is already installed and selected. If a numeric baud rate appears in the left display, the RS-232 interface is selected; press so that "IEEE" is displayed, then press , select the address, and press again.

```

10 ` EXAMPLE.BAS Hydra program to scan VDC, VAC, OHMS, FREQ, or TEMP
20 `       - initialize RS232 communication and set up Hydra
30 `       - display and record measurement data in "TESTDATA.PRN"
40 ` Hydra must be set up for RS232, 9600 baud, no parity (from front panel)
50 KEY OFF
60 ` Open communications port 9600 baud, no parity, 8 bit data,
70 `   ignore Clear to Send, Data Set Ready, Carrier Detect
80 OPEN "COM1:9600,N,8,,cs,ds,cd" FOR RANDOM AS #1
90 IF ERRORCODE <> 0 THEN PRINT "ERROR - Could not open com1:" : END
100 `
110 OPEN "testdata.prn" FOR OUTPUT AS #2       ` Open data file
120 IF ERRORCODE <> 0 THEN PRINT "ERROR - Could not open data file" : END
130 `
140 PRINT #1, "ECHO 0"                       ` Turn off command echo
150 `
160 NUMBEROFCHANS = 0
170 WHILE (NUMBEROFCHANS < 1) OR (NUMBEROFCHANS > 20)
180     INPUT "Enter number of channels (1-20): ", NUMBEROFCHANS
190 WEND
200 PRINT "(Wait...)"
210 FOR I = (NUMBEROFCHANS + 1) TO 20         ` Turn unused channels off
220     PRINT #1, "FUNC " + STR$(I) + ",OFF"
230     GOSUB 800
240 NEXT I
250 `
260 CLS
270 LOCATE 2,25 : PRINT "Sample Program for Hydra"
275 PRINT #1, "*IDN?" : GOSUB 800 : LINE INPUT #1, RESULTS$
276 LOCATE 3,20 : PRINT RESULTS$;
280 `
290 WHILE (1)
300 `   Print banner line at bottom of screen
310     LOCATE 25,1
320     PRINT "1 = VDC   2 = VAC   3 = OHMS   4 = FREQ   5 = TEMP   6 = QUIT";
330 `
340     FUNC$ = "0"
350     WHILE (FUNC$ < "1") OR (FUNC$ > "6")
360         LOCATE 23,1 : INPUT "           Selection: ", FUNC$
370     WEND
380 `   Exit and clean up if "QUIT"
390     IF FUNC$ = "6" THEN CLOSE 1, 2 : CLS : KEY ON : END
400 `
410 `   Set up latter part of command string to Hydra (function and range)
420     IF FUNC$ = "1" THEN CMD$ = "VDC, 1"
430     IF FUNC$ = "2" THEN CMD$ = "VAC, 1"
440     IF FUNC$ = "3" THEN CMD$ = "OHMS, 1, 2"
450     IF FUNC$ = "4" THEN CMD$ = "FREQ, 1"
460     IF FUNC$ = "5" THEN CMD$ = "TEMP, K"
470 `
480 `   Set up Hydra
485     LOCATE 23,1 : PRINT "Programming... ";
490     FOR I = 1 TO NUMBEROFCHANS           ` Program channels

```

Figure 4-2. Sample Program

```

500     PRINT #1, "FUNC " + STR$(I) + ", " + CMD$
510     GOSUB 800
520     NEXT I
530 `
540     LOCATE 23,1
550     PRINT "Measuring " + CMD$ + "          " ` Print to screen
560 `
570     FOR I = 1 TO 3                ` Scan 3 times
580         PRINT #1, "*TRG"          ` Start a single scan
590         GOSUB 800                  ` Get prompt
595         PRINT #1, "SCAN TIME?" : GOSUB 800 ` Get scan time stamp
597         LINE INPUT #1, RESULT$
598         PRINT #2, RESULT$          ` save time stamp in data file
600         FOR J = 1 TO NUMBEROFCHANS ` Request scan data
610             PRINT #1, "LAST? " + STR$(J) ` Request channel data
612             GOSUB 800                  ` Get prompt
620             INPUT #1, RESULT$          ` Get channel result
640             LOCATE J+3,25 : PRINT "Chan " + STR$(J) + ": ";
650             PRINT RESULT$;            ` Print results to screen
660             PRINT #2, RESULT$ + ", "; ` Print results to file
670         NEXT J
680     PRINT #2, ""
690     NEXT I
700 WEND
710 `
720 ` Subroutine: response
730 ` Checks prompt for errors
740 ` The possible command responses are:
750 `     "=>(CR)(LF)" (command successful)
760 `     "?>(CR)(LF)" (command syntax error)
770 `     "!>(CR)(LF)" (command execution error)
780 `
800 PROMPT$ = INPUT$(4, #1)           ` Get prompt
810 IF INSTR(1, PROMPT$, "=>") <> 0 THEN RETURN ` Command successful
820 IF INSTR(1, PROMPT$, "?>") <> 0 THEN PRINT "Command Syntax Error!!"
830 IF INSTR(1, PROMPT$, "!>") <> 0 THEN PRINT "Command Execution Error!!"
840 PRINT "Program execution halted due to communication errors."
850 END

```

Figure 4-2. Sample Program (cont)

Table 4-2. IEEE-488.1 Capabilities

| CAPABILITY | DESCRIPTION |
|-------------|--|
| SH1 and AH1 | Read and write bus handshaking, including hold off. |
| T5 | Basic talker with serial poll and without talk only mode. Serial poll is used to return the instrument status byte to the controller. |
| TE0 | No extended talker. |
| L4 | Basic listener without listen only mode. Listen only mode is only useful for an IEEE-488 device like a printer. |
| LE0 | No extended listener. |
| SR1 | Service request interface; allows SRQs (service requests). The SRQ function allows the instrument to notify the controller when an operation is complete. |
| RL1 | Remote local capability with local lock out. Usually the instrument front panel will not be operational while the instrument is in use by the IEEE-488 interface. Remote local capability enables the front panel. Local lock out disables the front panel. |
| PP0 | No parallel poll capability. Parallel poll is rarely used in the industry. It was intended as a fast way to get a status bit from several devices, but failed in gaining acceptance. |
| DC1 | Device clear capability. This allows the instrument to be initialized to a known state. The IEEE-488.2 standard describes exactly what this known state is. |
| DT1 | Device trigger capability. The only DT command is GET (group execute trigger). This allows several devices to all be triggered at the "same" time. This has some drawbacks, most notably that a device could still be processing a previous command when triggered. The IEEE-488.2 command *TRG corrects this. |
| C0 | Not a controller. |
| E1 | Open Collector Outputs |

Enabling the IEEE-488 Interface







The IEEE-488 interface can be enabled only from the front panel, using the following procedure. This procedure is also summarized in Table 4-3.






1. Select COMM (**SHIFT** **LIST**).

The left display shows "IEEE" or an RS-232 baud rate, and "bAUd" appears in the right display. Proceed with the following steps.


If "IEEE" is shown in the left display, the IEEE-488 interface is already enabled.

Table 4-3. IEEE-488 Setup

| | BAUD | ADDRESS |
|-------------------------------|---|---|
| PRESS THESE BUTTONS: | COMM (SHIFT LIST)   |   |
| |  |  |
| TO SELECT FROM THESE CHOICES: | IEEE 300 600 1200 2400 4800 9600 | 0 1 . . 30 |

2. Press  to scroll to "IEEE"; then press  to enable the IEEE-488 interface and disable the RS-232 interface. "IEEE" will not appear in the left display if the IEEE-488 interface is not installed.
3. The instrument must now be assigned an address ("0" to "30", inclusive). If you want to make a change, scroll to the desired address with the  and  buttons. Then press  to select the displayed address. The address remains selected until it is changed.

NOTE

Pressing  at any point returns the instrument to the Inactive Mode, leaving the original interface selection unchanged. If RS-232 was active, the instrument returns to RS-232, with all parameters unchanged.

Installation Test

The procedure below demonstrates how the instrument processes a computer interface command and, at the same time, confirms that the instrument has been properly set up and cabled for IEEE-488 operations:

NOTE

This is a program as entered from a Fluke 1722A Instrument Controller using Fluke BASIC commands. Syntax may vary with the host computer and language.

1. Enter the following at the host:

```
INIT PORT 0 <CR>
CLEAR PORT 0 <CR>
PRINT @ <address of instrument>, "*IDN?" <CR>
INPUT LINE @ <address of instrument>, AS <CR>
PRINT AS <CR>
```

2. Verify that the instrument sends the following identification response:

FLUKE,2620A,0,Mn.n An.n Dn.n

Mn.n identifies the main software version.

An.n identifies the A/D software version.

Dn.n identifies the display software version.

IF THE TEST FAILS

If the instrument does not respond to the test procedure as indicated, make the following checks:

1. Check all cable connections.
2. Check that the interface has been properly enabled and addressed.

GENERAL INFORMATION (RS-232 AND IEEE-488)

How the Instrument Processes Input

The following paragraphs summarize how the instrument processes input that is received from a host (or stand-alone terminal).

NOTE

*In this manual "input" means a string sent to the instrument from a host.
"Output" means a string sent from the instrument to the host.*

INPUT STRINGS

The instrument processes and executes valid input strings sent by the host. A valid input string is one or more syntactically correct commands, separated by semicolons (;), followed by an input terminator. ASCII and IEEE-488 bus codes are provided in Appendix B.

The instrument stores received input in a 350-byte input buffer.

NOTE

Input strings received over the RS-232 interface are not executed or checked for proper syntax until an input terminator is received.

If the RS-232 input buffer becomes full, a Device Dependent Error prompt is returned, and the input string is ignored.

The instrument accepts alphabetic characters in either upper- or lower-case. If a command cannot be understood (i.e., the equivalent of an IEEE-488 "Command Error"), the command and the rest of the command line are ignored.

INPUT TERMINATORS

An input terminator is a character or command (IEEE-488.1), sent by the host, that identifies the end of a string of one or more commands.

When an input terminator is received (RS-232 applications), the instrument executes all commands entered since the last terminator was received, on a first-in, first-out basis. (In IEEE-488 applications, commands are not delayed until receipt of an input terminator; commands are executed as they are received.)

As input characters are processed and commands executed, space is made available in the input buffer for new characters. In RS-232 applications, if a communications error (e.g., parity, framing, overrun) is detected or the input buffer fills, a device-dependent error is generated. If the input buffer is full, new characters are ignored as the instrument waits for a termination character.

If, on the other hand, the input buffer becomes full when the IEEE-488 interface is used, the instrument stops accepting characters until there is room in the buffer. Characters in the input buffer cannot be overwritten with the IEEE-488 interface.

The following are valid terminators for the RS-232 interface:

- LF (Line Feed)
- CR (Carriage Return)
- CR LF
- LF CR

The following are valid terminators for the IEEE-488 interface:

- EOI (End or Identity) on any character
- LF (Line Feed)

In some instances, a terminator is automatically transmitted by the host at the end of the command string (i.e., the instrument's input string). For example, in Fluke BASIC, the PRINT statement finishes with a CR LF pair.

TYPICAL INPUT STRINGS

Example strings that could be sent to the instrument over either interface are shown in Figure 4-3.

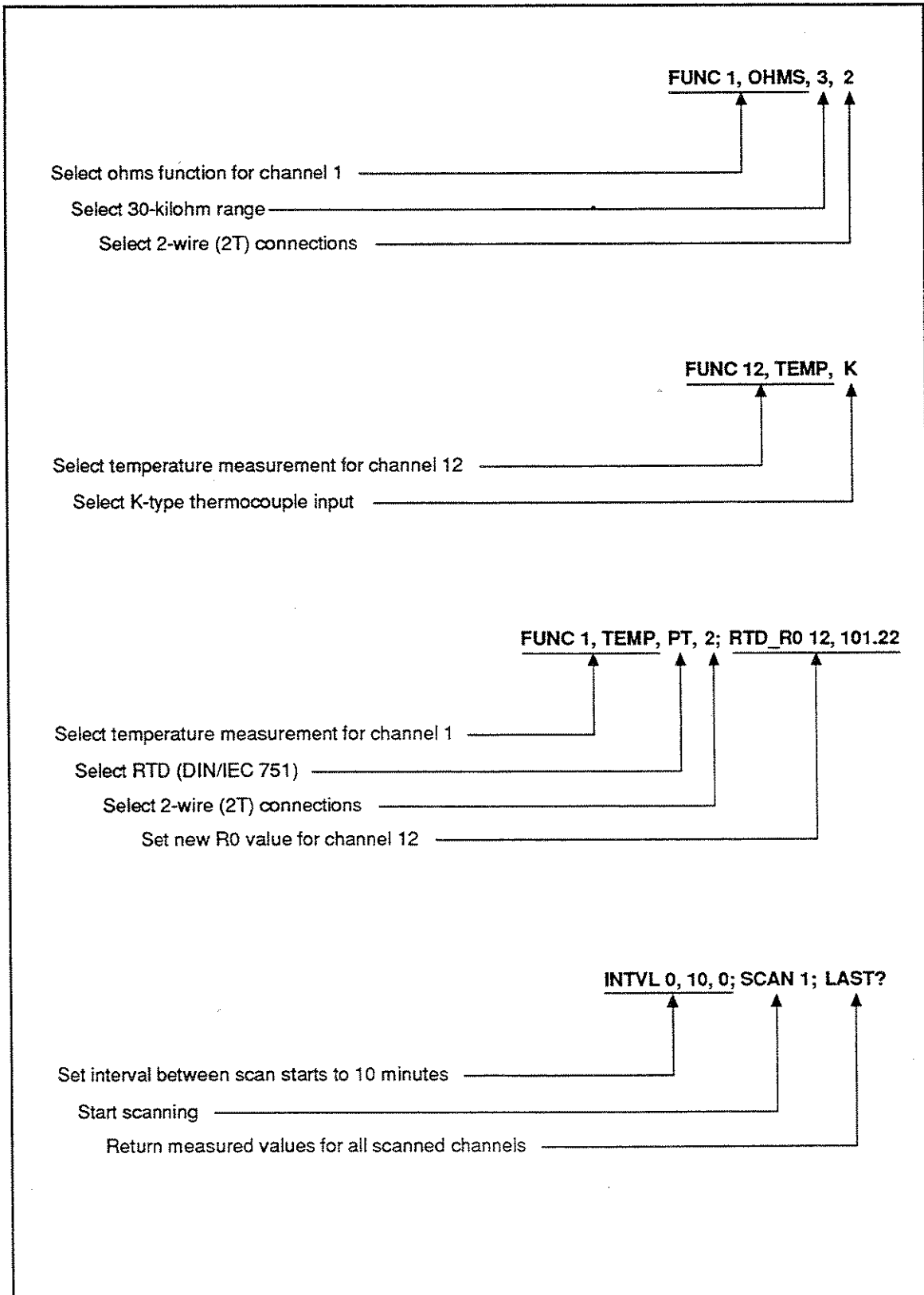


Figure 4-3. Typical Input Strings

SENDING NUMERIC VALUES TO THE INSTRUMENT (RS-232 AND IEEE-488)

Numeric values can be sent to the instrument as integers, real numbers, or real numbers with exponents, as shown in the following examples:

| EXAMPLE | EXPLANATION |
|-----------|-----------------------------------|
| +12345 | Sends the signed integer "+12345" |
| 123.45 | Sends the real number "123.45" |
| -1.2345E2 | Sends -1.2345×10^2 |

SENDING INPUT STRINGS TO THE INSTRUMENT

Observe the following rules when you construct strings to be sent to the instrument over the computer interface:

- **RULE 1: READ THE INSTRUMENT'S OUTPUT BUFFER ONLY ONCE FOR EACH QUERY COMMAND.**

This rule applies to the IEEE-488 interface only. The instrument's output buffer is cleared after it has been read. This prevents previously read data from being read a second time by mistake. If you attempt to read the instrument's output buffer twice, the instrument generates a query error.

- **RULE 2: READ QUERY RESPONSES BEFORE SENDING ANOTHER INPUT STRING.**

This rule applies to the IEEE-488 interface only. Output data remains available in the output buffer until it is read by the host or until the next input string is received by the instrument. This means the instrument's output buffer must be read by the host before, rather than after, the next input string is sent to the instrument. Otherwise, unread data in the buffer is overwritten.

- **RULE 3: THE INSTRUMENT EXECUTES EACH COMMAND COMPLETELY, IN THE ORDER RECEIVED, BEFORE MOVING ON TO THE NEXT COMMAND.**

If an input string contains a trigger, enter the commands from left to right, as follows:

1. Commands to configure the instrument (if any).
2. The trigger command (*TRG).
3. Queries to read the result of a triggered measurement (LAST?), or to reconfigure the instrument (if any).
4. The terminator.

How the Instrument Processes Output

The instrument outputs an alphanumeric string in response to any query from the host. (Query commands are easily identified because they all end with "?") An output string is terminated by a Carriage Return and Line Feed (<CR> <LF>) for RS-232 applications or a Line Feed with End or Identity (<LF> <EOI>) for IEEE-488 applications.

After sending the instrument a command string via the RS-232 interface, wait for the instrument to return a prompt before sending another command string. (A command string can consist of 1 or more syntactically correct commands.) If you do not do so, a device-dependent command error is generated, and the second string is discarded.

If the instrument is used in an IEEE-488 bus system, the output data is not actually sent onto the bus until the host addresses the instrument as a talker. When the output buffer is loaded, the Message Available (MAV) bit in the Status Byte Register is set true. (For more information, see "Status Byte Register" later in this section.)

Numeric output from the instrument is returned as shown in the following examples:

- Integer Values Examples

- | | |
|---|--|
| 3 | In response to RANGE? query, range is 3 for the selected function. |
| 0 | In response to ALARMS? query, there are no alarms on this channel. |

- Scientific Notation Values

- | | |
|----------------|--|
| +1.2345E+6 | Measured value of 1.2345×10^6 |
| +12.345E+6 OHM | Measured value of 12.345×10^6 ohms (format 2) |
| +1E+9 | Positive overload ("OL" appears on the display). |
| -1E+9 | Negative overload ("-OL" appears on the display). |
| +9E+9 | Open thermocouple indication ("otc" appears on the display). |

Service Requests (IEEE-488 only) and Status Registers

Service requests let an instrument on the IEEE-488 bus get the attention of the host. Service requests are sent over the service request (SRQ) line.

NOTE

If the instrument is in the remote state without front panel lockout (i.e., REMS), a service request can be sent from the front panel by pressing



If more than one instrument on the bus is capable of sending service requests, the host can determine which instrument made the request by taking a "serial poll". Each instrument on the bus responds to the poll by sending the contents of its Status Byte Register (STB). If an instrument on the bus has made a service request, the request service bit (RQS, bit 6) of its Status Byte Register (STB) will be set to 1, identifying it as an instrument that requested service.

The contents of the Status Byte Register (STB) are defined by the Service Request Enable Register (SRE), Event Status Register (ESR), Event Status Enable Register (ESE), and the output buffer. These status registers are discussed in the following paragraphs. Figure 4-4 shows the relationship of these registers.

Table 4-4. Status Byte Register

| BIT | NAME | DESCRIPTION |
|-------|----------|---|
| 0 | IEB | Instrument Event Bit. When any bit in the Instrument Event Register is set and the corresponding mask bit(s) in the Instrument Event Enable register is set, this Instrument Event Bit in the Status Byte will be set. When read, the Instrument Event Bit is recomputed based on the new value from the Instrument Event Register and its mask, the Instrument Event Enable Register. |
| 1,2,3 | not used | |
| 4 | MAV | Message Available |
| 5 | ESB | Event Status Bit |
| 6 | RQS/MSS | Request Service/Master Summary Status |
| 7 | not used | |

EVENT STATUS AND EVENT STATUS ENABLE REGISTERS

The Event Status Register (ESR) records specified events in specific bits. (See Figure 4-4 and Table 4-5). When a bit in the ESR is set (i.e., 1), the event that corresponds to that bit has occurred since the register was last read or cleared. For example, if bit 3 (DDE) is set to 1, a device-dependent error has occurred.

The Event Status Enable Register (ESE) is a mask register that allows the host to enable or disable (mask) each bit in the ESR. When a bit in the ESE is 1, the corresponding bit in the ESR is enabled. When any enabled bit in the ESR changes from 0 to 1, the ESB bit in the Status Byte Register also goes to 1. When the ESR is read (using the *ESR? query) or cleared (using the *CLS command), the ESB bit in the Status Byte Register returns to 0.

STATUS BYTE REGISTER

The Status Byte Register (STB) is a binary-encoded register that contains eight bits. Note that the Service Request Enable Register (SRE) uses bits 1 through 5 and bit 7 to set bit 6, the request service (RQS) bit, as enabled by the SRE. When the RQS bit is set true (1), the instrument sets the SRQ line true (1), which generates a service request. The eight bits of the Status Byte Register (as read by the *STB? query) are described in Table 4-4.

READING THE STATUS BYTE REGISTER

The host can read the Status Byte Register by taking a serial poll or by sending the instrument a *STB? query. The value of the status byte is not affected by the *STB? query.

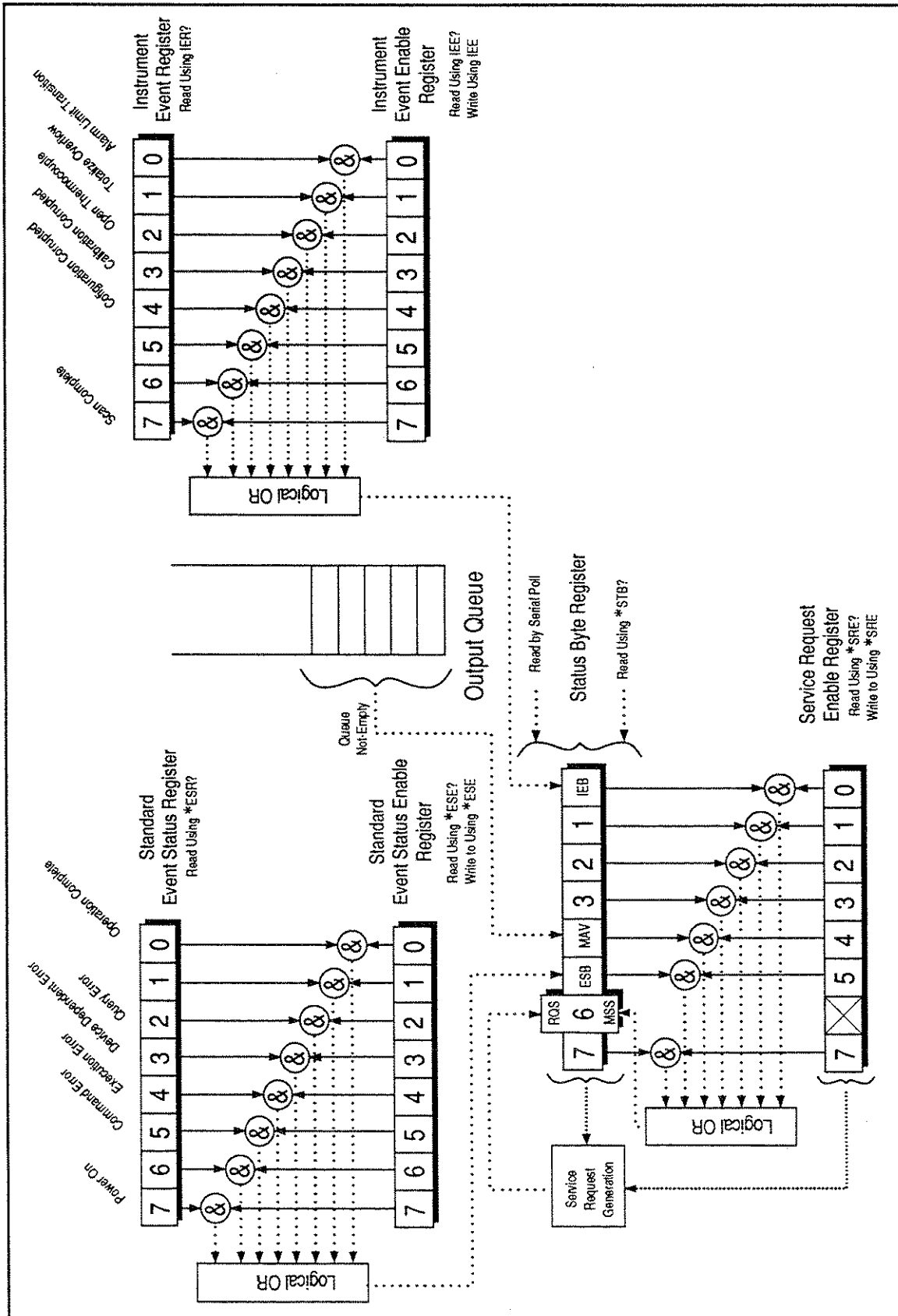


Figure 4-4. Overview of Status Data Registers

Table 4-5. Event Status Register

| BIT | NAME | DESCRIPTION |
|-----|----------|--|
| 0 | OPC | Operation Complete. Set true (1) upon execution of the *OPC command, indicating that the instrument has completed all selected pending operations. |
| 1 | not used | Always set to 0. |
| 2 | QYE | Query Error. Generated true (1) by the INTERRUPTED or UNTERMINATED message exchange state transitions. (See IEEE-488.2.) Sets the QYE bit of the Event Status Register. Under RS-232, this causes the "?>" prompt to be returned. |
| 3 | DDE | Device Dependent Error. Generated true (1) by overflows of the RS-232 input buffer or by calibration errors. Sets the DDE bit of the Event Status Register. Under RS-232, this causes the "!>" prompt to be returned. |
| 4 | EXE | Execution Error. Generated true (1) by parameters out of bounds or by a valid command that could not be processed due to an internal condition (such as calibration commands being received when calibration is not enabled). Sets the EXE bit of the Event Status Register. Under RS-232, this causes the "!>" prompt to be returned. |
| 5 | CME | Command Error. Generated true (1) by syntax errors, including: unrecognized command, incorrect command sequences, and GET messages inside a <program message>. Sets the CME bit of the Event Status Register. Under RS-232, this causes the "?>" prompt to be returned. |
| 6 | not used | Always set to 0. |
| 7 | PON | Power On. Set true (1) after an off-to-on transition has occurred in the instrument's power supply. |

NOTE

Changes to the status or enable registers are evaluated immediately. Therefore, an adequate change in cause or enabling criteria will change the status byte.

When the Status Byte Register is read, an integer is returned. This integer is the decimal equivalent of an 8-bit binary number. For example, 48 is the decimal equivalent of the binary 00110000, meaning that bit 4 (MAV) and bit 5 (ESB) are set to "1". Bit 4 contributes integer 16, and bit 5 contributes integer 32.

If the status byte is read by serial poll, bit 6 is returned as a request service (RQS); if it is read with an *STB? query, bit 6 is returned as Master Summary Status (MSS).

EXAMPLE EXPLANATION

*STB? Reads the Status Byte Register. Assume that "32" is returned. Converting 32 to the binary 00100000 indicates that bit 5 (ESB) is set to 1. To determine the event status, you would have to read the Event Status Register in the same manner, using the *ESR? query.

SERVICE REQUEST ENABLE REGISTER

The Service Request Enable Register (SRE) is an 8-bit register that enables or disables (i.e., masks) corresponding summary messages in the Status Byte Register (STB). The instrument can be programmed to make a service request on errors or when output is available. Conditions that trigger a service request are specified by writing a binary-weighted value to the Service Request Enable Register, using the *SRE command.

EXAMPLE EXPLANATION

*SRE 16 Enables the generation of an SRQ when bit 4 (MAV) in the Status Byte Register (STB) is set to 1.

16 is the decimal equivalent of 00010000 binary. This means that bit 4 in the Service Request Enable Register (SRE, which corresponds to the MAV bit in the Status Byte Register) is 1, and all other bits are 0.

*SRE 48 Enables the generation of an SRQ when bits 4 or 5 (MAV or ESB) in the Status Byte Register are set to 1. The binary equivalent of 48 is 00110000, indicating that bits 4 and 5 are set to 1.

If any bit in the SRE is set to 1 and the matching bit(s) in the STB become 1, the RQS bit (bit 6) in the Status Byte Register (STB) is set and a service request can be generated.

Use the *SRE? query to read the Service Request Enable Register. The instrument returns a binary-weighted integer that represents the enabled bits in the register. (The value of bit 6 will always be zero.) Convert the returned value to binary to determine the status of register bits.

EXAMPLE EXPLANATION

*SRE? Reads the value of the SRE Register. Assume "4" is returned. Converting 4 to the binary 00000100 indicates that bit 2 in the SRE is set to 1.

INSTRUMENT EVENT REGISTER

The Instrument Event Register (IER) is used in conjunction with the Instrument Event Enable Register (IEE) to determine the conditions under which the Instrument Event Bit of the Status Byte Register is set. Bits used in the Instrument Event Register are described in Table 4-6. Whenever the Instrument Event Register is read, the instrument bits are cleared.

Table 4-6. Instrument Event Register (IER)

| NOTE | | |
|--|----------|--|
| Whenever the Instrument Event Register is read, the condition bits are cleared. | | |
| This register is used in conjunction with the Instrument Event Enable Register to determine the conditions under which the Instrument Event Bit of the Status Byte is set. | | |
| BIT | NAME | DESCRIPTION |
| 0 | ALT | Alarm Limit Transition. Set high (1) when any measurement value has transitioned into or out of alarm. Alarms are defined through the front panel or the computer interface (ALARM_LIMIT). This bit is cleared when alarms or review values are cleared. |
| 1 | TOB | Totalize Overflow. Set high (1) when the Totalizer overflows (>65,535). This is cleared when the Totalizer is zeroed from the front panel or set to some other non-overflow value (<65,536) with the computer interface TOTAL command. |
| 2 | OTC | Open Thermocouple. Set high (1) when open thermocouple checking is enabled and any thermocouple channel is measured with a source impedance greater than 1 to 4 kilohms. |
| 3 | CCB | Calibration Corrupted. Set high (1) when the instrument calibration data is corrupted. When a calibration data check shows a corruption of calibration data, the calibration alarm bit remains set in the Instrument Status Register until the instrument is recalibrated. |
| 4 | CNC | Configuration Corrupted. The instrument configuration stored in NVRAM has been found to be corrupted. The RAM CRC is no longer valid. |
| 5,6 | not used | |
| 7 | SCB | Scan Complete. Set high (1) when a measurement scan has been completed. |

COMPUTER INTERFACE COMMAND SET

Generally, RS-232 and IEEE-488 commands are identical. A few exceptions apply only when the RS-232 interface is active.

See Table 4-7 for a summary of computer interface commands and queries. A detailed description of each command or query can be found in Table 4-8. (alphabetically arranged.)

NOTE

Computer interface command descriptions use angle brackets (<>) to denote a parameter that must be supplied by the user or a string that is returned by the instrument.

Table 4-7. Command and Query Summary

| | |
|---|--|
| Alarms | |
| ALARMS? | Active Alarms Query |
| ALARM_ASSOC | Associate Alarm Output |
| ALARM_ASSOC? | Alarm Association Query |
| ALARM_ASSOC_CLR | Clear Alarm Association |
| ALARM_DO_LEVEL | Set Alarm Output Level |
| ALARM_DO_LEVELS? | Alarm Output State Query |
| ALARM_LIMIT | Set Alarm Limit |
| ALARM_LIMIT? | Alarm Limit Assignments Query |
| Digital I/O | |
| DIO_LEVELS? | Digital I/O State Query |
| DO_LEVEL | Set Digital Output Level |
| Function and Range | |
| FUNC | Channel Function Definition |
| FUNC? | Channel Function Query |
| RTD_R0 | RTD Ice Point (R0) |
| RTD_R0? | RTD Ice-Point (R0) Query |
| RANGE? | Channel Range Query |
| IEEE Common Commands (includes Status Registers) | |
| *CLS | Clear Status |
| *ESE | Event Status Enable |
| *ESE? | Event Status Enable Query |
| *ESR? | Event Status Register Query |
| *IDN? | Identification Query |
| *OPC | Operation Complete |
| *OPC? | Operation Complete Query |
| *RST | Reset |
| *SRE | Service Request Enable |
| *SRE? | Service Request Enable Query |
| *STB? | Read Status Byte Query |
| *TRG | Trigger |
| *TST? | Self Test Query |
| *WAI | Wait-to-continue |
| IEE | Instrument Event Enable |
| IEE? | Instrument Event Enable Query |
| IER? | Instrument Event Register Query |
| Lock | |
| LOCK | Lock/unlock front panel control keys |
| LOCK? | Returns instrument front panel lock status |
| Measurement Rate | |
| RATE | Select Measurement Rate |
| RATE? | Measurement Rate Query |
| Measurement Values | |
| LAST? | Channel's Last Scan Value |
| MAX? | Channel's Maximum Value |
| MIN? | Channel's Minimum Value |
| NEXT? | Next Scan's Values |
| Monitor | |
| MON | Enable/Disable Monitoring |
| MON_CHAN? | Monitor Channel Number |
| MON_VAL? | Monitor Channel Value |

Table 4-8. Command and Query Reference (cont)

| | |
|--|---|
| Mx+B Scaling SCALE_MB SCALE_MB? | Set Mx+B Scaling Values Mx+B Scaling Values Query |
| RS-232 Commands (includes Autoprint) LOG? LOG_CLR LOG_COUNT? LOG_MODE LOG_MODE? LOGGED? LOG_BIN? PRINT PRINT? PRINT_TYPE PRINT_TYPE? LOCS LWLS REMS RWLS ECHO | Retrieve Logged Data Query Clear Logged Scans Logged Scan Count Query Action when Internal Memory is Full Action when Internal Memory is Full Query Retrieve Scanned Data Query Binary Upload of Logged Data Data Logging Enable/Disable Data Logging Query Set Data Logging Type Data Logging Type Query Local without Lockout Local with Lockout Remote without Lockout Remote with Lockout Enable/disable echoing |
| Response Format FORMAT FORMAT? | Response Format Query Response Format |
| Review Array REVIEW_CLR | Clear Review Values |
| Scan INTVL INTVL? SCAN SCAN? SCAN_TIME? | Set Scan Interval Scan Interval Query Enable/Disable Scanning Return Scan Status Time of Scan |
| Temperature Unit TEMP_CONFIG TEMP_CONFIG? | Temperature Configuration Temperature Configuration Query |
| Time/Date DATE TIME TIME_DATE? | Set Date Set the instrument clock. Retrieve Time and Date |
| Totalizer TOTAL TOTAL? TOTAL_DBNC TOTAL_DBNC? | Set Totalizer Count Totalizer Value Query Set Totalizing Debounce Totalizer Debounce Query |
| Triggering TRIGGER TRIGGER? | Select Trigger Type Trigger Type Query |

Table 4-8. Command and Query Reference

| *CLS | <p>Clear Status</p> <p>Clears all event registers summarized in the status byte, except for Message Available, which is cleared only if *CLS is the first message in the queue.</p> | | | | | | | | | | |
|--------------|---|-------|-------------|---|------------------------------|---|---|---|---|---|---------------------------|
| *ESE | <p>Event Status Enable</p> <p>Sets the Event Status Enable Register to the given value.</p> <p>*ESE <value></p> <p style="padding-left: 40px;"><value> = (0 .. 255)</p> <p>This is a mask for the Event Status Register and is the first step in determining which Events may issue an SRQ. The mask selects which events may set the Event Status Bit of the Status Byte. If the value is not in the range 0 to 255, an Execution Error is generated.</p> | | | | | | | | | | |
| *ESE? | <p>Event Status Enable Query</p> <p>Returns an integer representing the present value of the Event Status Enable Register.</p> | | | | | | | | | | |
| *ESR? | <p>Event Status Register Query</p> <p>First returns an integer representing the value of the Event Status Register, then clears the register.</p> | | | | | | | | | | |
| *IDN? | <p>Identification Query</p> <p>Returns the instrument identification code.</p> <p>The identification code consists of four descriptive fields separated by commas. Note that commas are reserved as field separators and cannot be used within the fields.</p> <table border="1"> <thead> <tr> <th>FIELD</th> <th>DESCRIPTION</th> </tr> </thead> <tbody> <tr> <td>1</td> <td>Manufacturer's name (FLUKE).</td> </tr> <tr> <td>2</td> <td>Instrument model number (2620A or 2625A).</td> </tr> <tr> <td>3</td> <td>0</td> </tr> <tr> <td>4</td> <td>Firmware revision levels.</td> </tr> </tbody> </table> <p>As an example, for main software version M2.41, display software version D1.3, A/D software version A3.7, the response would be:</p> <p>FLUKE,2620A,0,M2.41 A3.7 D1.3</p> | FIELD | DESCRIPTION | 1 | Manufacturer's name (FLUKE). | 2 | Instrument model number (2620A or 2625A). | 3 | 0 | 4 | Firmware revision levels. |
| FIELD | DESCRIPTION | | | | | | | | | | |
| 1 | Manufacturer's name (FLUKE). | | | | | | | | | | |
| 2 | Instrument model number (2620A or 2625A). | | | | | | | | | | |
| 3 | 0 | | | | | | | | | | |
| 4 | Firmware revision levels. | | | | | | | | | | |

Table 4-8. Command and Query Reference (cont)

| | |
|--------------|---|
| *OPC | Operation Complete |
| | Causes the instrument to generate an Operation Complete when parsed. |
| *OPC? | Operation Complete Query |
| | Causes the instrument to place an ASCII 1 in the output queue when parsed. |
| *RST | Reset |
| | Performs a Configuration Reset. See Table 3-1. The computer interface parameters (RS-232 and IEEE-488) are not changed. Also, the Status Byte and Event Status Registers are not changed, and calibration data is retained. |
| *SRE | Service Request Enable |
| | Sets the Service Request Enable Register to the given value. |
| | *SRE <value> |
| | <value> = (0 .. 255) |
| | If the value is greater than 255, a Command Error is generated. The value of bit 6 is ignored, since it is not used by the Service Request Enable Register. |
| *SRE? | Service Request Enable Query |
| | Returns the integer value of the Service Request Enable Register, with bit 6 set to 0. |
| *STB? | Read Status Byte Query |
| | Returns the integer value of the Status Byte, with bit 6 as the master summary bit. Note that a serial poll returns bit 6 as the RQS message. |
| *TRG | Trigger |
| | When parsed, this command causes the instrument to request a Single Scan. If a scan is already in progress when this command is parsed, an additional scan is not executed. |

Table 4-8. Command and Query Reference (cont)

| *TST? | <p>Self Test Query</p> <p>Causes internal self tests to be run. Results are returned as a binary-encoded integer. Self tests do not require any user interaction. Following the self tests, the instrument is initialized to the Configuration Reset conditions (see Table 3-1.) The binary coding is:</p> | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|----------------|---|--------------------------------------|--------------|-------|---|---|---------------------------|---|---|--------------------------|---|---|--------------------------|---|---|--------------------------|---|----|------------------------------|---|----|------------------------------------|---|----|-------------------------------------|---|-----|-----------------------------|---|-----|--------------------------|---|-----|---------------------|----|------|---------------------|----|------|----------------------|----|------|--------------------------------------|
| | <table border="1"> <thead> <tr> <th data-bbox="493 575 542 600">BIT</th> <th data-bbox="565 548 656 600">BINARY VALUE</th> <th data-bbox="695 575 786 600">ERROR</th> </tr> </thead> <tbody> <tr> <td data-bbox="493 625 509 646">0</td> <td data-bbox="565 625 581 646">1</td> <td data-bbox="695 625 980 651">ROM test failed (bad CRC)</td> </tr> <tr> <td data-bbox="493 657 509 678">1</td> <td data-bbox="565 657 581 678">2</td> <td data-bbox="695 657 948 682">External RAM test failed</td> </tr> <tr> <td data-bbox="493 688 509 709">2</td> <td data-bbox="565 688 581 709">4</td> <td data-bbox="695 688 948 714">Internal RAM test failed</td> </tr> <tr> <td data-bbox="493 720 509 741">3</td> <td data-bbox="565 720 581 741">8</td> <td data-bbox="695 720 932 745">Display self test failed</td> </tr> <tr> <td data-bbox="493 751 509 772">4</td> <td data-bbox="565 751 597 772">16</td> <td data-bbox="695 751 980 777">Display bad or not installed</td> </tr> <tr> <td data-bbox="493 783 509 804">5</td> <td data-bbox="565 783 597 804">32</td> <td data-bbox="695 783 1062 808">Instrument configuration corrupted</td> </tr> <tr> <td data-bbox="493 814 509 835">6</td> <td data-bbox="565 814 597 835">64</td> <td data-bbox="695 814 1110 840">EEPROM instrument configuration bad</td> </tr> <tr> <td data-bbox="493 846 509 867">7</td> <td data-bbox="565 846 613 867">128</td> <td data-bbox="695 846 1013 871">EEPROM calibration data bad</td> </tr> <tr> <td data-bbox="493 877 509 898">8</td> <td data-bbox="565 877 613 898">256</td> <td data-bbox="695 877 948 903">A/D bad or not installed</td> </tr> <tr> <td data-bbox="493 909 509 930">9</td> <td data-bbox="565 909 613 930">512</td> <td data-bbox="695 909 915 934">A/D ROM test failed</td> </tr> <tr> <td data-bbox="493 940 526 961">10</td> <td data-bbox="565 940 630 961">1024</td> <td data-bbox="695 940 915 966">A/D RAM test failed</td> </tr> <tr> <td data-bbox="493 972 526 993">11</td> <td data-bbox="565 972 630 993">2048</td> <td data-bbox="695 972 899 997">A/D self test failed</td> </tr> <tr> <td data-bbox="493 1003 526 1024">12</td> <td data-bbox="565 1003 630 1024">4096</td> <td data-bbox="695 1003 1094 1029">Memory RAM test failed (2625A only).</td> </tr> </tbody> </table> | BIT | BINARY VALUE | ERROR | 0 | 1 | ROM test failed (bad CRC) | 1 | 2 | External RAM test failed | 2 | 4 | Internal RAM test failed | 3 | 8 | Display self test failed | 4 | 16 | Display bad or not installed | 5 | 32 | Instrument configuration corrupted | 6 | 64 | EEPROM instrument configuration bad | 7 | 128 | EEPROM calibration data bad | 8 | 256 | A/D bad or not installed | 9 | 512 | A/D ROM test failed | 10 | 1024 | A/D RAM test failed | 11 | 2048 | A/D self test failed | 12 | 4096 | Memory RAM test failed (2625A only). |
| BIT | BINARY VALUE | ERROR | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 0 | 1 | ROM test failed (bad CRC) | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 1 | 2 | External RAM test failed | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 2 | 4 | Internal RAM test failed | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 3 | 8 | Display self test failed | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 4 | 16 | Display bad or not installed | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 5 | 32 | Instrument configuration corrupted | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 6 | 64 | EEPROM instrument configuration bad | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 7 | 128 | EEPROM calibration data bad | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 8 | 256 | A/D bad or not installed | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 9 | 512 | A/D ROM test failed | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 10 | 1024 | A/D RAM test failed | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 11 | 2048 | A/D self test failed | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 12 | 4096 | Memory RAM test failed (2625A only). | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| *WAI | <p>Wait-to-continue</p> <p>This command is accepted by Hydra, but has no effect. *WAI is required by the IEEE-488.2 standard, but is non-operational in Hydra.</p> | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| ALARMS? | <p>Active Alarms Query</p> <p>Returns alarm status for the indicated channel(s). The value returned represents data from the most recent scan. The most recent scan is the scan in progress or, if scanning is not in progress, the last completed scan.</p> <p>ALARMS? <channel></p> <p style="padding-left: 40px;"><channel> = (0 .. 20)</p> <p>If the channel specification field is left blank, values for all defined channels are returned (values for channels defined as OFF are not included.) An Execution Error results if a request is made for a channel defined as OFF, the channel specified is invalid, no scan measurements have been made, or review values have been cleared.</p> <p>Data is returned as comma-separated integer values, indicating which limits were in alarm when last scanned. The returned values are interpreted as follows:</p> | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |

Table 4-8. Command and Query Reference (cont)

| | |
|---|---|
| 0 | neither limit is in alarm and/or alarm(s) not defined |
| 1 | Limit "1" in alarm |
| 2 | Limit "2" in alarm |
| 3 | Limit "1" and Limit "2" in alarm |

If measurements are not active, the last known value is returned. The value 0 is returned for measured channels that do not have alarms defined.

For alarm status of all defined channels (no channel specification made), undefined (OFF) channels are not included. For each defined channel, an integer value (0, 1, 2, or 3) is returned. Commas separate integers for different channels, and no blank spaces are included. For example, if channel 1 has no alarm, channel 12 has Limit "2" in alarm, channel 13 has Limit "1" and Limit "2" in alarm, and channel 14 has Limit "1" in alarm, the return is "0,2,3,1".

ALARM_ASSOC

Associate Alarm Output

For the indicated channel and alarm limit, associate the given digital output line.

ALARM_ASSOC <channel>,<limit_num>,<DO_line>

| | | |
|-------------|---|-----------|
| <channel> | = | (4 .. 20) |
| <limit_num> | = | 1 2 |
| <DO_line> | = | (0 .. 7) |

Any other value or use of an invalid channel causes an Execution Error to be generated. If an association already exists for the specified channel and limit, executing this command revises the association. When switching alarm associations, the output being left (switched away from) is set to a high (non-alarm) state. To set multiple channels to a single DO_line, issue this command for each association to be made.

ALARM_ASSOC?

Alarm Association Query

Returns alarm output association for the indicated channel and alarm limit.

ALARM_ASSOC? <channel>,<limit_num>

| | | |
|-------------|---|-----------|
| <channel> | = | (4 .. 20) |
| <limit_num> | = | 1 2 |

Returns the digital output line number associated with the indicated alarm limit. An Execution Error is generated if no output is associated with this alarm limit, if invalid channel numbers are used, or if limits other than 1 or 2 are used.

Table 4-8. Command and Query Reference (cont)

ALARM_ASSOC_CLR Clear Alarm Association

Clear the digital output association for the indicated channel and alarm limit.

ALARM_ASSOC_CLR <channel>,<limit_num>

<channel> = (4 .. 20)
<limit_num> = 1 2

When the association is cleared, the output pin is left in a high (non-alarm) state. If the alarm limit specified is not 1 or 2, or if the channel is invalid, an Execution Error is generated.

ALARM_DO_LEVEL Set Alarm Output Level

Set or clear the indicated alarm digital output.

ALARM_DO_LEVEL <DO_line>,<DO_state>

<DO_line> = (0 .. 3)
<DO_state> = 1 (high) 0 (low)

Alarm outputs 0-3 correspond to channels 0-3, respectively. If the digital output line requested is not in the range 0 through 3, an Execution Error is generated. If the DO_state specified is not 1 (high) or 0 (low), an Execution Error is generated.

ALARM_DO_LEVELS? Alarm Output State Query

Returns digital output levels for the four alarm digital outputs.
Returns an integer value representing the state of each of the digital I/O lines. The low order four bits are the status of the alarm digital outputs; 0 indicates line is low (in alarm), and 1 indicates line is high (not in alarm). These lowest four bits correspond to alarm digital outputs 0 through 3, which are permanently associated to channels 0 through 3, respectively. A value of 15 indicates that all alarm outputs are in the non-alarm (high) state.

ALARM_LIMIT Set Alarm Limit

Store alarm limit information for the indicated channel and limit. The fields to be given (in order) are:

ALARM_LIMIT <channel>,<limit_num>,<sense>,<value>

<channel> = (0 .. 20)
<limit_num> = 1 2
<sense> = HI LO OFF
<value> = Signed numeric quantity

Table 4-8. Command and Query Reference (cont)

| | |
|---|---|
| <p>A Command Error is generated if a value is supplied when the sense is OFF. An Execution Error is generated under any of the following circumstances:</p> <ul style="list-style-type: none"> • <value> is outside the range ± 9999.9 Mega (E+6). • <channel>, <limit_num>, or <sense> are not specified from the given list. • A <channel> that is defined as OFF is specified. <p>Note that old alarm settings for a channel are lost when the function for that channel is changed.</p> | |
| ALARM_LIMIT? | <p>Alarm Limit Assignments Query</p> <p>Return alarm limit data for specified channel and limit.</p> <p>ALARM_LIMIT? <channel>,<limit_num></p> <p><channel> = (0 .. 20) <limit_num> = 1 2</p> <p>Returns HI, LO, or OFF, indicating the sense of that limit. For HI or LO limits, the value is returned in scientific notation format with five digits of resolution. If the channel specified is invalid, or the requested limit is not 1 or 2, an Execution Error is generated.</p> <p>Remember that old alarm settings for a channel are lost when the function for that channel is changed.</p> |
| DATE | <p>Set Date</p> <p>Set instrument calendar values. DATE <month>,<date>,<year></p> <p><month> = (1 .. 12) <date> = (1 .. 31) <year> = (00 .. 99)</p> <p>Invalid values generate an Execution Error.</p> |
| DIO_LEVELS? | <p>Digital I/O State Query</p> <p>Returns digital input and output levels for the eight configurable digital I/O lines.</p> <p>Returns an integer value representing the actual states of the digital I/O lines. The low-order eight bits are used to indicate the status of each configurable I/O line (0 indicates low; 1 indicates high.) Bits 0 through 7 correspond to I/O lines 0 through 7. The highest possible integer value is 255, indicating that all eight digital I/O lines are set high.</p> |

Table 4-8. Command and Query Reference (cont)

| <i>NOTE</i> | |
|--|---|
| <i>The digital I/O line levels returned by the DIO_LEVELS? query may not match the levels set with the DO_LEVEL command. Lines that were set to 1 (high) may have been externally driven low. The DIO_LEVELS? query causes the actual state of the lines to be read.</i> | |
| DO_LEVEL | <p>Set Digital Output Level</p> <p>Set or clear the indicated digital output.</p> <p>DO_LEVEL <DO_line>,<DO_state></p> <p><DO_line> = (0 .. 7) <DO_state> = 1 0</p> <p>If the digital output line requested is not in the range 0 through 7, an Execution Error is generated. If the DO_state specified is not 1 (high) or 0 (low), an Execution Error is generated.</p> <p>Low is the active alarm state. At power up, all digital outputs are set high.</p> |
| ECHO | <p>Enable/Disable RS-232 Echo Mode (RS-232 only)</p> <p>ECHO <1 0></p> <p>1 = Turn RS-232 echoing on. 0 = Turn RS-232 echoing off.</p> <p>If the IEEE-488 interface is selected, use of ECHO results in an execution error.</p> |
| FORMAT | <p>Response Format</p> <p>Set the output format type.</p> <p>FORMAT <f_type></p> <p><f_type>= 1 2</p> <p>The default is 1, which is IEEE-488.2 compatible. Since no measurement units are allowed in IEEE, an alternative (2) is provided. When format 2 is in effect the responses are no longer IEEE-488.2 compatible. The primary use for format 2 is with RS-232, as it provides a means of recording the units with the measurement value. Any parameter other than 1 or 2 causes an Execution Error to be generated. The units strings used are as follows:</p> |

Table 4-8. Command and Query Reference (cont)

| MEASUREMENT | UNITS STRING |
|---------------|--------------|
| Scaled "MX+B" | |
| Volts DC | "VDC" |
| Volts AC | "VAC" |
| Resistance | "OHMS" |
| Frequency | "HZ" |
| Temperature | "C" |
| Temperature | "F" |

FORMAT? Query Response Format

Returns the format presently in use:

- 1 The default. IEEE-488.2-compatible. No measurement units are allowed.
- 2 Responses are not IEEE-488.2-compatible, allowing a means of recording the units with the measurement value.

FUNC Channel Function Definition

Define the measurement function and range for the indicated channel. Attempting to use the FUNC command when measurements are active results in an Execution Error.

NOTE

Successful execution of the FUNC command clears any alarm limits and scaling values for this channel. Therefore, you must define a channel's function before setting alarm limits and/or scaling values for that channel. Also, the FUNC command clears all values in the Review array.

FUNC <channel>,<OFF>
 FUNC <channel>,<VAC VDC FREQ>,<range>
 FUNC <channel>,<OHMS>,<range>,<terminals>
 FUNC <channel>,<TEMP>,<thermocouple type>
 FUNC <channel>,<TEMP>,<PT>,<terminals>

<channel> = (0 .. 20)

If the channel number is invalid, an Execution Error is generated.

<function> = VAC VDC OHMS FREQ TEMP OFF

If the function is OFF, any additional supplied parameters generate a Command Error.

<range> = AUTO (1 .. 6) (Thermocouple/RTD_type)

Table 4-8. Command and Query Reference (cont)

Ranges for VAC, VDC, OHMS, and FREQ are listed in the following table. Enter AUTO to select autoranging. Use of any other values causes an Execution Error.

| RANGE | VOLTAGE | OHMS | FREQUENCY |
|-------|-----------|----------------|-----------|
| 1 | 300 mV | 300 Ω | 900 Hz |
| 2 | 3 V | 3 k Ω | 9 kHz |
| 3 | 30 V | 30 k Ω | 90 kHz |
| 4 | 150/300 V | 300 k Ω | 900 kHz |
| 5 | Error | 3 M Ω | 1 MHz |
| 6 | Error | 10 M Ω | Error |

For temperature functions, the "range" is a thermocouple type (J, K, E, T, N, R, S, B, C) or DIN/IEC 751 RTD (PT).

Use of any other value causes an Execution Error.

<terminals> = 2 (2-terminal)
4 (4-terminal)

Specification of terminals is necessary when the function type is OHMS or when an RTD temperature measurement is being defined. When this field is called for, a value must be supplied, or a Command Error is generated. Defining a 4-terminal channel (1 through 10) automatically sets the additional channel (11 through 20) to OFF.

If a value is supplied in this field when it is not necessary, a Command Error is generated. An Execution Error is generated if values other than 2 or 4 are used.

FUNC?

Channel Function Query

Return the function for the indicated channel.

FUNC? <channel>

<channel> = (0 .. 20)

If the channel indicated is invalid, an Execution Error is generated. For valid channels, two or three comma-separated data fields are returned. One of the following function definitions is returned in the first data field:

TEMP, VAC, VDC, OHMS, FREQ, OFF

For a 4-terminal configuration, two channels are used. For the lower channel, the instrument responds to FUNC? with OHMS or TEMP in the first field. For the upper channel (lower channel +10), the instrument responds with OFF in the first field.

Table 4-8. Command and Query Reference (cont)

| | |
|---------------|--|
| | <p>The second data field indicates the range when a function has been chosen. If the channel is set up to autorange, AUTO is returned. If the function is TEMP, the thermocouple/RTD_type is returned in this field. If the function is OFF, there is no range data returned.</p> <p>If the type is OHMS or RTD-temperature, a third field is included to indicate the number of terminals used. See the Channel Function Definition (FUNC) command for a definition of the data returned for the range and number-of-terminals fields.</p> |
| IEE | <p>Instrument Event Enable</p> <p>Sets the Instrument Event Enable Register to the given value.</p> <p>IEE <value> <value> = (0 .. 255)</p> <p>This is a mask for the Instrument Event Register and is the first step in determining which conditions may issue an SRQ. The mask selects which conditions may set the Instrument Event Bit of the Status Byte. If the value is not in the range 0 to 255, an Execution Error is generated.</p> |
| IEE? | <p>Instrument Event Enable Query</p> <p>Returns the present value of the Instrument Event Enable Register as an integer.</p> |
| IER? | <p>Instrument Event Register Query</p> <p>Returns the value of the Instrument Event Register as an integer, then clears all bits.</p> |
| INTVL | <p>Set Scan Interval</p> <p>Set scan interval time.</p> <p>INTVL <hours>,<minutes>,<seconds></p> <p><hours> = (0 .. 9) <minutes> = (0 .. 99) <seconds> = (0 .. 99)</p> <p>An Execution Error is generated if values outside the specified ranges are used or if measurements are active.</p> |
| INTVL? | <p>Scan Interval Query</p> <p>Return scan interval time. Returns three values: hours, minutes, and seconds.</p> |
| LAST? | <p>Channel's Last Scan Value</p> <p>Returns value(s) for channels measured in the most recent scan. The value returned represents data from the most recent scan. The most recent scan is the scan in progress or, if scanning is not in progress, the last completed scan.</p> <p>LAST? <channel> <channel> = (0 .. 20)</p> <p>Returns measurement values for either the indicated channel or all defined channels. If the channel specification field is left blank, values for all defined channels are returned (values for channels defined as OFF are not included.) An Execution Error results if a request is made for a channel defined as OFF, the channel specified is invalid, the channel specified has been set up but not yet measured, or Review array values have been cleared.</p> |

Table 4-8. Command and Query Reference (cont)

| | |
|--------------|--|
| | <p>The response is a signed number with decimal point and exponent. For slow scanning rate, 5 digits are returned (+/-XX.XXXE+/-X); for fast scanning rate, 4 digits are returned (+/-XX.XXE+/-X). The range setting determines placement of the decimal point.</p> <p>For values of all defined channels (no channel specification made), undefined (OFF) channels are not included. For each defined channel, a separate signed number with decimal point and exponent is returned. Commas separate numbers for different channels, and no blank spaces are included.</p> |
| LOCK | <p>Lock the instrument front panel so that only use of the arrow keys and the simultaneous use of FUNC and Mx+B are recognized. The following LOCK commands are recognized:</p> <p>LOCK 0 Unlock</p> <p>LOCK 1 Lock and begin review. If the instrument is no in review, a review is begun (even if there are no defined channels.)</p> <p>LOCK 2 Monitor lock. If the instrument is not already in monitor, an Execution Error is generated.</p> <p>The three LOCK states are non-volatile. If power is interrupted, the instrument retains the last LOCK setting.</p> |
| LOCK? | <p>Retrieve instrument front panel lock status.</p> <p>0, 1, or 2 is returned, identifying the state set with the LOCK command.</p> |
| LOCS | <p>Local without Lockout (RS-232 only)</p> <p>Enter the IEEE-488.1 local without front panel lockout (LOCS) state. All front panel buttons are enabled, and the REM annunciator is not lit. This is the state assumed by the instrument at power-up reset.</p> <p>If this command is used with the IEEE-488 interface, an Execution Error is generated.</p> |
| LOG? | <p>Retrieve Logged Data Query (RS-232 only)</p> <p>Return the oldest logged scan values for all configured channels and remove them from storage. This query is valid during scanning. The remaining count of stored scans (LOG_COUNT?) is decremented by 1. Channels defined as OFF are not included. If there are no (more) logged scans or if the instrument is a Hydra Data Acquisition Unit, an Execution Error is generated.</p> <p>The response includes the following information:</p> <ul style="list-style-type: none"> • Date and time at the start of the logged scan. <p>Date and time are returned as integer values. For example, returned values of "20,32,44,5,18,90" signify May 18, 1990 20:32:44.</p> <ul style="list-style-type: none"> • Values for the channels measured. <p>The measurement data is returned as a list of scientific notation values, separated by commas. For example, "+3.4567E-3,-4.9876E+6" are valid measurement values. If the fast measurement rate is used, the values have one less digit of resolution ("+3.457E-3,-4.988E+6").</p> <p>If you are using the RS-232 interface format 2, valid data responses would include: +894.45E+3 OHM,-9.1234E-3 C.</p> <ul style="list-style-type: none"> • State of the Digital I/O lines and totalize count at the end of the scan. <p>Two values are returned. The first is an integer in the range 0 through 15, identifying the four alarm output states. The second is an integer in the range 0 through 255, identifying digital I/O line states.</p> |

Table 4-8. Command and Query Reference (cont)

| | |
|-------------------|--|
| | <p>The Totalizer count is returned as a scientific notation value in the range 0 through 65535 (00.000E+3 through 65.535E+3). If the Totalizer has overflowed, a value of 1E+9 is returned.</p> <p>An Execution Error is generated if this query is used with the IEEE-488 interface.</p> <p>The following example shows the type of data received in response to LOG?. The first line shows time and date. The second line shows measurement values. The third line shows alarm outputs state, DIO state, and totalizer value. Note that the actual response combines all this information on one line; three lines are shown here for presentation clarity.</p> <pre>16,15,30,10,3,90, -034.53E-3,+09.433E+0,+09.433E+0,+09.434E+0,+09.434E+0, 15,255,+00.000E+3</pre> |
| LOGGED? | <p>Retrieve specified scan data from memory (RS-232 only)</p> <pre>LOGGED? <index> <index> = (1 .. 2047)</pre> <p>Scan data is not removed from memory with this query. Use of <index> values outside the range causes an Execution Error. Use of <index> values within the range and have no data stored will also cause an Execution Error. An Execution Error is generated if the instrument is a Hydra Data Acquisition Unit.</p> <p>Scan data is returned in the same format as for the LOG? query.</p> |
| LOG_BIN? | <p>Binary Upload of Logged Data (RS-232 only)</p> <p>For quick upload of logged data from a 2625A. See Appendix F. An Execution Error is generated if the instrument is a Hydra Data Acquisition Unit, or <index> is out of range or invalid.</p> <pre>LOG_BIN? <index></pre> |
| LOG_CLR | <p>Clear Logged Scans (RS-232 only)</p> <p>Clear all stored scan data. An Execution Error is generated if the instrument is a Hydra Data Acquisition Unit.</p> |
| LOG_COUNT? | <p>Logged Scan Count Query (RS-232 only)</p> <p>Return the number of stored scans. Returns an integer value representing the number of scans presently stored in memory. The maximum value that can be returned is 2047; 0 indicates that there are no stored scans. An Execution Error is generated if the instrument is a Hydra Data Acquisition Unit.</p> |
| LOG_MODE | <p>Determines treatment of new scan data when memory is full (RS-232 only)</p> <pre>LOG_MODE <mode></pre> <p>0 Wrap around. When memory is full, oldest scans are discarded to make room for new scans. This is the default mode.</p> <p>1 Discard new scans. New scans are stored only when memory becomes available. (See LOG? and LOG_CLR.)</p> <p>The LOG_MODE setting is non-volatile and cannot be changed from the instrument front panel. An Execution Error is generated if the instrument is Hydra Data Acquisition Unit.</p> |
| LOG_MODE? | <p>Query treatment of new scan data when memory is full (RS-232 only)</p> <p>0 or 1 is returned, signifying the mode set with the LOG_MODE command. An Execution Error is generated if the instrument is a Hydra Data Acquisition Unit.</p> |

Table 4-8. Command and Query Reference (cont)

| | |
|-------------|--|
| LWLS | <p>Local with Lockout (RS-232 only)</p> <p>Enter the IEEE-488.1 local with front panel lockout (LWLS) state. All front panel buttons are disabled. The REM annunciator is not lit. If this command is used with the IEEE-488 interface, an Execution Error is generated.</p> |
| MAX? | <p>Channel's Maximum Value</p> <p>Returns maximum value(s) for channels measured in the most recent scan. The value returned represents data from the most recent scan. The most recent scan is the scan in progress or, if scanning is not in progress, the last completed scan.</p> <p>MAX? <channel></p> <p style="padding-left: 40px;"><channel> = (0 .. 20)</p> <p>Leave the channel specification field blank if values for all defined channels are desired. An Execution Error results if a request is made for a channel defined as OFF, the channel specified is invalid, the channel specified has been set up but not yet measured, or Review array values have been cleared. The response is a signed number with decimal point and exponent. For slow scanning rate, 5 digits are returned ($\pm XX.XXXE\pm X$); for fast scanning rate, 4 digits are returned ($\pm XX.XXE\pm X$). The range setting determines placement of the decimal point.</p> <p>For maximum values of all defined channels (no channel specification made), undefined (OFF) channels are not included. For each defined channel, a separate signed number with decimal point and exponent is returned. Commas separate numbers for different channels, and no blank spaces are included.</p> |
| MIN? | <p>Channel's Minimum Value</p> <p>Returns minimum value(s) for channels measured in the most recent scan. The value returned represents data from the most recent scan. The most recent scan is the scan in progress or, if scanning is not in progress, the last completed scan.</p> <p>MIN? <channel></p> <p style="padding-left: 40px;"><channel> = (0 .. 20)</p> <p>If the channel specification field is left blank, values for all defined channels are returned. Channels defined as OFF are not included. An Execution Error results if a request is made for a channel defined as OFF, the channel specified is invalid, the channel specified has been set up but not yet measured, or Review array values have been cleared.</p> |

Table 4-8. Command and Query Reference (cont)

| | |
|------------------|---|
| | <p>The response is a signed number with decimal point and exponent. For slow scanning rate, 5 digits are returned ($\pm XX.XXXE\pm X$); for fast scanning rate, 4 digits are returned ($\pm XX.XXE\pm X$). The range setting determines placement of the decimal point.</p> <p>For minimum values of all defined channels (no channel specification made), undefined (OFF) channels are not included. For each defined channel, a separate signed number with decimal point and exponent is returned. Commas separate numbers for different channels, and no blank spaces are included.</p> |
| MON | <p>Enable/Disable Monitoring</p> <p>This command performs the same function as MON on the front panel.</p> <p>MON 1,<channel> Enables monitoring of given channel (if monitoring is disabled).</p> <p> Changes monitored channel (if monitoring is already enabled).</p> <p>MON 0 Disables monitoring.</p> <p>The <channel> parameter can be 0 through 20. A command error is generated if no <channel> parameter is given when enabling monitoring. If the channel to be monitored is invalid or defined as OFF, or if values other than 0 or 1 are given, an Execution Error is generated.</p> <p>The MON and SCAN commands work in conjunction with the front panel controls. The Monitor and Scan functions can be enabled or disabled from either the front panel or the computer interface. The most recently specified monitor channel (from front panel or computer interface) becomes the one channel monitored.</p> <p>Front panel SCAN and MON buttons work only when the lockout state is LOCS.</p> |
| MON_CHAN? | <p>Monitor Channel Number</p> <p>This query asks for the number of the presently defined monitor channel. If monitoring is not active, an Execution Error is generated.</p> |
| MON_VAL? | <p>Monitor Channel Value</p> <p>This query asks for a measurement on the monitor channel. If monitoring is not active, an Execution Error results.</p> |

Table 4-8. Command and Query Reference (cont)

| | |
|-------------------|--|
| NEXT? | Next Scan's Values |
| | <p>The NEXT? query returns data values for the next scan to complete. If a scan is in progress when the NEXT? query is processed, the data values returned are from the scan in progress. If a scan is not presently in progress, the NEXT? query waits for data to become available. When scanning is occurring, use the NEXT? query to return data from each scan.</p> |
| | <p>NEXT? returns comma-separated information for the date and time at the start of the next measurement scan, the values for channels measured, the state of the Digital I/O lines, and the totalize count.</p> |
| | <p>The time and date are returned in the following order: Hours (0-23), Minutes (0-59), Seconds (0-59), Month (1-12), Date (1-31), Year (0-99)</p> |
| | <p>Measurement data is returned as a list of scientific notation values. For an overload (OL), "1E+9" is returned. If an open thermocouple is detected, "9E+9" is returned.</p> |
| | <p>Alarm output and digital I/O values are returned as integer values. The Totalizer value is returned as a scientific notation value.</p> |
| | <p>Channels defined as OFF are not included. If all channels are defined as OFF, an Execution Error is generated.</p> |
| PRINT | Data Logging Enable/Disable (RS-232 only) |
| | Turn data logging on or off. |
| | <pre>PRINT <state> <state> = 1 (on) 0 (off)</pre> |
| | <p>An Execution Error is generated if any other value is used or if this command is used with the IEEE-488 interface.</p> |
| PRINT? | Data Logging Query (RS-232 only) |
| | <p>Return the status of data logging. Returns 0 (OFF) or 1 (ON). An Execution Error is generated if this query is used with the IEEE-488 interface.</p> |
| PRINT_TYPE | Set Data Logging Type (RS-232 only) |
| | <p>Enable internal Memory Storage or Autoprint and set the type of scan data logged.</p> |

Table 4-8. Command and Query Reference (cont)

| | |
|---------------------------|---|
| | <p>PRINT_TYPE <destination>,<type></p> <p><destination> = 0 (PRINT SCANS) 1 (STORE SCANS) 2 (BOTH)</p> <p><type> = 0 (ALL) 1 (channel in ALARM) 2 (channel had alarm TRANSition)</p> <p>An Execution Error is generated if any other value is used, if this command is used with a 2620A and you attempt to select STORE SCANS or BOTH.</p> <p>The Hydra Data Logger can hold 2047 scans, with each scan containing 21 channels of data. Refer to "List Button Functions" in Section 3 for an example of some printed scans.</p> |
| <p>PRINT_TYPE?</p> | <p>Data Logging Type Query (RS-232 only)</p> <p>Return the Autoprint or internal Memory Storage type and the type of scan data logged. Returns 0 (AUTOPRINT), 1 (STORE), OR 2 (BOTH), and 0 (ALL), 1 (ALARM), or 2 (TRANS). For example, "1,0" could be returned, signifying that all scan data is sent to internal Memory Storage.</p> <p>An Execution Error is generated if this query is used with the IEEE-488 interface.</p> |
| <p>RANGE?</p> | <p>Channel Range Query</p> <p>Returns the range used for the most recent scan involving this channel. The most recent scan is the scan in progress or, if scanning is not in progress, the last completed scan.</p> <p>This is the range presently in use for channels set up to autorange. Note that measurements on the monitor channel do not affect the response to this command.</p> <p>RANGE? <channel></p> <p><channel> = (0 .. 20)</p> <p>If the channel specification field is left blank, values for all defined channels are returned. Channels defined as OFF are not included. An Execution Error results if a request is made for a channel defined as OFF, the channel specified is invalid, or if the channel has been set up but not measured. The range value returned is the measurement range and is not affected by Mx+B scaling. Temperature functions (thermocouple and RTD) have only one range, which is considered fixed (1).</p> |

Table 4-8. Command and Query Reference (cont)

For each defined channel, an integer value (1-6) is returned. Commas separate integers for different channels, and no blank spaces are included. For example, if channel 1 last used the 30V range during a scan measurement, channel 11 used the 3 M Ω range, channel 12 used the 900 Hz range, and channel 13 measured a thermocouple, the response is "3,5,1,1". Refer to the FUNC description for range definitions.

RATE

Select Measurement Rate

Specify the measurement rate. Successful execution of this command clears all values in the Review array.

```
RATE <rate>
      <rate> =      0 (slow) 1 (fast)
```

An Execution Error is generated if the argument is not 0 or 1 or if measurements are active.

RATE?

Measurement Rate Query




Return measurement rate for the instrument.

Returns 0 (SLOW) or 1 (FAST).

REMS

Remote without Lockout (RS-232 only)

Enter the IEEE-488.1 remote without front panel lockout (REMS) state. The REM annunciator is lit, and only the following three front panel buttons are now active (with special REMS functionality):

-  triggers a single scan.
-  generates a service request.
-  returns the instrument to normal front panel control.

If this command is used with the IEEE-488 interface, an Execution Error is generated.

REVIEW_CLR

Clear Review Values

Clear all minimum, maximum, and last values (all channels) in the Review array. (It is not possible to selectively clear individual entries in the Review array.) The Review clearing operation is carried out only at the completion of any scan in progress.

Clearing the Review array also clears all alarm status.

Table 4-8. Command and Query Reference (cont)

| | |
|-----------------|--|
| RTD_R0 | <p>RTD Ice Point (R0)</p> <p>For the indicated channel, store the numeric data as RTD R0. Successful execution of this command clears all Review array values (all channels.)</p> <p>RTD_R0<channel>, <R0> <channel> = (0 .. 20) <R0> 0 <= R0 <= 999.99</p> <p>An Execution Error is generated if the R0 value supplied is not within the indicated range, the channel specified is invalid, the channel is not defined as RTD temperature, or measurements are active.</p> |
| RTD_R0? | <p>RTD Ice-Point (R0) Query</p> <p>Return RTD R0 (ice-point resistance) value for the indicated channel.</p> <p>RTD_R0? <channel> <channel> = (0 .. 20)</p> <p>If the channel number is invalid, an Execution Error is generated. If a channel is defined OFF, or if no change has been made to R0 for a channel, the value "100.00" is returned.</p> |
| RWLS | <p>Remote with Lockout (RS-232 only)</p> <p>Enter the IEEE-488.1 remote with front panel lockout (RWLS) state. All front panel buttons are disabled, and the REM annunciator is lit.</p> <p>If this command is used with the IEEE-488 interface, an Execution Error is generated.</p> |
| SCALE_MB | <p>Set Mx+B Scaling Values</p> <p>Set the M and B scaling values for the indicated channel, and display the results of the Mx+B calculation in the indicated display range. Successful execution of this command clears all values in the Review array (all channels.)</p> <p>SCALE_MB <channel>,<M_value>,<B_value>,<disp_range></p> <p><channel> = (0 .. 20) <M_value> = signed numeric quantity <B_value> = signed numeric quan<disp_range> = (16) <disp_range> = (1 .. 16)</p> |

Table 4-8. Command and Query Reference (cont)

| CODE | DISPLAY | MAX OFFSET VALUE | CODE | DISPLAY | MAX OFFSET VALUE |
|------|-----------|------------------|------|----------|------------------|
| 1 | 0.0000 m | 0.01 | 9 | 0.0000 k | 1.0E4 |
| 2 | 00.000 m | 0.1 | 10 | 00.000 k | 1.0E5 |
| 3 | 000.00 m | 1.0 | 11 | 000.00 k | 1.0E6 |
| 4 | 0000.0 m | 1.0 | 12 | 0000.0 k | 1.0E6 |
| 5 | 0.0000 x1 | 10.0 | 13 | 0.0000 M | 1.0E7 |
| 6 | 00.000 x1 | 100.0 | 14 | 00.000 M | 1.0E8 |
| 7 | 000.00 x1 | 1000.0 | 15 | 000.00 M | 1.0E9 |
| 8 | 0000.0 x1 | 1000.0 | 16 | 0000.0 M | 1.0E10 |

When M=1 and B=0, Mx+B scaling is effectively nonexistent. The values for M and B must be in the span ± 9999.9 Mega (E+6).

An Execution Error is generated for any of the following:

- Invalid entries for channel number, M or B values, or display range code are used.
- The range required by the B value is larger than allowed by the display range code.
- The channel is defined as OFF.
- Measurements are active.

Mx+B scaling values for a channel are automatically reset to 1 (M) and 0 (B) when the function for that channel is changed.

SCALE_MB?

Mx+B Scaling Values Query

Return the M and B scaling values for the indicated channel.

SCALE_MB? <channel>

<channel> = (0 .. 20)

If the channel number given is invalid, an Execution Error is generated. Remember that Mx+B scaling values are automatically reset to 1 (M) and 0 (B) when the function for that channel is changed.

This command returns three values. The first two are the M and B values for the channel indicated, even when M=1 and B=0 or the function is defined as OFF. These first two values are returned in M and B order and in scientific notation format with five digits of resolution. The third value returned indicates the Mx+B resultant display range.

SCAN

Enable/Disable Scanning

This command performs the same function as SCAN on the front panel.

SCAN 1 Enable scanning.

SCAN 0 Disable scanning (any scan in progress is completed first.)

Table 4-8. Command and Query Reference (cont)

| <p>If there are no configured channels (all are defined as OFF) or values other than 0 or 1 are given, an Execution Error is generated.</p> <p>The MON and SCAN commands work in conjunction with the front panel controls. The Monitor and Scan functions can be enabled or disabled from either the front panel or the computer interface. The most recently specified monitor channel (from front panel or computer interface) becomes the one channel monitored.</p> <p>Front panel <input type="checkbox"/> SCAN and <input type="checkbox"/> MON buttons work only when the lockout state is LOCS.</p> | | | | | | | | | | | | | | | | |
|--|--|-------------------------------------|-------|---------|---|---|----|---|---|----|---|---|-------------------------------------|---|---|------------------------------------|
| SCAN? | <p>Return scan status. If a scan is in progress, a "1" is returned at the end of the scan. (A response delay may occur if SCAN? is sent early in a scan.) This feature allows synchronization for other commands that would not be recognized if received during a scan. For example, SCAN?;*TRG could be used to trigger a new scan after completion of the current scan. Otherwise, a *TRG command sent while a scan is in progress would be discarded. If a scan is not in progress, a "0" is returned immediately.</p> | | | | | | | | | | | | | | | |
| SCAN_TIME? | <p>Time of Scan</p> <p>Returns values indicating the time and date at start of last scan. Uses the same format and order as the TIME_DATE? query. The data is returned in the following order: Hours (0-23), Minutes (0-59), Seconds (0-59), Month (1-12), Date (1-31), Year (0-99). Setting of time does not include seconds, but retrieval of time does.</p> | | | | | | | | | | | | | | | |
| TEMP_CONFIG | <p>Temperature Configuration</p> <p>Set temperature configuration using the given value. Successful execution of this command clears all Review array values (all channels.)</p> <p>TEMP_CONFIG <value></p> <p style="padding-left: 40px;"><value> = encoded bit fields</p> <p>Use the lowest two bits of the value given as individual flags to specify the temperature configuration. Therefore, the value given must be in the range from 0 through 3 or an Execution Error is generated. These settings affect every channel; they cannot be set for each channel individually. If this command is attempted when measurements are active, an Execution Error results.</p> <table border="1" style="margin-left: auto; margin-right: auto;"> <thead> <tr> <th style="text-align: center;">BIT NUMBER</th> <th style="text-align: center;">VALUE</th> <th style="text-align: center;">MEANING</th> </tr> </thead> <tbody> <tr> <td style="text-align: center;">0</td> <td style="text-align: center;">0</td> <td style="text-align: center;">°C</td> </tr> <tr> <td style="text-align: center;">0</td> <td style="text-align: center;">1</td> <td style="text-align: center;">°F</td> </tr> <tr> <td style="text-align: center;">1</td> <td style="text-align: center;">0</td> <td style="text-align: center;">Disable open thermocouple detection</td> </tr> <tr> <td style="text-align: center;">1</td> <td style="text-align: center;">1</td> <td style="text-align: center;">Enable open thermocouple detection</td> </tr> </tbody> </table> | BIT NUMBER | VALUE | MEANING | 0 | 0 | °C | 0 | 1 | °F | 1 | 0 | Disable open thermocouple detection | 1 | 1 | Enable open thermocouple detection |
| BIT NUMBER | VALUE | MEANING | | | | | | | | | | | | | | |
| 0 | 0 | °C | | | | | | | | | | | | | | |
| 0 | 1 | °F | | | | | | | | | | | | | | |
| 1 | 0 | Disable open thermocouple detection | | | | | | | | | | | | | | |
| 1 | 1 | Enable open thermocouple detection | | | | | | | | | | | | | | |
| TEMP_CONFIG? | <p>Temperature Configuration Query</p> <p>Response to this query corresponds to settings made with the TEMP_CONFIG command, as follows:</p> | | | | | | | | | | | | | | | |

Table 4-8. Command and Query Reference (cont)

| BIT NUMBER | VALUE | MEANING |
|------------|-------|-------------------------------------|
| 0 | 0 | °C |
| | 1 | °F |
| 1 | 0 | Disable open thermocouple detection |
| | 1 | Enable open thermocouple detection |

TIME

Set the instrument clock.

TIME <hours>,<minutes>

<hours> = (0 .. 23) (24-hour scale, 18:00 = 6:00 pm).

<minutes> = (0 .. 59)

Invalid values generate an Execution Error.

Seconds are automatically set to 00 with the TIME command.

TIME_DATE?

Retrieve Time and Date

Returns comma-separated integer values for time, date, and year as maintained by the instrument clock. These returned values use the TIME and DATE command integer formats as follows:

hours 0-23
minutes 0-59
seconds 0-59
month 1-12
day 1-31
year 00-99

Seconds are returned, but cannot be set other than to 00.

TOTAL

Set Totalizer Count

Give the Totalizer count a new initial value.

TOTAL <t_value>
<t_value> = (0 .. 65535)

If the value is not in the range 0 through 65,535, an Execution Error is generated.

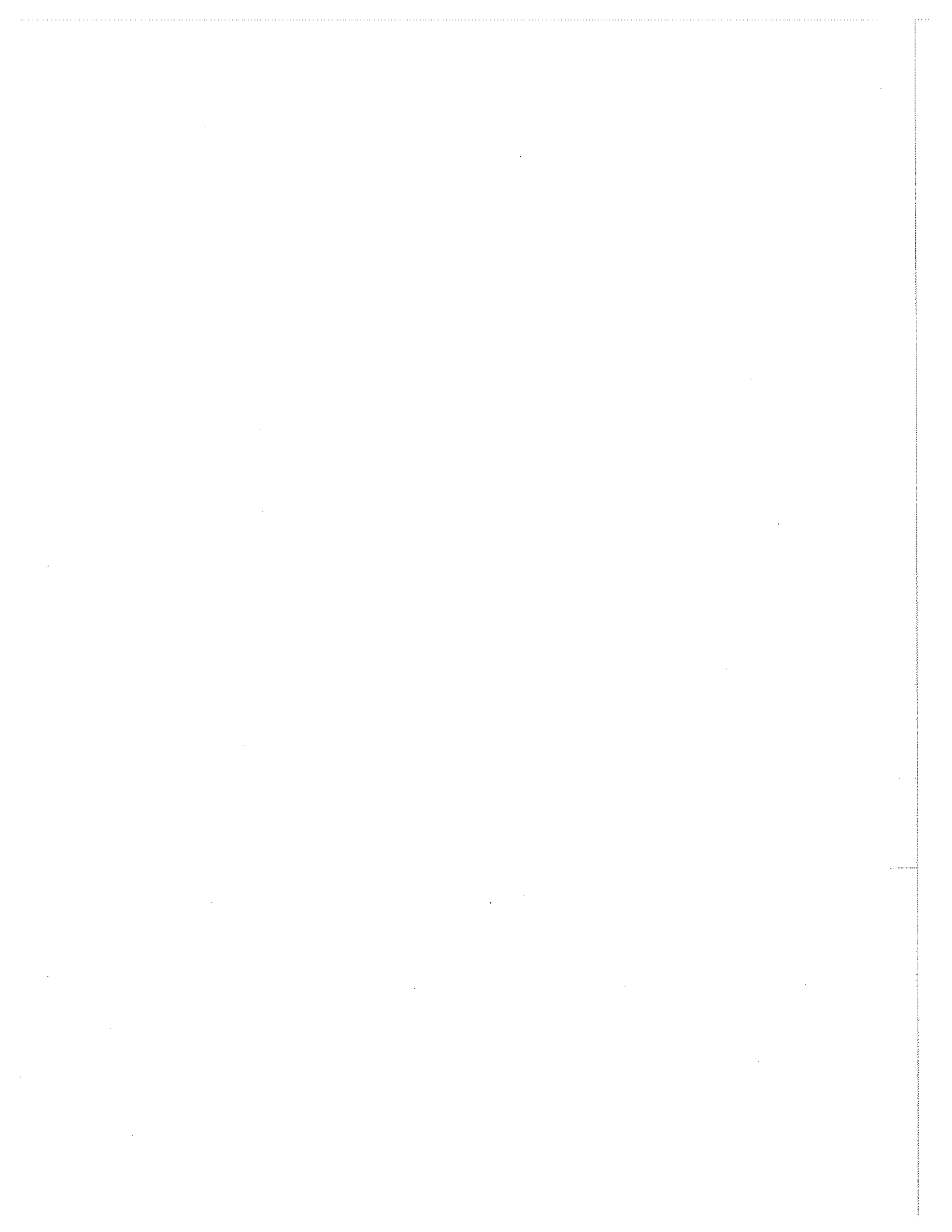
Clear the Totalizer count by setting the Totalizer to zero (0).

Table 4-8. Command and Query Reference (cont)

| | |
|--------------------|---|
| TOTAL? | <p>Totalizer Value Query</p> <p>Returns the value of the present Totalizer count. Format of the value is +00.000E+3. When the Totalizer has overflowed, the value returned is +001.00E+9.</p> |
| TOTAL_DBNC | <p>Set Totalizing Debounce</p> <p>Set totalizing input debounce state.</p> <p>TOTAL_DBNC <dbnc_state> <dbnc_state> = 1(on) 0(off)</p> <p>Use of any other value causes an Execution Error to be generated. At initial power up, totalize debounce is disabled (0).</p> |
| TOTAL_DBNC? | <p>Totalizer Debounce Query</p> <p>Returns the totalizing input's debounce state as an integer. When disabled, the response is 0, indicating debounce is not in use. When enabled, the response is 1, indicating debounce is being used.</p> |
| TRIGGER | <p>Select Trigger Type</p> <p>Select the type of scan triggering.</p> <p>TRIGGER <trig_type> <trig_type> = 0 (off) 1(on) 2 (alarm)</p> <p>Off (0) signifies that external triggering is disabled. Only normal scan interval triggering can be used. If the scan interval is 0, continuous scanning results.</p> <p>On (1) means that external triggering is enabled. An acceptable low input on the External Trigger input (TR terminal on the rear panel) then affects scanning as follows:</p> <ul style="list-style-type: none"> - If the instrument is in Inactive Mode or Monitor Mode, the low input enables scanning. When the TR input returns to high, scanning is disabled. - If scanning is already enabled, the external trigger requests a single scan. This request is ignored if a scan is presently in progress. <p>Alarm (2) signifies that an alarm condition on the monitor channel triggers a single scan. When the scan is completed, the Monitor function is resumed. This cycle repeats as long as the alarm condition is encountered on the monitor channel. The external trigger input is disabled. The *TRG and GET commands can still be used.</p> |

Table 4-8. Command and Query Reference (cont)

| | |
|---|---|
| If the type given is not one of the listed values, an Execution Error is generated. | |
| TRIGGER? | Trigger Type Query |
| | Returns an integer representing the present trigger type: |
| 0 | (off) |
| 1 | (on) |
| 2 | (alarm) |



Section 5

Additional Considerations

INTRODUCTION

Section 5 discusses some topics that will help you use the instrument more effectively. These considerations assume that you are familiar with the basic operation of the instrument and have some basic understanding of electronics.

MEASUREMENT RATE

The two measurement rates provide a choice of maximum accuracy and noise rejection (slow rate) or maximum throughput (fast rate). The selected rate applies to all channels on the instrument. Therefore, your rate selection will be based on overall consideration of the speed and accuracy you need.

Exact measurement rates vary somewhat by type of measurement. Refer to Appendix A, Specifications for complete measurement rate information.

ADVANCED TRIGGER MECHANISMS

Normally, the built-in scan interval timer controls when scan measurements are taken. However, two additional mechanisms are available for activating scans:

1. An external trigger signal, connected at the rear panel "TR" input.
2. An alarm condition on the Monitor channel.

NOTE

These two additional trigger mechanisms are mutually exclusive.

The External Trigger input and Monitor-Alarm trigger can be enabled from the front panel or through computer interface commands.

Front Panel Trigger Control

To access the trigger controls from the front panel, select TRIGS (). Then press or to cycle through the choices for trigger types:

- OFF Both External and Monitor-Alarm triggers are disabled.
- On The External Trigger input is enabled.
- ALAr The Monitor-Alarm trigger is enabled.

Press once you've selected the desired trigger type. Note that internal scan interval triggering is not affected by this selection and remains available.

Computer Interface Trigger Control

Select a scan trigger type over the computer interface by sending the command:

TRIGGER <type>

where <type> is:

- 0 Both External and Monitor-Alarm triggers are disabled.
- 1 The External Trigger input is enabled.
- 2 The Monitor-Alarm trigger is enabled.

If one of these types is not specified, an Execution Error is generated.

Verify the trigger type over the computer interface by sending the query:

TRIGGER?

Single scans can be triggered via the RS-232 interface or the IEEE-488 interface by sending the *TRG command. Note that the IEEE-488 interface GET command can be used only when the IEEE-488 interface is enabled.

NOTE

*If the instrument is in the remote state without front panel lockout (i.e., REMS), a *TRG can be generated from the front panel by pressing .*

Both External and Monitor Alarms Disabled (Type 0)

External trigger input is disabled (Front Panel OFF, Computer Interface TRIGGER=0). The *TRG and GET commands can still be used, and only normal scan interval triggering can be used. If the scan interval is 0:00:00, continuous scanning results. Also, a small scan interval (specifying a time less than that required by the instrument to complete a full scan) effectively becomes continuous scanning. The number of channels in the scan and the types of measurement determine the time necessary to complete one scan.

External Trigger Enabled (Type 1)

This corresponds to the Front Panel ON or Computer Interface TRIGGER=1 setting. When External Trigger is enabled, a low signal on the rear panel TR terminal affects scanning as follows:

- If the scan function has already been activated, the trigger signal causes a single set of scan measurements to be taken. This feature is convenient in cases where you want to collect normal scheduled scans, as well as scan measurements in response to some abnormal situation. When the condition arises, a trigger signal can be sent to the instrument, causing it to take an extra set of scan measurements.
- If scan measurements are occurring when the trigger requesting a single scan arrives, this request for another scan is ignored. (This stipulation applies whether the scan in progress was initiated by the scan interval timer, a command over the computer interface, or from a previous external-trigger signal.)
- If the instrument is in Inactive Mode, or just the Monitor function is selected, the low trigger signal enables interval scanning. Scans are executed at the specified scan interval. (If the scan interval is 0, continuous scanning results; a small scan interval time effectively becomes continuous scanning.) When the TR input returns high, interval scanning is disabled. This feature is handy in cases where you want to begin normal scheduled scans after the system under test has reached some particular operating condition. When that condition arises, a trigger signal can be sent to the instrument, causing it to begin interval scanning.
- If the instrument is in Configuration Mode, all external trigger signals are ignored. The instrument must be in Inactive Mode or Active Mode before any external trigger signal will be recognized.

The external trigger accepts a contact closure or logic low signal; the input is non-isolated and TTL compatible. Note that scanning is enabled on the falling edge of the trigger signal. This trigger signal must be held low for a minimum of 5 microseconds; it must also have previously been unasserted (high) for at least 100 milliseconds. Refer to Figure 5-1. Signal level constraints are as follows:

High 2.0V min., 7.0V max.
Low -0.6V min., 0.8V max.

Monitor Alarm Enabled (Type 2)

This corresponds to the Front Panel ALAr or Computer Interface TRIGGER=2 setting. When the Monitor Alarm trigger is enabled and the Monitor function is on, a scan is triggered if the monitor measurement is found to be in alarm. After this scan occurs, a monitor measurement is again made. If the monitor measurement is still in alarm, another scan is triggered. This pattern continues as long as the monitor channel remains in alarm.

Monitor alarm trigger can be used when interval scanning is enabled. This feature is convenient when you want to take normal scheduled scans and also use the monitor function as a “watchdog” on a particular channel. Whenever an alarm condition arises on that monitored channel, the instrument automatically takes additional scan measurements.

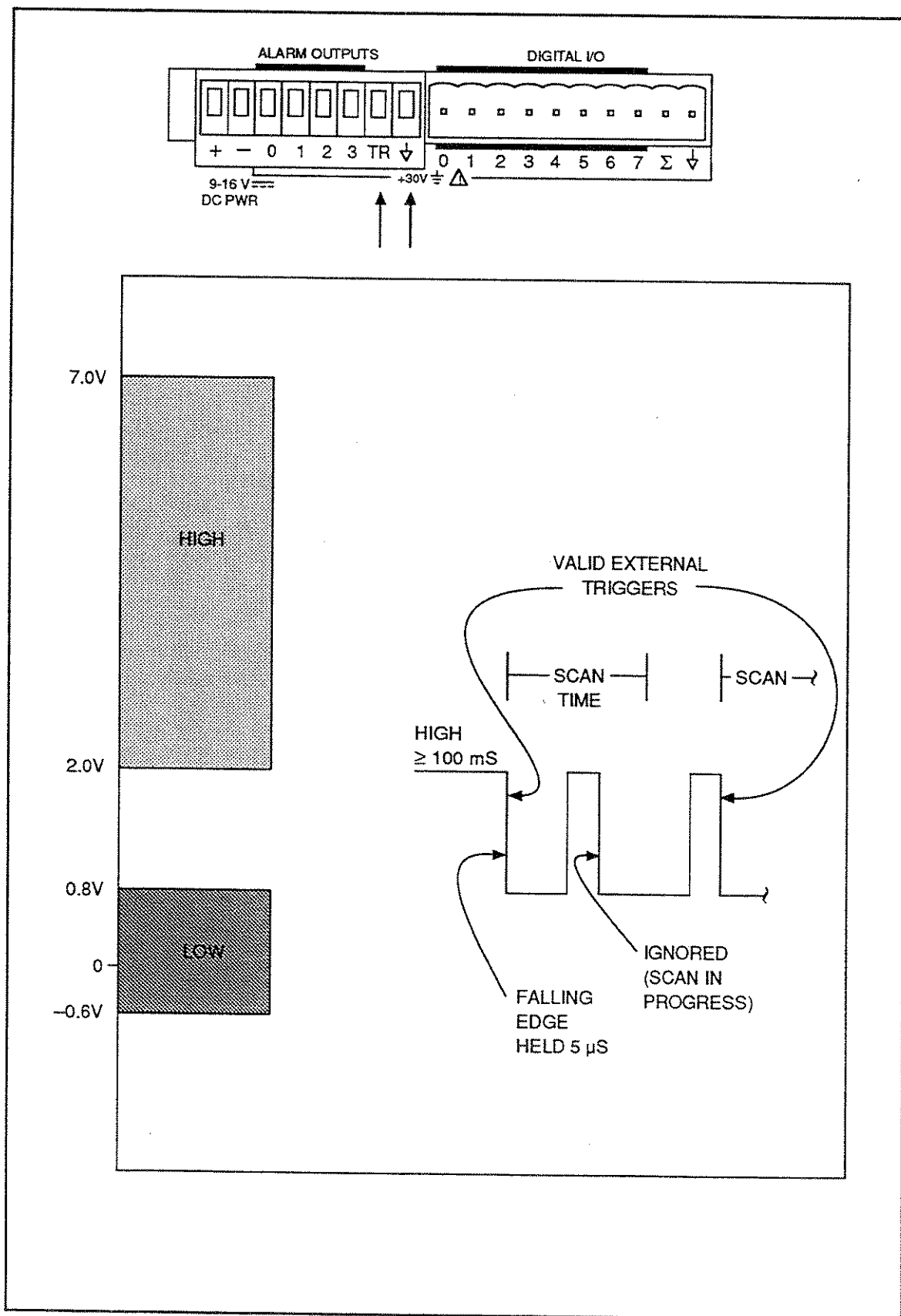


Figure 5-1. External Trigger Timing

If you change the Monitor function to a different channel while the Monitor-alarm trigger is in use, measurements on the new monitor channel are used to trigger scans when the monitor measurement is in alarm. When monitor and scanning are both enabled, at least one monitor channel measurement is taken after every set of scan measurements - even in the case of continuous scanning.

THERMAL VOLTAGES

Thermal voltages are the thermovoltaic potentials that appear at the junction between dissimilar metals. Thermal voltages, which can easily exceed $1 \mu\text{V}$, typically arise where wires are attached to binding posts.

With low-level dc voltage and thermocouple temperature measurements, these thermal voltages can be an additional source of measurement error.

Thermal voltages can also cause problems in the low ohms ranges. Some low value resistors are constructed with dissimilar metals. Just handling such resistors can cause thermal voltages large enough to introduce measurement errors.

On Hydra, the rear panel Input Module (channels 1 through 20) contains an isothermal block to minimize thermal voltage errors. The front connector pair (channel 0), which does not attach directly to this block, is more susceptible to thermal voltage errors. Use the following techniques to reduce the effect of thermal voltages:

1. Use similar metals for connections wherever possible (e.g., copper-to-copper, gold-to-gold, etc.).
2. Use tight connections.
3. Use clean connections (especially free of grease and dirt).
4. Use caution when handling the measurement source.
5. Wait for all measurement connections to reach thermal equilibrium. (Thermal voltages are generated only where there is a temperature gradient.)

WHEN MEASURING RESISTANCE (Ω) OR TEMPERATURE (RTD)

The instrument can measure a resistance with two or four terminal connections. Advantages for each configuration are discussed below:

- 2-Terminal Configuration

The instrument measures resistance in a 2-terminal configuration using a resistance ratio (sometimes called ratio-ohms) technique. Using only the high (H) and low (L) terminals for one channel, 2-terminal resistance measurements are simple to set up and yield good results for many measurement conditions. However, if lead wire and internal relay resistances are significant in relation to the resistances being measured, the 4-terminal configuration should be used. (Internal relay resistances are noted in Appendix A, Specifications.)

A 2-terminal configuration is illustrated in Figure 5-2.

The full-scale voltage for each resistance range is shown in Table 5-1. The V Ω (or H) input test lead is positive with respect to the COM (or L) lead.

Table 5-1. Ohms Test Voltage

| RANGE | TYPICAL FULL SCALE VOLTAGE |
|-------------------|----------------------------|
| 300.00 Ω | 0.22 |
| 3.0000 k Ω | 0.25 |
| 30.000 k Ω | 0.29 |
| 300.00 k Ω | 0.68 |
| 3.0000 M Ω | 2.25 |
| 10.000 M Ω | 2.72 |

Note: Open circuit voltage is 3.2V (maximum) on the 300.00 Ω , 300.00 k Ω , 3.0000 M Ω , and 10.000 M Ω ranges, and 1.5V (maximum) on the 3.000 k Ω and 30.000 k Ω ranges.

- 4-Terminal Configuration

In 4-terminal configuration, the instrument uses a second pair of leads to automatically eliminate measurement-lead and internal-relay resistance errors.

With measurement lead and internal relay resistances eliminated, this configuration yields the most accurate readings.

Four-terminal measurements are allowed on channels 1 through 10 only. However, two pairs of high (H) and low (L) terminals are needed for this type of measurement. The first pair is provided by the selected channel (any of channels 1 through 10). The second pair is provided by the channel 10 numbers higher. For example, channels 2 and 12 (or 7 and 17) could provide the two pairs of terminals. This second channel provides the necessary two additional terminals, and is therefore not available for any other use until the first channel is changed to a function other than 4-terminal OHMS or RTD.

A 4-terminal configuration is illustrated in Figure 5-2.

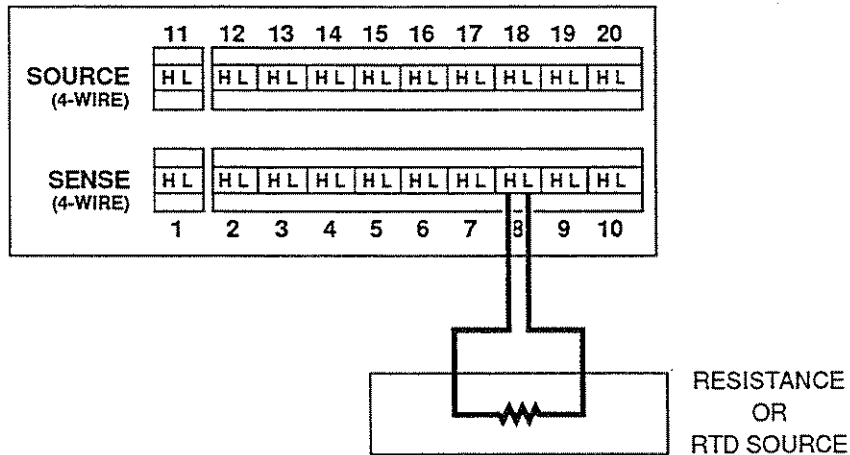
TRUE RMS MEASUREMENTS

The instrument measures the true rms value of ac voltages. In physical terms, the rms (root-mean-square) value of a waveform is the equivalent dc value that causes the same amount of heat to be dissipated in a resistor. True rms measurement greatly simplifies the analysis of complex ac signals. Since the rms value is the dc equivalent of the original waveform, it provides a reliable basis for comparing dissimilar waveforms.

Effects of Internal Noise in AC Measurements

With the input shorted and the instrument set for ac volts (VAC) measurement, internal amplifier noise causes a typical display reading of approximately 0.50 mV. Since the instrument is a true rms responding measurement device, this noise contributes minimally to the reading at the specified floor of each range. When the rms value of the two signals (internal noise and range floor) is calculated, the effect of the noise is shown as:

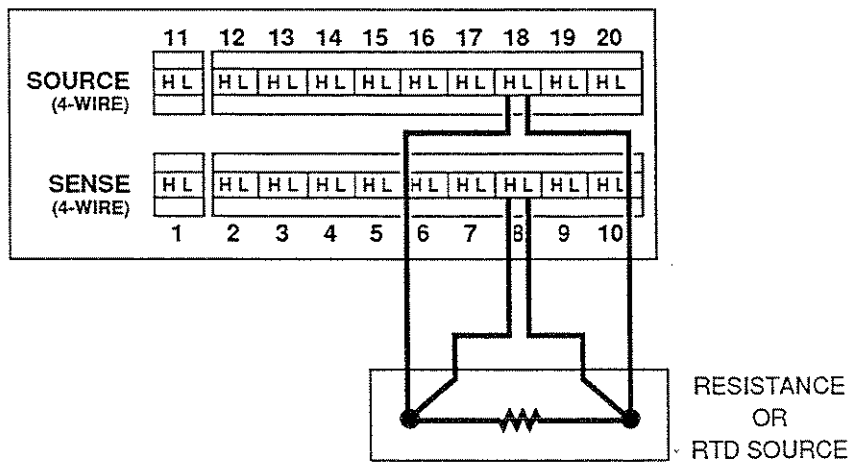
2-WIRE (2T) CONNECTION



USE H AND L TERMINALS FOR ANY CHANNEL.

- CHANNEL 0 ON FRONT PANEL
- CHANNELS 1 THROUGH 20 ON REAR PANEL INPUT MODULE (CHANNEL 8 SHOWN HERE).

4-WIRE (4T) CONNECTION



USE H AND L TERMINALS FOR TWO CHANNELS ON REAR PANEL INPUT MODULE. CONNECTIONS FOR CHANNEL 8 SHOWN HERE WITH CHANNEL 18 PROVIDING ADDITIONAL TWO CONNECTIONS.

FOR EACH 4-WIRE CONNECTION, ONE SENSE CHANNEL (1 THROUGH 10) AND ONE SOURCE CHANNEL (SENSE CHANNEL NUMBER +10 = 11 THROUGH 20) ARE USED.

Figure 5-2. 2T and 4T Connections

$$\text{Total rms digits} = \sqrt{0.50^2 + 15.00^2} = 15.008$$

The display will read 15.01. At the 28.00 mV input level on the 300.00 mV range in the slow rate, the display will read 28.00 with no observable error.

Waveform Comparison (True RMS vs Average Responding)

Figure 5-3 illustrates the relationship between ac and dc components for common waveforms and compares readings for true-rms measurements (such as with the instrument) and average-responding measurements. For example, consider the first waveform, a 1.41421V (zero-to-peak) sine wave. Both the instrument and rms-calibrated average-responding measurement devices display the correct rms reading of 1.0000V (the dc component equals 0). However, consider the 2V (peak-to-peak) square wave.

Both types of measurement correctly display the dc component (0V), but the instrument also correctly measures the ac component (1.0000V). The average-responding device measures 1.111V, which amounts to an 11% error.

Average-responding measurement devices have been in use for a long time; you may have accumulated test or reference data based on such instruments. The conversion factors in Figure 5-3 can aid in converting between the two measurement methods.

MAKING MIXED MEASUREMENTS

With multiple channels, Hydra allows mixing of measurement types. But the possibility of the ac signal on one channel affecting measurements on other channels must be considered. This effect is known as cross talk.

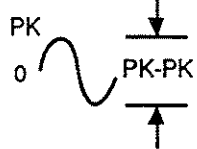
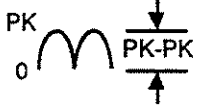
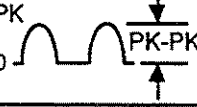
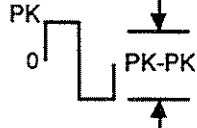

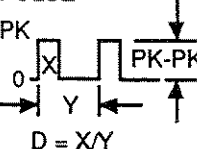
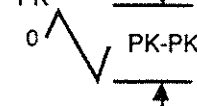
The ac volts signal could be either a voltage that is to be measured on another channel (which is known as a normal mode signal) or an ac voltage signal on another channel that is present between the channel inputs and earth ground (which is known as a common mode signal). A common mode signal could occur, for example, if an unshielded thermocouple were to be used to measure the metal case temperature of an ac power line diode.

AC voltage cross talk can affect the various measurement types differently. It can cause other ac voltage measurements to read too high. DC and resistance (OHMS) measurements could either shift or read noisy. Frequency measurements could be noisy, or, in the extreme case, the cross talk frequency could actually become the measured signal.

Cross talk can occur at numerous places: in the device or process being monitored, in the wiring to the Hydra instrument, or within the Hydra instrument itself.

Fortunately, precautions can be taken to provide error-free measurements by minimizing the effects of cross talk. Use the following guidelines to minimize cross talk between ac volts signal inputs and other sensitive channels:

- Keep any input wiring carrying ac volts signals physically separate from other sensitive channel's input wiring.
- Avoid connecting inputs with ac volts signals adjacent to sensitive channel inputs. (Leave unconnected channels between the inputs, if possible).

| AC-COUPLED INPUT WAVEFORM | PEAK VOLTAGES | | MEASURED VOLTAGES | | | DC AND AC TOTAL RMS TRUE RMS = $\sqrt{ac^2 + dc^2}$ |
|---|---------------|-------|-------------------|-------|-------------------|---|
| | PK-PK | 0-PK | AC COMPONENT ONLY | | DC COMPONENT ONLY | |
| | | | RMS CAL * | HYDRA | | |
| SINE  | 2.828 | 1.414 | 1.000 | 1.000 | 0.000 | 1.000 |
| RECTIFIED SINE (FULL WAVE)  | 1.414 | 1.414 | 0.421 | 0.436 | 0.900 | 1.000 |
| RECTIFIED SINE (HALF WAVE)  | 2.000 | 2.000 | 0.779 | 0.771 | 0.636 | 1.000 |
| SQUARE  | 2.000 | 1.000 | 1.111 | 1.000 | 0.000 | 1.000 |
| RECTIFIED SQUARE  | 1.414 | 1.414 | 0.785 | 0.707 | 0.707 | 1.000 |
| RECTANGULAR PULSE  $D = X/Y$ $K = \sqrt{D-D^2}$ | 2.000 | 2.000 | $4.442 K^2$ | 2K | 2D | $2\sqrt{D}$ |
| TRIANGLE SAWTOOTH  | 3.464 | 1.732 | 0.962 | 1.000 | 0.000 | 1.000 |

* RMS CAL IS THE DISPLAYED VALUE FOR AVERAGE RESPONDING INSTRUMENTS THAT ARE CALIBRATED TO DISPLAY RMS FOR SINE WAVES

Figure 5-3. Comparison of Common Waveforms

5/ADDITIONAL CONSIDERATIONS

- Avoid connecting inputs with ac volts signals to any channel 10 numbers away from a sensitive channel (i.e. 4-terminal input channels.)
- Avoid tying L (low) or (especially) H (high) inputs of a sensitive channel to earth (chassis) ground. This is very important in resistance measurements.
- Avoid high source impedances on sensitive channels, or minimize the capacitance of the sensitive channel to earth (chassis) ground for high impedance inputs.
- Whenever high ohms measurements ($> 10 \text{ k}\Omega$) must be made accurately, avoid connecting any inputs carrying ac volts signals to the Hydra instrument.

NOTE

If frequencies other than 50 or 60 Hz must be present on other channels while measuring resistance, temperature, or dc voltage, frequencies of 40 Hz + multiples of 80 Hz (40, 120, 200, etc.) up to 2 kHz should be avoided. Otherwise, frequencies at intervals of 5 Hz will generally contribute no more error to a resistance measurement than frequencies of 50 or 60 Hz.

It is not necessary to follow all of these guidelines. In fact, for most applications, adhering to just one of these guidelines will provide satisfactory results. Refer to Appendix E for detailed information about cross talk.

USING SHIELDED WIRING

Shielded wires and sensors, such as sheathed thermocouples, are often used in noisy environments to reduce measurement errors. When you are connecting these sensors to a measuring instrument, the proper connection of the shield depends on the entire measurement system and environment.

General Rule

Connect the shield to L (low) at the input terminals for each Hydra channel.

Alternate Suggestions

In specific instances, following the General Rule may not result in the optimum noise rejection; it may be necessary to try alternate configurations and check for improved performance.

NON-ISOLATED SENSOR CONFIGURATION

If non-isolated sensors are used, (e.g. a thermocouple probe where the sensor and its shield are electrically connected), try leaving the shield disconnected (open) at the 2620A-100 Input Module.

ISOLATED AND SHIELDED SENSOR CONFIGURATION

WARNING

THE FOLLOWING SUGGESTIONS RELY ON THE SHIELD BEING KEPT ELECTRICALLY ISOLATED FROM THE SENSOR H (HIGH) AND L (LOW) WIRING, EXCEPT WHERE SPECIFICALLY STATED OTHERWISE.

If isolated and shielded sensors are used with the instrument, (e.g., an isolated thermocouple probe where the thermocouple junction is electrically isolated from shield), two additional configurations to try are:

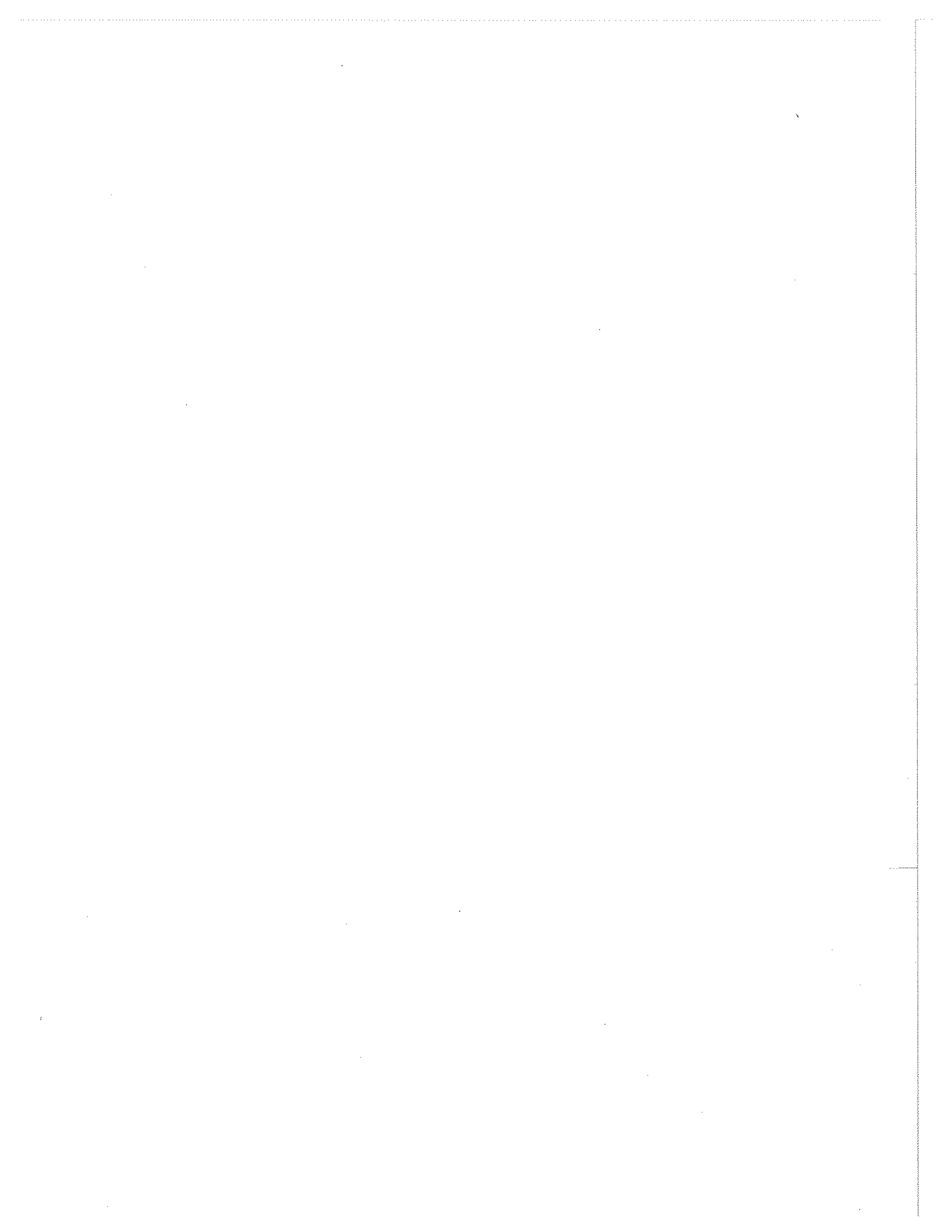
1. Connect the shield to L (low) at the 2620A-100 Input Module, and try connecting the sensor shield to a quiet earth ground at or very near the measurement sensor end (and at only one place), or
2. Connect the shield to L (low) at the Input Module, and try connecting the shield to earth ground (only) as close to the rear of the instrument as possible. Isolated and shielded sensors will likely result in the best instrument measurement performance possible in a noisy environment.

In More Detail

If a low noise configuration is required, adhering to the following two rules minimizes measurement errors and noise when using shielded sensors and wiring:

1. Connect the shield so that it and the L (low) terminal are at the same or very nearly the same voltage, and
2. Connect the shield so that common-mode voltages will not cause current to flow through the L (or H) source resistance(s).

One key to applying these rules is to note that very high, but finite impedances exist between H (high) and L (low), between H and earth ground, and between L and earth ground inside the instrument.



Section 6

Maintenance

INTRODUCTION

This section describes basic maintenance that the instrument user can perform. Do not attempt any maintenance not described in this section. For additional maintenance, service, and calibration procedures, qualified service personnel can refer to the Hydra Service Manual (P/N 889589).

CLEANING

WARNING

TO AVOID ELECTRICAL SHOCK OR DAMAGE TO THE INSTRUMENT, NEVER GET WATER INSIDE THE CASE. TO AVOID DAMAGING THE INSTRUMENT'S HOUSING, NEVER APPLY SOLVENTS TO THE INSTRUMENT.

For cleaning, wipe the instrument with a cloth that is lightly dampened with water or mild detergent. Do not use aromatic hydrocarbons, chlorinated solvents, or methanol-based fluids.

LINE FUSE

The instrument uses a T 125 mA, 250V (Slow blow) line fuse in series with the power supply. To replace this fuse (located on the rear panel), unplug the line cord and remove the fuse holder with the fuse as shown in Figure 6-1. The instrument is shipped with a replacement fuse that is loosely secured in the fuse holder.

SELF-TEST DIAGNOSTICS AND ERROR CODES

When the instrument is powered up, the entire display lights.

NOTE

*To hold the display fully lit, press and hold **SHIFT**, then press **POWER ON** and wait a moment for the instrument to beep. Then release **SHIFT**. The entire display will now stay on until you press any button; the power-up sequence then resumes.*

Self-test diagnostics are performed each time the instrument is powered up. Any errors encountered during this initial 4-second period are displayed momentarily. Even in the presence of an error, the instrument still attempts to complete the self-test routine and begin normal operation.

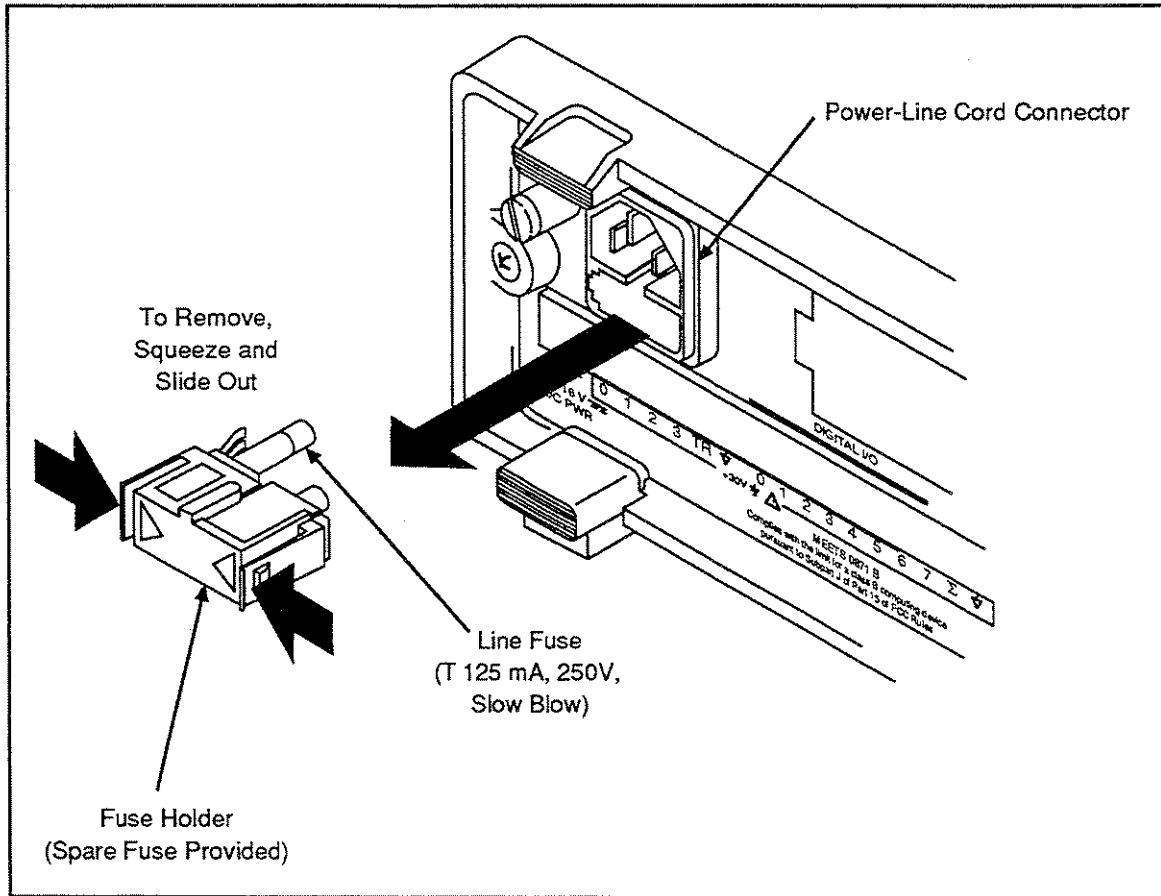


Figure 6-1. Replacing the Line Fuse

An error indicates that a malfunction has occurred and maintenance is required. If you encounter an error, note the number or letter and consult Table 6-1. See if the instrument repeats the error. If the problem persists and you intend to repair the instrument yourself, refer to the Service Manual. Otherwise, package the instrument securely (using the original container if available.) Then forward the package, postage paid, to the nearest Fluke Service Center. A list of Service Centers is provided in Appendix D of this manual. Include a brief description of the problem. Fluke assumes no responsibility for damage in transit.

PERFORMANCE TESTS

When received, the 2620A/2625A Hydra Instrument is calibrated and in operating condition. The following Performance Verification Procedures are provided for acceptance testing upon initial receipt or to verify correct operation at any time. All tests may be performed in sequence to verify overall operation, or the tests may be run independently.

If the instrument fails any of these performance tests, calibration adjustment and/or repair is needed. To perform these tests, you will need a Fluke 5700A Multifunction Calibrator or equipment meeting the minimum specifications given in Table 6-2.

Table 6-1. Power-Up Error Codes

| ERROR | DESCRIPTION |
|-------|---|
| 1 | ROM checksum error |
| 2 | External RAM test failed |
| 3 | Internal RAM test failed |
| 4 | Display power-up test failure |
| 5 | Display not responding |
| 6 | Instrument configuration corrupted |
| 7 | EEPROM instrument configuration corrupted |
| 8 | EEPROM calibration data corrupted |
| 9 | A/D not responding |
| A | A/D ROM test failure |
| b | A/D RAM test failure |
| C | A/D self test failure |

Table 6-2. Recommended Test Equipment

| INSTRUMENT TYPE | MINIMUM SPECIFICATIONS | | | RECOMMENDED MODEL |
|--------------------------------|---|--------------------------------|----------------|---|
| Multifunction Calibrator | DC Voltage: | | | Fluke 5700A |
| | Range: 90 mV to 300V dc. Accuracy: .005% | | | |
| | AC Voltage: | | | |
| | FREQUENCY | VOLTAGE | ACCURACY | |
| | 1 kHz 100 kHz | 29 mV to 300V 15 mV to 300V | 0.05% 1.25% | |
| | Frequency: | | | |
| | 10 kHz | 1V rms | .0125% | |
| Decade Resistance Source | Ohms | Accuracy | | General Resistance Inc. Model RDS 66A |
| | 290Ω | 0.0125% | | |
| | 2.9 kΩ | 0.0125% | | |
| | 29 kΩ | 0.0125% | | |
| | 290 kΩ 2.9 MΩ | 0.0125% 0.0125% | | |
| | <p style="text-align: center;">NOTE</p> <p><i>The 5700A Calibrator can be used for 0.05% accuracy (rated) on the 3.0 kΩ, 30 kΩ, 300 kΩ, and 3.0 MΩ ranges. The 5700A can be used for 0.06% accuracy on the 300Ω range.</i></p> | | | |

Table 6-2. Recommended Test Equipment (cont)

| INSTRUMENT TYPE | MINIMUM SPECIFICATIONS | RECOMMENDED MODEL |
|--|---|-------------------|
| Mercury Thermometer | 0.02 degrees Celsius resolution | Princo ASTM-56C |
| Thermocouple Probe | Type K | Fluke P-20K |
| Room Temperature Oil/Water Bath | Thermos bottle and cap | |
| Multimeter | Measures +5V dc. | Fluke 77. |
| Signal Generator | Sinewave, 0.5 to 1V rms 10 Hz to 5 kHz | Fluke 6011A |
| ALTERNATE EQUIPMENT LIST (Minimum specifications are the same as in the Standard Equipment List) | | |
| INSTRUMENT TYPE | RECOMMENDED MODEL | |
| DC Voltage Calibrator | Fluke 5440B | |
| DMM Calibrator | Fluke 5100B (for AC Volts only) | |
| Function/Signal Generator | Philips PM5193 or Fluke 6011A | |

Each of the measurements listed in the following steps assume the instrument is being tested after a ½ hour warmup, in an environment with an ambient temperature of 18 to 28 degrees C, and a relative humidity of less than 70%.

NOTE

All measurements listed in the performance test tables are made in the slow reading rate unless otherwise noted.

WARNING

THE 2620A/2625A INSTRUMENT CONTAINS HIGH VOLTAGES THAT CAN BE DANGEROUS OR FATAL. ONLY QUALIFIED PERSONNEL SHOULD ATTEMPT TO SERVICE THE INSTRUMENT. TURN OFF THE HYDRA AND REMOVE ALL POWER SOURCES BEFORE PERFORMING THE FOLLOWING PROCEDURES.

Accuracy Verification Test

1. Power up the instrument and allow it to temperature stabilize for ½ hour.
2. Connect a cable from the Output VA HI and LO connectors of the 5700A to the V Ω and COM connectors on the front panel of the Hydra Instrument. Select the channel 0 function and range on the Hydra and the input level from the 5700A using the values listed in Table 6-3. Press the MON (monitor) button to measure and display the measurement value for channel 0. The display should read between the minimum and maximum values listed in the table, inclusive.

Channel Integrity Test

Assure the Accuracy Verification Test for channel 0 meets minimum acceptable levels before performing this test.

1. Switch OFF power to the instrument and disconnect all high voltage inputs.
2. Remove the Input Module from the rear of the instrument. Open the Input Module and connect a pair of test leads to the H (high) and L (low) terminals of channel 1. Install the Input Module back into the instrument.
3. Connect the ends of the test leads together to apply a short (0 ohms).
4. Reconnect power and switch the instrument ON.
5. For channel 1, select the 2-terminal ohms function and 300 ohms range on the Hydra Instrument. Press MON and ensure the display reads a resistance of less than or equal to 1.5 ohms. (This test assumes that lead wire resistances are less than 0.1 Ω .)
6. Open the ends of the test leads and ensure that the display reads "OL" (overload).
7. Press MON. This will stop the measurement.
8. Connect a cable from the Output VA HI and LO of the 5700A to the Input Module test leads (observe proper polarity).
9. Select the VDC function and 300 volt range on the Hydra and apply first 0V dc then 290V dc input from the 5700A. Ensure the display reads between the minimum and maximum values as shown in Table 6-3 for the 0 and 290V dc input levels.

NOTE

Channels 0, 1, and 11 can accommodate a maximum input of 300V dc or ac. However, the maximum input for all other channels can only be 150V dc or ac.

10. With the exception of the selected voltage range and input voltage from the 5700A, repeat steps 1 through 9 for each remaining Input Module channel (2 through 20). Channels 2 through 10 and 12 through 20 should be configured for the 150V dc range and an input voltage of 150 volts.

Table 6-3. Performance Tests (Voltage, Resistance, and Frequency)

| FUNCTION | RANGE | INPUT LEVEL | FREQUENCY | DISPLAY ACCURACY (1 Year, 18-28°C) | |
|--|-------------------------------|-------------|-----------|---------------------------------------|---------|
| | | | | MIN | MAX |
| DC Volts | 300 mV | 0V | -- | -0.02 | 0.02 |
| | 300 mV | 150 mV | -- | 149.93 | 150.07 |
| | 300 mV | 290 mV | -- | 289.89 | 290.11 |
| | 3V | 2.9V | -- | 2.8988 | 2.9012 |
| | 3V | -2.9V | -- | -2.9012 | -2.8988 |
| | 30V | 29V | -- | 28.990 | 29.010 |
| | 150V | 150V | -- | 149.94 | 150.06 |
| | 300V | 290V | -- | 289.90 | 290.10 |
| NOTE | | | | | |
| <i>Voltages greater than 150V can only be applied to channels 0, 1, and 11.</i> | | | | | |
| AC Volts | 300 mV | 20 mV | 1 kHz | 19.71 | 20.28 |
| | 300 mV | 20 mV | 100 kHz | 18.50 | 21.50 |
| | 300 mV | 290 mV | 1 kHz | 289.26 | 290.74 |
| | 300 mV | 290 mV | 100 kHz | 275.00 | 305.00 |
| | 3V | 2.9V | 1 kHz | 2.8934 | 2.9066 |
| | 30V | 29V | 1 kHz | 28.931 | 29.069 |
| | 150V | 150V | 1 kHz | 149.54 | 150.46 |
| | 300V | 290V | 1 kHz | 289.34 | 290.66 |
| NOTE | | | | | |
| <i>Voltages greater than 150V can only be applied to channels 0, 1, and 11. The rear Input Module must be installed when measuring ac volts on channel 0.</i> | | | | | |
| NOTE | | | | | |
| <i>For 2-terminal measurements, the resistance accuracy given in this table applies to Channel 0 and makes allowance for up to 0.05 ohm of lead wire resistance. You must add any additional lead wire resistance present in your set up to the resistance values given in this table.</i> | | | | | |
| Resistance | Using inputs in decades of 3: | | | | |
| | 300 ohm | short | | 0.00 | 0.09 |
| | | 300 ohms | | 299.80 | 300.27 |
| | 3 kohm | short | | 0.0000 | 0.0003 |
| | | 3 kohms | | 2.9981 | 3.0020 |
| | 30 kohm | 30 kohms | | 29.980 | 30.020 |
| | 300 kohm | 300 kohms | | 299.81 | 300.19 |
| | 3 Mohm | 3 Mohms | | 2.9979 | 3.0021 |

Table 6-3. Performance Tests (Voltage, Resistance, and Frequency) (cont)

| Using inputs in decades of 1.9: | | | | | |
|--|----------|---------------|--|--------|--------|
| | 300 ohm | short | | 0.00 | 0.09 |
| | | 190 ohms | | 189.87 | 190.20 |
| | 3 kohm | short | | 0.0000 | 0.0003 |
| | | 1.9 kohms | | 1.8987 | 1.9014 |
| | 30 kohm | 19 kohms | | 18.987 | 19.013 |
| | 300 kohm | 190 kohms | | 189.87 | 190.13 |
| | 3 Mohm | 1.9 Mohms | | 1.8986 | 1.9014 |
| Using inputs in decades of 1: | | | | | |
| | 300 ohm | short | | 0.00 | 0.09 |
| | | 100 ohms | | 99.92 | 100.15 |
| | 3 kohm | short | | 0.0000 | 0.0003 |
| | 3 kohm | 1 kohms | | 0.9992 | 1.0009 |
| | 30 kohm | 10 kohms | | 9.992 | 10.008 |
| | 300 kohm | 100 kohms | | 99.92 | 100.08 |
| | 3 Mohm | 1 Mohms | | 0.9992 | 1.0008 |
| | 10 Mohm* | 10 Mohms | | 9.986 | 10.014 |
| * Optional test point if standards available. | | | | | |
| NOTE | | | | | |
| All channels (0 through 20) can accommodate 2-terminal resistance measurements. Channel 0, with only two connections, cannot be used for 4-terminal measurements. Four-terminal resistance measurements can be defined for channels 1 through 10 only. Channels 11 through 20 are used, as required, for 4-terminal to provide the additional two connections. For example, a 4-terminal set up on channel 1 uses channels 1 and 11, each channel providing two connections. | | | | | |
| Frequency | 90 kHz | 10 kHz/2V p-p | | 9.994 | 10.006 |

Thermocouple Measurement Range Accuracy Test

Assure the Accuracy Verification Test for channel 0 meets minimum acceptable levels before performing this test.

Thermocouple temperature measurements are accomplished using Hydra's internal 100 mV and 1V dc ranges. (The ranges are not configurable by the operator.) This procedure will provide the means to test these ranges.

To test the 100 mV and 1V dc ranges requires computer interfacing with a host (terminal or computer). The host must send commands to select these ranges. These ranges cannot be selected from the front panel of Hydra.

1. Ensure that communication parameters (i.e., transmission mode, baud rate, parity, and echo mode) on the Hydra and the host are properly configured to send and receive serial data. Refer to Section 4.

2. Power up Hydra and allow it to temperature stabilize for ½ hour.
3. Connect a cable from the Output VA HI and LO connectors of the 5700A to the V Ω and COM connectors on the front panel of the Hydra Instrument.
4. Set the 5700A to output 0V dc
5. Using either a terminal or a computer running a terminal emulation program as the selected host, send the following commands to Hydra:

```
FUNC 0,VDC,I100MV <CR>
```

```
MON 1,0 <CR>
```

```
MON_VAL? <CR>
```

The returned value for channel 0 should be 0 mV \pm 0.007 mV.

Set the 5700A to output 90 mV DC. Send the following command:

```
MON_VAL? <CR>
```

The value returned should now be 90 mV \pm 0.038 mV (between 89.962 and 90.038 mV).

6. Change Hydra's channel 0 function to the internal 1V dc range by redefining channel 0. Send the following commands:

```
MON 0 <CR>
```

```
FUNC 0,VDC,I1V <CR>
```

Set the 5700A to output 0.9V dc. Send the following commands:

```
MON 1,0 <CR>
```

```
MON_VAL? <CR>
```

The value returned should be 900 mV \pm 0.22 mV (899.78 to 900.22 mV.)

4-Terminal Resistance Test

Assure Channel 0's Accuracy Verification Test for DC Volts and Resistance meets minimum acceptable levels.

1. Switch OFF power to the instrument and disconnect all high voltage inputs.
2. Remove the Input Module from the rear of the instrument. Open the Input Module and connect a pair of test leads (keep as short as possible) to the H (high) and L (low) terminals of channel I and a second pair of test leads to the H and L terminals of channel II. Install the Input Module back into the instrument.

3. Observing polarity connect channel 1's test leads to the Sense HI and LO terminals of the 5700A and channel 11's test leads to the Output HI and LO terminals of the 5700A. Connect as shown in Figure 6-2.
4. Switch the instrument ON.
5. Select the 4-terminal OHMS function, AUTO range, for channel 1 on the Hydra Instrument.
6. Set the 5700A to output the resistance values listed in Table 6-3 (Use decades of 1.9).
7. On Hydra press MON and ensure the display reads between the minimum and maximum values shown on Table 6-3.
8. The 4-terminal Resistance Test is complete. However if you desire to perform this test on Input Module channels (2 through 10) repeat steps 1 through 7 substituting in the appropriate channel number.

NOTE

4-terminal connections are made using pairs of channels. 4-terminal measurements can only be made on channels 1 through 10. The accompanying pairs are channels 11 through 20.

Thermocouple Temperature Accuracy Test

Assure the Thermocouple Measurement Range Accuracy Test meets minimum acceptable levels before performing this test.

1. Switch OFF power to the instrument and disconnect all high voltage inputs.
2. Remove the Input Module from the rear of the instrument. Open the Input Module and connect a K-type thermocouple to the H (high) and L (low) terminals of channel 1. Install the Input Module back into the instrument.

NOTE

If other than a K type thermocouple is used, be sure that the instrument is set up for the type of thermocouple used.

3. Reconnect power and switch the instrument ON.
4. Insert the thermocouple and a mercury thermometer in a room temperature bath. Allow 20 minutes for thermal stabilization.
5. Select the temperature and K-type thermocouple function for channel 1. Press MON.

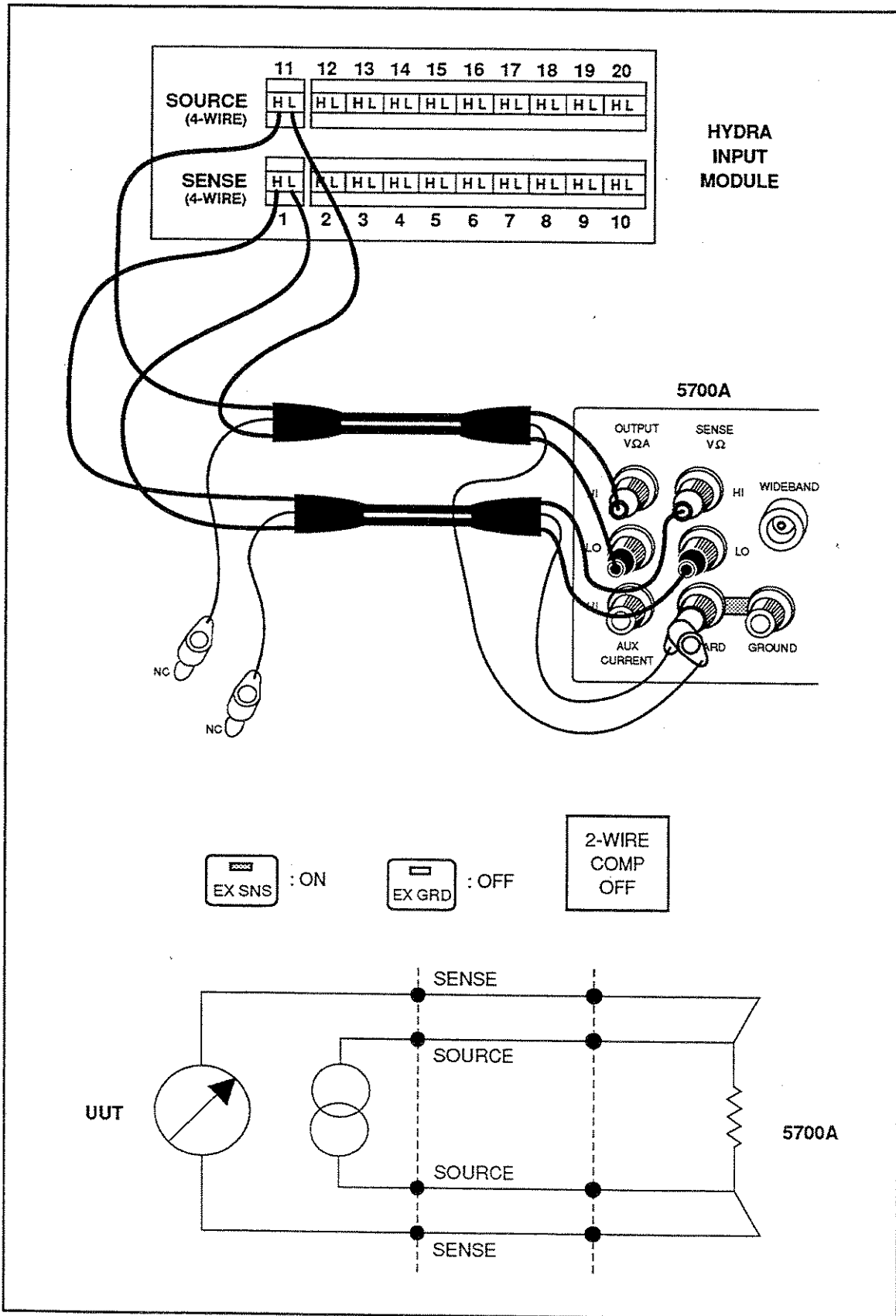


Figure 6-2. 4-Terminal Connections to 5700A

6. The value displayed should be the temperature of the room temperature bath as measured by the mercury thermometer (within tolerances given in Table 6-4, plus any sensor inaccuracies.)
7. The Thermocouple Temperature Accuracy Test is complete. However if you desire to perform this test on any other Input Module channel (2 through 20) repeat steps 1 through 6 substituting in the appropriate channel number.

Table 6-4. Performance Tests for Thermocouple Temperature Function

| THERMOCOUPLE TYPE | THERMOCOUPLE ACCURACY SPECIFICATIONS 1 YEAR @ 18-28 DEGREES C |
|-------------------|--|
| J | $\pm 0.40^{\circ}\text{C}$ |
| K | $\pm 0.44^{\circ}\text{C}$ |
| N | $\pm 0.53^{\circ}\text{C}$ |
| E | $\pm 0.38^{\circ}\text{C}$ |
| T | $\pm 0.45^{\circ}\text{C}$ |

Open Thermocouple Response Test

1. Switch OFF power to the instrument and disconnect all high voltage inputs.
2. Remove the Input Module from the rear of the instrument. Open the Input Module and connect test leads to the H (high) and L (low) terminals of channel 1. Install the Input Module back into the instrument.
3. Reconnect power and switch the instrument ON.
4. Connect the test leads from the Input Module to an 820 ohm resistor.
5. Select the temperature and K-type thermocouple function for channel 1. Press MON.
6. The value displayed should approximate the ambient temperature.
7. Replace the 820 ohm resistor with a 4 kilohm resistor to simulate a high resistance or open thermocouple.
8. Verify a reading of "otc".
9. The Open Thermocouple Response Test is complete. However if you desire to perform this test on any other Input Module channel (2 through 20) repeat steps 1 through 8 substituting in the appropriate channel number.

RTD Temperature Accuracy Test

The following two RTD Temperature Accuracy Tests are different in that one uses a Decade Resistance Source and the other uses an RTD. Only one of the tests need to be performed to assure operation.

RTD TEMPERATURE ACCURACY TEST (USING DECADE RESISTANCE SOURCE)

Assure Channel 0's Accuracy Verification Test for DC Volts and 300 Ohm Resistance Range meets minimum acceptable levels.

1. Switch OFF power to the instrument and disconnect all high voltage inputs.

2. Remove the Input Module from the rear of the instrument. Open the Input Module and connect a pair of test leads (keep as short as possible) to the H (high) and L (low) terminals of channel 1. For 4-terminal performance testing, connect a second pair of test leads to the H (high) and L (low) terminals of channel 11. Install the Input Module back into the instrument.
3. Connect channel 1's test leads to the Output HI and LO terminals of the Decade Resistance Source. For 4-terminal performance testing, also connect channel 11's test leads to the Output HI and LO terminals of the Decade Resistance Source. Connect as shown in Figure 6-3.

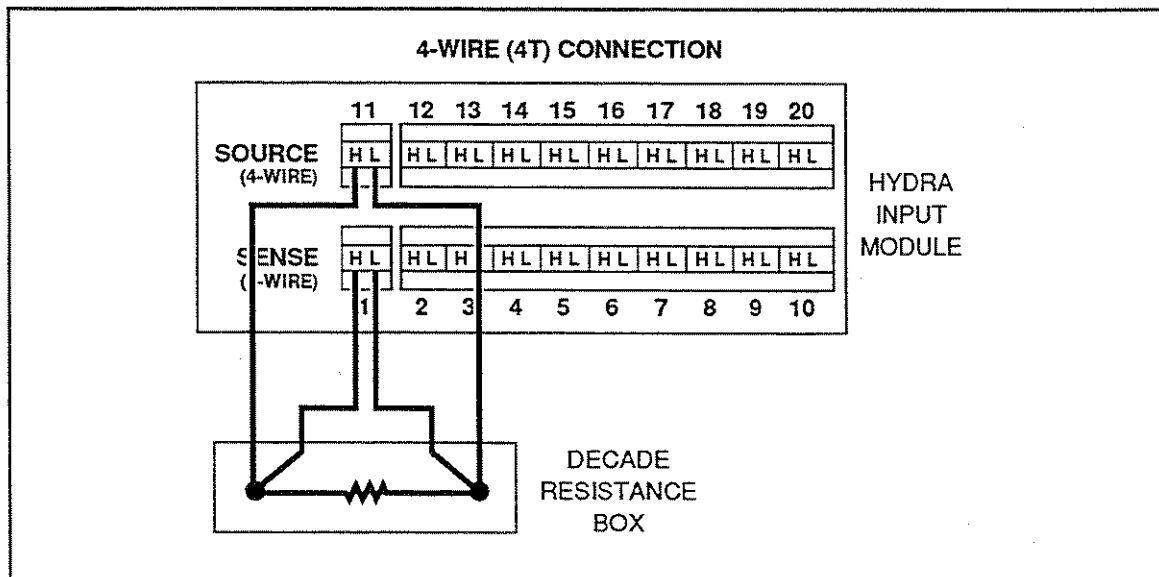


Figure 6-3. 4-Terminal Connections to Decade Resistance Box

NOTE

4-terminal connections are made using pairs of channels. 4-terminal measurements can only be made on channels 1 through 10. The accompanying pairs are channels 11 through 20.

4. Switch the instrument ON.
5. Select the 4-terminal RTD temperature function, RTD type PT, for channel 1 on the Hydra Instrument. Press MON and ensure the display reads between the minimum and maximum values shown on Table 6-5.
6. The RTD Temperature Accuracy test is complete. However if you desire to perform this test on Input Module channels (2 through 10) repeat steps 1 through 5 substituting in the appropriate channel number.

NOTE

The only type of temperature measurement that can be made on channel 0 is 2-terminal RTD. Channels 11 through 20 will support only 2-terminal RTD's.

Table 6-5. Performance Tests for RTD Temperature Function (Resistance Source)

| RESISTANCE SOURCE | SIMULATED DEGREES C | 1 YEAR @ 18-28 DEGREES C |
|-------------------|---------------------|--------------------------|
| 100 ohms | 0 | ± 0.24°C |
| 200 ohms | 266.58 | ± 0.48°C |
| 300 ohms | 558.00 | ± 0.75°C |

These figures assume that RTD R0 is set to 100.00 ohms for each channel.

Accuracy given is for 4-wire measurements only. For 2-wire measurements, degrade the accuracy specifications by 5.2°C per ohm of single lead wire resistance. For 2-wire measurements, degrade the accuracy by an additional 4°C (channels 1 .. 20) or 0.05°C (channel 0)..

RTD TEMPERATURE ACCURACY TEST (USING DIN/IEC 751)

1. Switch OFF power to the instrument and disconnect all other high voltage inputs.
2. Remove the Input Module from the rear of the instrument. Open the Input Module and connect a Platinum RTD, conforming to the European Standards IEC 751 (DIN 43760).

2-terminal RTD: Connect the RTD's excitation leads to the H (high) and L (low) terminals of channel 1.

4-terminal RTD: Connect the RTD's excitation leads (one red and one black wire) to the H (high) and L (low) terminals of channel 1. Connect the RTD's second pair of red and black leads to the H and L leads of channel 11 (refer to Figure 6-3 for proper connection). Install the Input Module back into the instrument.

NOTE

4-terminal connections are made using pairs of channels. 4-terminal measurements can only be made on channels 1 through 10. Their accompanying pairs are channels 11 through 20.

3. Switch the instrument ON.
4. Insert the RTD probe and a mercury thermometer in a room temperature bath. Allow 20 minutes for thermal stabilization.
5. Dependent on the type connection made in step 2, select either the 2 Terminal or 4 Terminal RTD temperature function, RTD type PT (DIN IEC 751), for channel 1 on the Hydra Instrument. Press MON and ensure the display reads the temperature of the room temperature bath (within tolerances shown in Table 6-6) as measured by the mercury thermometer.

Table 6-6 Performance Tests for RTD Temperature Function (DIN IEC 751)

| RTD TYPE (DIN 43760 RTD) | TEMPERATURE ACCURACY SPECIFICATIONS 1 YEAR @ 18-28 DEGREES C |
|--|---|
| 2-wire (channel 0) | -0.65°C to +0.70°C |
| 2-wire (channels 1-20) | -0.65°C to 4.65°C |
| 4-wire | ±0.65°C |
| Assumes RTD R0 is set to 100.00 ohms for each channel. | |

- The RTD Temperature Accuracy test is complete. However if you desire to perform this test on any other channel (0 or 2 through 20) repeat steps 1 through 5 substituting in the appropriate channel number.

NOTE

The only type of temperature measurement that can be made on channel 0 is 2-terminal RTD. Channels 11 through 20 will support only 2-terminal RTD's.

Digital Input/Output Verification Tests

Digital Input/Output verification testing requires computer interfacing with a host (terminal or computer). The host must send commands to the instrument to control the digital lines for this test. Refer to Section 4 for a description of configuring and operating the instrument.

DIGITAL OUTPUT TEST

- Ensure that communication parameters (i.e., transmission mode, baud rate, parity, and echo mode) on the Hydra and the host are properly configured to send and receive serial data. Refer to Section 4.
- Switch OFF power to the instrument and disconnect all high voltage inputs.
- Remove the Digital I/O ten terminal connector from the rear of the instrument and all external connections to it. Connect short wires (to be used as test leads) to the ground (ψ) and 0 through 7 terminals. Leave the other wire ends unconnected at this time. Reinstall the connector.
- Switch power ON to both Hydra and the host. Verify that Hydra is not scanning. If Hydra is scanning, press SCAN to turn scanning off, then cycle power off-on again.
- Using a digital multimeter (DMM), verify that all digital outputs (0-7) are in the OFF or HIGH state. This is done by connecting the low or common of the multimeter to the ground test lead and the high of the multimeter to the digital output and verifying a voltage greater than +3.8V dc.
- Using either a terminal or a computer running a terminal emulation program, set up Hydra to turn Digital Outputs ON (LOW state).

In sequence send the following commands to Hydra and measure that the correct Digital Output line transitioned LOW measures less than +0.8V dc.

DO_LEVEL 0,0 <CR>

Assure output 0 measures a LOW state.

DO_LEVEL 1,0 <CR>

Assure output 1 measures a LOW state.

DO_LEVEL 2,0 <CR>

Assure output 2 measures a LOW state.

Repeat the command for all eight outputs.

7. Set up Hydra to turn Digital Outputs OFF (HIGH state).

In sequence send the following commands to Hydra and measure that the correct Digital Output line transitioned HIGH measures greater than +3.8V dc.

DO_LEVEL 0,1 <CR>

Assure output 0 measures a HIGH state.

DO_LEVEL 1,1 <CR>

Assure output 1 measures a HIGH state.

Repeat the command for all eight outputs.

DIGITAL INPUT TEST

1. Perform the DIGITAL OUTPUT TEST steps 1 through 5.
2. Using either a terminal or a computer running a terminal emulation program, set up Hydra to read the Digital Input lines.

Send the following command to Hydra:

DIO_LEVELS? <CR>

Verify that the returned value as shown on the Host screen = 255.

NOTE

The number returned is the decimal equivalent of the Digital Input binary word (inputs 0 through 7's status). See Table 6-7 to determine if the number returned corresponds to the bits jumpered to ground in this test.

3. Jumper input 0 to ground by connecting the ground test lead to input 0's test lead.
Then send the following command to Hydra:
DIO_LEVELS? <CR>
Verify that the returned value as shown on the Host screen = 254.
4. Disconnect input 0 from ground then jumper input 1 to ground.
Send the command: DIO_LEVELS? <CR>
Verify the returned value is 253.
5. Repeat step 4 for each input and verify the correct returned value (See Table 6-7).

Table 6-7. Digital Input Values

| TERMINAL GROUNDED | STATE OF DIGITAL INPUTS | DECIMAL VALUE |
|-------------------|--------------------------------------|---------------|
| none | inputs 0-7, all HIGH | 255 |
| 0 | inputs 1-7 HIGH, input 0 LOW | 254 |
| 1 | inputs 0,2-7 HIGH, input 1 LOW | 253 |
| 2 | inputs 0-1 and 3-7 HIGH, input 2 LOW | 251 |
| 3 | inputs 0-2 and 4-7 HIGH, input 3 LOW | 247 |
| 4 | inputs 0-3 and 5-7 HIGH, input 4 LOW | 239 |
| 5 | inputs 0-4 and 6-7 HIGH, input 5 LOW | 223 |
| 6 | inputs 0-5 and 7 HIGH, input 6 LOW | 191 |
| 7 | inputs 0-6 HIGH, input 7 LOW | 127 |

TOTALIZER TEST

This totalizer verification test requires toggling the Digital Output line 0 and using it as the Total input. The test requires computer interfacing with a host (terminal or computer). The host must send commands to the 2620A/2625A instrument to control the digital line for this test. Refer to Section 4 for a description of configuring and operating the Hydra instrument.

1. Ensure that communication parameters (i.e., transmission mode, baud rate, parity, and echo mode) on the Hydra and the host are properly configured to send and receive serial data. Refer to Section 4.
2. Switch OFF power to the instrument and disconnect all high voltage inputs.
3. Remove the Digital I/O ten terminal connector from the rear of the instrument and all external connections to it. Connect short wires (to be used as test leads) to the 0 terminal and the Total (Σ) terminal. Leave other ends of wires unconnected at this time. Reinstall the connector.
4. Switch ON power to both Hydra and the host.
5. Press the TOTAL button on the front panel of Hydra.
Assure Hydra displays a 0 value.
6. Jumper output 0 to the Total (Σ) input by connecting the (Σ) terminal test lead to output 0's test lead.
7. Using either a terminal or a computer running a terminal emulation program, set up Hydra to toggle (turn ON and OFF) Digital Output 0.

In sequence send the following commands to Hydra and assure Hydra measures and displays the correct total value:

DO_LEVEL 0,0 <CR>

DO_LEVEL 0,1 <CR>

Assure Hydra displays a totalizer count of 1.

8. Again in sequence send the commands:

DO_LEVEL 0,0 <CR>

DO_LEVEL 0,1 <CR>

A totalizer count of 2 should now be displayed.

9. Repeat step 8 for each incremental totalizing count.

10. Set the Hydra's totalized count to a value near full range (65535) and test for overload.

Send the following commands to Hydra:

TOTAL 65534 <CR>

DO_LEVEL 0,0 <CR>

DO_LEVEL 0,1 <CR>

A totalizer count of 65535 should be displayed.

11. Send:

DO_LEVEL 0,0 <CR>

DO_LEVEL 0,1 <CR>

Hydra's display should now read "OL". This indicates that the counter has been overrun.

TOTALIZER SENSITIVITY TEST

1. Perform the Totalizer Test and assure it is operational.
2. Remove the jumper connecting the (Σ) terminal test lead to output 0's test lead.
3. Assure Hydra is still in the total measuring mode. If not press the TOTAL button. Reset the totalizer count shown on the display by pressing Hydra's front panel SHIFT button followed by ZERO (total) button.
Hydra's display should now show a value of 0.
4. Connect the output of the signal generator to the (Σ) and ground (\downarrow) terminals.

5. Program the signal generator to output a 1.5V rms sine signal at 10 Hz.

Hydra's display should now show the totalizing value incrementing at a 10 count per second rate.

Dedicated Alarm Output Test

The Dedicated Alarm Output Test verifies that Alarm Outputs 0 through 3 are functioning properly. Because this test is dependent on voltage readings the Accuracy Verification Test for channel 0 and the Channel Integrity Test for channels 1 through 3 should be performed if voltage readings are suspect.

1. Switch OFF power to the instrument and disconnect all high voltage inputs.
2. Remove the Alarm Output eight terminal connector module from the rear of Hydra and all external connections to it. Connect short wires (to be used as test leads) to the ground (\downarrow) and 0 through 3 terminals. Leave other ends of wires unconnected at this time. Reinstall the connector.
3. Remove the Input Module from the rear of Hydra. Open the Input Module and jumper the H (high) terminal of channels 1, 2, and 3 together. Connect a test lead to the H of channel 1. Also jumper the L (low) terminals of channel 1, 2, and 3 together. Connect a second test lead to the L of channel 1. Install the Input Module back into Hydra. Refer to Figure 6-4.
4. Switch power ON.
5. Using a digital multimeter (DMM), verify that alarm outputs 0 through 3 are in the OFF or HIGH state. Perform this test by connecting the low or common of the multimeter to the ground test lead and the high of the multimeter to the alarm output. Verify a voltage greater than +3.8V dc.
6. Connect a cable from the Output VA HI and LO connectors of the 5700A to the V Ω and COM connectors on the front panel of Hydra. Then jumper Hydra's V Ω terminal to the H (high) test lead of the Input Module and the COM terminal to the L (low) test lead (See Input Connection diagram).
7. On Hydra, select the VDC function, 3V range, and assign a HI alarm limit of +1.0000 for channels 0 through 3. Set up all other channels (4-20) to the OFF function. Select a scan interval of 5 seconds.
8. Set the 5700A to output +0.9900 volts.
9. Press Hydra's SCAN button. Hydra should scan channels 0 through 3 every 5 seconds.
10. Using a digital multimeter, again verify that alarm outputs 0 through 3 are in the OFF or HIGH state.
11. Set the 5700A to output +1.1000 volts. Verify that the alarm outputs 0 through 3 are in the ON or LOW state (measure less than +0.8V dc).

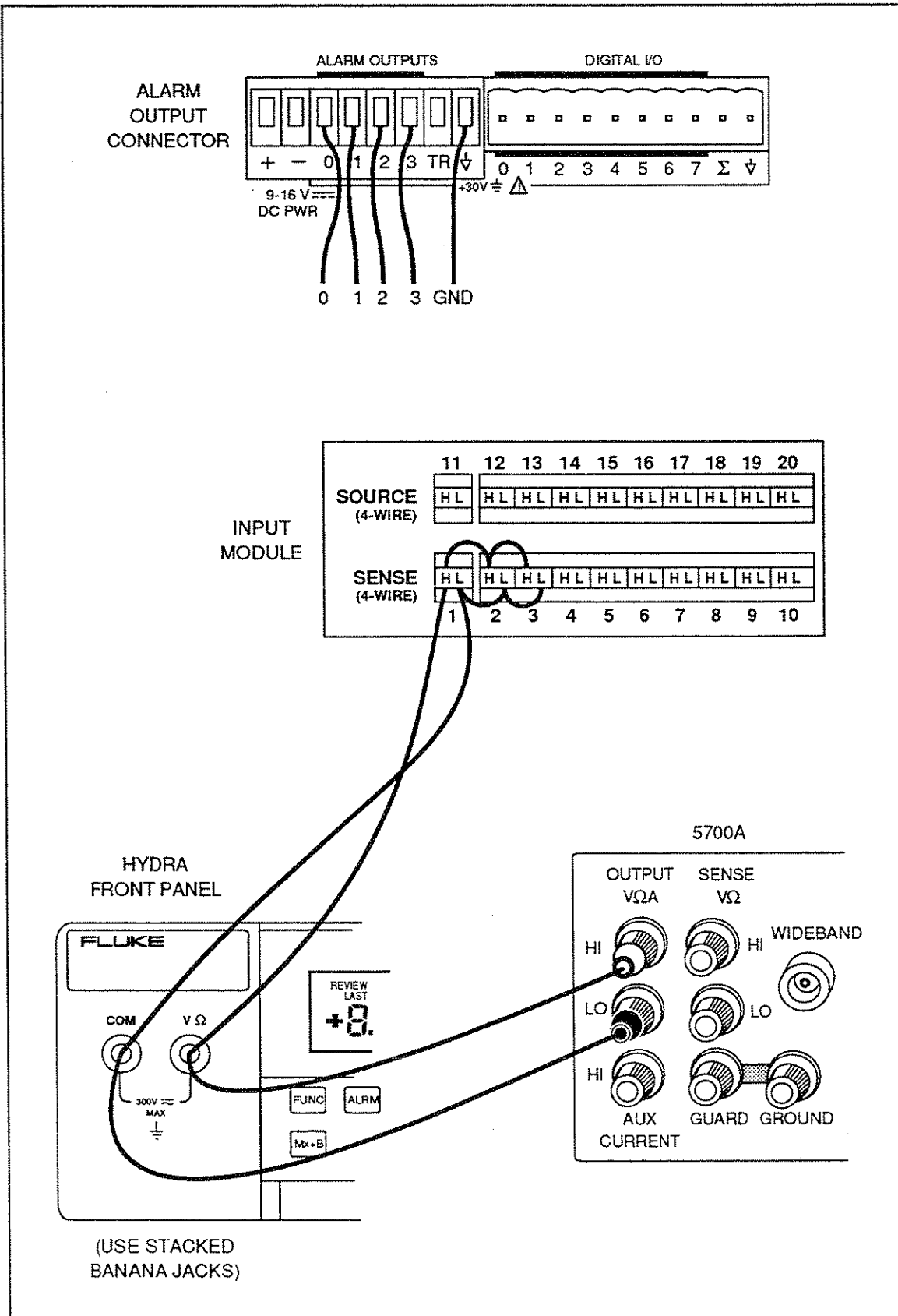


Figure 6-4. Dedicated Alarms Output Test

External Trigger Input Test

The External Trigger Input Test verifies that the rear panel trigger input of Hydra is functioning properly.

1. Switch OFF power to the instrument and disconnect all high voltage inputs.
2. Remove the Alarm Output eight terminal connector module from the rear of Hydra and all external connections to it. Connect short wires (to be used as test leads) to the ground (\downarrow) and TR terminals. Leave other ends of wires unconnected at this time. Reinstall the connector. Refer to Figure 6-5.

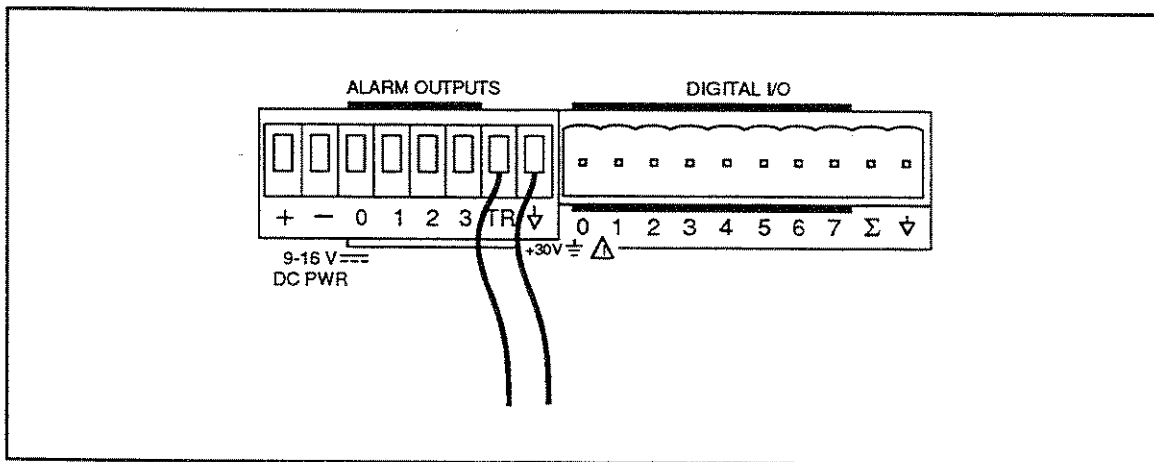


Figure 6-5. External Trigger Test

3. Switch power ON.
4. On Hydra, select the VDC function, 30V range for channels 0 through 5. Select a scan interval of 30 seconds.
5. Select trigger ON to enable the external trigger input. Press the SHIFT and MON(TRIGS) buttons (the display shows TRIG), then press either the up or down arrow buttons to display ON. Press ENTER.
6. Press Hydra's SCAN button. Hydra should scan channels 0 through 5 once every 30 seconds.
7. During the interval when scanning is not occurring, connect (short) the test leads of the TR and ground Alarm Output terminals.
Ensure the connection causes a single scan to occur.
8. Disconnect (open) the TR and ground connection.
Ensure the scan continues to execute at its specified interval.

CALIBRATION

NOTE

Refer to the Fluke Hydra Service Manual (P/N 889589) for calibration procedures. The instrument must be stabilized in an environment with ambient temperature of 22 to 24° C and relative humidity of less than 70% and have been turned on for at least 1/2 hour prior to calibration.

The instrument features closed-case calibration controlled over the Computer Interface. Using known reference sources, closed-case calibration has many advantages. There are no parts to disassemble, no mechanical adjustments to make, and the instrument can be calibrated by an automated instrumentation system.

The instrument should normally be calibrated on a regular cycle, typically every 90 days or 1 year. The chosen calibration cycle depends on the accuracy specification you wish to maintain. The instrument should also be calibrated if it fails the performance test or has undergone repair.

NOTE

Do not press CAL ENABLE unless you have a copy of the Service Manual and intend to calibrate the instrument. If you have activated calibration and wish to exit calibration, press CAL ENABLE until CAL disappears from the display (or press power OFF).

Refer to the Hydra Service Manual for the essential calibration procedures.

VARIATIONS IN THE DISPLAY

Under normal operation, the display presents various combinations of brightly and dimly lit annunciators and digits. However, you may encounter other, random irregularities across different areas of the display under the following circumstances:

- After prolonged periods of displaying the same information.
- If the display has not been used for a prolonged period.

This phenomenon can be cleared by activating the entire display and leaving it on overnight (or at least for several hours). Use the following procedure to keep the display fully lit:

1. With power OFF, press and hold SHIFT, then press power ON.
2. Wait a moment for the instrument to beep, then release SHIFT. The entire display will now stay on until you are ready to deactivate it.
3. At the end of the activation period, press any button on the front panel; the instrument resumes the mode in effect prior to the power interruption (Active or Inactive.)

SERVICE

If the instrument fails, check that operating instructions presented earlier in this manual are being followed. If the problem cannot be remedied, forward the instrument, postage paid, to the nearest Fluke Service Center. A list of Service Centers is provided in Appendix D. Be sure to pack the instrument securely; use the original container if available. Include a brief description of the problem. Fluke assumes NO responsibility for damage in transit.

Appendix A

Specifications

INTRODUCTION

The instrument specifications presented here are applicable within the conditions listed in the Environmental section.

The specifications state total instrument accuracy following calibration, including:

- A/D errors
- Linearization conformity
- Initial calibration errors
- Isothermality errors
- Relay thermal emf's
- Reference junction conformity
- Temperature coefficients
- Humidity errors

Sensor inaccuracies are not included in the accuracy figures.

Accuracies at Ambient Temperatures Other Than Specified

To determine typical accuracies at temperatures intermediate to those listed in the specification tables, linearly interpolate between the applicable 0°C to 60°C and 18°C to 28°C accuracy specifications.

Response Times

Refer to Typical Scanning Rate and Maximum Autoranging Time later in this Appendix.

A/SPECIFICATIONS

DC VOLTAGE INPUTS

| Range | Resolution | |
|--------|------------|--------|
| | Slow | Fast |
| 300 mV | 10 μ V | 0.1 mV |
| 3V | 0.1 mV | 1 mV |
| 30V | 1 mV | 10 mV |
| 300V | 10 mV | 0.1V |

| Range | Accuracy \pm (% \pm V) | | | | |
|--------|----------------------------|---------------------|-----------------|---------------------|-----------------|
| | 18°C to 28°C | | | 0°C to 60°C | |
| | 90 Days, Slow | 1 Year, Slow | 1 Year, Fast | 1 Year, Slow | 1 Year, Fast |
| 300 mV | 0.026% + 20 μ V | 0.031% + 20 μ V | 0.047% + 0.2 mV | 0.070% + 20 μ V | 0.087% + 0.2 mV |
| 3V | 0.028% + 0.2 mV | 0.033% + 0.2 mV | 0.050% + 2 mV | 0.072% + 0.2 mV | 0.089% + 2 mV |
| 30V | 0.024% + 2 mV | 0.029% + 2 mV | 0.046% + 20 mV | 0.090% + 2 mV | 0.107% + 20 mV |
| 300V | 0.023% + 20 mV | 0.028% + 20 mV | 0.045% + 0.2V | 0.090% + 20 mV | 0.107% + 0.2V |

Input Impedance

100 M Ω minimum in parallel with 150 pF maximum for all ranges 3V and below
 10 M Ω in parallel with 100 pF maximum for the 30V and 300V ranges

Normal Mode Rejection

53 dB minimum at 60 Hz \pm 0.1%, slow rate
 47 dB minimum at 50 Hz \pm 0.1%, slow rate

Common Mode Rejection

120 dB minimum at dc, 1 k Ω imbalance, slow rate
 120 dB minimum at 50 or 60 Hz \pm 0.1%, 1 k Ω imbalance, slow rate

Maximum Input

300V dc or ac rms on any range for channels 0, 1, and 11
 150V dc or ac rms for channels 2 to 10 and 12 to 20
 Voltage ratings between channels must not be exceeded

Cross-Talk Rejection

Refer to Appendix E.

THERMOCOUPLE INPUTS

| Thermocouple | | Accuracy ($\pm^{\circ}\text{C}$) | | | | |
|-----------------------------|-------------|--|-------------|-------------|---|-------------|
| | | 18 $^{\circ}\text{C}$ to 28 $^{\circ}\text{C}$ | | | 0 $^{\circ}\text{C}$ to 60 $^{\circ}\text{C}$ | |
| Type ($^{\circ}\text{C}$) | Temperature | 90 Days Slow | 1 Year Slow | 1 Year Fast | 1 Year Slow | 1 Year Fast |
| J | -100.00 | 0.49 | 0.53 | 1.00 | 0.73 | 1.22 |
| | 0.00 | 0.38 | 0.40 | 0.77 | 0.53 | 0.91 |
| | 760.00 | 0.49 | 0.54 | 0.97 | 0.91 | 1.35 |
| K | -100.00 | 0.57 | 0.60 | 1.20 | 0.82 | 1.43 |
| | 0.00 | 0.42 | 0.44 | 0.88 | 0.57 | 1.02 |
| | 1000.00 | 0.73 | 0.80 | 1.46 | 1.36 | 2.03 |
| | 1372.00 | 0.95 | 1.05 | 1.89 | 1.85 | 2.70 |
| N | -100.00 | 0.66 | 0.69 | 1.48 | 0.90 | 1.70 |
| | 0.00 | 0.51 | 0.53 | 1.14 | 0.66 | 1.29 |
| | 400.00 | 0.46 | 0.49 | 0.99 | 0.72 | 1.23 |
| | 1300.00 | 0.75 | 0.83 | 1.53 | 1.45 | 2.16 |
| E | -100.00 | 0.50 | 0.53 | 0.99 | 0.75 | 1.22 |
| | 0.00 | 0.36 | 0.38 | 0.72 | 0.52 | 0.86 |
| | 500.00 | 0.40 | 0.43 | 0.77 | 0.71 | 1.05 |
| | 1000.00 | 0.58 | 0.65 | 1.11 | 1.16 | 1.63 |
| T | -150.00 | 0.79 | 0.84 | 1.66 | 1.16 | 1.99 |
| | 0.00 | 0.42 | 0.45 | 0.89 | 0.58 | 1.04 |
| | 400.00 | 0.37 | 0.40 | 0.74 | 0.61 | 0.97 |
| R | 250.00 | 0.96 | 0.98 | 2.48 | 1.14 | 2.65 |
| | 1000.00 | 0.86 | 0.91 | 2.10 | 1.29 | 2.48 |
| | 1767.00 | 1.14 | 1.24 | 2.65 | 1.96 | 3.38 |
| S | 250.00 | 1.01 | 1.03 | 2.62 | 1.20 | 2.80 |
| | 1000.00 | 0.97 | 1.02 | 2.37 | 1.42 | 2.77 |
| | 1767.00 | 1.29 | 1.39 | 3.02 | 2.17 | 3.80 |
| B | 600.00 | 1.26 | 1.28 | 3.52 | 1.40 | 3.64 |
| | 1000.00 | 0.92 | 0.95 | 2.48 | 1.16 | 2.69 |
| | 1820.00 | 0.97 | 1.03 | 2.41 | 1.51 | 2.89 |
| C | 0.00 | 0.76 | 0.78 | 1.87 | 0.92 | 2.01 |
| | 500.00 | 0.66 | 0.69 | 1.53 | 0.96 | 1.81 |
| | 1000.00 | 0.85 | 0.91 | 1.90 | 1.41 | 2.41 |
| | 1850.00 | 1.47 | 1.61 | 3.18 | 2.70 | 4.29 |
| | 2316.00 | 2.30 | 2.53 | 4.93 | 4.35 | 6.77 |

Input Impedance

100 M Ω minimum in parallel with 150 pF maximum

Common Mode and Normal Mode Rejection

See Specifications, DC Voltage Inputs

Cross-Talk Rejection

Refer to Appendix E.

Open Thermocouple Detect

Small ac signal injection and detection scheme before each measurement detects greater than 1 to 4 k Ω as open. Performed on each channel unless defeated by computer command.

A/SPECIFICATIONS

RTD INPUTS

Type

DIN/IEC 751, 100Ω Platinum

| RTD Temperature (°C) | 1 Year, 4-Wire Accuracy (±°C) | | | | | |
|----------------------------|-------------------------------|------|--------------|------|-------------|------|
| | Resolution | | 18°C to 28°C | | 0°C to 60°C | |
| | Slow | Fast | Slow | Fast | Slow | Fast |
| -200.00 | 0.02 | 0.1 | 0.08 | 0.49 | 0.12 | 0.54 |
| 0.00 | 0.02 | 0.1 | 0.21 | 0.67 | 0.50 | 0.96 |
| 100.00 | 0.02 | 0.1 | 0.27 | 0.75 | 0.69 | 1.17 |
| 300.00 | 0.02 | 0.1 | 0.41 | 0.92 | 1.10 | 1.60 |
| 600.00 | 0.02 | 0.1 | 0.65 | 1.21 | 1.77 | 2.33 |

2-Wire Accuracy

For 2-wire sensors with $R_0 = 100\Omega$: degrade accuracy by 5.0°C per lead-ohm, plus degrade accuracy an additional 4°C for channels 1 to 20 and 0.05°C for channel 0.

Maximum Current Through Sensor

1 mA

Typical Full Scale Voltage

0.22V

Maximum Open Circuit Voltage

3.2V

Maximum Sensor Temperature

600°C nominal

Cross-Talk Rejection

Refer to Appendix E.

AC VOLTAGE INPUTS (TRUE RMS AC VOLTAGE, AC-COUPLED INPUTS)

| Range | Resolution | | Minimum Input For Rated Accuracy |
|--------|-------------|-------------|----------------------------------|
| | Slow | Fast | |
| 300 mV | 10 μ V | 100 μ V | 20 mV |
| 3V | 100 μ V | 1 mV | 200 mV |
| 30V | 1 mV | 10 mV | 2V |
| 300V | 10 mV | 100 mV | 20V |

| Range | Frequency | 1 Year Accuracy \pm (% \pm V) | | | |
|--------|------------------|-----------------------------------|----------------|-----------------|----------------|
| | | 18°C to 28°C | | 0°C to 60°C | |
| | | Slow | Fast | Slow | Fast |
| 300 mV | 20 Hz - 50 Hz | 1.17% + 0.15 mV | 1.17% + 0.3 mV | 1.28% + 0.15 mV | 1.28% + 0.3 mV |
| | 50 Hz - 100 Hz | 0.28% + 0.15 mV | 0.28% + 0.3 mV | 0.39% + 0.15 mV | 0.39% + 0.3 mV |
| | 100 Hz - 10 kHz | 0.17% + 0.15 mV | 0.17% + 0.3 mV | 0.28% + 0.15 mV | 0.28% + 0.3 mV |
| | 10 kHz - 20 kHz | 0.37% + 0.15 mV | 0.37% + 0.3 mV | 0.48% + 0.15 mV | 0.48% + 0.3 mV |
| | 20 kHz - 50 kHz | 1.9% + 0.20 mV | 1.9% + 0.4 mV | 2.0% + 0.20 mV | 2.0% + 0.4 mV |
| | 50 kHz - 100 kHz | 5.0% + 0.50 mV | 5.0% + 1.0 mV | 5.1% + 0.50 mV | 5.1% + 1.0 mV |
| 3V | 20 Hz - 50 Hz | 1.16% + 1.5 mV | 1.16% + 3 mV | 1.27% + 1.5 mV | 1.27% + 3 mV |
| | 50 Hz - 100 Hz | 0.27% + 1.5 mV | 0.27% + 3 mV | 0.38% + 1.5 mV | 0.38% + 3 mV |
| | 100 Hz - 10 kHz | 0.14% + 1.5 mV | 0.14% + 3 mV | 0.25% + 1.5 mV | 0.25% + 3 mV |
| | 10 kHz - 20 kHz | 0.22% + 1.5 mV | 0.22% + 3 mV | 0.33% + 1.5 mV | 0.33% + 3 mV |
| | 20 kHz - 50 kHz | 0.6% + 2.0 mV | 0.6% + 4 mV | 0.7% + 2.0 mV | 0.7% + 4 mV |
| | 50 kHz - 100 kHz | 1.0% + 5.0 mV | 1.0% + 10 mV | 1.1% + 5.0 mV | 1.1% + 10 mV |
| 30V | 20 Hz - 50 Hz | 1.17% + 15 mV | 1.17% + 30 mV | 1.32% + 15 mV | 1.32% + 30 mV |
| | 50 Hz - 100 Hz | 0.27% + 15 mV | 0.27% + 30 mV | 0.43% + 15 mV | 0.43% + 30 mV |
| | 100 Hz - 10 kHz | 0.15% + 15 mV | 0.15% + 30 mV | 0.30% + 15 mV | 0.30% + 30 mV |
| | 10 kHz - 20 kHz | 0.22% + 15 mV | 0.22% + 30 mV | 0.38% + 15 mV | 0.38% + 30 mV |
| | 20 kHz - 50 kHz | 0.9% + 20 mV | 0.9% + 40 mV | 1.0% + 20 mV | 1.0% + 40 mV |
| | 50 kHz - 100 kHz | 2.0% + 50 mV | 2.0% + 100 mV | 2.1% + 50 mV | 2.1% + 100 mV |
| 300V | 20 Hz - 50 Hz | 1.16% + 0.15V | 1.16% + 0.3V | 1.31% + 0.15V | 1.31% + 0.3V |
| | 50 Hz - 100 Hz | 0.27% + 0.15V | 0.27% + 0.3V | 0.42% + 0.15V | 0.42% + 0.3V |
| | 100 Hz - 10 kHz | 0.14% + 0.15V | 0.14% + 0.3V | 0.29% + 0.15V | 0.29% + 0.3V |
| | 10 kHz - 20 kHz | 0.22% + 0.15V | 0.22% + 0.3V | 0.38% + 0.15V | 0.38% + 0.3V |
| | 20 kHz - 50 kHz | 0.9% + 0.20V | 0.9% + 0.4V | 1.0% + 0.20V | 1.0% + 0.4V |
| | 50 kHz - 100 kHz | 2.5% + 0.50V | 2.5% + 1.0V | 2.6% + 0.50V | 2.6% + 1.0V |

| Frequency | Maximum Input at Upper Frequency |
|------------------|----------------------------------|
| 20 Hz - 50 Hz | 300V rms |
| 50 Hz - 100 Hz | 300V rms |
| 100 Hz - 10 kHz | 200V rms |
| 10 kHz - 20 kHz | 100V rms |
| 20 kHz - 50 kHz | 40V rms |
| 50 kHz - 100 kHz | 20Vrms |

A/SPECIFICATIONS

AC VOLTAGE INPUTS (cont)

Input Impedance

1 M Ω in parallel with 100 pF maximum

Maximum Crest Factor

3.0

2.0 for rated accuracy

Crest Factor Error

Non-sinusoidal input signals with crest factors between 2 and 3 and pulse widths 100 μ s and longer add 0.2% to the accuracy specifications.

Common Mode Rejection

80 dB minimum at 50 or 60 Hz \pm 0.1%, 1 k Ω imbalance, slow rate

Maximum AC Input

300V rms or 424V peak on channels 0, 1, and 11

150V rms or 212V peak on channels 2 to 10 and 12 to 20

Voltage ratings between channels must not be exceeded

2 x 10⁶ Volt-Hertz product on any range, normal mode input

1 x 10⁶ Volt-Hertz product on any range, common mode input

DC Component Error

SCAN and first MONitor measurements will be incorrect if the dc signal component exceeds 6 counts. To measure ac with a dc component present, MONitor the input and wait 5 seconds before recording the measurement.

Cross-Talk Rejection

Refer to Appendix E.

OHMS INPUTS

| Range | Resolution | | Typical Full Scale Voltage | Maximum Current Through Unknown | Maximum Open Circuit Voltage |
|--------|------------|-------|----------------------------|---------------------------------|------------------------------|
| | Slow | Fast | | | |
| 300Ω | 10 mΩ | 0.1Ω | 0.22V | 1 mA | 3.2V |
| 3 kΩ | 0.1Ω | 1Ω | 0.25V | 110 μA | 1.5V |
| 30 kΩ | 1Ω | 10Ω | 0.29V | 13 μA | 1.5V |
| 300 kΩ | 10Ω | 100Ω | 0.68V | 3.2 μA | 3.2V |
| 3 MΩ | 100Ω | 1 kΩ | 2.25V | 3.2 μA | 3.2V |
| 10 MΩ | 1 kΩ | 10 kΩ | 2.72V | 3.2 μA | 3.2V |

| Range | 4-Wire Accuracy \pm (% \pm Ω) | | | | |
|--------|-----------------------------------|----------------|----------------|----------------|----------------|
| | 18°C to 28°C | | | 0°C to 60°C | |
| | 90 Days, Slow | 1 Year, Slow | 1 Year, Fast | 1 Year, Slow | 1 Year, Fast |
| 300Ω | 0.056% + 20 mΩ | 0.060% + 20 mΩ | 0.060% + 0.2Ω | 0.175% + 20 mΩ | 0.175% + 0.2Ω |
| 3 kΩ | 0.053% + 0.2Ω | 0.057% + 0.2Ω | 0.057% + 2Ω | 0.172% + 0.2Ω | 0.172% + 2Ω |
| 30 kΩ | 0.055% + 2Ω | 0.059% + 2Ω | 0.059% + 20Ω | 0.176% + 2Ω | 0.176% + 20Ω |
| 300 kΩ | 0.053% + 20Ω | 0.057% + 20Ω | 0.057% + 200Ω | 0.184% + 20Ω | 0.184% + 200Ω |
| 3 MΩ | 0.059% + 200Ω | 0.063% + 200Ω | 0.063% + 2 kΩ | 0.184% + 200Ω | 0.184% + 2 kΩ |
| 10 MΩ | 0.115% + 2 kΩ | 0.120% + 2 kΩ | 0.200% + 30 kΩ | 0.253% + 2 kΩ | 0.253% + 30 kΩ |

2-Wire Accuracy

Add 1.5Ω to accuracy specifications for channels 1 to 20, and add 20 mΩ for channel 0.
Lead wire resistances are not included.

Input Protection

300V dc or ac rms on all ranges

Cross-Talk Rejection

Refer to Appendix E.

A/SPECIFICATIONS

FREQUENCY INPUTS

Frequency Range

15 Hz to greater than 1 MHz

| Range | Resolution | | Accuracy + (% ± Hz) | |
|----------------|------------|--------|---------------------|----------------|
| | Slow | Fast | Slow | Fast |
| 15 Hz - 900 Hz | 0.01 Hz | 0.1 Hz | 0.05% + 0.02 Hz | 0.05% + 0.2 Hz |
| 9 kHz | 0.1 Hz | 1 Hz | 0.05% + 0.1 Hz | 0.05% + 1 Hz |
| 90 kHz | 1 Hz | 10 Hz | 0.05% + 1 Hz | 0.05% + 10 Hz |
| 900 kHz | 10 Hz | 100 Hz | 0.05% + 10 Hz | 0.05% + 100 Hz |
| 1 MHz | 100 Hz | 1 kHz | 0.05% + 100 Hz | 0.05% + 1 kHz |

Sensitivity

| Frequency | Level (Sine Wave) |
|-------------------|-------------------|
| 15 Hz - 100 kHz | 100 mV rms |
| 100 kHz - 300 kHz | 150 mV rms |
| 300 kHz - 1 MHz | 2V rms |
| Above 1 MHz | Not specified |

Maximum AC Input

300V rms or 424V peak on channels 0, 1, and 11
150V rms or 212V peak on channels 2 to 10 and 12 to 20
Voltage ratings between channels must not be exceeded

2×10^6 Volt-Hertz product on any range, normal mode input
 1×10^6 Volt-Hertz product on any range, common mode input

Cross-Talk Rejection

Refer to Appendix E.

TYPICAL SCANNING RATE

(Channels per Second, for 1, 10, and 20 Channel Scans with Shorted Inputs)

| | | SLOW | | | FAST | | |
|--------------|-----------|------|-----|-----|------|------|------|
| | CHANNELS: | 1 | 10 | 20 | 1 | 10 | 20 |
| FUNCTION | RANGE | | | | | | |
| VDC | 300 mV | 1.8 | 3.8 | 4.1 | 2.4 | 13.4 | 17.8 |
| | 3V | 1.8 | 3.8 | 4.1 | 2.4 | 13.4 | 17.8 |
| | 30V | 1.8 | 3.8 | 4.1 | 2.4 | 13.3 | 17.7 |
| | 150/300V | 1.8 | 3.8 | 4.1 | 2.4 | 13.2 | 17.5 |
| | AUTO | 1.7 | 3.6 | 3.8 | 2.4 | 11.0 | 13.7 |
| °F (TEMP) | J | 1.0 | 3.3 | 3.8 | 2.1 | 11.1 | 15.7 |
| | PT | 1.8 | 3.6 | 3.8 | 2.3 | 8.1 | 9.4 |
| VAC* | 300 mV | 1.0 | 1.5 | 1.6 | 1.3 | 2.5 | 2.6 |
| | 3V | 1.0 | 1.5 | 1.6 | 1.3 | 2.5 | 2.6 |
| | 30V | 1.0 | 1.5 | 1.6 | 1.3 | 2.5 | 2.6 |
| | 150/300V | 1.0 | 1.5 | 1.6 | 1.3 | 2.5 | 2.6 |
| | AUTO | 1.0 | 1.5 | 1.5 | 1.3 | 2.4 | 2.5 |
| OHMS | 300Ω | 1.8 | 3.6 | 3.8 | 2.3 | 8.1 | 9.4 |
| | 3 kΩ | 1.8 | 3.6 | 3.8 | 2.3 | 8.1 | 9.4 |
| | 30 kΩ | 1.8 | 3.6 | 3.8 | 2.3 | 8.1 | 9.4 |
| | 300 kΩ | 1.2 | 1.9 | 1.9 | 1.9 | 4.7 | 5.1 |
| | 3 MΩ | 1.1 | 1.6 | 1.7 | 1.8 | 4.0 | 4.3 |
| | 10 MΩ | 1.1 | 1.6 | 1.6 | 1.7 | 3.8 | 4.0 |
| | AUTO | 1.8 | 3.6 | 3.8 | 2.3 | 8.1 | 9.4 |
| | AUTO | 1.1 | 1.6 | 1.6 | 1.7 | 3.8 | 4.0 |
| | (open) | | | | | | |
| FREQ* | any | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 |

**Overloaded AC Voltage measurements or any Frequency measurements require approximately a 1.2 second recovery period before another AC Voltage or Frequency measurement can be started. Any DC Voltage or Ohms measurements will be done without delay during this time period.*

A/SPECIFICATIONS

MAXIMUM AUTORANGING TIME

(Seconds per Channel)

| FUNCTION | RANGE CHANGE | SLOW | FAST |
|----------|----------------|------|------|
| VDC | 300 mV → 150V | 0.25 | 0.19 |
| 150V | 300 mV → 0.26 | 0.19 | |
| VAC | 300 mV → 150V | 4.50 | 4.12 |
| 150V | 300 mV → 1.38 | 1.08 | |
| OHMS | 300Ω → 10.0 MΩ | 1.30 | 0.59 |
| 10.0 MΩ | 300Ω → 1.81 | 0.75 | |

TOTALIZING INPUT

Input Voltage

30V maximum
-4V minimum
2V peak minimum signal

Isolation

None
dc-coupled

Threshold

1.4V

Hysteresis

500 mV

Input Debouncing

None or 1.66 ms

Rate

0 to 5 kHz with debouncing off

Maximum Count

65,535

DIGITAL INPUTS**Input Voltage**

30V maximum
-4V minimum

Isolation

None
dc-coupled

Threshold

1.4V

Hysteresis

500 mV

TRIGGER INPUT**Input Voltages**

contact closure and TTL compatible
"high" = 2.0V min, 7.0V max
"low" = -0.6V min, 0.8V max

Isolation

None
dc-coupled

Minimum Pulse Width

5 μ s

Maximum Frequency

5 Hz

Specified Conditions

The instrument must be in the quiescent state, with no interval scans in process, no commands in the queue, no RS-232 or IEEE interface activity, and no front panel activity if the latency and repeatability performance is to be achieved. For additional information, refer to Section 5.

Maximum Latency

Latency is measured from the edge of the trigger input to the start of the first channel measurement for the Specified Conditions (above).

480 ms for fast rate, scanning DCV, ACV, ohms, and frequency only
550 ms for fast rate, scanning any thermocouple or 100 mV dc channels
440 ms for slow rate, scanning DCV, ACV, ohms, and frequency only
890 ms for slow rate, scanning any thermocouple or 100 mV dc channels

A/SPECIFICATIONS

Repeatability

3 ms for the Specified Conditions (above)

DIGITAL AND ALARM OUTPUTS

Output Logic Levels

Logical "zero": 0.8V max for an I_{out} of -1.0 mA (1 LSTTL load)
Logical "one": 3.8V min for an I_{out} of 0.05 mA (1 LSTTL load)

For non-TTL loads:

Logical "zero": 1.8V max for an I_{out} of -20 mA
3.25V max for an I_{out} of -50 mA

Isolation

None

REAL-TIME CLOCK AND CALENDAR

Accuracy

Within 1 minute per month for 0°C to 50°C range

Battery Life

10 years minimum for Operating Temperature range

ENVIRONMENTAL

Warmup Time

1 hour to rated specifications
15 minutes when relative humidity is kept below 50% (non-condensing)

Temperature Coefficient

0.1 times the applicable 18°C to 28°C accuracy specification per degree C maximum for 0°C to 18°C and 28°C to 60°C (32°F to 64.4°F and 82.4°F to 140°F)

Operating Temperature

0°C to 60°C (32°F to 140°F)

Storage Temperature

-40°C to +75°C (-40°F to +167°F)

Relative Humidity (Non-Condensing)

90% maximum for 0°C to 28°C (32°F to 82.4°F),
75% maximum for 28°C to 35°C (82.4°F to 95°F),
50% maximum for 35°C to 60°C (95°F to 140°F),
(Except 70% maximum for 0°C to 35°C (32°F to 95°F) for the 300 k Ω ,
3 M Ω , and 10 M Ω ranges.)

Altitude

Operating: 3,050m (10,000 ft) maximum
Non-operating: 12,200m (40,000 ft) maximum

Vibration

0.7g at 15 Hz
1.3g at 25 Hz
3g at 55 Hz

Shock

30g half sine per Mil-T-28800
Bench handling per Mil-T-28800

A/SPECIFICATIONS

GENERAL

Channel Capacity

21 Analog Inputs
4 Alarm Outputs
8 Digital I/O (Inputs/Outputs)

Measurement Speed

Slow rate: 4 readings/second nominal
Fast rate: 17 readings/second nominal

1.5 readings/second nominal for ACV and high- Ω inputs

For additional information, refer to Typical Scanning Rate and Maximum Autoranging Time.

Memory Life

10 years minimum over Operating Temperature range
Stores: real-time clock, set-up configuration, and measurement data

Common Mode Voltage

300V dc or ac rms maximum from any analog input (channel) to earth provided that channel to channel maximum voltage ratings are observed.

Voltage Ratings

Channels 0, 1, and 11 are rated at 300V dc or ac rms maximum from a channel terminal to earth and from a channel terminal to any other channel terminal.

Channels 2 to 10 and 12 to 20 are rated at 150V dc or ac rms maximum from a channel terminal to any other channel terminal within channels 2 to 10 and 12 to 20.

Size

9.3 cm high, 21.6 cm wide, 31.2 cm deep
(3.67 in high, 8.5 in wide, 12.28 in deep)

Weight

Net, 2.95 kg (6.5 lbs)
Shipping, 4.0 kg (8.7 lbs)

Power

90 to 264V ac (no switching required), 50 and 60 Hz, 10 VA maximum
9V dc to 16V dc, 10W maximum
If both sources are applied simultaneously, ac is used if it exceeds approximately 8.3 times dc.
Automatic switchover occurs between ac and dc without interruption.

(At 120V ac the equivalent dc voltage is ~14.5V).

Standards

Complies with IEC 1010, UL 1244 and CSA Bulletin 556B.

Complies with ANSI/ISA-S82.01-1988 and CSA C22.2 No. 231 when channel 0, 1, and 11 inputs are restricted to 250V dc or ac rms maximum.

Complies with VDE 0871B when shielded cables are used.

Complies with FCC-15B, at the Class A level when shielded cables are used.

RS-232-C

Connector: 9 pin male (DB-9P)
Signals: TX, RX, DTR, GND
Modem Control: full duplex
Baud rates: 300, 600, 1200, 2400, 4800, and 9600
Data format: 8 data bits, no parity bit, one stop bit, or
7 data bits, one parity bit (odd or even), one stop bit
Flow control: XON/XOFF
Echo: on/off

2625A DATA STORAGE

Stores 2047 scans
Each scan includes:

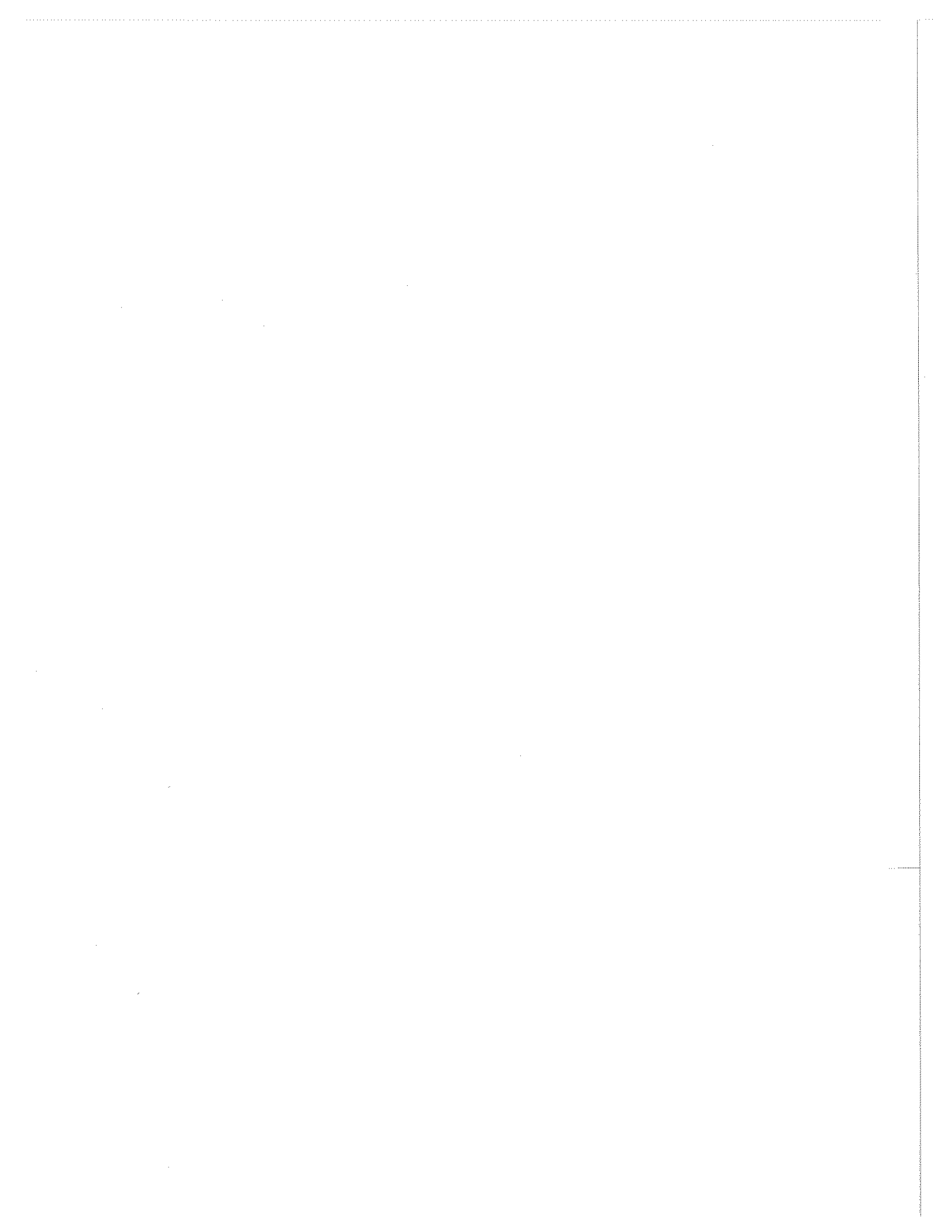
- Time stamp
- Readings for all defined analog input channels
- Status of the four alarm outputs
- Status of the eight digital I/O
- Totalizer count

Memory is battery-backed
Memory life: 5 years minimum at 25°C

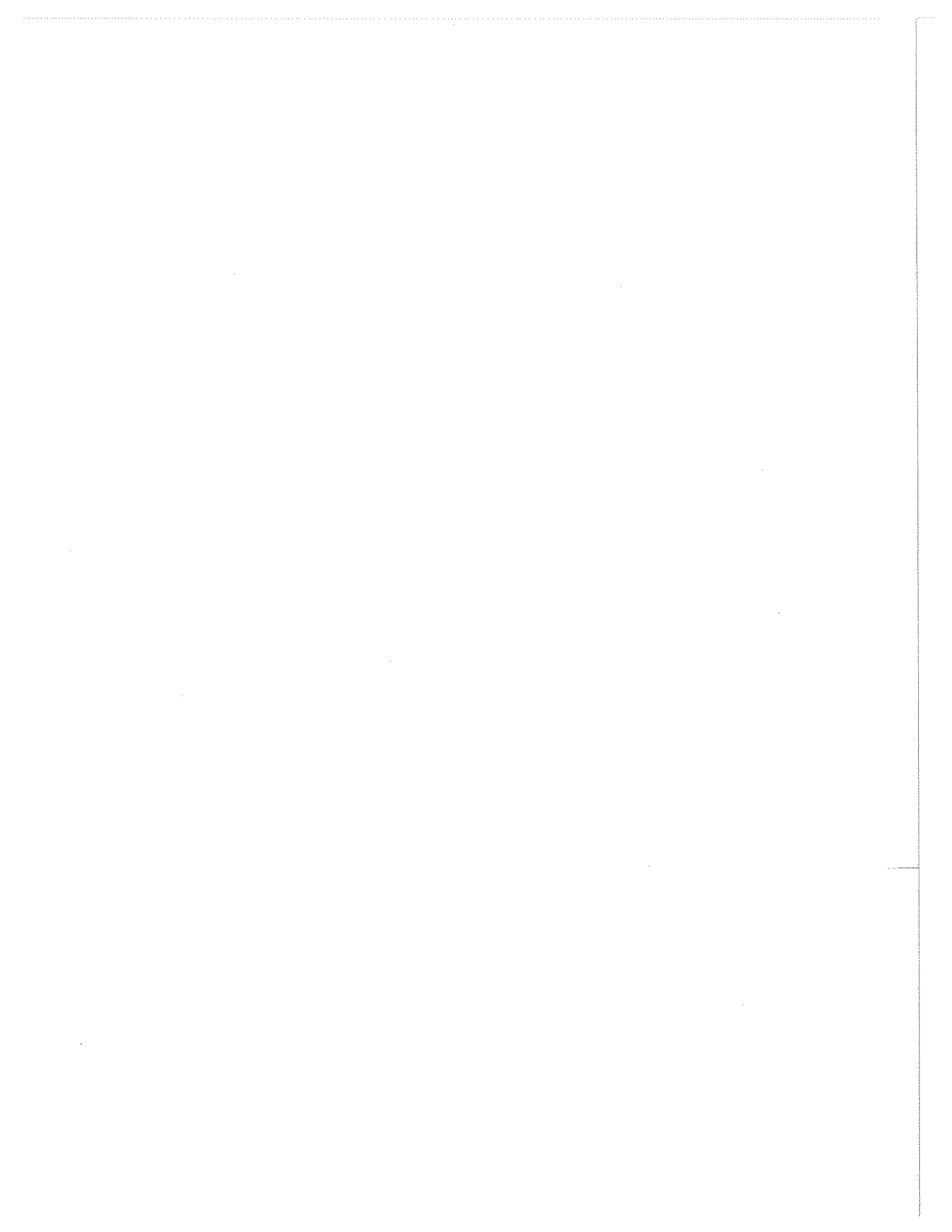
2620A OPTIONS

IEEE-488 (Option -05K)

Capability codes: SH1, AH1, T5, L4, SR1, RL1, PP0, DC1, DT1, E1, TE0, LE0 and C0
Complies with IEEE-488.1 standard



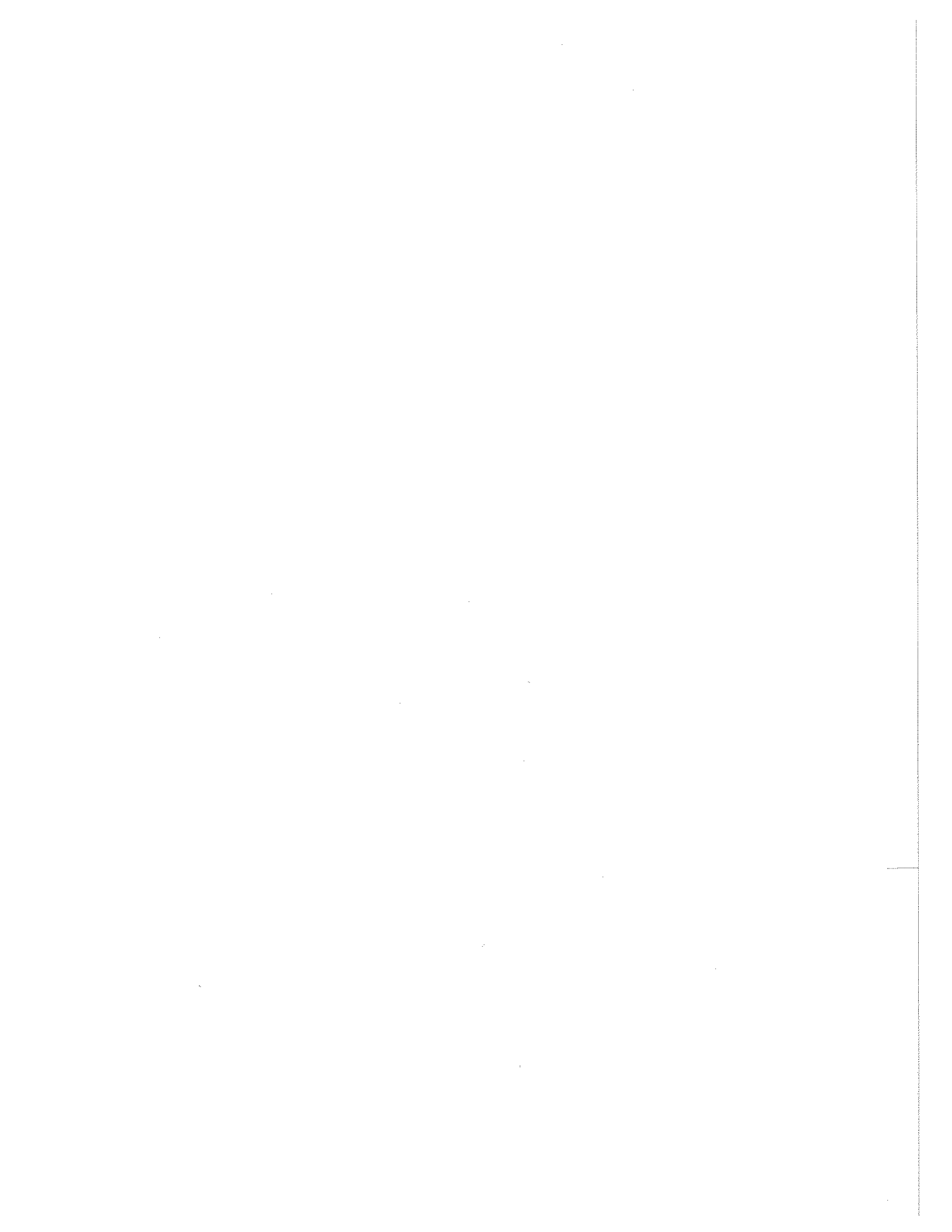
Appendix B
ASCII/IEEE-488 Bus Codes



FLUKE ASCII & **IEEE-488** BUS CODES

| B ⁷ B ⁶ B ⁵ B ⁴ BITS | 0 0 0 0 | 0 0 0 1 | 0 0 1 0 | 0 0 1 1 | 0 1 0 0 | 0 1 0 1 | 0 1 1 0 | 0 1 1 1 | 2 ⁷ 2 ⁶ 2 ⁵ 2 ⁴ |
|--|--|------------------|---------------------|------------------|-------------------|------------------|------------------------------------|------------------------------|--|
| B ³ B ² B ¹ B ⁰ | CONTROL | | NUMBERS SYMBOLS | | UPPER CASE | | LOWER CASE | | |
| 0 0 0 0 | 0 NUL | 16 P DLE | 32 SP SPACE | 48 0 MLA0 | 64 @ MTA0 | 80 P MTA16 | 96 , MSA0 | 112 p MSA16 | |
| 0 0 0 1 | 1 β SOH | 17 σ GTL | 33 ! MLA1 | 49 1 MLA17 | 65 A MTA1 | 81 Q MTA17 | 97 a MSA1 | 113 q MSA17 | |
| 0 0 1 0 | 2 γ STX | 18 τ DC2 | 34 " MLA2 | 50 2 MLA18 | 66 B MTA2 | 82 R MTA18 | 98 b MSA2 | 114 r MSA18 | |
| 0 0 1 1 | 3 δ ETX | 19 υ DC3 | 35 # MLA3 | 51 3 MLA19 | 67 C MTA3 | 83 S MTA19 | 99 c MSA3 | 115 s MSA19 | |
| 0 1 0 0 | 4 ε EOT | 20 φ SDC | 36 \$ MLA4 | 52 4 MLA20 | 68 D MTA4 | 84 T MTA20 | 100 d MSA4 | 116 t MSA20 | |
| 0 1 0 1 | 5 ζ ENQ | 21 χ PPC | 37 % MLA5 | 53 5 MLA21 | 69 E MTA5 | 85 U MTA21 | 101 e MSA5 | 117 u MSA21 | |
| 0 1 1 0 | 6 η ACK | 22 ψ SYN | 38 & MLA6 | 54 6 MLA22 | 70 F MTA6 | 86 V MTA22 | 102 f MSA6 | 118 v MSA22 | |
| 0 1 1 1 | 7 BEL BEL | 23 ω ETB | 39 , MLA7 | 55 7 MLA23 | 71 G MTA7 | 87 W MTA23 | 103 g MSA7 | 119 w MSA23 | |
| 1 0 0 0 | 8 BS BS | 24 Ω GET | 40 (MLA8 | 56 8 MLA24 | 72 H MTA8 | 88 X MTA24 | 104 h MSA8 | 120 x MSA24 | |
| 1 0 0 1 | 9 HT HT | 25 √ TCT | 41) MLA9 | 57 9 MLA25 | 73 I MTA9 | 89 Y MTA25 | 105 i MSA9 | 121 y MSA25 | |
| 1 0 1 0 | 10 LF LF | 26 → SUB | 42 * MLA10 | 58 : MLA26 | 74 J MTA10 | 90 Z MTA26 | 106 j MSA10 | 122 z MSA26 | |
| 1 0 1 1 | 11 VT VT | 27 ESC ESC | 43 + MLA11 | 59 ; MLA27 | 75 K MTA11 | 91 [MTA27 | 107 k MSA11 | 123 { MSA27 | |
| 1 1 0 0 | 12 FF FF | 28 ↑ FS | 44 , MLA12 | 60 < MLA28 | 76 L MTA12 | 92 \ MTA28 | 108 l MSA12 | 124 : MSA28 | |
| 1 1 0 1 | 13 CR CR | 29 ÷ GS | 45 - MLA13 | 61 = MLA29 | 77 M MTA13 | 93] MTA29 | 109 m MSA13 | 125 } MSA29 | |
| 1 1 1 0 | 14 SO SO | 30 Σ RS | 46 . MLA14 | 62 > MLA30 | 78 N MTA14 | 94 ^ MTA30 | 110 n MSA14 | 126 ~ MSA30 | |
| 1 1 1 1 | 15 SI SI | 31 ≈ US | 47 / MLA15 | 63 ? UNL | 79 O MTA15 | 95 - UNT | 111 o MSA15 | 127 ■ RUB-OUT MSA31 | |
| 2 ³ 2 ² 2 ¹ 2 ⁰ | ADDRESSED UNIVERSAL COMMANDS COMMANDS | | LISTEN ADDRESSES | | TALK ADDRESSES | | SECONDARY ADDRESSES OR COMMANDS | | |

KEY decimal 38 & 26 hex 1722A DISPLAY
ASCII & MLA6 **IEEE-488**



Appendix C

IEEE-488.2 Device Documentation Requirements

INTRODUCTION

Section 4.9 of the IEEE Standard 488.2-1987 states: "All devices shall supply information to the user about how the device has implemented this standard." (In this context, "device" means the Fluke 2620A Hydra Data Acquisition Unit. The Fluke Hydra Data Logger cannot be equipped for IEEE-488 operation.) The information in Appendix C is provided in compliance with this requirement.

IMPLEMENTATION OF IEEE STANDARD 488.2-1987

Items 1-23 below correspond to the specific items of information required by Section 4.9, "Device Documentation Requirements", of the Standard. The information supplied by Fluke in response is italicized. (Throughout Appendix C, the word "Section" refers to the section[s] in the Standard, not this manual.)

1. A list of IEEE 488.2 Interface Function subsets implemented, Section 5.

IEEE-488.1 interface functions implemented in the Fluke Data Acquisition Unit are listed under "IEEE-488" capability codes in Appendix A.

2. A description of device behavior when the address is set outside the range 0-30, Section 5.2.

It is not possible to set the Fluke Data Acquisition Unit address outside the specified range.

3. A description of when a user initiated address change is recognized by the device.

An address change is recognized when set via the IEEE setup menu, which is entered by pressing COMM (SHIFT LIST). This address will be used until it is changed. The address change is recognized after ENTER is pressed to accept the address shown on the display.

4. A description of the device setting at power-on, Section 5.12. Any commands which modify the power-on settings shall also be included.

The initial power-up device setting is:

*Channels 0 - 20: OFF.
Measurement rate: Slow.
Scaling (M): 1 (all channels)
Offset (B): 0 (all channels)
Alarm parameters: Limit-1 and Limit-2 OFF. All limit values 0.
Alarm assignments: Channels 0-3 assigned to outputs 0-3, respectively. Channels
4-20 assigned to digital I/O lines 4-7, as shown in Table 3-8.*

*Scan interval time: 0:00:00 (continuous)
Review values (MIN, MAX, LAST) cleared for all channels.
Digital I/O lines: high (non-alarm)
Totalizer: 0, with debounce disabled.
Autoprint/Memory Storage: OFF.
RTD R0 parameter: 100.00 (all channels)
Open Thermocouple Detection (OTC) enabled.*

5. A description of message exchange options:

The size and behavior of the input buffer.

The input buffer size is 350 bytes. If the input buffer fills, the IEEE-488.1 bus will be held off until there is room in the buffer for a new byte.

Which queries return more than one <RESPONSE MESSAGE UNIT>, Section 6.4.3.

The following queries always return more than one <RESPONSE MESSAGE UNIT>:

*LOG?, NEXT?, INTVL?, TIME_DATE?, PRINT_TYPE?, *IDN?,
SCAN_TIME?, SCALE_MB?*

The following queries may return more than one <RESPONSE MESSAGE UNIT>:

FUNC?, MIN?, MAX?, LAST?, ALARMS?, RANGE?, ALARM_LIMIT?

Which queries generate a response when parsed, Section 6.4.5.4.

All queries generate a response when parsed.

Which queries generate a response when read, Section 6.4.5.4.

No queries generate a response when read by the controller.

Which commands are coupled, Section 6.4.5.3.

No commands are coupled.

6. A list of functional elements used in constructing device-specific commands. Whether \langle compound command program header \rangle elements are used must also be included, Section 7.1.1 and 7.3.3.

Device-specific commands used:

\langle PROGRAM MESSAGE \rangle
 \langle PROGRAM MESSAGE TERMINATOR \rangle
 \langle PROGRAM MESSAGE UNIT \rangle
 \langle PROGRAM MESSAGE UNIT SEPARATOR \rangle
 \langle COMMAND MESSAGE UNIT \rangle
 \langle QUERY MESSAGE UNIT \rangle
 \langle COMMAND PROGRAM HEADER \rangle
 \langle QUERY PROGRAM HEADER \rangle
 \langle PROGRAM DATA \rangle
 \langle CHARACTER PROGRAM DATA \rangle
 \langle DECIMAL NUMERIC PROGRAM DATA \rangle

7. A description of any buffer size limitations related to block data, Section 7.7.6.5.

No block data is used.

8. A list of \langle PROGRAM DATA \rangle elements which may appear within an \langle expression \rangle as well as the maximum sub-expression nesting depth. Any additional syntax restrictions which the device may place on the \langle expression \rangle shall also be included.

No sub-expressions are used. The only \langle PROGRAM DATA \rangle functional elements used are \langle CHARACTER PROGRAM DATA \rangle AND \langle DECIMAL NUMERIC PROGRAM DATA \rangle .

9. A description of the response syntax for every query, Section 8.

\langle NR1 NUMERIC RESPONSE DATA \rangle is returned for:

**ESE?, *ESR?, *OPC?, *SRE?, *STB?, *TST?, IEE?, IER?, RATE?, RANGE?, INTVL?, TEMP_CONFIG?, MON_CHAN?, FORMAT?, ALARMS?, ALARM_ASSOC?, ALARM_DO_LEVELS?, TOTAL_DBNC?, TIME_DATE?, TRIGGER?, EEREG?, SCAN_TIME?, LOG_COUNT?, DIO_LEVELS?*

\langle NR3 NUMERIC RESPONSE DATA \rangle is returned for:

MON_VAL?, TOTAL?, RTD_R0?, MIN?, MAX?, LAST?

\langle CHARACTER RESPONSE DATA \rangle is returned for:

**IDN?, FUNC?*

The following queries return data in two formats:

ALARM_LIMIT?

Sense (HI, LO, OFF) in \langle CHARACTER RESPONSE DATA \rangle

Value (if HI or LO) in \langle NR3 NUMERIC RESPONSE DATA \rangle

SCALE_MB?

M and B values in <NR3 NUMERIC RESPONSE DATA>

Resultant display range in <NR1 NUMERIC RESPONSE DATA>

NEXT?, LOG?

Time, date, and digital I/O values in <NR1 NUMERIC RESPONSE DATA>

Measurement data and Totalizer in <NR3 NUMERIC RESPONSE DATA>

10. A description of any device-to-device message transfer traffic which does not follow the rules for <RESPONSE MESSAGE> elements, Section 8.1.

There are no device-to-device messages.

11. The size of any block data responses, Section 8.7.9.4.

There are no block data responses.

12. A list of common commands and queries which are implemented, Section 10.

**CLS, *ESE, *ESE?, *ESR?, *IDN?, *OPC, *OPC?, *RST, *SRE, *SRE?, *STB?, *TRG, *TST?, *WAI*

13. A description of the state of the device after successful completion of the Calibration query, Section 10.2.

*The *CAL? command not implemented (an optional command).*

14. The maximum length of the block used to define the trigger macro, if *DDT is implemented, Section 10.4.

**DDT is not implemented.*

15. The maximum length of macro labels, the maximum length of the block used to define a macro, and how recursion is handled during macro expansion, if the macro commands are implemented, Section 10.7.

Macros are not implemented.

16. A description of the response to the identification common query, *IDN?, Section 10.14.

*The *IDN? query returns:*

FLUKE,2620A,0,M2.41 A3.7 D1.3

The version number of the main software is "M2.41", "A3.7" is the version number of the analog sub-system software, and "D1.3" is the version number of the display sub-system software.

17. The size of the protected user data storage area, *PUD, Section 10.27.

**PUD not implemented. There is no protected user data storage area.*

18. The size of the resource description, if the *RDT command or *RDT? query are implemented, Sections 10.30 and 10.31.

*The *RDT and *RDT? commands are not implemented.*

19. A description of the states affected by *RST (Section 10.32), *LRN? (Section 10.17), *RCL (Section 10.29), and *SAV (Section 10.33).

**RST restores the device to the state assumed at initial power-up, except for those items specifically forbidden by the *RST command definition. The initial power-up state is defined under item "4.", above.*

**LRN?, *RCL, and *SAV are not implemented.*

20. A description of the scope of the self-test performed by the *TST? query, Section 10.38.

**TST? performs the tests listed under "*TST?" in Table 4-8 of the User's Manual. The device reverts to the power-up state after performing these tests.*

21. A description of additional status data structures used in the device's status reporting, Section 11.

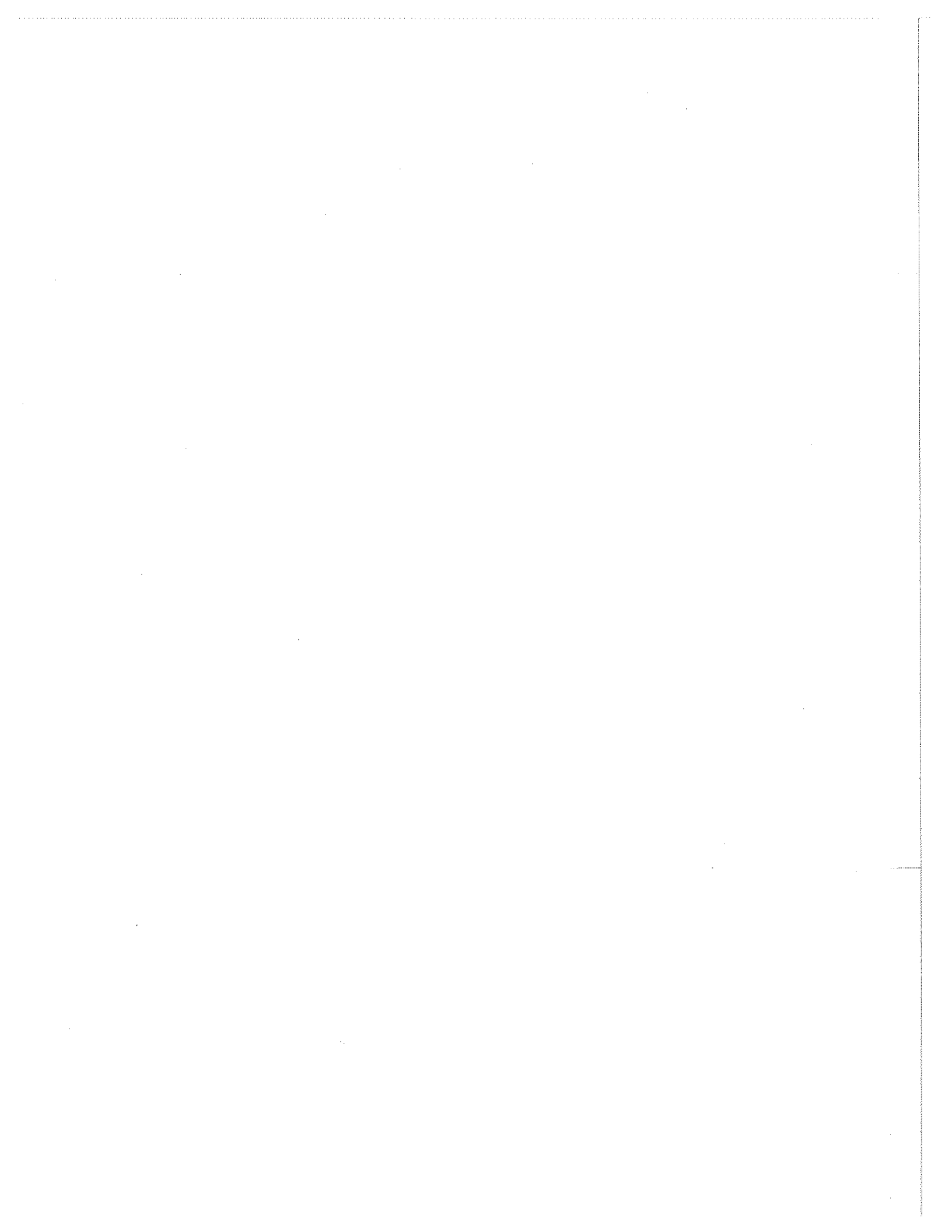
The Instrument Event Enable (IEE) register and the Instrument Event Register (IER) are described in Figure 4-4.

22. For each command, a statement describing whether is overlapped or sequential.

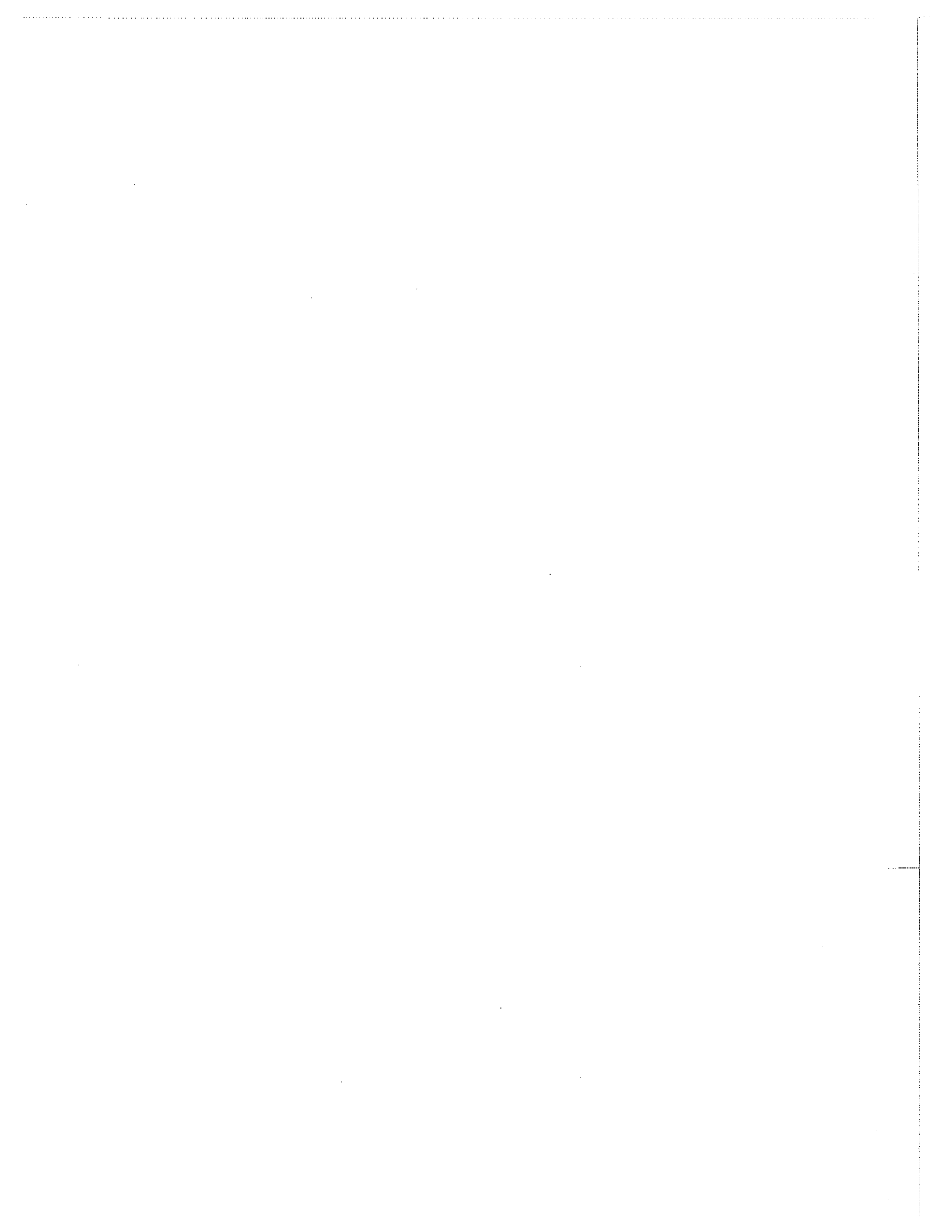
All commands are sequential; none are overlapped.

23. For each command, the device documentation shall specify the functional criteria that are met when an operation complete message is generated in response to that command, Section 12.8.3.

Operation complete is generated when the command is parsed.



Appendix D Service Centers



SERVICE CENTERS

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46610 Landing Parkway
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Altamonte Springs, FL 32701-5227
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Palatine, IL 60067
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Caracas 1070-A
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FAX: 58-2-241-1939

Appendix E

Making Mixed Measurements

INTRODUCTION

This appendix augments the discussion of ac signal effects on other channels (cross talk) found in Section 5 (*"Making Mixed Measurements"*). Effects on each measurement function are discussed below. These numbers should only be considered as references. Since cross talk can be introduced into a measurement system in many places, each setup must be considered individually.

The effect of cross talk could be much better than shown for *"Typical"*; in extreme cases, the effect could be worse than the *"Worst Case"* numbers. In general, the *"Worst Case"* information assumes that none of the guidelines for minimizing cross talk (Section 5) have been followed; the *"Typical"* information assumes that the guidelines have been followed where reasonable.

These numbers assume that input L (low) is tied to earth ground; refer to *"Using Shielded Wiring"* in Section 5. For dc volts and thermocouple temperature measurements, a source impedance of 1 k in series with the H (high) input is assumed (except where otherwise noted.)

AC SIGNAL CROSS TALK IN A DC VOLTAGE CHANNEL

$$\text{DCV Error Ratio (CTRR)} = \left[\frac{VDC(\text{error})}{VAC_{rms}} \right]$$

| | <u>Worst case</u> | <u>Typical</u> |
|--------------------------|----------------------|----------------------|
| 50, 60 Hz, $\pm 0.1\%$: | 1.1×10^{-7} | 2.0×10^{-8} |
| Other Frequencies: | 3.8×10^{-6} | 8.6×10^{-7} |

For example, to find the typical effect of a 300V ac signal at 60 Hz on another channel for the 300 mV range, you would calculate: $300 \times 2.0 \times 10^{-8} = 0.01 \text{ mV}$.

AC SIGNAL CROSS TALK INTO AN AC VOLTAGE CHANNEL

$$\text{ACV Error Ratio} = \left[\frac{VACrms(error)}{VACrms(crosstalk) \times \text{Frequency}(crosstalk)} \right]$$

| <u>Range</u> | <u>Ratio (worst case)</u> | <u>Ratio (typical)</u> |
|-----------------|---|---|
| 300.00mV | $4.8 \times 10^{-8} \left[\frac{V}{V \times Hz} \right]$ | $1.4 \times 10^{-8} \left[\frac{V}{V \times Hz} \right]$ |
| 3.0000 V | $1.1 \times 10^{-7} \left[\frac{V}{V \times Hz} \right]$ | $3.0 \times 10^{-8} \left[\frac{V}{V \times Hz} \right]$ |
| 30.000 V | $1.2 \times 10^{-6} \left[\frac{V}{V \times Hz} \right]$ | $2.6 \times 10^{-7} \left[\frac{V}{V \times Hz} \right]$ |
| 150.00/300.00 V | $1.2 \times 10^{-5} \left[\frac{V}{V \times Hz} \right]$ | $3.4 \times 10^{-6} \left[\frac{V}{V \times Hz} \right]$ |

For example, to find the typical effect of a 60 Hz, 220V ac signal on another channel for the the 300 mV range, you would calculate: $220 \times 60 \times 1.4 \times 10^{-8} = 0.18 \text{ mV}$.

AC SIGNAL CROSS TALK INTO AN OHMS CHANNEL

AC Frequency = 50, 60 Hz, $\pm 0.1\%$

$$\text{OHMS Error Ratio}^1 = \left[\frac{Ohms(error)}{VACrms(crosstalk)} \right]$$

| <u>Range</u> | <u>Ratio (worst case)</u> | <u>Ratio (typical)</u> |
|-------------------|--|--|
| 300.00 Ω | $3.3 \times 10^{-5} \left[\frac{Ohms}{Vrms} \right]$ | NoEffect |
| 3.0000 k Ω | $2.4 \times 10^{-6} \left[\frac{kOhms}{Vrms} \right]$ | $6.7 \times 10^{-7} \left[\frac{kOhms}{Vrms} \right]$ |
| 30.000 k Ω | $3.1 \times 10^{-4} \left[\frac{kOhms}{Vrms} \right]$ | $8.4 \times 10^{-5} \left[\frac{kOhms}{Vrms} \right]$ |
| 300.00 k Ω | $5.6 \times 10^{-3} \left[\frac{kOhms}{Vrms} \right]$ | $3.7 \times 10^{-3} \left[\frac{kOhms}{Vrms} \right]$ |
| 3.0000 M Ω | $3.8 \times 10^{-4} \left[\frac{MOhms}{Vrms} \right]$ | $3.8 \times 10^{-5} \left[\frac{MOhms}{Vrms} \right]$ |
| 10.000 M Ω | $1.4 \times 10^{-3} \left[\frac{MOhms}{Vrms} \right]$ | $4.3 \times 10^{-4} \left[\frac{MOhms}{Vrms} \right]$ |

For example, to find the typical effect of a 60 Hz, 100V ac signal on another channel for the 30 k Ω range, you would calculate: $100 \times 8.4 \times 10^{-5} = 0.008 \text{ k}\Omega$.

AC SIGNAL CROSS TALK INTO A FREQUENCY CHANNEL

Frequency measurements are unaffected by cross talk as long as the voltage-frequency product is kept below the following limits:

| | <u>Worst case</u> | <u>Typical</u> |
|-----------------------------|---------------------------------|---------------------------------|
| $V \times Hz$ Product Limit | $3.7 \times 10^4 (V \times Hz)$ | $1.0 \times 10^6 (V \times Hz)$ |

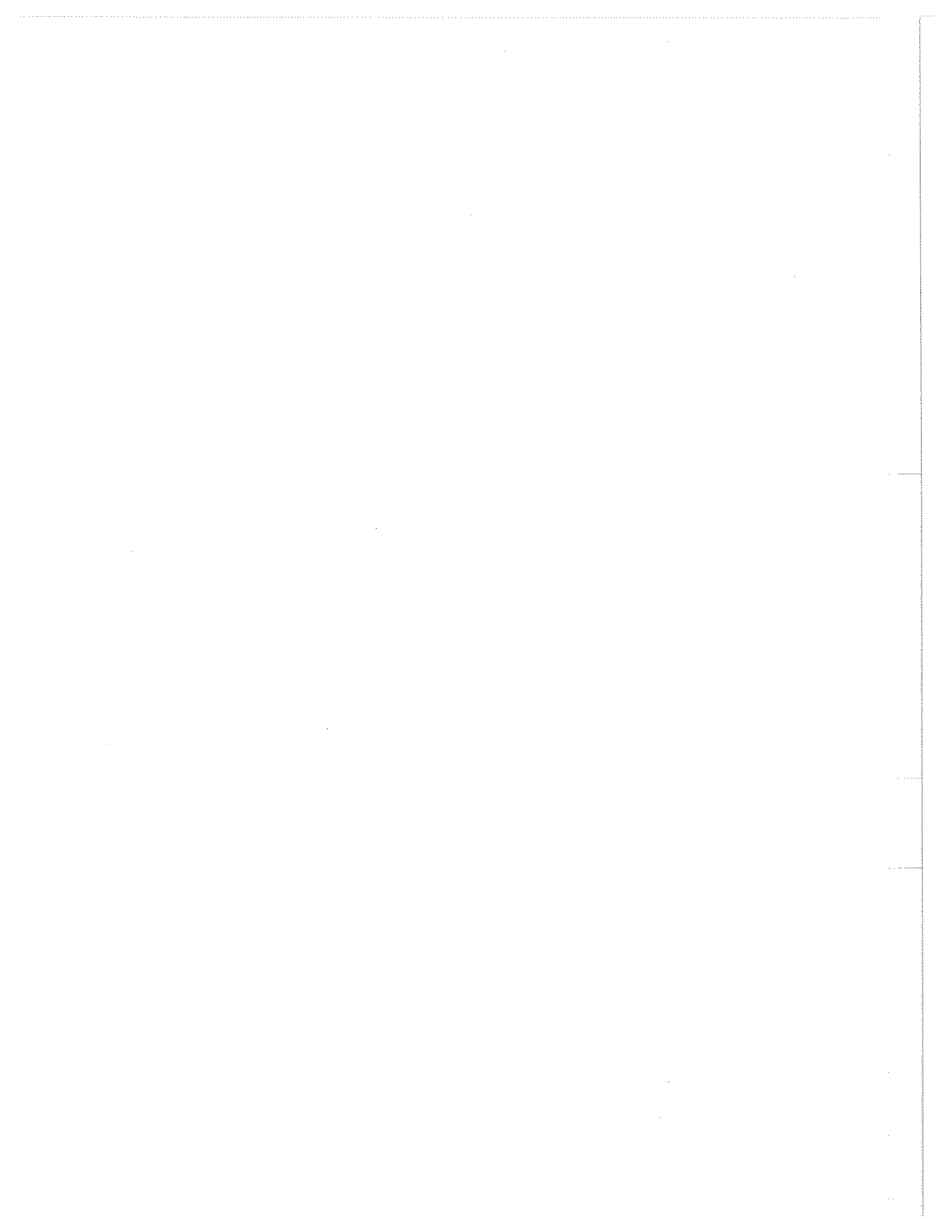
¹ These values assume no more than 1000 pF of capacitance between either end of the resistor (HI and LOW) and earth ground.

AC SIGNAL CROSSTALK INTO A TEMPERATURE CHANNEL

Frequency = 50, 60 Hz

$$\text{TEMPERATURE Error Ratio} = \left[\frac{^{\circ}\text{C} (\text{error})}{VAC_{rms} (\text{crosstalk})} \right]$$

| | <u>Worst case</u> | <u>Typical</u> |
|----------------------|--|--|
| Types J, K, E, T, N: | $2.7 \times 10^{-3} \left[\frac{^{\circ}\text{C}}{V_{rms}} \right]$ | $5.0 \times 10^{-4} \left[\frac{^{\circ}\text{C}}{V_{rms}} \right]$ |
| Types R, S, B, C: | $1.1 \times 10^{-2} \left[\frac{^{\circ}\text{C}}{V_{rms}} \right]$ | $2.0 \times 10^{-3} \left[\frac{^{\circ}\text{C}}{V_{rms}} \right]$ |
| Type PT (RTD): | $8.6 \times 10^{-5} \left[\frac{^{\circ}\text{C}}{V_{rms}} \right]$ | <i>NoEffect</i> |



Appendix F

Binary Upload of Logged Data (LOG_BIN?) (2625A only)

INTRODUCTION

The LOG_BIN? <index> query can be used to quickly upload logged data from a 2625A. The response is a single ASCII string, which encodes the raw binary data stored at the specified <index> position. The logged data is also retained in the 2625A.

The measurement data returned from the 2625A is in the (binary) IEEE single-precision floating point format. Making use of this data can be difficult and is very machine dependent. A working example, using the C programming language on an IBM PC, is provided in this appendix. This example uses a pre-computed LOG_BIN? response string, and checks that the conversion process works as expected.

Two steps are required in adapting the LOG_BIN? response string for use with your computer.

- First, you must decode the ASCII string into binary data.

For example, one possible LOG_BIN? response string is:

```
LOG_BIN? 1
42@Y40BA00oo000007o0001oP000?h000
=>
```

This ASCII string represents the following binary (hex) data:

```
10 24 29 10 04 91 00 0f ff
00 00 00 00 7f c0 00 00 7f
80 00 00 3f 80 00 00 00 00
```

- Second, you must convert this binary data into valid floating point numbers for your underlying computer architecture.

DECODING THE ASCII STRING

The ASCII response string contains six bits of raw data for each ASCII character, offset from ASCII '0' (0x30 hex, 48 decimal). Therefore, the conversion process subtracts 48 from the integer value of each character, then shifts it into place. Each set of four ASCII characters form three bytes of raw data. The number of bytes of raw data depends on the number of channels for the scan. The C code shown in Figure F-1 converts a LOG_BIN? response string into a byte array.

F/Binary Data Upload (LOG_BIN?)

```

/*
** decode(): Decode LOG_BIN? response string into raw byte stream
** Decoding is done on multiples of four input bytes:
**
**      543210   543210   543210   543210   (bit number in ASCII bytes)
**      +-----+ +-----+ +-----+ +-----+
**      | src[0] | | src[1] | | src[2] | | src[3] | | ASCII string input
**      +-----+ +-----+ +-----+ +-----+
**      765432   107654   321076   543210   (bit number in raw bytes)
**
**      |-----| |-----| |-----|
**      |       | |       | |       |
**      |-----| |-----| |-----|
**      76543210 76543210 76543210   (bit number in raw bytes)
**      +-----+ +-----+ +-----+
**      | dst[0] | | dst[1] | | dst[2] | | Raw data output
**      +-----+ +-----+ +-----+
**
** Inputs:
**   dst   Destination for binary data (must have enough space
**         allocated; the maximum needed is 6 timestamp bytes + 3
**         bytes for temp units, measurement rate, and digital I/O
**         + 4 bytes/float * 22 floating point values = 97 bytes).
**   src   Source ASCII string (null terminated)
**
** Outputs:
**   dst   Set to binary data, based on ASCII string
**
** Returns:
**   Number of bytes placed in destination buffer
**
*/

int
decode(dst, src)
unsigned char *dst;
char *src;
{
    /* src to dst xlate */
    static struct nibtab_s {
        int lindex;
        int lmask;
        int lshift;
        int rindex;
        int rmask;
        int rshift;
    } nibtab[3] = {
        /* left      right */
        0, 0x3f, 2,   1, 0x30, 4,   /* dst[0] from src[0] and src[1] */
        1, 0x0f, 4,   2, 0x3c, 2,   /* dst[1] from src[1] and src[2] */
        2, 0x03, 6,   3, 0x3f, 0,   /* dst[2] from src[2] and src[3] */
    };

    auto unsigned char n;
    auto struct nibtab_s *t;
    auto unsigned char tmpsrc[4];
    auto int dst_bytes;

    /* Number of bytes created */
    dst_bytes = 0;

    /* Process src in chunks of four */
    while (*src) {
        /* Copy source, filling "holes" at end with zeros */
        for (n = 0; n < 4; n++) {
            if (*src)
                tmpsrc[n] = *src++ - '0';
            else
                tmpsrc[n] = 0;
        }

        /* Mung source into destination */
        for (t = nibtab; t < &nibtab[3]; t++) {
            *dst = (tmpsrc[t->lindex] & t->lmask) << t->lshift;
            *dst |= (tmpsrc[t->rindex] & t->rmask) >> t->rshift;

            dst++;
            dst_bytes++;
        }
    }
    return (dst_bytes);
}

```

Figure F-1. ASCII String Decoding

The raw data output array contains the information listed below. Note that the number of floating point values is equal to the number of channels in use, plus one. (The totalizer count is always present in the data, and is stored as a floating point number.)

- Time stamp (BCD format)

byte 0: hours
 byte 1: minutes
 byte 2: seconds
 byte 3: month
 byte 4: date
 byte 5: year

- Temperature units, measurement rate, and I/O

byte 6: temperature units and rate (0x10 bit means degrees Fahrenheit, else Centigrade; 0x01 bit means fast rate, else slow rate)

byte 7: Alarm outputs
 byte 8: Digital I/O

- Totalizer value as 32-bit single-precision IEEE floating point number stored using the byte ordering shown below. The format of this number is explained under "Floating Point Conversion".

byte 9: MMSB of float
 byte 10: MLSB of float
 byte 11: LMSB of float
 byte 12: LLSB of float

- Measurement data; only defined channels are included (exactly like LOG? query); same floating point format, but with a wider range of values. NaN (Not a Number) is used to indicate open thermocouple, and plus or minus Inf (infinity) to indicate overload. The bit values for NaN and Inf are explained in the next section.

byte 13: MMSB of float
 byte 14: MLSB of float
 byte 15: LMSB of float
 byte 16: LLSB of float

bytes 17-20: Second measurement result, if any
 bytes 21-24: Third measurement result, if any

.....

Since the ASCII decoding (explained above) creates data multiples of three in length, it is possible that there will be one or two unused bytes at the end of the decoded byte stream.

FLOATING POINT CONVERSION

ANSI/IEEE Std 754-1985, "IEEE Standard for Binary Floating-Point Arithmetic," describes the single-precision floating point format used to return measurement data. This standard defines the format for single-precision floating point as:

$$X = (-1)^s \times 2^{(e-127)} \times 1.m$$

where

s = sign

e = exponent

m = mantissa

The floating point format used is 32-bit with a 1-bit sign, 8-bit exponent, and 24-bit mantissa with the most significant bit hidden under the LSB of the exponent. The number is formatted as shown in Table F-1.

Table F-1. Floating Point Format

| sign 1 bit | exponent 8 bits | mantissa 23 bits (plus one hidden bit) | | |
|---------------------|-----------------------|---|--------------------|--|
| high byte (MMSB) | hi-mid byte (MLSB) | low-mid byte (LMSB) | low byte (LLSB) | |

For all other measurement queries, Hydra returns the string "+9E+9" for open thermocouple (OTC) measurement values. However, for the LOG_BIN? query, NaN (not a number) is returned instead. The IEEE floating point standard defines NaN as a positive, maximum exponent number with non-zero mantissa bits. Hydra sets just the most significant mantissa bit, so the raw binary byte stream value is 7f c0 00 00 (hex).

For all other measurement queries, Hydra usually returns +/- 1e9 for overload (OL) measurement values. However, for the LOG_BIN? query, Hydra returns Inf (infinity) instead. The IEEE floating point standard defines Inf as a positive or negative maximum exponent number with a zero mantissa. Hydra returns +Inf as the byte stream 7f 80 00 00 (hex) and -Inf as ff 80 00 00 (hex).

The C code in Figure F-2 converts raw data into a useful format for the Intel x86 (IBM PC) architecture. The BCD time stamp is converted to integers, and floating point numbers created for the totalizer and measurement values.

EXAMPLE

Figure F-3 is a short example that uses the routines in Figures F-1 and F-2 to decode a fixed (pre-computed) LOG_BIN? response string.

When compiled and run on an Intel architecture computer, the program should print "Conversion worked".

Although this example is useful for educational purposes, it is not very efficient. If desired, the decoding and conversion processes can be combined into a single, fast algorithm.

```

/* Import globals from main program */
extern int timestamp[];
extern int misc[];
extern float values[];

/*
** convert(): Convert a LOG_BIN? array of binary data into useful data
**
** Converts BCD values to integer, raw floating point values into float
** values usable under the Intel x86 (IBM PC) architecture.
**
** Inputs:
**     src          Array of binary data, from LOG_BIN? query
**     length       Number of bytes in src array
**
** Outputs:
**     timestamp[]  Set to decimal timestamp values
**     misc[]       Set to temp units, rate, and digital I/O values
**     values[]     Set to floating point values found in binary data
**                 (must be room for a maximum of 22 floats)
**
*/

void
convert(src, length)
    unsigned char *src;
    int length;
{
    unsigned char *m;
    int n;

    /* Convert timestamp from BCD to decimal */
    for (n=0; n < 6; n++, src++) {
        /* Binary Coded Decimal (BCD) format, packs the upper nibble as the */
        /* tens digit, the lower nibble as the ones digit. Convert this */
        /* into an integer number. */
        timestamp[n] = (10 * (*src >> 4) + (*src & 0x0f));
    }

    /* Save temperature units, measurement rate, and digital I/O values */
    for (n=0; n < 3; n++) {
        misc[n] = *src++;
    }

    /* Convert raw measurement data into floating point */
    m = (unsigned char *)values;
    for (length -= 9; length > 3 length -= 4) {
#ifdef sun
        /* SunOS architecture (also works for Motorola CPUs) */
        *m++ = src[0];
        *m++ = src[1];
        *m++ = src[2];
        *m++ = src[3];
#else
        /* Assume Intel x86 architecture */
        *m++ = src[3];
        *m++ = src[2];
        *m++ = src[1];
        *m++ = src[0];
#endif
        src += 4;
    }
}

```

Figure F-2. Floating Point Conversion

F/Binary Data Upload (LOG_BIN?)

```

/* Globals convert() uses for destination */
int timestamp[6];          /* Scan timestamp */
int misc[3];              /* Temperature units, measurement rate, digital I/O */
float values[22];         /* Measurement values */

extern int isnan();       /* Floating point value is NaN (not a number) */
extern int isinf();       /* Floating point value is Inf (infinity) */

/*
** main(): LOG_BIN? query response example program
** Converts a hard-coded LOG_BIN? response string into usable data.
*/

main()
{
    extern int decode();   /* ASCII to binary decoding */
    extern void convert(); /* Convert Hydra binary to usable types */

    /* Canned response for three channels: channel 1 is OTC, channel 5 is */
    /* OL and channel 10 is 1.0; remaining encoded data described below */
    /* (note that you can not determine the channel number, measurement */
    /* units, or measurement range, from this string; you must keep track */
    /* of that elsewhere) */
    char *log_bin_response = "42@Y40BA000000007000010P000?h000";

    /* Place to temporarily store raw data; 100 bytes is more than enough */
    /* for any LOG_BIN? response string */
    unsigned char raw_data[100];

    /* Decode string into raw data, then convert raw data into usable data */
    convert(raw_data, decode(raw_data, log_bin_response));

    /* Above global variables now usable; check example LOG_BIN? data */
    /* against expected values */

    if ((timestamp[0] == 10) &&          /* Hours */
        (timestamp[1] == 24) &&         /* Minutes */
        (timestamp[2] == 29) &&         /* Seconds */
        (timestamp[3] == 10) &&         /* Month */
        (timestamp[4] == 4) &&          /* Day */
        (timestamp[5] == 91) &&         /* Year */
        (misc[0] == 0) &&               /* Temp units and rate */
        (misc[1] == 15) &&              /* Alarm outputs */
        (misc[2] == 255) &&             /* Digital I/O */
        (values[0] == 0.0) &&           /* Totalizer */
        isnan(values[1]) &&             /* Channel 1 data */
        isinf(values[2]) &&            /* Channel 5 data */
        (values[3] == 1.0)) {
        printf("Conversion worked\n");
    }
    else {
        printf("ERROR: conversion did not succeed!\n");
    }

    exit(0);
}

/* If your math library supplies alternatives to isnan() or isinf(), */
/* use them instead! */

int
isnan(f)
float f;
{
    /* This is not portable, or completely accurate (since NaN mantissa */
    /* must only be non-zero, and the sign bit can be set), but this works */
    /* for NaN values returned by Hydra */

    /* Compiler was free to promote to double */
    float ff = f;

    return ((*(unsigned long *)&ff) == 0x7fc00000L);
}

int
isinf(f)
float f;
{
    /* Again, this is not portable, but this time it is accurate */

    /* Compiler was free to promote to double */
    float ff = f;

    return ((*(unsigned long *)&ff) == 0x7f800000L) ||
           ((*(unsigned long *)&ff) == 0xff800000L);
}

```

Figure F-3. Example

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