For the benefit and convenience of its customers, Fluke Corporation (Fluke) has reproduced this copy of a manual which is no longer in production. This manual has not been edited or updated since the revision date shown on the lower left hand corner of the first page. Fluke will not be liable for any claims, losses or damages of any kind incurred by any user arising from use of this manual.

HELIOS I

COMPUTER FRONT END

System Manual

PN 834366
JANUARY 1988 Rev. 1, 8/88

©1993 Fluke Corporation. All rights reserved. Printed in U.S.A.
All product names are trademarks of their respective companies

FLUKE®

LIMITED WARRANTY & LIMITATION OF LIABILITY

Each Fluke product is warranted to be free from defects in material and workmanship under normal use and service. The warranty period is one year and begins on the date of shipment. Parts, product repairs and services are warranted for 90 days. This warranty extends only to the original buyer or end-user customer of a Fluke authorized reseller, and does not apply to fuses, disposable batteries or to any product which, in Fluke's opinion, has been misused, altered, neglected or damaged by accident or abnormal conditions of operation or handling. Fluke warrants that software will operate substantially in accordance with its functional specifications for 90 days and that it has been properly recorded on non-defective media. Fluke does not warrant that software will be error free or operate without interruption.

Fluke authorized resellers shall extend this warranty on new and unused products to end-user customers only but have no authority to extend a greater or different warranty on behalf of Fluke. Warranty support is available if product is purchased through a Fluke authorized sales outlet or Buyer has paid the applicable international price. Fluke reserves the right to invoice Buyer for importation costs of repair/replacement parts when product purchased in one country is submitted for repair in another country.

Fluke's warranty obligation is limited, at Fluke's option, to refund of the purchase price, free of charge repair, or replacement of a defective product which is returned to a Fluke authorized service center within the warranty period.

To obtain warranty service, contact your nearest Fluke authorized service center or send the product, with a description of the difficulty, postage and insurance prepaid (FOB Destination), to the nearest Fluke authorized service center. Fluke assumes no risk for damage in transit. Following warranty repair, the product will be returned to Buyer, transportation prepaid (FOB Destination). If Fluke determines that the failure was caused by misuse, alteration, accident or abnormal condition of operation or handling, Fluke will provide an estimate of repair costs and obtain authorization before commencing the work. Following repair, the product will be returned to the Buyer transportation prepaid and the Buyer will be billed for the repair and return transportation charges (FOB Shipping Point).

THIS WARRANTY IS BUYER'S SOLE AND EXCLUSIVE REMEDY AND IS IN LIEU OF ALL OTHER WARRANTIES, EXPRESS OR IMPLIED, INCLUDING BUT NOT LIMITED TO ANY IMPLIED WARRANTY OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE. FLUKE SHALL NOT BE LIABLE FOR ANY SPECIAL, INDIRECT, INCIDENTAL OR CONSEQUENTIAL DAMAGES OR LOSSES, INCLUDING LOSS OF DATA, WHETHER ARISING FROM BREACH OF WARRANTY OR BASED ON CONTRACT, TORT, RELIANCE OR ANY OTHER THEORY.

Since some countries or states do not allow limitation of the term of an implied warranty, or exclusion or limitation of incidental or consequential damages, the limitations and exclusions of this warranty may not apply to every buyer. If any provision of this Warranty is held invalid or unenforceable by a court of competent jurisdiction, such holding will not affect the validity or enforceability of any other provision.

Fluke Corporation
P.O. Box 9090
Everett WA 98206-9090

Fluke Europe B.V.
P.O. Box 1186
5602 B.D.
Eindhoven
The Netherlands

5/94

8 Error Messages

Introduction 8-3
What to Do About an Error 8-4
Error Information 8-5

9 Appendices

9a. Configuring Your Computer 9a-1
9b. Serial Data Reference 9b-1
9c. ASCII Character Codes 9c-1
9d. Power Up and Reset Routines 9d-1
9e. Sales and Service Centers 9e-1
9f. Glossary 9f-1

CAUTION

THIS IS AN IEC SAFETY CLASS 1 PRODUCT. THE GROUND WIRE IN THE LINE CORD MUST BE CONNECTED FOR SAFETY.

INTERFERENCE INFORMATION

This equipment generates and uses radio frequency energy and if not installed and used in strict accordance with the manufacturer's instructions, may cause interference to radio and television reception. It has been type tested and found to comply with the limits for a Class B computing device in accordance with the specifications in Subpart J of Part 15 of FCC Rules, which are designed to provide reasonable protection against such interference in a residential installation. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient the receiving antenna
- Relocate the equipment with respect to the receiver
- Move the equipment away from the receiver
- Plug the equipment into a different outlet so that the computer and receiver are on different branch circuits

If necessary, the user should consult the dealer or an experienced radio/television technician for additional suggestions. The user may find the following booklet prepared by the Federal Communications Commission helpful: How to Identify and Resolve Radio-TV Interference Problems. This booklet is available from the U.S. Government Printing Office, Washington, DC 20402. Stock No. 004-000-00345-4.

Declaration of the Manufacturer or Importer

We hereby certify that the Fluke Helios I Computer Front End is in compliance with Postal Regulation Vfg. 1046 and is RFI suppressed. The marketing and sale of the equipment was reported to the German Postal Service. The right to retest this equipment to verify compliance with the regulation was given to the German Postal Service.

John Fluke Mfg. Co., Inc.

Bescheinigung des Herstellers/Importeurs

Hiermit wird bescheinigt, daß das Fluke Helios I Computer Front End Übereinstimmung mit den Bestimmungen der Amtsblattverfügung Vfg. 1046 funk-entstört ist. Der Deutschen Bundespost wurde das Inverkehrbringen dieses Gerätes angezeigt und die Berechtigung zur Überprüfung der Serie auf Einhaltung der Bestimmungen eingeräumt.

John Fluke Mfg. Co., Inc.

PREFACE

How to Use This Manual

The Fluke Helios I Computer Front End is a member of an exceptional family of Computer Front Ends and Data Loggers. This Front End offers a full line of field-proven data acquisition hardware. It is both easy to configure and to integrate into a mainframe or personal computer-based measurement system.

This manual has been designed with a variety of readers in mind. The job you will be doing with the Computer Front End will partly determine how you can get the most benefit from this manual.

System Designers

To design and assemble the components of a measurement/data acquisition system you need in-depth information about the capabilities, specifications, and available operations of the proposed equipment. As a system designer, you are not as interested in keystroke-level operations as in the operational characteristics of the unit. If you need this kind of information, begin in Section 2, Specifications. Section 2 gives the specifications of the Computer Front End and all available options. If you need to know more about how the Front End operates, read the introductory parts of Section 4, Using the Commands. You might also look up selected topics of interest in the index.

Applications Engineers

This manual was written mainly for applications engineers who will be installing, connecting, and programming the Helios I Computer Front End. The major sections are tab-divided for quick reference when you're in a hurry. Also, the sections are divided into conveniently sized tasks.

When you're just beginning to use this manual, you'll probably make the best headway by first scanning it to familiarize yourself with its organization. Then, depending on your specific task, you might branch to the section on installation. If someone else has already installed the system and you need to begin programming the Front End, then Section 4 will get you going quickly. After that, you'll probably only need Section 5 as a reference to the commands.

Technicians

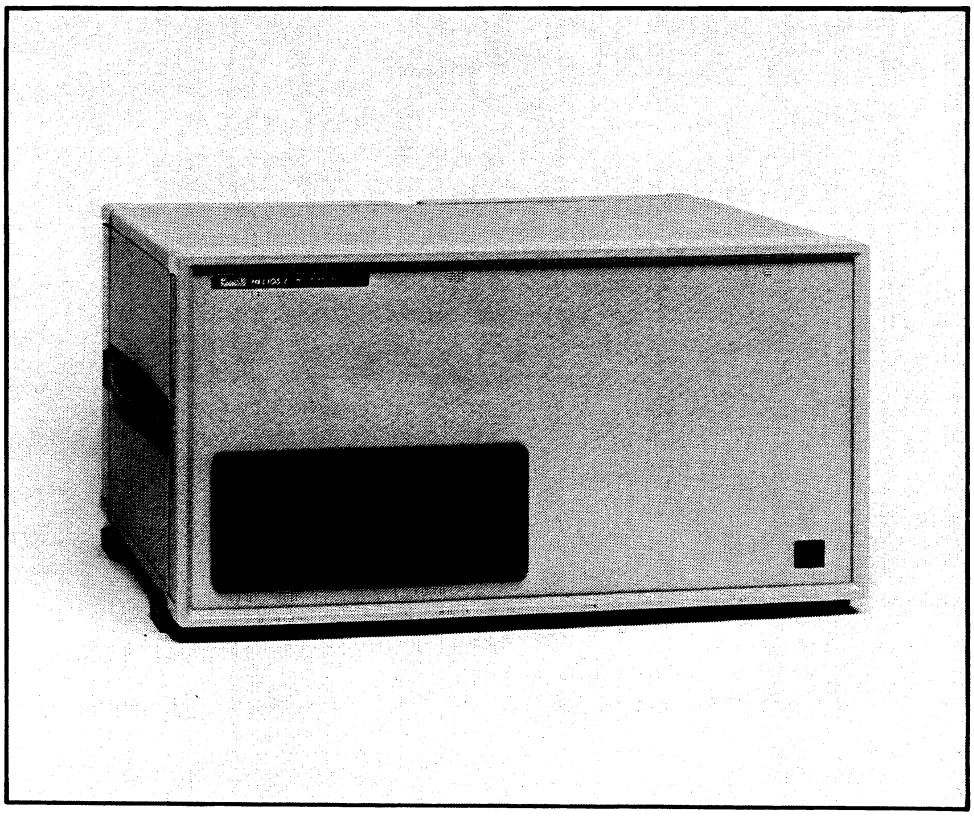
Persons installing, operating, troubleshooting, or changing the configuration of the measurement system may need just about any piece of information in this manual. If you are to be the system technician, you will probably need to consult the table of contents and the index to locate what you need. For schematics or other servicing information, order Fluke Part Number 834382, Helios I Computer Front End Service Manual from your local Fluke Service Center (see Appendix D).

Carefully follow all the installation instructions when you are first setting up the system. If you feel you have a service problem, be sure to call your Fluke service representative for assistance.

Purchasing Agents

If you make purchasing decisions, you have probably already seen the specifications for the Helios I Computer Front End. This manual can still help in your task. Section 2 is entirely devoted to the specifications of the mainframe and all the available options.

However, specifications alone may not provide enough information to evaluate the instrument. You may be interested in some less tangible factors, like ease-of-use. Reading the introductory parts of Section 3, Installation, can help you get a feel for the task of setting up the system you have in mind. Similarly, glancing over Section 4, Using the Commands, should indicate how communications are established between the computer and the measurement system.



Helios I Computer Front End

Contents

1 **Getting Started**

Getting Started - Introduction 1-2
The Mainframe 1-4
Extender Chassis 1-4
Option Assemblies 1-6
Accessories 1-9

Getting Started - Setup 1-10
Unpacking 1-10
Connecting to Your Computer or Terminal 1-11
Non-Volatile Memory Battery Charging 1-12
Cabling to the Host Computer 1-13
Communicating with the Front End 1-15
Terminal Mode 1-16
Computer Mode 1-16
Turning On the Computer Front End 1-17

Where to Go From Here 1-18

Contents, continued

2 Specifications

Mainframe Specifications 2-3
Interface Specifications 2-4

Option Specifications 2-9
-160 AC Voltage Input Connector 2-9
-161 High Performance A/D Converter 2-10
-162 Thermocouple/DC Volts Scanner 2-11
-163 RTD Scanner 2-13
-164 Transducer Excitation Module 2-15
-167 Counter/Totalizer 2-17
-168 Digital I/O 2-19
-169 Status Output Connector 2-20
-170 Analog Output Module 2-21
-171 Current Input Connector 2-23
-174 Transducer Excitation Connector 2-24
-175 Isothermal Input Connector 2-25
-176 Voltage Input Connector 2-26
-177 RTD/Resistance Input Connector 2-27
-179 Digital/Status Input Connector 2-29
-201 Scan/Alarm Option 2-30

System Accuracy Specifications
Temperature Measurement
Using Thermocouples 2-31
Using RTDs 2-33
DC Voltage Measurement 2-41
AC Voltage Measurement 2-42
DC Current Measurement 2-43
Resistance Measurement 2-44
Strain Measurement 2-49

3 Installation and Setup

Introduction 3-5

3A Mainframe

Placement 3a-1
Rack Mounting 3a-2
Configuring the Front End 3a-3
Line Power Voltage Selection 3a-3
Preparing to Connect to The Host Computer ... 3a-7
Configuration Summary 3a-8
Where to Go From Here 3a-8
Setting the Communication Switches 3a-9
Connecting to the Host Computer 3a-12
The Dual Function Interface Connector 3a-12
RS-232-C Signal Descriptions 3a-12
Data Channel Protocols 3a-16
Direct Connection 3a-16
Communicating Using Modems 3a-16
Communicating Using Auto-Answer Modems . 3a-17
Cable Configurations and Connections 3a-18
Two-Point Direct-Connect Network 3a-18
Two-Point With Modems Over a Dedicated Line 3a-18
Linking to Telephone Service With an Auto-Answer Modem 3a-19
RS-422 Signal Descriptions 3a-19
Cable Connections 3a-22
Two-Point Configuration 3a-22
Multipoint Configuration 3a-23
Connecting to the Printer Port (Scan/Alarm) 3a-26
Setting the Communication Switches 3a-26
RS-232-C Printer Port Signal Descriptions ... 3a-27

Contents, continued

3B: Options and Accessories

The Options 3b-1
System Considerations 3b-2
1. Identify System Requirements 3b-3
2. Define the Options Required 3b-4
3. Load the Options 3b-6
    Categorize the Options 3b-7
    Load Stand-Alone Options in Upper Slots 3b-7
    Load Interdependent Option Sets at the Bottom 3b-8
4. Determine Additional Power Requirements 3b-9
    General 3b-9
    Maximum Power Required 3b-9
    Serial Link Cable Length 3b-11
5. Setup the Addressing Scheme 3b-12
    Example Address Assignment 3b-13
-160 AC Volts Input Connector 3b-15
-161 High Performance A/D Converter 3b-21
-162 Thermocouple/DC Volts Scanner 3b-27
-163 RTD/Resistance Scanner 3b-33
-164 Transducer Excitation Module 3b-39
-167 Counter/Totalizer 3b-45
-168 Digital I/O Assembly 3b-53
-169 Status Output Connector 3b-59
-170 Analog Output 3b-67
-171 Current Input Connector 3b-73
-174 Transducer Excitation Connector 3b-79
-175 Isothermal Input Connector 3b-93
-176 Voltage Input Connector 3b-101
-177 RTD/Resistance Input Connector 3b-109
-179 Digital/Status Input Connector 3b-117
-201 Scan/Alarm Option 3b-129
2281A Extender Chassis 3b-137
-402 Extender Cable 3b-143
-403 Extender Cable Connectors 3b-145
-431 Power Supply 3b-149
Y2044 Rack Slide Kit 3b-159
Y2045 Rack Mount Kit 3b-165
Y2047 Multiconnector/Adapter 3b-169
Y1060 RS-422 Multipoint Connector 3b-170
RS-232-C Cables 3b-171

3C: Installation Verification

Mainframe Installation Testing 3c-1
Option Assembly Testing 3c-3
Scan/Alarm Testing 3c-3

4 Using the Commands

Introduction 4-3
Command Format 4-4
Command Set Summary 4-4
    Definition (DEF) Command 4-6
    Set Command 4-7
    System Variables 4-8
    LIST Command 4-9
    RESET Command 4-10
    SEND Command 4-10
    TEST Command 4-11
    Repeat ("!") Command 4-11
    Special Characters 4-11
Operating the Front End From a Terminal 4-13
    Powering Up and Entering Terminal Mode 4-14
    Command Responses 4-15
Operating the Front End From a Computer 4-16
    Powering Up and Entering Computer Mode 4-17
    Command Responses 4-18
    Implementing a Reliable Communication Link .. 4-20
        Communication Character Buffering 4-21
        Timeouts 4-23
        Error Buffers 4-24
Scan/Alarm Option Commands 4-24
Conclusion 4-28

Contents, continued

5 Command Reference

Introduction 5-5
Using Command Reference Information 5-6
Notation Conventions 5-6
Syntax Diagrams 5-8
Syntax Diagram Examples 5-9
Common Syntactic Elements 5-13
The Channel Function 5-13
Channel Numbers 5-17
Numeric Representation 5-18

Alphabetical Reference to the Commands

DEF Command
DEF ABUF 5-21
DEF CHAN
Alarm Limits 5-23
Channel Function 5-27
Analog Output 5-29
Counter/Totalizer Input 5-31
Digital I/O 5-33
Direct Current Input 5-35
Resistance Input 5-37
Strain Input 5-39
Temperature Input - RTD 5-45
Temperature Input - TC 5-49
Voltage Input 5-53
DEF SBUF 5-57
DEF SCAN 5-59
DEF TABLE 5-61

LABEL CHAN Command 5-64-1

LIST Command
LIST ABUF 5-65
LIST CHAN 5-67
Computer Mode 5-69
Terminal Mode 5-77
LIST ERROR 5-79
LIST SBUF 5-83
LIST SCAN 5-85
LIST TABLE 5-89

RESET Command
RESET 5-93
RESET ALL 5-93
RESET CHAN 5-93
RESET ABUF 5-95
RESET SBUF 5-95

SEND Command
SEND ABUF 5-97
SEND CHAN 5-103
SEND SBUF 5-109
SEND Value of System Variable 5-113

Set Command
Set CHAN
Analog Output 5-119
Status Output 5-121
Set System Variable to Constant
CAL 5-123
COUNT 5-125
DATE$ 5-127
EOL 5-129
FORMAT 5-131
HOSTTO 5-137
INTERRUPT 5-139
LINEFR 5-141
MODE 5-143
TERM 5-145
TIME 5-147
TIME$ 5-149
TUNIT 5-151

Contents, continued

SHOW Command
SHOW ABUF 5-153
SHOW FIRST|LAST|AGAIN ABUF 5-153
SHOW SBUF 5-155
SHOW FIRST|LAST|AGAIN SBUF 5-155

START SCAN Command 5-157

STOP SCAN Command 5-161

TEST and TEST CHAN Command 5-163

6 **Measurement Reference**

Analog Output 6a-1
Current Measurements 6b-1
Digital/Status Inputs 6c-1
Frequency Measurements 6d-1
Resistance Measurements 6e-1
Status Outputs 6f-1
Strain Measurement 6g-1
Temperature Measurement Using RTDs 6h-1
Temperature Measurement Using Thermistors 6i-1
Temperature Measurement Using Thermocouples 6j-1
Totalizing Measurement 6k-1
Voltage Measurement - Alternating 6l-1
Voltage Measurement - Direct 6m-1

7 **Maintenance**

Introduction 7-1
Setting the Line Voltage 7-1
Fuse Replacement 7-6
Fan Filter Cleaning 7-6
General Cleaning 7-7
Service Information 7-8

Section 1
Getting Started

CONTENTS

GETTING STARTED - INTRODUCTION 1-2

THE MEASUREMENT SYSTEM 1-4
- The Mainframe 1-4
- Extender Chassis 1-4
- Option Assemblies 1-6
  - OPTION CARDS 1-6
  - CONNECTOR OPTIONS 1-7
  - SCAN/ALARM OPTION 1-8
- Accessories 1-9

GETTING STARTED - SETUP 1-10
- Unpacking 1-10
- Connecting to Your Computer or Terminal 1-11
- Non-Volatile Memory Battery Charging 1-12
- Cabling to the Host Computer 1-13
  - COMMUNICATIONS FORMAT 1-14
- Communicating with the Front End 1-15
- Terminal Mode 1-16
- Computer Mode 1-16
- Turning On the Computer Front End 1-17

WHERE TO GO FROM HERE 1-18

GETTING STARTED - INTRODUCTION

The Fluke Helios I Computer Front End is a data acquisition and control subsystem that can be used with any kind of personal or mainframe computer. The Front End combines a full range of measurement capabilities with easy programmability. It includes:

- An RS-232-C and an RS-422 standard serial interface port for communication with a host computer.
- A microcomputer with ROM and RAM to provide local intelligence.
- Six option slots that accept any of a range of measurement and control modules, supporting a variety of both analog and digital inputs and outputs. Expansion chassis can be added to accommodate more up to a maximum of 1500 in the system. A maximum of 1000 channels can be accommodated if the Scan/Alarm option is in use.

The Computer Front End is a smart intermediary between a computer and a real world measurement application. Through a standard computer interface, the Front End gathers data about physical quantities and generates control or stimulus signals.

The Front End is a medium speed, highly accurate measurement and control system. It can be adapted to a very broad spectrum of applications, with a capacity ranging from a single channel in a minimal configuration to 1500 (or 1000 with the Scan/Alarm option) in a fully expanded system.

A microcomputer in the Front End executes commands received from the host computer, drives the measurement and control hardware, and sends appropriate responses back to the host. The command set is a collection of high level instructions, presented in a readable and easy-to-grasp format.

Channel definition commands select ranges and sensor types. From then on, automatic signal conditioning and data conversion take place for sensors as common as thermocouples, RTDs and strain gauges, or as unique as a user-defined sensor type. Thus, the Front End responds to a measurement request command by returning a value in appropriate units of measurement. Conversely, a channel set command, which assigns a value to a control output, is translated into an electrical signal.

THE MEASUREMENT SYSTEM

The Helios measurement system has been designed with a modular architecture that allows great flexibility in hardware configuration and placement. At the heart of the system is the Computer Front End mainframe.

The Mainframe

The mainframe is a chassis packaged in a vinyl-clad housing with carrying handles and feet. The feet can be removed for mounting the instrument into a standard 19" instrument rack.

The Front End mainframe is supplied with a computer interface module that includes a 16-bit microprocessor. Nonvolatile RAM holds information about channel sensors and EPROMs contain a command interpreter and tables for converting the output of commonly-used sensors into engineering units.

Six horizontal slots in the rear of the mainframe can accept any of a complete set of measurement and output options. An extender chassis is available if more slots are needed, or if the system architecture requires the options to be remotely located.

Extender Chassis

The 2281A Extender Chassis is a passive unit that acts as an extension of the mainframe. Like the mainframe, this extender also contains six horizontal slots in the rear panel for accepting options, and it can be used as a bench instrument or mounted in a standard 19" instrument rack.

The Front End and its associated options all use a distributed system design that allows great flexibility in hardware placement. All of the measurement and output options communicate with the computer interface module over a high-speed serial communications link. This design permits any option assembly that can be installed in the mainframe to be installed in an Extender Chassis located up to 1,000 meters away. All measurements are digitized at the remote location and transmitted back to the Front End over the serial link. This approach greatly reduces wiring costs and assures accurate measurements in electrically noisy environments.

Fig 1-1 illustrates the distributed system concept.

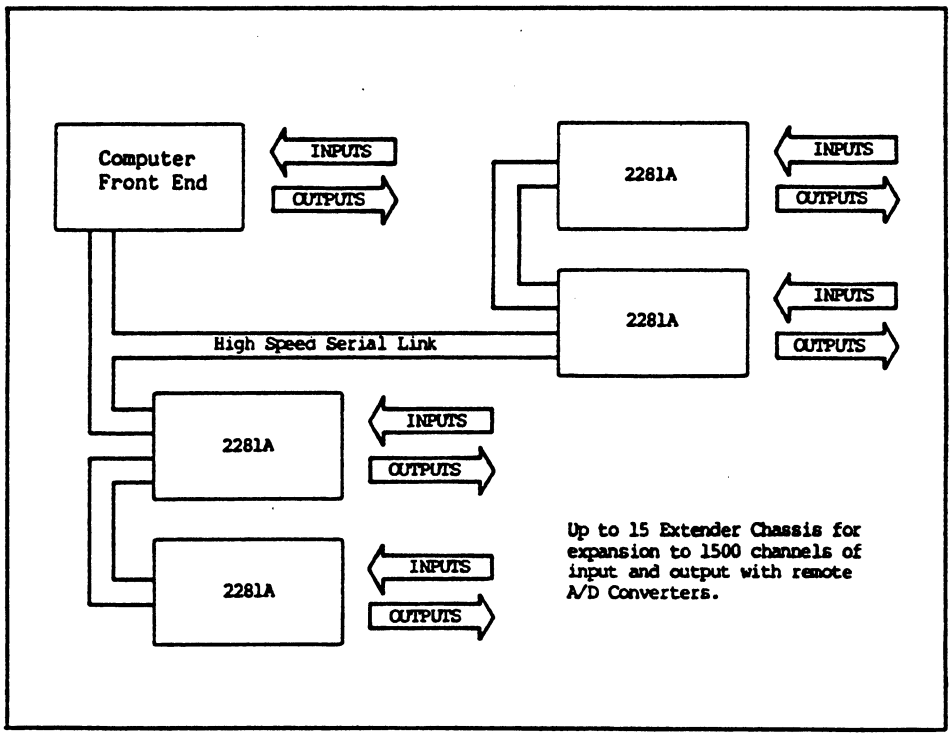


Figure 1-1. Distributed System Concept

Option Assemblies

All connections between the Computer Front End and the process to be monitored or controlled are made through plug-in option assemblies. The use of option assemblies allows for a wide range of configurations. The option assemblies slip into position easily from the Front End's access panel. Installation and use of each assembly is documented in Section 3B of this manual. The options are categorized as follows:

OPTION CARDS

Option cards are circuit cards that can be installed in either the Computer Front End or the 2281A Extender Chassis. These are the devices that link the measurement environment to the Front End. These options include:

- High Performance A/D Converter (-161)

  High Performance A/D converter with 17 bits of resolution. Up to 15 per system (or 10 with a Scan/Alarm option), each measuring up to 100 channels.

- Thermocouple/DC Volts Scanner (-162)

  A 20-channel, 3-pole reed multiplexer for voltage, current and thermocouple measurements.

- RTD/Resistance Scanner (-163)

  20-channel reed multiplexer with on-board excitation for resistance and RTD measurements.

- Transducer Excitation Module (-164)

  Isolated transducer excitation module with current and voltage sources for strain and resistance measurements. Used in conjunction with 3-pole scanner card.

- Counter/Totalizer (-167)

  6-channel, isolated event counting and frequency measurement card.

- Digital I/O Assembly (-168)

  20-bit, isolated digital I/O card for parallel or single-bit I/O.

- Analog Output (-170)

  4-channel, isolated current/voltage analog output card (D/A converter).

CONNECTOR OPTIONS

Connector options are modules that plug on to the option card. They allow for wiring connections and routing to the measurement environment. The available option connectors are:

- AC Voltage Input Connector (-160)
- Digital/Status Input Connector (168)
- Status Output Connector (-169)
- Current Input Connector (-171)
- Transducer Excitation Connector (-174)
- Isothermal Input Connector (-175)
- Voltage Input Connector (-176)

SCAN/ALARM (OPTION -201)

The Scan/Alarm option provides the following features:

- Automatic Scanning of Input Channels
- Limit Checking
- Data Buffering
- Polynomial Linearizations
- Local Printout
- Alarm Outputs
- Alarm Annunciation
- Communication Monitoring
- Host Interrupt on Alarm
- Printer Port Formatting
- Time Averaging

Accessories

Several option assemblies apply specifically to use of the 2281A Extender Chassis with the Front End. Installation instructions for these options are provided in Section 3 of this manual. Complete documentation can be found in the 2281A Instruction Manual.

- Extender Cable (2281A-402)

  When used with the 2281A-403 cable connector, this assembly provides the serial link interface between two Extender Chassis.

- Extender Cable Connector (2281A-403)

  This is a set of male/female 15-pin, D-type connectors. A housing provides strain relief for cable connections and stand-off bolts for securing the cable connector to the mainframe connector.

- Power Supply (2281A-431)

  This assembly provides a regulated 20V dc source for option devices when the extender chassis placement (distance) and configuration (number of devices) exceed the power capabilities of the Front End.

The following accessories are available to aid in installing either the Computer Front End or the 2281A Extender Chassis:

- Y1702, Y1703, Y1705 Null Modem Cables

  For connecting the Front End to the host computer, these cables are 2 meters, 4 meters, and 25 centimeters long respectively. Both ends have DB 25S (Socket) connectors.

- Y1707, Y1708 RS-232 Interface Cables

  These RS-232 cables are 2 meters and 10 meters in length respectively. One end has a DB 25S (Socket) and the other other a DB 25S (Plug) connector.

- Y2044 Rack Slide Kit

  This accessory facilitates servicing the Front End (or 2281A) while it is installed in a standard 19-inch electronic equipment rack. The unit is secured in the equipment rack, yet may be pulled out along the slide for servicing and reconfiguring of serial link devices.

- Y2045 Rack Mount Kit

  This kit facilitates placing a Front End or 2281A into a standard 19-inch electronic equipment rack.

- Y2047 Serial Link Multiconnect

  This accessory is used in 2281A placements to support star configurations.

GETTING STARTED - SETUP

The remainder of this section describes the steps to follow in setting up the Computer Front End when it is being installed for the first time.

Unpacking

To unpack the Computer Front End, first examine the shipping container for any obvious damage. If no damage is apparent, open the container and remove enough packing material to expose the instrument and remove it.

Verify that each pwb (printed wiring board) is firmly seated in the chassis. If shipping and handling have loosened any pwb, fully insert these pwb's before proceeding. Refer to Section 3 or to the appropriate section of the Front End Service Manual for detailed installation instructions if required.

CAUTION

Do not energize the Front End until directed to do so later in this section. Any pwb loosened in shipment must be fully inserted at this time. If additional pwb's are to be installed, refer to the instructions presented in Section 3B of this manual.

Along with the Front End, the shipping container holds an accessory box. Check that this box contains the line power cord and any accessories (such as cables) that were ordered.

Connecting to Your Computer or Terminal

A set of switches on the Computer Interface Module configure the Computer Front End for host computer communications characteristics and for the incoming line power setting. Access to these switches requires removal of the Computer Interface Module from the Front end chassis.

CAUTION

Incorrect voltage selection may damage the Computer Interface Module and void your warranty. If the voltage is not set for the correct incoming power, the unit will fail to operate and may be severely damaged.

It may be possible to configure your host computer to match the factory settings of the Computer Front End switches, and eliminate the need to remove the Computer Interface Module at this time. The factory settings of these switches correspond to these characteristics:

LINE VOLTAGE	90-132 or 180-264 VAC (as appropriat
LINE FREQUENCY	50 or 60 Hz (as appropriate)
COMMUNICATIONS TYPE	RS-232-C
TRANSMISSION MODE	Full Duplex
BAUD RATE	9600
PARITY	NONE
NUMBER OF DATA BITS	8
NUMBER OF STOP BITS	1
XON/XOFF	Enabled

Non-Volatile Memory Battery Charging

The Computer Interface Assembly uses rechargeable batteries to maintain its non-volatile memory.

NOTE

Programs saved on a newly-received Helios I may not be maintained in non-volatile memory. Any Helios I shipped with the Computer Interface Assembly already installed comes with the batteries connected. If such a Helios I has not been powered up for some time, these batteries may be at a charge state insufficient to maintain memory. Therefore, it is important to leave a newly-received Helios I powered up for 24 hours to allow for adequate charging.

If the Computer Interface Assembly is shipped separately, as with a module exchange, the batteries are disconnected and must be connected as shown in Figure 1-2. In this case, since there has been no drain on the batteries during transit and storage times, the charge should be sufficient to maintain non-volatile memory.

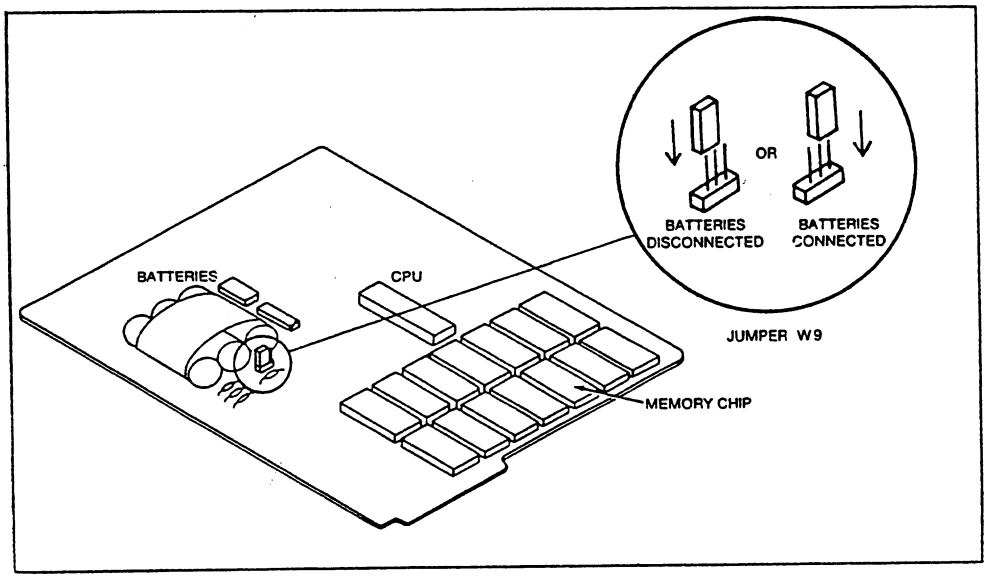


Figure 1-2. Battery Power Jumper

Cabling to the Host Computer

A cable must connect the controlling computer (or terminal) and the Front End to permit communication between the two instruments. The Computer Front End supports two different communications standards: RS-232-C DTE (Data Terminal Equipment), and RS-422. The RS-232-C standard is the more popular of the two, and is supported to some degree by nearly all computer equipment.

Different computers and terminals support RS-232-C communications in different ways. See Appendix 9a for details on how to connect some common computers, or consult your particular computer documentation to determine cabling requirements.

If you are using RS-422 communications, or RS-232 with modems, refer to Section 3A.

COMMUNICATIONS FORMAT

Once your computer is cabled properly to the Computer Front End, data is transferred one bit at a time over the Transmit Data and Receive Data lines. The character format and speed (baud rate) of the data transfer can vary greatly among systems. See Appendix 9b for a detailed description of serial data conventions. All computer equipment that supports RS-232 communications provides some means to select these parameters.

Though many different character formats and speeds can be successfully used, it is very important that the computer or terminal and the Front End are set to exactly the same character format and baud rate. If they are not, communications between the units will not succeed. Fluke recommends that the Front End factory default settings described earlier in this section be used to check out the operation of the system. Consult Appendix 9a or your computer documentation to set your computer to this default configuration. If for some reason your terminal or computer cannot accommodate this configuration, refer to section 3 to reconfigure the Front End to match your computer's capability.

Communicating with the Front End

The Computer Front End does nothing until it is asked by the host computer. For this reason, it is sometimes called a "command/response" instrument. Once a request for information has been made, the Front End performs all the measurement and output functions necessary, converts inputs to engineering units (such as degrees or PSI), sends the results to the host computer, and then returns to the idle state.

Now that the Computer Front End is properly configured and connected to your computer or terminal, you are ready to request and retrieve information from the instrument.

The Computer Front End has been designed with a multitude of users and applications in mind, so the instrument supports two different modes of communication: Terminal Mode and Computer Mode.

Terminal Mode

In Terminal Mode, the Front end assumes that it is connected directly to a terminal and that a keyboard is communicating directly to it. To make communications easier in this situation, the Front End displays a prompt **HCLI>** on the terminal to indicate it is ready to accept a command.

As commands are received, all characters are echoed back to the the terminal so you can see what you are typing. In addition, some line editing is provided by the key which sends the ASCII <DEL> character. If a mistake is caught before <RETURN> is pressed, this key removes the last character typed.

When <RETURN> is pressed, the Front End executes the requested command. If there are any errors in the command an error message in plain English appears on the terminal display.

Terminal Mode is useful for system checkout and program development.

Computer Mode

In this mode, the Front End assumes that commands are issued from a computer program. In Computer Mode, the Front End sends a single-character prompt (!) followed by <CR><LF>. The Front End does not echo commands to the computer, and returns error information as a series of numbers because a program can decode number strings more easily than English.

Turning On the Computer Front End

1. When the communications parameters have been set and the host computer has been connected to the Front End, apply power to the host computer or terminal. If you are using a computer, load system software.

2. Power up the Computer Front End. Wait ten seconds for the Front End to complete its initialization routines.

3. Press the <RETURN> key (marked ↵ on the IBM PC), or whatever key is used to generate the ASCII sequence <CR>. The Front End responds by sending the prompt associated with the mode it is operating in (**!** for Computer Mode, **HCLI>** for Terminal Mode).

4. The appearance of either prompt indicates that the Front End is communicating bi-directionally with the host computer or terminal. Other responses may indicate a problem, either with the host, the Front End, or with the communications link. Recheck your work before continuing. If failure continues and your work seems to be in order, see Section 7, Maintenance.

NOTE

Remember that a Helios I shipped with the Computer Interface Module installed may not have a sufficient battery charge to maintain non-volatile memory for programs you create. If in doubt, leave the Helios I powered up for 24 hours to ensure an adequate charge.

WHERE TO GO FROM HERE

This section has presented a general procedure for setting up the Computer Front End and a computer or terminal as its host. More specific information on setting up the mainframe, options, and the Extender Chassis can be found in Section 3. Appendix 9a offers guidelines for setting up many popular computers, and includes a short installation verification program.

Section 2
Specifications

CONTENTS

MAINFRAME SPECIFICATIONS 2-3
Interface Specifications 2-4

OPTION SPECIFICATIONS 2-9
-160 AC Voltage Input Connector 2-9
-161 High Performance A/D Converter 2-10
-162 Thermocouple/DC Volts Scanner 2-11
-163 RTD Scanner 2-13
-164 Transducer Excitation Module 2-15
-167 Counter/Totalizer 2-17
-168 Digital I/O 2-19
-169 Status Output Connector 2-20
-170 Analog Output Module 2-21
-171 Current Input Connector 2-23
-174 Transducer Excitation Connector 2-24
-175 Isothermal Input Connector 2-25
-176 Voltage Input Connector 2-26
-177 RTD/Resistance Input Connector 2-27
-179 Digital/Status Input Connector 2-29
-201 Scan/Alarm Option 2-30

SYSTEM ACCURACY SPECIFICATIONS

Temperature Measurement
Using Thermocouples 2-31
Using RTDs 2-33
DC Voltage Measurement 2-41
AC Voltage Measurement 2-42
DC Current Measurement 2-43
Resistance Measurement 2-44
Strain Measurement 2-49

MAINFRAME SPECIFICATIONS

Channel Capacity
- Mainframe ..... 100 Analog or 120 Digital
- System ..... 1500 maximum
  1000 maximum
  (Scan/Alarm Option)

Memory ..... Nonvolatile, with 15 day typical, 10 day minimum battery backup

Scanning Speed (analog inputs)
Dependent on system configuration and programming

Maximum System Scanning Speed in Channels per Second

A/D Converters in System	Direct Voltage Readings
1	16
2	30
3	42
4	50

2/Mainframe Specifications

Power	
AC	90-132V, 180-264V, 47-440 Hz
Dissipation	<40W
Temperature	
Operating	0 to 50°C
Storage	-40 to 70°C
Humidity (non-condensing)	
0 to 25°C	<95%
25 to 40°C	<75%
40 to 50°C	<45%
Weight	8.5 kg (19 lbs) Without options
Dimensions	Height Width Depth 23.8 cm x 43.9 cm x 35.9 cm 9.35" x 17.30" x 14.13"
Altitude	
Operating	3050m (10,000 feet)
Non-operating	12,200m (40,000 feet)
Shock and Vibration	Meets MIL-T-28800C Class 5, Style F Standard
EMI and RFI Emissions	Tested to FCC part 15, Subpart J, Class A; VDE 0871, Class B.

Interface Specifications

Type	Asynchronous, either RS-232-C or RS-422
Connector	25-pin male; pinout depends on S1 setting: RS-232 or RS-422

25-Pin Host Connector Pinout (S1 in RS-232-C Position)

PIN NUMBER	SIGNAL
(1)	Shield
(2)	Transmitted Data
(3)	Received Data
(4)	Request to Send
(5)	Clear to Send
(6)	Data Set Ready
(7)	Signal Ground
(8)	Received Line Signal Detector
(12)	Secondary Received Line Signal Detector
(20)	Data Terminal Ready
(22)	Ring Indicator

Required RS-232-C Signals	Transmit Data, Receive Data, Signal Ground. All other lines are passively asserted true. Instrument will operate if these other lines are left disconnected.
RS-232 Modem Control	Full duplex

25-Pin Connector Pinout (S1 in RS-422 Position)

PIN NUMBER	SIGNAL
(1)	Shield
(7)	Common
(9)	Transmit +
(10)	Transmit -
(14)	Receive +
(15)	Receive -

NOTE: RS-232-C signals are present on their associated pins even when S1 is set for RS-422 operation, but they are not used when configured for RS-422.

Baud Rate	Switch-selectable: 110, 300, 600, 1200, 2400, 4800, 9600, 19200
ASCII format	7 or 8 bit, 1 or 2 stop bits. Switch-selectable
Parity	Odd, even, or none. Switch-selectable
Multi-drop capability	Available via RS-422. Ten mainframes can be addressed by a host through a single RS-422 port. Address is switch-selectable.

OPTION SPECIFICATIONS

-160 AC Voltage Input Connector Specifications

Channels	10 AC, 10 DC
Terminals	40 (2 per channel)
AC Voltage	
Range	5V to 250V rms
Resolution	0.1V ac
Maximum Input	250V rms between two terminals
Frequency Range	45 Hz to 450 Hz
Accuracy	See System Accuracy Specifications
Conversion Method	1/2 wave, average responding, calibrated to indicate the rms value of a sine wave.
DC Voltage	
Ranges and Accuracy	Determined by the option -162.
Maximum Input	250V dc between any two terminals
Maximum Common Mode Voltage	250V dc between terminals or between a terminal and ground.
Compatibility	Attaches to the Thermocouple/DC Volts Scanner (option -162).
Temperature	
Operating	-20 to 70°C
Storage	-55 to 75°C
Relative Humidity (without condensation)	
Below 25°C	<= 95%
25 to 40°C	<= 75%
40 to 50°C	<= 45%
50 to 70°C	<= 40%
Altitude	
Non-Operating	40,000 feet
Operating	10,000 feet
Shock and Vibration	Meets MIL-T-28800C, Class 5 Standards

-161 High Performance A/D Converter Specifications

Dynamic Range (internal)	±131,071 counts at 50 Hz ±109,226 counts at 60 Hz
Common Mode Rejection	170 dB at 50 Hz ±0.1%
(with 100 ohm imbalance)	170 dB at 60 Hz ±0.1% 160 dB at dc
Normal Mode Rejection	60 dB at 50 Hz ±0.1% or 60 Hz ±0.1%
Isolation	250V dc or ac rms between -161 and any other module.
Measurement Method	Dual slope, integrating over 1 line cycle
Zero Stability	Automatic zero
Ranges, Resolution, Accuracy	Determined by Scanner (see -162 and -163 and application. See Accuracy sections: Temperature Measurement Using Thermocouples Temperature Measurement Using RTDs DC Voltage Measurement AC Voltage Measurement DC Current Measurement Resistance Measurement Strain Measurement
Temperature	
Operating	-20 to 70°C
Storage	-55 to 75°C
Relative Humidity (without condensation)	
Below 25°C	<= 95%
25 to 40°C	<= 75%
40 to 50°C	<= 45%
50 to 70°C	<= 40%
Altitude	
Non-Operating	40,000 feet
Operating	10,000 feet
Shock and Vibration	Meets MIL-T-28800C, Class 5 Standards

-162 Thermocouple/DC Volts Scanner Specifications

Channels	20
Poles per Channel	3 (HI, LO, SHIELD)
Input Impedance	
64 mV and 512 mV Ranges	>200 megohm in parallel with 5600 pF
8V and 64V Ranges	10 megohm
Voltage Offset (max)	1 uV

Ranges and Displayed Resolution	60 Hertz	50 Hertz
64 mV Range	0.6 uV	0.5 uV
512 mV Range	5.0 uV	4.2 uV
8V Range	73 uV	61 uV
64V Range	0.6 mV	0.5 mV

Accuracy	Determined by application. See Accuracy sections: Temperature Measurement Using Thermocouples, DC Voltage Measurement, AC Voltage Measurement, DC Current Measurement, Strain Measurement
Zero Stability	Automatic Zero
Input Isolation	250V dc or ac rms between any two channels or any channel and ground
Overload without Damage	250V dc or 250V ac rms
Common Mode Voltage (max)	250V dc or ac rms between any 2 terminals or a terminal and ground
Common Mode Rejection (with 100 ohm imbalance)	170 dB at 50 Hz ±0.1% 170 dB at 60 Hz ±0.1% 160 dB at dc
Normal Mode Rejection	60 dB at 50 Hz ±0.1% or 60 Hz ±0.1%

-162 Thermocouple/DC Volts Scanner

Temperature	
Operating	-20 to 70°C
Storage	-55 to 75°C
Relative Humidity (without condensation)	
Below 25°C	<= 95%
25 to 40°C	<= 75%
40 to 50°C	<= 45%
50 to 70°C	<= 40%
Altitude	
Non-Operating	40,000 feet
Operating	10,000 feet
Shock and Vibration	Meets MIL-T-28800C, Class 5 Standards

-163 RTD/Resistance Scanner Specifications

Channels	20
Poles per Channel	4 (HI EXCITATION, HI, LO, LO EXCITATION)
Common Return Poles	2 (LO COM for channels 0-9, LO COM for channels 10-19)
Measurement Modes (3)	4-Wire (4W) (no reed resistances in measurement path). 3-Wire Accurate (3WA) (no reed resistances in measurement path. Channels in a decade share a common return). 3-Wire Isolated (3WCM) (one reed resistance in measurement path).
Measurement Mode Selection	2 jumpers select scanner measurement mode
Current Sources	2 (1 mA, 32 uA)
Resistance Ranges, Resolution, and Excitation	
Range	256 ohm
Internal Resolution	2.4, 2.0 milliohm (60, 50 Hz.)
Excitation	1 mA
Range	2048 ohm
Internal Resolution	19, 16 milliohm (60, 50 Hz.)
Excitation	1 mA
Range	64 kilohm
Internal Resolution	0.6, 0.5 ohm (60, 50 Hz.)
Excitation	32 uA
Accuracy	Determined by application. See Accuracy sections: Temperature Measurement Using RTDs, Resistance Measurement
Zero Stability	Automatic zero

-163 RTD/Resistance Scanner

Input Channel Isolation	
4-Wire (4W)	250V dc or ac rms between any two channels
3-Wire Accurate (3WA)	250V dc or ac rms between decades of channels
3-Wire Isolated (3WCM)	250V dc or ac rms between any two channels
Overload without Damage	30V dc or 24V ac rms between any two terminals of a channel
Common Mode Isolation	250V dc or ac rms between scanners, 250V dc or ac rms between decades of channels, 250V dc or ac rms between channels within a decade for 4-Wire (4W) and 3-Wire isolated (3WCM) measurement modes, 30V dc or 24V ac rms between any terminals in the same decade except between LO COM's for the 3-Wire Accurate (3WA) measurement mode
Temperature	
Operating	-20 to 70°C
Storage	-55 to 75°C
Relative Humidity (without condensation)	
Below 25°C	<= 95%
25 to 40°C	<= 75%
40 to 50°C	<= 45%
50 to 70°C	<= 40%
Altitude	
Non-Operating	40,000 feet
Operating	10,000 feet
Shock and Vibration	Meets MIL-T-28800C, Class 5 Standards

-164 Transducer Excitation Module Specifications

Outputs	5 constant current sources 1 constant voltage source
Channels of Excitation	20, selectable in groups of 4 for either voltage or current outputs
Common Mode Voltage	No user-applied common mode voltage allowed. All sensors must be isolated.
4-Wire Resistance Measurements	5 constant current sources. Each source excites up to 4 transducers.
3-Wire Resistance and Strain Gage Measurements	Any combination of 1/4, 1/2, and/or Full Bridge strain gages or 3-wire RTDs with voltage excitation and user-supplied bridge completion resistors.
Current Excitation	
Excitation Current	1.0 mA
Accuracy	
Initial Setting	0.005%
Temperature 15 to 35°C	0.015%
Time since calibration	90 days
Temperature 15 to 35°C	0.030%
Time since calibration	1 year
Temperature -20 to 70°C	0.050%
Time since calibration	1 year
Temperature Coefficient (<15 or >35°C)	10 ppm per °C
Maximum Compliance Voltage	0.6V

-164 Transducer Excitation Module

Voltage Excitation	
Excitation Voltage	switch selectable to 2.0V dc or 4.0V dc
2 Volt Accuracy	
Initial Setting	0.0025%
Temperature 15 to 35°C	0.03%
Time since calibration ..	90 days
Temperature 15 to 35°C	0.04%
Time since calibration ..	1 year
Temperature -20 to 70°C ...	0.05%
Time since calibration ..	1 year
4 Volt Accuracy	
Initial Setting	0.0035%
Temperature 15 to 35°C	0.015%
Time since calibration ..	90 days
Temperature 15 to 35°C	0.030%
Time since calibration ..	1 year
Temperature -20 to 70°C ...	0.05%
Time since calibration ..	1 year
Temperature Coefficient	
(<15 or >35°C)	7 ppm per °C
Maximum Current	250 mA
Accuracy	Determined by application. See the Accuracy Specifications section.
Temperature	
Operating	-20 to 70°C
Storage	-55 to 75°C
Relative Humidity (without condensation)	
Below 25°C	<= 95%
25 to 40°C	<= 75%
40 to 50°C	<= 45%
50 to 70°C	<= 40%
Altitude	
Non-Operating	40,000 feet
Operating	10,000 feet
Shock and Vibration	Meets MIL-T-28800C, Class 5 Standards

-167 Counter/Totalizer Specifications

Channels	6
Functions	Event counting and frequency measurement selectable by channel pairs
Timebase	
Frequency	10 MHz
Accuracy	±0.01%
Input Signals	
Types	TTL, CMOS, contacts, and analog waveforms
Minimum Pulse Width	1.25 microseconds
Minimum Signal Amplitude	175 mV rms 0.5V p-p sine wave 0.35V p-p square wave
Maximum Signal Amplitude	± 15V dc or ac peak
Adjustments	Signal threshold, deadband, and contact debounce
Frequency Measurement	
Minimum Frequency	2 Hz
Maximum Frequency	400 kHz
Accuracy	Timebase accuracy ± 1 digit
Totalizing Measurement	
Maximum Counts	8,388,607
Counting Rate	dc to 400 kHz
Isolation	30V dc or ac rms between any terminal and ground. No isolation between channels.
Power Consumption	4.0 watts maximum

-167 Counter/Totalizer

Temperature
    Operating ..... -20 to 70 degrees Celsius
    Storage ..... -55 to 75 degrees Celsius
Relative Humidity (without condensation)
    Below 25 degrees Celsius ..... <= 95%
    25 to 40 degrees Celsius ..... <= 75%
    40 to 50 degrees Celsius ..... <= 45%
    50 to 70 degrees Celsius ..... <= 40%

Altitude
    Non-Operating ..... 40,000 feet
    Operating ..... 10,000 feet
Shock and Vibration ..... Meets MIL-T-28800C, Class 5 Standards

-168 Digital I/O Specifications

Isolation	30V dc or ac rms between any terminal and ground.
Input Line	Pulled up to +5V through a 47K ohm resistor.
Input Handshake Line Circuit	Pulled up to +5V through a 47K ohm resistor.
Inputs	
Channels	20 single bit, or one 5 BCD digit word, or one 17-bit binary word
Type	Low Power Schottky TTL
Maximum Input Voltage	6V
Outputs	
Channels	20 single bit
Type	Open-collector, diode clamped, NPN transistors
Output Drive	100 mA with 1V drop
Maximum Voltage on Output	30V dc
Power Consumption	1.5 watts maximum
Temperature	
Operating	-20 to 70°C
Storage	-55 to 75°C
Relative Humidity (without condensation)	
Below 25°C	<= 95%
25 to 40°C	<= 75%
40 to 50°C	<= 45%
50 to 70°C	<= 40%
Altitude	
Non-Operating	40,000 feet
Operating	10,000 feet
Shock and Vibration	Meets MIL-T-28800C, Class 5 Standards

-169 Status Output Connector Specifications

Outputs	20
Terminals	2 per channel
Compatibility	Connects to Digital I/O (option 168)
Temperature	
Operating	-20 to 70°C
Storage	-55 to 75°C
Relative Humidity (without condensation)	
Below 25°C	<= 95%
25 to 40°C	<= 75%
40 to 50°C	<= 45%
50 to 70°C	<= 40%
Altitude	
Non-Operating	40,000 feet
Operating	10,000 feet
Shock and Vibration	Meets MIL-T-28800C, Class 5 Standards

-170 Analog Output Specifications

Channels	4
Terminals	5 per channel
Accuracy	±0.1% of range
Time since calibration	90 days
Operating Temperature	15 to 35°C
Accuracy	±0.2% of range
Time since calibration	1 year
Operating Temperature	15 to 35°C
Accuracy	±0.4% of range
Time since calibration	1 year
Operating Temperature	-20 to 70°C
Noise	< 0.02% of range in a 10 kHz bandwidth
Voltage Outputs	
Ranges	-5 to +5V, 0 to +10V
Resolution	2.5 mV/count
Maximum Current	2 mA
Capacitive Load	10,000 pF maximum
Output Protection	short-circuit protected
Current Output	
Range	4 to 20 mA
Resolution	4 uA
Maximum Compliance Voltage	10V
Maximum External Voltage	±24V
Isolation	30V dc or ac rms between any terminal and ground. No isolation between channels. Current outputs share a common return.
Power Consumption	4.1 watts maximum

-170 Analog Output

Temperature
    Operating ..... -20 to 70°
    Storage ..... -55 to 75°
Relative Humidity (without condensation)
    Below 25° ..... <= 95%
    25 to 40° ..... <= 75%
    40 to 50° ..... <= 45%
    50 to 70° ..... <= 40%
Altitude
    Non-Operating ..... 40,000 feet
    Operating ..... 10,000 feet
Shock and Vibration ..... Meets MIL-T-28800C, Class 5 Standards

-171 Current Input Connector Specifications

Channels	20
Terminals	2 per channel
Shunt Resistor	8 ohms ±0.02 ohm
Measurement Range	64 mA
Overload without Damage	250 mA
Common Mode Voltage	250V dc or ac rms between any two channels or between a channel and ground.
Accuracy	0.25% Input ±4 uA
Time since A/D calibration	90 days
Resolution	1 uA
Compatibility	Attaches to Thermocouple/DC Volts Scanner (option 162).
Temperature	
Operating	-20 to 70°C
Storage	-55 to 75°C
Relative Humidity (without condensation)	
Below 25°C	<= 95%
25 to 40°C	<= 75%
40 to 50°C	<= 45%
50 to 70°C	<= 40%
Altitude	
Non-Operating	40,000 feet
Operating	10,000 feet
Shock and Vibration	Meets MIL-T-28800C, Class 5 Standards

-174 Transducer Excitation Connector Specifications

Channels	20
Terminals	5 per channel
Programming	5 jumpers select voltage or current excitation on 5 groups of 4 channels.
Compatibility	Attaches to Transducer Excitation Module (option 164)
Temperature	
Operating	-20 to 70°C
Storage	-55 to 75°C
Relative Humidity (without condensation)	
Below 25°C	<= 95%
25 to 40°C	<= 75%
40 to 50°C	<= 45%
50 to 70°C	<= 40%
Altitude	
Non-Operating	40,000 feet
Operating	10,000 feet
Shock and Vibration	Meets MIL-T-28800C, Class 5 Standards

-175 Isothermal Input Connector Specifications

Channels	20
Terminals	60 (HI, LO, SHIELD per channel)
Maximum Voltage Rating	250V dc or ac rms from any terminal to any other terminal or ground.
Temperature	
Operating	-20 to 70°C
Storage	-55 to 75°C
Relative Humidity (without condensation)	
Below 25°C	<= 95%
25 to 40°C	<= 75%
40 to 50°C	<= 45%
50 to 70°C	<= 40%
Altitude	
Non-Operating	40,000 feet
Operating	10,000 feet
Shock and Vibration	Meets MIL-T-28800C, Class 5 Standards

-176 Voltage Input Connector Specifications

Channels	20
Terminals	60 (HI, LO, SHIELD per channel)
Maximum Voltage Rating	250V dc or ac rms from any terminal to any other terminal or ground.
Temperature	
Operating	-20 to 70°C
Storage	-55 to 75°C
Relative Humidity (without condensation)	
Below 25°C	<= 95%
25 to 40°C	<= 75%
40 to 50°C	<= 45%
50 to 70°C	<= 40%
Altitude	
Non-Operating	40,000 feet
Operating	10,000 feet
Shock and Vibration	Meets MIL-T-28800C, Class 5 Standards

-177 RTD/Resistance Input Connector Specifications

Channels	20
Terminals	100
	(HI EXC, HI, LO, LO EXC, and LO COM per Channel)
Maximum Voltage Rating and Mating RTD/Resistance Scanner Mode	
163 Measurement Mode	4-wire (4W)
Ratings	250V dc or ac rms between two channels or a channel and ground; 30V or 24V ac rms between channel terminals
163 Measurement Mode	3-wire Accurate (3WA)
Ratings	250V dc or ac rms between channels in different decades or between channels in a decade and ground; 30V dc or 24V ac rms between terminals within a decade except between LO COMs. (LO COMs of channels in a decade are connected internally.)
163 Measurement Mode	3-Wire Isolated (3WCM)
Ratings	Same as for 4-Wire
Compatibility	Attaches to RTD/Resistance Scanner (Option 163)

-177 RTD/Resistance Input Connector

Temperature	
Operating	-20 to 70°C
Storage	-55 to 75°
Relative Humidity (without condensation)	
Below 25°	<= 95%
25 to 40°	<= 75%
40 to 50°	<= 45%
50 to 70°	<= 40%
Altitude	
Non-Operating	40,000 feet
Operating	10,000 feet
Shock and Vibration	Meets Mil-T-28800C, Class 5 standards

-179 Digital/Status Input Connector Specifications

Channels	20 single bit, or one 5 BCD digit word, or one 17-bit binary word
Terminals	72
Maximum Input Voltage	6V dc
Isolation	30V dc or ac rms between any terminal and ground.
Compatibility	Attaches to Digital I/O (option 168)
Temperature	
Operating	-20 to 70°C
Storage	-55 to 75°C
Relative Humidity (without condensation)	
Below 25°C	<= 95%
25 to 40°C	<= 75%
40 to 50°C	<= 45%
50 to 70°C	<= 40%
Altitude	
Non-Operating	40,000 feet
Operating	10,000 feet
Shock and Vibration	Meets MIL-T-28800C, Class 5 Standards

-201 Scan/Alarm Option

This module replaces the Computer Interface Module. The following additional specifications apply:

Printer Port Connector - 25 pin

PIN NUMBER	SIGNAL
1	Shield
2	Transmitted Data
3	Received Data
4	Request to Send
5	Clear to Send
6	Data Set Ready
7	Signal Ground

Alarm Annunciator Terminator Strip

TERMINAL NUMBER	FUNCTION
8	Connect to Normally Closed Contact of Alarm Acknowledgement Push Button.
7	Connect to Normally Open Contact of the Alarm Acknowledgement Push Button.
6	Connect to Common Contact of the Alarm Acknowledgement Push Button
5	No Connection
2,4	Normally Open Contacts for Visual Alarm Light (Max 110Vac, 1 Ampere)
1,3	Normally Open Contacts for Audible Alarm. (Max 110Vac, 1 Ampere)

ACCURACY SPECIFICATIONS

Temperature Measurement Using Thermocouples

Hardware Used ..... -161 High Performance A/D
-162 Thermocouple/DC Volts Scanner
-175 Isothermal Input Connector

Accuracy In ±°C

Thermocouple Type (Sensor Temperature Range) Sensor Temperature (°C)	Time Since A/D Calibration (Operating Temperature in °C)		
	90 Days (15 to 35)	1 Year (15 to 35)	1 Year (-20 to +70)
J NBS (-200 to 760°C)			
-200 to -100	0.45	0.5	1.6
-100 to +200	0.35	0.4	0.9
+200 to +760	0.45	0.5	0.75
J DIN (-200 to 760°C)			
-200 to -100	0.45	0.5	1.6
-100 to +200	0.35	0.4	0.9
+200 to +900	0.45	0.5	0.75
K NBS (-225 to 1350°C)			
-225 to -100	0.45	0.5	1.9
-100 to +200	0.35	0.4	1.0
+200 to 1350	0.5	0.6	1.25
T NBS (-230 to 400°C)			
-230 to -100	0.45	0.5	1.9
-100 to +200	0.35	0.4	1.0
+200 to +400	0.45	0.5	0.6
T DIN (-200 to 600°C)			
-230 to -100	0.45	0.5	1.9
-100 to +200	0.35	0.4	1.0
+200 to +600	0.45	0.5	1.25

2/Thermocouple Accuracy

	90 Days (15 to 35)	1 Year (15 to 35)	1 Year (-20 to +70)
E NBS (-250 to 838°C)			
-250 to -100	0.45	0.5	1.5
-100 to +250	0.35	0.4	0.9
+250 to +838	0.45	0.6	0.85
R NBS (0 to 1767°C)			
0 to +200	1.15	1.35	2.2
+200 to +1767	0.95	1.15	1.6
S NBS (0 to 1767°C)			
0 to +200	1.15	1.35	2.2
+200 to +1767	0.95	1.15	1.6
B NBS (200 to 1820°C)			
+200 to +500	1.05	1.25	10.0
+500 to +1820	1.05	1.25	3.8
N NBS (-200 to 400°C) (For 28-gauge thermocouple wire)			
-200 to -100	0.45	0.5	1.9
-100 to +200	0.35	0.4	1.0
+200 to +400	0.5	0.6	1.25
C HOS (0 to 2315°C)			
0 to +2315	0.85	1.05	1.8

Temperature Measurement Using RTDs

Hardware Used ..... -161 High Performance A/D
-163 RTD/Resistance Scanner
-177 RTD/Resistance Input Connector

Performance

RTD Type, Scanner Range, and Scanner Measurement Mode (sensor temperature range) Sensor Temperature (°C)	90 Days Since A/D Calibration 18 to 28°C Operating Temperature Temperature Shift dT/dt < 1°C / 10min		
	ACCURACY	RESOLUTION	REPEATABILITY
Platinum 385 DIN, High Resolution, 4-Wire (4W), and (-200 to 425°C)			
-200 to 150	0.09°C*	0.006°C	0.03°C
150 to 425	0.13°C	0.006°C	0.04°C
Platinum 385 DIN, High Temperature, 4-Wire (4W), and (-200°C to probe limit)			
-200 to 600	0.25°C	0.05°C	0.14°C
10 Ohm Copper, 4-Wire (4W) (-75°C to +150°C)	0.28°C	0.06°C	0.16°C
Platinum 385 DIN, 3-Wire Accurate (3WA)	+0.007°C**	+0.001°C**	
10 Ohm Copper, 3-Wire Accurate (3WA)	+0.065°C**	+0.008°C**	

NOTES:

* An ice-point initialization allows 385 DIN RTDs to have an accuracy of 0.05°C + probe conformity.

** Add °C per ohm lead resistance to 4W specifications.

2/RTD Accuracy

	ACCURACY	RESOLUTION	REPEATABILITY
Platinum 385 DIN, 3-Wire Isolated (3WCM)	±1.97°C*		±1.97°C*
10 Ohm Copper, 3-Wire Isolated (3WCM)	±18.2°C*		±18.2°C*
10 Ohm Copper, 3-Wire Isolated (3WCM) (Special, modified -163)	±0.8°C*		±0.8°C*

Performance

RTD Type, Scanner Range, and Scanner Measurement Mode (sensor temperature range) Sensor Temperature (°C)	90 Days Since A/D Calibration 15 to 35°C Operating Temperature Temperature Shift dT/dt < 1°C / 10min ACCURACY	RESOLUTION	REPEATABILITY
Platinum 385 DIN, High Resolution, 4-Wire (4W), and (-200 to 425°C)			
-200 to 150	0.10°C	0.006°C	0.04°C
150 to 425	0.15°C	0.006°C	0.04°C
Platinum 385 DIN, High Temperature, 4-Wire (4W), and (-200°C to probe limit)			
-200 to 600	0.27°C	0.05°C	0.16°C

* NOTE: Add °C to 3WA specifications.

Performance

RTD Type, Scanner Range, and Scanner Measurement Mode (sensor temperature range) Sensor Temperature (°C)	90 Days Since A/D Calibration 15 to 35°C Operating Temperature Temperature Shift dT/dt < 1°C / 10min		
	ACCURACY	RESOLUTION	REPEATABILITY
10 Ohm Copper, 4-Wire (4W) (-75°C to +150°C)	0.3°C	0.06°C	0.16°C
Platinum 385 DIN, 3-Wire Accurate (3WA)	+0.007°C*	+0.001°C*	
10 Ohm Copper, 3-Wire Accurate (3WA)	+0.065°C*	+0.008°C*	
Platinum 385 DIN, 3-Wire Isolated (3WCM)	+1.97°C**	+1.97°C**	
10 Ohm Copper, 3-Wire Isolated (3WCM)	+18.2°C**	+18.2°C**	
10 Ohm Copper, 3-Wire Isolated (3WCM) (Special, modified -163)	+0.8°C*	+0.8°C*	

NOTES:
* Add °C per ohm lead resistance to 4W specs
** Add °C to 3WA specs

2/RTD Accuracy

Performance

RTD Type, Scanner Range, and Scanner Measurement Mode (sensor temperature range)	1 Year Since A/D Calibration 15 to 35°C Operating Temperature Temperature Shift dT/dt < 1°C / 10min	
Sensor Temperature (°C)	ACCURACY	RESOLUTION
Platinum 385 DIN, High Resolution, 4-Wire (4W), and (-200 to 425°C)		
-200 to 150	0.11°C	0.006°C
150 to 425	0.16°C	0.006°C
Platinum 385 DIN, High Temperature, 4-Wire (4W), and (-200°C to probe limit)		
-200 to 600	0.28°C	0.05°C
10 Ohm Copper, 4-Wire (4W) (-75°C to +150°C)	0.3°C	0.06°C
Platinum 385 DIN, 3-Wire Accurate (3WA) (full range)	Add 0.008°C per ohm lead resistance to 4W specs	

10 Ohm Copper, 3-Wire Accurate (3WA)
(full range) Add 0.073°C per ohm lead resistance to 4W specs

Platinum 385 DIN, 3-Wire Isolated (3WCM)
(full range) Add 2.53°C to 3WA specs

10 Ohm Copper, 3-Wire Isolated (3WCM)
(full range) Add 23.4°C to 3WA specs

10 Ohm Copper, 3-Wire Isolated (3WCM)
(Special, modified -163)
Add 1.5°C to 3WA specs

2/RTD Accuracy

Performance		
RTD Type, Scanner Range, and Scanner Measurement Mode (sensor temperature range) Sensor Temperature (°C)	1 Year Since A/D Calibration -20 to 70°C Operating Temperature Temperature Shift dT/dt < 1°C / 10min	
	ACCURACY	RESOLUTION
Platinum 385 DIN, High Resolution, 4-Wire (4W), and (-200 to 425°C)		
-200 to 150	0.19°C	0.006°C
150 to 425	0.29°C	0.006°C
Platinum 385 DIN, High Temperature, 4-Wire (4W), and (-200°C to probe limit)		
-200 to 600	0.44°C	0.05°C
10 Ohm Copper, 4-Wire (4W) (-75°C to +150°C)	0.4°C	0.06°C
Platinum 385 DIN, 3-Wire Accurate (3WA) (full range)	Add 0.010°C per ohm lead resistance to 4W specs	

10 Ohm Copper, 3-Wire Accurate (3WA)
(full range) Add 0.096°C per ohm lead resistance to 4W specs

Platinum 385 DIN, 3-Wire Isolated (3WCM)
(full range) Add 2.53°C to 3WA specs

10 Ohm Copper, 3-Wire Isolated (3WCM)
(full range) Add 23.4°C to 3WA specs

10 Ohm Copper, 3-Wire Isolated (3WCM)
(Special, modified -163)
Add 1.5°C to 3WA specs

Temperature Measurement Using RTDs

Hardware Used .... -161 High Performance A/D
-164 Transducer Excitation Module
-174 Transducer Excitation Connector
(with current excitation selected)
-162 Thermocouple/DC Volts Scanner
Choice of Connector:
-175 Isothermal Input
-176 Voltage Input
-160 AC Voltage Input

Performance

RTD Type and Scanner Range (sensor temperature range) Sensor Temperature (°C)	90 Days Since Calibration 15 to 35°C Operating Temperature		
	ACCURACY	RESOLUTION	REPEATABILITY
Platinum 385 DIN (-200°C to probe limit)			
-200 to 600	0.2°C	0.013°C	0.08°C
10 Ohm Copper (full range)	1.0°C	0.1°C	0.2°C

DC Voltage Measurement Accuracy

Hardware Used ..... -161 High Performance A/D
-162 Thermocouple/DC Volts Scanner
Choice of Connector:
-175 Isothermal Input
-176 Voltage Input
-160 AC Voltage Input

Accuracy

Range	Internal Resolution (microvolts)		Time Since A/D Calibration (Operating Temperature in °C) (± % Input ± microvolts)		
	60Hz	50Hz	90 Days (15 to 35)	1 Year (15 to 35)	1 Year (-20 to +70)
±64 mV	0.6	0.5	0.005% + 7.0	0.01% + 8.0	0.03% + 9.0
±512 mV	5.0	4.2	0.005% + 30	0.01% + 40	0.03% + 50
±8V	73	61	0.005% + 700	0.01% + 800	0.03% + 900
±64V	600	500	0.009% + 3 mV	0.02% + 4 mV	0.05% + 5 mV

AC Voltage Measurement Accuracy

Hardware Used ..... -161 High Performance A/D
-162 Thermocouple/DC Volts Scanner
-160 AC Voltage Input Connector

Performance

Range and Frequencies	90 Days Since A/D Calibration 15 to 35°C Operating Temperature	
	RESOLUTION	ACCURACY
5V to 250V ac rms, 45 Hz to 450 Hz	0.1V	±1% Input ±.1V

DC Current Measurement Accuracy

Hardware Used ..... -161 High Performance A/D
-162 Thermocouple/DC Volts Scanner
-171 Current Input Connector

Performance

Range	90 Days Since A/D Calibration 15 to 35°C Operating Temperature	
	RESOLUTION	ACCURACY
±64 mA	0.6 uA	±.25% ±4 uA

Resistance Measurement Accuracy

Hardware Used ..... -161 High Performance A/D
-163 RTD/Resistance Scanner
-177 RTD/Resistance Input Connector

Performance

Scanner Range and Measurement Mode	90 Days Since A/D Calibration 18 to 28°C Operating Temperature Temperature Shift dT/dt < 1°C / 10min			
	(mohm)		(±% Input ± mohm)	
	RESOLUTION 60Hz	RESOLUTION 50Hz	ACCURACY	REPEATABILITY
256 ohm, 4-Wire (4W)	2.4	2.0	0.0142% + 5.7	0.0037% + 5.7
2048 ohm, 4-Wire (4W)	19	16	0.0137% + 38	0.0032% + 38
64 kilohm, 4-Wire (4W)	600	500	0.055% + 1.2 ohm	0.0040% + 1.2 ohm**
All, 3-Wire Accurate (3WA)	same as 4W		Add 2.4 mohm per ohm lead resistance to 4W specs	Add 0.2 mohm per ohm lead resistance to 4W specs
All, 3-Wire Isolated (3WCM)	same as 4W		Add 0.7 ohm to 3WA specs	Add 0.7 ohm to 3WA specs

**Humidity 15%RH less than listed for the -163 Scanner

Performance

Scanner Range and Measurement Mode	90 Days Since A/D Calibration 15 to 35°C Operating Temperature Temperature Shift dT/dt < 1°C / 10 min			
	(mohm)		(±% Input ± mohm)	
	RESOLUTION 60Hz	RESOLUTION 50Hz	ACCURACY	REPEATABILITY
256 ohm, 4-Wire (4W)	2.4	2.0	0.0170% + 5.7	0.0065% + 5.7
2048 ohm, 4-Wire (4W)	19	16	0.0165% + 38	0.0060% + 38
64 kilohm, 4-Wire (4W)	600	500	0.06% + 1.2 ohm	0.0075% + 1.2 ohm**
All, 3-Wire Accurate (3WA)	same as 4W		Add 2.5 mohm per ohm lead resistance to 4W specs	Add 0.3 mohm per ohm lead resistance to 4W specs
All, 3-Wire Isolated (3WCM)	same as 4W		Add 0.7 ohm to 3WA specs	Add 0.7 ohm to 3WA specs

**Humidity 15%RH less than listed for the -163 Scanner

2/Resistance Accuracy

Performance

Scanner Range and Measurement Mode	1 Year Since A/D Calibration 15 to 35°C Operating Temperature Temperature Shift dT/dt < 1°C / 10 min		
	(MILLIOHMS) RESOLUTION		ACCURACY
	60Hz	50Hz	
256 ohm, 4-Wire (4W)	2.4	2.0	±.0175% Input ±5.7 mohm
2048 ohm, 4-Wire (4W)	19	16	±.0170% Input ±38 mohm
64 kilohm, 4-Wire (4W)	600	500	±.06% Input ±1.2 ohm
All, 3-Wire Accurate (3WA)	same as 4W		Add 2.8 mohm per ohm lead resistance to the 4W specifications
All, 3-Wire Isolated (3WCM)	same as 4W		Add 0.9 ohm to the 3WA specifications

Performance

Scanner Range and Measurement Mode	1 Year Since A/D Calibration -20 to 70°C Operating Temperature Temperature Shift dT/dt < 1°C / 10 min		
	(MILLIOHMS) RESOLUTION 60Hz	50Hz	ACCURACY
256 ohm, 4-Wire (4W)	2.4	2.0	±.0365% Input ±7 mohm
2048 ohm, 4-Wire (4W)	19	16	±.0360% Input ±38 mohm
64 kilohm, 4-Wire (4W)	600	500	±.23% Input ±1.2 ohm
All, 3-Wire Accurate (3WA)	same as 4W		Add 3.7 mohm per ohm lead resistance to the 4W specifications
All, 3-Wire Isolated (3WCM)	same as 4W		Add 0.9 ohm to the 3WA specifications

2/Resistance Accuracy

Resistance Measurement Accuracy

Hardware Used .... -161 High Performance A/D
-164 Transducer Excitation Module
-174 Transducer Excitation Connector
(with current excitation selected)
-162 Thermocouple/DC Volts Scanner
Choice of Connector:
-175 Isothermal Input
-176 Voltage Input
-160 AC Voltage Input

Performance

Range	90 Days Since Calibration 15 to 35°C Operating Temperature		
	(MILLIOHMS) RESOLUTION		ACCURACY
	60Hz	50Hz	
64 ohm	0.6	0.5	±.02% Input ±7 mohm
512 ohm	5.0	4.2	±.02% Input ±30 mohm

Strain Measurement Accuracy

Hardware Used .... -161 High Performance A/D
-164 Transducer Excitation Module
-174 Transducer Excitation Connector
(with voltage excitation selected)
-162 Thermocouple/DC Volts Scanner
Choice of Connector:
-175 Isothermal Input
-176 Voltage Input
-160 AC Voltage Input

Performance

Gage Type	90 Days Since Calibration 20 to 30°C Operating Temperature	
	RESOLUTION	ACCURACY
Full Bridge	0.25 uE	±.05% Input ±2 uE
1/2 Bridge	0.5 uE	±.05% Input ±13 uE
1/4 Bridge	0.5 uE	±.05% Input ±25 uE

CONTENTS

INTRODUCTION 3-5

3A: MAINFRAME

PLACEMENT 3a-1
RACK MOUNTING 3a-2
CONFIGURING THE FRONT END 3a-3
Line Power Voltage Selection 3a-3
Preparing to Connect to The Host Computer ... 3a-7
Configuration Summary 3a-8
Where to Go From Here 3a-8
Setting the Communication Switches 3a-9
CONNECTING TO THE HOST COMPUTER 3a-12
The Dual Function Interface Connector 3a-12
RS-232-C Signal Descriptions 3a-12
Data Channel Protocols 3a-16
Direct Connection 3a-16
Communicating Using Modems 3a-16
Communicating Using Auto-Answer Modems . 3a-17
Cable Configurations and Connections 3a-18
Two-Point Direct-Connect Network 3a-18
Two-Point With Modems Over a Dedicated Line 3a-18
Linking to Telephone Service With an Auto-Answer Modem 3a-19
RS-422 Signal Descriptions 3a-19
Cable Connections 3a-22
Two-Point Configuration 3a-22
Multipoint Configuration 3a-23

CONNECTING TO THE PRINTER PORT (SCAN/ALARM) 3a-26
Setting the Communication Switches 3a-26
RS-232-C Printer Port Signal Descriptions ... 3a-27

3B: OPTIONS AND ACCESSORIES

THE OPTIONS 3b-1
SYSTEM CONSIDERATIONS 3b-2
1. IDENTIFY SYSTEM REQUIREMENTS 3b-3
2. DEFINE THE OPTIONS REQUIRED 3b-4
3. LOAD THE OPTIONS 3b-6
Categorize the Options 3b-7
Load Stand-Alone Options in Upper Slots 3b-7
Load Interdependent Option Sets at the Bottom 3b-8
4. DETERMINE ADDITIONAL POWER REQUIREMENTS 3b-9
General 3b-9
Maximum Power Required 3b-9
RULE 1 ..... 3b-10
EXAMPLE 1 ..... 3b-10
EXAMPLE 2 ..... 3b-11
Serial Link Cable Length 3b-11
RULE 2 ..... 3b-12
5. SETUP THE ADDRESSING SCHEME 3b-12
Example Address Assignment 3b-13

-160 AC Volts Input Connector 3b-15
-161 High Performance A/D Converter 3b-21
-162 Thermocouple/DC Volts Scanner 3b-27
-163 RTD/Resistance Scanner 3b-33
-164 Transducer Excitation Module 3b-39
-167 Counter/Totalizer 3b-45
-168 Digital I/O Assembly 3b-53
-169 Status Output Connector 3b-59
-170 Analog Output 3b-67
-171 Current Input Connector 3b-73
-174 Transducer Excitation Connector 3b-79
-175 Isothermal Input Connector 3b-93
-176 Voltage Input Connector 3b-101
-177 RTD/Resistance Input Connector 3b-109
-179 Digital/Status Input Connector 3b-117
-201 Scan/Alarm Option 3b-129

2281A Extender Chassis 3b-137

-402 Extender Cable 3b-143
-403 Extender Cable Connectors 3b-145
-431 Power Supply 3b-149

Y2044 Rack Slide Kit 3b-159
Y2045 Rack Mount Kit 3b-165
Y2047 Multi-Connector/Adapter 3b-169
Y1060 RS-422 Multipoint Connector 3b-170
RS-232-C Cables 3b-171

3C: INSTALLATION VERIFICATION

MAINFRAME INSTALLATION TESTING 3c-1
OPTION ASSEMBLY TESTING 3c-3
SCAN/ALARM TESTING 3c-3

INTRODUCTION

This section of the manual is divided into three main parts:

SECTION 3A explains how to set up a measurement system using the Fluke Helios I Computer Front End. It explains how to prepare the mainframe for installation. Directions on how to configure some of the more popular models of computers are given in an Appendix. Even if your computer is not included in the setup instructions in the appendix of this manual, the guidelines there may help you locate the necessary information in the literature that accompanied your computer at the time it was purchased.

Read this section before attempting to install or operate the Front End. Refer to Section 1 for unpacking instructions and other preliminary information needed before you turn on the instrument. Refer to Section 3B for specific instructions on setting up the various options. If any difficulties arise during installation or operation, contact your nearest Fluke Service Representative.

SECTION 3B explains how to set up each of the many options available for the Computer Front End. For each option, this section provides a short description of function and capability, a photograph to aid in identification, a few words explaining where to find measurement and applications information, followed by setup, installation, and programming information.

SECTION 3C contains tests to verify correct operation of the Front End after it has been installed.

SECTION 3A - THE MAINFRAME

This first part of Section 3 contains instructions for setting up the mainframe, including voltage selection and setting the internal communications switches.

PLACEMENT

After unpacking and inspecting the Computer Front End, select a location for installation. Case dimensions are shown in Figure 3-1. The self-contained case may be placed in any convenient location, but provide adequate clearance for rear-panel cabling and ventilation.

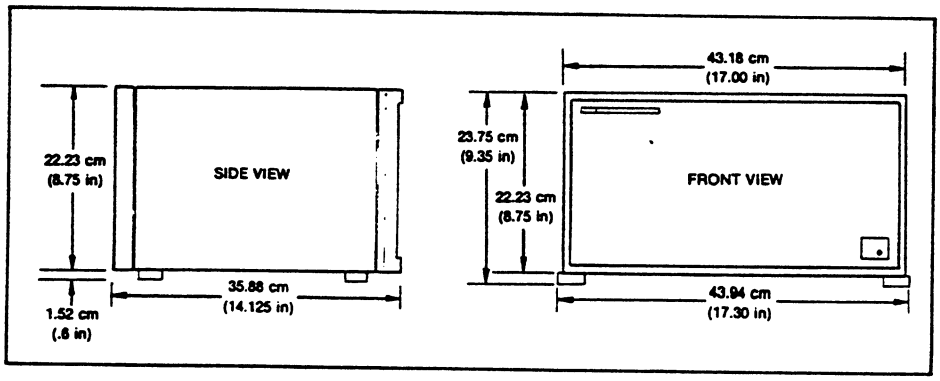


Figure 3-1. Case Dimensions

RACK MOUNTING

Two accessories are available to aid in mounting the Front End.

- Rack Mount Kit (Y2045)

  The Y2045 Rack Mount Kit facilitates the placement of a front end into a standard 19-inch electronic equipment rack. The only tool required for installation is a medium-sized, Phillips screwdriver.

- Rack Slide Kit (Y2044)

  The Y2044 Rack Slide Kit facilitates servicing a front end while it is installed in a standard 19-inch electronic equipment rack. The unit is secured in the equipment rack, yet may be pulled out along the slide for reconfiguring and servicing the system. The only tools required for installation are medium-sized, Phillips and flat-head screwdrivers.

Full installation instructions are provided with each kit and included in Section 3B of this manual.

CONFIGURING THE FRONT END

The next few pages describe how to change the electrical characteristics of the Front End to match local power and the computer to which it will be connected. You only need to change these settings if they don't agree with local line power or if the host computer cannot be set to match the Front End's default settings.

Line Power Voltage Selection

WARNING

THESE SERVICE INSTRUCTIONS ARE FOR USE BY QUALIFIED PERSONNEL ONLY. TO AVOID ELECTRIC SHOCK, DO NOT PERFORM ANY SERVICING UNLESS YOU ARE QUALIFIED TO DO SO.

Before connecting the power cord to the Front End and turning on the power, first see if the power supply has been set to the proper line voltage. A label on the back of the unit indicates the factory setting.

CAUTION

Incorrect voltage selection may damage the Computer Interface Module and void your warranty. If the voltage is not set for the correct operating voltage, the unit will either fail to operate, or will be severely damaged.

If it is necessary to change the line voltage, perform the following procedure with the power cord disconnected:

1. Remove the Computer Interface Module by removing the four #6-32 phillips-head screws on the rear panel. See Figure 3-2 to locate the screws.

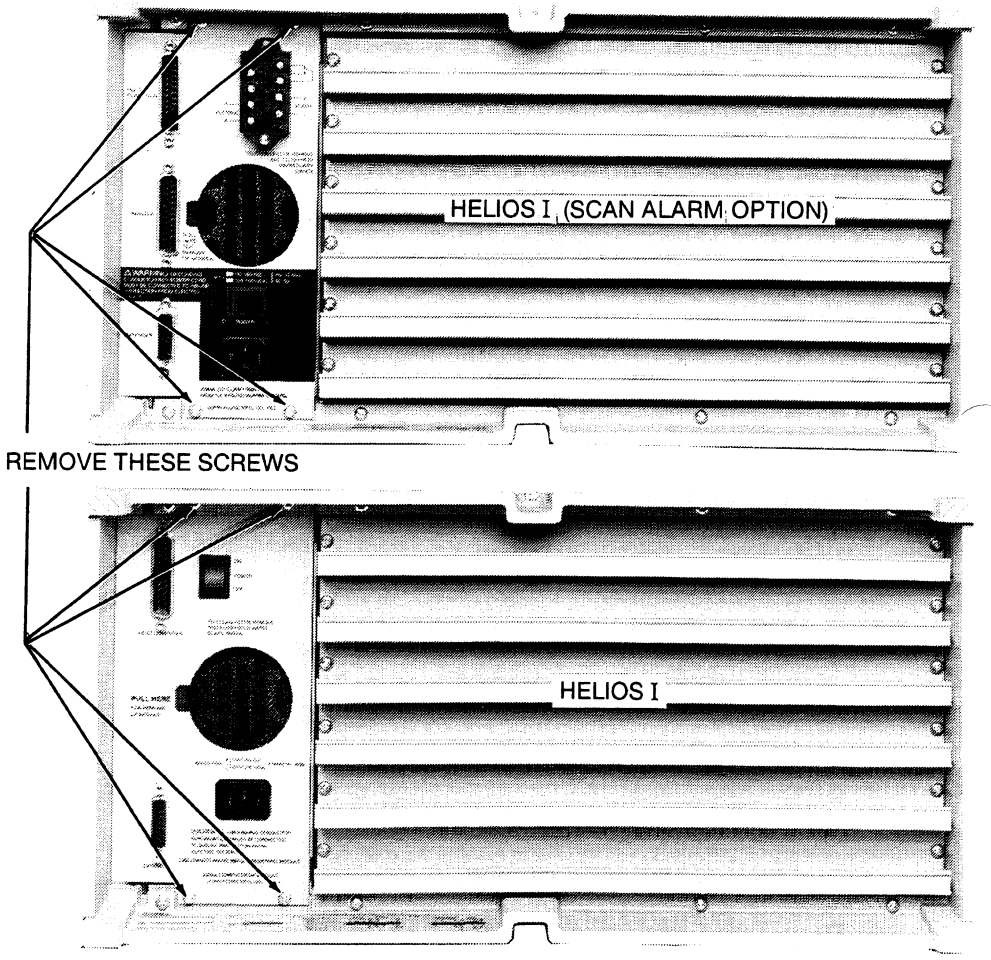


Figure 3-2. Computer I/F Module Securing Screws

2. See Figure 3-3. Slide the Module out by grasping the finger indentation in the fan filter hole and slide it straight back and out.

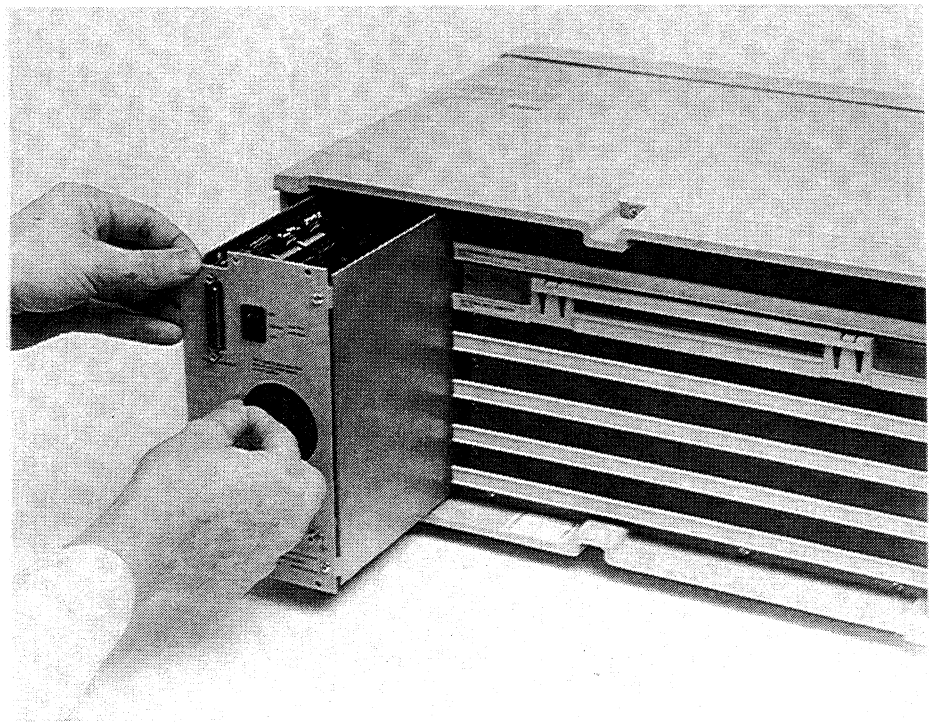


Figure 3-3. Removing the Computer Interface Module

3. Refer to Figure 3-4 to locate the Line Power Voltage Pins. To select 180-264V operation, connect the wire to the pin marked 220V. For 90-132V operation, place the wire on the pin labeled 110V.

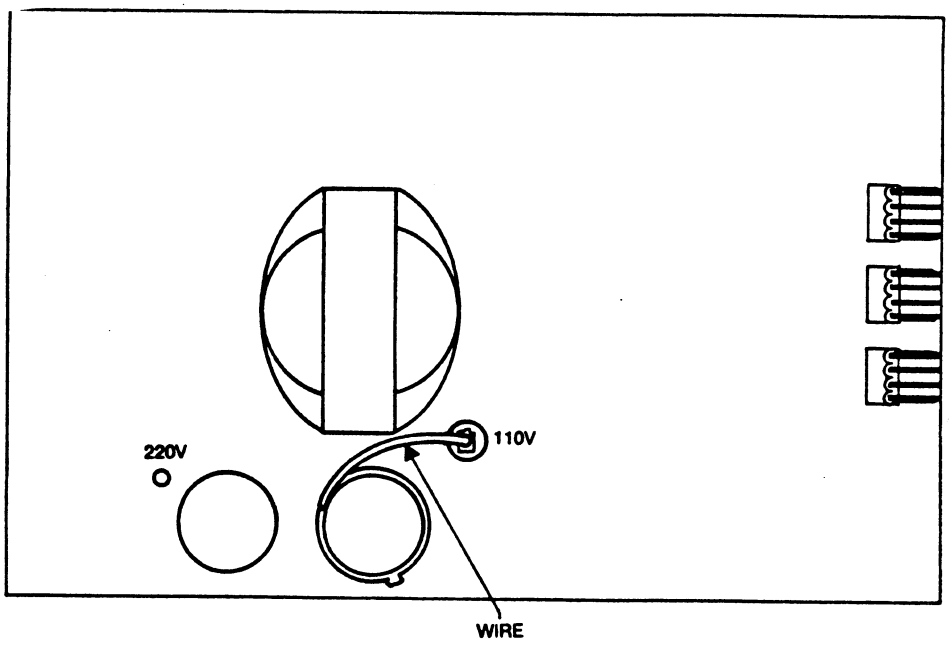


Figure 3-4. Line Power Voltage Pins

4. While the unit is open, locate the 50/60 Hz line frequency selection switch on S3. Ensure that it is in the proper position to match the local line frequency. If it is not, change its position before continuing. For 50 Hz operation, place the switch in the 0 position (toward card cage). For 60 Hz Operation, place it in the 1 position.

5. Properly mark the power setting on the outside of the unit after changing the line power voltage.

6. If no other settings need to be changed, slide the Computer Interface Module back into the Front End, and reinstall the phillips-head screws. If you need to change any of the communication parameters, refer to the next section before reinstalling the Computer Interface Module.

Preparing to Connect to The Host Computer

The Computer Front End can be controlled by any computer that has an RS-232-C port or an RS-422 port by using a variety of asynchronous bit-serial communication techniques. The two major categories are:

- Serial Interfacing Using Modems

  Using the RS-232-C interface with appropriate modems (devices that transmit and receive bit-serial data) connected to the telephone service, the Computer Front End may be programmed and run from great distances. In a similar way, several Front Ends can be accessed by one host computer.

- Serial Interfacing Using Dedicated Lines

  Serial interfacing is also possible over runs of certain lengths without using modems. Using the RS-232-C interface, with a distance of less than 50 feet between the Front End and the host, a hard-wired direct connection can be made using a null-modem cable which duplicate the effect of two modems. Null-modem cables are available as Fluke Accessories Y1702, Y1703, or Y1705 . In systems with runs up to 4000 feet, hard-wired connections can be made in an RS-422 system using twisted-pair cable.

Configuration Summary

The Computer Front End can be remotely accessed by a host computer in the following types of networks:

- RS-232-C direct-connect, two-point
- RS-232-C with modems over a dedicated line, two-point
- RS-232-C with auto-answer modems (switched serviced)
- RS-422 direct-connect, two-point
- RS-422 direct-connect, multipoint (up to ten Front Ends)

Where to Go From Here

To use the Front End in the way best suited to your application, it is important to understand the nature of serial data and how it is transferred. Appendix 9b provides an introduction to serial data, a description of the character format choices available, and an overview of the sequence of events that have to occur to accomplish data transfer. If you are experienced with serial communication, and know exactly how you want to configure the Computer Front End and host computer, continue with this section. Persons who are unfamiliar with serial data communications may find a short detour to the Appendix to be of value.

Setting the Communication Switches

The Computer Front End and the host computer must be configured so that the communication characteristics match. The table below shows the configuration of the Computer Front End as it is shipped from the factory.

Table 3-1. Default Communication Parameters

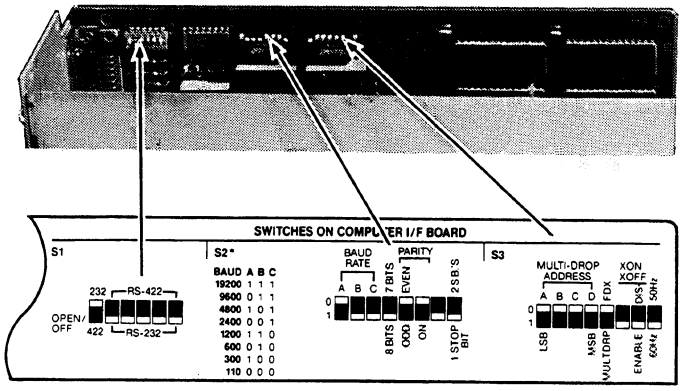
COMMUNICATIONS TYPE	RS-232-C
TRANSMISSION MODE	Full Duplex
BAUD RATE	9600
PARITY	OFF
NUMBER OF DATA BITS	8
NUMBER OF STOP BITS	1

If these settings match your chosen communication method, use the table to configure the host computer's communication parameters. If you don't know how to change these things on your computer, Appendix 9a has instructions for many major brands. If your computer is not included, be sure to consult the literature that came with it.

If these settings do not match your chosen communication method, then you will have to change the settings of the Computer Front End. To begin, refer to the "Line Power Voltage Selection" procedure in the previous section to remove the Computer Interface Module.

Figure 3-5 shows the location of the communication parameter selection switches. Tables within the Figure show the settings (except for the multidrop address) needed to configure the Front End for various kinds of operation.

HELIOS I



HELIOS I (SCAN/ALARM OPTION)

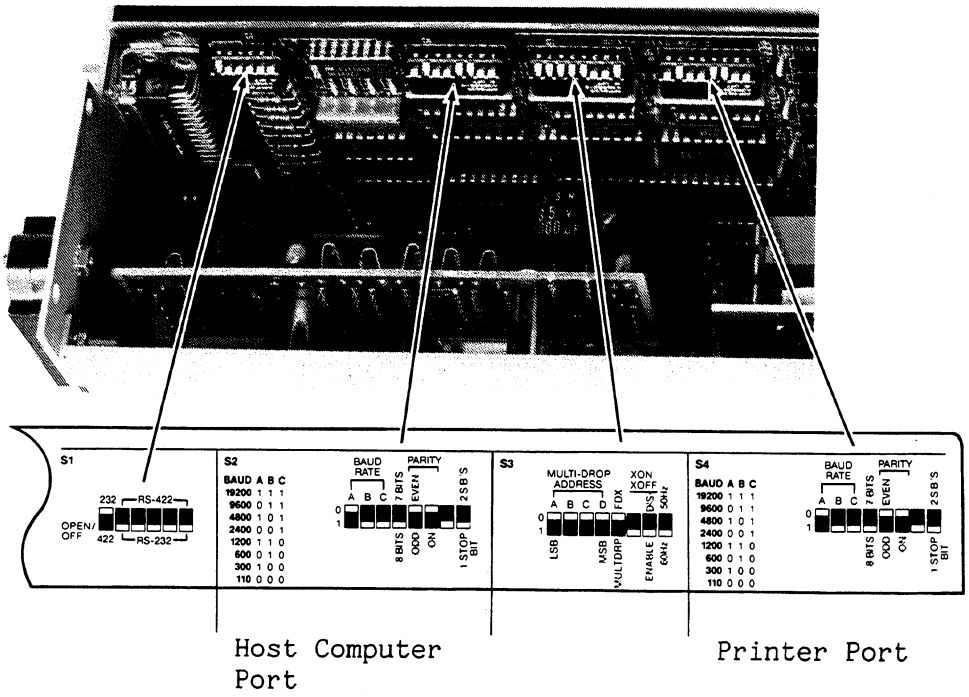


Figure 3-5. Communications Parameter Selection Switches

NOTE

The switches are shown in the position as shipped (white = switch position). The 50/60 Hz switch is set to the position required to match the line frequency used in the country to which the unit is shipped.

If you are using RS-422 and have selected multipoint mode, then use Table 3-2 below to select the multipoint address 0 through 9 for the Front End you are configuring.

Table 3-2. Multipoint Addresses

Address	A	B	C	D
0	0	0	0	0
1	1	0	0	0
2	0	1	0	0
3	1	1	0	0
4	0	0	1	0
5	1	0	1	0
6	0	1	1	0
7	1	1	1	0
8	0	0	0	1
9	1	0	0	1

CONNECTING TO THE HOST COMPUTER

The next several pages describe the interface in detail. This information is a technical description of the way that the RS-232 and RS-422 interface standards have been implemented on the Computer Front End, and gives the connector pin assignments and signal descriptions.

The Dual Function Interface Connector

The Serial Data Interface is brought out to a 25-pin subminiature "D" connector that functions both for RS-232-C and for RS-422 communications. This connector is the uppermost one when the Computer Interface Module is installed in the Front End.

RS-232-C Signal Descriptions

The Computer Front End is implemented as data terminal equipment (DTE) as described by Electronic Industries Association (EIA) standard RS-232-C. As a DTE unit, the Front End must be connected to data communication equipment (DCE). Modems and null-modem cables are examples of DCE.

Table 3-3 lists the RS-232-C signals used by the Front End, and their functions and pin assignments. The following section gives a brief description of each circuit. The signals are also specified by Comite Consultatif International Telegraphique et Telephonique (CCITT).

Table 3-3. RS-232-C Circuits Supported By the Serial Interface

Pin Number		Circuit Name	Direction
1	AA	Protective Ground	(Chassis Ground)
2	BA	Transmitted Data	To modem
3	BB	Received Data	From modem
4	CA	Request to Send	To modem
5	CB	Clear to Send	From modem
6	CC	Data Set Ready	From modem
7	AB	Signal Ground	(Reference Ground)
8	CF	Received Line Signal Detect	From modem
9	(no connection)		
10	(no connection)		
11	(no connection)		
12	SCF	Secondary Received Line Signal Detect (not used)	
13	(no connection)		
14	(no connection)		
15	(no connection)		
16	(no connection)		
17	(no connection)		
18	(no connection)		
19	(no connection)		
20	CD	Data Terminal Ready	To modem
21	(no connection)		
22	CE	Ring Indicator	From modem
23	(no connection)		
24	(no connection)		
25	(no connection)		

NOTE

When an RS-232-C signal is high, its logic state is true, and its voltage level is more positive than plus three volts. When the signal is low, its logic state is false, and its voltage level is more negative than minus three volts.

The functions of RS-232-C signals used by the Computer Front End are described below. The CCITT codes are included in parentheses:

- AA (101) - Protective Ground
  Protective Ground is the common chassis ground for the Serial Interface and modem, and is connected to earth ground through the power cord.

- AB (102) - Signal Ground
  Signal Ground is the common reference for all the following interface signals.

- BA (103) - Transmitted Data
  Transmitted Data carries the stream of data bits generated by the Front End to the modem.

- BB (104) - Received Data
  Received Data is the line that carries data received and demodulated by the modem to the Front End.

- CA (105) - Request to Send
  Request to Send activates the modem. When this signal is high, the modem starts sending a primary carrier and the Serial Interface is in the transmit mode. In full-duplex systems, CA is always high as long as the network is in a connected state and the equipment power is on.

- CB (106) - Clear to Send
  Clear to Send is set high by the modem when CA (Request to Send) is detected to be high. CB is set high to show that the modem is sending a carrier and is ready to send data. There is often a slight response delay from the time CA is sent to the time CB goes high.

- CC (107) - Data Set Ready
  Data Set Ready is set high when the modem is powered-on and ready for operation.

- CD (108.2) - Data Terminal Ready

  Data Terminal Ready is set high when the Computer Front End is powered on and ready for operation. When an auto-answer modem is used, CD remains low until CE (Ring Indicator) is detected to be high. When CE is high, the Front End responds by setting CD high. When CD is high, the modem is taken off-hook to establish a telephone line connection, and when CD is set low, the modem hangs up the line. The connection may be ended when the host sets CD low, sends the character sequence, DLE EOT, or stops sending a carrier. Also, when the Front End detects CF (Received Line Signal Detect) to be low for more than 10 seconds, it sets CD low to disconnect the line.

- CE (125) - Ring Indicator
  Ring Indicator is constantly monitored by the Front End when it is in the auto-answer mode. When CE is detected to be high, the Serial Interface sets CD (Data Terminal Ready) high, to instruct the modem to answer the line, establishing a communication channel with the host.

- CF (109) - Received Line Signal Detect
  Received Line Signal Detect is set high by the modem whenever it detects a suitable primary carrier in the receive state. This lets the Front End know that the primary carrier is on.

- SCF (122) - Secondary Received Line Signal Detect
  Not used by Computer Front End.

Data Channel Protocols

A variety of system configurations are possible in an RS-232-C system. The Computer Front End can be connected directly to the host computer if the units are separated by a distance of 50 feet or less. If the Front End and the host are more than 50 feet apart, modems may be used to provide the communication medium.

Helios always operates in full-duplex mode.

DIRECT CONNECTION

In a full-duplex, direct-connect system the Computer Front End and host computer are both acting as DTE. Therefore, a Null-Modem Cable must be used to simulate the presence of two modems. The Null-Modem Cable connects CA (Request to Send) to CB (Clear to Send) thus allowing the Front End to transmit at any time, and routes the transmitted data to the receive channel at the other end. The Null-Modem Cable can be used alone or in conjunction with a standard RS-232 cable to connect the Front End to the host computer.

When the Computer Front End is operated as part of a full-duplex direct-connect system, CA (Request to Send), SCA (Secondary Request to Send), and CD (Data Terminal Ready) are set high at power-up, to enable two-way communication.

COMMUNICATING USING MODEMS

The RS-232-C specifications allow up to 50 feet of cable in a direct connect system. For longer distances between the host and the Computer Front End, full-duplex communication can be established using modems. Two of the most commonly used modems are the Bell Standard 103, which transmits at a bit rate of 300 baud, and the Bell Standard 212A, which transmits at a bit rate of 1200 baud.

Full-duplex modems connected to the Front End and the host can be linked by a dedicated wire or a telephone line. Using full-duplex, each modem transmits data on its own channel. Each channel has its own carrier frequency, allowing two-way data transfer to take place on the same line.

In full-duplex data communication over a telephone line, there is no distance limit, but there is a limit on speed. Two communication channels must fit within the typical three kilohertz bandwidth of a telephone line. Since a signal with a higher baud has a wider bandwidth, baud is limited. When two data channels share a line, the maximum bit rate is typically 1200 baud, depending on the type of modem. Check the modem specifications.

COMMUNICATING USING AUTO-ANSWER MODEMS

If the Front End is used with a full-duplex modem with auto-answer capability on the direct dial telephone network, the host computer can access the Front End from a remote location. The host computer can be connected to the direct dial network with an auto-dial modem (such as the Racal-Vadic VA212PA).

At power-up the Computer Front End asserts signal CD (Data Terminal Ready) low if auto-answer mode has been selected and if the line is not ringing. The host computer may dial the number for the Front End at the remote site at any time. When it does, the Front End detects signal CE (Ring Indicator) high, and responds by asserting CD (Data Terminal Ready) high. This tells the auto-answer modem to answer the line and a connection is established. The modem, in turn, signals to the Front End that the line has been answered, and communication between the host and the Front End can begin.

Cable Configurations And Connections

To link the Computer Front End to a host computer using the RS-232-C interface, a cable must be attached between the Front End and either a modem or the host itself. Use the following steps to interconnect the system you have chosen to use. Each network type has its own set of instructions.

TWO-POINT DIRECT-CONNECT NETWORK

1. Connect one end of an RS-232-C Null-Modem Cable (such as the Fluke Accessory Y1702 Two-Meter Null-Modem Cable) to the male 25-pin D-type connector on the Front End.

2. Connect the other end of the Null Modem Cable to the RS-232-C connector on the host computer.

TWO-POINT WITH MODEMS OVER A DEDICATED LINE

1. Connect one end of a standard RS-232-C cable (such as the Fluke Accessory Y1707 Two-Meter Cable) to the male 25-pin D-type connector on the Computer Front End.

2. Connect the other end of the cable to the RS-232-C connector on the modem.

3. Make similar connections between the host computer and its modem (follow the instructions supplied with the modem).

LINKING TO TELEPHONE SERVICE WITH AN AUTO-ANSWER MODEM

1. Connect one end of a standard RS-232-C cable (such as the Fluke Accessory Y1707 Two-Meter Cable) to the male 25-pin D-type connector on the Computer Front End.

2. Connect the other end of the cable to the auto-answer modem, following the instructions for that particular modem.

When the communication session is complete, the host computer transmits the character sequence DLE EOT to the Computer Front End. On recognition of this character sequence, the Front End asserts CD (Data Terminal Ready) low, telling the modem to hang up the telephone line. CD is also set low to disconnect the line if at any time the Front End detects signal CF (Received Line Signal Detect) to be low for more than 10 seconds. This could be caused by line interruption, or by the host computer hanging up at its end of the line.

RS-422 Signal Descriptions

Electronic Industries Association (EIA) standard RS-422 gives the specifications for the "electrical characteristics of balanced voltage digital interface circuits." The RS-422 interface uses a balanced (differential) voltage signal. This allows digital communication over as much as 4,000 feet of twisted-pair 24 AWG wire at bit rates up to 19,200 baud. Two-point and multipoint configurations can be used with RS-422.

The standard is only an electrical standard; it does not define the mechanical interface characteristics. When S1 on the Computer Interface Module is set to the RS-422 positions, the Computer Front End presents the RS-422 signal connections on the same subminiature 25-pin D-type connector as it uses for the RS-232-C signals. Table 3-4 lists the six signals used by the RS-422 interface on the Computer Front End and gives their pin assignments.

Table 3-4. RS-422 Signals and Associated Pin Assignments

Pin Number	Signal Name	Direction
1	Shield	(Chassis Ground)
14	R+	From Host Computer
15	R-	From Host Computer
9	T+	To Host Computer
10	T-	To Host Computer
7	Common	(Signal Common)

The following is a description of each of the RS-422 Interface signals to help you understand better how the RS-422 Interface works.

- Shield
  Shield is the direct connection to chassis ground for the shield around the twisted-pair cable between the host computer and the Front End. Shield is used when the devices at both end of the communication line have the same chassis potentials. This is the case when the AC power grounds at each end are the same.

- R+
  R+ is one of two differential received data signals from the host computer. R+ is the logical inverse of R-. When R+ is greater than 0.2 volts more positive than R-, the received data signal is considered to be a logic 1 (or mark) state. This is the normal state of the interface and corresponds to a stop bit. When R+ is greater than 0.2 volts more negative than R-, the data signal is considered to be a logic 0 (or space) state. The space state represents a start bit at the beginning of character transmission.

- R-
  R- is the other of the two differential data signals received from the host computer. R- is the logical inverse of R+.

- T+
  T+ is one of two differential data signals transmitted to the host computer. T+ is the logical inverse of T-. When T+ is greater than 0.2 volts more positive than T-, the transmitted data signal is considered to be in a logic 1 (or mark) state. This is the normal state of the interface and corresponds to a stop bit. When T+ is greater than 0.2 volts more negative than T-, the data signal is considered to be in a logic 0 (or space) state. This is the state in which the interface generates a start bit at the beginning of character transmission.

- T-
  T- is the other of the two differential data signals transmitted to the host computer. T- is the logical inverse of T+.

- Common
  Common is the common reference signal for R+, R-, T+, and T-.

CABLE CONNECTIONS

The Computer Front End can be used as an RS-422 interface in two different system configurations. The simplest configuration is two-point, where a host computer is connected to a single Front End. The other possible configuration is multipoint, where several Front Ends are addressable separately by a host computer.

TWO-POINT CONFIGURATION

After configuring and installing the Computer Interface Module, connect the Front End for two-point RS-422 operation as follows:

1. Obtain the desired length of shielded cable containing at least three twisted-pairs of conductors (minimum size 24 AWG).

2. Referring to Table 3-4 for pin assignments, install a 25-pin, subminiature D-type connector on the end of the cable that will connect to the Front End. Make the following pin connections:

3. Connect one twisted pair to pins 9 and 10 (T+, T-).

4. Connect another twisted pair to pins 14 and 15 (R+, R-).

5. Connect one conductor of the third twisted pair to pin 7 (common).

6. Connect the cable shield(s) to pin 1.

7. Install an appropriate connector for the host computer end of the cable, making sure to attach the correct signal lines to each pin, matching the requirements of the host computer.

MULTIPOINT CONFIGURATION

After configuring, setting the multipoint address, and installing the Computer Interface Module in each Front End, connect the Front Ends for multipoint RS-422 operation as follows:

1. Attach the Y1060 Serial Link Multi-Connectors. Refer to Figure 3-6 for a typical RS-422 multipoint configuration.

2. Determine requirements for cables "A", "B", and "C" in Figure 3-6.

   - o Cable length: Prepare the required lengths of shielded, twisted-pair cables. Each cable must contain at least three twisted pairs (minimum size 24 AWG).

   - o Connectors: Determine plug and socket configuration requirements. Remember that each Y1060 supplies one plug and two sockets. One of these socket connectors is required for each CFE connection.

3. Install the cable connectors associated with CFE#1, CFE#2, and CFE#3. Refer to Table 3-4 for pin assignments.

   a. Connect one twisted pair to pins 9 and 10 (T+, T-).

   b. Connect another twisted pair to pins 14 and 15 (R+, R-).

c. Connect one conductor of a third twisted pair to pin 7 (common).

d. Connect the cable shield(s) to pin 1.

4. At the host computer end of cable "A", install a plug (or socket) connector, as required. Make sure that the lines connected here match host computer signal requirements.

5. Attach cables "A", "B", and "C" (Figure 3-6).

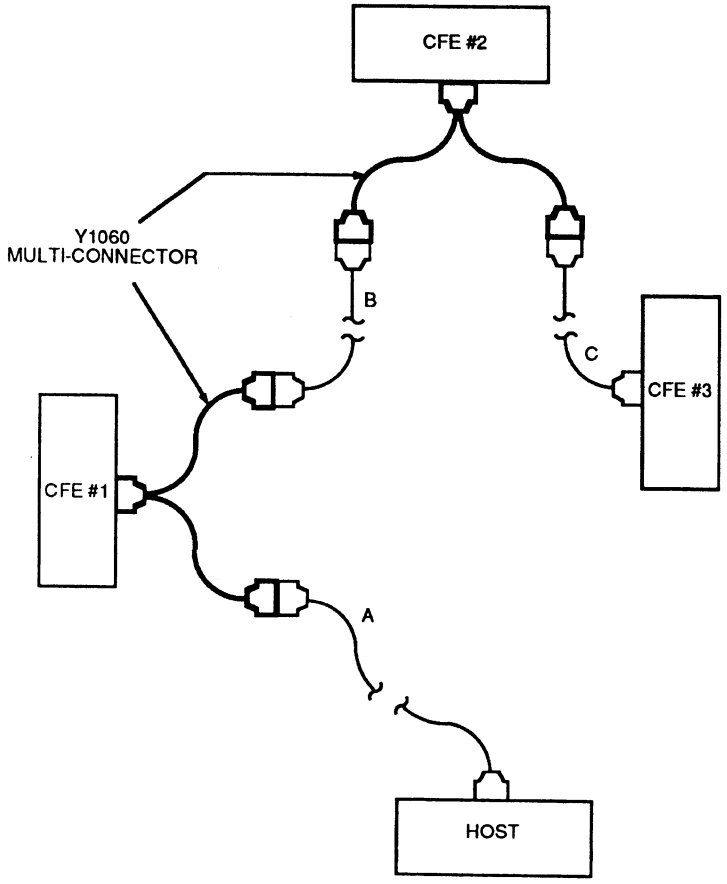


Figure 3-6. RS-422 Multipoint Cabling Configuration

In a multipoint direct-connect system (RS-422), each Front End in the system has a unique address. Up to ten Front Ends may be connected in such a system. Each Front End in the system is assigned an address from zero to nine, as set on the ADDRESS switch (S3) on the Computer Interface Module. After one Computer Front End is addressed, the other Front Ends remain idle until there is another address sequence.

In a two-point network, there is no establishment procedure, since there is only one Computer Front End. In a multipoint network, however, a logical connection must be established between the host and only one Front End at a time.

The host establishes an RS-422 communication link between itself and a particular Computer Front End in a multipoint network as follows:

1. The host sends an address character followed by the Enquiry character, ENQ. The address character is the mathematical sum of the address (0 - 9) and ASCII-coded character "0" (ASCII decimal 48).

2. When a Front End detects its address sequence, it responds by echoing its address character, followed by the Acknowledge character (ACK), establishing the connection.

NOTE

When using a multipoint system, make sure that only one Front End is addressed at a time. The recommended way of doing this is to perform the termination sequence prior to addressing any Front End.

CONNECTING TO THE PRINTER PORT (SCAN/ALARM OPTION -201)

The following section deals with connecting to the Printer Port. This is an output port only and is intended to be connected to an RS-232C printer or display monitor.

Setting the Communication Switches

The Printer Port must be configured so the communication characteristics match those of the printer or display monitor. Table 3-5 shows the configuration of the Printer Port as it is shipped from the factory.

Table 3-5. Default Printer Port Communication Parameters

BAUD RATE	9600
PARITY	NONE
NUMBER OF DATA BITS	8
NUMBER OF STOP BITS	1

If these settings do not match your chosen printer or display terminal, then you will have to change the settings of the Computer Front End. To begin, refer to the "Line Power Voltage Selection" procedure in the previous section to remove the Computer Interface Module.

Figure 3-5 shows the location of the printer port communication parameter selection switch (S4). The Table within the Figure show the settings needed to configure the Front End for various Baud Rates and Data Configurations.

NOTE

The switch is shown in the position as shipped (white = pressed).

RS-232-C Printer Port Signal Descriptions

The Printer Port is implemented as a data terminal equipment (DTE) as described by Electronic Industries Association (EIA) standard RS-232-C. As a DTE unit, the equipment must be connected to a data communication equipment (DCE). As most printers and terminals are also DTE equipment a Null Modem must be used to properly interface with them. Modems and null-modem cables are examples of DCE.

Table 3-6 lists the RS-232-C signals used by the Printer Port, their functions and pin assignments.

Table 3-6. RS-232-C Circuits Supported By The Printer Port

Pin Number	Circuit Name		Direction
1	AA	Protective Ground	(Chassis Ground)
2	BA	Transmitted Data	To Printer
3	BB	Received Data	From Printer
4	CA	Request to Send	To Printer
5	CB	Clear to Send	From Printer
6	CC	Data Set Ready	From Printer
7	AB	Signal Ground	(Reference Ground)

THE OPTIONS

The use of option cards allows for a wide range of Computer Front End configurations. The option cards slip into position easily from the rear panel of either the Front End or the 2281A Extender Chassis.

The options are identified by three-digit number as follows:

-160 AC Voltage Input Connector
-161 High Performance A/D Converter
-162 Thermocouple/DC Volts Scanner
-163 RTD/Resistance Scanner
-164 Transducer Excitation
-167 Counter/Totalizer
-168 Digital I/O Assembly
-169 Status Output Connector
-170 Analog Output
-171 Current Input Connector
-174 Transducer Excitation Connector
-175 Isothermal Input Connector
-176 Voltage Input Connector
-177 RTD/Resistance Input Connector
-179 Digital/Status Input Connector

SYSTEM CONSIDERATIONS

At this point, consider the nature of your Computer Front End system. Below are five important system set-up considerations. If any of these issues has not already been resolved, please read the general installation information that follows. If you are satisfied with your system design, or if you just need more specific information about an option, refer to the appropriate subsection at the end of this section. Each subsection is identified by three-digit option number.

1. Identify System Requirements

   What measurement functions are required?
   What output functions are required?
   How many channels are required?

2. Define the Options Required

   What option cards are necessary to fulfill system requirements?

3. Load the Options

   Which options double-up in the same slot?
   Which options must be installed adjacent to each other?
   How do the options fit into the general slot-loading hierarchy?

4. Determine Additional Power Requirements

   If one or more Extender Chassis is used, what additional power will the Front End have to provide?
   Is an additional power supply needed?

5. Set-Up the Channel Addressing Scheme

The following pages answer these questions.

1. IDENTIFY SYSTEM REQUIREMENTS

What do you plan to do with the Computer Front End? Many types of inputs can be measured, and both status and analog outputs can be specified. This manual deals with Front End functions under the following categories:

Analog Output
Current Measurement
Digital/Status Input
Frequency Measurement
Resistance Measurement
Status Output
Strain Measurement
Temperature Measurement Using RTDs
Temperature Measurement Using Thermistors
Temperature Measurement Using Thermocouples
Totalizing Measurement
Voltage Measurement - AC
Voltage Measurement - DC

One of these categories satisfies virtually any measurement or output function.

2. DEFINE THE OPTIONS REQUIRED

The Table 3B-1 identifies the options that are required for each function. The list also shows how many measurement channels are available with each option or combination of options. Three terms are used:

- Chan (channel): a discrete measurement or output path. Typically, each option handles several channels.
- Assy (assembly): an option or set of options occupying a single slot in the Front End or Extender Chassis.
- Unit: The Front End or a 2281A Extender Chassis.

Most of the option cards perform measurement functions. These cards can be classed either as connectors, allowing for external wire routing and attachment, or as scanners, providing measurement signal conversions and interfacing to the Front End or Extender Chassis. A connector attaches directly to a scanner, with both occupying a single rear panel slot.

- Connectors: -160, -171, -175, -176, -177, -179.
- Scanners: -162, -163, -168.

In addition, the -167 option card performs analog measurements using its own terminal block for external connections.

The -174 connector and -164 option card aid in several measurement functions by providing a voltage or current source for external transducers.

Table 3B-1. Option Requirements

Function	Option Cards Scanner	Connector	Chan/ Assy	Assy/ Unit	Chan/ Unit
TEMPERATURE					
Thermocouple	-162	-175	20	5	100
RTD					
Config A	-163	-177	20	5	100
Config B	-164	-174	20	2	40
	-162	-175/176			
Thermistor	-163	-177	20	5	100
VOLTAGE					
AC	-162	-160	10 ac/ 10 dc	5	50 ac/ 50 dc
DC	-162	-175/176	20	5	100
CURRENT	-162	-171	20	5	100
RESISTANCE					
Config A	-163	-177	20	5	100
Config B	-164	-174	20	2	40
	-162	-175/176			
FREQUENCY	-167	included	6	5	30*
TOTALIZING	-167	included	6	5	30*
STRAIN	-164	-174	20	2	40
	-162	-175/176			
DATA INPUT (Binary/BCD)	-168	-179	1	6	6
STATUS INPUT	-168	-179	20	6	120
STATUS OUTPUT	-168	-169	20	6	120
ANALOG OUTPUT	-170	included	4	5	20*

* Due to power requirements, do not use sixth position. (A/D Converter, -161, required with -162 or -163)

Conversion of analog measurements to a digital format is accomplished with the -161 option card. This card must be used whenever measurements with the -162 or -163 scanner are made.

The -168 option card accepts the -179 connector for digital/status inputs. The -161 option is not required for such non-analog inputs.

The -170 Analog Output option card provides voltage or current outputs to connection points on its own terminal block.

The -168 option card accepts the -169 connector for status outputs.

The Computer Front End system accommodates a maximum of 1500 input and output channels (1000 for Scan/Alarm option). This total is met with options installed in multiple system units (Computer Front End and 2281A Extender Chassis). Six option slots are available in each unit. The number of channels supported by each unit depends on the option types in use.

3. LOAD THE OPTIONS

At this point, you have already defined the Computer Front End functions needed in your system, the types of options to support those functions, and, probably, the number of option cards needed. Now, you need to determine the best positioning for these cards in the Computer Front End and Extender Chassis.

Each unit (Front End or Extender Chassis) provides six option slots. One, two, or three slots may be needed per function. In addition, certain slots are preferred for performance and interconnection considerations. A few recommendations aid in placing an option mix.

Categorize the Options

Separate the options into stand-alone and interdependent categories. Differentiate the two by the number of slots required to perform a function. A function requiring one slot, whether using a single card or a card-connector combination, defines a stand-alone option. Interdependent options use more than one slot to perform a function.

- Stand-alone options:
  - Counter/Totalizer (-167)
  - Digital I/O Assembly (-168) with connector (-169 or -179)
  - Analog Output (-170)

- Interdependent options:
  - A/D Converter (-161) and one or more analog scanner/connector pairs.
    (-162 and -160 or -171 or -175 or -176)
    (-163 and -177)
  - A/D Converter (-161) with one or two combinations of analog scanner/connector and Transducer Excitation Module/Connector.
    (-162 and -175 or -176 // -164 and -174)

Load Stand-Alone Options in Upper Slots

Load stand-alone options in the upper slots. These options include:

Analog Outputs
Counter/Totalizers (any order)
Digital Scanners

Load Interdependent Option Sets at the Bottom

Load interdependent option sets below the stand alone options. Load scanner/connector pairs first (bottom up), followed by the associated A/D Converter. Load a Transducer Excitation Module/Connector pair immediately below the related scanner/connector.

```
          ^     A/D Converter.
          ^     Analog scanner/connector
          ^     Transducer Excitation Module/Connector
     (bottom)
```

For two scanner/connector - Transducer Excitation sets:

```
          ^     A/D Converter.
          ^     Analog scanner/connector
          ^     Transducer Excitation Module/Connector
          ^     Analog scanner/connector
          ^     Transducer Excitation Module/Connector
     (bottom)
```

For multiple scanner/connector sets:

```
          ^     A/D Converter.
          ^     Analog scanner/connector
                .
                .
          ^     Analog scanner/connector
     (bottom)
```

If two A/D Converters are being used in the same unit and a vacant slot is available, leave a blank slot between the converter-scanner sets.

```
          ^     A/D Converter.
          ^     Analog scanner/connector
     (blank)
          ^     A/D Converter.
          ^     Analog scanner/connector
     (bottom)
```

4. DETERMINE ADDITIONAL POWER REQUIREMENTS

General

Option assemblies receive power from either the Front End power supply (supplying 12V) or the optional -431 power supply (supplying 20 volts). The serial link cable distributes power both from the Front End and between Extender Chassis.

Care must be taken to insure that all options have enough power available to function properly. Two factors must be considered:

1. The power consumption of each option receiving power directly from the serial link.

2. The distance from the power supply to the options.

Maximum Power Required

Total power available to option assemblies is:

- 21 watts from the Computer Front End.

- 20 watts from a -431 power supply, which must be derated for operating temperatures above 40 ^{o}C (see the 2281A Manual for details).

Power requirements for option assemblies are summarized in Table 3B-1. Option assemblies not mentioned in this table receive power over the serial link from one of the options in Table 3B-1. For example, the -175 connector and the -162 scanner receive power from the -161 A/D Converter. Maximum power requirements mentioned in this table cover both the option mentioned and related options powered from that option.

Table 3B-1. Maximum Power Consumption

Option	Maximum
-161 High Performance A/D Converter	2.5 Watts
-164 Transducer Excitation Module	3.5 Watts
-167 Counter/Totalizer	4.0 Watts
-168 Digital Input/Output	1.5 Watts
-170 Analog Output	4.1 Watts

RULE 1

Using Table 3B-1, compute the total power requirement for all options in both the Front End and 2281A Extender Chassis located within 2 meters of the Front End. If this total is greater than 21 watts, a -431 is required in at least one of the Extenders.

EXAMPLE 1

FRONT END		2281A EXTENDER CHASSIS	
Option	Watts	Option	Watts
-161	2.5	-170	4.1
-162	*	-170	4.1
-164	3.5	-168	1.5
-161	2.5	-168	1.5
-162	*	-168	1.5
-164	3.5	-168	1.5

* Denotes option receiving power from another option.

Total power requirement = 26.2 watts. A -431 is needed.

EXAMPLE 2

FRONT END		2281A EXTENDER CHASSIS	
Option	Watts	Option	Watts
-168	1.5	-161	2.5
-167	4.0	-162	*
-161	2.5	-164	3.5
-162	*	-	-
-162	*	-	-
-163	*	-	-

* Denotes option receiving power from another option.

Total power requirement = 14 watts. A -431 is not required.

Serial Link Cable Length

The length of the serial link cable is an important consideration in supplying sufficient voltage to all options assemblies. Voltage drops along the cable limit the power available. When the voltage at the option drops below 12 volts, the respective power requirement can no longer be met. The -431 power supply can then be used to provide a voltage boost.

The 2281A Extender Chassis Instruction Manual provides extensive guidance in determining the need for and placement of -431 power supplies. This information can be used for the Computer Front End, with one reservation. The 2281A Instruction Manual documents the 2280A Datalogger, which uses a 24 volt power supply. The Computer Front End power supply provides 12 volts. Therefore, only minimal distances (2 meters) can be allowed between the Front End and external options in an extender chassis. Since the -431 power supply provides 20V, distances between a -431 and external options can be greater.

RULE 2

If the first 2281A Extender Chassis is more the 2 meters from the Front End, a -431 is required in that 2281A. Other -431 power supplies may be required where multiple extender chassis are used. Refer to the 2281A Instruction Manual.

5. SETUP THE ADDRESSING SCHEME

With the option configuration established, the final step involves setting up a consistent addressing pattern. Within the system, 1500 (0 - 1499) addresses (or channel numbers) are available. With the Scan/Alarm option, 1000 (0-999) channels are available. A unique block of addresses must be reserved for each option.

Option addresses are set in one of two ways.

- o If the option is associated with a -161 A/D Converter, a base group of 100 addresses is established on the converter. Associated options then indirectly derive an address block from their position relative to the converter.

  The -164 (if installed directly below the -161), -162, and -163 derive their addresses in this manner. Each uses a block of 20 addresses.

- o Switches are used to assign address blocks directly for other options. These include:

Option	Addresses Reserved	Addresses Used
-161	0	0 - 100
-167	10	6
-168 (Status I/O)	20	20
-168 (Binary/BCD)	10	1
-170	10	4

Selecting unique addresses for a small system is easily accomplished. For larger systems, the following procedure is recommended:

1. Set each -161 to a unique 100's address.

2. Count the number of options that are used with and installed under a -161.

3. Multiply this number by 20, and add the hundreds address of the -161. This calculation yields the beginning address used in the next available block.

4. Repeat steps 2 and 3 for each -161 in the system.

5. Set each -167, -168, and -170 to unique 100's and 10's addresses (not used by options associated with a -161).

NOTE

If a -168 is used as a Status Input or Status Output, the 10's address following the selected address is not available.

Example Address Assignment

For example, set up the addressing pattern for a system with the following options:

1. A -161 with -162, -164, and -163 associated directly below.

2. A -161 with five -162's associated directly below.

3. A -167

4. A -168 set for Status Input.

5. A -170

Option	Assigned 100's	Assigned 10's	Used
-161	0	-	-
-162	-	-	0 - 19
-164	-	-	20 - 39
-163	-	-	40 - 59
-168	0	6	60 - 79
-170	1	0	100 - 103
-161	2	-	-
-162	-	-	200 - 219
-162	-	-	220 - 239
-162	-	-	240 - 259
-162	-	-	260 - 279
-162	-	-	280 - 299
-167	3	1	310 - 315

INTRODUCTION

The AC Voltage Input Connector attaches to the rear of the Thermocouple/DC Volts Scanner (-162). This combination allows for voltage measurement on 20 channels (10 for ac volts, 10 for dc volts).

- AC Volts: measurements ranging from 5V to 250V can be made on any of 10 ac channels. The voltage applied to any ac channel must not exceed 250V rms. The frequency range for ac measurements is 45 to 450 Hz.

- DC Volts: measurements up to 64V dc can be made on any of 10 dc channels.

The AC Voltage Input Connector is shown in Figure 160-1.

160/AC Voltage Input Connector

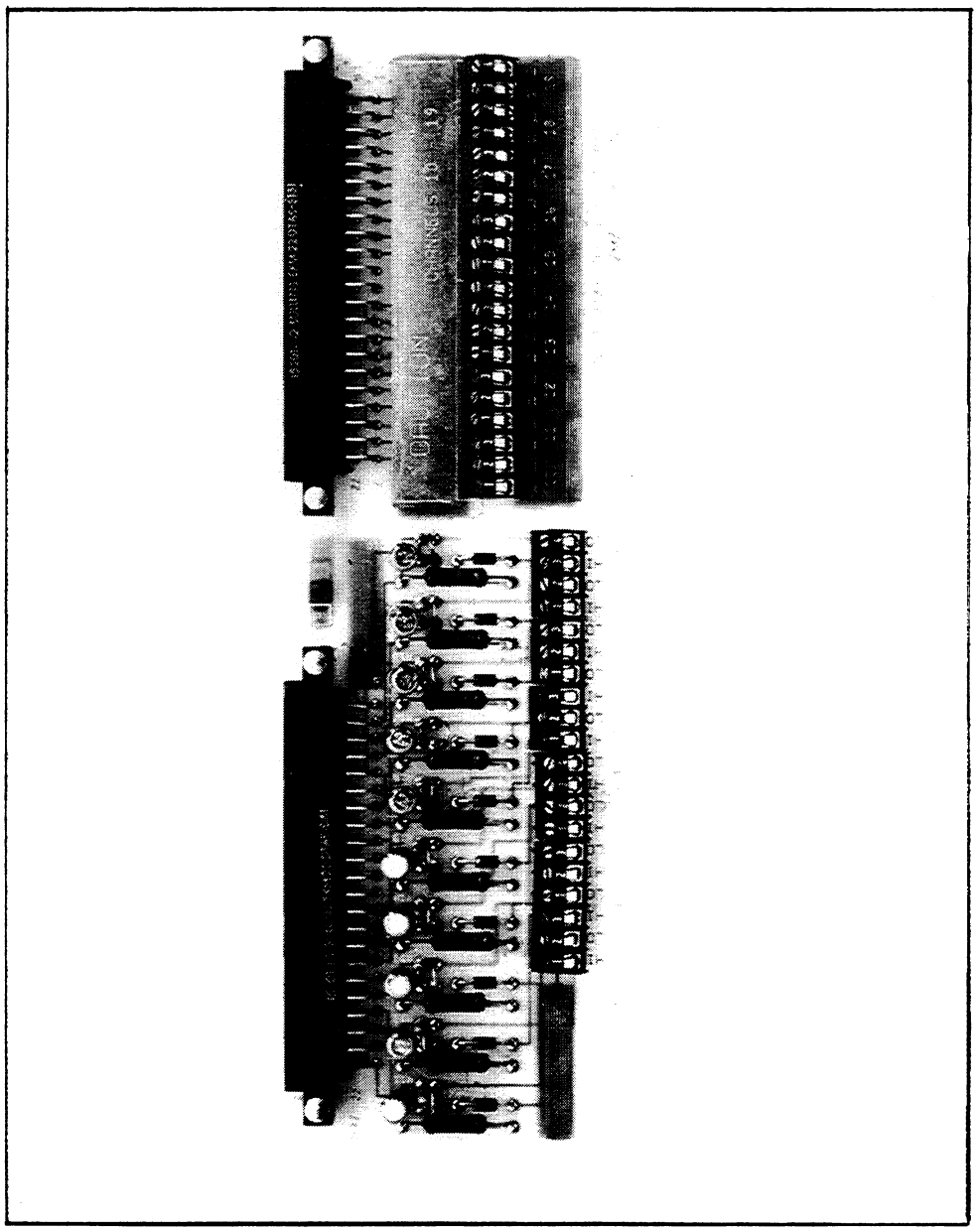


Figure 160-1. AC Voltage Input Connector

WHERE TO FIND MORE INFORMATION

This subsection presents general and installation information specifically related to the AC Voltage Input Connector.

Other sections provide information related to specific applications. These include:

- Section 6L. Voltage Measurement - AC:
  This section discusses use of the AC Voltage Input Connector and the Thermocouple/DC Volts Scanner in measuring ac voltage.

- Other measurement functions use the dc voltage measurement capabilities of the AC Voltage Input Connector. These include

  - Section 6H: Temperature Measurement Using RTDs, Configuration B
  - Section 6M: Voltage Measurement - DC
  - Section 6G: Strain Measurement
  - Section 6E: Resistance Measurement, Configuration B

Section 3C provides an installation verification procedure.

SPECIFICATIONS

Specifications for the AC Voltage Input Connector are presented in Section 2. Section 2 also contains system accuracy specifications for ac voltage measurement.

160/AC Voltage Input Connector

REMOVAL AND INSTALLATION

Connections from external ac and dc voltage sources to the Front End or Extender Chassis are made via external wiring to the AC Voltage Input Connector. Preparation of the AC Voltage Input Connector involves opening the connector housing, connecting the appropriate wiring on the terminals, closing the connector housing, and reconnecting it to the Thermocouple/DC Volts Scanner (-162).

WARNING

BEFORE REMOVING OR INSTALLING THE CONNECTOR, ENSURE THAT ALL LINE POWER TO THE FRONT END IS DISCONNECTED. LETHAL VOLTAGES MAY BE PRESENT WITHIN THE COMPUTER FRONT END AND ON SOME OPTION CARDS. DO NOT REMOVE ANY INSTRUMENT COVERS UNLESS YOU ARE QUALIFIED TO DO SO.

The connector is designed so that installation can be accomplished without removing the associated scanner.

Connector Removal

If the connector is already installed, but needs new or changed wiring connections, perform the following initial procedure:

1. With line power disconnected and the POWER switch set at OFF, locate the connector housing in the rear panel of the Computer Front End.

2. Loosen the two retaining screws.

3. Firmly grasp the housing at each end and pull until the enclosed connector block is disconnected from the scanner.

Wire Connections

With the connector withdrawn from the Front End or Extender Chassis, perform the following steps:

WARNING

BE SURE THAT THE WIRES BEING CONNECTED ARE NOT ENERGIZED. IF POSSIBLE, DISCONNECT THESE WIRES AT THE OTHER END. IN ANY EVENT, ENSURE THAT THE EXTERNAL CIRCUIT CONNECTED TO THESE WIRES IS NOT ENERGIZED. LETHAL VOLTAGES COULD OTHERWISE BE ENCOUNTERED.

1. Open the housing by pressing each locking tab.

2. The AC Voltage Input Connector is now ready to be wired to external measurement systems. For each connection, loosen the channel terminal screw, attach the external wire to the screw, then tighten the screw until the wire is firmly in place. Notice that the two terminals for each channel are marked HI and LO. Starting at Channel 0, attach the external wiring for the desired application.

160/AC Voltage Input Connector

NOTE

For proper reading polarity on the dc channels, ensure that the current flows into the HI terminal and out of the LO terminal.

3. Close the housing over the input connector, ensuring that the external wires exit the rear of the enclosure without being pinched.

Connector Installation

1. With line power disconnected and the POWER switch set at OFF, position the enclosed (and wired) input connector in the guides of the rear panel slot containing the appropriate scanner.

2. Push the connector onto the card edge connector at the rear of the scanner. Press the connector firmly into place.

3. Attach the connector housing to the chassis with the two retaining screws.

INTRODUCTION

The High Performance A/D Converter (-161) provides high accuracy analog to digital conversion of scanner input voltages. For analog measurements, at least one A/D Converter must be installed. The configurations listed below are permissible:

- A maximum of 15 High Performance A/D Converters can be supported by the Computer Front End with 2281A Extender Chassis.
- Each High Performance A/D Converter can support a maximum of five scanners. This limit can be filled with any combination of Thermocouple/DC Volts Scanners (-162) and RTD/Resistance Scanners (-163).
- Each scanner can support 20 measurement channels.
- The normal capacity for the Computer Front End Mainframe is one A/D Converter and five Scanners (i.e., 100 channels). Alternately, up to three A/D Converters could be installed in the Computer Front End if each is associated with only one scanner.
- These same configurations are possible with the 2281A Extender Chassis.

161/High Performance A/D Converter

The High Performance A/D Converter is illustrated in Figure 161-1.

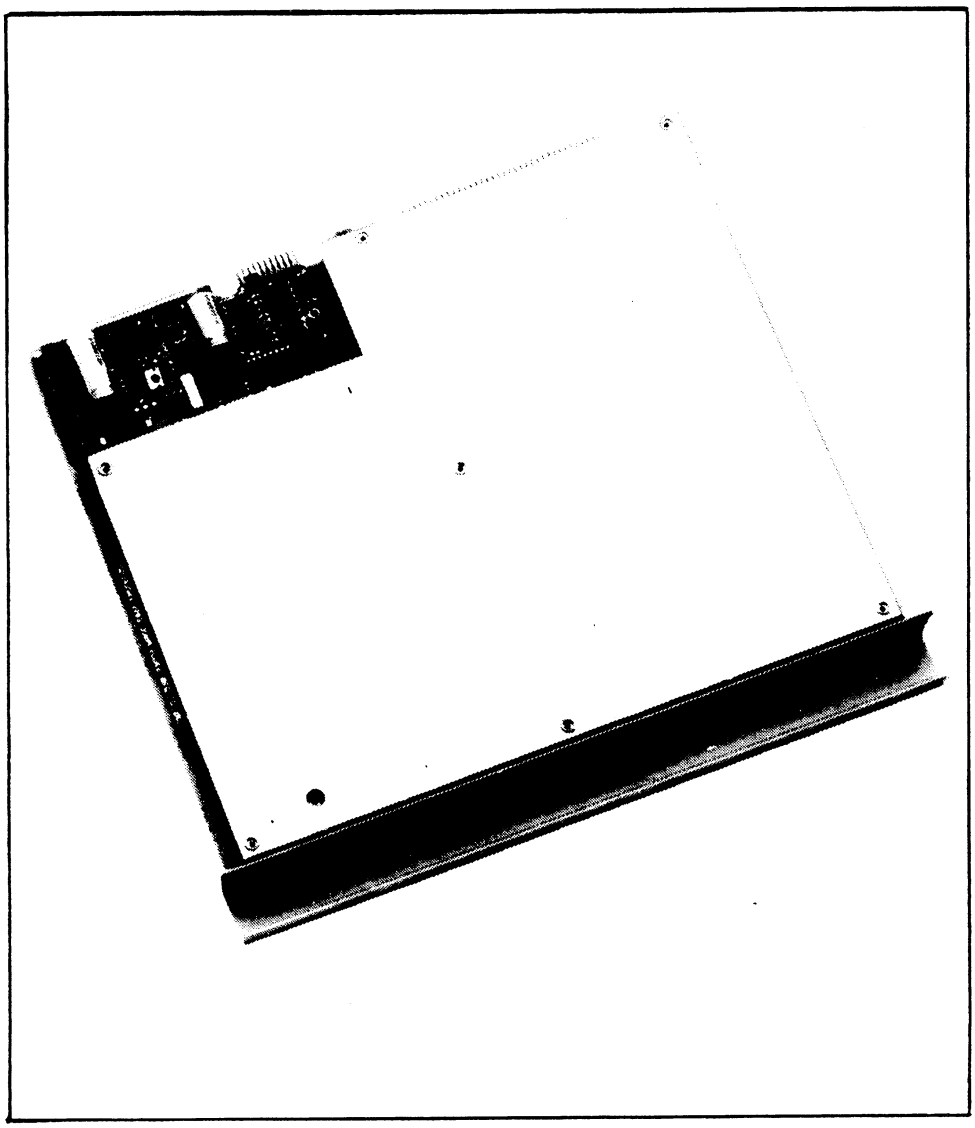


Figure 161-1. High Performance A/D Converter

WHERE TO FIND MORE INFORMATION

This subsection presents general and installation information specifically related to the High Performance A/D Converter.

The High Performance A/D Converter is used with analog measurement functions. These include:

- Section 6B: Current Measurement
- Section 6D: Resistance Measurement, Configuration B
- Section 6H: Temperature Measurement Using RTDs, Configuration B
- Section 6I: Temperature Measurement Using Thermistors
- Section 6J: Temperature Measurement Using Thermocouples
- Section 6L: Voltage Measurement - AC
- Section 6M: Voltage Measurement - DC

Section 3C provides an installation verification procedure.

SPECIFICATIONS

Specifications for the High Performance A/D Converter are presented in Section 2. Section 2 also contains system accuracy specifications for each analog measurement function supported by the A/D Converter.

161/High Performance A/D Converter

HARDWARE CONFIGURATION

An address must be established for each A/D Converter installed in the system. This address identifies the range of channel numbers associated with the A/D Converter. The A/D Converter address corresponds to the "hundreds" digit of the associated channel numbers. This correspondence is defined in Table 161-2. If an A/D Converter is associated with less than 100 channels, the lowest channel addresses available (within the respective block of 100) must be used. Higher, unused addresses are thereby made available for other serial link devices.

Table 161-2. A/D Address Switch Settings and Channel Ranges

ADDRESS SWITCH SETTING	CHANNEL RANGE
0	0-99
1	100-199
2	200-299
3	300-399
4	400-499
5	500-599
6	600-699
7	700-799
8	800-899
9	900-999
10	1000-1099
11	1100-1199
12	1200-1299
13	1300-1399
14	1400-1499
15	NOT USED

The address switch is located in the rear left corner of the board. The switch setting can be viewed through the window labeled ADDRESS.

For each A/D Converter in your system, locate the A/D Converter address switch on the left corner of the A/D Converter board. Using a screwdriver, move the switch to the desired address switch setting.

The High Performance A/D Converter requires no further adjustments.

INSTALLATION

The High Performance A/D Converter is installed in the slot directly above its associated scanner(s). Each High Performance A/D Converter should be installed as follows:

WARNING

ENSURE THAT ALL POWER TO THE MAINFRAME OR EXTENDER CHASSIS IS DISCONNECTED BEFORE STARTING THIS PROCEDURE. LETHAL VOLTAGES MAY BE PRESENT WITHIN THE COMPUTER FRONT END AND ON SOME OPTION CARDS. DO NOT REMOVE ANY INSTRUMENT COVERS UNLESS YOU ARE QUALIFIED TO DO SO. PRESS THE POWER SWITCH TO OFF.

2. Locate the horizontal slot on the rear of the Computer Front End or 2281 where the A/D is to be installed. The A/D Converter should reside directly above its associated scanner(s).

CAUTION

Only handle the assembly by the edges, not including the gold fingers. This avoids contaminating the sensitive circuitry with oil from the hands while minimizing the risk of damage by static discharge.

3. Align the A/D Converter in the desired slot so that the board-edge connector, is toward the motherboard in the rear of the slot. Push the board straight in until it is mated with the motherboard connectors.

4. Secure the A/D Converter to the chassis with the two retaining screws.

INTRODUCTION

The Thermocouple/DC Volts Scanner (-162) is a plug-in, one microvolt, 20-channel thermocouple and multi-voltage range relay scanner contained on a single pwb (printed wiring board). All channels are equipped with three poles, including a Shield input. The scanner operates as a self-calibrating analog multiplexer, linking the A/D Converter to external measurement points. It accepts a variety of analog inputs, depending on the type of connector in use (Current Connector, Isothermal Connector, Voltage Connector, or AC Voltage Connector).

The Thermocouple/DC Volts Scanner must be used with a High Performance A/D Converter. A maximum of five scanners can be used with a single A/D Converter. The Thermocouple/DC Volts Scanner is illustrated in Figure 162-1.

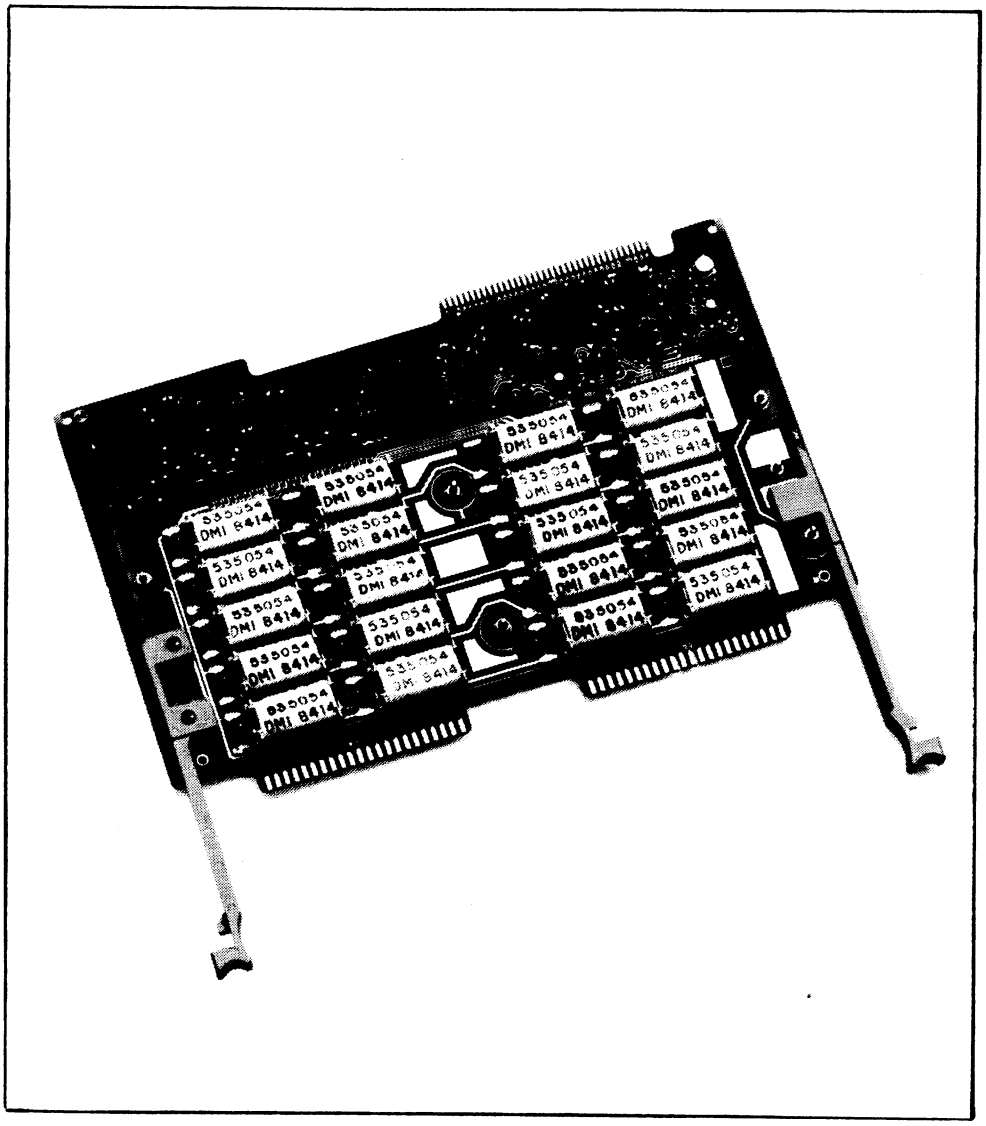


Figure 162-1. Thermocouple/DC Volts Scanner

WHERE TO FIND MORE INFORMATION

This subsection presents general and installation information specifically related to the Thermocouple/DC Volts Scanner.

Where the Thermocouple/DC Volts Scanner is used in a specific measurement function, other sections of this manual provide more appropriate information. Examples include:

- Section 6B: Current Measurement
- Section 6E: Resistance Measurement, Configuration B
- Section 6G: Strain Measurement
- Section 6H: Temperature Measurement Using RTDs, Configuration B
- Section 6J: Temperature Measurement Using Thermocouples
- Section 6L: Voltage Measurement - AC
- Section 6M: Voltage Measurement - DC

Section 3C provides an installation verification procedure.

SPECIFICATIONS

Specifications for the Thermocouple/DC Volts Scanner are presented in Section 2. Section 2 also contains separate system operating specifications for each type of measurement supported by this scanner. These include voltage, current, temperature (using thermocouples), and strain measurements. Measurements using variable resistance transducers (excited by the Transducer Excitation Module/Connector and measured as a dc voltage) are also possible.

INSTALLATION

The Thermocouple/DC Volts Scanners (up to 5 per A/D Converter) are installed in the slot(s) directly below their associated A/D Converter. Install the Thermocouple/DC Volts Scanner using the following procedure:

WARNING

ENSURE THAT ALL LINE POWER TO THE MAINFRAME OR EXTENDER CHASSIS IS DISCONNECTED BEFORE STARTING THIS PROCEDURE. LETHAL VOLTAGES MAY BE PRESENT WITHIN THE COMPUTER FRONT END OR EXTENDER CHASSIS AND ON SOME OPTION CARDS. DO NOT REMOVE ANY INSTRUMENT COVERS UNLESS YOU ARE QUALIFIED TO DO SO.

1. Press the POWER switch to OFF.

2. From the rear of the Computer Front End, identify the mounting slot appropriate for the Thermocouple/DC Volts Scanner(s). A maximum of five scanners may be associated with one A/D Converter. All scanners must be positioned immediately below the associated A/D Converter. Any other serial link device (Counter/Totalizer, Digital I/O Assembly, Analog Output) must not interrupt this hierarchy.

CAUTION

Only handle the assembly by the edges, not including the gold fingers. This avoids contaminating the sensitive circuitry with oil from the hands while minimizing the risk of damage by static discharge.

3. Align the Thermocouple/DC Volts Scanner in the desired slot. The board-edge connector must face in (toward the motherboard).

4. Secure the scanner board in the slot. Push the board straight in until it makes contact with the motherboard connectors. Then continue pressing firmly until it is mated with these connectors. Ensure that the two plastic retainer clips (on either side of the board) snap into the slots on the chassis side wall.

NOTE

To extract the scanner board, first push or pull the plastic retainer handles away from the chassis sides. Then pull the assembly straight out.

Connections must be made between the Thermocouple/DC Volts Scanner and outside measurement points. These external connections are made through a connector card attached to the scanner card. Available connectors are:

- Current Input Connector (-171)
- Isothermal Input Connector (-175)
- Voltage Input Connector (-176)
- AC Voltage Input Connector (-160)

Refer to the appropriate option subsection for complete external connection instructions.

INTRODUCTION

The RTD/Resistance Scanner is a 20-channel resistance measuring scanner. When used with the RTD/Resistance Connector (-177), it can be used to make measurements of resistances and variable resistance transducers. The RTD/Resistance Scanner is illustrated in Figure 163-1.

Resistance measurements are usually made to determine the value of some other parameter that they are directly related to, such as temperature. The Computer Front End software provides the ability to translate resistance measurements made on RTDs into appropriate temperature readings.

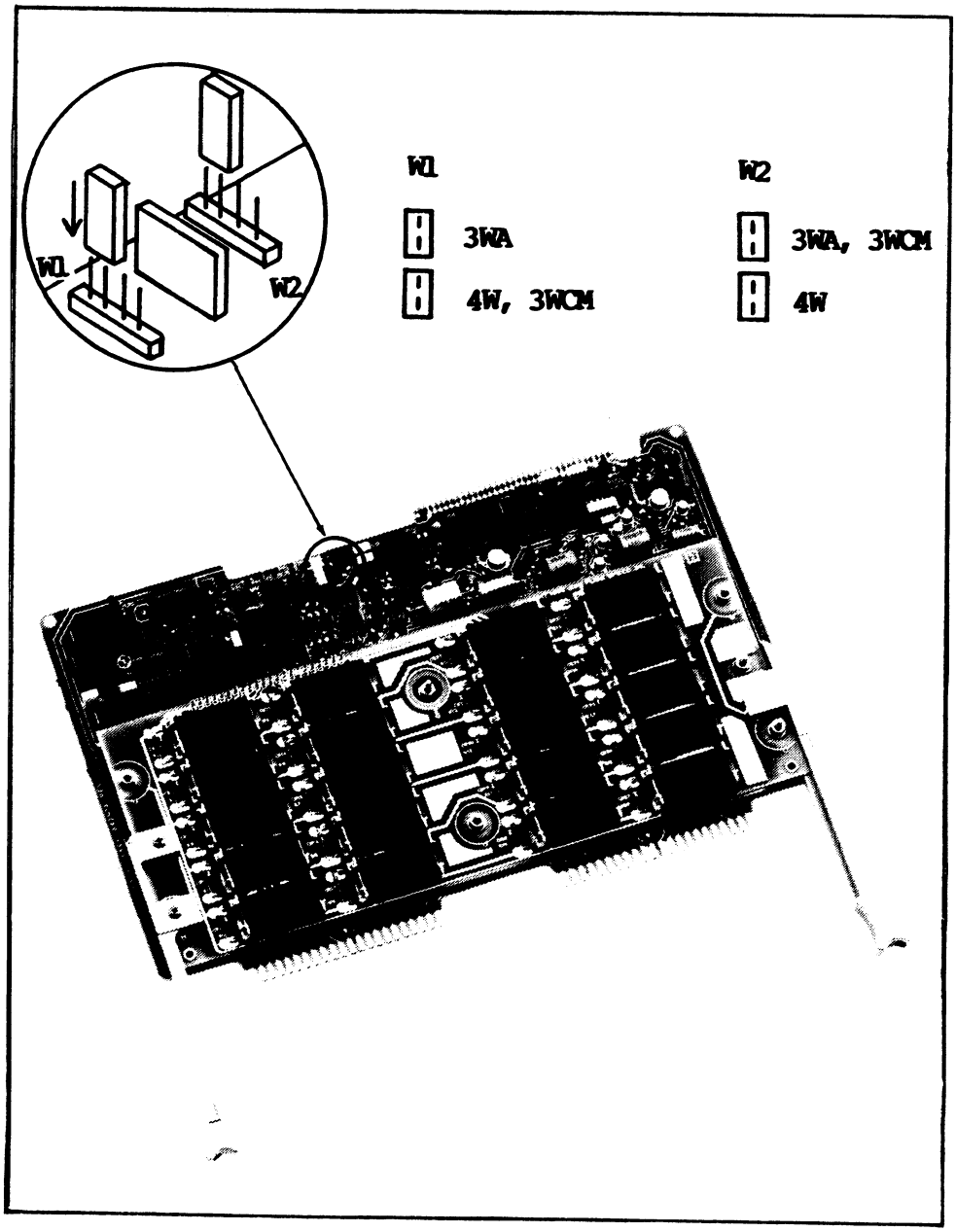


Figure 163-1. RTD/Resistance Scanner

WHERE TO FIND MORE INFORMATION

This subsection presents general and installation information specifically related to the RTD/Resistance Scanner.

Other sections in this manual provide more detailed information when the RTD/Resistance Scanner is to be used to implement a specific measurement function. These sections are:

- Section 6E: Resistance Measurement
- Section 6H: Temperature Measurement Using RTDs, Configuration A.

Section 3C provides an installation verification procedure.

SPECIFICATIONS

Specifications for the RTD/Resistance Scanner are presented in Section 2. Section 2 also contains system accuracy specifications for each type of measurement supported by this scanner. These include Temperature Measurement Using RTDs and Resistance Measurement.

HARDWARE CONFIGURATION

One measurement mode, 4-Wire (4W), 3-Wire Accurate (3WA), or 3-Wire Isolated (3WCM), must be selected prior to physically installing the scanner. This choice is made with the two jumpers shown in Figure 163-1. The measurement modes are described in Section 6E, Resistance Measurement, and Section 6H, Temperature Measurement Using RTDs.

INSTALLATION

The RTD/Resistance Scanner(s), from one to five per A/D Converter, are installed in the slot(s) directly below the A/D Converter with which they are to work. This arrangement must be maintained in the Computer Front End mainframe and the 2281A Extender Chassis. Install each RTD/Resistance Scanner using the following procedure:

WARNING

ENSURE THAT ALL LINE POWER TO THE MAINFRAME OR EXTENDER CHASSIS IS DISCONNECTED BEFORE STARTING THIS PROCEDURE. LETHAL VOLTAGES MAY BE PRESENT WITHIN THE COMPUTER FRONT END, THE 2281A EXTENDER CHASSIS, AND ON SOME OPTION CARDS. DO NOT REMOVE ANY INSTRUMENT COVERS UNLESS YOU ARE QUALIFIED TO DO SO.

1. Press the POWER switch to OFF.

2. From the rear of the Computer Front End or Extender Chassis, identify the mounting slot(s) appropriate for the RTD/Resistance Scanner(s). A maximum of five RTD/Resistance or Thermocouple/DC Volts scanners in any combination may be associated with one A/D Converter. All scanners that are to work with an A/D Converter must be installed immediately below the A/D Converter. This order must not be interrupted by any other serial link device (such as the Counter/Totalizer, Digital I/O, or Analog Output.)

CAUTION

Only handle the assembly by the edges, not including the gold fingers. This avoids contaminating the sensitive circuitry with oil from the hands, while minimizing the risk of damage by static discharge.

3. Align the RTD/Resistance Scanner (component side up) in the desired slot, keeping the two plastic retainer handles located on both side edges pointed away from the motherboard.

4. Secure the scanner board in the slot, by pushing the board straight in until it makes contact with the motherboard connectors, and continuing to press firmly until the board mates fully with the connector. Ensure that the retainer handles snap into the slots on the chassis side wall.

NOTE

To extract the scanner board, first push or pull the plastic retainer handles away from the chassis sides. Then pull the assembly straight out.

Connections between the RTD/Resistance Scanner and outside measurement points are made through the RTD/Resistance Input Connector, which is attached to the rear of the scanner. Wiring from the external resistance to the connector terminals must be made while the connector is physically separated from the scanner. Refer to the RTD/Resistance Input Connector (-177) subsection for complete external connection instructions.

163/RTD/Resistance Scanner

INTRODUCTION

The Transducer Excitation Module and the Transducer Excitation Connector (-174) provide voltage or current excitation for variable resistance transducers. Multiple functions (RTD temperature measurement, strain gauge measurement, strain-based transducers measurement, and low resistance transducer measurement) can thereby be supported.

Measuring the voltage of the stimulated transducer is accomplished with other option assemblies. The Thermocouple/DC Volts Scanner (-162) and either the Voltage Input Connector (-176), the Isothermal Input Connector (-175), or the AC Voltage Input Connector (-160) provide this measurement capability.

The Transducer Excitation Module is shown in Figure 164-1.

164/Transducer Excitation Module

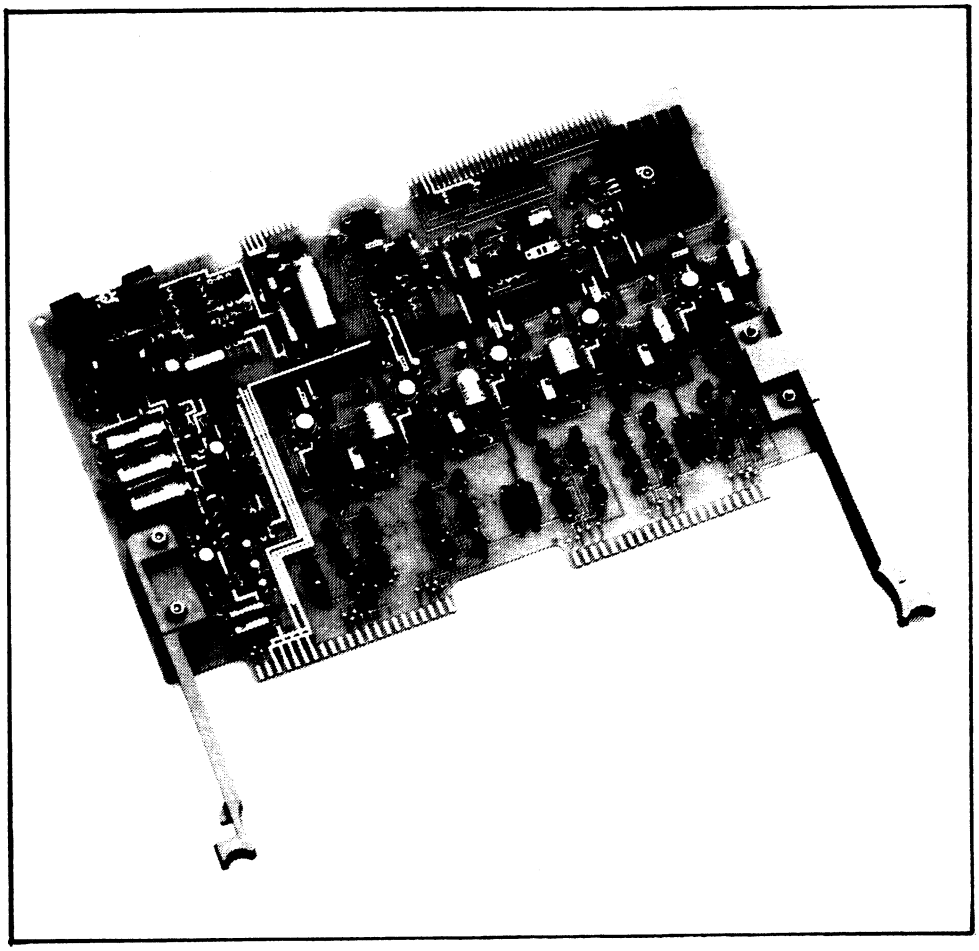


Figure 164-1. Transducer Excitation Module

WHERE TO FIND MORE INFORMATION

This subsection presents general and installation information specifically related to the Transducer Excitation Module.

Where the Transducer Excitation Module is used in a specific measurement function, other sections of this manual provide more appropriate information. Examples include:

- Section 6E: Resistance Measurement, Configuration B
- Section 6G: Strain Measurement
- Section 6H: Temperature Measurement Using RTDs, Configuration B
- Section 6I: Temperature Measurement Using Thermistors

Section 3C provides an installation verification procedure.

SPECIFICATIONS

Specifications for the Transducer Excitation Module are presented in Section 2. Section 2 also contains system accuracy specifications for each type of measurement supported by the module. These include temperature measurements (using RTDs or thermistors), strain measurements and measurements using variable resistance transducers.

HARDWARE CONFIGURATION

Voltage or current excitation is manually selected through positioning of jumper assemblies on the Transducer Excitation Connector. The voltage level, 2V or 4V, is switch-selectable on the Transducer Excitation Module. Refer to the -174 subsection.

INSTALLATION

Physical Installation

The Transducer Excitation Module is installed directly below the associated Thermocouple/DC Volts Scanner in either the Computer Front End mainframe or the 2281A Extender Chassis. Use the following installation procedure:

WARNING

ENSURE THAT ALL LINE POWER TO THE MAINFRAME OR EXTENDER CHASSIS IS DISCONNECTED BEFORE STARTING THIS PROCEDURE. LETHAL VOLTAGES MAY BE PRESENT WITHIN THE COMPUTER FRONT END, THE 2281A EXTENDER CHASSIS, AND ON SOME OPTION CARDS. DO NOT REMOVE ANY INSTRUMENT COVERS UNLESS YOU ARE QUALIFIED TO DO SO.

1. Press the POWER switch to OFF.

2. From the rear of the Computer Front End or Extender Chassis, identify the mounting slot(s) appropriate for the Transducer Excitation Module(s). Each module must occupy a slot immediately below the associated scanner. Any other serial link device (Counter/Totalizer, Digital I/O Assembly, Analog Output) must not interrupt this hierarchy.

CAUTION

Only handle the assembly by the edges, not including the gold fingers. This avoids contaminating the sensitive circuitry with oil from the hands while minimizing the risk of damage by static discharge.

3. Align the Transducer Excitation Module in the desired slot. The board-edge connector must face in (toward the motherboard).

4. Secure the board in the slot. Push the board straight in until it makes contact with the motherboard connectors. Then continue pressing firmly until it is mated with these connectors. Ensure that the two plastic retainer clips (on either side of the board) snap into the slots on the chassis side wall.

NOTE

To extract the module, first push or pull the plastic retainer handles away from the chassis sides. Then pull the assembly straight out.

External Connections

Connections must be made between the Transducer Excitation Module and the external resistance transducer. These external connections are made through the Transducer Excitation Connector, which is attached to the rear of the module. Wiring from the external resistance to the connector terminals must be made while the connector is physically separated from the module.

The connector provides screw terminal connections for 20 channels. RTD channels each require four terminal connections. Strain gauge channels require up to five terminals each.

Channels can be connected in blocks of four, allowing a mixture of RTD and strain gauge connections to the same Transducer Excitation Connector.

Refer to the Transducer Excitation Connector subsection (-174) for complete external connection instructions.

INTRODUCTION

The Counter/Totalizer is a six-channel measurement option that supports two functions: event counting and frequency. The assembly is shown in Figure 167-1.

WHERE TO FIND MORE INFORMATION

This subsection presents general and installation information for the Counter/Totalizer. Application instructions for the Counter/Totalizer are found in the following sections:

- Section 6D: Frequency Measurement
- Section 6K: Totalizing Measurement

Section 3C provides an installation verification procedure.

167/Counter/Totalizer Assembly

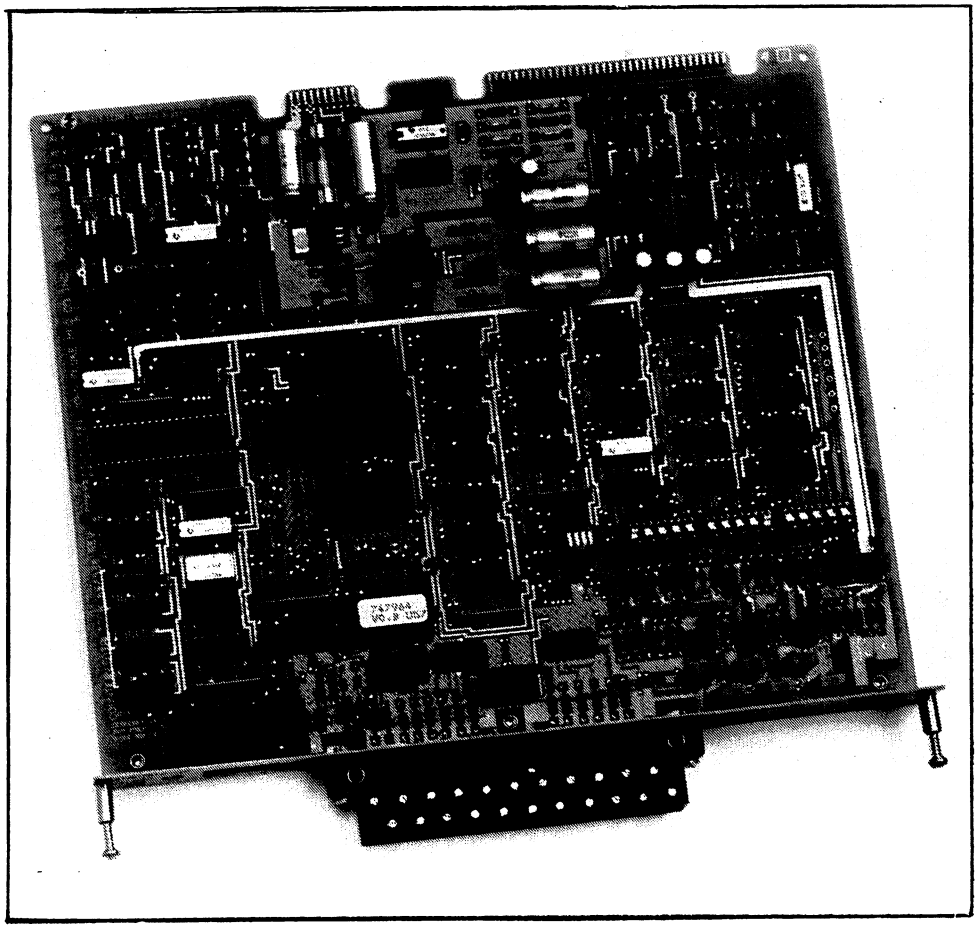


Figure 167-1. Counter/Totalizer Assembly

SPECIFICATIONS

Specifications for the Counter/Totalizer are presented in Section 2. Section 2 also contains system accuracy specifications for frequency and totalizing measurements.

HARDWARE CONFIGURATION

Adjustments

Switches on the Counter/Totalizer assembly select the function of each channel. The assembly also has adjustments that allow it to measure various signal types:

- The reference voltage and input deadband are adjustable. These adjustments define the high and low voltage thresholds of the input.
- Debouncers and input pull-ups allow the Counter/Totalizer to count contact closures.

The intended measurements, either frequency or totalizing, determine the adjustments needed on the Counter/Totalizer assembly. The setup instructions are found in Sections 6D and 6K. Refer to these sections to make the necessary adjustments during installation of the assembly.

167/Counter/Totalizer Assembly

Addressing

The channel decade switches on the Counter/Totalizer determine the channel numbers assigned to the assembly. The switches are accessible through the Counter/Totalizer rear panel. The channel decade switches select the channel numbers as shown in the following example:

ADDRESS SWITCH SETTING		
100's	10's	CHANNELS ASSIGNED
0	0	0 - 5
0	1	10 - 15
0	2	20 - 25
0	3	30 - 35
.		
.		
9	9	990 - 995
.		
.		
14	9	1490 - 1495

Note that position 15 of the hundreds switch is not allowed. If the hundreds switch is set to position 15, the assembly will not respond to any commands.

3. Each channel requires two connections, INPUT and RETURN. The terminal assignments for each channel are listed on the Counter/Totalizer rear panel. The THRESHOLD OUT and VAR REF VOLT OUT terminals are used to adjust the input threshold voltages. Refer to Sections 6D and 6K for instructions on setting the threshold levels for frequency and totalizing measurements.

CAUTION

Since individual channels are not isolated from each other, all RETURN terminals are connected together on the Counter/Totalizer assembly. All RETURN wires must be at the same voltage.

4. For each terminal, loosen the appropriate screw, insert the external wire into the connector, and tighten the screw until the wire is secured.

5. Install the wired connector on the Counter/Totalizer assembly, and secure the connector to the rear panel with the two retaining screws.

167/Counter/Totalizer Assembly

INSTALLATION

Physical Installation

The Counter/Totalizer can be installed in either the Computer Front End mainframe or the 2281A Extender Chassis.

WARNING

ENSURE THAT ALL LINE POWER TO THE MAINFRAME OR EXTENDER CHASSIS IS DISCONNECTED. LETHAL VOLTAGES MAY BE PRESENT WITHIN THE COMPUTER FRONT END AND ON SOME OPTION CARDS. DO NOT REMOVE ANY INSTRUMENT COVERS UNLESS YOU ARE QUALIFIED TO DO SO.

1. Press the POWER switch to OFF. If the Counter/Totalizer is being installed in a 2281A, verify that the POWER indicator is off.

CAUTION

Only handle the assembly by the edges, not including the gold fingers. This avoids contaminating the sensitive circuitry with oil from the hands while minimizing the risk of damage by static discharge.

2. Align the assembly with one of the slots in the back of the instrument. Orient the assembly with the component side up.

3. Slide the assembly into the chassis and press firmly until it is seated in the connectors. Secure the assembly in the chassis using the two rear panel retaining screws.

167/Counter/Totalizer Assembly

External Connections

The individual channels on the Counter/Totalizer assembly are not electrically isolated from each other. However, the entire card is isolated from chassis ground.

WARNING

ENSURE THAT ALL LINE POWER TO THE MAINFRAME OR EXTENDER CHASSIS IS DISCONNECTED. LETHAL VOLTAGES MAY BE PRESENT WITHIN THE COMPUTER FRONT END AND ON SOME OPTION CARDS. DO NOT REMOVE ANY INSTRUMENT COVERS UNLESS YOU ARE QUALIFIED TO DO SO.

1. With line power disconnected and the POWER switch set to OFF, locate the 22-pin screw terminal connector on the Counter/Totalizer at the rear panel of the instrument.

2. Remove the two retaining screws that hold the connector to the rear panel. Remove the connector from the Counter/Totalizer assembly.

WARNING

BE SURE THAT THE WIRES BEING CONNECTED ARE NOT ENERGIZED. IF POSSIBLE, DISCONNECT THESE WIRES AT THE OTHER END. IN ANY EVENT, ENSURE THAT THE EXTERNAL CIRCUIT CONNECTED TO THESE WIRES IS NOT ENERGIZED. LETHAL VOLTAGE COULD OTHERWISE BE ENCOUNTERED.

WHERE TO FIND MORE INFORMATION

This subsection presents general and installation information specifically related to the Digital I/O Assembly.

Additional information for related option assemblies (Status Output Connector and Digital/Status Input Connector) is presented elsewhere in this manual. Related functions are described in the following subsections:

- Section 6C: Digital/Status Input
- Section 6F: Status Output

Section 3C provides an installation verification procedure.

SPECIFICATIONS

Specifications for the Digital I/O Assembly are presented in Section 2.

HARDWARE CONFIGURATION

Addressing

Each Digital I/O Board must be assigned a unique numeric address. The numeric address is derived from the first channel number within the associated channel block. Dividing this channel number by 10 yields the numeric address. For example, for the channel block beginning with channel 200, the first channel (200) divided by 10 is 20 (the address).

168/Digital I/O Assembly

Use the following procedure:

1. With line power disconnected, locate the address switches in the rear left corner of the Digital I/O Board.

2. Access the address switches by removing the Input (or Output) Connector from the Digital I/O Board.

3. Position the address switches to the desired numeric address setting. An appropriate setting corresponds to the block of channels being used.

Addressing depends on channel use as Status I/O or Digital Input. The following paragraphs define the differences.

STATUS I/O

Status input/output addresses each specify a block of 20 channels. For maximum utilization of available channels, only even addresses should be used. The use of odd addresses results in fewer available channels.

ADDRESS	CHANNEL BLOCK
0 0	0 - 19
0 2	20 - 39
0 4	40 - 59
0 6	60 - 79
0 8	80 - 99
1 0	100 - 119
1 2	120 - 139
.	.
.	.
6 8	680 - 699
1 0 0	1000 - 1019
.	.
.	.
1 4 0	1400 - 1419
1 4 8	1480 - 1499

INTRODUCTION

The Digital Input/Output Board allows for information exchange with a digital peripheral device. The four types of exchange are:

- Status Output

  Use the Status Output Connector with the Digital I/O Board. Refer to the -169 subsection.

- Status Input, BCD Input, Binary Input

  A Digital/Status Input Connector (-179) must be configured and used with the Digital I/O Board. Also, for BCD and binary inputs, these digital input devices depend on a handshake procedure to accept data. Refer to the -179 subsection when configuring the Digital/Status Input Connector with the Digital I/O Board.

The Digital I/O Assembly is illustrated in Figure 168-1.

168/Digital I/O Assembly

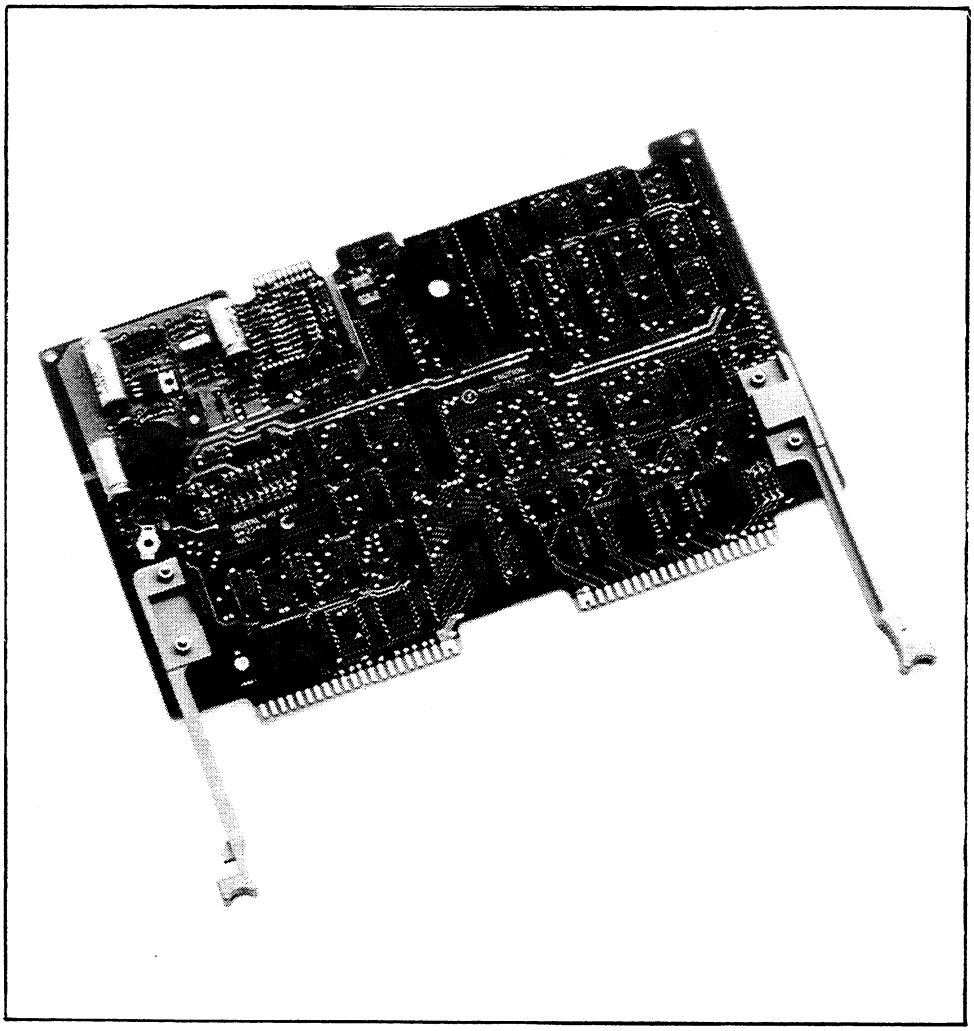


Figure 168-1. Digital I/O Assembly

DIGITAL INPUT

Although each Digital I/O Assembly occupies space for 10 channels, it can support only one digital (BCD or binary) input. As required by the addressing scheme, this input can be addressed as 0 or 10 or any multiple of 10. Some examples:

ADDRESS	CHANNEL
0 0	0
0 1	10
0 2	20
.	.
1 1	110
1 0 3	1030
.	.
1 4 0	1400
1 4 9	1490

Communication Format

As shown above, each Digital I/O Board supports either 20 channels of status input/output or one channel of binary or BCD input.

If a Digital/Status Input Connector (-179) is used with the Digital I/O Board, jumpers must be installed on the connector to configure the Digital I/O Board as desired. These instructions are presented with the -179 information.

INSTALLATION

The Digital Input/Output Board is installed in any one of the available option I/O slots in the Computer Front End or 2281A Extender Chassis. Install the board as follows:

WARNING

ENSURE THAT ALL LINE POWER TO THE COMPUTER FRONT END OR 2281A EXTENDER CHASSIS IS DISCONNECTED BEFORE STARTING THIS PROCEDURE. LETHAL VOLTAGES MAY BE PRESENT WITHIN EITHER UNIT AND ON SOME OPTION CARDS. DO NOT REMOVE ANY INSTRUMENT COVERS UNLESS YOU ARE QUALIFIED TO DO SO.

1. Verify that power is OFF.

CAUTION

Only handle the assembly by the edges, not including the gold fingers. This avoids contaminating the sensitive circuitry with oil from the hands while minimizing the risk of damage by static discharge.

2. From the rear of the instrument, align the Digital I/O board in the desired slot. The board-edge connector must be facing the motherboard.

3. Secure the board in position. Push the board straight in until it is mated with the motherboard connectors. Verify that the plastic retainers snap into place as the connector mates.

3. Close the housing over the input connector, ensuring that the external wires exit the rear of the enclosure without being pinched.

Connector Installation

1. With line power disconnected and the POWER switch set at OFF, position the enclosed (and wired) input connector in the guides of the rear panel slot containing the appropriate I/O Assembly.

2. Push the connector onto the card edge connector at the rear of the scanner. Press the connector firmly into place.

3. Attach the connector housing to the chassis with the two retaining screws.

NOTE

If the Digital I/O Board is also being used as a relay driver, the flyback diode terminals on the Status Output Connector must be used to suppress the voltage spike that is generated when the relay coil is shut off. The flyback diodes are connected to different channel blocks on the 20-channel Status Output Connector and are marked: CLAMP 0-6, CLAMP 7-13, and CLAMP 14-19. The 20 output channels may be protected by connecting the proper pin to the coil voltage of the relays being driven. See Figures 169-2 and 169-3. Users wishing to drive relays at varying coil voltages with a single group of channels should provide flyback protection using discrete components.

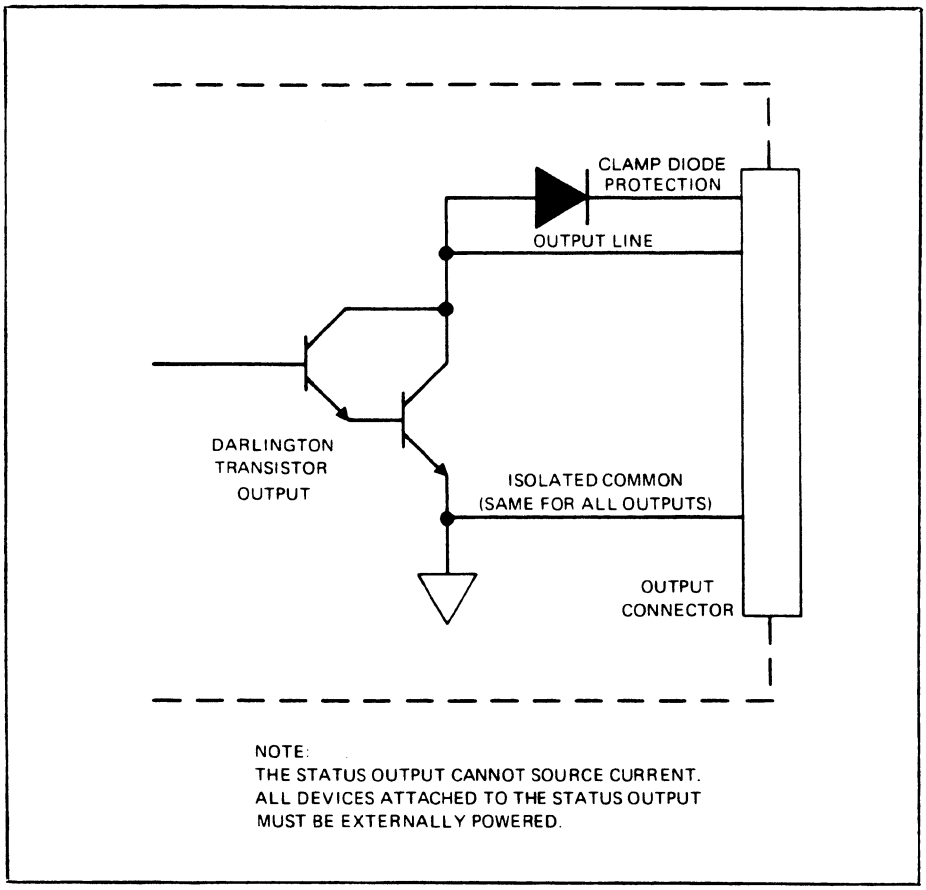


Figure 169-2. Equivalent Circuit for Each Status Output Signal

SPECIFICATIONS

Specifications for the Status Output Connector are presented in Section 2.

REMOVAL AND INSTALLATION

Connections from external control points or terminals to the Computer Front End are made via external wiring to the Status Output Connector. Preparation of the Status Output Connector involves opening the connector housing, connecting the appropriate wiring on the terminals, closing the connector housing, and reconnecting it to the Digital I/O Board. The following steps detail this procedure:

WARNING

BEFORE REMOVING OR INSTALLING THE CONNECTOR, ENSURE THAT ALL LINE POWER TO THE FRONT END IS DISCONNECTED. LETHAL VOLTAGES MAY BE PRESENT WITHIN THE COMPUTER FRONT END AND ON SOME OPTION CARDS. DO NOT REMOVE ANY INSTRUMENT COVERS UNLESS YOU ARE QUALIFIED TO DO SO.

The connector is designed so that installation can be accomplished without removing the associated I/O Assembly.

Connector Removal

If the connector is already installed, but needs new or changed wiring connections, perform the following initial procedure:

1. With line power disconnected and the POWER switch set at OFF, locate the connector housing in the rear panel of the Computer Front End.

2. Loosen the two retaining screws that hold the housing to the chassis.

3. Firmly grasp the housing at each end and pull until the enclosed connector block is disconnected from the I/O Assembly.

External Connections

With the connector withdrawn from the Front End or Extender Chassis, perform the following steps:

WARNING

BE SURE THAT THE WIRES BEING CONNECTED ARE NOT ENERGIZED. IF POSSIBLE, DISCONNECT THESE WIRES AT THE OTHER END. IN ANY EVENT, ENSURE THAT THE EXTERNAL CIRCUIT CONNECTED TO THESE WIRES IS NOT ENERGIZED. LETHAL VOLTAGE COULD OTHERWISE BE ENCOUNTERED.

1. Open the housing by pressing each locking tab.

WARNING

SINCE INDIVIDUAL CHANNELS ARE NOT ISOLATED FROM EACH OTHER, ALL RETURN TERMINALS ARE CONNECTED TOGETHER ON THE STATUS OUTPUT CONNECTOR. ALL RETURN WIRES MUST BE AT THE SAME VOLTAGE.

2. The connector is now ready to be wired to external measurement systems. For each connection, loosen the channel terminal screw, attach the external wire to the screw, then tighten the screw until the wire is firmly in place. Notice that the two terminals for each channel are marked OUTPUT and RETURN.

INTRODUCTION

The Status Output Connector can send 20 single-bit output signals from the Digital I/O board to external control points or terminals. Each output is individually selectable and can be used either to drive lamps and relays or change logic levels.

The Status Output Connector is mounted to the 44-pin card-edge connector on the left, rear side of the Digital I/O Board. The connector assembly is enclosed in a plastic housing, allowing protection for the terminal connections and strain relief for the external wiring. The Status Output Connector is illustrated in Figure 169-1.

WHERE TO FIND MORE INFORMATION

This subsection presents general and installation information specifically related to the Status Output Connector. Applications are discussed in:

- Section 6F: Status Output

Section 3C provides an installation verification procedure.

169/Status Output Connector

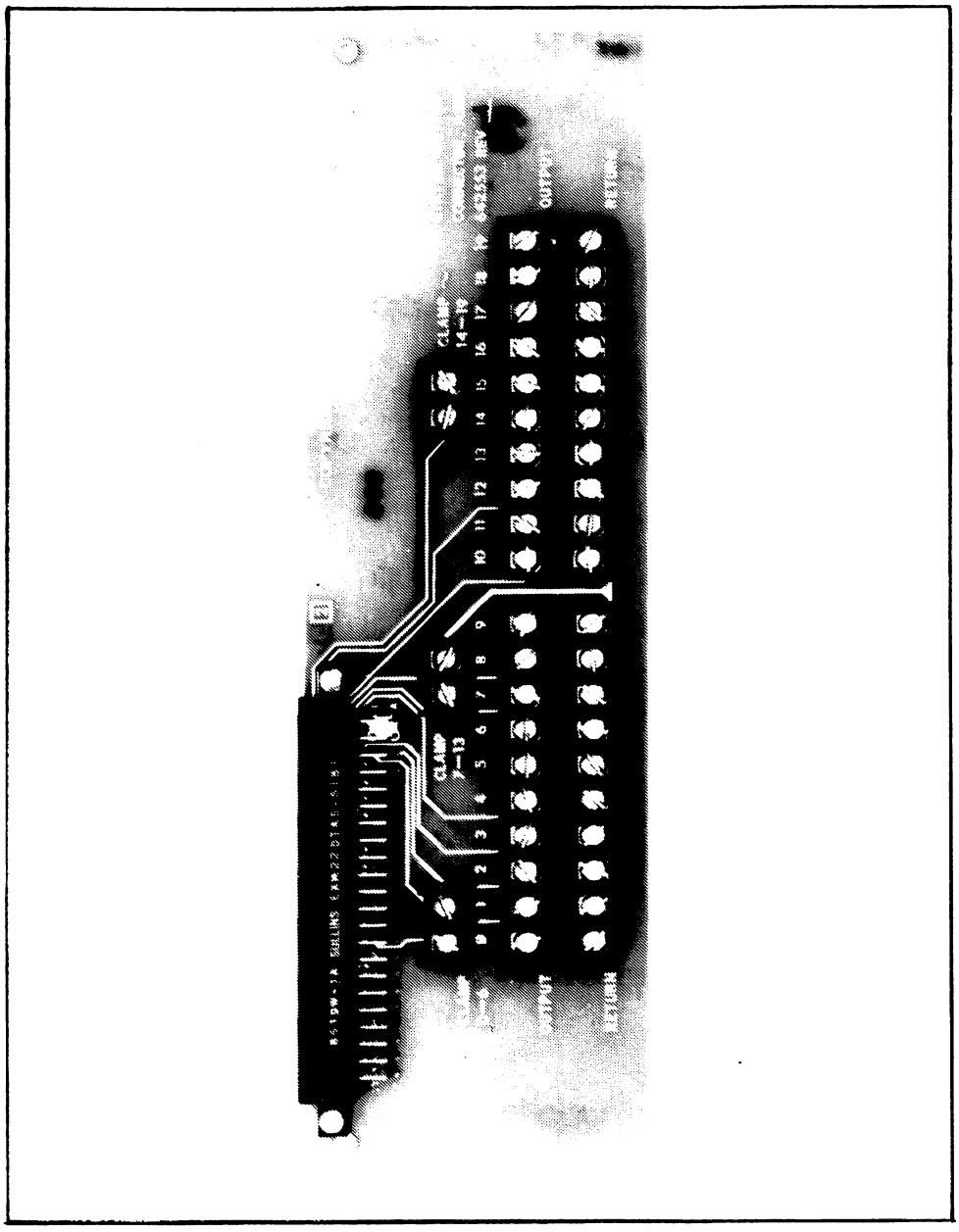


Figure 169-1. Status Output Connector

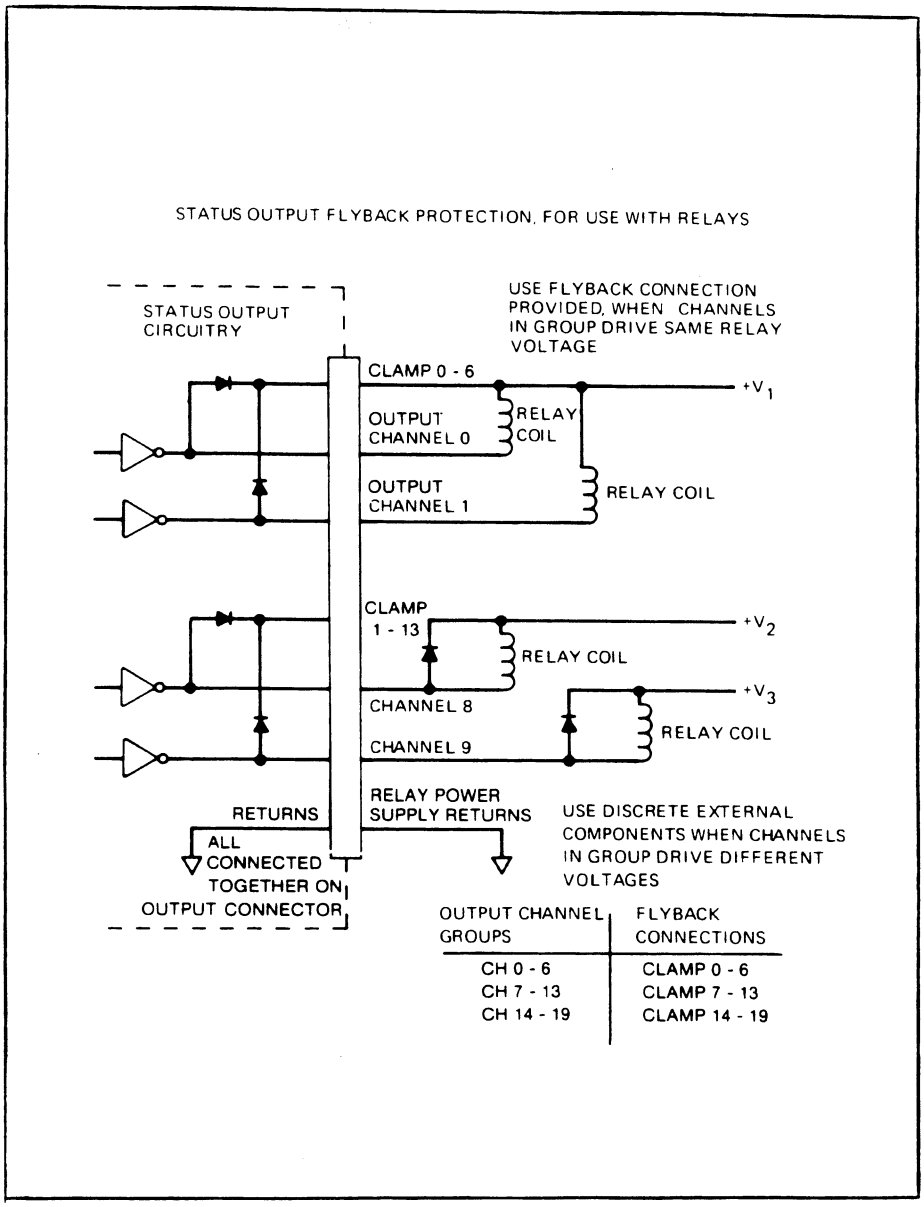


Figure 169-3. Status Output Flyback Protection

169/Status Output Connector

SPECIFICATIONS

Specifications for the Analog Output are presented in Section 2.

HARDWARE CONFIGURATION

Address selection sets the channel numbers for each of the four output channels. These switches are accessible through the rear panel of the Analog Output and can be set at any time.

The addressing procedure uses two switches to select the hundreds and tens address for the four channels on the assembly. Table 170-1 further identifies the correspondence between the switch settings and the analog output channel numbers.

Table 170-1. Addressing

ADDRESS SWITCH SETTING		
100's	10's	CHANNELS ASSIGNED
0	0	0 - 3
0	1	10 - 13
0	2	20 - 23
.		
.		
9	9	990 - 993
.		
.		
14	9	1490 - 1493

INSTALLATION

External Connections

The individual channels on an Analog Output are not electrically isolated from each other. However, the entire card is isolated from chassis ground.

Each channel requires two terminal connections. But five screw terminal connections are provided on each of the four output channels. Connecting the correct two terminals on a given channel defines the type of output (current or voltage) for that channel. The three possibilities are:

- Current: 4-20 mA "SOURCE" to "RETURN"
- Unipolar Voltage: VOLTAGE "SOURCE" to "0 TO 10V RTN"
- Bipolar Voltage: VOLTAGE "SOURCE" to "-5 TO +5 V RTN"

WARNING

BE SURE THAT THE WIRES BEING CONNECTED ARE NOT ENERGIZED. IF POSSIBLE, DISCONNECT THESE WIRES AT THE OTHER END. IN ANY EVENT, ENSURE THAT THE EXTERNAL CIRCUIT CONNECTED TO THESE WIRES IS NOT ENERGIZED. LETHAL VOLTAGES COULD OTHERWISE BE ENCOUNTERED.

For each terminal, loosen the appropriate screw, attach the external wire to the screw, then tighten the screw until the wire is firmly in place. Connections are summarized in Table 170-2.

INTRODUCTION

The Analog Output option provides four voltage or current output channels. The Analog Output is shown in Figure 170-1.

WHERE TO FIND MORE INFORMATION

This subsection presents general and installation information related to the Analog Output. Related applications are discussed in:

- Section 6A: Analog Output

Section 3C provides an installation verification procedure.

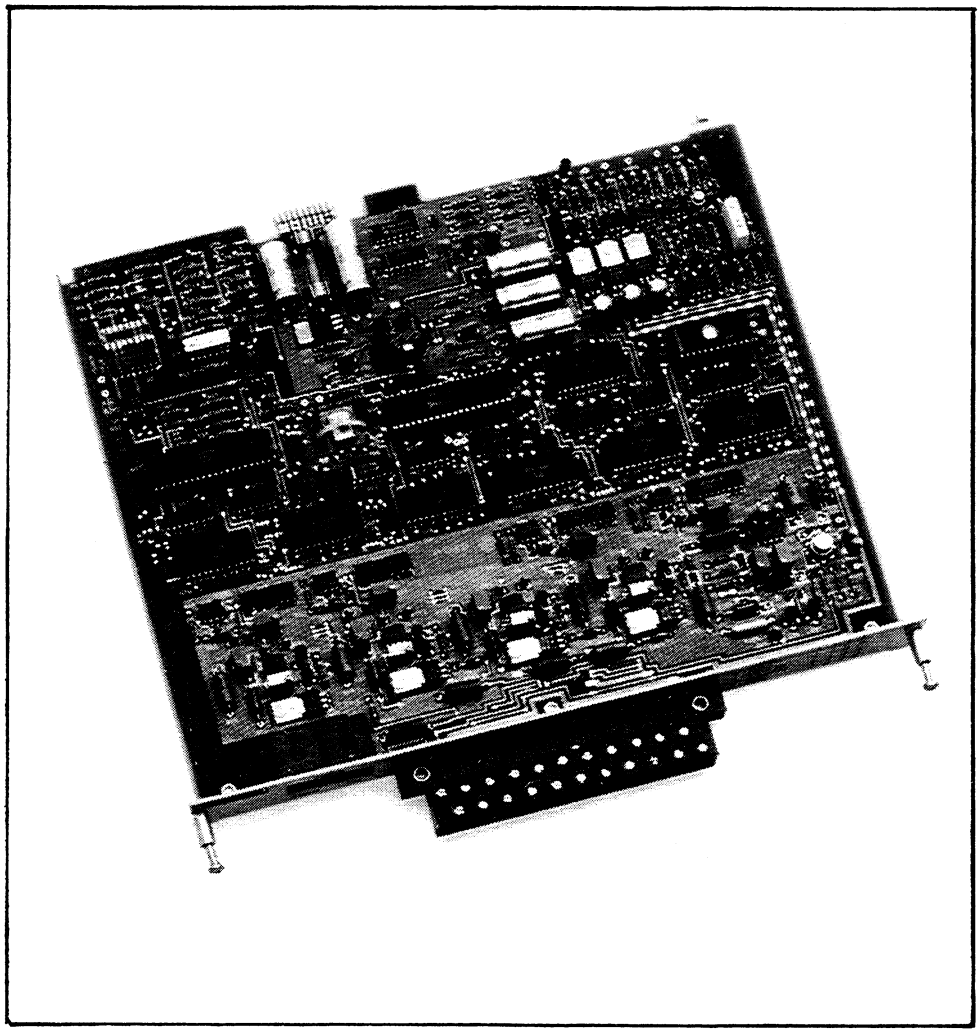


Figure 170-1. Analog Output

INTRODUCTION

The Current Input Connector routes a maximum of 20 current input channels to the scanner. The connector consists of an assembly that mounts to the rear 88-pin card-edge connector on the scanner. The connector assembly is enclosed in a plastic housing to protect the terminal connections and provide strain relief for the external wiring. The Current Input Connector is illustrated in Figure 171-1.

Each connector channel uses two screw terminals (HIGH and LOW) and one resistor. The shield is internally connected to LOW (no separate screw terminal is provided for the shield).

171/Current Input Connector

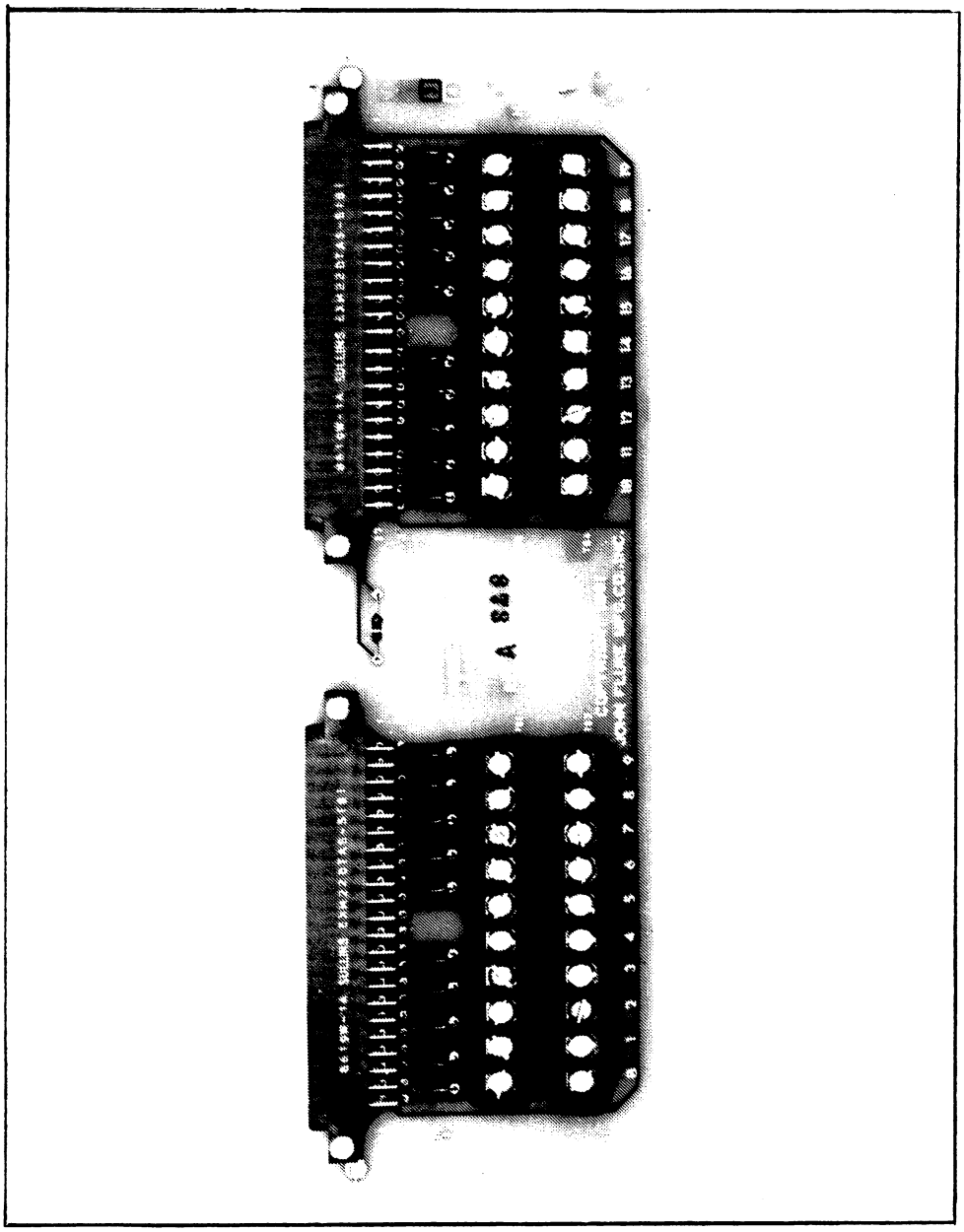


Figure 171-1. Current Input Connector

Table 170-2. External Connections

CHANNEL	SIGNAL NAME		TERMINAL NUMBER
0	VOLTAGE	SOURCE	1
		0 TO 10V RTN	2
		-5 TO +5V RTN	3
	4-20 mA	SOURCE	4
		RETURN	5
1	VOLTAGE	SOURCE	6
		0 TO 10V RTN	7
		-5 TO +5V RTN	8
	4-20 mA	SOURCE	9
		RETURN	10
2	VOLTAGE	SOURCE	11
		0 TO 10V RTN	12
		-5 TO +5V RTN	13
	4-20 mA	SOURCE	14
		RETURN	15
3	VOLTAGE	SOURCE	16
		0 TO 10V RTN	17
		-5 TO +5V RTN	18
	4-20 mA	SOURCE	19
		RETURN	20

CAUTION

Although they are independent of each other, each type of return (0 TO 10V RTN, -5 TO +5V RTN, and RETURN) is common among channels. Do not connect different potentials to the same type of return.

170/Analog Output

Physical Installation

Use the following procedure when installing the Analog Output:

WARNING

ENSURE THAT ALL LINE POWER TO THE COMPUTER FRONT END OR 2281A EXTENDER CHASSIS IS DISCONNECTED BEFORE STARTING THIS PROCEDURE. LETHAL VOLTAGES MAY BE PRESENT WITHIN EITHER UNIT AND ON SOME OPTION CARDS. DO NOT REMOVE ANY INSTRUMENT COVERS UNLESS YOU ARE QUALIFIED TO DO SO.

1. Press the POWER switch to OFF. If an Analog Output is being installed in the 2281A, verify that the POWER indicator is off.

CAUTION

Only handle the assembly by the edges, not including the gold fingers. This avoids contaminating the sensitive circuitry with oil from the hands while minimizing the risk of damage by static discharge.

2. Align the Analog Output in the desired slot. The board-edge connector must face in (toward the motherboard).

3. Secure the Analog Output in the slot. Push the board straight in until it makes contact with the motherboard connectors. Then continue pressing firmly until it is mated with these connectors. Now secure the two retaining screws to the chassis.

Connector Installation

1. With line power disconnected and the POWER switch set at OFF, position the enclosed (and wired) input connector in the guides of the rear panel slot containing the appropriate scanner.

2. Push the connector onto the card edge connector at the rear of the scanner. Press the connector firmly into place.

3. Attach the connector housing to the chassis with the two retaining screws.

171/Current Input Connector

WHERE TO FIND MORE INFORMATION

This subsection presents general and installation information specifically related to the Current Input Connector. Applications for the connector are covered in:

- Section 6B: Current Measurement

Section 3C provides an installation verification procedure.

SPECIFICATIONS

Specifications for the Current Input Connector are presented in Section 2. Section 2 also contains system accuracy specifications for current measurement.

REMOVAL AND INSTALLATION

Connections from external current sources to the Front End or Extender Chassis are made via external wiring to the Current Input Connector. Preparation of the Current Input Connector involves opening the connector housing, connecting the appropriate wiring on the terminals, closing the connector housing, and reconnecting it to the Thermocouple/DC Volts Scanner (-162).

WARNING

BEFORE REMOVING OR INSTALLING THE CONNECTOR, ENSURE THAT ALL LINE POWER TO THE FRONT END IS DISCONNECTED. LETHAL VOLTAGES MAY BE PRESENT WITHIN THE COMPUTER FRONT END AND ON SOME OPTION CARDS. DO NOT REMOVE ANY INSTRUMENT COVERS UNLESS YOU ARE QUALIFIED TO DO SO.

The connector is designed so that installation can be accomplished without removing the associated scanner.

171/Current Input Connector

Connector Removal

If the connector is already installed, but needs new or changed wiring connections, perform the following initial procedure:

1. With line power disconnected and the POWER switch set at OFF, locate the connector housing in the rear panel of the Computer Front End.

2. Loosen the two retaining screws that hold the housing to the chassis.

3. Firmly grasp the housing at each end and pull until the enclosed connector block is disconnected from the scanner.

External Wiring

With the connector withdrawn from the Front End or Extender Chassis, perform the following steps:

WARNING

BE SURE THAT THE WIRES BEING CONNECTED ARE NOT ENERGIZED. IF POSSIBLE, DISCONNECT THESE WIRES AT THE OTHER END. IN ANY EVENT, ENSURE THAT THE EXTERNAL CIRCUIT CONNECTED TO THESE WIRES IS NOT ENERGIZED. LETHAL VOLTAGE COULD OTHERWISE BE ENCOUNTERED.

1. Open the housing by pressing each locking tab.

2. Loosen the each channel terminal screw, attach the external wire to the screw, then tighten the screw. Ensure that current flows into the HI terminal and out of the LO terminal.

3. Close the housing over the input connector, ensuring that the external wires exit the rear of the enclosure without being pinched.

WHERE TO FIND MORE INFORMATION

This subsection presents general and installation information specifically related to the Transducer Excitation Connector.

Where the Transducer Excitation Connector is used in a specific application, the following sections provide more appropriate information. Examples include:

- Section 6E: Resistance Measurement, Configuration B
- Section 6G: Strain Measurement
- Section 6H: Temperature Measurement Using RTDs, Configuration B
- Section 6I: Temperature Measurement Using Thermistors

Section 3C provides an installation verification procedure.

SPECIFICATIONS

Specifications for the Transducer Excitation Module (-164) and the Transducer Excitation Connector (-174) are presented in Section 2. Section 2 also contains system accuracy specifications relating use of the module and the connector in providing voltage or current stimulation to various types of measurement transducers. Applicable measurement types include strain, temperature (using RTDs and thermistors), and other resistance measurements.

174/Transducer Excitation Connector

INSTALLATION

Applications using the Transducer Excitation Module/Connector involve both excitation and measurement connections.

Initially, each group of four channels must be configured for voltage or current excitation by correctly positioning the respective jumper on the Transducer Excitation Connector (-174). Refer to the connector decal for details.

Briefly, installation involves first making external connections to the Transducer Excitation Connector. Interconnections are then made between this connector (which performs the excitation function) and the connector performing the measurement function. Measurement is actually a dc voltage function and can be accomplished with any of the following three input connectors: Voltage Input Connector, Isothermal Input Connector, or AC Voltage Input Connector (dc terminals).

The connector (excitation or measurement) must then be attached to the appropriate option assembly already installed in the Computer Front End. For the excitation function, this is the Transducer Excitation Module. The measurement function uses the Thermocouple/DC Volts Scanner.

Wire Connections

The following procedure describes Transducer Excitation Connector installation on two levels. First, wiring connections are explained. This procedure involves interconnections between the measurement connector (Voltage Input Connector, Isothermal Input Connector, or AC Voltage Input Connector) and the Transducer Excitation Connector. It also requires connections between the Transducer Excitation Connector and the external measurement source.

INTRODUCTION

The Transducer Excitation Module (-164) and the Transducer Excitation Connector (-174) provide voltage or current excitation for variable resistance transducers. Multiple functions such as RTD temperature measurement, strain gage measurement, strain-based transducers measurement, and low resistance transducer measurement can thereby be supported.

Measuring the voltage of the stimulated transducer is accomplished with other option assemblies. The Thermocouple/DC Volts Scanner (-162) and either the Voltage Input Connector (-176), the Isothermal Input Connector (-175), or the AC Voltage Input Connector (-160) provide this measurement capability.

The Transducer Excitation Connector is illustrated in Figure 174-1.

174/Transducer Excitation Connector

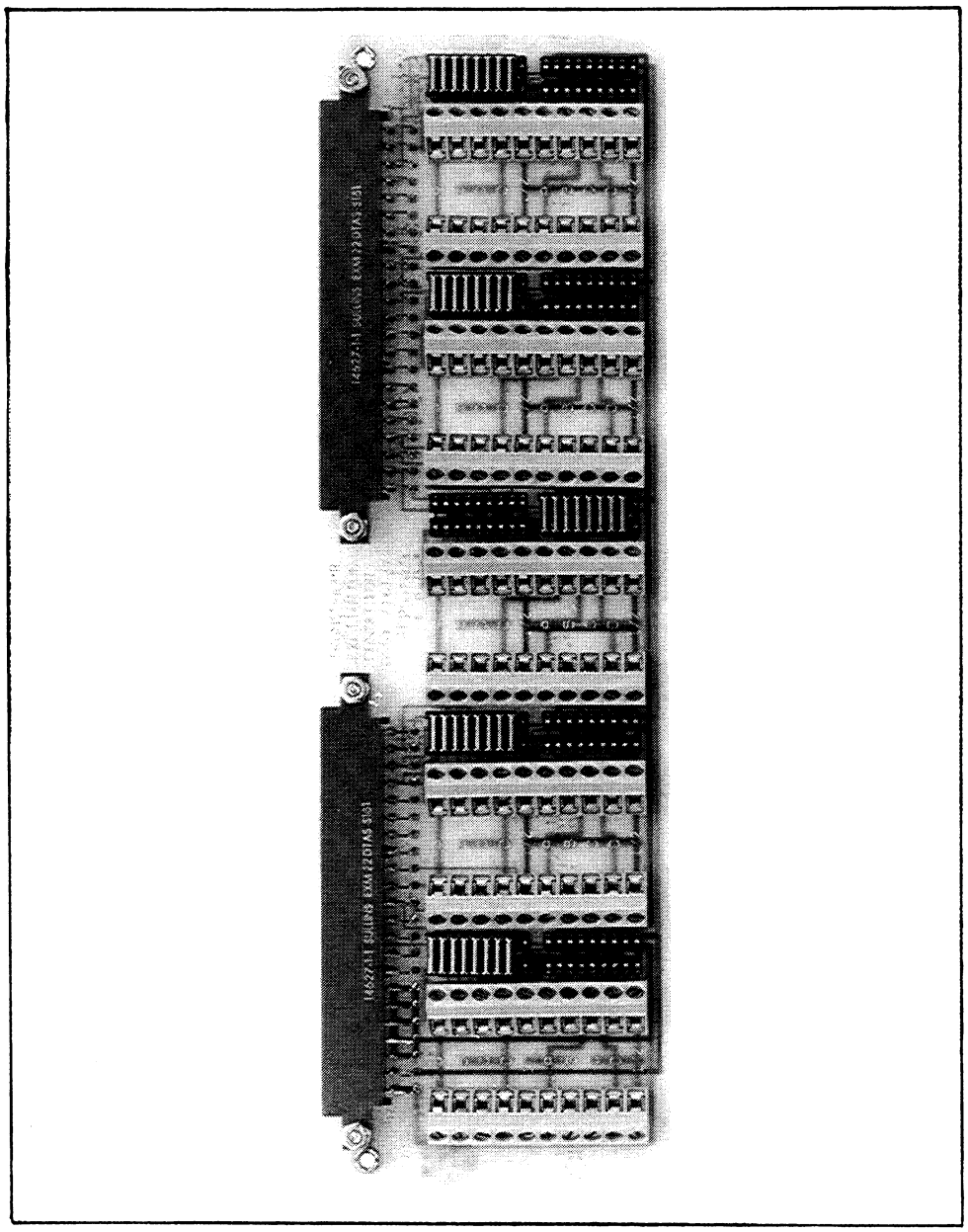


Figure 174-1. Transducer Excitation Connector

Connector Installation

WARNING

BEFORE INSTALLING THE WIRED INPUT CONNECTOR AT THE COMPUTER FRONT END REAR PANEL, ENSURE THAT ALL LINE POWER TO THE MAINFRAME OR EXTENDER CHASSIS IS DISCONNECTED. LETHAL VOLTAGES MAY BE PRESENT WITHIN THE COMPUTER FRONT END AND ON SOME OPTION CARDS. DO NOT REMOVE ANY INSTRUMENT COVERS UNLESS YOU ARE QUALIFIED TO DO SO.

Complete the installation by physically installing the connectors as follows:

1. Position the enclosed (and wired) connectors in the guides of the appropriate Computer Front End rear panel slots. Ideally, the Thermocouple/DC Volts Scanner will occupy the slot immediately above that used by the Transducer Excitation Module.

2. Push the connector onto the card edge connection until it is fully engaged.

3. Attach each connector housing to the chassis with the retaining screws.

174/Transducer Excitation Connector

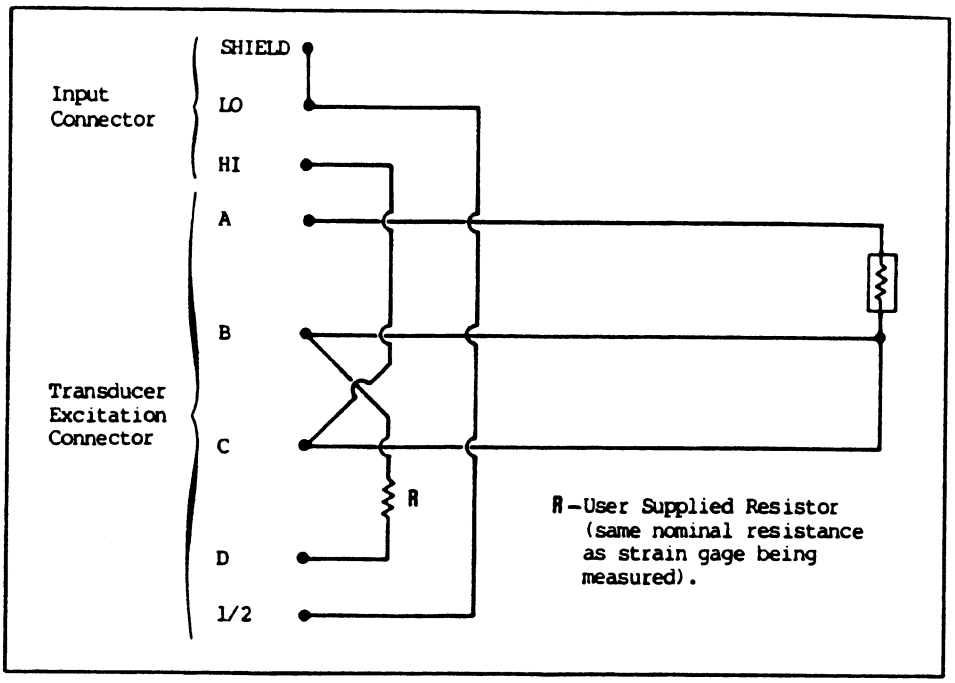


Figure 174-2. Wiring (1/4-Bridge Strain)

174/Transducer Excitation Connector

Once the Transducer Excitation Connector has been wired, it can be installed on the rear of the Transducer Excitation Module. Installation explanations for the measurement connector (Voltage Input Connector, Isothermal Input Connector, or AC Voltage Input Connector) are covered in the appropriate subsection (-176, -175, or -160, respectively).

NOTE

Install the Transducer Excitation Module/Connector directly below the scanner/connector being used for the interconnections. This arrangement allows for maximum ease of installation.

1. Ensure that line power is disconnected and the POWER switch is set to OFF.

2. Open the Transducer Excitation Connector housing by gently pressing each locking tab.

WARNING

BE SURE THAT THE WIRES BEING CONNECTED ARE NOT ENERGIZED. IF POSSIBLE, DISCONNECT THESE WIRES AT THE OTHER END. IN ANY EVENT, ENSURE THAT THE EXTERNAL CIRCUIT CONNECTED TO THESE WIRES IS NOT ENERGIZED. LETHAL VOLTAGE COULD OTHERWISE BE ENCOUNTERED.

3. Familiarize yourself with the connecting terminal arrangement.

   - Five connecting terminals are available for each channel.

   - Twenty sets of terminals are provided on each input connector.

4. Wiring between the connectors and from the Transducer Excitation Connector to the external measurement source depends on the type of measurement being made. The figures mentioned below can be found at the end of this subsection.

   - Strain measurements must be wired according to Figure 174-2, 174-3, or 174-4 for 1/4-, 1/2-, or full-bridge configurations, respectively.

   - RTD measurements using a 3-wire, constant voltage source must use the wiring shown in Figure 174-5.

   - RTD measurements using a 3-wire, constant current source must use the wiring shown in Figure 174-6.

   - RTD measurements using a 4-wire arrangement must use the wiring shown in Figure 174-7.

   - Each group of four channels must be configured for voltage or current excitation by positioning a jumper on the Transducer Excitation Connector. Refer to the connector decal for details.

5. For each connection, loosen the channel terminal screw, attach the external wire (or jumper) to the screw, then tighten the screw until the wire is firmly in place.

6. For each connector, close the housing and ensure that the external wires exit the rear of the enclosure without being pinched.

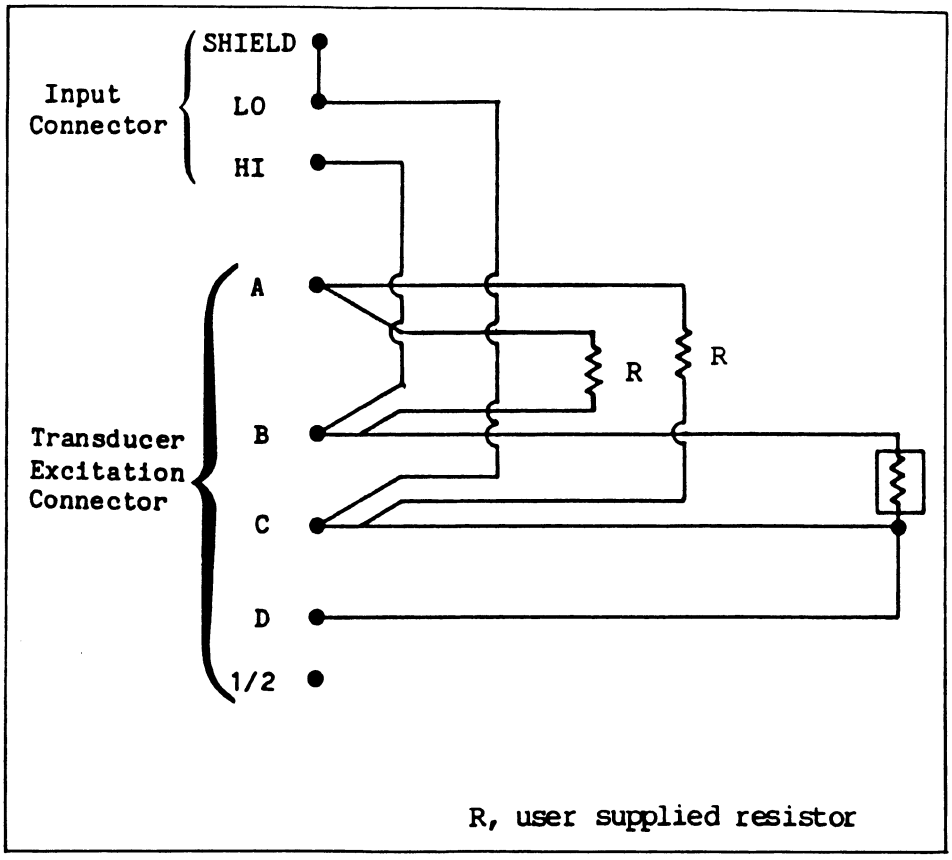


Figure 174-5. Wiring (3-Wire RTD, Constant Voltage)

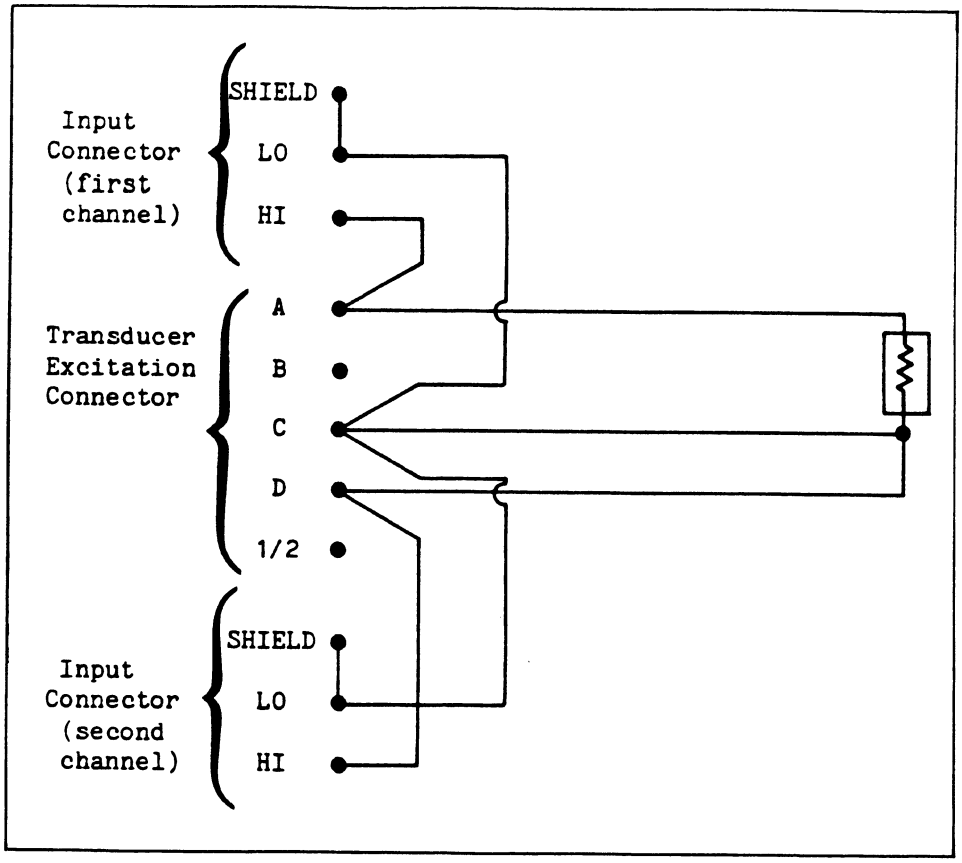


Figure 174-6. Wiring (3-Wire RTD, Constant Current)

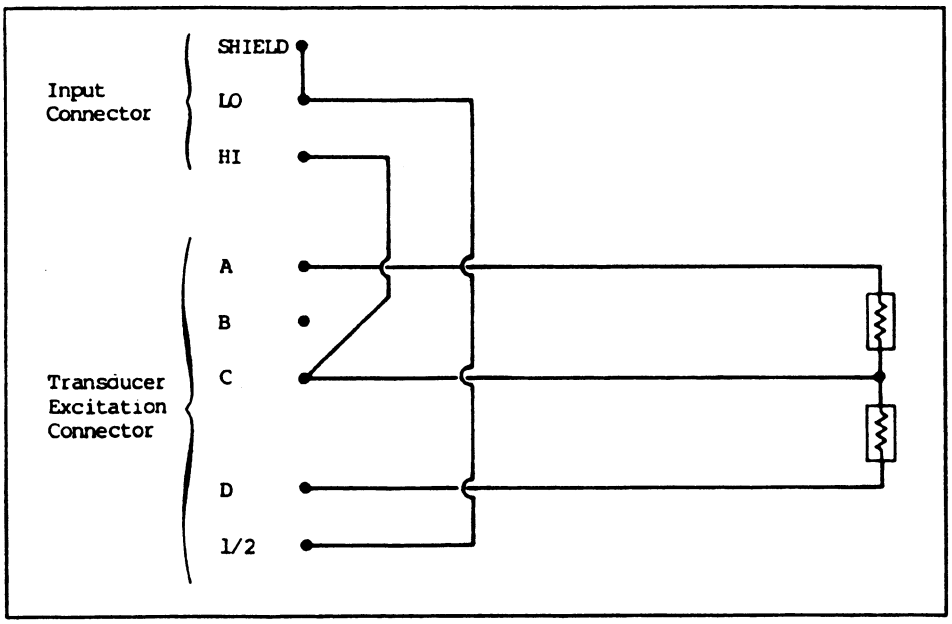


Figure 174-3. Wiring (1/2-Bridge Strain)

174/Transducer Excitation Connector

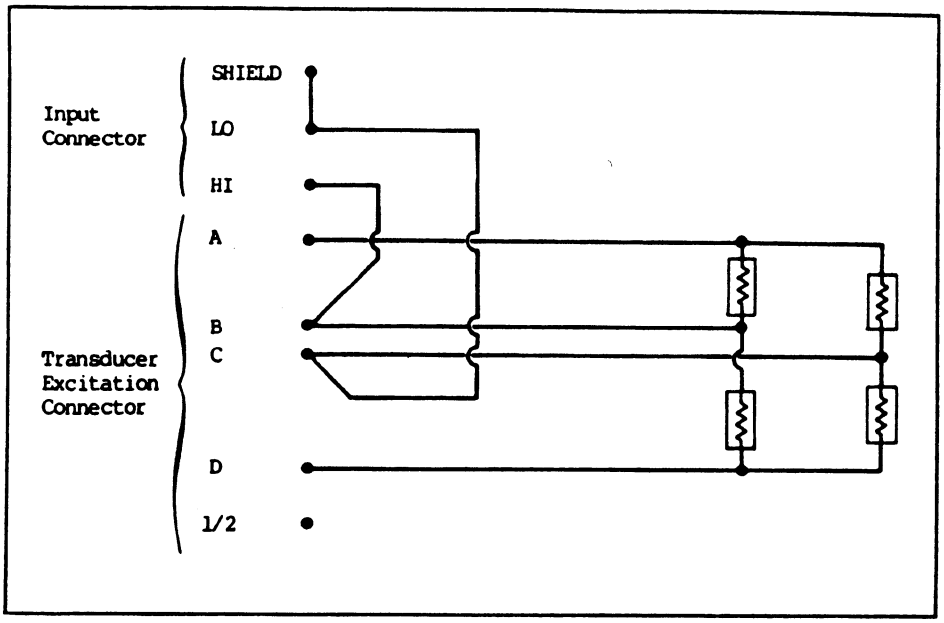


Figure 174-4. Wiring (Full-Bridge Strain)

INTRODUCTION

The Isothermal Input Connector routes a maximum of 20 thermocouple or voltage input channels to the scanner. The connector attaches to the 88-pin edge connector at the rear of the scanner card. The Isothermal Input Connector is illustrated in Figure 175-1.

The connector assembly is enclosed in a plastic housing. This arrangement provides protection for the terminal connections and strain relief for the external wiring. Retaining screws secure the housing to the scanner chassis.

Each Input Connector channel uses three screw terminals (HIGH, LOW, and SHIELD). Each terminal can withstand a maximum of 250 volts rms. An isothermal block of aluminum surrounding the terminals helps to maintain a uniform temperature among all channel terminals.

175/Isothermal Input Connector

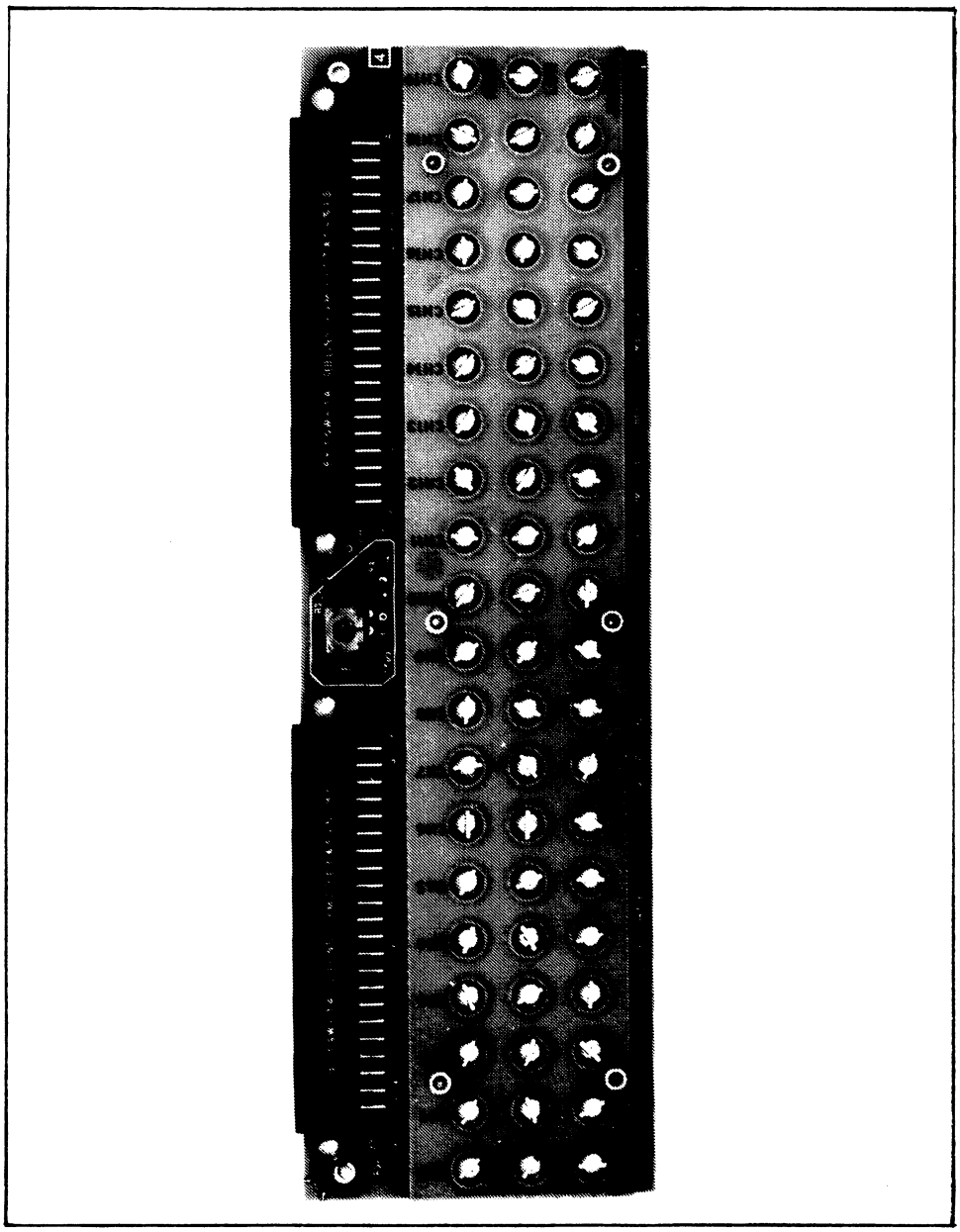


Figure 175-1. Isothermal Input Connector

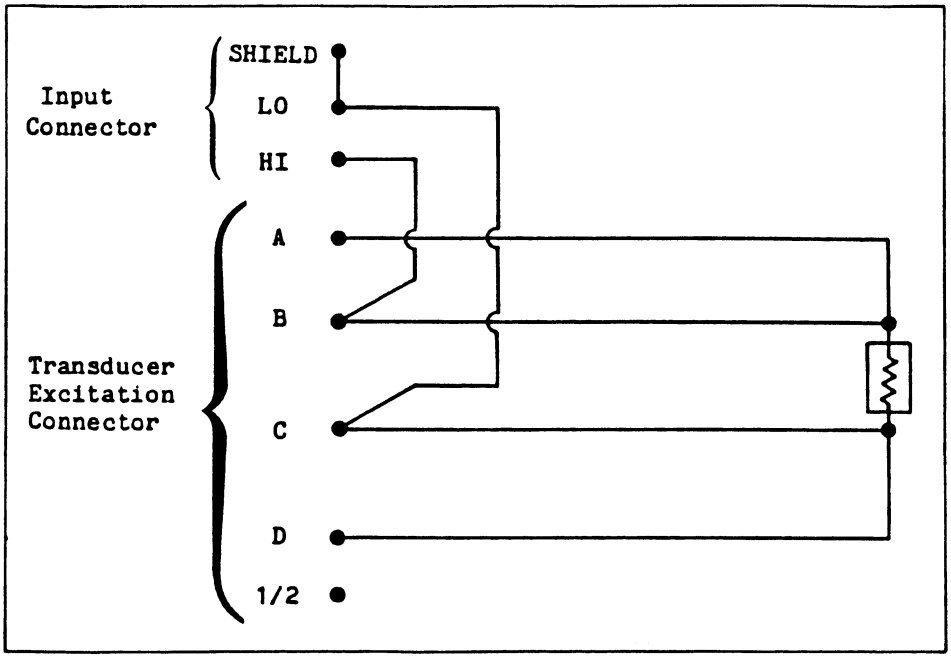


Figure 174-7. Wiring (4-Wire RTD, Constant Current)

174/Transducer Excitation Connector

Shield Considerations

Current resulting from a capacitive charge and discharge between the A/D Converter and the chassis can produce unstable readings. Therefore, a path for this current is utilized by connecting the SHIELD lead to the LOW lead at the measurement point. This arrangement (shown in Figure 175-2) improves common-mode noise rejection.

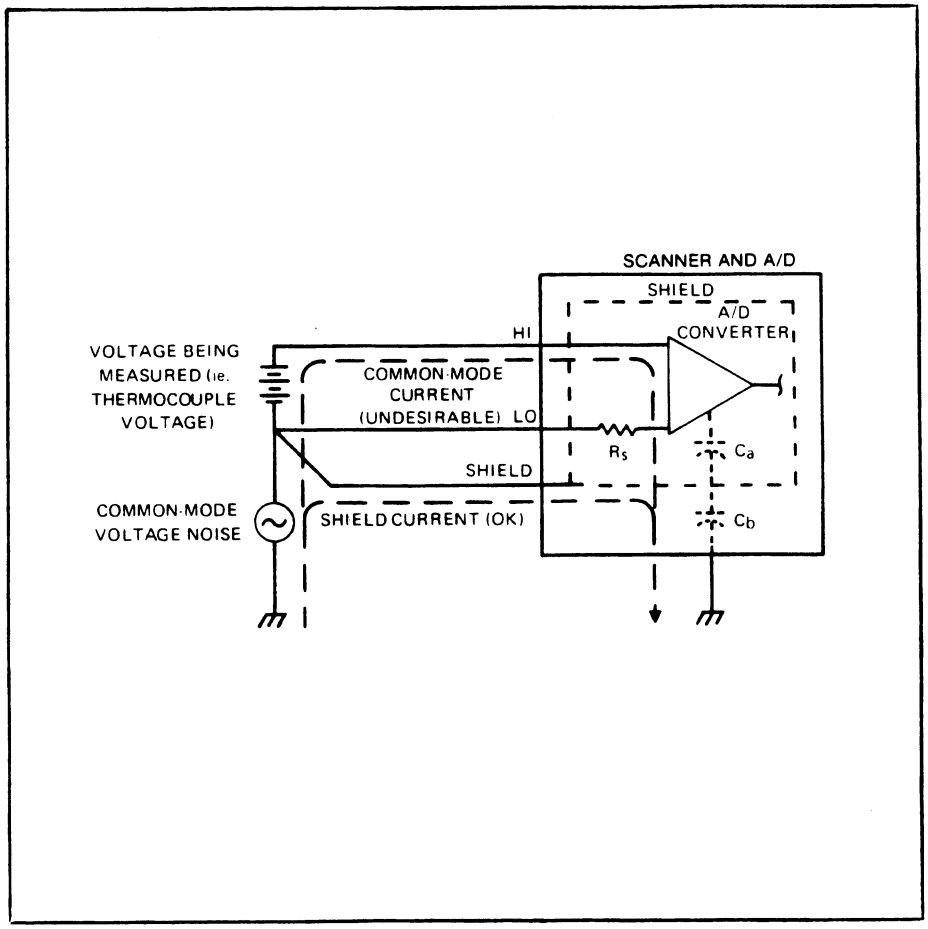


Figure 175-2. Shield Connection for Optimum Common Mode Rejection

175/Isothermal Input Connector

With the A/D Converter and the instrument shield tracking the same voltage, common-mode current in the HI and LOW leads is minimized. Note that HI, LOW and Shield are fully isolated and capable of being safely floated to 250 volts above ground.

Use the following SHIELD guidelines when connecting the Isothermal Input Connector:

1. If significant RFI (Radio Frequency Interference) or EMI (Electro-Magnetic Interference) is present, the best measurement results are obtained by connecting SHIELD to LOW (on the input connector) with the shortest possible path.

2. If significant common mode voltage (greater than one volt) is present, connect SHIELD to LOW by means of a third wire at the measurement point. This arrangement is shown in Figure 175-2.

3. Never tie SHIELD to HI. This may actually amplify the effects of noise on the signal, causing a degradation in measurement performance.

4. Never leave SHIELD unconnected. Static charge buildup may cause the maximum SHIELD to LOW voltage to be exceeded, resulting in instrument damage.

5. Never connect SHIELD to earth ground unless the LOW terminal is also grounded. This results in greatly increased common mode currents due to the large value of capacitance between the Shield and the A/D Converter.

WHERE TO FIND MORE INFORMATION

This subsection presents general and installation information specifically related to the Isothermal Input Connector.

Other sections provide information related to specific applications. These include:

- Section 6J: Temperature Measurement Using Thermocouples.

- Other measurement functions use the dc voltage measurement capabilities of the Isothermal Input Connector. These include

  - Section 6H: Temperature Measurement Using RTDs, Configuration B
  - Section 6M: Voltage Measurement - DC
  - Section 6G: Strain Measurement
  - Section 6E: Resistance Measurement, Configuration B

Section 3C provides an installation verification procedure.

SPECIFICATIONS

Specifications for the Isothermal Input Connector are presented in Section 2. Section 2 also contains system accuracy specifications for the types of measurements supported by this connector (thermocouple temperature measurements and dc voltage measurements).

175/Isothermal Input Connector

REMOVAL AND INSTALLATION

Connections from external measurement sources to the Computer Front End are made via wiring to the input connector block. Installation of the Isothermal Connector involves assembling and connecting the wires to the terminals, and attaching the connector to the appropriate scanner.

WARNING

BEFORE REMOVING OR INSTALLING THE CONNECTOR, ENSURE THAT ALL LINE POWER TO THE FRONT END IS DISCONNECTED. LETHAL VOLTAGES MAY BE PRESENT WITHIN THE COMPUTER FRONT END AND ON SOME OPTION CARDS. DO NOT REMOVE ANY INSTRUMENT COVERS UNLESS YOU ARE QUALIFIED TO DO SO.

The connector is designed so that installation can be accomplished without removing the associated scanner.

Connector Removal

If the connector is already installed, but needs new or changed wiring connections, perform the following initial procedure:

1. With line power disconnected and the POWER switch set at OFF, locate the connector housing in the rear panel of the Computer Front End.

2. Loosen the two retaining screws that hold the housing to the chassis.

3. Firmly grasp the housing at each end and pull until the enclosed connector block is disconnected from the scanner.

Thermocouple Connections

The Isothermal Input Connector is now ready to be wired to the external thermocouples. For each connection, loosen the channel terminal screw, attach the external wire to the screw, then tighten the screw until the wire is firmly in place. Notice that the three terminals for each channel are marked HIGH, LOW, and SHIELD. Starting at Channel 0, attach the external wiring for the desired application.

WARNING

BE SURE THAT THE WIRES BEING CONNECTED ARE NOT ENERGIZED. IF POSSIBLE, DISCONNECT THESE WIRES AT THE OTHER END. IN ANY EVENT, ENSURE THAT THE EXTERNAL CIRCUIT CONNECTED TO THESE WIRES IS NOT ENERGIZED. LETHAL VOLTAGE COULD OTHERWISE BE ENCOUNTERED.

NOTE

For proper reading polarity, ensure that the red lead is always connected to LO and the remaining lead is always connected HIGH.

Close the housing over the input connector, ensuring that the external wires exit the rear of the enclosure without being pinched.

175/Isothermal Input Connector

Connector Installation

Complete the Isothermal Input Connector installation:

1. Position the assembled input connector in the guides of the Computer Front End rear panel slot containing the appropriate scanner.

2. Push the connector firmly into place on the card edge connector at the rear of the scanner.

3. Attach the connector housing to the chassis with the two retaining screws.

WHERE TO FIND MORE INFORMATION

This subsection presents general and installation information specifically related to the Voltage Input Connector. Where the Voltage Input Connector is used in a specific measurement function, other sections of the this manual provide more appropriate information. Examples include:

- Section 6E: Resistance Measurement, Configuration B
- Section 6G: Strain Measurement
- Section 6H: Temperature Measurement Using RTDs, Configuration B
- Section 6I: Temperature Measurement Using Thermistors, Configuration B
- Section 6M: Voltage Measurement - DC

Section 3C provides an installation verification procedure.

SPECIFICATIONS

Specifications for the Voltage Input Connector are presented in Section 2. Section 2 also contains system accuracy specifications for dc voltage measurement.

176/Voltage Input Connector

REMOVAL AND INSTALLATION

External measurement sources are connected to the Computer Front End via wiring to the input connector block. Installation of the Voltage Input Connector involves assembling and connecting wiring to the terminals and attaching the connector to the appropriate scanner.

WARNING

BEFORE REMOVING OR INSTALLING THE CONNECTOR, ENSURE THAT ALL LINE POWER TO THE FRONT END IS DISCONNECTED. LETHAL VOLTAGES MAY BE PRESENT WITHIN THE COMPUTER FRONT END AND ON SOME OPTION CARDS. DO NOT REMOVE ANY INSTRUMENT COVERS UNLESS YOU ARE QUALIFIED TO DO SO.

The connector is designed so that installation can be accomplished without removing the associated scanner.

Connector Removal

If the connector is already installed, but needs new or changed wiring connections, perform the following initial procedure:

1. With line power disconnected and the POWER switch set at OFF, locate the connector housing in the rear panel of the Computer Front End.

2. Loosen the two retaining screws that hold the housing to the chassis.

3. Firmly grasp the housing at each end and pull until the enclosed connector block is disconnected from the scanner.

INTRODUCTION

The Voltage Input Connector routes a maximum of 20 voltage input channels to the scanner. The connector assembly is enclosed in a plastic connector housing both for protection of the terminal connections and strain relief for the external wiring. This assembly is mounted to the 88-pin card-edge connector on the rear of the scanner. Retaining screws attach this housing to the chassis. The Voltage Input Connector is illustrated in Figure 176-1.

Each Input Connector channel uses three screw terminals (HIGH, LOW, and SHIELD). Each terminal can withstand a maximum of 250 volts rms.

176/Voltage Input Connector

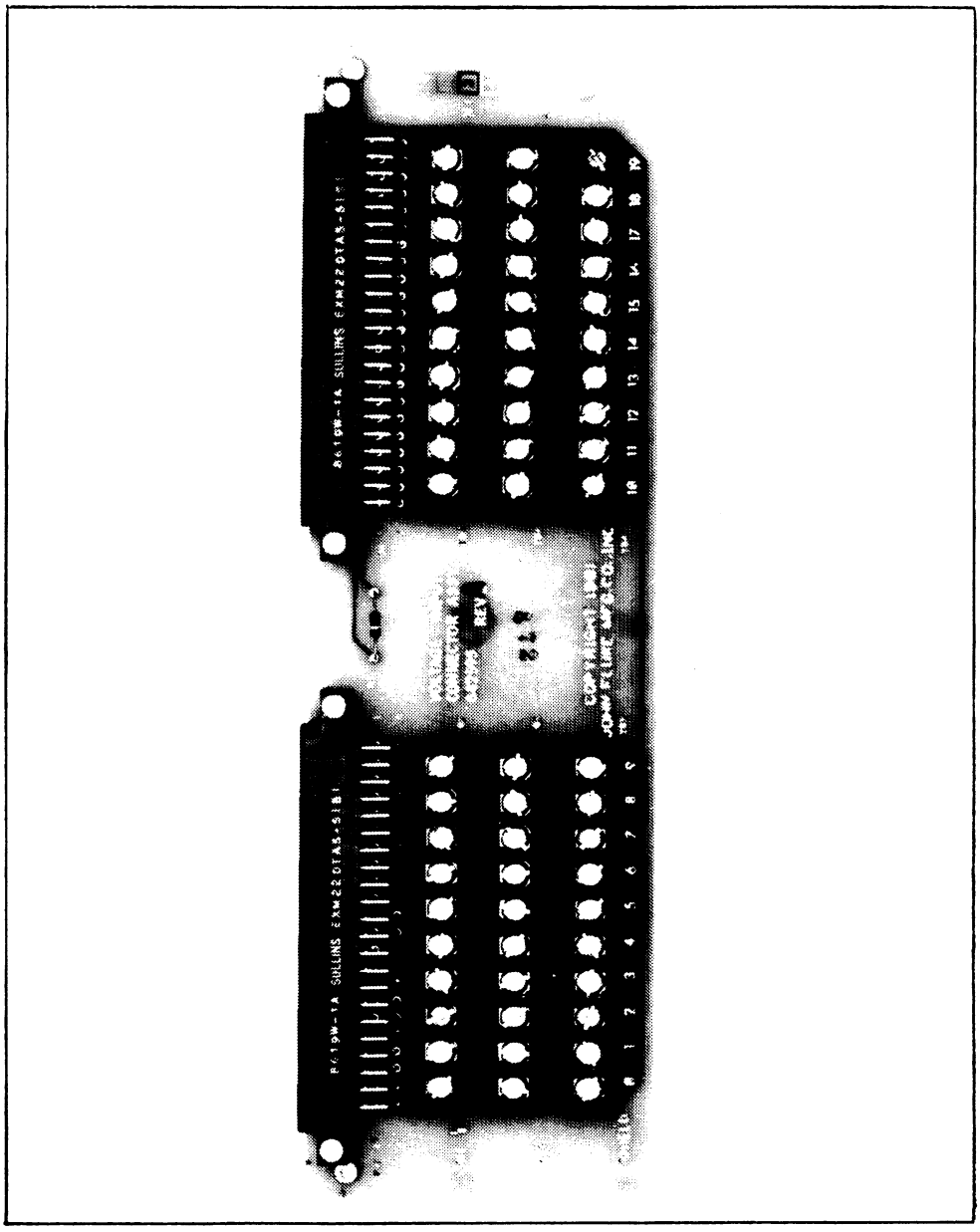


Figure 176-1. Voltage Input Connector

External Wire Connections

WARNING

BE SURE THAT THE WIRES BEING CONNECTED ARE NOT ENERGIZED. IF POSSIBLE, DISCONNECT THESE WIRES AT THE OTHER END. IN ANY EVENT, ENSURE THAT THE EXTERNAL CIRCUIT CONNECTED TO THESE WIRES IS NOT ENERGIZED. LETHAL VOLTAGE COULD OTHERWISE BE ENCOUNTERED.

The Voltage Input Connector is now ready to be wired to external measurement systems. Proceed as follows:

1. For each connection, loosen the channel terminal screw, attach the external wire to the screw, then tighten the screw until the wire is firmly in place.

2. Notice that the three terminals for each channel are marked HIGH, LOW, and SHIELD. Starting at Channel 0, attach the external wiring for the desired application. Observe proper polarity.

3. Close the housing over the input connector, ensuring that the external wires exit the rear of the enclosure without being pinched.

Connector Installation

Complete the Voltage Input Connector Installation:

1. Position the enclosed (and wired) input connector in the guides of the Computer Front End rear panel slot containing the appropriate scanner.

2. Push the connector firmly into place on the card-edge connector at the rear of the scanner.

3. Attach the connector housing to the chassis with the two retaining screws.

176/Voltage Input Connector

Shield Considerations

Current resulting from a capacitive charge and discharge between the A/D Converter and the chassis can produce unstable readings. Therefore, a path for this current is utilized by connecting the SHIELD lead to the LOW lead at the measurement point. This arrangement (shown in Figure 176-2) improves common-mode noise rejection. With the A/D Converter and the instrument shield tracking the same voltage, common-mode current in the HI and LOW leads is minimized. Note that HI, LOW and Shield are fully isolated and capable of being safely floated to 250 volts above ground.

Use the following guidelines when connecting the Voltage Input Connector:

1. If significant RFI (Radio Frequency Interference) or EMI (Electro-Magnetic Interference) is present, the best measurement results are obtained by connecting SHIELD to LOW (on the input connector) with the shortest possible path.

2. If significant common mode voltage (greater than one volt) is present, connect SHIELD to LOW by means of a third wire at the measurement point. This arrangement is shown in Figure 176-2.

3. Never tie SHIELD to HI. This may actually amplify the effects of noise on the signal, causing a degradation in measurement performance.

4. Never leave SHIELD unconnected. Static charge buildup may cause the maximum SHIELD to LOW voltage to be exceeded, resulting in instrument damage.

5. Never connect SHIELD to earth ground unless the LOW terminal is also grounded. This results in greatly increased common mode currents due to the large value of capacitance between the Shield and the A/D Converter.

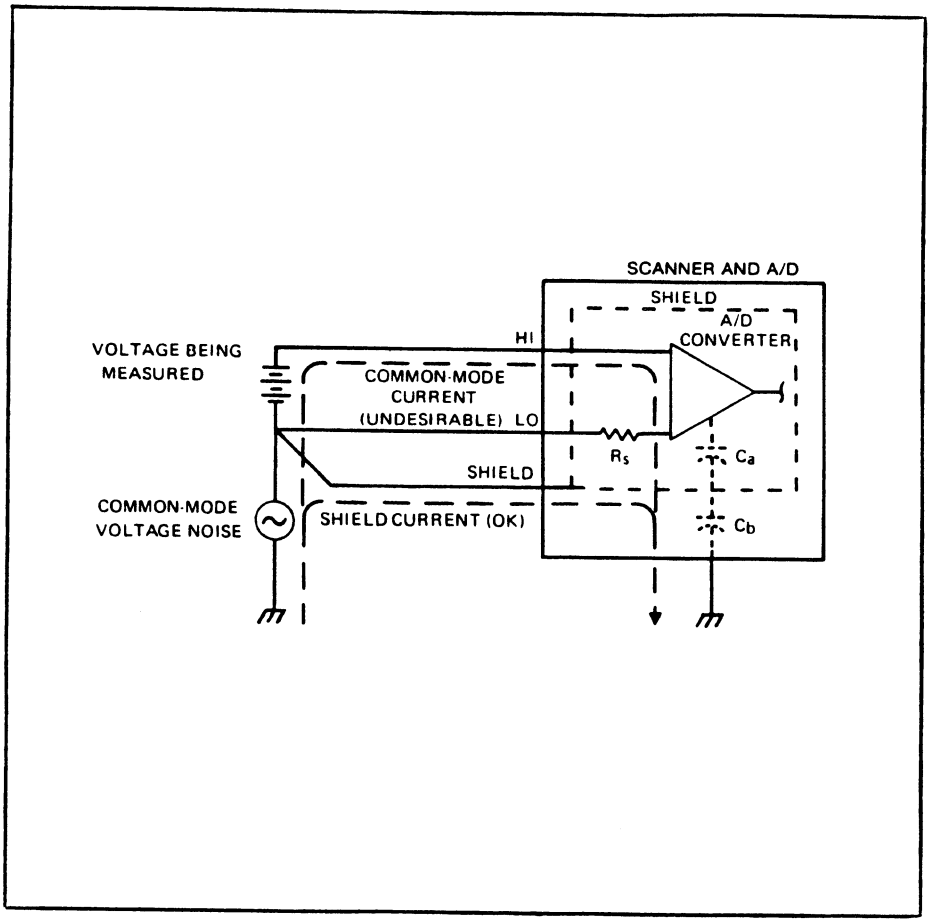


Figure 176-2. Shield Connection for Optimum Common Mode Rejection

External Wiring Connections

WARNING

BE SURE THAT THE WIRES BEING CONNECTED ARE NOT ENERGIZED. IF POSSIBLE, DISCONNECT THESE WIRES AT THE OTHER END. IN ANY EVENT, ENSURE THAT THE EXTERNAL CIRCUIT CONNECTED TO THESE WIRES IS NOT ENERGIZED. LETHAL VOLTAGES COULD OTHERWISE BE ENCOUNTERED.

The RTD/Resistance Input Connector can now be wired to external resistance sensors. Proceed as follows:

1. Familiarize yourself with the arrangement of the connecting terminals.

    - Five connecting terminals are available for each channel.
    - Twenty sets of terminals are provided on each input connector.
    - Wiring for each set of terminals is defined by the 4-Wire (4W), 3-Wire Accurate (3WA), or 3-Wire with Common Mode (3-Wire Isolated) (3WCM) measurement mode selected on the associated RTD/Resistance Scanner.
    - Where lead wire resistance errors are negligible, 2-Wire connections can be used when the Scanner is set for 4-Wire operation.
    - Refer to the following Figures 177-2 through 177-5. The connector housing decal is also a good reference source.

2. For each connection, loosen the terminal block screw with a 3mm standard blade screwdriver, place the stripped end of the external wire or jumper inside the terminal block opening, and tighten the screw until the wire is firmly clamped in place.

NOTE

To form jumpers with and connect all but the largest gauge lead wire, strip about 30mm (1.2in) of insulation from the end of the wire. Place the end in one of the two terminal block openings and clamp it in. Form a sharp "U" in the lead wire approximately 15mm (0.6in) from the terminal block. Stuff the bottom of the "U" in the second terminal block opening and clamp it in, thereby connecting the lead wire and forming a jumper at the same time.

3. Close the input connector housing, ensuring that the external wires exit the rear of the enclosure without being pinched.

Connector Installation

Complete the connector installation as follows:

1. Position the wired and enclosed input connector in the the Computer Front End rear panel slot containing the RTD/Resistance Scanner.

2. Push the input connector firmly into place on the scanner rear card edge.

3. Attach the connector housing to the chassis with the two retaining screws.

WHERE TO FIND MORE INFORMATION

This subsection presents general and installation information directly related to the use of the RTD/Resistance Input Connector with the RTD/Resistance Scanner.

Other sections in this manual provide more detailed information when the RTD/Resistance Connector is used to implement a specific measurement function. These sections are:

- Section 6E: Resistance Measurement
- Section 6H: Temperature Measurement Using RTDs, Configuration A

Section 3C provides an installation verification procedure.

SPECIFICATIONS

Specifications for the RTD/Resistance Input Connector are presented in Section 2. Section 2 also contains system accuracy specifications for each type of measurement supported by the RTD/Resistance Scanner/Connector. These include temperature (using RTDs) and resistance measurements.

177/RTD/Resistance Input Connector

REMOVAL AND INSTALLATION

External resistance sensors are connected to the Computer Front End through the RTD/Resistance Input Connector. Installation of this connector involves assembling and connecting the sensor lead wires to the connector terminals and attaching the connector to the RTD/Resistance Scanner.

WARNING

BEFORE REMOVING OR INSTALLING THE CONNECTOR, ENSURE THAT ALL LINE POWER TO THE FRONT END IS DISCONNECTED. LETHAL VOLTAGES MAY BE PRESENT WITHIN THE COMPUTER FRONT END AND ON SOME OPTION CARDS. DO NOT REMOVE ANY INSTRUMENT COVERS UNLESS YOU ARE QUALIFIED TO DO SO.

The connector is designed so that installation can be accomplished without removing the associated scanner.

Connector Removal

If the connector is already installed, but needs new or changed wiring connections, perform the following initial procedure:

1. With Computer Front End line power disconnected and the POWER switch set at OFF, locate the horizontal connector housing in the back.

2. Loosen the two retaining screws that hold the housing to the chassis.

3. Firmly grasp the housing at both ends and pull until the enclosed connector block is disconnected from the scanner.

4. Open the housing by gently pressing each locking tab.

INTRODUCTION

The RTD/Resistance Input Connector provides 20 sets of connection points for wiring external resistance transducers to the RTD/Resistance Scanner. The RTD/Resistance Input Connector is illustrated in Figure 177-1.

Each of the 20 channels of terminals provides five termination points for accommodating 4-Wire, 3-Wire, and 2-Wire lead wire measurement configurations. The use of a 3mm (1/8 in) standard blade screwdriver is required for fastening the lead wires in the terminal blocks.

177/RTD/Resistance Input Connector

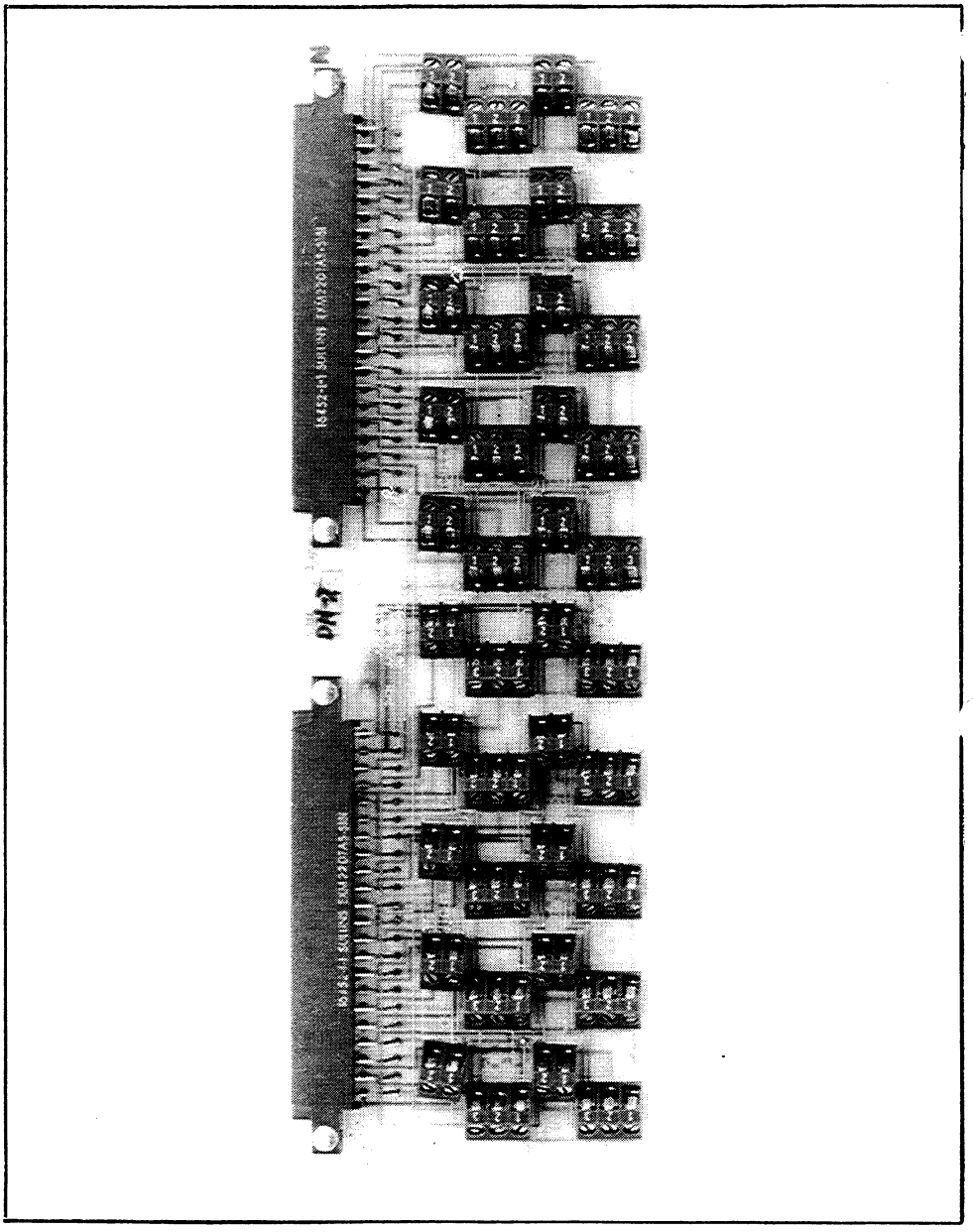


Figure 177-1. RTD/Resistance Input Connector

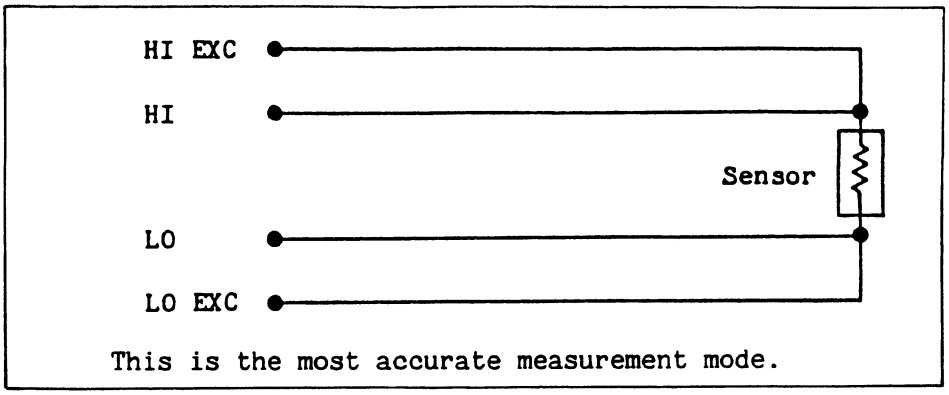


Figure 177-2. 4-Wire Wire Connections

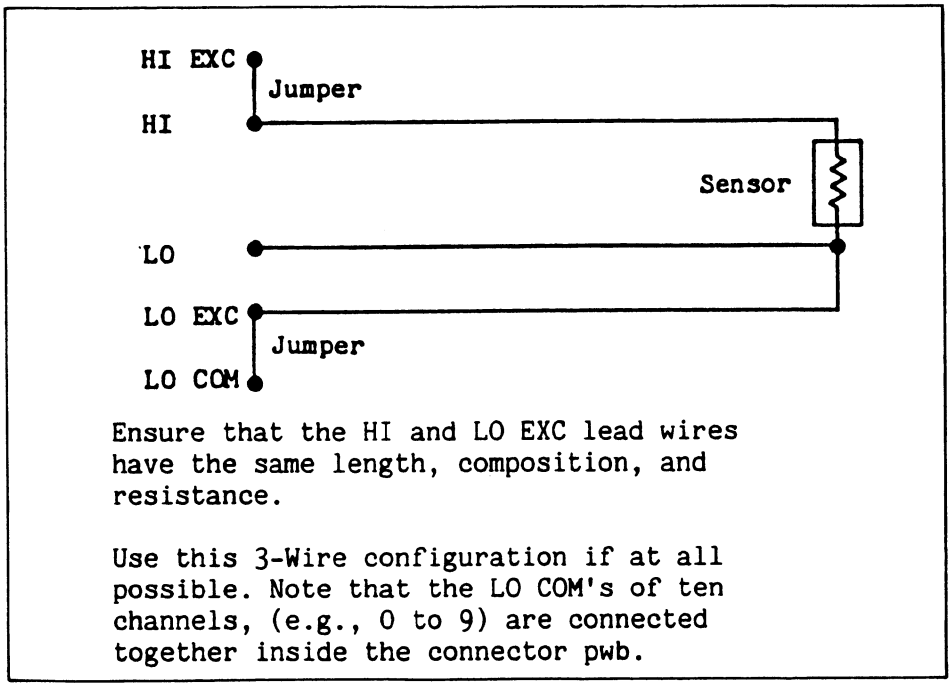


Figure 177-3. 3-Wire Accurate Connections

177/RTD/Resistance Input Connector

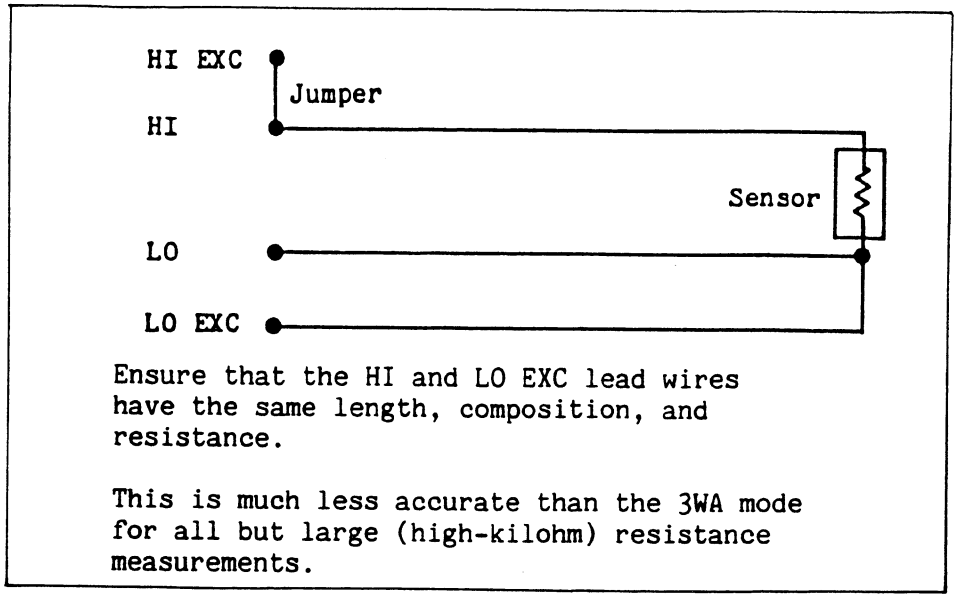


Figure 177-4. 3-Wire Isolated Connections

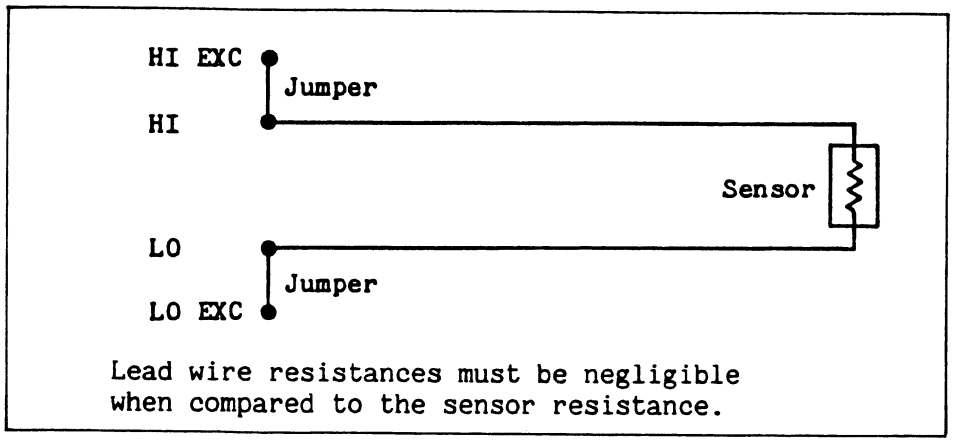


Figure 177-5. 2-Wire Connections

INTRODUCTION

The Digital/Status Input Connector can be used for the mutually exclusive functions of providing BCD digital input, binary digital input, or status input information. This assembly connects to the Digital I/O Board (-168). It can be configured by the user.

The Digital/Status Input Connector is illustrated in Figure 179-1.

WHERE TO FIND MORE INFORMATION

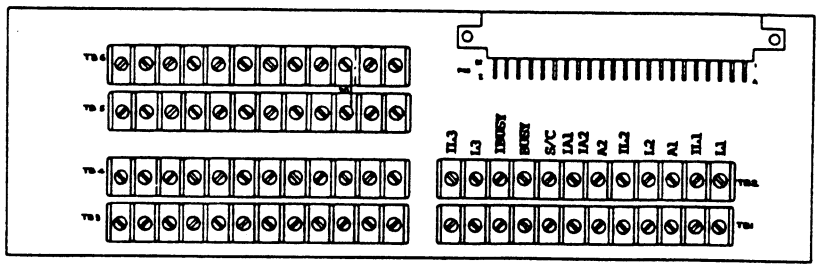
This subsection presents general and installation information specifically related to the Digital/Status Input Connector.

Additional information is presented elsewhere in this manual. Specific applications are discussed in:

- Section 6C: Digital/Status Input

Section 3C provides an installation verification procedure.

179/Digital/Status Input Connector



Handshake Terminal Abbreviations

Symbol	Name	Signal Direction
IL3	Invert LOAD3	Input
L3	LOAD3	Input
IBUSY	Invert BUSY	Output
BUSY	BUSY	Output
S/C	Single/Continuous Control	Input
IA1	Invert Acknowledge 1	Output
IA2	Invert Acknowledge 2	Output
A2	Acknowledge 2	Output
IL2	Invert LOAD2	Input
L2	LOAD2	Input
A1	Acknowledge 1	Output
IL1	Invert LOAD1	Input
L1	LOAD1	Input

Figure 179-1. Digital/Status Input Connector

SPECIFICATIONS

Specifications for the Digital/Status Input Connector are presented in Section 2.

HARDWARE CONFIGURATION

Each Digital/Status Input Connector must be configured for use with the Digital I/O Board. Also, a handshake procedure must be specified to allow BCD or binary data exchange with external devices.

Input Data Format

Digital input data formats (BCD and Binary) are shown in Figure 179-2. One of the following two data formats can be specified by the user:

- 5-digit BCD (Binary-Coded Decimal that ranges from +/- 79999), with polarity sign
- 16-bit Binary Format with sign

The desired format is chosen by configuring inputs 21 and 22 on the Digital/Status Input Connector as follows:

Binary	BCD
Input 21 -- 0	Input 21 -- 1
Input 22 -- 0	Input 22 -- 0

Zero (0) indicates a jumper from the SIGNAL terminal to its RETURN. One (1) indicates no connection.

NOTE

Do not leave both inputs open. Digital I/O Board operation is undefined if the inputs are open.

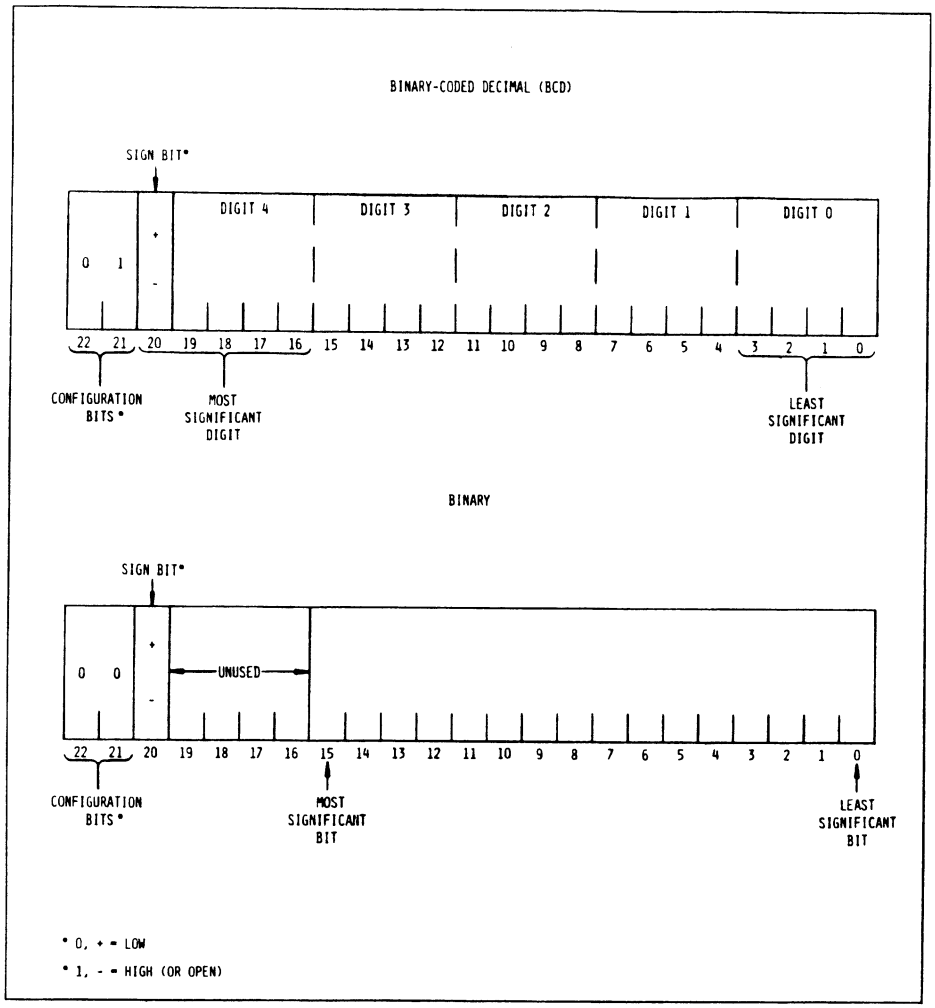


Figure 179-2. Digital Input Data Formats

Digital Input

When configured for digital input, the Digital/Status Input Connector allows the Digital I/O Board to accept parallel digital data from an external source. This data is received at the channel address set on the associated Digital I/O Board.

One of three data input handshake methods must be used to properly interface the connector with digital input data. The three methods are illustrated in Figure 179-3. Although any one handshake method acts independently of the other two, the functions performed by each are identical. Note that a data input handshake process is used for BCD or Binary input configurations only.

Select the desired method by connecting the external device to the proper handshake terminals on the Digital/Status Input Connector. These terminals are located on the right side of the assembly, directly below the connector pins. Refer to Figure 179-3 for the location of the proper handshake terminals. Terminal abbreviations are summarized in Table 179-1. Also note the following:

- Unless otherwise specified, all control signals are active (1) in HIGH logic state. Each signal may be set to zero by connecting it to its RETURN terminal or by driving it to a logic low level with respect to the RETURN.

- The load inputs (L1, L2, L3, IL1, IL2, IL3) are sampled inputs. The minimum pulse duration is 12.5 usec.

- The load inputs L1, L2, and L3 cause data to be loaded when a logic 0 to logic 1 transition occurs. The inverted load inputs IL1, IL2, and IL3 are effective when a high to low transition takes place.

Table 179-1. Handshake Terminal Abbreviations

Symbol	Name	Signal Direction
IL3	Invert LOAD3	Input
L3	LOAD3	Input
IBUSY	Invert BUSY	Output
BUSY	BUSY	Output
S/C	Single/Continuous Control	Input
IA1	Invert Acknowledge 1	Output
IA2	Invert Acknowledge 2	Output
A2	Acknowledge 2 (ACK 2)	Output
IL2	Invert LOAD2	Input
L2	LOAD2 (LOAD 2)	Input
A1	Acknowledge 1 (ACK 1)	Output
IL1	Invert LOAD1	Input
L1	LOAD1 (LOAD 1)	Input

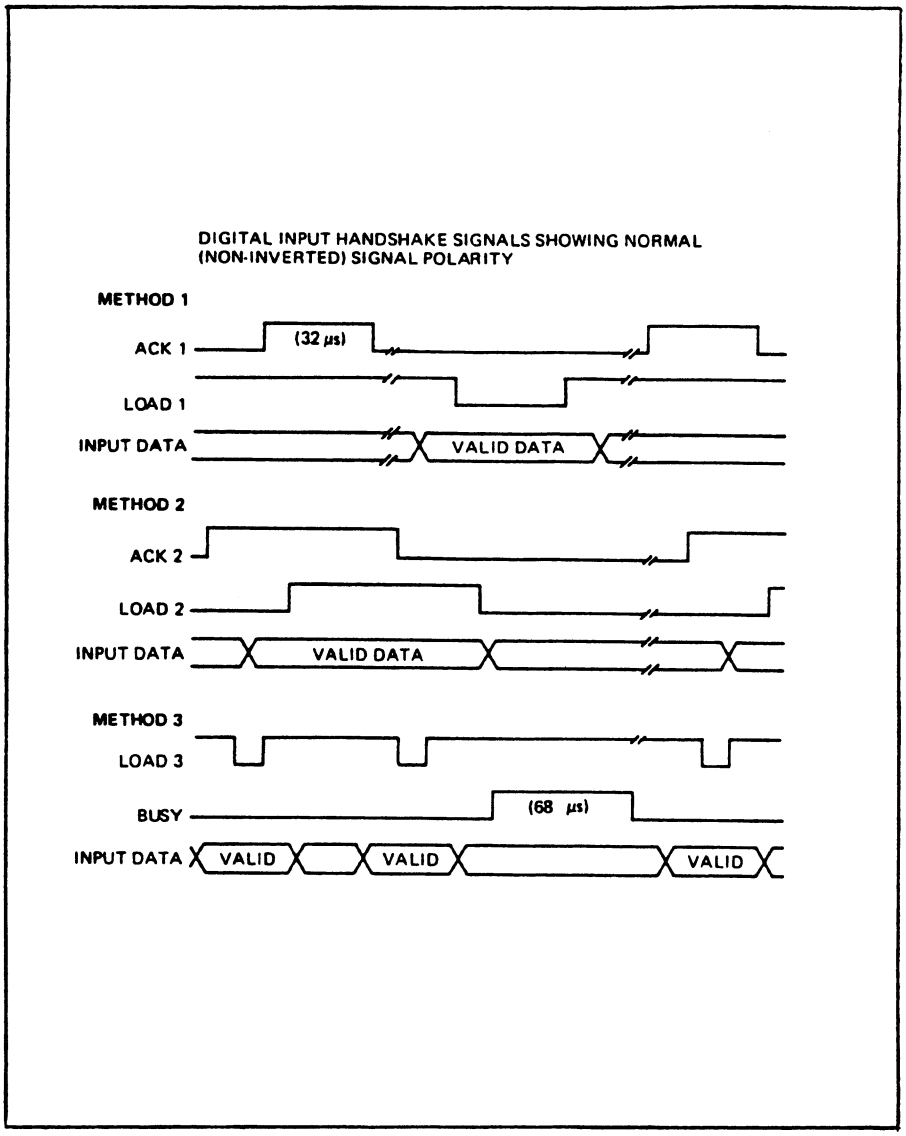


Figure 179-3. Digital Input Handshake Signals Showing Normal (Non-Inverted) Signal Polarity

- The terminals marked S/C on the connector comprise the Single/Continuous control.

  If left unconnected, the S/C control line sets the Digital I/O Board in a continuous input mode. In this mode, the handshake and data loading process are performed repeatedly between input data sampling by the Computer Front End. The Computer Front End reads only the latest data loaded.

  If the S/C SIGNAL terminal is connected to RETURN, the Digital I/O board is placed in a single input mode. In this mode, data may be loaded only once between samplings by the Computer Front End. Once a load has occurred, the handshake process is inhibited until the Computer Front End has retrieved the input data from the Digital I/O Board.

HANDSHAKE METHOD #1

Immediately following power-up, A1 (Acknowledge 1) is asserted (high). A1 is a 17-microsecond pulse generated by the Digital I/O board indicating that data may be loaded. Data is entered by the external device and latched with the L1 (LOAD1) control signal. In the continuous mode, A1 is again asserted after L1 is reset. In the single mode, A1 is inhibited until the input data is sampled by the Computer Front End.

HANDSHAKE METHOD #2

Following power-up, A2 (Acknowledge 2) is asserted by the Digital I/O board. L2 (LOAD2) may then be asserted by the external device to load the data on the input lines. A2 is withdrawn once the data is received. L2 may then be withdrawn. In the continuous mode, A2 is again asserted after L2 becomes low. In the single mode, A2 remains inactive until the Computer Front End has sampled the data. In either case, L2 must be reset low before the cycle may be repeated.

HANDSHAKE METHOD #3

L3 (LOAD3) may be asserted by the external device at any time. In the continuous mode, each assertion of L3 causes the input data to be loaded. In the single mode, only the first L3 following power-up, or following a data sampling by the Computer Front End, is effective. The Digital I/O Board generates a BUSY signal during the time that the data is being sampled. L3 is not effective during this time. BUSY is asserted for a period of approximately 15 microseconds.

Status Input

When configured for status input, the Digital/Status Input Connector allows the Digital I/O Board to accept a maximum of 20 separate one-bit inputs from an external source for each Digital I/O Board installed in either the Computer Front End or the 2281A Extender Chassis. Each bit is associated with a channel programmed as status input.

The Status Input configuration is achieved on the Digital/Status Input Connector by installing a jumper at input 21 and leaving input 22 open.

CAUTION

Do NOT leave both inputs 21 and 22 open. This code makes the Digital I/O act as a Status Output.

179/Digital/Status Input Connector

REMOVAL AND INSTALLATION

Connections from external control points or terminals to the Computer Front End are made via external wiring to the Digital/Status Input Connector. Preparation of the Digital/Status Input Connector involves opening its connector housing, assembling and connecting the appropriate wiring on the terminals, closing the connector housing, and connecting it back to the Digital I/O board. The following steps detail this procedure:

WARNING

ENSURE THAT ALL LINE POWER TO THE COMPUTER FRONT END OR EXTENDER CHASSIS IS DISCONNECTED. LETHAL VOLTAGES MAY BE PRESENT WITHIN THE COMPUTER FRONT END AND ON SOME OPTION CARDS. DO NOT REMOVE ANY INSTRUMENT COVERS UNLESS YOU ARE QUALIFIED TO DO SO.

The connector is designed so that installation can be accomplished without removing the associated Digital I/O Assembly.

Connector Removal

If the connector is already installed, but needs new or changed wiring connections, perform the following initial procedure:

1. With line power disconnected and the POWER switch set to OFF, locate the connector housing in the rear panel of the Computer Front End.

2. Remove the two retaining screws that hold the housing assembly to the chassis.

3. Firmly grasp the connector housing at its midpoint and pull until the enclosed connector block is disconnected from the Digital I/O Board.

4. Open the housing by gently pressing each locking tab.

External Wire Connections

WARNING

BE SURE THAT THE WIRES BEING CONNECTED TO THE DIGITAL/STATUS INPUT CONNECTOR ARE NOT ENERGIZED. IF POSSIBLE, DISCONNECT THESE WIRES AT THE OTHER END. IN ANY EVENT, ENSURE THAT THE ASSOCIATED EXTERNAL CIRCUIT IS DEENERGIZED. HAZARDOUS VOLTAGE COULD OTHERWISE BE ENCOUNTERED.

Use the following procedure when connecting wires from the external circuit. Notice that the two terminals for each channel are marked SIGNAL and RETURN. All returns are connected together on the card and are tied to logic common on the Digital I/O Board.

WARNING

SINCE INDIVIDUAL CHANNELS ARE NOT ISOLATED FROM EACH OTHER, ALL RETURN TERMINALS ARE CONNECTED TOGETHER ON THE DIGITAL/STATUS INPUT CONNECTOR. ALL RETURN WIRES MUST BE AT THE SAME VOLTAGE.

179/Digital/Status Input Connector

1. Starting at channel 0, attach the external wiring for the desired application. To make each attachment, do the following:

   - o Loosen the channel terminal screws.
   - o Attach the external wires to the screws.
   - o Tighten the screws until the wires are firmly in place.

2. Close the connector housing over the input connector, ensuring that the external wires exit the rear of the enclosure without being pinched.

Connector Installation

With all external connections in place, attach the connector assembly as follows:

1. Position the enclosed (and wired) Digital/Status Input Connector at the guides of the Computer Front End rear panel slot containing the Digital I/O Assembly.

2. Then, grasping the Digital/Status Input Connector firmly, mate it with the Digital I/O Assembly until it is firmly in place.

3. Use the two retaining screws to secure the connector housing to the chassis.

INTRODUCTION

The Scan/Alarm option (-201) provides a variety of additional functions useful for alarm and monitoring applications. A description of these functions is listed below. The exact details of their implementation can be found in the command reference section.

- Automatic Scanning of Input Channels.

  The Scan/Alarm option provides a mechanism for measuring the input channels on a regular time interval without intervention from the host. Up to four different Scan Groups can be established, each measuring the inputs with their own independent time interval. Channels 0 through 999 are available.

- Limit Checking

  Each channel can have up to four alarm limits associated with it. These alarm limits, two high alarms and two low alarms, permit Helios I to be used as a high accuracy monitoring system without the intervention of the host computer.

201/Scan/Alarm Option

- Data Buffering

  Up to four data buffers may be specified to hold measurement data while the host computer is busy with higher priority tasks. While the amount of available data storage depends on the size of the system involved, most systems are able to store up to 20,000 readings. The data is stored with a time stamp and status, and the oldest reading is read from the buffer first.

- Polynomial Linearizations

  Frequently, measurements requiring linearizations are made to convert the raw data to engineering units. The Scan/Alarm option provides a second order polynomial linearization function for this purpose. This frees up the host computer for more important tasks.

- Local Printout

  The Scan/Alarm option permits the measured data to be logged directly on a local printer without the intervention of the host computer. This is useful when the host computer is not available or is not located at the measurement site.

- Alarm Outputs

  Status outputs may be directly coupled to alarm conditions. In the event a hazardous condition is detected, this provides a means for corrective action without the intervention of the host computer.

- Alarm Annunciation

  To facilitate monitoring applications, an alarm annunciator is included in the Scan/Alarm option. This feature provides all the drive signals necessary to implement the flashing light and audible alarm indications common to these applications.

- Communication Monitoring

  In the event the host computer does not communicate with Helios I for a user-specified period of time, all alarm data is logged directly on the local printer. This will continue until the host re-establishes communications with Helios I.

- Host Interrupt on Alarm

  The Scan/Alarm option allows Helios I to initiate communications with the host if an alarm condition has occurred. This feature allows a monitor system to "report on exception" basis only and reduces the amount of communications required by the host computer.

- Printer Port Formatting

  Controlling the printer port output is possible by specifying the value format, a units string, a number variable, and control characters necessary for cursor positioning.

- Time Averaging

  Sampled data can be manipulated to present the minimum or maximum value encountered, or to show the average or total of values measured.

201/Scan/Alarm Option

INSTALLATION

The Scan/Alarm option replaces the Computer Interface Assembly in the Helios mainframe. Any Scan/Alarm option purchased with a Helios I is already installed. In such cases, you can skip the next few paragraphs and start at "Alarm Annunciator Connection."

If your Scan/Alarm option is not already installed, you must first remove the Computer Interface Assembly. See Section 3A for instructions on removing the Computer Interface Assembly from the mainframe. Once you have removed the Computer Interface Assembly, note the settings for switches S1, S2, and S3. Also, note the line voltage setting on the Power Supply.

Remove the Scan/Alarm module from its shipping box and remove the shorting bar from the card edge connector. Refer to Section 3A for selection of the proper power line voltage settings. Set switches S1, S2, and S3 to the same settings that were on the computer interface module you removed from the unit. If you wish to change the communications interface, refer to Section 3A for the correct setting for your new interface. If you are going to use a printer connected to the interface, set switch S4 to select the proper communication parameters for your printer.

Before installing the Scan/Alarm Option into the mainframe, see if the power supply has been set to the proper line voltage. A label on the back of the unit indicates the factory setting. If it is necessary to change the line voltage, refer to Section 3A for detailed instructions.

CAUTION

Incorrect voltage selection may damage the Scan/Alarm option and void your warranty. If the voltage is not set for the correct operating voltage, the unit will either fail to operate, or will be severely damaged.

After you have confirmed the power line selection and communication line switch settings, you are ready to install the option. Slide the unit into the mainframe using the same slots that were used by the computer interface module, and reinstall the phillips-head screws to secure the Scan/Alarm option to the mainframe.

ALARM ANNUNCIATOR CONNECTION

WARNING

THESE SERVICE INSTRUCTIONS ARE FOR USE BY QUALIFIED PERSONNEL ONLY. TO AVOID ELECTRIC SHOCK, DO NOT PERFORM ANY SERVICING UNLESS YOU ARE QUALIFIED TO DO SO. HIGH VOLTAGES MAY EXIST ON THE WIRES TO THE ANNUNCIATOR CONNECTOR DURING NORMAL OPERATION. THESE VOLTAGES SHOULD BE REMOVED PRIOR TO SERVICING THE CONNECTOR OR THE SCAN/ALARM OPTION.

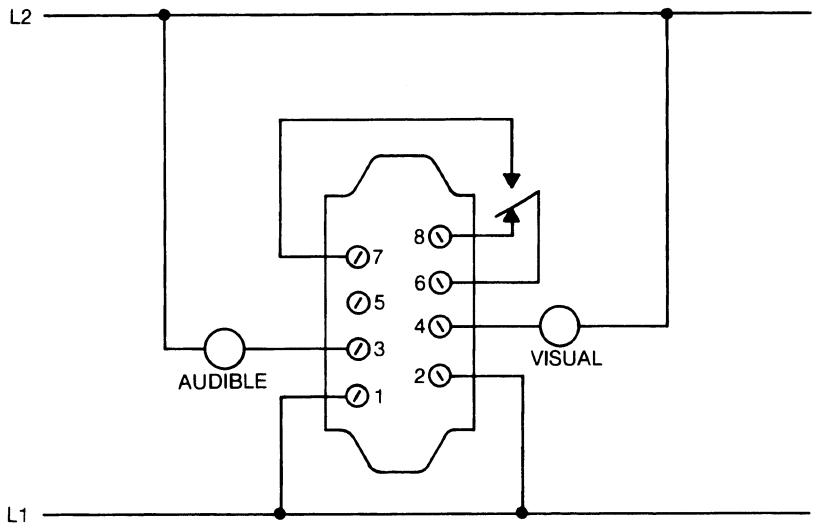
The alarm annunciator is connected as shown in Figure 201-1. The wire used should be 12-30 AWG and should be stripped to expose a maximum of 1/4 inch (6.4mm) of bare wire. Caution must be exercised to insure that all strands of the wire are properly inserted in the connector opening. The clamping screw must be turned all the way down to insure that the wire is properly secured in the connector.

ALARM ANNUNCIATOR OPERATION

When an alarm is detected, the audible alarm contacts (pins 1 & 3) close and the visual alarm contacts (pins 2 & 4) begin opening and closing about once every 800 milliseconds (1.25 Hz). This action continues until the alarm condition is acknowledged. Once acknowledged, the audible alarm contacts open, and the visual alarm contacts close and remain closed. When the alarm condition is removed, the visual alarm contacts will open and remain open.

In the event the alarm condition is removed prior to the time the alarm is acknowledged, the visual alarm contacts continue to open and close, and the audible alarm contact remains closed. In this case, when the alarm is acknowledged, both the visual and audible alarm contacts will return to their normally open state.

The alarm acknowledge sequence requires, first, that a connection be made between pins 8 & 6. This connection must then be removed and a connection made between pins 6 & 7. This connection must now be removed and the connection between pins 8 & 6 re-established. This is the action that occurs when a single pole - double throw pushbutton is used, as shown in Figure 201-1. This sequence of actions is required to prevent the alarm acknowledge contacts from being permanently wired in the acknowledged position. For safety reasons, operator action is required to acknowledge the alarm.



WARNING

TO AVOID ELECTRICAL SHOCK, DISCONNECT L1 AND L2 BEFORE MAKING ANY ALARM CONNECTIONS.

Figure 201-1. Typical Alarm Wiring

PRINTER PORT

Data may be logged to the Printer Port located on the back of the Scan/Alarm module. This is an RS-232-C connector with active pins as defined in Section 2. Switch S4 must be set to select the correct baud rate and data format for your printer. See Section 3A for switch settings.

ADDITIONAL INFORMATION

The features provided by this option are accessed by the Scan/Alarm commands described in Section 5. Each Scan/Alarm option page is clearly identified as such.

The 2281A is used to expand the input and output capacity of the Computer Front End. The Computer Front End supports a system capacity of 1500 input and output channels. Hardware for these channels can be installed in either the Computer Front End or the 2281A Extender Chassis. When connected to a Computer Front End via its serial link cable, the modules within the 2281A are viewed by the Computer Front End as residing in the Computer Front End.

2281A Extender Chassis

The 2281A is shown in Figure 2281-1.

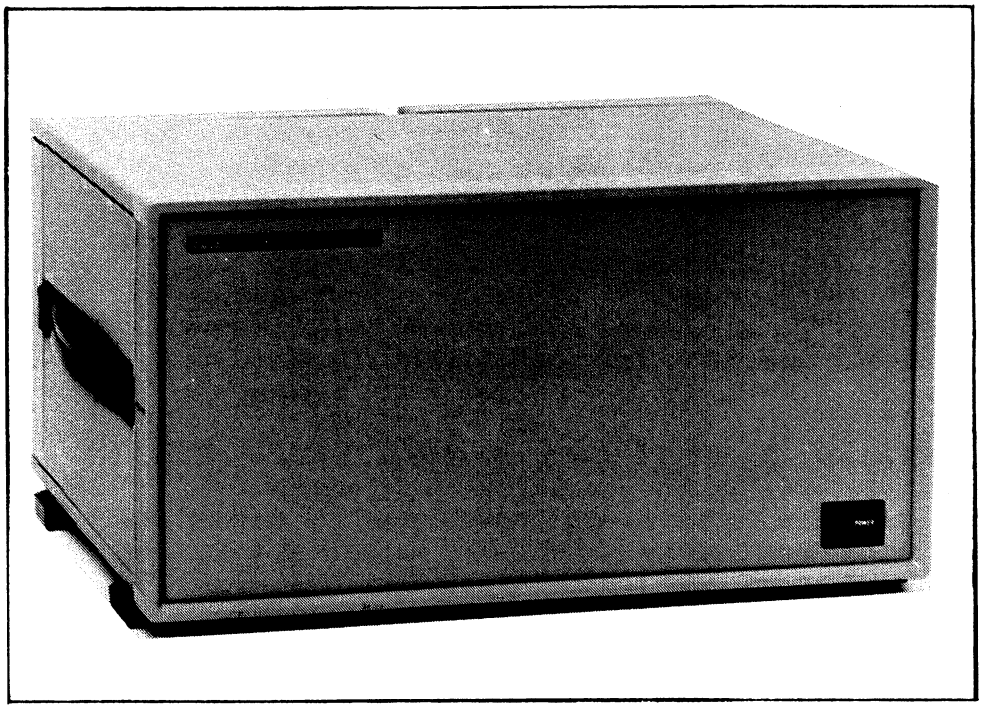


Figure 2281-1. 2281A Extender Chassis

Using the 2281A extender in the Computer Front End can be advantageous.

- Cost effectiveness is realized when long runs of thermocouple wire are no longer necessary. For example, a maximum of 100 thermocouples can be connected to a 2281A extender, and each extender can be located up to 1 kilometer from the parent Computer Front End.

- Measurement accuracy at remote-sensing locations is also assured by the use of digital communication between the 2281A and the Computer Front End.

- Use of the 2281A broadens the operating temperature range of serial link options by removing those devices from more temperature-sensitive components residing within the Computer Front End.

The 2281A receives operating power by one of two paths. First, it can receive power through the serial link cable. Second, it can receive power through a 2281A-431 Power Supply installed in a 2281A chassis. The 2281A-431 is described later in this section.

The 2281A can be located with considerable flexibility relative to the Computer Front End.

- Star configurations can be supported with the Y2047 multiconnect accessory.

- Multipoint configurations can be directly supported by the 2281A extender chassis.

- For either configuration, the maximum allowable length of cable from the 2281A extender to the Computer Front End mainframe is one kilometer.

2281A Extender Chassis

The Computer Front End and Extender Chassis form a distributed system concept that is illustrated in Figure 2281-2.

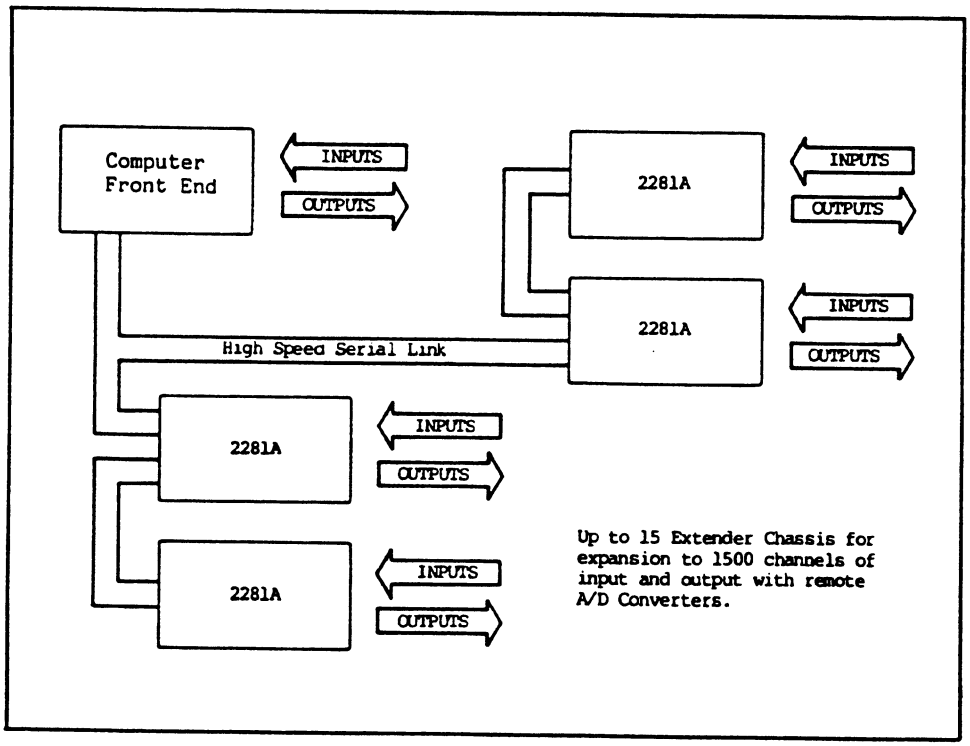


Figure 2281-2. Distributed System Concept

The 2281A may be stacked on top of other full-width Fluke instruments, bench mounted, or rack mounted using the Y2045 Rack Mount Kit or the Y2044 Rack Slide Kit. In some remote Extender Chassis applications it will be necessary to configure the 2281A with the -431 Power Supply.

Additional information is available in the 2281A Instruction Manual, as amended by the information presented here in Section 3B. Specifically, power requirements for the Computer Front End differ from those mentioned in the 2281A Instruction Manual. The Front End provides +12V, not +24V. Refer to "Determine Extender Chassis and Additional Power Requirements" earlier in this section.

2281A Extender Chassis

DESCRIPTION

The -402 Extender Cable with the -403 provides the serial link interface for transmitting and receiving data between the Computer Front End and the 2281A. Power for the 2281A Extender Chassis is also provided over this cable from the Computer Front End or a 2281A-431. The Extender Cable consists of six shielded twisted pairs and is sold by the meter. The -403 connector completes this assembly.

Three of the twisted pairs carry the +12V dc (and returns) from the Computer Front End to the 2281A. RS-442 data is transmitted over TX+ and TX- from the Computer Front End on one twisted pair while RX+ and RX-, the received data from the serial link devices within the 2281A, are carried over another pair of twisted wire. The last twisted pair connects the +5V dc return (+5RTN) from the Computer Front End for signal ground continuity with the 2281A.

Cable pin identification for the -403 connectors can be found with the -403 information. A cable diagram (with connectors installed) is included in this information.

402/Extender Cable

DESCRIPTION

The 2281A-403 Extender Cable Connector is a set of male/female 15-pin, D-type connectors. A housing provides strain relief for cable connections and stand-off bolts for securing the cable connector to the mainframe connector. The cost includes factory installation onto the 2281A-402 Extender Cable and continuity testing before shipment.

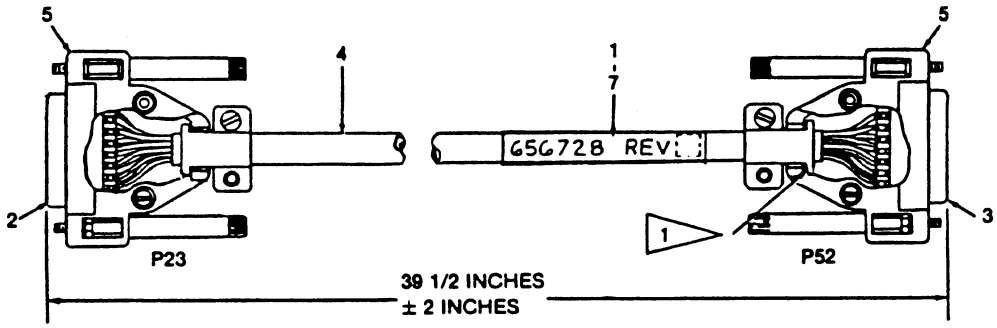
Table 403-1 shows the pin identification of the two connectors. Figure 403-1 shows the -403 connectors assembled to the Extender Cable. Individual connector part numbers (for replacement only) are also listed in Figure 403-1.

403/Extender Cable Connectors

Table 403-1. Connector Pin Identification

SIGNAL MNEMONIC	P23 PIN NUMBER	P52 PIN NUMBER
+24 VDC	1	1
+24 VDC	2	2
+24 VDC	3	3
+5 RTN	5	5
+5 RTN	6	6
RX -	7	7
RX +	8	8
+24 RTN	9	9
+24 RTN	10	10
+24 RTN	11	11
TX -	13	13
TX +	14	14
SHIELD	15	15*

*For cables longer than 4 meters, no shield connection is made at P52.



1 For cables longer than 4 meters, no shield connection is made at P52.

QTY	ITEM	PART NO.	DRAWING NO.	DESCRIPTION
1	1	610600	2281A-2010	LABEL
1	2	436881		CONN, 15 PIN
1	3	436899		CONN, 15 SOCKET
3.291ft	4	682773		CABLE
2	5	682765		CONNECTOR HOUSING
.55ft	6	113845		SLEEVING
.27ft	7	295782		THERMOFIT, CLEAR

Figure 403-1. Internal View

INTRODUCTION

This subsection presents descriptive and installation information for the 2281A-431 Power Supply.

The 2281A-431 is more fully described in the 2281A Instruction Manual. The following additional items can be found in the 2281A manual: Specifications, Theory of Operation, Performance Test, Calibration Procedures, Parts List, and Schematic Diagram.

DESCRIPTION

The -431 Power Supply is a rear panel-mounted dc power supply for the 2281A Extender Chassis. The power supply provides a regulated 20V dc source for the serial link devices when the Extender Chassis placement (distance) and configuration (number of serial link devices) exceeds the power capabilities of the Computer Front End.

Requirements for the -431 power supply are discussed in the 2281A Instruction Manual and earlier in Section 3 of this manual (see "4. Determine Additional Power Requirements").

431/Power Supply

The -431 may accept input power sources of ac line voltages, +12V and +24V dc voltages. The power supply has an automatic crossover from ac line to 12V dc and 24V dc to the 12V dc input. In addition, while the -431 is operating from ac line or 24V dc, a trickle charge is provided to the 12V dc input for maintaining the charge of a backup battery.

The power supply pwb (printed wiring board) is installed in place of the extender interface card and the power supply rear panel assembly is installed in place of the extender interface rear panel. The power supply rear panel provides a serial link feed-through for interconnecting multiple Extender Chassis. An illustration of the rear panel assembly is shown in Figure 431-1, and a detailed description is provided by Table 431-1.

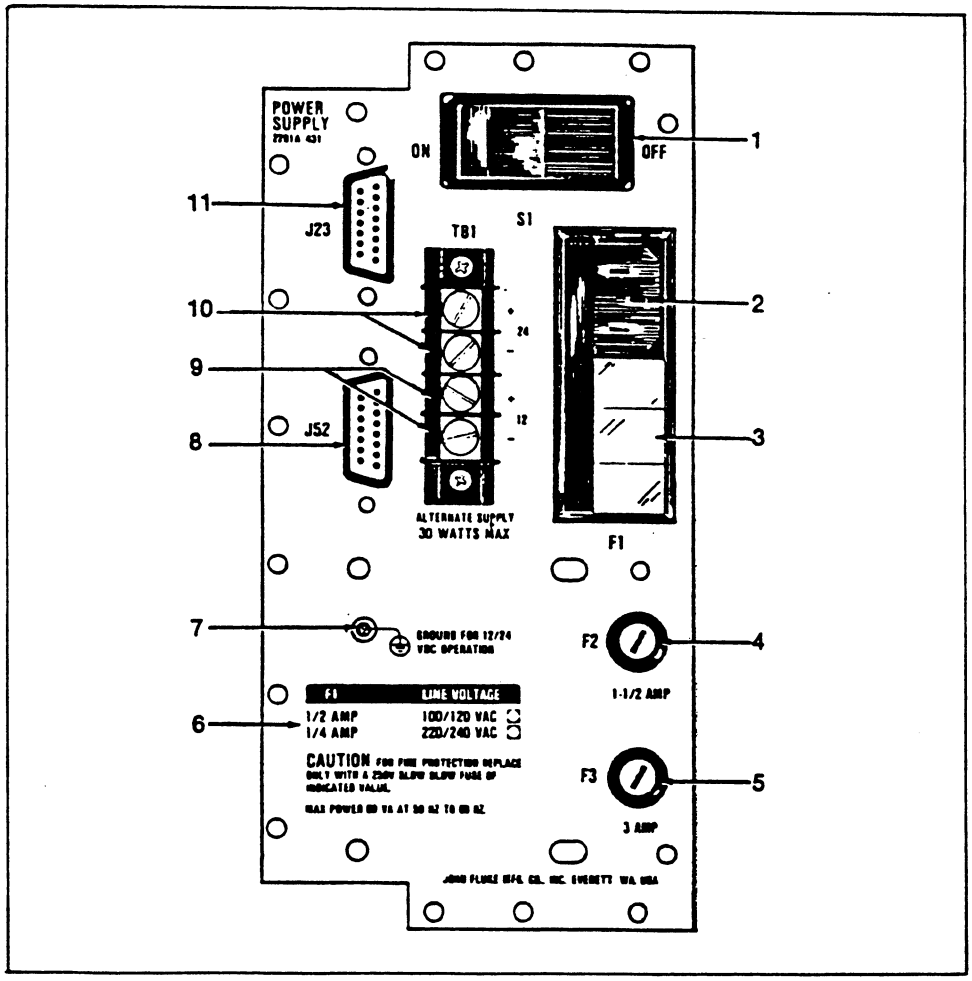


Figure 431-1. Rear Panel Assembly

Table 431-1. Rear Panel Features

ITEM	FEATURE NAME	DESCRIPTION
1	S1	ON/OFF power switch, for ac line and dc voltages.
2	ac Input	Standard male ac input socket.
3	F1	Fuse holder for ac line fuse. Sliding plastic door prevents access while ac line power is connected.
4	F2	Fuse holder for 24V dc input.
5	F3	Fuse holder for 12V dc input.
6	Fuse/Voltage	Silkscreened annotation of ac Fuse ratings and line voltage selection.
7	Ground Lug	Threaded ground lug termination for dc inputs.
8	J52	15 pin, male connector for serial link extender cable from the 2280A.
9	TB1 (12)	Terminal block connection points for the 12V dc input or backup battery.
10	TB1 (24)	Terminal block connection points for the 24V dc input.
11	J23	15 pin, female connector for serial link extender cable feedthrough to another 2281A.

INSTALLATION

Hardware Installation

Use the following procedure to install the -431 Power Supply into the Extender Chassis. After completing the hardware, electrical, and cabling installation sections, complete the initial verification procedure (given in the later part of this section).

1. Remove all the Phillips screws from the extender interface rear panel assembly.

2. Pull out the rear panel and pwb assembly. They should be affixed by the pwb connector cable retaining nuts.

3. Remove the connector cable retaining nuts from the power supply pwb.

4. Plug P54 (from power supply rear panel assembly) into J54 (on power supply pwb assembly).

NOTE

The connector is keyed; DO NOT FORCE. To release, squeeze the side tabs on the connector.

5. Slide the pwb into the left-most slot of the Extender Chassis until P12 is seated in the motherboard connector J12.

6. Secure the power supply rear panel assembly over the pwb using 12 Phillips screws.

7. Replace the cable retaining nuts of the power supply pwb connector.

8. Hardware installation is now complete.

Electrical Installation

The 2281A-431 is shipped with the proper operating voltage already selected as specified by the customer. The following paragraphs explain how to reconfigure the 2281A-431 for other voltage settings and how to connect the 2281A-431 to the system. After completing the hardware, electrical, and cable installation sections, complete the installation verification procedure (given later in this section).

Input Voltage Selection

To power the 2281A-431 with 24V or 12V dc, the appropriate supply is connected to a terminal block (TB1) on the power supply rear panel. It is recommended that power source cables be terminated with No. 6 spade lugs for safety and convenience. Table 431-2 lists the proper fuse ratings for all voltages. The following procedure and Figure 431-2 show how to reconfigure the 2281A-431 to a different ac line voltage.

1. Open the cover door on the ac input module (under S1) and rotate the "fuse-pull" lever to the left to remove the fuse.

2. Using a pair of pliers, grasp the small pwb, located underneath the fuse holders, between the metal tabs and remove.

3. Reinstall the pwb so that the required operating voltage is shown in the opening as in Figure 431-2A. Push the pwb in firmly.

4. Slide the fuse-pull lever to the right, and insert the proper fuse (F1) for the selected operating voltage. See Table 431-2 for fuse ratings.

Table 431-2. Fuse Ratings

REF DES	SUPPLY	RATING
F1	100/120V ac	1/2 A/250V Slow Blo
F1	220/240V ac	1/4 A/250V Slow Blo
F2	+24V dc	1.5 A/250V Fast Blo
F3	+12V dc	3.0 A/250V Fast Blo

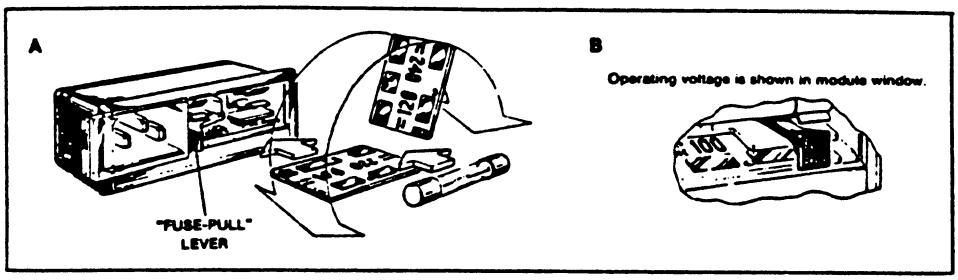


Figure 431-2. AC Voltage Selection

2281A-431 Cable Connections

Figure 431-3 illustrates the 2281A-431 cabling for ac and dc operation. After completing the hardware, electrical, and cable installation sections, complete the installation verification.

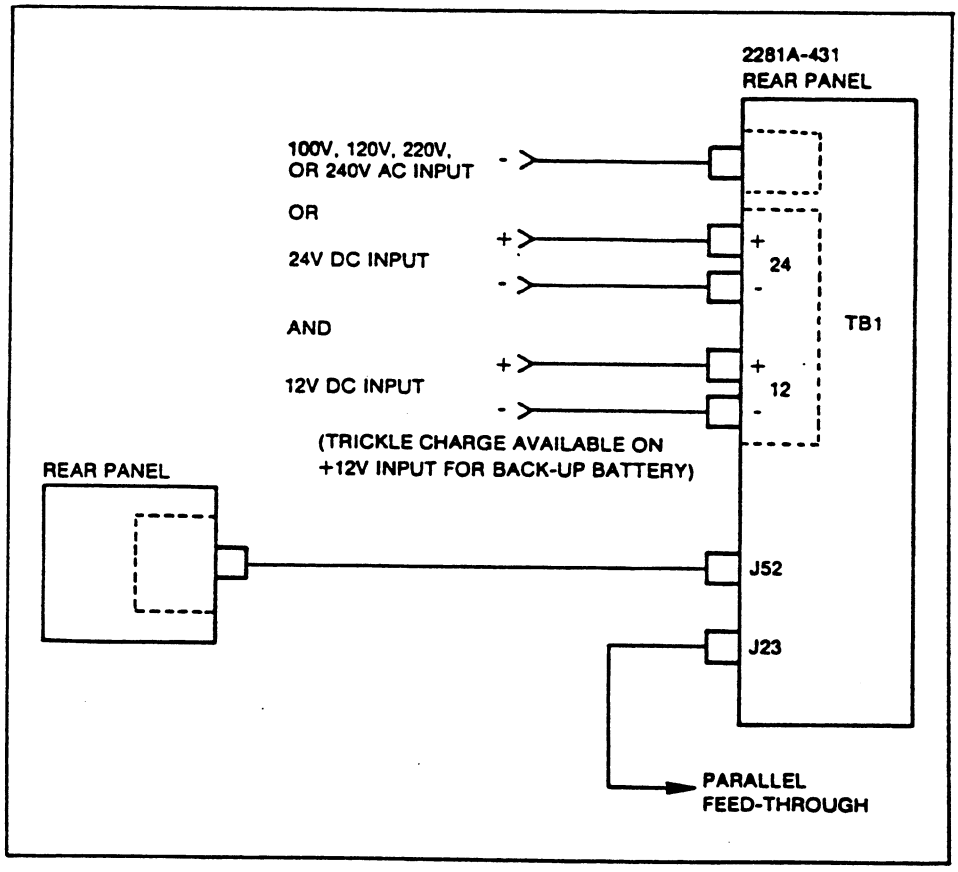


Figure 431-3. Cabling Diagram

INSTALLATION VERIFICATION

This procedure is used to verify the proper operation of the 2281A-431 after it is installed in the 2281A. No special tools or test equipment are required.

1. Connect ac or +24V dc power to the -431.

2. Set S1 on the 2281A-431 rear panel to ON.

3. Switch on power to the Computer Front End. Verify that the 2281A-431 front panel LED is illuminated.

4. Turn off power to the Computer Front End. Verify that the front panel LED extinguishes.

5. If a 12V back-up battery is connected to TB1, complete the following steps.

   a. Set S1 to OFF.

   b. Disconnect the ac line and/or +24V dc source.

   c. Set S1 to ON.

   d. Switch on power to the Computer Front End. Verify that the 2281A front panel LED is illuminated.

   e. Switch off power to the Computer Front End. Verify that the 2281A front panel LED goes off.

6. This concludes the installation verification procedure for the 2281A-431. Switch off all power sources to the 2281A-431 before dismantling the test setup.

DESCRIPTION

The Y2044 Rack Slide Kit facilitates the servicing of the Computer Front End (or 2281A) while it is installed in a standard 19-inch electronic equipment rack. The unit is secured in the equipment rack, yet may be pulled out along the slide for reconfiguring and servicing serial link devices. Parts and hardware for this kit are listed in Table 1. The only tools required for installation are medium-sized, Phillips and flat-head screwdrivers.

INSTALLATION

The rack slide kit is shipped in two separate containers. All necessary hardware for installing the kit is contained in the wrapped package. All required parts and hardware for the rack slide kit are listed in Table 1. After verifying that all kit parts are present, proceed to the installation procedure.

Table 1. Parts and Hardware

ITEM	NAME	DESCRIPTION
1	Chassis Track	Two gray metal slide tracks (packaged in a cardboard box).
2	Rear Support Bracket	Two machined metal angle brackets (packaged in a cardboard box).
3	Bar Nuts	Six metal strips with four threaded holes.
4	Rack Ears	Two white machined angle pieces.
5	Slide Spacer 8.4 Inches	Two 8.4 inch pieces of metal bar stock with five punched holes and two 5.85 inch pieces of metal bar stock with two punched holes (for use with 2280B only).
6	Rack Ear Hardware	A small envelope containing eight machine screws with plastic washers, and clipnuts.
7	Miscellaneous Hardware	The following screws are used to install the Rack Slide Kit: twelve 8-32 x 7/8" Phillips twelve 10-32 x 3/8" pan-head Phillips

NOTE

Some of the parts included with the Y2044 may not be used. Once, the installation is complete, discard any unused parts.

The installation procedure for the Y2044 is as follows.

1. Remove the four molded plastic feet from the bottom cover of the instrument.

2. On both front side corners of the instrument remove the decals bearing the Fluke name.

3. Refer to Figure 2044-1 and complete these steps:

   a. Remove the three screws (indicated by asterisks) from both sides of the instrument.

   b. Placing the cutout side of the rack ears against the front corner of the instrument, align the recessed holes with the holes vacated in step a.

   c. Secure the rack ears to the instrument using six of the 8-32 x 7/8-inch screws.

   d. Remove the instrument side handles by unfastening the two Phillips screws.

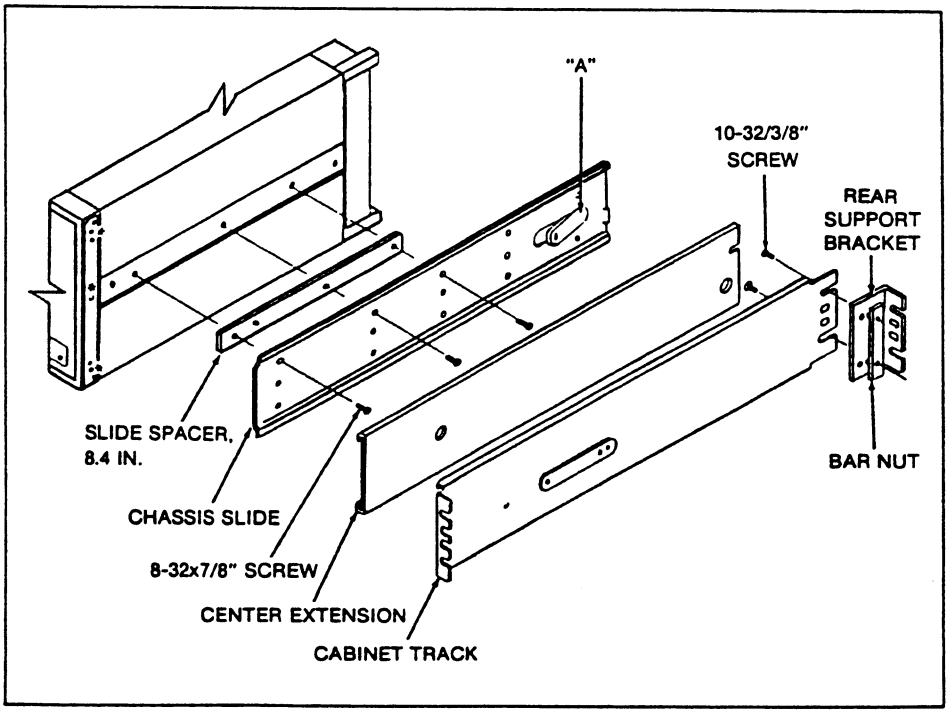


Figure 2044-1. Installation Details

e. Disassemble the chassis slide of the chassis track by fully retracting the extensions and releasing the spring-loaded retaining button marked with an "A".

f. With the slide spacer in place, secure the chassis slide to the instrument using three 8-32 x 7/8-inch screws (for both sides).

NOTE

Use the upper row of mounting holes on the chassis slide.

g. Attach the rear support bracket flush with the end of the cabinet slide using a bar nut and two of the 10-32 x 3/8-inch screws (on each chassis track).

h. Insert the center extension of the chassis track into the cabinet slide, aligning the retaining button with the center extension hole.

i. Install the assembly from step (h) into the equipment rack using bar nuts and 10-32 x 3/8-inch screws in the top and bottom slots of the cabinet slide ends.

j. Extend the center extension towards the front of the equipment rack until it locks.

k. Insert the chassis slide into the center extension, depressing the retaining button as it slides in.

NOTE

At this point it may be necessary to readjust the chassis track to align the rack ear mounting holes with those of the equipment rack.

l. Attach the clip nuts to the equipment rack, matching the hole pattern in the rack ears.

m. Use the machine screws (with plastic washers) to secure the instrument and prevent it from sliding out.

Y2044

DESCRIPTION

The Y2045 Rack Mount Kit facilitates the placement of a Computer Front End or 2281A Extender Chassis into a standard 19-inch electronic equipment rack. Parts and hardware for this kit are listed in Table 1. The only tool required for installation is a medium-sized, Phillips screwdriver.

Table 1. Parts and Hardware

ITEM	NAME	DESCRIPTION
1	Shelf Bracket	Two large "L" shaped metal strips with press-fitted nuts.
2	Rack Ears	Two smaller "L" shaped metal strips with cutouts.
3	Hardware	One package of hardware containing: a. Six 8-32 x 7/8" Phillips screws. b. A small package of eight 10-32 x 3/8" Phillips screws. c. A small package of eight machine screws with plastic washers. d. A small package of 12 clip nuts.

INSTALLATION

Remove the contents of the Y2045 from its shipping container and compare the contents to Table 1. After verifying that all kit parts are present, proceed with the following installation procedure.

1. Remove the four molded plastic feet from the bottom cover of the instrument.

2. On both front side corners of the instrument, remove the decals bearing the Fluke name.

3. Refer to Figure 2045-1 while performing the following steps.

   a. Remove the three screws indicated by the asterisk from both sides of the instrument and discard the screws.

   b. Placing the cutout side of the rack ears against the front corner of the instrument, align the recessed holes with the holes vacated in step a.

   c. Secure the rack ears to the instrument using the six 8-32 x 7/8-inch screws.

4. Note the orientation of the instrument's shelf bracket in Figure 2045-1. Install the shelf bracket into the equipment cabinet using two 10-32 x 3/8-inch screws on each of the four tabs.

5. Insert the instrument three-fourths of the way into the equipment cabinet along the shelf bracket.

6. Attach the clip nuts to the front flange of the equipment cabinet aligning the clip nuts with the slotted holes of the rack ears.

7. Slide the instrument into the equipment cabinet and secure it using the machine screws.

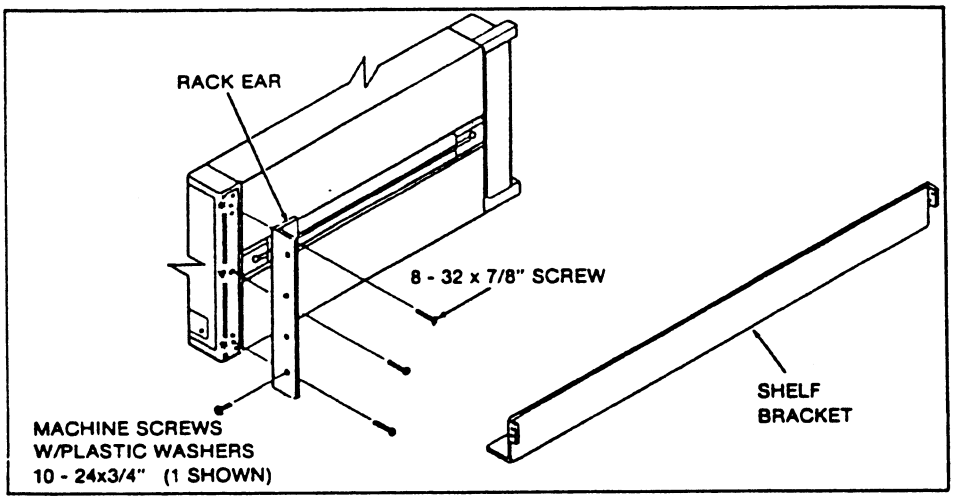


Figure 2045-1. Installation Details

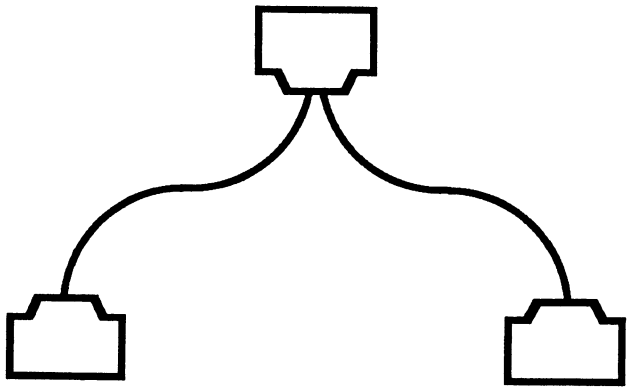
Y2045

The Y2047 Serial Link Multiconnect is used in 2281A placements to support star configurations. Examples of star configurations are shown in Section 2 of the 2281A Instruction Manual.

The Y2047 contains two D-type, 15-pin sockets on one face of its 1 3/4-inch x 1-inch x 1 3/4-inch metal housing and a single D-type, 15-pin plug on the opposite face.

The Y2047 male plug can be connected to J23 on the rear panel of the Computer Front End or the 2281A Extender Chassis. If a star connection is desired from a 2281A with a -431 installed, the Y2047 must be connected to J23 (2281A) using either a -402 Extender Cable (with -403 Extender Cable connectors) or the cable supplied with the 2281A. Use the two Phillips screws on the reverse side, between the two parallel sockets, to secure the Y2047 to the cable retaining nuts of J23.

Accessory Y1060 25-Conductor Multipoint Connector is a three-way connector assembly necessary in a multipoint RS-422 network. It is comprised of three 25-pin D-type connectors with required signal lines connected in parallel. Required signal lines attach to pins 1, 7, 9, 10, 14, and 15. One Y2055 25-Conductor Multipoint Connector is required for each Computer Front End mainframe except the last one in an RS-422 multipoint system.



RS-232-C NULL-MODEM CABLES

An RS-232-C Null-Modem Cable is used when the Computer Front End and the host computer are direct-connected without modems. The Null-Modem cable reverses the pins carrying Transmitted Data (TD) and Received Data (RD). It takes the place of two modems when a direct-connect network is desired.

The following Fluke RS-232-C Null-Modem Cables are complete with connectors:

- Y1702 -- 2m RS-232-C Null-Modem Cable
- Y1703 -- 4m RS-232-C Null-Modem Cable
- Y1705 -- 30 cm RS-232-C Null-Modem Cable

The Y1705 is intended to be used in conjunction with a standard RS-232-C cable.

Wiring for these cables is shown in Figure 17XX-1. Pin signal names are identified in Table 17XX-1.

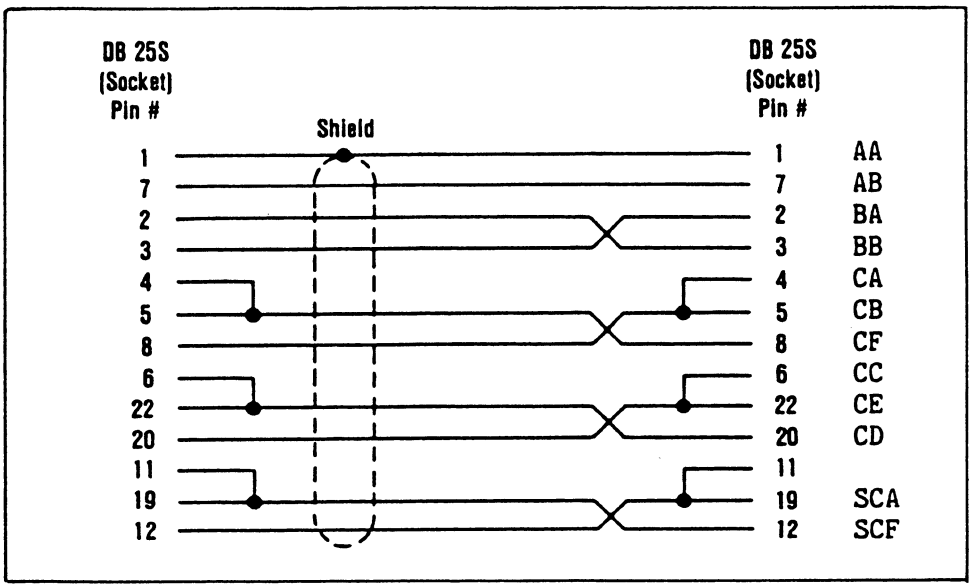


Figure 17XX-1. Y1702, Y1703, Y1705 Wiring

RS-232-C INTERFACE CABLES

These cables may be used to connect the Computer Front End to Data Communication Equipment (DCE). An example of DCE is a modem. RS-232-C cables complete with connectors are available from Fluke as the following accessories:

- Accessory Y1707 -- 2m RS-232-C Cable
- Accessory Y1708 -- 10m RS-232-C Cable

Refer to Figure 17XX-2 for cable wiring connections. Pin signal names are identified in Table 17XX-1.

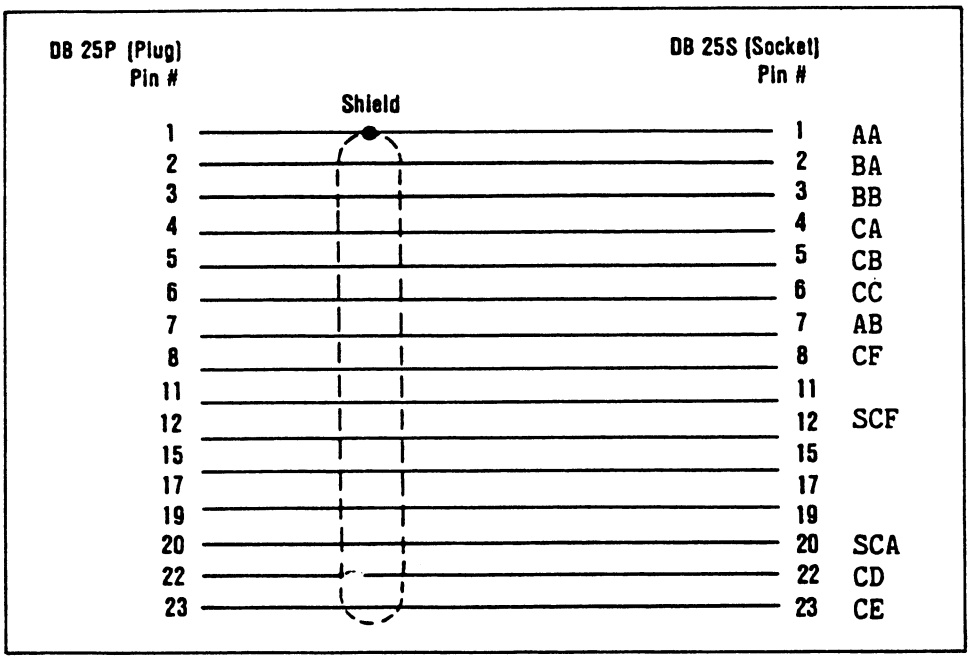


Figure 17XX-2. Y1707, Y1708 Wiring

PRINTER CABLE

The Y1709 is a 1m cable allowing for serial printer connections. Wiring is illustrated in Figure 17XX-3. Pin signal names are identified in Table 17XX-1.

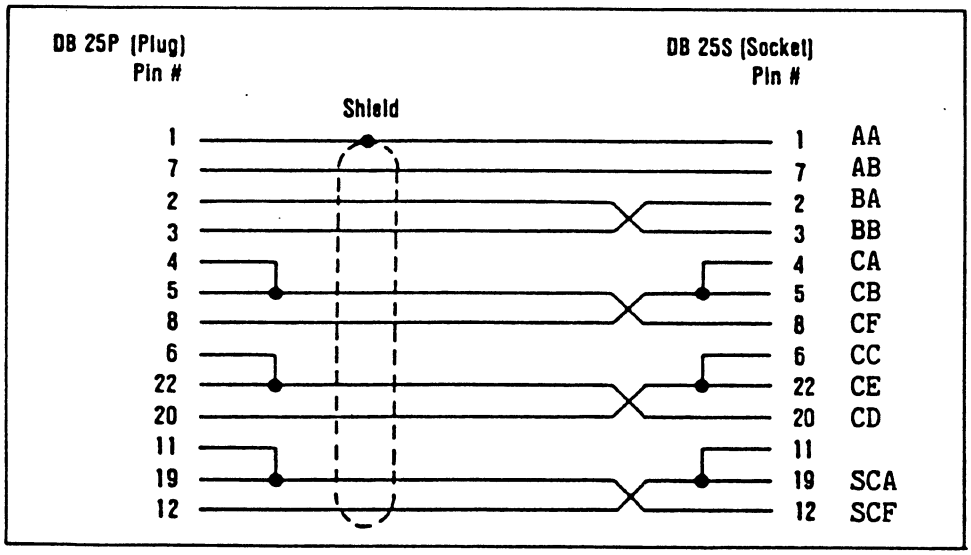


Figure 17XX-3. Y1709 Wiring

Table 17XX-1. RS-232-C Pin Identification

AA	1	Protective Ground
AB	7	Signal Ground
BA	2	Transmitted Data
BB	3	Received Data
CA	4	Request to Send
CB	5	Clear to Send
CF	8	Received Line Signal Detect
CC	6	Data Set Ready
CE	22	Ring Indicator
CD	20	Data Terminal Ready
	11	Unassigned
SCA	19	Secondary Request to Send
SCF	12	Secondary Received Line Signal Detect

MAINFRAME INTERFACE TESTING

When interface configuration and installation is complete, test the system to verify correct operation. The following installation verification test should be performed regardless of the type of host computer you are using.

Note that this test procedure only checks the communications interface. It does not test any installed option assemblies. If option assemblies are installed during a failed test, remove the options and repeat the test.

Follow these steps to verify correct installation and operation of the interface:

1. Connect the host computer to the Front End using the appropriate equipment and cables for the type of electrical interface (RS-232-C or RS-422). Check to make sure each connection is tight.

2. Connect the host computer and the Front End to line power.

3. Set the Front End POWER switch to ON.

4. Switch the host computer on. If this is a multi-point connection, establish the line connection as discussed in Section 3A, under "Mainframe Multidrop Configuration." Briefly, this procedure amounts to sending first the address of the desired Front End, then the ENQ character. A two-point direct-connect system does not require this step.

5. Send the following command to the Front End from the host computer:

   SEND VERSION$

6. Verify that the response from the Front End to the host computer indicates one of the following:

   Helios-I Version x.y

   Helios Scan/Alarm Version x.y
   Software by Polar Software Systems

If the system does not function properly, check all connections, then try the installation verification test again. If the system fails to function properly the second time, verify the interface of the host computer with another system or device to eliminate the computer as the source of the problem. If the host computer functions properly, contact your nearest Fluke Service Representative.

OPTION ASSEMBLY TESTING

Once the mainframe installation test has been passed, and after option assemblies have been installed, the LIST CHAN command can be used to verify the hardware configuration. Use this format:

```
LIST CHAN (channel[s])
```

This command returns a listing of the definitions of designated channels. Each listing describes both hardware configurations and software channel definitions. The form in which a listing is returned depends on whether the front end is operating in the Terminal (TERM) or Computer (COMP) mode.

In the Computer Mode, the LIST CHAN(channel[s]) command returns six numeric fields on a single line. Fields are separated by commas. Each field represents a hardware configuration or element of a channel's definition.

In the Terminal Mode, channel definition data are returned as alphabetic, rather than numeric, strings, making them more readily understandable.

Refer to Section 5, LIST CHAN for full descriptions of listing responses. Also, refer to the appropriate type of measurement or output described in Section 6, where examples entitled "Putting it all Together" can be used to verify hardware installation.

SCAN/ALARM OPTION TESTING

To test an installed Scan/Alarm option, first perform the mainframe tests presented earlier in Section 3C. Then, if a printer is being used, make the related connections called for in Section 3A.

3C/Installation Verification

Use the following steps to verify correct installation and operation of the Scan/Alarm option.

1. On the alarm annunciator connector, connect a wire between pin 6 and pin 8.

2. From the host computer, send the following command to the Front End:

   HOSTTO = 1

3. After about one second, check for a printer message indicating that the host computer is off line. Also, the audible alarm contacts (pins 1 and 3) should close, and the visual alarm contacts (pins 2 and 4) should begin opening and closing.

4. Remove the wire from pin 8. Now, momentarily connect it to pin 7, then reconnect it to pin 8. Check that the visual alarm contacts close and remain closed and that the audible alarm contacts open.

5. Send the following command from the host computer to the Front End:

   HOSTTO = 0

6. Check that the visual alarm contacts open.

If the system does not function properly, check all connections and switch settings. Then try the installation verification again. If the system still fails to function properly, verify that the host computer interfaces successfully with another system or device. If this interface test is successful, the host computer is not the source of the problem. At this point, contact your nearest Fluke Service Representative.

CONTENTS

INTRODUCTION 4-3
COMMAND FORMAT 4-4
COMMAND SET SUMMARY 4-5
Definition (DEF) Command 4-6
Set Command 4-7
System Variables 4-8
LIST Command 4-9
RESET Command 4-10
SEND Command 4-10
TEST Command 4-11
Repeat ("!") Command 4-11
Special Characters 4-11
Delete (Decimal 127) 4-12
Abort (<CTRL>/C, Decimal 3) 4-12
Stall and Unstall(<CTRL>/S and <CTRL>/Q) 4-12
ENQ 4-13
EOT 4-13
DLE + EOT 4-13
& 4-13
OPERATING THE FRONT END FROM A TERMINAL 4-14
Powering Up and Entering Terminal Mode 4-14
Command Responses 4-15
OPERATING THE FRONT END FROM A COMPUTER 4-16
Powering Up and Entering Computer Mode 4-17
Command Responses 4-18
Implementing a Reliable Communication Link .. 4-20
Communication Character Buffering 4-21
Timeouts 4-23
Error Buffers 4-24
SCAN/ALARM OPTION COMMANDS 4-24
CONCLUSION 4-28

INTRODUCTION

The Front End can be programmed and operated using a terminal, a computer, or a computer running a terminal emulation program. Operation amounts to the computer or terminal sending commands to the Front End and reading back or displaying the Front End's responses to the command. This section presents an overview of communications, describing commands understood by the Front End, methods of sending these commands from the terminal or computer, and responses read by the computer or displayed on the terminal.

The Front End can be used in one of two communication modes. The first, Terminal Mode, provides descriptive prompts and messages. The second, Computer Mode, uses abbreviated prompts and messages (usually abbreviated to numeric codes) to simplify operation of the Front End from a computer program.

Either mode can be used to control the Front End. The following considerations should be made when deciding which mode to use.

- Speed. Computer Mode allows for faster communication. It best complements the speed of the controlling computer when the front end is under direct program control.

- Clarity of Feedback. Terminal Mode provides more meaningful feedback to the operator. Command characters appear on the terminal screen as they are typed, and returned measurements and error information are provided in descriptive phrases.

- Editing of Inputs. Terminal Mode allows some editing of commands as they are being entered. Typing mistakes can be corrected. Computer Mode allows no editing of commands.

4/Using the Commands

COMMAND FORMAT

The Computer Front End uses a straightforward command structure. Examples of commands are:

```
SEND VERSION$ <CR>
DEF CHAN(0..19)=DVIN <CR>
FORMAT = HEX <CR>
```

where <CR> represents a carriage return character. Depending on the type of computer or terminal, this character may be entered with the RETURN, ENTER, return arrow, or other key.

As shown above, a command to the Front End has three parts: it begins with a word that identifies the type of command, is followed by a list of parameters that further describe the operation to be performed, and is completed with a carriage return character. A <CR><LF> (where <LF> represents a line feed) sequence can also be used to terminate commands.

Commands to the Front End use many different words. The examples above used the words:

```
SEND    VERSION$     DEF       CHAN
DVIN    FORMAT       HEX
```

These words can be sent to the Front End using upper or lower case characters or a combination of both. These words are all equivalent:

```
SEND    send    Send
```

Spaces cannot occur within a word.

A command must be 80 characters or less. Commands longer than 80 characters are truncated, often resulting in a command syntax error.

COMMAND SET SUMMARY

The commands of the Computer Front End are organized into seven functional groups.

- Definition (DEF) commands establish the characteristics of measurement or output channels and the transfer function of linearization tables.
- Set commands are used to change the values of system variables and output channels.
- LIST commands retrieve information about channel setup, interpolation table contents, and error history.
- RESET commands allow channels, groups of channels, or the entire Front End to be put in a known operating state.
- SEND commands fetch the reading on a channel, group of channels, or obtain the current value of a system variable or output channel.
- TEST commands check the operability of a channel, group of channels, or the entire Front End.
- The repeat command ("!") provides a shorthand method to repeat the execution of the previous command.

The following paragraphs provide a more detailed introduction to the commands. A complete description of each command is presented in Section 5, Command Reference.

Definition (DEF) Command

Defines measurement and output channel parameters including signal conditioning selection and engineering unit conversion. Use the format:

DEF CHAN(<channels>) = <definition parameters><CR>

As an example, define channels 0 through 19, 24 and 40 through 59 as type J (National Bureau of Standards) thermocouple inputs.

DEF CHAN(0..19, 24, 40..59) = TC, TYPE = JNBS <CR>

The definition command is also used to define interpolation tables. Use the following format:

DEF TABLE(<table number>) = <table x-y pairs><CR>
DEF TABLE(<table number>) = / <table x-y pairs> <CR>

For example, define table 0 to multiply a measurement by 2.

DEF TABLE(0) = 0,0 / 1,2 <CR>

Now, add two x-y pairs to the end of table 0.

DEF TABLE(0) = / 3,6 / 4,8 <CR>

TIME	Time of day in milliseconds since midnight.
TIME$	Time of day in hours, minutes, second (hh:mm:ss) format.
TUNIT	System temperature units (CELSIUS, FAHRENHEIT, KELVIN, RANKINE)
VERSION$	Software version number (set by system, cannot be set using a set command).

LIST Command

The LIST command has three uses. First, it is used to obtain hardware configuration and channel definition information established using DEF CHAN commands. Along with the channel definitions, the Front End's hardware configuration is returned. This makes it easy to check option configuration and verify switch settings.

Use the following format:

```
LIST CHAN(<channels>) <CR>
```

As an example, send the current hardware configuration and definitions on channels 0 through 19.

```
LIST CHAN(0..19) <CR>
```

LIST can also be used to obtain the interpolation table definitions set up using the DEF TABLE command. The format is then:

```
LIST TABLE(<table number>) <CR>
```

For example, list the current definition of interpolation table number 4.

```
LIST TABLE(4) <CR>
```

Finally, LIST is used to retrieve error information.

```
LIST ERROR <CR>
```

The format of the response to this command is different for Terminal and Computer Mode. Refer to the Section 5, Command Reference, for a detailed description of the LIST command response format.

RESET Command

The RESET command is used to put specified Front End channels in their power-up states, and to re-initialize the entire system. Any of the following formats can be used:

```
RESET <CR>
RESET ALL <CR>
RESET CHAN(<channels>) <CR>
```

SEND Command

The SEND command is probably the most often used command since it causes measurements to be made and the resulting readings to be returned to the computer or terminal complete with engineering unit conversion. Use the format:

```
SEND CHAN(<channels>) <CR>
```

For example, make measurements on channels 0 through 19.

```
SEND CHAN(0..19) <CR>
```

The response format to the SEND CHAN command is dependent on values for the system variables COUNT and FORMAT.

Refer to the Section 5, Command Reference, for a detailed description of the SEND command response format.

SEND can also be used to verify the value of a system variable:

SEND <system variable name> <CR>

For example, send the string indicating the software version number:

SEND VERSION$ <CR>

TEST Command

This command is used to perform a self test on the entire system or on specific measurement or output channels. Possible formats are:

TEST <CR>
TEST CHAN (<channels>) <CR>

Repeat ("!") Command

The repeat command provides a shorthand method to repeat the execution of the previous command.

! <CR>

Special Characters

In addition to the commands introduced in the preceding paragraphs, the Front End responds to several ASCII characters. These special characters are used to implement communication flow control (such that the

computer or Front End won't send characters faster than the other can consume them), initialize the instrument, and select or deselect a specific Front End in a multipoint configuration.

The following paragraphs briefly describe the function of these characters.

DELETE (DECIMAL CODE 127)

The DEL or delete character is used in terminal mode to erase the previous character while a command is being entered.

ABORT (<CTRL>/C, DECIMAL CODE 3)

The <CTRL>/C character causes the following to occur:

1. A currently executing command continues execution to completion with response outputting disabled.

2. Any characters currently in the input buffer (a partial command) are discarded.

3. Any characters currently in the output buffer are discarded.

4. Any stall condition, due to receipt of a <CTRL>/S character, is lifted.

STALL AND UNSTALL (<CTRL>/S AND <CTRL>/Q)

<CTRL>/S (decimal code 19) and <CTRL>/Q (decimal code 17) characters can be used by the computer or terminal to prevent the loss of characters if, for some reason, the computer or terminal cannot handle the characters at the rate being transmitted by the Front End. When the Front End receives a <CTRL>/S character, the transmission of characters is halted until the Front End receives a <CTRL>/Q (or <CTRL>/C) character.

Set Command

The set command differs somewhat from other commands in that a special word is not required at the beginning of the command. The first word of the command is the name of the system variable or output channel to which a value is being assigned.

Analog output and status output channels and system variables can have their values set.

Detailed descriptions of the system variables are provided in Section 5, Command Reference. They are also listed at the end of this command description.

The following formats can be used:

CHAN(<output channels>) = <value> <CR>

<system variable name> = <value> <CR>

For example, set the output on analog output channel 101 to 4.9.

CHAN(101) = 4.9 <CR>

Or, set the output on status output channel 120 to 1.

CHAN(120) = 1 <CR>

This command sets the time string to 6 o'clock.

TIME$ = 06:00:00 <CR>

System Variables

Following is a brief description of each system variable. More detailed information is provided in Section 5.

CAL	Enables or disables auto calibration.
COUNT	Enables sending count of number of readings returned in a SEND CHAN command.
DATE$	Date in dd-Mmm-yy format (e.g., 01-Jan-86).
EOL	Sequence of characters the Front End sends at the end of each line.
FORMAT	Selects numeric format of returned measurement values (DECIMAL, HEX, or BINARY). (XASCII, XDECIMAL, XHEX, or XBINARY - Scan/Alarm option only)
HOSTTO	Contains the timeout interval for the host communications (Scan/Alarm option only).
INTERRUPT	Determines if host is interrupted on a change of status. (Scan/Alarm option only)
LINEFR	Power line frequency (50, 60, or 400 Hz).
MEMSIZ	Memory remaining (set by system, cannot be set using a set command).
MODE	Selects terminal or computer mode.
STATUS	Holds current status of a number of system resources. (Scan/Alarm option only)
TERM	Controls transmission of exclamation mark during Send and List commands.

The Front End does not send <CTRL>/S or <CTRL>/Q characters to the computer to stall output from the computer.

ENQ

The ENQ (decimal code 5) character is used to accomplish multipoint addressing in RS-422 installation configurations.

EOT

The single character EOT (decimal code 4) disconnects the Computer Front End from the host computer, but any pending output is retained until reconnection.

DLE + EOT

When the Front End is set for multi-drop (MULTDRP selected), the DLE (decimal code 16) and EOT sequence unaddresses the Front End, aborting any pending output.

When the Front End is set for full duplex (FDP selected), this sequence instructs the Front End to disconnect its modem and abort any pending output.

&

(Scan/Alarm Option only.) The ampersand (decimal code 38) echoes end-of-line sequence. You can continue typing on the next line.

OPERATING THE FRONT END FROM A TERMINAL

Terminal Mode allows the Front End to be controlled from a terminal or a computer behaving as a terminal. In this mode the Front End echoes each character it receives (except control characters <CTRL>/S, <CTRL>/Q, <CTRL>/C, DLE, EOT, or ENQ). All prompts and responses to commands from the Front End are displayed in a readable format.

Terminal Mode can be used to verify Front End installation or for familiarization with commands and responses.

Powering Up and Entering Terminal Mode

Terminal Mode is selected by executing the command:

MODE = TERM <CR>

The Front End responds to the command by returning the prompt:

HCLI>

This indicates that the Front End has completed the execution of the command and is ready to receive the next command. Characters entered while the Front End is in TERM mode are echoed and displayed on the terminal screen. If COMP mode is in effect, no characters are echoed.

The mode of operation, either Terminal or Computer, is remembered by the instrument while power is off.

Command Responses

The Front End sends a response back to the terminal for each command executed. The response may simply be the command prompt

HCLI>

or, it could consist of information requested using a SEND or LIST command followed by the command prompt

<send or list data><eol>
HCLI>

or, it could be a descriptive error message followed by the prompt

?<textual error message><eol>
HCLI>

Note that <CR> means a single carriage return character or a carriage return - line feed sequence and <eol> means the end-of-line sequence (EOL system variable).

Specific examples of Front End command responses in Terminal Mode are:

Command: SED CHAN(900)<CR>

Response: ?No such command<eol>
HCLI>

An error has occurred. In this example, the SEND command has been improperly entered.

```
Command:    SEND CHAN(900, 3..4)<CR>

Response:    7.16724E+01<eol>
            -1.23456E-03<eol>
             0.00000E+00<eol>
            HCLI>
```

Successful measurement were made on channels 900, 3, and 4, and the readings were returned.

```
Command:    LIST CHAN(20)<CR>

Response:   aichan(20)=rtd, type=din385,range=hi<eol>
            HCLI>
```

The response to the LIST CHAN command indicates that channel 20 is defined as an RTD channel.

OPERATING THE FRONT END FROM A COMPUTER

Computer mode is used when the Front End is being operated through a program running on a host computer. Commands from the computer to the Front End are identical to those used in Terminal Mode. Characters are not echoed back to the host computer, however. Responses to commands contain the same information as Terminal Mode responses but the representation is abbreviated to improve throughput and make it easier to interpret with a computer program.

Powering Up and Entering Computer Mode

Computer Mode is set when the Front End is initially powered up or when a RESET ALL command is executed. At any other time, Computer Mode can be selected by executing the command:

```
MODE = COMP <CR>
```

The Front End responds to the command by returning the prompt:

```
!<eol>
```

This indicates that the Front End has completed the execution of the command and is ready to receive the next command.

The mode of operation, either Terminal or Computer, is remembered by the instrument while power is off. This warrants a word of caution. If the Front End is in Terminal Mode when powered up it responds to the MODE = COMP <CR> command in terminal mode, that is, echoing the characters back to the host. This means that the MODE = COMP <CR> command response is:

```
MODE = COMP <CR>
!<eol>
```

To handle this situation, you can read characters back until the sequence !<eol> is detected. This allows you to get the Front End into computer mode regardless of its mode at power up.

Command Responses

The responses to commands when the Front End is in Computer Mode contain the same information as responses in Terminal Mode. The format of the information is different such that it can more easily be interpreted by a computer program. The response may simply be the command prompt

!<eol>

or, it could consist of information requested using a SEND or LIST command

<send or list data><eol>

or, it could be an error indication in numeric format

?<error number><eol>

Note that <CR> means a single carriage return character or a carriage return - line feed sequence and <eol> means the end-of-line sequence (EOL system variable).

Specific examples of Front End command responses in Computer Mode are:

Command: SED CHAN(900)<CR>

Response: ?27<eol>

- Characters may be received by the computer that were not sent from the peripheral due to noise in the communication link from wiring, modems, or telephone switching equipment.

- The transmission errors in either direction may not be permanent. They may be intermittent.

The likelihood of having one or more of these problems is dependent on the configuration of your installation. A direct wire configuration where the computer and the Front End are connected together using a shielded null modem cable and located in the same rack of equipment or same room exhibits a very low error rate. However, an installation using modems over a public switched telephone facility could have a modest to frequent error rate. In either case, the following suggestions may help when designing the computer program that sends commands to and reads responses from the Front End.

COMMUNICATION CHARACTER BUFFERING

Serial communications between computers and peripherals often involve the buffering of characters. Buffering is a means to improve the overall system throughput and to manage the disparity between the speed at which the characters can be transmitted and the rate at which they can be processed.

When the computer sends a command to the Front End, the characters go through a buffer residing in the computer before they are transmitted on the RS-232 link. The computer program can put the characters in the buffer extremely fast and, once the characters are buffered, continue executing additional program steps. Characters, meanwhile, are extracted from the buffer at a rate dependent on the baud rate of the link and transmitted out the serial link. The characters are received by the Front End, entered into a buffer and extracted one by one by a program executing on the microcomputer residing within the Front End.

Characters are entered into the Front End's output buffer as a result of executing the received command and then transmitted back to the computer. Now, back at the computer, received characters are buffered and read from the buffer using the programming language's INPUT (or equivalent) statement. All this is taking place behind the scenes to improve system throughput and make the job of writing a program to operate the Front End easy.

Now, the word of caution. If you are not careful, characters could be present in the computer's input buffer that are remnants from earlier commands or spontaneously generated characters resulting from communication link problems. It's a good idea to eliminate the characters in the computer's input buffer and the Front End's output buffer before each command is executed. This helps in assuring that the computer is reading the response to the command and not some garbage characters.

The Front End's input and output buffers can be emptied by issuing the <CTRL>/C command, that is, sending it a single <CTRL>/C (decimal code 3) character.

Also, the host computer programming language usually has some way to clear the input buffers. Often the OPEN statement empties the input buffer. Or, if there is a function that reports the number of characters in the buffer, a simple FOR..NEXT loop can be used to read characters (and throw them away) until the buffer is empty.

TIMEOUTS

A character sent by a computer to a peripheral device may never arrive at the peripheral. This can be caused by an intermittent cabling connection or by any number of noise sources affecting the communication link. When a character of a Front End command doesn't arrive at the Front End, the failure is dependent on which character or characters are lost. If the command termination character is lost, the Front End continues to look fruitlessly for one, and the computer does not receive the command response that it expected.

Characters can also be lost in transit from the peripheral to the computer. This can result in improperly formatted data or insufficient data.

These problems can be taken care of by using a timeout on character reception from the Front End. Anytime the computer expects the Front End to send a character, it should look for that character for a finite time. If no character is received before the timer expires, the system should be reinitialized and the command retried.

The implementation of this scheme in the system depends on the programming language and computer in the system. Many computers and programming languages provide timeouts on formatted input statements. In these situations, a timer is started at the beginning of the execution of an INPUT (or equivalent) statement. If the timer expires before the INPUT statement completes execution, an error routine is called.

Other computers provide more primitive capabilities that allow the timeout to be implemented. They allow the program to obtain the current number of characters in the communications port input buffer, read characters one at a time, and read the system time. These together can be used to implement the timeout scheme.

ERROR BUFFERS

The Front End is designed to accumulate measurement error information detected during SEND command execution. Errors such as "open thermocouple", "over range", "illegal BCD digit", "no convergence", and "over temperature" can be detected and reported back to the computer using a LIST command. The Front End can accumulate and store information on up to twenty errors. If more than twenty errors are detected before being sent back to the computer, the additional error information is lost.

If it is likely that you will encounter these types of errors, it is a good practice to limit the number of channels requested in a SEND command to twenty. Therefore, potentially important error information will not be lost. The computer program should also be designed to read the error information, using the LIST ERROR <CR> command, after each SEND command. This technique prevents multiple SEND commands from overrunning the error buffer.

SCAN/ALARM OPTION COMMANDS

Substitution of the Scan/Alarm Option (-201) for the standard Computer Interface Assembly allows for several enhanced data retrieval, manipulation, and output features. These features include:

- Input/Output Channel Scanning

  Each of four different channel groups can be monitored over time intervals specified directly by Helios I. Channels 0 through 999 are available when the Scan/Alarm option is installed. If the host computer is allocated to a higher priority task, data buffers can be used for temporary storage of monitored inputs or outputs.

An error has occurred. In this example, the SEND CHAN command has been improperly entered.

```
Command:      SEND CHAN(900, 3..4)<CR>

Response:     3.00000E+00<eol>
              7.16724E+01<eol>
             -1.23456E-03<eol>
              0.00000E+00<eol>
```

Successful measurements were made on three channels (900, 3, and 4). But note that there are four lines in the response. The first line represents the number of actual measurements, which are found on lines two through four, and is present whenever the COUNT variable is set to ON.

```
Command:      LIST CHAN(20)<CR>

Response:     1<eol>
              20,1,2,2,0,0<eol>
```

The response to the LIST CHAN command indicates that channel 20 is defined as an RTD channel. Section 5, Command Reference, contains the information necessary to interpret the response to the LIST command.

Implementing a Reliable Communication Link

The previous paragraphs have demonstrated the command set of the Front End. This introduction, and the reference material in Section 5, can be used to compose the necessary commands and read back the responses for a wide variety of applications.

When a computer is using an RS-232 or RS-422 serial link, problems may occur in communicating with a peripheral device (e.g., a Computer Front End). The following paragraphs address these problems.

Serial communication with a peripheral can be remarkably easy. The computer sends out a string of characters (a command) and reads back a string of characters (the response). This could be done with the following BASIC program fragment:

```
10  PRINT #1, "SEND CHAN (9)"
20  INPUT #1, A
```

Line 10 outputs the SEND CHAN (9) command and line 20 reads the response into the variable named A. But what can go wrong? Will this program always work? Consider the following:

- The command sent from the computer may not arrive at the peripheral as it was sent from the computer.
- Characters may be received by the peripheral that were not sent from the computer due to noise in the communication link from wiring, modems, or telephone switching equipment.
- The command response may not be received by the computer in the same format as it was sent from the peripheral.

- Alarm Operations

  The Scan/Alarm option provides for extensive alarm testing and communications. Two high alarm limits and two low alarm limits can be established for each channel. Alarm outputs can be coupled to a regular status output channel or to special audible and/or visual alarm indicators. If the host computer does not communicate with Helios I for a specified period, alarm data can be logged on a printer connected directly to Helios I. Further, Helios I can initiate communication with the host computer if an alarm condition has occurred.

- Local Printer Port Operations

  Information from monitored channels or alarm data can be logged on a printer (or crt terminal) connected directly to the Scan/Alarm option. Output to this printer port can be controlled with special commands specifying the value format, a units string, a number variable, and control characters necessary for cursor positioning.

- Additional Math Functions

  Polynomial and square root functions are available with the Scan/Alarm option. Sampled data can also be manipulated to present the minimum or maximum value encountered, or to show the average or total of values measured.

Scan/Alarm features are fully documented in Section 5 of this manual. These feature descriptions, which are molded into the alphabetical organization of Section 5, are clearly marked as applying to the Scan/Alarm option. Scan/Alarm-specific features can be referenced in Section 5 under the following headings:

DEF ABUF
: Define an alarm buffer for temporary storage of alarm data.

DEF CHAN (Alarm Limits)
: A maximum of four limits, along with a hysteresis value and an alarm output channel, can be specified.

DEF CHAN (Channel Function) POLY
: Three polynomial coefficients can be defined for local conversion of measurement inputs to engineering values.

DEF CHAN (Channel Function) SQR
: Offset and scaling coefficients can be specified for a local square root function.

DEF SBUF
: Define a scan buffer for storage of scan data.

DEF SCAN
: Define a scan task, which executes directly from Helios I on a user-defined periodic basis.

LABEL CHAN
: Customize the printer port output with name and measurement units strings, engineering or fixed-point format, and cursor-control escape sequences.

LIST ABUF
Check the actual number of records in the alarm buffer.

LIST SBUF
Check the maximum number of records that can be stored in the scan buffer.

LIST SCAN
List the scan task definition.

RESET ABUF
Remove alarm buffer records that have already been viewed with the SHOW ABUF command.

RESET SBUF
Remove scan buffer records that have already been viewed with the SHOW SBUF command.

SEND ABUF
Return, and then delete, the oldest record in the alarm buffer.

SEND SBUF
Return, and then delete, the oldest record in the scan buffer.

Set FORMAT
Specify xascii, xbinary, xdecimal, or xhex.

Set HOSTTO
Specify a host computer timeout in seconds.

Set INTERRUPT
Enable or disable Helios I status change reporting to the host computer.

SHOW ABUF
View the next alarm buffer record.

SHOW FIRST|LAST|AGAIN ABUF
View the oldest or newest alarm buffer record, or repeat viewing the same record.

SHOW SBUF
View the next scan buffer record.

SHOW FIRST|LAST|AGAIN SBUF
View the oldest or newest scan buffer record, or repeat viewing the same record.

START SCAN
Start a scan task, and specify the output device, interval between scans, delay before the initial scan, and period of each scan.

STOP SCAN
Stop a previously-started scan task.

CONCLUSION

This section has provided an overall view of communications between the computer or terminal and the Front End. It has introduced various command lines that can be sent to the Front End.

This manual now offers several directions. If you are comfortable with Terminal and Computer Mode operations, go ahead and setup the Front End. If you need additional instruction about specific measurements or outputs, refer to Section 6, Measurement Reference. And if you want more specific information about individual commands and the responses to the commands, consult Section 5, Command Reference.

CONTENTS

INTRODUCTION 5-5
USING COMMAND REFERENCE INFORMATION 5-6
Notation Conventions 5-6
Syntax Diagrams 5-8
Syntax Diagram Examples 5-9
EXAMPLE 1 5-10
EXAMPLE 2 5-11
COMMON SYNTACTIC ELEMENTS 5-13
The Channel Function 5-13
SYNTAX DIAGRAM 5-14
INTERPOLATION TABLE (TABLE) 5-15
POLYNOMIAL FUNCTION (POLY) 5-15
SQUARE ROOT FUNCTION (SQR) 5-16
Channel Numbers 5-17
SYNTAX DIAGRAM 5-17
Numeric Representation 5-18
SYNTAX DIAGRAM 5-19
EXAMPLES 5-19

ALPHABETICAL REFERENCE TO THE COMMANDS

DEF Command
- DEF ABUF 5-21
- DEF CHAN
  - Alarm Limits 5-23
  - Channel Function 5-27
  - Analog Output 5-29
  - Counter/Totalizer Input 5-31
  - Digital I/O 5-33
  - Direct Current Input 5-35
  - Resistance Input 5-37
  - Strain Input 5-39
  - Temperature Input - RTD 5-45
  - Temperature Input - TC 5-49
  - Voltage Input 5-53
- DEF SBUF 5-57
- DEF SCAN 5-59
- DEF TABLE 5-61

LABEL CHAN Command 5-64-1

LIST Command
- LIST ABUF 5-65
- LIST CHAN 5-67
  - Computer Mode 5-69
  - Terminal Mode 5-77
- LIST ERROR 5-79
- LIST SBUF 5-83
- LIST SCAN 5-85
- LIST TABLE 5-89

RESET Command
- RESET 5-93
- RESET ALL 5-93
- RESET CHAN 5-93
- RESET ABUF 5-95
- RESET SBUF 5-95

SEND Command
SEND ABUF 5-97
SEND CHAN 5-103
SEND SBUF 5-109
SEND Value of System Variable 5-113

Set Command
Set CHAN
Analog Output 5-119
Status Output 5-121
Set System Variable to Constant
CAL 5-123
COUNT 5-125
DATE$ 5-127
EOL 5-129
FORMAT 5-131
HOSTTO 5-137
INTERRUPT 5-139
LINEFR 5-141
MODE 5-143
TERM 5-145
TIME 5-147
TIME$ 5-149
TUNIT 5-151

SHOW Command
SHOW ABUF 5-153
SHOW FIRST|LAST|AGAIN ABUF 5-153
SHOW SBUF 5-155
SHOW FIRST|LAST|AGAIN SBUF 5-155

START SCAN Command 5-157

STOP SCAN Command 5-161

TEST and TEST CHAN Command 5-163

INTRODUCTION

This section provides complete, alphabetically arranged reference information to all available commands for the Computer Front End. The section is divided into three main parts:

- The first several pages describe how to read and use the reference information. This first part discusses notation conventions and how to read the syntax diagrams.

- The second main topic is a discussion of the channel function, channel numbers, and numerical representation. These topics are presented separately because they are global in nature; that is, they apply to virtually all the available commands and are needed as background information.

- The largest part of this section is the reference information. Each command is discussed separately. The commands are arranged alphabetically so needed information can be located quickly.

USING THE COMMAND REFERENCE INFORMATION

The description of a command is often keyed to a specific function. For example, the DEF command is expanded to separate reference pages for each type of measurement or output that can be defined. Relevant uses of DEF can therefore be accessed directly.

Reference information is presented in complete examples. Each item appears in the context of a command line. For ease of expression, command lines are represented in three ways. First, the **Format** of a command gives a general description of the construction of a valid command line. The second type of expression is graphical, showing each type of command line as a syntax diagram. Finally, a textual description uses notation conventions to express the relationship of the various elements.

Notation Conventions

Several conventions are used to distinguish command line keystrokes from the surrounding text. In the following examples, brackets ([ ]) and angle brackets (< >) are used to separate parts of the command line, but are not actual parts of the command line. Do not type these symbols.

<XXX> Angle brackets enclosing all upper-case letters mean "press the XXX key".

Example: **<CR>**

means to press the CARRIAGE RETURN or ENTER key.

<xxx> Angle brackets enclosing all lower-case letters indicate required information to be entered by the user.

Example:

DEF TABLE(<table number>) = <table definition>

means supply a "table definition" for TABLE(table number).

[xxx] Indicates an optional input statement.

Example: **[,MAX = <volts>]**

means that specifying a maximum expected voltage is optional.

XXX Computer Front End keywords are represented as all upper-case characters to distinguish them from surrounding text. However, keywords can be entered in any combination of upper and lower case characters.

Example: **MODE**

means to type the command "MODE" or "mode" or "Mode".

| Indicates that the user can choose among the options listed.

Example: **MODE = COMP | TERM**

means that the user can enter either MODE = COMP or MODE = TERM.

.. "Double Periods" define an inclusive range.

Example: **CHAN(0..99) = 1**

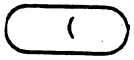
assigns logic '1' to channels zero through ninety-nine.

Syntax Diagrams

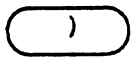
The structure and syntax of the commands are graphically represented in the form of syntax diagrams. These visual portrayals provide an excellent way to learn and reference the various command usages.

Syntax diagrams use a standard symbol for each type of activity. Following is an overview of these symbols:

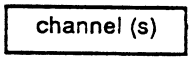
A Word inside an oval is a keyword. In the syntax diagram, keywords will be in upper case. However, they can be entered in any combination of upper and lower case characters.



This indicates a left parenthesis.



This indicates a right parenthesis.



A box with lower-case words means that you supply some information. In this case, you would enter channel number(s).

Words in parentheses are explanations of some kind. They give information about the nearest block or path.

Syntax Diagram Examples

A syntax diagram represents a critical path for entering a command line. The diagram shows the most direct route, along with any optional paths. To read a syntax diagram, start at the upper left and follow the arrows. Any branches in the diagram define an optional part. Either continue along the critical path, or enter the optional command line parts before returning to the critical path. Figures 5-1 and 5-2 present syntax diagrams for the Computer Front End.

EXAMPLE 1

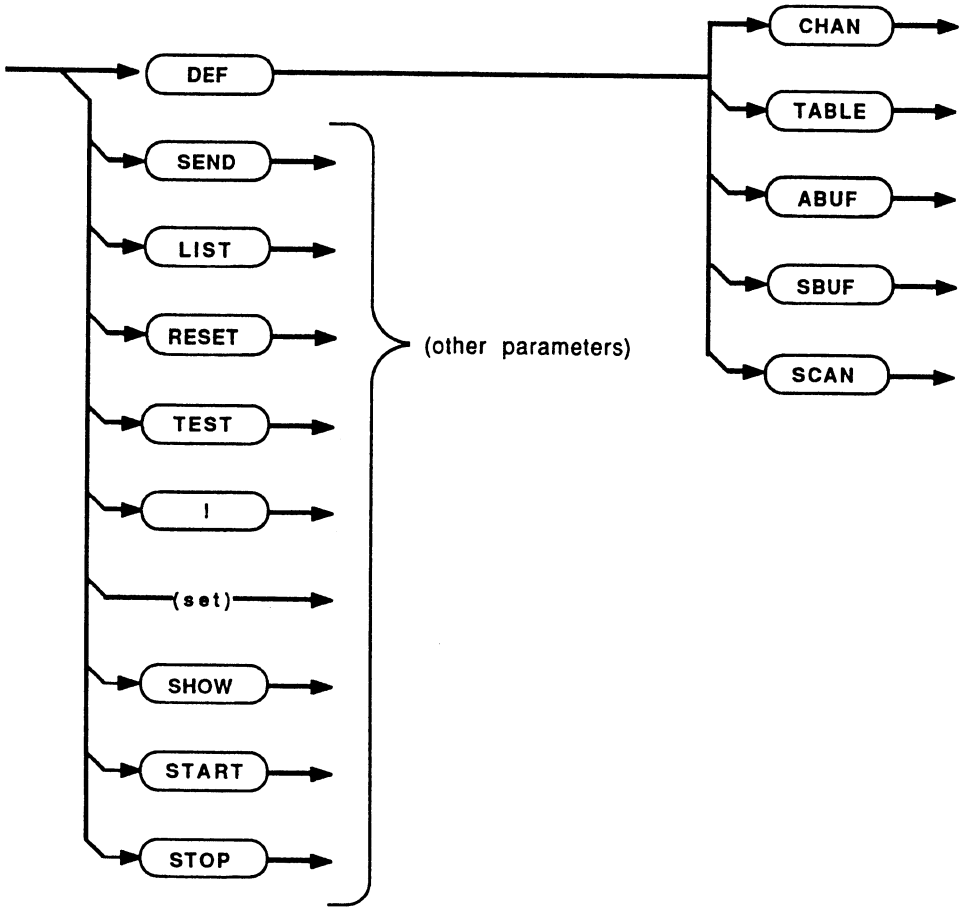


Figure 5-1. Syntax Diagram - Commands

This example shows the highest level of syntax. All command lines start with one of these keywords: DEF, SHOW, START, STOP, SEND, LIST, RESET, TEST, !. "Set" requires no initial command keyword. Some syntax rules are as follows:

- Keywords are case insensitive, although they are rendered in upper-case characters for emphasis.
- Spaces may not be inserted between the letters of a keyword, but a space character is required between the keywords of a command.
- To enhance readability, spaces may be inserted between elements of a command line.

EXAMPLE 2

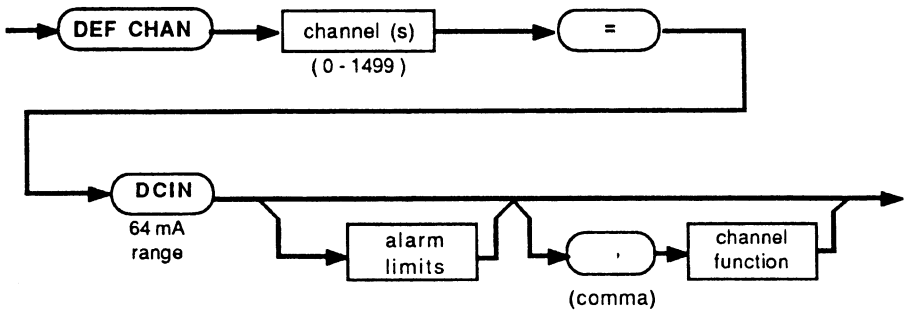


Figure 5-2. Syntax Diagram - DEF

This example expands on syntax for the DEF command. DEF can be used to define a channel, an interpolation table, a scan, an alarm buffer, or a scan group. The example demonstrates some additional rules about syntax diagrams:

- Where indicated, commas must be used as separators within the command string.
- Explanatory information, appearing in parentheses, further defines the boxes or paths. Parentheses can also indicate the range of a parameter. An instance here shows that the 64 mA range is the only range available.
- Optional syntax is shown as a branch from the main (shortest) path. Here, a channel function table can be called.

Based on this syntax, a valid command line would be:

```
DEF CHAN(00..09)=DCIN
```

COMMON SYNTACTIC ELEMENTS

This second part of the command reference section gives needed background information on three topics:

- The Channel Function. Most Front End operations take place via measurement channels. Therefore, the channel function is used with nearly all of the commands. Rather than repeat the necessary information many times, this function is discussed here as a separate topic.

- Channel Numbers. As a part of all channel commands, Channel Numbers are repetitive. A clear understanding of how to represent Channel Numbers is an aid to using the Front End command set efficiently.

- Numeric Representation. This discussion describes the valid ways of expressing numbers when sending commands to the Front End.

The Channel Function

Although optional, the channel function can be appended to any channel definition (DEF CHAN) command. It applies one or more of the following values to specified channels:

- An interpolation table, which is defined in the TABLE statement appended to the DEF CHAN command but separately set up with the table definition command DEF TABLE.

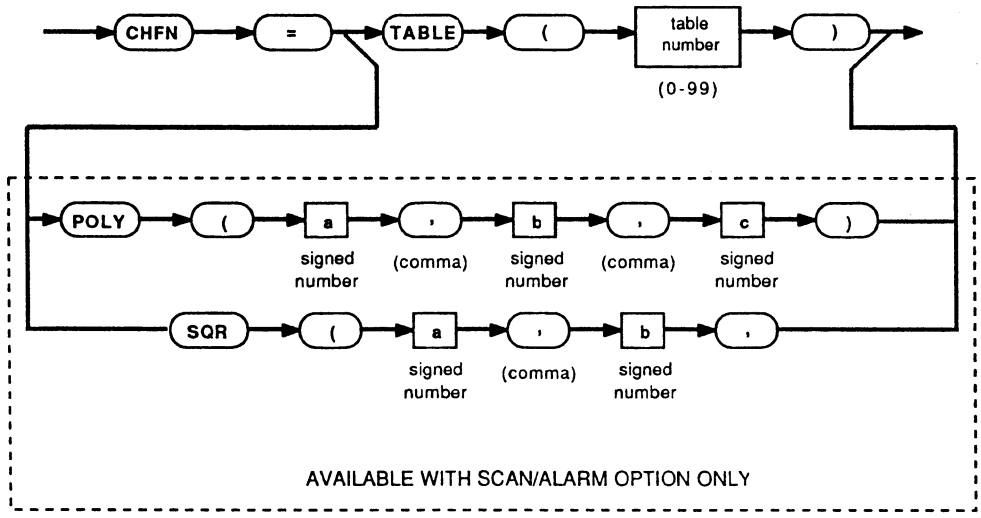
- A polynomial function, which is defined in the POLY(a,b,c) statement appended to the DEF CHAN command. Scan/Alarm option only.

- A square root function, which is defined in the SQR(a,b) statement appended to the DEF CHAN command. Scan/Alarm option only.

SYNTAX DIAGRAM

A syntax diagram with this block: channel function

expands to the following complete syntax:



INTERPOLATION TABLE (TABLE)

An interpolation table requires two types of commands:

```
DEF TABLE(1) = 0.004,0/0.020,100/...
DEF CHAN(33) = DCIN, CHFN =TABLE(1)
```

In this example, the first line defines points on an interpolation table (Table 1). The second line applies these points to the defined channel. Channel 33 is defined for direct current measurements. Measurements are filtered through the table. This command makes possible very flexible linearization and result interpolation, so be sure to refer to the DEF TABLE command reference page for details on how to construct useful tables.

POLYNOMIAL FUNCTION (POLY)

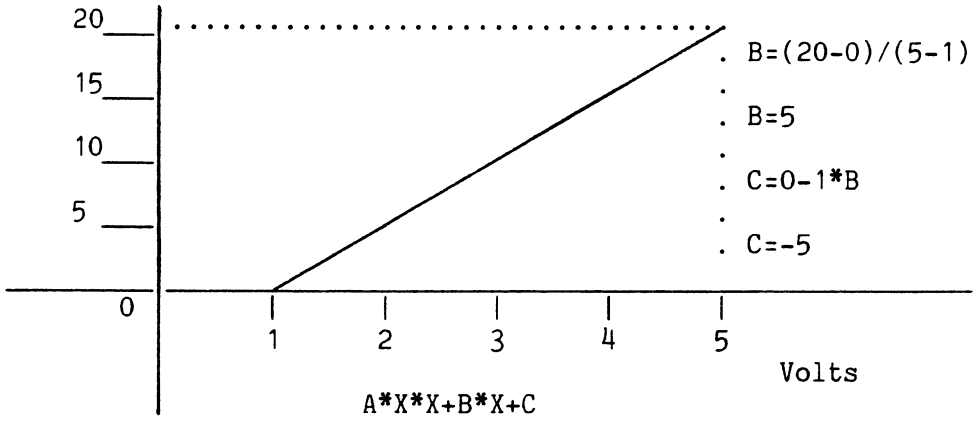
The polynomial function is organized as:

$$\text{Result} = aX^2 + bX + c$$

The coefficients (numbers) a, b and c have to be given by the user; X is the unscaled (measurement) value. The syntax "POLY" (no number between the brackets) indicates that the polynomial function is a local one. This means that the polynomial parameters can be accessed only by the associated channel; this is in contrast with Table definitions where the same Table can be shared by all system channels.

Suppose you want to measure pressure using a transducer whose output is between 1 and 5 volts, corresponding to 0 to 20 kiloPascals. The relationship between pressure and output voltage is linear but the measurement contains an offset. Refer to the figure below for a representation of the problem.

kilo Pascal



The channel can be defined as follows:

DEF CHAN(0) = DVIN, CHFN = POLY(0,5,-5) <CR>

SQUARE ROOT FUNCTION (SQR)

The square root function is structured as:

Result = a*SQR(x + b)

The number coefficients "a" (multiplier) and "b" (offset) can be specified by the user. With no specification, "a" defaults to 1, and "b" defaults to 0. The channel input value is represented by "x".

For example, the channel definition

DEF CHAN(19)=DVIN, MAX=4, CHFN=SQR(20.0,0)

could be used for a channel connected to a flow transducer that outputs a signal proportional to the difference in pressure across an orifice plate. The rate of flow is proportional to the square root of the differential pressure. The maximum anticipated signal output of 4V corresponds to 40 gallons/minute.

Channel Numbers

Channel Numbers, which can be specified as part of several commands (DEF CHAN, LIST CHAN, SEND CHAN, (set) CHAN, RESET CHAN, DEF SCAN, etc), identify the channels being defined, listed, and so on.

A valid channel identifier can consist of one or more channel numbers separated by commas (,), a range of channels, or multiple ranges separated by commas.

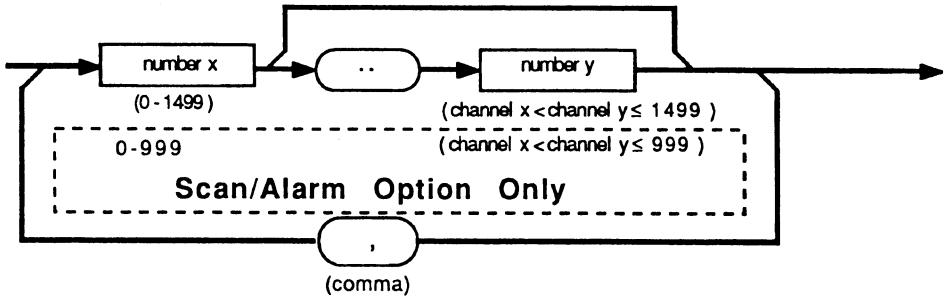
Channel numbers must be represented as positive numbers in the range 0 through 1499 (0 through 999 for Scan/Alarm option). Negative channel numbers or numbers outside the allowable range produce an error.

A valid range of channel identifiers is indicated by two numbers separated by double-periods (..). In specifying a channel range, the first channel number must always be less than the second or an error results.

SYNTAX DIAGRAM

This block in a syntax diagram: **channel (s)** **(0-1499)**

expands to:



Examples of valid channel identifiers:

```
CHAN(3)          CHAN(6..12)
CHAN(30,50)      CHAN(9,13..31,33,70..77)
CHAN(77,32,55)   CHAN(1,3..4)
```

Examples of invalid channel identifiers:

```
CHAN(55..33)   First channel larger than second.
CHAN(-3)       Negative channel number.
CHAN(1..1500)  Second channel outside valid range.
```

Numeric Representation

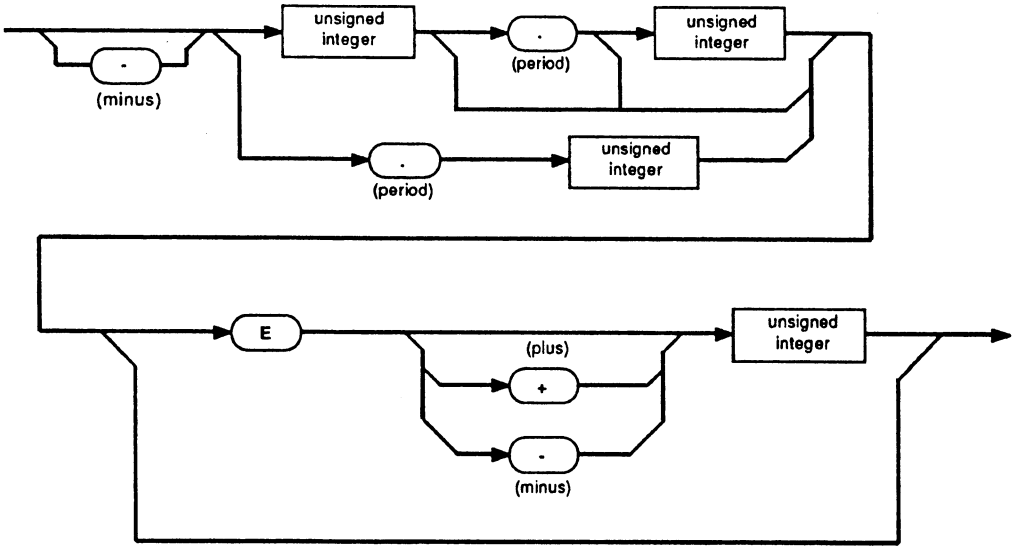
Numbers may be expressed in fixed decimal-point format or in scientific notation.

The legal range is any number between 0.29E-38 and 0.17E+39. Numbers are stored in the memory of the Front End in a 32-bit floating-point format with 8 bits of exponent, 24 bits of mantissa (most significant bit under exponent) and 1 sign bit. No spaces, carriage returns, or line feeds can be embedded in a number.

SYNTAX DIAGRAM

This block in a syntax diagram: number

expands to:



EXAMPLES

Examples of valid numbers are:

10

1.

12.E3

.75

-3.0E-01

The number

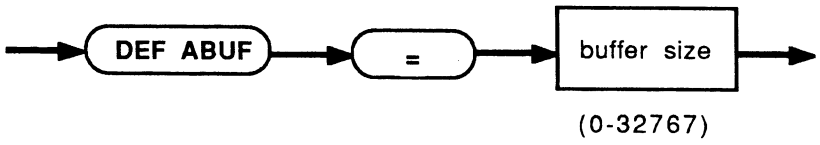
```
1.2E 4
```

is invalid because it contains a space.

Format

DEF ABUF=<buffer size>

Syntax Diagram



Description

This command defines a memory buffer for temporary storage of alarm data. The buffer size indicates the number of alarm records that can be stored. This number is limited by the size of available memory.

The different alarm types stored in the alarm buffer are:

1. System and channel status transitions
2. Scan buffer overruns
3. System hardware errors

Each alarm record stored in the buffer contains the following items:

1. Alarm type
2. Date and time
3. Channel or scan task number (if applicable)
4. Status word (if applicable)
5. A measurement value (if applicable)

DEF ABUF Buffer Function
Scan/Alarm Option

An alarm buffer is a circular 'first in/first out' buffer of a defined size (i.e. a number of records), in which the alarm records are stored as soon as they are available and from which they can be retrieved whenever necessary.

Alarm information sent to the printer port is appended with any UNITS and label information specified for that channel. Refer to LABEL CHAN later in this section for additional information.

Example

An alarm buffer which is capable of holding the last 25 alarm messages should be defined as follows:

```
DEF ABUF=25 <CR>
```

See Also

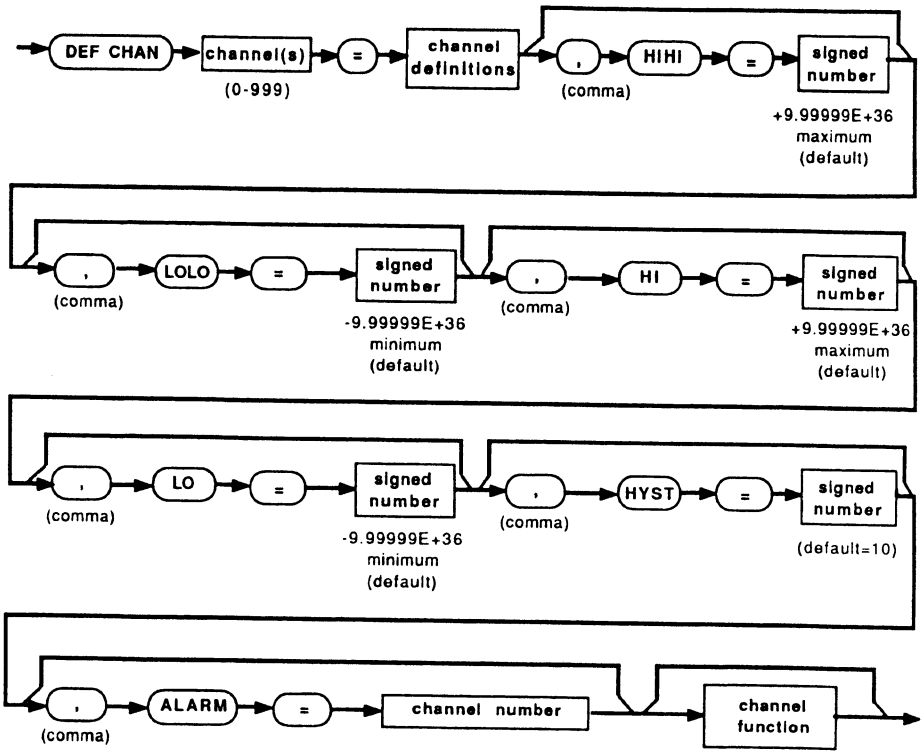
```
SEND ABUF
SHOW ABUF
SHOW FIRST|LAST|AGAIN ABUF
RESET ABUF
```

Format

```
DEF CHAN(channels) = <channel type>
     [,HIHI = <high-high limit>]
     [,LOLO = <low-low limit>]
     [,HI = <high limit>]
     [,LO = <low limit>]
     [,HYST = <hysteresis>]
     [,ALARM = <alarm channel number>]
```

DEF CHAN (Alarm Limits)
(Scan/Alarm Option)

Syntax Diagram



Description

Each channel definition, no matter which type has been specified, can be extended with the definition of a limit set. This limit set consists of up to four limits, a hysteresis value, and an alarm output channel. The alarm output channel is a user-selected status output channel that changes value when any of the four alarms occurs.

The limit values are indicated as HIHI, LOLO, HI and LO. These values are applied to the scaled value of the measurement. They can be used with both analog inputs and analog outputs.

The hysteresis value HYST must be expressed as a percentage of the difference between two associated limits (either HIHI and LOLO or HI and LO). This difference is called span. The hysteresis value should not exceed 100%, with values below 10% being normal.

Care must be taken in setting limits. An unreasonable amount of hysteresis could result if a previously defined HYST percentage is applied to a span defined by widely divergent limits. This problem can be especially evident when only one limit is defined. For example, if the HI limit is set to 100 and the LO limit is left at the -9.99999E+36 default value, hysteresis will clearly be excessive. In such a case, HYST would have to be set to 0.

Limit parameters that are not specified are set to the following default values:

Parameter	Default Value
HIHI	+9.99999E+36
LOLO	-9.99999E+36
HI	+9.99999E+36
LO	-9.99999E+36
HYST	10

Examples

Suppose we want to measure a temperature using a K-type thermocouple. Further, we want to ensure that the temperature is between 100 and 120 degrees.

The channel definition could be:

```
DEF CHAN(0) = TC, TYPE = KNBS, HIHI = 120,&
LOLO = 100, HYST = 10, ALARM = CHAN(100)
```

This definition causes status output channel 100 to equal 1 whenever either alarm limit is tripped.

Notice that the hysteresis is 2, defined by 10% of the 20-degree span from LOLO to HIHI. Therefore, if the HIHI limit is exceeded, the alarm is not withdrawn until the input drops back below 118 (120-2) degrees. Similarly, the LOLO alarm is not withdrawn until the temperature climbs back above 102 (100+2) degrees.

If HI and LO limits are also defined, another span is created. For example, if HI is set 115 and LO is set to 105, a separate span of 10 is created. Since HYST is already set to 10 (percent), a 1-degree hysteresis (at 114 and 106) is specified. The resulting four hysteresis values (with HYST=10) are summarized below:

HIHI	LOLO	HI	LO	Span	Hysteresis
120	100			20	120-118
					100-102
		115	105	10	115-114
					105-106

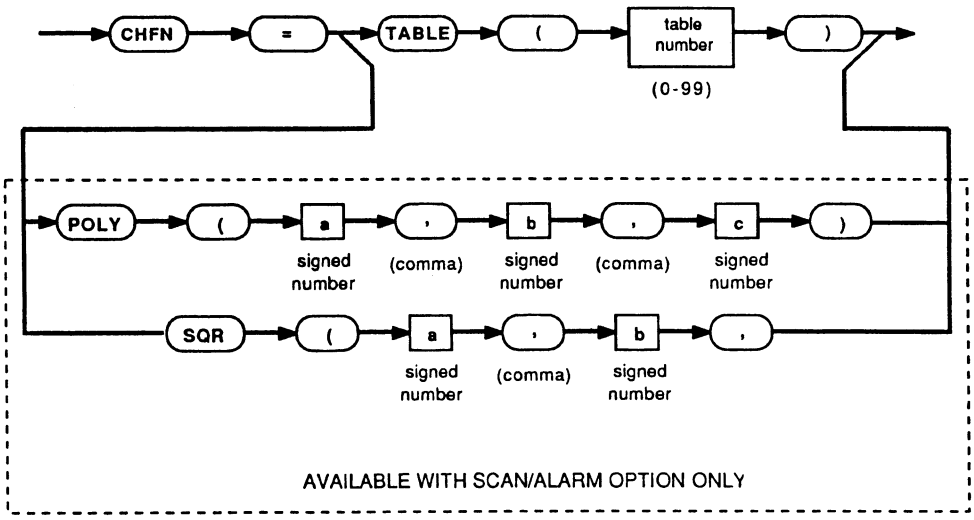
See Also

SEND ABUF

Format

```
DEF CHAN(<channels>) = <channel type>
     <limits> [, CHFN = TABLE (<table number>)
              | , CHFN = POLY (<a>,<b>,<c>)
              | , CHFN = SQR (<a>,<b>)]
```

Syntax Diagram



DEF CHAN (Channel Function)

Description

The channel function (CHFN) for a channel (or group of channels) can be defined for an interpolation table (TABLE), a polynomial equation (POLY), or a square root function (SQR).

INTERPOLATION TABLE (TABLE)

An interpolation table requires two types of commands:

- DEF TABLE(<table number>) = <x,y values>

  This command specifies both the table number and a series of input/output value pairs.

- DEF CHAN(channels) = <channel type>,
  CHFN =TABLE(<table number>)

  This command applies the designated interpolation table to a channel or set of channels.

POLYNOMIAL FUNCTION (POLY)

The polynomial function is organized as:

$$\text{Result} = aX^2 + bX + c$$

The coefficients (numbers) a, b and c have to be given by the user; X is the unscaled (measurement) value. The syntax "POLY" (no number between the brackets) indicates that the polynomial function is a local one. This means that the polynomial parameters can be accessed only by the associated channel; this is in contrast with Table definitions where the same Table can be shared by all system channels.

SQUARE ROOT FUNCTION (SQR)

The square root function is structured as:

```
Result = a*SQR(x + b)
```

The number coefficients "a" (multiplier) and "b" (offset) can be specified by the user. If no such specification is made, "a" defaults to 1 and "b" defaults to 0. The channel input value is represented by "x".

Examples

INTERPOLATION TABLE

```
DEF TABLE(1) = 0.004,0/0.020,100/...
DEF CHAN(33) = DCIN, CHFN =TABLE(1)
```

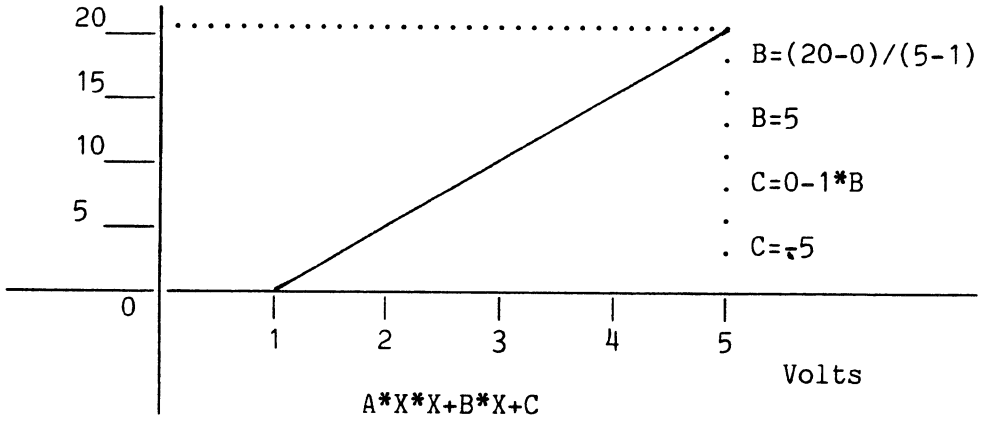
In this example, the first line defines points on an interpolation table (Table 1). The second line applies these points to the defined channel. Channel 33 is defined for direct current measurements. Measurements are filtered through the table. This command makes possible very flexible linearization and result interpolation, so be sure to refer to the DEF TABLE command reference page for details on how to construct useful tables.

POLYNOMIAL FUNCTION (POLY)

Suppose you want to measure pressure using a transducer whose output is between 1 and 5 volts, corresponding to 0 to 20 kiloPascals. The relationship between pressure and output voltage is linear but the measurement contains an offset. Refer to the following figure for a representation of the problem.

DEF CHAN (Channel Function)

kilo Pascal



The channel can be defined as follows:

DEF CHAN(0) = DVIN, CHFN = POLY(0,5,-5) <CR>

SQUARE ROOT FUNCTION (SQR)

The channel definition

DEF CHAN(19)=DVIN, MAX=4, CHFN=SQR(20.0,0)

could be used for a channel connected to a flow transducer that outputs a signal proportional to the difference in pressure across an orifice plate. The rate of flow is proportional to the square root of the differential pressure. The maximum signal output anticipated is 4V (corresponding to 40 gallons/minute), which would be evaluated as follows:

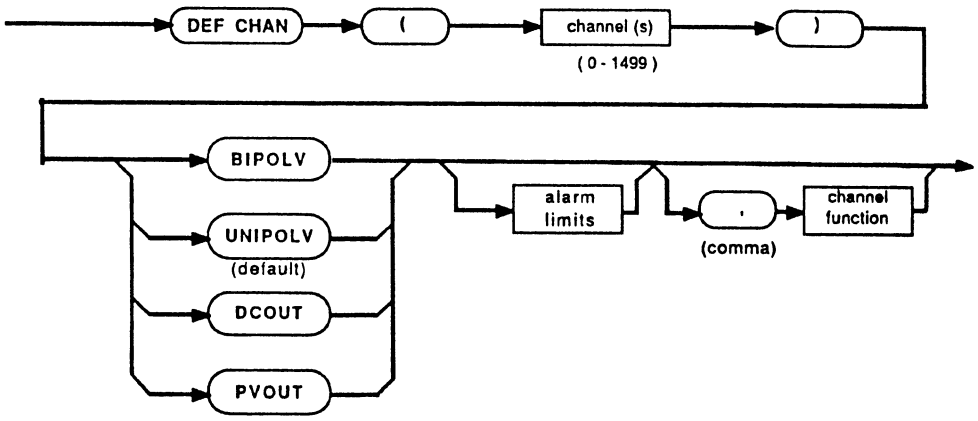
Reading = 20.0 Square(4.0 - 0.0) = 40

If the orifice plate exhibits an initial zero-flow output, a non-zero correcting value could be added to this definition. For example, SQR(20.0,-0.5) would correct for a 0.5V zero-flow output.

Format

```
DEF CHAN(<channels>) = <analog output> [<alarm limits>]
                       [,<channel function>]
```

Syntax Diagram



Description

This command defines a type of <analog output> for designated channel(s).

The <analog output> type is defined in order to allow a value assigned to a channel to be translated properly into an electrical signal. The definition of an analog output channel must correspond to hardware connections or the output will be incorrect.

DEF CHAN Analog Output

The analog output card (option -170) provides three sets of output terminals for each of four channels. The output terminals can be configured to any of the following four types of <analog output>:

BIPOLV - A bipolar voltage source from -5 to +5V
UNIPOLV - A unipolar voltage source from 0 to +10V
DCOUT - A current source 4 to 20 mA
PVOUT - A current source as Process Variable 0 to 100%

Default is unipolar (UNIPOLV).

For BIPOLV and UNIPOLV, the assigned value corresponds directly with the output voltage. For PVOUT, an assigned value of 0% corresponds with 4 mA and 100% yields 20 mA. When DCOUT is used, current can be specified directly.

Examples

To define channels 100 through 103 to be output channels of process variable type, enter:

```
DEF CHAN(100..103) = PVOUT<CR>
```

To apply a current of 19.5 mA (0.0195A) on the current output terminals of channel 100, enter

```
DEF CHAN(100) =DCOUT<CR>
CHAN(100) = 0.0195<CR>
```

See Also

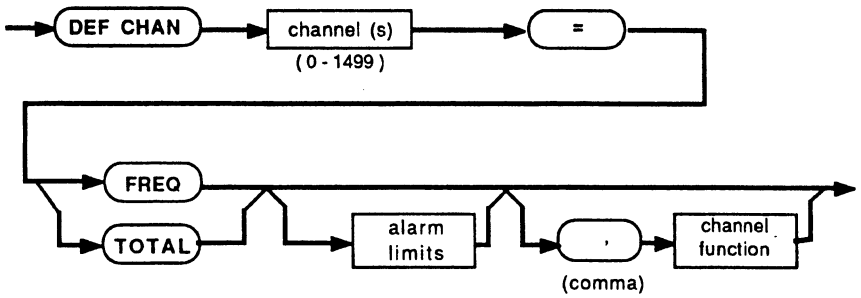
Introduction to this section
Section 6, Measurement Reference: Analog Output

DEF CHAN (Channel Type)
Define Channel Type
(Counter/Totalizer Input)

Format

```
DEF CHAN(<channels>) = FREQ | TOTAL [<alarm limits>]
                       [,<channel function>]
```

Syntax Diagram



Description

This command defines designated channel(s) as Counter (FREQ) or Totalizer (TOTAL) input channel(s).

Switches on the Counter/Totalizer card (option -167), set the board to frequency or totalizing operation. It is not necessary to use this explicit DEF CHAN command. However, to use alarm limits or a channel function, a counter/totalizer input must be defined explicitly. The definition must, of course, correspond to the hardware set-up.

DEF CHAN Counter/Totalizer Input

NOTE

There are six counter/totalizer channels per option assembly. The switch settings occur in adjacent pairs, which must be defined as the same mode.

Example

To set up the Counter/Totalizer as two frequency channels and four totalizers, enter

```
DEF CHAN(900..901) = FREQ
DEF CHAN(902..905) = TOTAL
```

To utilize a channel function, enter

```
DEF CHAN(90, 91) = FREQ, CHFN = TABLE(4)
```

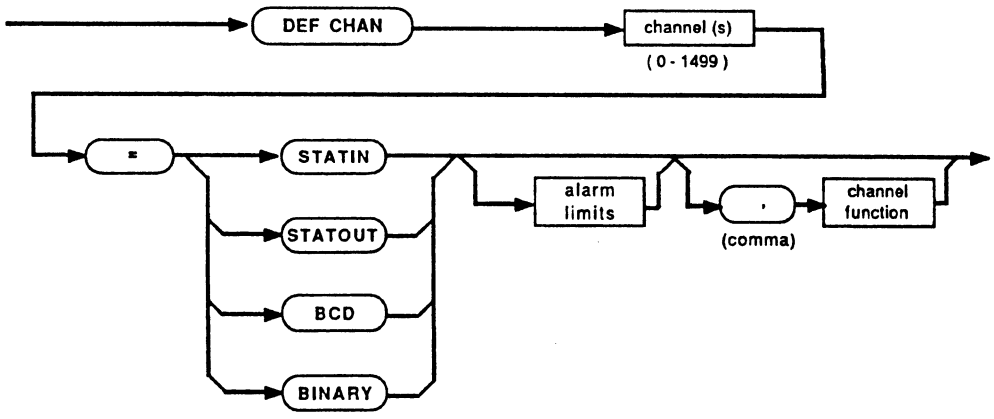
See Also

Section 6, Measurement Reference: Frequency Measurement and Totalizing Measurement

Format

```
DEF CHAN(<channels>) = <digital I/O type>
[<alarm limits>] [,<channel function>]
```

Syntax Diagram



Description

This command defines designated channel(s) as a type of digital I/O. The Digital I/O card (option -168) can be used as either an input or output card. This is determined by the type of connector that is used with it.

DEF CHAN Digital I/O

Channel numbers and types are determined by connectors and jumpers on the assembly, so there is usually no need for explicit channel definition statements. However, to use a channel function or alarm limits on a digital I/O channel, it must be defined explicitly. The definition must, of course, correspond to the hardware set-up.

The following I/O types are allowed:

STATIN	One-bit status input
STATOUT	One-bit status output
BCD	Five-digit binary-coded decimal input
BINARY	Seventeen-bit binary input

Examples

To define channel 120 as BINARY input, enter

```
DEF CHAN(120) = BINARY
```

To apply a table function, enter

```
DEF CHAN(120) = BINARY, CHFN = TABLE(11)
```

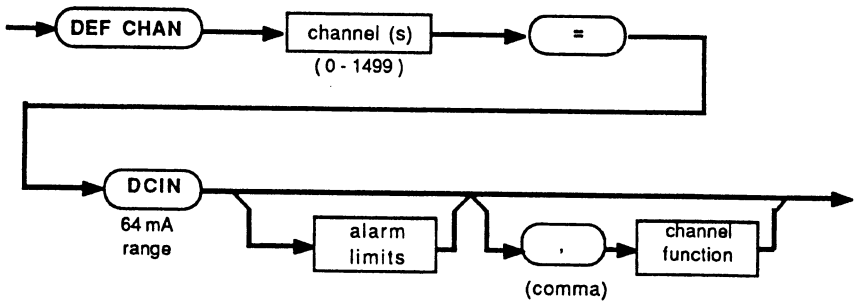
See Also

Section 6, Measurement Reference: Digital/Status Input, Status Output

Format

DEF CHAN(<channels>) = DCIN [<alarm limits>][,<channel function>

Syntax Diagram



Description

This command defines channel(s) of analog input for direct current input measurements. All measurements are taken using a 64 mA range.

Channels defined as current inputs must be equipped with the current input connector (option -171).

Example

To define channels 0 through 5, and channels 8 and 9 as direct current input, enter

```
DEF CHAN(0..5,8,9) = DCIN
```

See Also

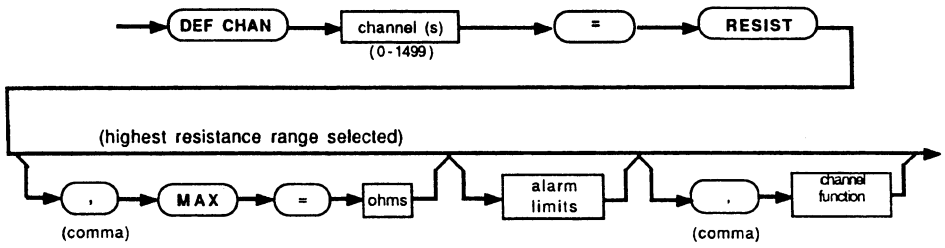
Section 6, Measurement Reference: Current Measurement

DEF CHAN (Channel Type)
Define Channel Type
(Resistance Input)

Format

```
DEF CHAN(<channels>) = RESIST[, MAX = <ohms>]
[<alarm limits>] [, <channel function>]
```

Syntax Diagram



Description

This command defines designated channel(s) as resistance input channels.

Resistance measurements can be made more accurately by specifying the range of expected measurement values with the MAX parameter. To do this, set MAX to the highest expected measurement value, in ohms. Lower ranges yield higher measurement accuracy. If MAX is not set, Helios defaults to the highest range.

DEF CHAN Resistance Input

Two hardware configurations are possible for measuring resistances: an RTD/Resistance Scanner (option -163) or a Voltage Scanner (option -162) with a Transducer Excitation Module (option -164). The first configuration provides three ranges: 256, 2048 and 64000 Ohms. The second provides two ranges: 64 and 512 ohms. Lower ranges yield higher resolution.

Examples

```
DEF CHAN(803) = RESIST

DEF CHAN(30..37) = RESIST, MAX = 300
```

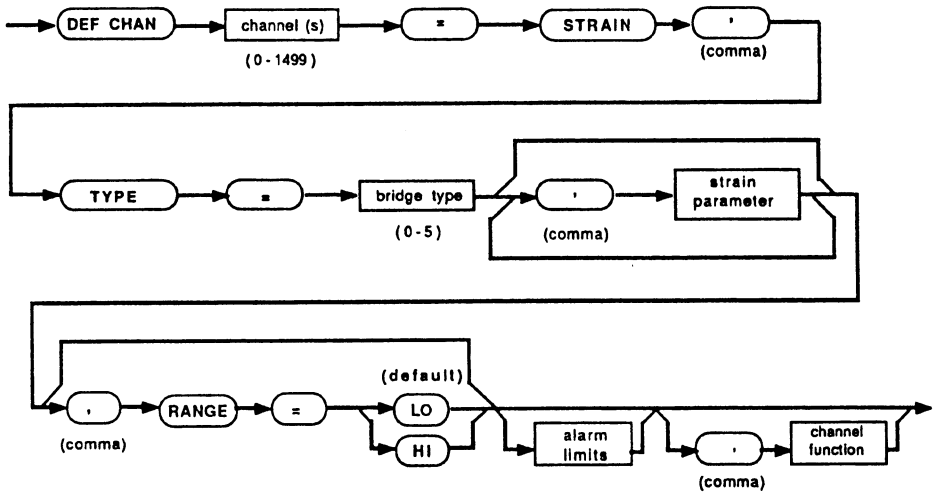
See Also

Section 6, Measurement Reference: Resistance Measurement, Temperature Measurement Using Thermocouples

Format

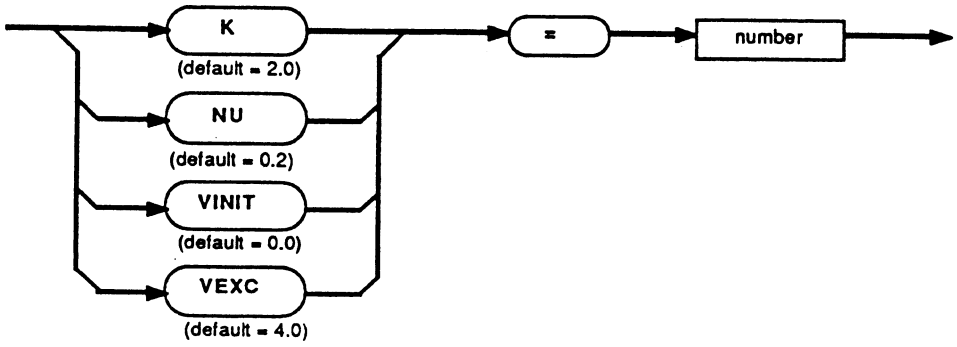
```
DEF CHAN(<channels>) = STRAIN, TYPE = <bridge type>
[,<strain parameter>][,RANGE = HI|LO]
[<alarm limits>][,<channel function>]
```

Syntax Diagram



DEF CHAN Strain Input

Strain Parameter:

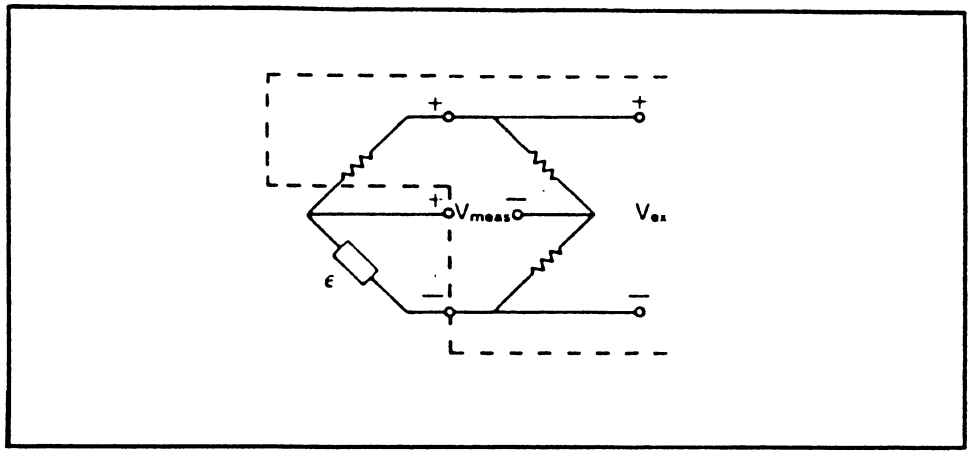


Description

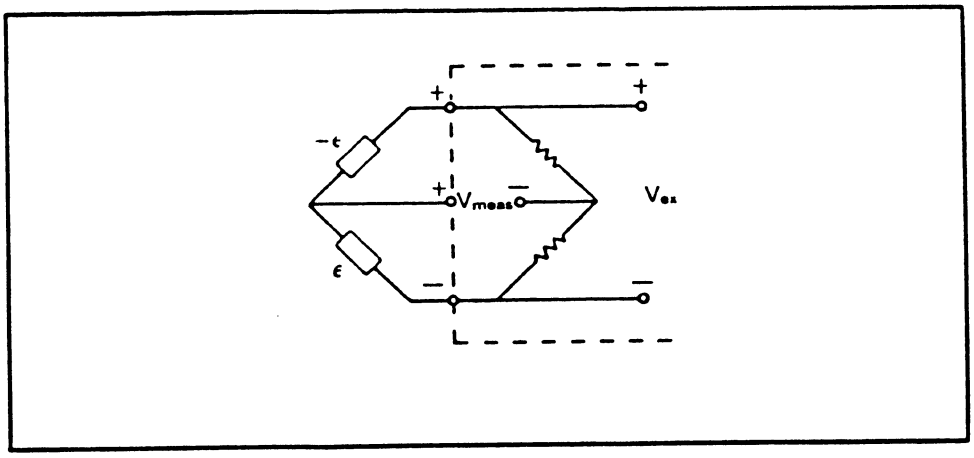
This command defines specified analog input channels as strain gauge measurement channels.

All readings are automatically converted into units of microstrain.

The "TYPE = <bridge type>" expression defines the bridge configuration to be used. Six bridge types, illustrated below, are available.

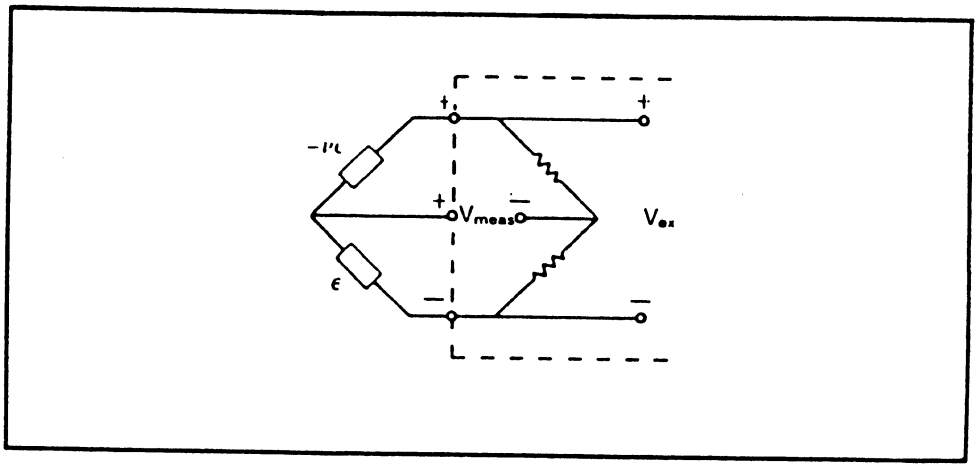


Type 0. Quarter Bridge

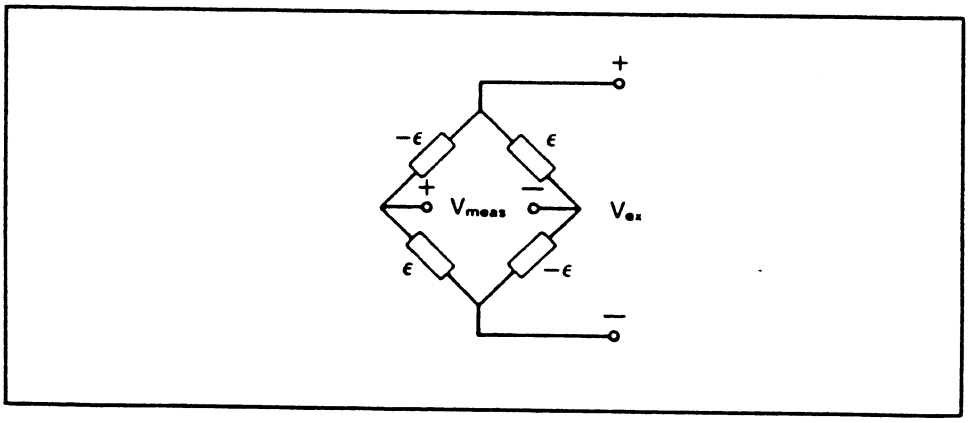


Type 1. Half Bridge with Equal and Opposite Strains

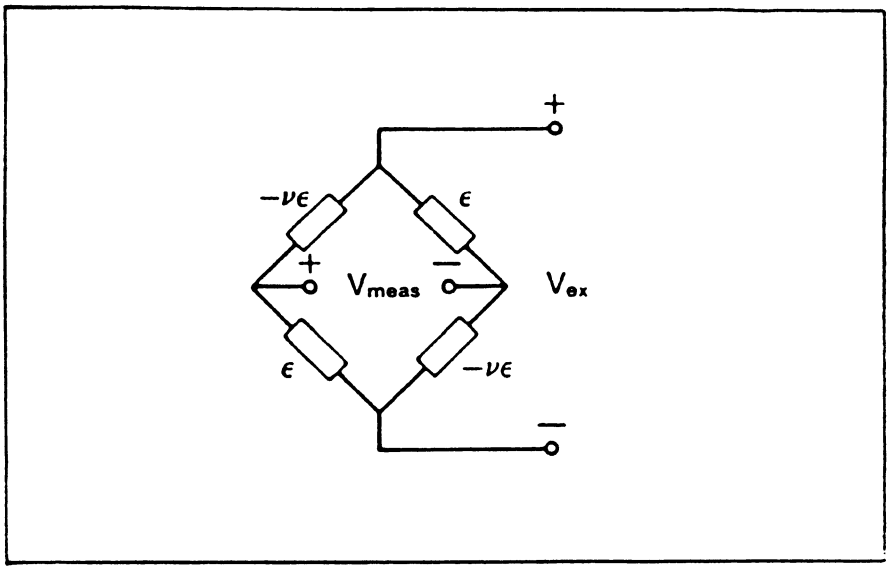
DEF CHAN Strain Input



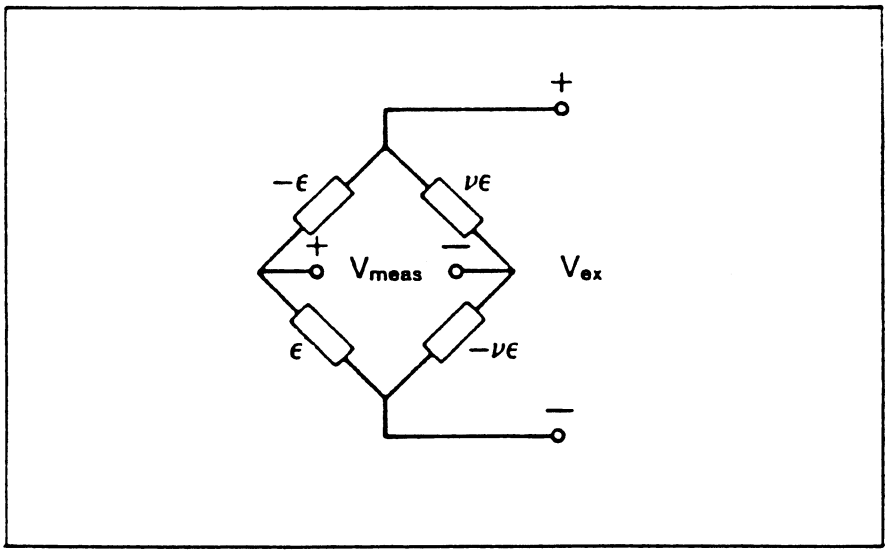
Type 2. Half Bridge with One Principle and One Poisson Strain



Type 3. Full bridge with Two Pairs of Equal and Opposite Strains



Type 4. Full Bridge with Two Principle and Two Poisson Strains



Type 5. Full Bridge with Two Principle and Two Poisson Strains

DEF CHAN Strain Input

The value of one to four strain parameters can be set per channel. If a strain parameter value is not specified, a default value is assigned.

When a strain parameter is changed on a strain channel, a subsequent redefinition of that channel will use the same value, unless the constant in question is redefined or a RESET command is executed.

HI or LO ranges are available. If no range is specified, "range" defaults to LO, allowing the most sensitive voltage measurement. If the output of the strain measurement bridge is expected to exceed 60mV, then HI range must be specified to prevent saturation.

Example

To set up channel 0 to measure strain with bridge type 1 (half bridge with equal and opposite strains) and an unstrained voltage of 100 microvolts, enter

```
DEF CHAN(0) = STRAIN, TYPE = 1, VINIT = 0.0001
```

See Also

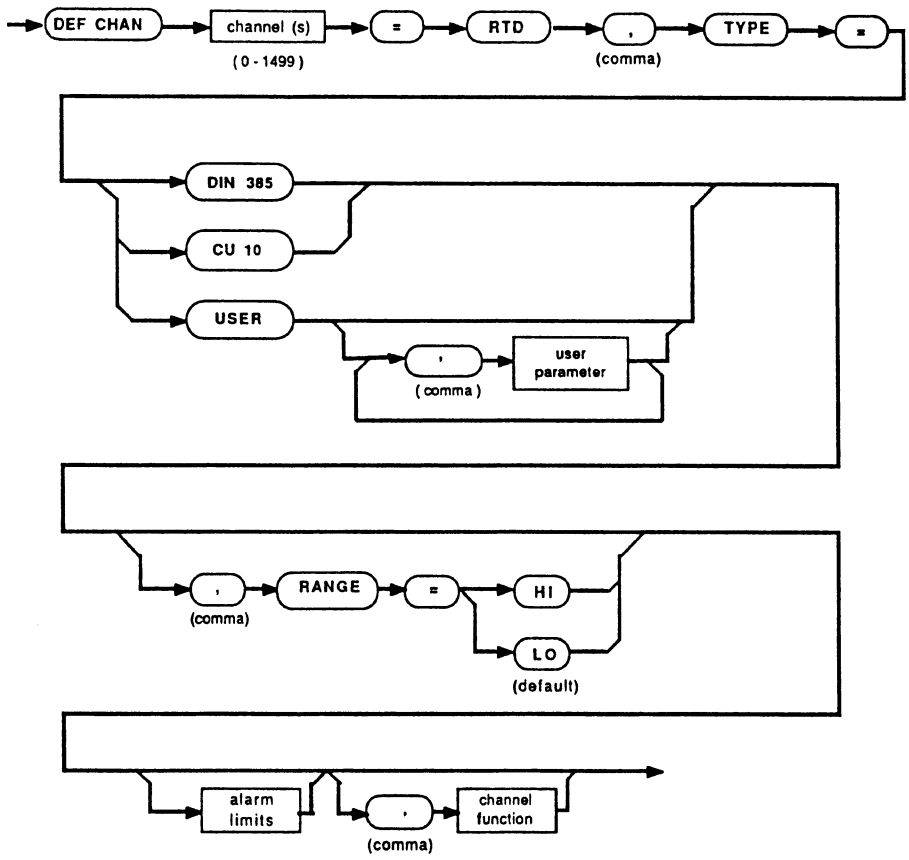
Section 6, Measurement Reference: Strain Measurement

DEF CHAN (Channel Type)
Define Channel Type
(Temperature Input - RTD)

Format

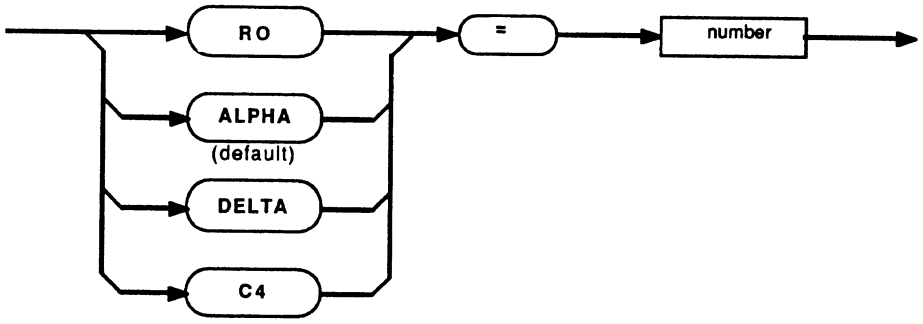
```
DEF CHAN(<channels>) = RTD, TYPE = <rtd type>
[<alarm limits>] [, <channel function>]
```

Syntax Diagram



DEF CHAN Temperature Input (RTD)

User Parameter:



Description

This command defines designated analog input channel(s) as Resistance Temperature Detector (RTD) measurement channels.

Measurements are in the units specified by the temperature unit selection (TUNIT) statement.

The "TYPE =" expression specifies the kind of RTD being used. An RTD type must always be designated. Two standard types are offered:

- DIN385 for 100 ohms platinum
- CU10 for 10 ohms copper

In addition, a user-selected type, other than those listed above, can be specified. With the user type, four RTD constants must be specified. If a value is not assigned to an RTD constant, the Front End assigns a default value. RTD constants and defaults are:

```
RO    = 100.0
Alpha = 3.850E-3
Delta = 1.45
C4    = 1.19619E-13
```

When a constant is changed on an RTD channel, a subsequent redefinition of that channel will use the same value, unless the constant in question is redefined or a RESET command is executed.

Two ranges can be selected. But range selection is only significant if the RTD scanner is used with a 100 ohm platinum RTD. In the LO range, the maximum temperature is limited to 425 degrees Celsius. In the HI range, the maximum becomes 600 degrees Celsius, but the resolution is reduced.

Examples

To define channel 30 to measure a DIN 43760 100 ohm platinum RTD, enter

```
DEF CHAN(30) = RTD, TYPE = DIN385
```

To define channels 31 through 35 to measure 100 Ohm platinum RTD, with user-defined constants for temperatures around 500 degrees Celsius, using an RTD scanner, enter

```
DEF CHAN(31..35) = RTD, TYPE = USER,
                   ALPHA = 3.92E-3, RANGE = HI
```

See Also

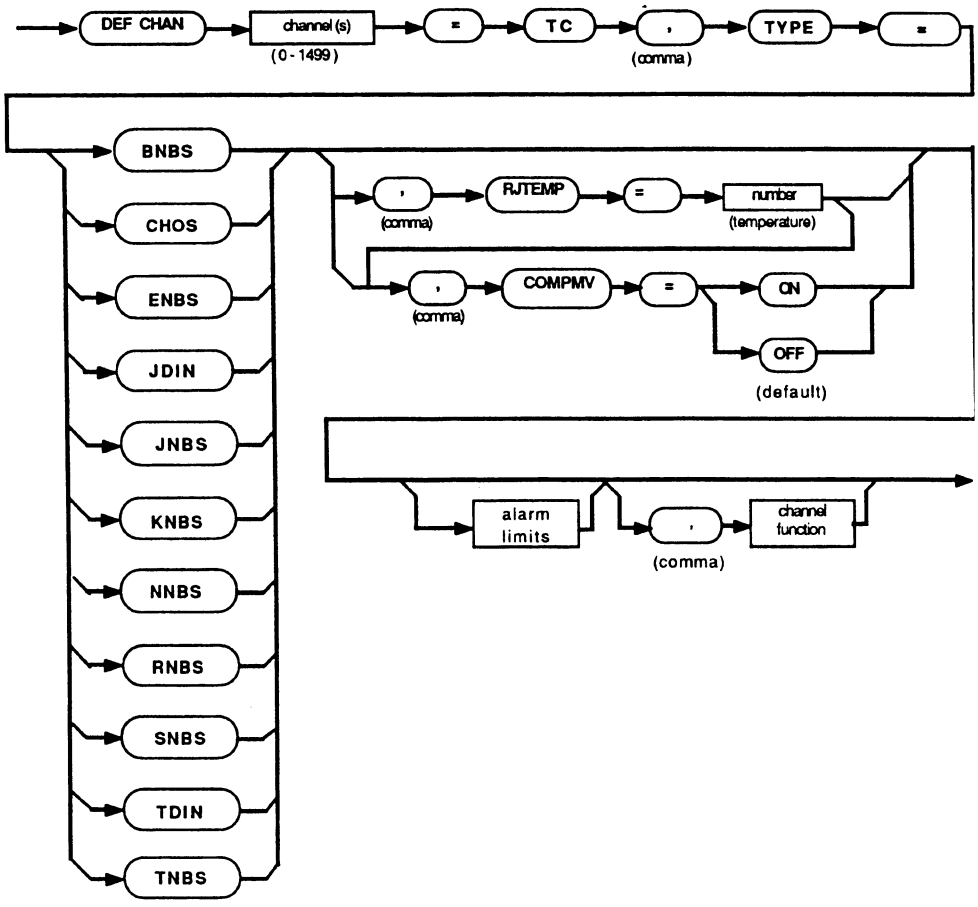
Section 6, Measurement Reference: Temperature Measurement Using RTDs

DEF CHAN (Channel Type)
Define Channel Type
(Temperature Input - TC)

Format

```
DEF CHAN(<channels>) = TC, TYPE = <tc type>
[, RJTEMP = <reference junction temperature>]
[, COMPMV = ON|OFF] [<alarm limits>] [, <channel function>]
```

Syntax Diagram



DEF CHAN Temperature Input (TC)

Description

This command defines designated analog input channel(s) as thermocouple measurement channels.

The expression, "TYPE = <tc type>", indicates the type of thermocouple to be used. Eleven types of thermocouples are supported:

TYPE	Description
BNBS	B Thermocouple, NBS
CHOS	C Thermocouple, Hoskins Wo-5% Re vs Wo-26% Re
ENBS	E Thermocouple, NBS
JDIN	J Thermocouple, DIN
JNBS	J Thermocouple, NBS
KNBS	K Thermocouple, NBS
NNBS	N Thermocouple, NBS
RNBS	R Thermocouple, NBS
SNBS	S Thermocouple, NBS
TDIN	T Thermocouple, DIN
TNBS	T Thermocouple, NBS

Normally, thermocouples are measured with the TC/DC Scanner (option -162), combined with the isothermal input connector (option -175). However, thermocouples may also be terminated in an external reference junction, from which copper wires extend to a voltage input connector (option -175, -176, or -160). If an external reference junction is used, specify the external reference junction temperature using the RJTEMP parameter. When specifying the reference junction temperature, Helios assumes that the temperature is specified in the temperature units of the TUNITS system variable; so care should be taken to set TUNITS to the desired value before defining the channel.

Readings are usually returned in temperature units. However, compensated millivolts (COMPMV) can also be selected on channels where the user does not want built in linearization.

Examples

To define channels 10 through 15 for J (NBS) type thermocouple measurement with temperature to be returned in degrees C, enter

```
TUNIT = CELSIUS
DEF CHAN(10..15) = TC, TYPE =JNBS
```

To define channels 40 through 59 as T (DIN) type thermocouple inputs, with an external reference junction temperature of 23.4 degrees Celsius, enter

```
DEF CHAN(40..59) = TC, TYPE = TDIN, RJTEMP = 23.4
```

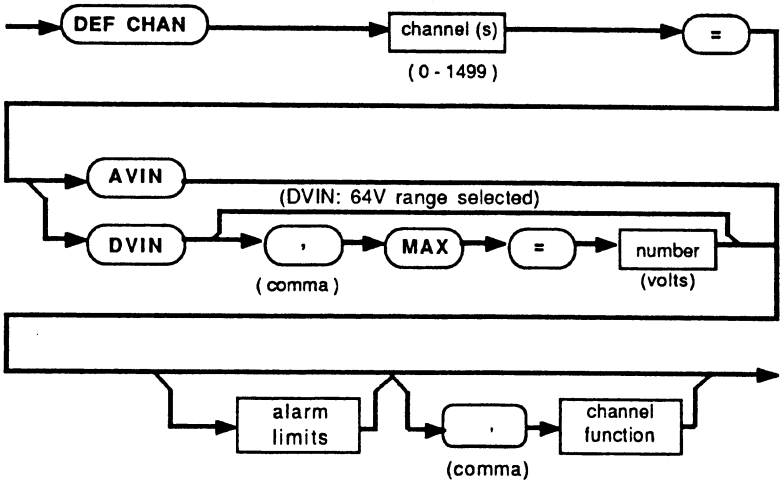
See Also

Section 6, Measurement Reference: Temperature Measurement Using Thermocouples

Format

```
DEF CHAN(<channels>) = DVIN [,MAX = <volts>]
[<alarm limits>] [,<channel function>]

DEF CHAN(<channels>) = AVIN [<alarm limits>]
[,<channel function>]
```

Syntax Diagram



DEF CHAN Voltage Input

Description

This command defines designated analog input channel(s) as either direct or alternating voltage input. Measurement results are in volts.

Direct voltage input is selected by entering the keyword DVIN on the define channel(s) (DEF CHAN) command line.

Alternating voltage input is selected by entering the keyword AVIN on the define channel(s) (DEF CHAN) command line. Measurements are in volts. 250V (rms) is the only range.

When measuring direct voltage (DVIN), measurements can be made more accurately by specifying the range of expected measurement values with the MAX parameter. To do this, set MAX to the highest expected measurement value, in volts. Lower ranges yield higher measurement accuracy. If MAX is not set, Helios defaults to the highest range.

Although each analog input module accommodates twenty channels, only the first ten of each block can be used for alternating voltage input. This means that the corresponding channel numbers must fall with a decade that begins with an even multiple of ten (for example: 0..9, 20..29, 40..49, etc.,). This restriction is imposed by the hardware (option -160).

Examples

```
DEF CHAN(0) = DVIN

DEF CHAN(20..29) = DVIN, MAX = 0.8
  (The system selects the 8V range because the 0.512V
  range cannot accommodate 0.8V)

DEF CHAN(40..49, 60..69) = AVIN
```

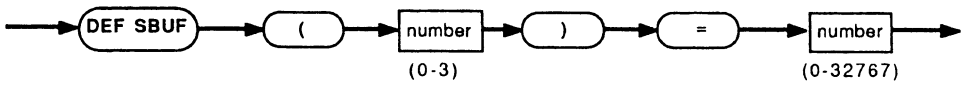
See Also

Section 6, Measurement Reference: Voltage Measurement

Format

DEF SBUF(<scan task number>)=<buffer size>

Syntax Diagram



Description

This command defines a scan buffer for storage of scan data. When a scan buffer is defined, space for <buffer size> records of scan data is allocated within Helios memory. Each scan record contains data about a single scan, which includes: the date and time of the scan, the scan task number, the number of channels scanned, the channel numbers of the channels scanned, the channel measurements, and the status of each of the channels at the time of the scan. Scan data is stored in a scan buffer whenever a scan task is executing, which sends its output to a scan buffer.

Before defining a scan buffer, the scan task associated with the scan buffer must be defined using the DEF SCAN command; for example, scan task zero must be defined before scan buffer zero is defined. If a scan task is defined after its associated scan buffer is defined, the scan buffer definition will be erased. A scan buffer definition may also be erased by defining a scan buffer with a buffer size of zero.

DEF SBUF Buffer Function
Scan/Alarm Option

Scan records may be read from the scan buffer by using the SEND SBUF command or a version of the SHOW SBUF command. SEND SBUF removes scan records from the scan buffer, while the SHOW SBUF commands do not. Generally, scan data is read from the scan buffer in the same order as it is entered. Exceptions occur with SHOW FIRST SBUF, which reads the oldest record, SHOW AGAIN SBUF, which repeats the most recently shown record, and SHOW LAST SBUF, which reads the newest record.

If a scan buffer is filled, scan task data will continue to be logged to the scan buffer, with the oldest records being overwritten by the newest records. The Helios system variable STATUS will also be set to indicate that a buffer overrun has occurred.

Example

Define a 60-record scan buffer.

```
DEF SCAN(1) = CHAN(0..19,40..119)
DEF SBUF(1) = 60
```

With the SCAN definition of 100 channels (20+80), the buffer reserves room for 60 * 100 = 6000 measurement values.

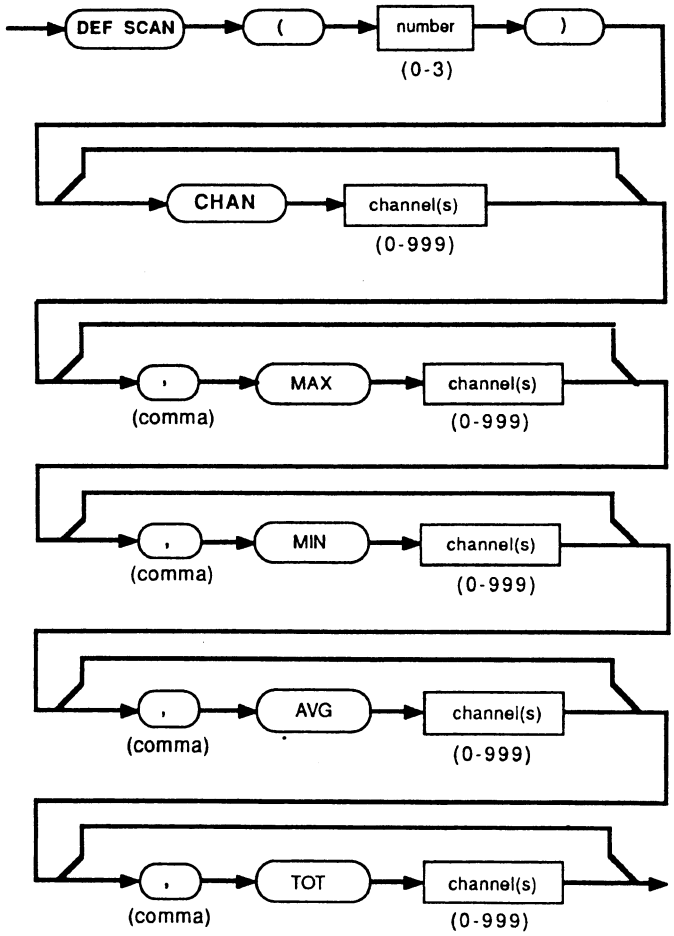
See Also

SEND SBUF
SHOW SBUF
SHOW FIRST|LAST|AGAIN SBUF
RESET SBUF
DEF SCAN
START SCAN
STOP SCAN

Format

```
DEF SCAN(<scan task number>)=CHAN (<channel(s)>)
[,MAX(<channel(s)>)] [,MIN(<channel(s)>)]
[,AVG(<channel(s)>)] [,TOT(<channel(s)>)]
```

Syntax Diagram



DEF SCAN Scan Function
Scan/Alarm Option

Description

This command defines a scan task. A scan task is a program that executes on Helios and measures a set of channels on a periodic basis. Measurement data from a scan task is sent to an output device, which may be the Helios host computer port, the Helios printer port, or a scan buffer in Helios memory.

Channel values can be represented in different ways using the following math functions:

- MAX

  The value shown for each channel represents the highest sampled value for that channel during the specified scan period.

- MIN

  The value shown for each channel represents the lowest sampled value for that channel during the specified scan period.

- AVG

  The value shown for each channel represents the average of all sampled values for that channel during the specified scan period.

- TOT

  The value shown for each channel represents the total of all sampled values for that channel during the specified scan period.

Three commands control the use of scan tasks. The DEF SCAN command described here assigns a set of channels to a scan task. START SCAN starts the execution of a scan task and specifies the period (in number of scans) required by the MAX, MIN, AVG, and TOT functions. STOP SCAN terminates the execution of a scan task.

When scan data is output to a scan buffer, use commands DEF SBUF, SEND SBUF, and SHOW SBUF to define and read from the scan buffer.

Scan tasks must be defined before they can be executed. When using a scan buffer to store scan data, the scan task must be defined before the scan buffer is defined, because defining a scan task erases any existing definition of the associated scan buffer. Up to four scan tasks may be defined and executed. Scan tasks are identified by their scan task number, which may be 0,1,2, or 3. When executing multiple scan tasks simultaneously, scheduling conflicts are resolved by scan task priority. The scan task priority is determined by the scan task number, with lower numbers having higher priority.

Examples

The definition for a single scan of channels 0 through 13, 20, and 300 through 349 would appear as:

```
DEF SCAN(1) = CHAN(0..13, 20, 300..349) <CR>
START SCAN(1), OUTPUT=SBUF(1), INTERVAL=600
```

Values from these channels are placed in scan buffer number 1 over a 10-minute (600-second) interval.

Using some math functions, a single scan of channels 10 through 14 and 100 through 104, with overall average, maximum, and minimum values would appear as:

DEF SCAN Scan Function
Scan/Alarm Option

```
DEF SCAN(0) = CHAN(10..14, 100..104), AVG(10..14,
100..104), MAX(10..14, 100..104), MIN(10..14, 100..104)
START SCAN(0), OUTPUT=SBUF(0), INTERVAL=600, PERIOD=6
```

It is also important to note the additional PERIOD parameter in this START SCAN statement. This parameter is essential for meaningful assessment of math function (MAX, MIN, AVG, TOT) values in any associated scan definition statement. In this example, a period of six scan intervals of ten minutes each is scanned, for a total of one hour.

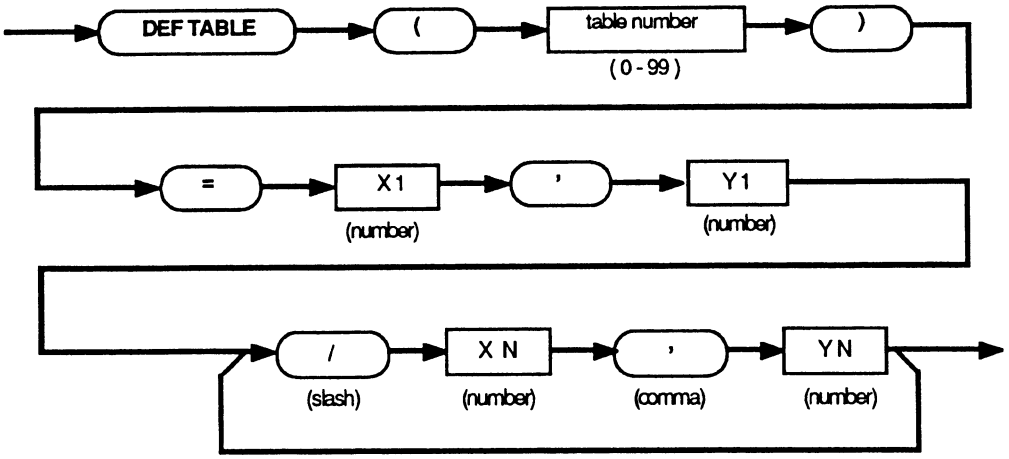
See Also

DEF SBUF
START SCAN
STOP SCAN
SHOW SBUF
SHOW FIRST|LAST|AGAIN SBUF
SEND SBUF

Format

```
DEF TABLE(<table number>) = <x1>,<y1>/<x2>,
<y2> [.../<xn>,<yn>]
```

Syntax Diagram



Description

This command creates a user-defined interpolation table.

Up to 100 tables (numbered 0 - 99) can be created. These tables provide the user a transfer function which, when used on input channels, allows the measured value to be transformed to a user-specified value. On output channels, the transformation takes place before the output channel is set.

The contents of a table are entered as pairs of numbers, representing X,Y coordinates in a Cartesian system. Input values are along the X-axis and output values are along the Y-axis.

DEF TABLE Interpolation Table

At least two pairs must be entered to define a valid table. Table size is limited only by available memory. Each pair consists of an input value and an output value, separated by a comma. Pairs are separated by a slash (/). The pairs must be entered in ascending order for the input values.

If the input falls between input value points in the table, a linear interpolation is used to determine its output. If the input falls outside the table, then a linear extrapolation is performed.

If a table definition is too long to fit on a single line, the definition can be continued on the next line, beginning with "DEF TABLE (<table number>) = /".

All input/output values for a given table can be viewed with the LIST TABLE (<table number>) command. The first line returned indicates the number of input/output entries in the table. Each subsequent line shows one or more input/output pair of values.

Examples

Let's measure pressure using a transducer (output 0.1 to 0.2 volts, corresponding to 1 to 20 kilopascals).

The relationship between pressure and output voltage is not linear. The Front End will perform a linearization if a table is defined and the channel function option (CHFN) is included on the DEF CHAN command line.

A legal table for this linearization could be:

```
DEF TABLE(0) = 0.1,1/0.12,3/0.14,6/0.16,10
DEF TABLE(0) = /0.18,15/0.2,20
```

The accompanying channel definition would be:

```
DEF CHAN(0) = DVIN, MAX = 0.2, CHFN = TABLE(0)
```

Suppose we want to use the unipolar voltage output of an analog output channel so that the output reflects some linear relationship with the value we want to apply. Assume these values range from -100 to +500 and the actual output ranges 0 through 10. The table must be defined as follows:

```
DEF TABLE(3) = -100,0/500,10
```

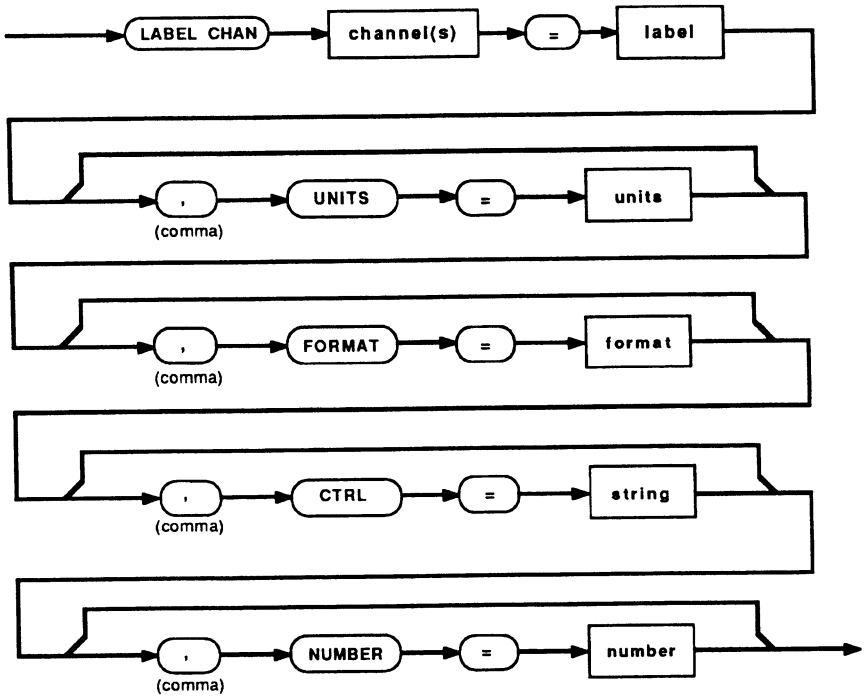
The accompanying channel definition would be:

```
DEF CHAN(100) = UNIPOLV, CHFN = TABLE(3)
```

Format

```
LABEL CHAN(<channels>) ="<label>"[, UNITS="<units>"]
[, FORMAT=<format] [, CTRL=<string>]
[, NUMBER=<number>]
```

Syntax Diagram



LABEL CHAN Output Format
Scan/Alarm Option

Description

The LABEL CHAN statement permits customization of the printer port output value. For example, a non-customized output of

```
CHAN 9    9.50000E02
```

could be transformed into

```
CYLINDER 1 950 DEG C
```

The output sent to the printer port is constructed as follows:

```
<ctrl><label><value><units><type><status><eol>
```

Unique features of the LABEL CHAN statement are:

o "<label>"

The label string can be used to identify a channel with a name describing that channel's function. For example, a channel measuring operating temperature of an engine could be labeled "ENGINE 9". The label string is also used for any alarm data sent to the printer port.

The label string must be composed of printable characters, all of which are enclosed in quotation marks. The string may total twelve characters or less, but the output space reserved for the string will always be exactly twelve characters in length. Strings of less than twelve characters will be left-justified in the output, with space characters filling out the field.

Finally, where multiple channels are specified in the LABEL CHAN statement, a "#" symbol can be used in the string to further customize each output to a specific channel. Each "#" symbol causes substitution of one channel number digit, beginning from the left. Therefore, three "#" symbols must be used to substitute three-digit channel numbers. For example, LABEL CHAN(9,14)="ENGINE ##" produces labels:

```
ENGINE 9
ENGINE 14
```

- UNITS

The UNITS string can be a maximum of six characters in length, with spaces filling out the right side of smaller strings. The UNITS string is appended to both scan and alarm information sent to the printer port.

- FORMAT

This parameter specifies output value decimal point placement in fixed (F) or engineering (E) notation. The number following the F or E (0 .. 5) specifies the number of digits to the right of the decimal point. The formatted value is printed right-justified (as shown below) in a 12-character field. With the fixed (F) formats, leading zeros are not displayed.

LABEL CHAN Output Format
Scan/Alarm Option

The following specifications can be used:

Specification	Output Format
F0	sXXXXXXX
F1	sXXXXXX.X
F2	sXXXXX.XX
F3	sXXXX.XXX
F4	sXXX.XXXX
F5	sXX.XXXXX
E0	sX.EsXX
E1	sX.XEsXX
E2	sX.XXEsXX
E3	sX.XXXEsXX
E4	sX.XXXXEsXX
E5	sX.XXXXXEsXX

Initial "s" = sign, only "-" printed
"Es" = engineering notation and sign

o CTRL

This parameter consists of up to eight decimal codes. Each code represents an ASCII character in a standard escape sequence used for output cursor positioning on a crt. A semi-colon (;) separates decimal character codes.

Five cursor-positioning escape sequences used with the Fluke 1020 terminal are presented below. Escape sequences required by other terminals may differ, and additional terminal-specific sequences may be available. Refer to documentation provided with your terminal for more information.

ESCAPE SEQUENCE	EQUIVALENT HELIOS I DECIMAL STRING
Move Cursor to Absolute Position	
<ESC>[<pl>;<pc>H	CTRL=27;91;53;59;48;52;48;72 (moves to line 0, column 40)
Move Cursor Forward	
<ESC>[<pn>C	CTRL=27;91;49;48;67 (move 10 characters forward)
Move Cursor Backward	
<ESC>[<pn>D	CTRL=27;91;53;68 (move back 5 characters)
Move Cursor Up	
<ESC>[<pn>A	CTRL=27;91;48;50;49;65 (move up 21 lines)
Move Cursor Down	
<ESC>[<pn>B	CTRL=27;91;49;50;66 (move down 12 lines)

<pl> = line number
<pc> = column number
<pn> = number of characters to move

Refer to Appendix 9c for a complete listing of ASCII decimal codes.

LABEL CHAN Output Format
Scan/Alarm Option

- NUMBER

  The NUMBER parameter can be used in conjunction with the label string's "#" symbol. NUMBER overrides the related channel number, specifying a unique starting point for the series of channel labels. For example, LABEL CHAN(9,14)="ENGINE #", NUMBER=1 yields:

```
ENGINE 1
ENGINE 2
```

Examples

The following example returns a two-decimal place reading in degrees C, labeled for CHAMBER 1.

```
LABEL CHAN(19)=CHAMBER 1, UNITS=DEG C, FORMAT=F2
```

A response from this channel could be:

```
CHAMBER 1   23.44 DEG C
```

The next example returns a series of four two-decimal place readings in degrees C, labeled for CYLINDER 1 through CYLINDER 4.

```
LABEL CHAN(0..3)=CYLINDER #, UNITS=DEG C, FORMAT=F2,&
NUMBER =1
```

Possible responses are:

```
CYLINDER 1   90.33 DEG C
CYLINDER 2   91.09 DEG C
CYLINDER 3   92.82 DEG C
CYLINDER 4   90.98 DEG C
```

Format

LIST ABUF

Syntax Diagram

Description

Computer Mode

This command returns the size of the alarm buffer in number of records.
Note : No information is given about the number of records actually stored in the buffer.

Terminal Mode

In Terminal Mode the size of the alarm buffer is returned in the following form.

abuf = 25

This means that an alarm buffer has been defined capable of storing 25 alarm records.

See Also

SEND ABUF
SHOW ABUF
SHOW FIRST|LAST|AGAIN ABUF

LIST ABUF Definition
Scan/Alarm Option

Example 1 (Computer Mode)

After receiving the commands

```
MODE = COMP <CR>
DEF ABUF=25 <CR>
LIST ABUF <CR>
```

HELIOS returns

```
25
```

Example 2 (Terminal Mode)

After receiving the additional commands

```
MODE = TERM <CR>
LIST ABUF <CR>
```

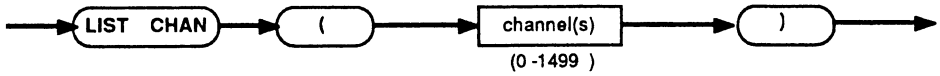
HELIOS returns

```
abuf = 25
```

Format

LIST CHAN (<channels>)

Syntax Diagram



Description

This command returns a listing of the definitions of designated channels.

Each listing describes both hardware configurations and software channel definitions. The form in which a listing is returned depends on whether the front end is operating in the Terminal (TERM) or Computer (COMP) mode. Explanations of channel listing formats in Terminal and Computer Mode follow on separate pages.

Computer Mode

In the Computer Mode, the LIST CHAN command returns a single line with the number of channels in the list. This is followed by one or more lines for each channel in the list. The first line returned for each channel consists of six numeric fields. Fields are separated by commas. Each field represents a hardware configuration or element of a channel definition. Additional lines of data, when present, represent user-defined parameters, alarm limits parameters, channel function parameters or combinations.

The data returned in the fields of the first line are:

Field 1 = Channel Number
Field 2 = I/O Card
Field 3 = I/O Sub-type
Field 4 = Analog Input Definition
Field 5 = Sensor/Range or Mode Selection
Field 6 = Channel Function and Limits Flags

Field 1. The number in this field identifies the channel number whose definition is listed on the same line.

Field 2. Represents the installed hardware associated with that channel. A number from 0 to 4 will be returned.

Field 3. Represents a further definition of the installed hardware defined by Field 2. The meaning of the number in this field varies, according to the installed hardware option, as shown in the following table.

Field 4. This field is meaningful only for analog input channels. Otherwise the value in the field is always zero (0). The meaning of the value in this field is shown in the following table.

Field 5. Has meaning only if the channel is an Analog Input or Analog Output channel. Field 5 provides additional information about the Analog channel.

FIELD 2		FIELD 3		FIELD 4	
0	(nothing installed)				
1	Analog Input	0	-162/-175	0	(undefined)
		1	-162	1	DVIN
		2	-163	2	RTD
		3	-	3	STRAIN
		4	Y2056 Cal	4	RESIST
		5	-164	5	DCIN
				6	AVIN
				7	CAL
				8	TC
				9	TC, COMPMV
				10	TC, RJTEMP
				11	TC, COMPMV/RJTEMP
2	Digital I/O	0	STATOUT	0	
		1	STATIN		
		2	BINARY		
		3	BCD		
3	Analog Output	0		0	
4	Counter/ Totalizer	0	TOTAL	0	
		1	FREQ		

LIST CHAN Computer Mode

FIELD 5

	TC	DVIN	RESIST *	RTD **	STRAIN ***	DCIN	AVIN	CAL
0	JNBS	64 mV	256/64	CU10/LO	0/LO	64mA	250V	-
1	KNBS	512 mV	2048/512	CU10/HI	0/HI			
2	RNBS	8V	64000	DIN385/LO	1/LO			
3	SNBS	64V	-	DIN385/HI	1/HI			
4	TNBS	-	-	USER/LO	2/LO			
5	BNBS	-	-	USER/HI	2/HI			
6	CHOS	-	-	-	3/LO			
7	ENBS	-	-	-	3/HI			
8	NNBS	-	-	-	4/LO			
9	JDIN	-	-	-	4/HI			
10	TDIN	-	-	-	5/LO			
11	-	-	-	-	5/HI			

0	UNIPOLV
1	BIPOLV
2	DCOUT
3	PVOUT

* Range with -163 Option/Range with -164 and -162 Option
** RTD Type/Range
*** Bridge Type/Range

Field 6. This field indicates whether or not user-defined alarm limits, a channel function, or both have been assigned to a channel. The meaning of the value in this field is shown in the following table (n=1..100):

Value	Meaning
0	No interpolation table selected No polynomial function defined No alarm limits defined
n	Interpolation table n-1 selected No alarm limits defined

For the Scan/Alarm Option, four features (alarm limits, interpolation table, polynomial function, square root function) can be identified with this field. The following one-byte or two-byte decimal values define these features when the Scan/Alarm Option is in use:

128	Polynomial function only.
256	Alarm limits only.
512	Square root function only.
256+n	Alarm limits and interpolation table n-1 are selected.
256+128	Alarm limits and polynomial function are selected.
256+512	Alarm limits and square root function are defined.

User-defined Parameter Line. The next line returned is the user parameter line. This line is returned only when the user specifies an RTD type 'USER', or a strain type, or when a reference junction temperature (RJTEMP) parameter is specified in a thermocouple (TC) definition.

The RTD constants RO, ALPHA, DELTA and C4 are returned for the user-defined RTD.

Gauge factor (K), Poisson factor (NU), initial voltage (VINIT), and excitation voltage (VEXC) are returned for STRAIN.

Only reference junction temperature (RJTEMP) is returned for a TC with a specified reference junction temperature.

Channel Alarm Limits Line (Scan/Alarm Option only). The next line to be sent is the channel alarm limits line. If no limits have been defined, this line will not be sent. This line consists of six fields separated by commas. The default value will be substituted for any alarm limit value not defined. The alarm channel field contains the alarm channel + 1. If no alarm channel is specified, a "0" is used.

Field 1 = HIHI LIMIT
Field 2 = LOLO LIMIT
Field 3 = HI LIMIT
Field 4 = LO LIMIT
Field 5 = HYST
Field 6 = ALARM CHANNEL + 1

Polynomial Coefficients Line (Scan/Alarm Option only). The next line to be sent contains the polynomial coefficients. If no polynomial has been defined, this line will not be sent. The line consists of three fields separated by commas.

```
Field 1 = A coefficient
Field 2 = B coefficient
Field 3 = C coefficient
```

Examples

```
DEF CHAN(99) = TC, TYPE = TNBS
LIST CHAN (99)
```

The returned listing is:

```
1
99,1,0,8,2,0
```

This means channel 99 is an analog input equipped with a TC/DC volts Scanner (-162) and Isothermal Input Connector (-175), and is defined to measure type R (NBS) thermocouples without a channel function.

```
DEF CHAN(23) = RTD, TYPE = USER, C4 = 1.2E-13,
    RANGE = HI, CHFN = TABLE(0)
LIST CHAN(23)
```

The returned listing is:

```
1
23,1,2,2,5,1
1.00000E+02,3.85000E-03,1.45000+00,1.20000E-13
```

This indicates that channel 23 is an analog input with RTD scanner and is defined to measure a user-defined RTD on high range with interpolation table 0 (1-1). The next line returns values for the four RTD parameters (R0, Alpha, Delta, C4).

```
DEF CHAN(99) = TC, TYPE = KNBS, HI = 100, LO = 90, &
HYST = 1, CHFN = POLY (1.234E-03, 1, 5.67)
LIST CHAN(99)
```

The returned listing is:

```
1
99,1,0,8,1,384
9.99999E+36,-9.99999E+36,1.00000E+02,9.00000E+01,1.00000E+00, 0
1.23400E-03,1.000000E+00,5.67000E+00
```

This means channel 99 is an analog input equipped with a TC/DC volts scanner (-162) and Isothermal Input Connector (-175), and is defined to measure type K(NBS) thermocouples.

The code 384 (256+128) in field 6 indicates that both alarm limits and a polynomial function have been defined. Limit values not defined in the limit list of the channel definitions are replaced by their default value. (+/- 9.99999E+36).

The second line then indicates that a HI alarm limit of 100 degrees and a LO alarm limit of 90 degrees with a 1% hysteresis has been specified (units of degrees are determined by the TUNIT command and are not reflected in the channel listing). The third line indicates that the following polynomial has been specified:

$$.001234x^2 + x + 5.67$$

Terminal Mode

In the Terminal Mode, channel definition data are returned as alphabetic, rather than numeric, strings, making them more readily understandable.

- All responses begin with an I/O device category.

```
aichan:   -161
     iso:       -162/-175
     v/i:       -162
     r:         -163
     exc:       -164

dgchan:   -168
     statin:    -179 as status inputs
     statout:   -169
     binary:    -179 as binary input
     bcd:       -179 as BCD input

aochan:   -170
     unipolv:   as 0 to 10V output
     bipolv:    as -5 to 5V output
     dcout:     as 4 to 20 mA output
     pvout:     as 0 to 100% output

ctchan:   -167
     total      as totalizer input
     freq       as frequency input
```

- The channel number is identified in the parentheses associated with the device category.

LIST CHAN Terminal Mode

- The hardware type is identified for the specified channel. Type is defined by the installed option assembly and, in several cases, by switch settings on those assemblies (see Table below).

- The measurement specification made for this channel in a DEF CHAN command is listed.

- Additional parameters identifying any further items specified by the definition are given.

Examples

```
aichan(0) = iso, def = tc, type = jnbs

aichan(20) = R, def = rtd, type = din385, range = hi,
                  chfn = table(1)

aochan(100) = dcout, chfn = table(3)

dgchan(200) = binary

aichan(1) = iso, def = tc, type = jnbs,
 hihi = 9.99999E+36, lolo = -9.99999E+36,
 hi = 1.00000E+02, lo = 2.00000E+01, hyst = 10.0,
 chfn = poly (1.00000E+01, 2.00000E+01, 1.00000E+01)
```

Format

LIST ERROR

Syntax Diagram

Description

This command lists the error log, which contains the errors detected while making measurements with the SEND CHAN command. The error log may hold up to 20 errors. If there are more than 20 errors, only the last 20 errors detected will be remembered. Once errors are listed, they will be removed from the error log.

The format in which the error log is returned depends on whether the system is operating in Terminal or Computer Mode.

Computer Mode

In the Computer Mode, the error log is returned as a series of lines in decimal format. The first line consists of a single number, which indicates the number of errors returned. Each subsequent line represents a single channel. Each channel line contains two numbers, separated by a comma: the first indicates the number of the channel being reported; the second indicates the error code number. The error code number can then be looked up in the Error Code List in Section 8 of this manual.

LIST ERROR Log

Terminal Mode

In the Terminal Mode, the error log is returned in a more easily readable form, shown below.

chan(x) <error message>

The "x" field indicates the channel number.

Examples

Computer Mode

The command

LIST ERROR

would return an error log looking something like:

```
3
30,19
66,15
71,15
```

This error log reports errors on three channels: error 19 on channel 30, error 15 on channels 66 and 71. In the Error Code List, Error 15 reads "Out of range," meaning that an input was measured that exceeded the programmed range. Error 19 reads "Over Temperature," which means the temperature is outside the range for the thermocouple or RTD being used.

The Terminal Mode command

```
LIST ERROR
```

would return an error log looking something like:

```
chan(30) - Illegal BCD

chan(68) - Open TC
```

This means that on channel 30, a BCD digit greater than 9 was present in one or more digit fields of a digital input; and that on channel 68, a thermocouple is broken or damaged.

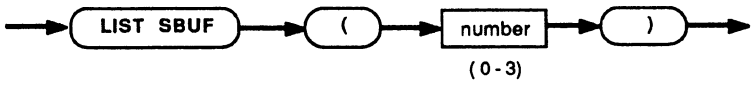
See Also

Section 8, Error Messages

Format

LIST SBUF(<scan task number>)

Syntax Diagram



Description

This command returns the number of records that can be stored in the scan buffer. It does not return the number of records that are stored in the buffer or any scan data. To read scan records from the scan buffer, use command SEND SBUF or SHOW SBUF.

The format in which the scan buffer definition is returned depends on the setting of the Helios system variable MODE. See examples which follow for details.

LIST SBUF Definition
Scan/Alarm Option

Examples

Computer Mode

After receiving the commands

```
MODE = COMP

DEF SBUF(1)=60
LIST SBUF(1)
```

Helios returns :

```
60
```

Terminal Mode

```
MODE = TERM

LIST SBUF(1)
```

Helios returns:

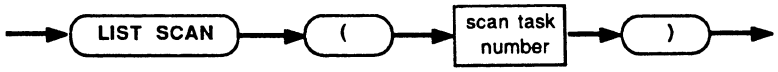
```
sbuf(1) = 60
```

This means that scan buffer 1 had been defined to reserve memory for 60 records.

Format

LIST SCAN(<scan task number>)

Syntax Diagram



Description

This command returns a listing of the definition of the designated SCAN task, i.e. the SCAN task identification, number of channel groups and all channel numbers associated with that particular SCAN task. The order in which the channel numbers appear in the list is identical to the order in the SCAN definition.

Computer Mode

In computer mode, a listing with the following fields will be returned.

Field 1 = scan task number
Field 2 = number of channel groups
<EOL>
Field 3 = first channel number of a group
Field 4 = last channel number of a group
<EOL>

Fields 3, 4 and <eol> are repeated [Field 2] times. Fields are separated by commas.

Terminal Mode

In Terminal Mode, the listing of the definition of the designated SCAN task will be returned in a more readable form, as shown below. The order in which the channel numbers appear in the list is identical to the order in the SCAN definition.

Examples

Computer Mode

The commands:

```
MODE = COMP

DEF SCAN(1)=CHAN(0..5,10..15,17,20..39) <CR>
LIST SCAN(1)
```

will result in the following listing:

```
1,4
0,5
10,15
17,17
20,39
```

The Terminal Mode command

```
MODE = TERM

LIST SCAN(1)
```

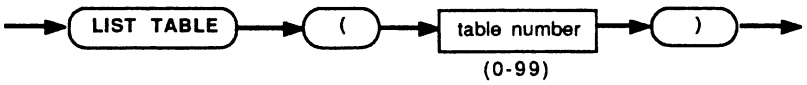
would return scan information looking like

```
scan(1) = chan(0..5,10..15,17,20..39)
```

Format

LIST TABLE(<table number>)

Syntax Diagram



Description

This command returns the contents of a user-defined interpolation table from the Computer Front End memory. One table is returned with each command.

The form in which the interpolation table is returned will be determined by whether the system is operating in Computer or Terminal Mode.

LIST TABLE (Interpolation)

Computer Mode

In the Computer Mode, the designated table is returned as a series of (at least) three data lines in the following format.

```
n
x0,y0
x1,y1
.
.
xn-1,yn-1
```

The first line consists of a single field, "n", which indicates the number of pairs in the table.

Each subsequent line consist of pairs of numbers, separated by a comma (,). These numbers are the actual contents of the table. The first number of each pair is the input and the second is the corresponding output. The numbers are represented in scientific notation.

Terminal Mode

In the Terminal Mode, the command, LIST TABLE(table number), returns the contents of a user-defined interpolation table in the following form.

```
table(t) = x0,y0 / x1,y1 / .. / xn-1,yn-1
```

"t" indicates the table number, while x0,y0 through xn-1,yn-1 are the contents. Numbers are represented in scientific notation.

Example

The Computer Mode command

```
MODE = COMP
LIST TABLE(19)
```

returns table 19, which has four pairs, in the following form

```
4
 1.00000E+00, 1.12345E+00
 2.20000E+00,-3.22453E+00
 5.50000E+00,-8.45987E+00
 1.00000E+01,-1.23453E+01
```

The Terminal Mode command

```
MODE = TERM
LIST TABLE(25)
```

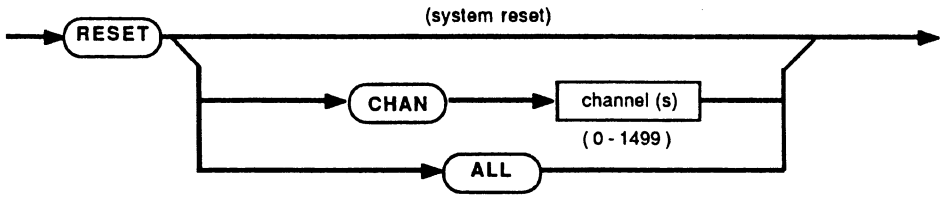
returns Table 25 in the following form

```
table(25)=1.20000E+00,1.00000E+00/1.20000E+01,3.33333E+00
```

Format

RESET [ALL | CHAN(<channel[s]>)]

Syntax Diagram



Description

RESET causes the Front End to:

- Perform a system self test. If errors are detected, the highest priority error message is sent to the host.
- Clear all channel definitions, interpolation tables, labels, and the channel list.
- Reset and initialize all I/O devices. The output of all status output channels are set to zero and analog output channels are set to -5V, 0V, or 4 mA, depending on the output channels.
- Build a list containing all channels in the system.

RESET System or Channel[s]

- o Calibrate all system A/D converters.
- o For the Scan/Alarm option, erase the scan task, scan buffer, and alarm buffer definitions.

RESET ALL causes the Front End to:

- o Reset all system variables except TIME$ and DATE$ to default values.
- o Clear the error log.
- o Execute all of the items in the RESET description above.
- o For the Scan/Alarm option, reset alarms.

RESET CHAN(channel[s]) causes the Front End to:

- o Reset the channel descriptions of the named channel[s] to the initial state.

Examples

To reset the entire system, simply enter

```
RESET ALL
```

To reset channels 15 through 30, enter

```
RESET CHAN(15..30)
```

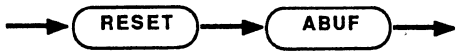
See Also

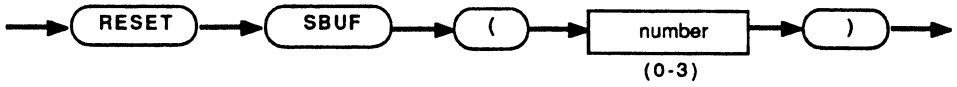
Appendix 9d

Format

```
RESET ABUF
RESET SBUF(<scan task number>)
```

Syntax Diagram





Description

These commands remove those records from the designated buffer that have been previously read with the 'SHOW ABUF' or 'SHOW SBUF' command.

Example:

```
RESET ABUF <CR>
RESET SBUF(1) <CR>
```

RESET Alarm/Scan Buffer

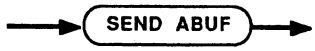
See Also

SHOW ABUF
SHOW FIRST|LAST|AGAIN ABUF
SEND ABUF
SHOW SBUF
SHOW FIRST|LAST|AGAIN SBUF
SEND SBUF

Format

SEND ABUF

Syntax Diagram



Description

This command returns the oldest record in the alarm buffer. The alarm record is then deleted from the alarm buffer.

Each alarm record has six fields of information:

Field 1: Date
Field 2: Time
Field 3: Alarm Type
Field 4: Alarm Parameter 1
Field 5: Alarm Parameter 2
Field 6: Alarm Parameter 3

Fields 4, 5, and 6 are only relevant to certain alarm types (see the table below) and have undefined values elsewhere.

SEND ABUF Data
Scan/Alarm Option

Condition	Field 3 (Alarm Type)	Field 4 (Alarm Parameter 1)	Field 5 (Alarm Parameter 2)	Field 6 (Alarm Parameter 3)
End-of-Buffer	0	N/A	N/A	N/A
Cold Start	1	N/A	N/A	N/A
Warm Start	2	N/A	N/A	N/A
Status Change	3	Channel #	New Status	New Value
Host Off-line	4	N/A	1	N/A
Host On-line	5	N/A	0	N/A
Abuf Overflow	6	N/A	N/A	N/A
Abuf Cleared*	7	N/A	N/A	N/A
Sbuf Overflow	8	Task #	1	N/A
Sbuf Cleared*	9	Task #	0	N/A

Where:

'new value' is the channel value at the time of the channel status change.

'channel #' is the number of the channel that had a status change.

'new status' is the most recent status of the channel (see table for channel status codes).

'task #' is the scan task number of the buffer that changed status.

* Buffer overflow condition was cleared

Channel status codes are composed of a set of flags encoded in the bits of a two-byte number:

Bit	Meaning When Set
0	lo alarm
1	hi alarm
2	lolo alarm
3	hihi alarm
4..7	unused
8..15	error code

where 'error code' is one of the error codes listed in Section 8.

The format in which the alarm buffer data is returned depends on the value of the system variable FORMAT.

FORMAT is XASCII:

dd-Mmm-yy hh:mm:ss : Alarm message <EOL>

where:

dd-Mmm-yy	is the date the alarm condition was detected; e.g., 21-Jan-84
hh:mm:ss	is the time the alarm condition was detected in hours, minutes, and seconds; e.g., 20:12:23
alarm message	contains the information in Fields 3 through 6 in a self-explanatory format

End-of-Buffer Format:

[EOB]

SEND ABUF Data
Scan/Alarm Option

FORMAT is DECIMAL or XDECIMAL:

<day>, <month>, <year>, <time>, <alarm type>,
<alarm parameter 1>, <alarm parameter 2>,
<alarm parameter 3> <EOL>

where:

<day> is the day of the month

<month> is the month number; i.e., a number from 1 to 12

<year> is a number representing the last two digits of the year; e.g., 1987 would be returned as '87'

<time> is a number representing the number of milliseconds past midnight

<alarm type> *
is the number indicating either the alarm type or the end-of-buffer condition.

<alarm parameter 1> *
<alarm parameter 2> *
<alarm parameter 3> *
are the parameters related to particular alarm types. Alarm parameter 3 is represented in scientific notation.

* See previous page for fields 3 through 6.

FORMAT is HEX or XHEX:

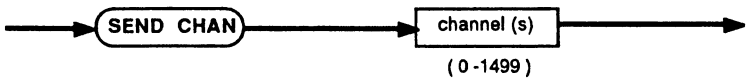
This form resembles DECIMAL and XDECIMAL except:

- Each field is represented as a single-precision IEEE floating-point value encoded as eight hexadecimal digits.
- End-of-line sequences, instead of commas, separate fields.

Format

SEND CHAN(<channels>)

Syntax Diagram



Description

This command returns a channel measurement (in appropriate units). In contrast, the LIST CHAN command returns the definition of designated channels.

A single channel, multiple channels, or a range of channels or multiple ranges can be specified. Valid channel numbers are 0 through 1499 (or 999 when the Scan/Alarm option is installed).

Channels are returned in the order in which they appear in the SEND list. However, they are not necessarily measured in that order. A channel is measured only once, regardless of the number of times it may (inadvertently) appear in the SEND list.

SEND CHAN Measurement

The response to a SEND CHAN command depends on the FORMAT system variable setting. The following descriptions show the response format for the different system variable settings:

- XASCII Format

  chan(nnn) sf.fffffE±ee <status message>

- DECIMAL Format

  sf.fffffE±ee

- XDECIMAL Format

  nnn,sf.fffffE±ee,<channel status code>

- HEX Format

  hhhhhhhh <EOL>

- XHEX Format

  iiiiiiii <EOL>
  hhhhhhhh <EOL>
  jjjjjjjj <EOL>

- BINARY Format

  bbbb

- XBINARY Format

  aaaa bbbb cccc

FORMAT is BINARY or XBINARY:

This representation is the same as HEX and XHEX except:

- Each field is represented as a single-precision IEEE floating point value encoded as four bytes.
- Fields are not separated by anything.
- An end-of-line sequence does not follow the record.

Examples

The following are valid responses to SEND ABUF:

In XASCII format:

```
05-Jun-87   11:05:16  :  Cold start
05-Jun-87   11:05:16  :  Warm start
05-Jun-87   11:05:16  :  Status change  chan(003)
                         4.91761E+00 lo alarm
05-Jun-87   11:05:16  :  Host off-line
05-Jun-87   11:05:16  :  Host on-line
05-Jun-87   11:05:16  :  ABUF overflow
05-Jun-87   11:05:16  :  ABUF cleared
05-Jun-87   11:05:16  :  SBUF overflow  sbuf(0)
05-Jun-87   11:05:16  :  SBUF cleared   sbuf(0)
05-Jun-87   11:05:16  :  Status change  chan(003)
                         5.91761E+00
05-Jun-87   11:05:16  :  Status change  chan(003)
                         9.99999E+37  ERROR  5
```

SEND ABUF Data
Scan/Alarm Option

In DECIMAL format:

```
15, 6,87,4546321,3,8,1, 0.00000E+00
```

which is a channel status change alarm for channel 8 where the status changed to a lo alarm.

where:

aaaa represents the channel number in IEEE single-precision floating-point format.

bbbb represents the channel value in IEEE single-precision floating-point format.

cccc represents the status code as a binary IEEE single-precision floating-point format.

hhhhhhhh represents the channel value as eight hexadecimal digits in IEEE single-precision floating-point format

iiiiiiii represents the channel number as eight hexadecimal digits in IEEE single-precision floating-point format.

jjjjjjjj represents the channel status message as eight hexadecimal digits in IEEE single-precision floating-point format.

nnn represents the channel number.

sf.fffffE+-ee represents the channel value in scientific notation.

If an error is detected as a result of a SEND CHAN command, the value

9.99999E+37

is returned for that channel. By listing the error log (LIST ERROR), the last 20 errors can be inspected.

If the system variable COUNT is ON, the first value of a returned measurement indicates the number of channel measurements to be returned.

Examples

After receiving the commands:

```
COUNT OFF
FORMAT=DECIMAL
SEND CHAN(3)
```

Helios responds with:

```
1.23456E+00
```

After receiving the commands:

```
MODE = COMP
COUNT ON
SEND CHAN(5,7,9)
```

Helios responds with:

```
3.00000E+00
1.23456E+00
3.45678E+00
4.56789E+00
```

After receiving the commands:

```
MODE = TERM
FORMAT=XASCII
SEND CHAN(3)
```

Helios responds with:

```
CHAN(003)  1.23567E+00  hi alarm
```

After receiving the commands:

```
FORMAT=DECIMAL
SEND CHAN(3)
```

Helios responds with:

```
1.23567E+00
```

After receiving the commands:

```
FORMAT=XDECIMAL
SEND CHAN(3)
```

Helios responds with:

```
3, 1.23567E+00, 2
```

After receiving the commands:

```
FORMAT=HEX
SEND CHAN(3)
```

Helios responds with:

```
3A000008
```

After receiving the commands:

```
FORMAT =XHEX
SEND CHAN(3)
```

Helios responds with:

```
00000000
41A00000
40000000
```

SEND CHAN Measurement

The following are valid SEND commands:

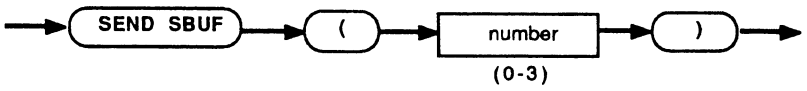
```
SEND CHAN(4)

SEND CHAN(7,9,14)

SEND CHAN(3..6,9..15)

SEND CHAN(12..20,34..38,42..48)

SEND CHAN(13..19,17..27)
```

Note: In the last command, channels 17 through 19 are measured once but reported twice.

Format

SEND SBUF(<scan buffer number>)

Syntax Diagram



Description

This command returns the oldest record in the designated scan buffer. The scan record is then deleted from the scan buffer.

Each scan record incorporates a scan header subrecord and zero or more channel measurement subrecords. Alternately, a user-defined header can be specified as part of the START SCAN statement for the printer port. This feature is fully described in the START SCAN area of this section.

The scan header is as follows:

- FORMAT is XASCII

  Header format for records that contain measurement data:

  dd-Mmm-yyy, hh:mm:ss, scan(n)<EOL>

  Header format for indicating end of buffer:

  [EOB]

- FORMAT is DECIMAL or XDECIMAL

  <day>,<month>,<year>,<time>,<buffer identification>

  <day> is the day of the month.

  <month> is the month number (1-12).

  <year> is a number representing the last two digits of the year; e.g. 1987 would be returned as "87".

  <time> is a number representing the number of milliseconds past midnight.

  <buffer identification> is the scan buffer number plus one for records that contain measurement data and is zero (0) for indicating the end of buffer.

- FORMAT is HEX or XHEX

  The header format is the same as for DECIMAL or XDECIMAL except:

  Each number is represented as a single-precision IEEE floating-point value encoded as eight hexadecimal digits.

  End-of-line sequences separate numbers instead of commas.

- FORMAT is BINARY or XBINARY

  The header format is the same as for HEX or XHEX except:

  Each single-precision IEEE floating-point value is encoded as four bytes.

  Numbers are not separated by anything.

  An end-of-line sequence does not follow the record.

The format in which the optional count and scan buffer measurement data is returned also depends on the value of the system variable FORMAT. This format is the same as that shown for the SEND CHAN command.

SEND SBUF Data
Scan/Alarm Option

Examples

SEND SBUF(2) <CR>

If FORMAT is XASCII then the following record may be output:

```
10-Oct-86, 11:42:06, scan(2)
chan(000) -3.66211E-04
chan(001) -8.54493E-02 lo alarm
     |          |
chan(019) -9.99999E+37 ERROR 10
```

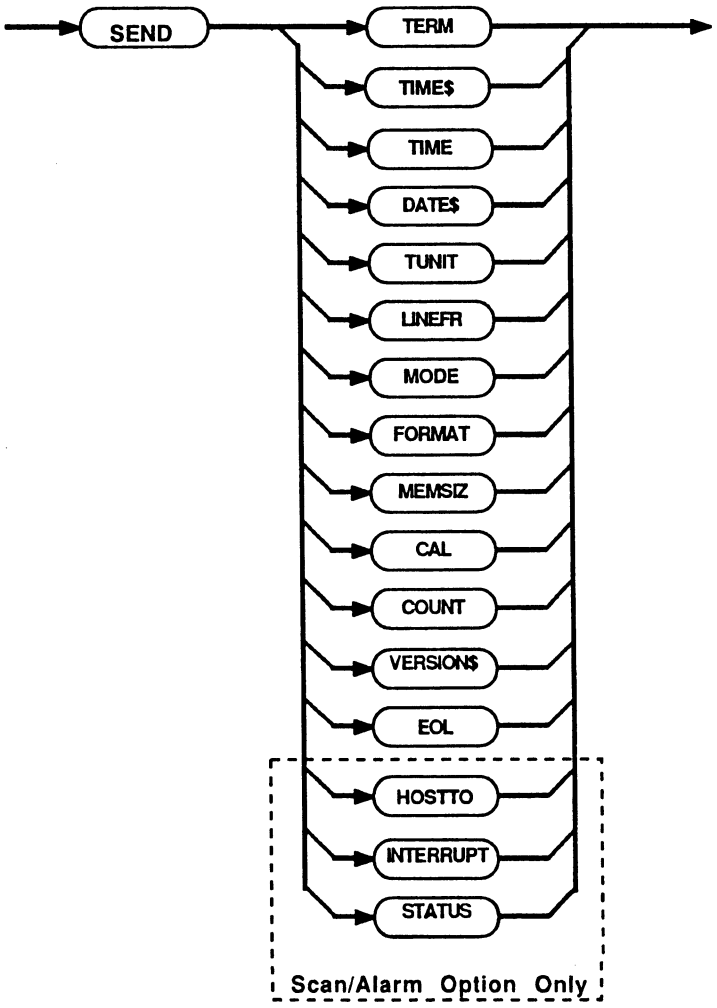
If FORMAT is XDECIMAL the output may look like:

```
10,10,86,15962120,3
0,-3.66211E-04,0
1,-8.54493E-04,1
```

Format

SEND <system variable>

Syntax Diagram



SEND Value of System Variable

Description

The value contained in <system variable> is returned to the host.

The system variables whose values can be returned are shown in the syntax diagram (above). The format in which each variable is returned is shown below. Each returned value is followed by an end-of-line sequence.

CAL (A/D auto-calibration)	"on" or "off"
COUNT (Channel count)	"on" or "off"
DATE$ (In day-Month-year)	dd-Mmm-yy
EOL (End-Of-Line Character(s))	ASCII character code(s)
FORMAT (Of Measurement Values)	"decimal", "hex" or "binary" "xascii", "xbinary", "xdecimal", "xhex" (Scan/Alarm)
HOSTTO (Host Time Out Interval) (in seconds)	sss (Scan/Alarm)
INTERRUPT (Host Alarm Interrupt)	"on" or "off" (Scan/Alarm)
LINEFR (Line Frequency in Hz)	"50,"60," or "400"
MEMSIZ (Memory Size in Bytes)	1 to 5 digits
MODE (Operating Mode)	"term" or "comp"

STATUS (System Status Code) (see information below)	1 to 5 digits (Scan/Alarm)
TERM (End-Of-Response Indicator)	"on" or "off"
TIME$ (In hours:minutes:seconds)	hh:mm:ss
TIME (In ms since midnight)	8 digits
TUNIT (Temperature Units)	"kelvin", "celsius", "fahrenheit", "rankine"
VERSION$ (Firmware version)	Helios-I Version x.y or Helios Scan/Alarm Version x.y Software by Polar Software Systems

System Status Codes (Scan/Alarm)

The system status code (STATUS) returns 1 to 5 digits that represent a 16-bit number. Refer to the SEND STATUS example presented later in this subsection. Bit descriptions are as follows:

Bit	Description
0	Host off line. When this bit is set, the watchdog timer is expired, meaning that the host did not send a command during a given period of time.
1	Alarm line set. This bit is set when the alarm line is set.
2	Alarm buffer contains information. This bit is set when a new alarm is recorded in the alarm buffer and cleared when all alarms are removed.
3	Alarm buffer overflow. This bit is set on an alarm buffer overflow and cleared when alarms are removed from the buffer.

SEND Value of System Variable

Bit	Description
4-7	Spare.
8	Scan buffer 0 contains information. This bit is set whenever scan buffer 0 contains one or more records and cleared when all records have been removed from scan buffer 0.
9	Scan buffer 0 overflow. This bit is set when scan buffer 0 overflows and cleared as soon as records are removed from the buffer.
10	Scan buffer 1 contains information. This bit is set whenever scan buffer 1 contains one or more records and cleared when all records have been removed from scan buffer 1.
11	Scan buffer 1 overflow. This bit is set when scan buffer 1 overflows and cleared as soon as records are removed from the buffer.
12	Scan buffer 2 contains info. This bit is set whenever scan buffer 2 contains one or more records and cleared when all records have been removed from scan buffer 2.
13	Scan buffer 2 overflow. This bit is set when scan buffer 2 overflows and cleared as soon as records are removed from the buffer.
14	Scan buffer 3 contains info. This bit is set whenever scan buffer 3 contains one or more records and cleared when all records have been removed from scan buffer 3.
15	Scan buffer 3 overflow. This bit is set when scan buffer 3 overflows and cleared as soon as records are removed from the buffer.

Examples

Standard Unit

SEND DATE$	Response: 25-Apr-86
SEND TIME	Response: 42423459
SEND TIME$	Response: 15:31:27

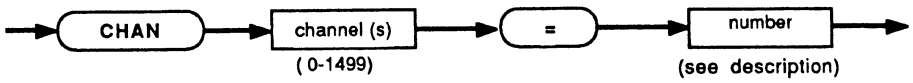
Scan/Alarm Option

SEND FORMAT	Response: xascii
SEND STATUS	The response '1029' means, for example, that bits 0, 2 and 10 are set, indicating that the host has been offline, and both the alarm buffer and scan buffer 1 contain information.

Format

CHAN (<channels>) = <analog output value>

Syntax Diagram



Description

This commands assigns an analog output value to the designated channel(s).

The way the assigned value is interpreted depends on the type of analog output (BIPOLV, UNIPOLV, DCOUT, PVOUT). Undefined channels default to unipolar (UNIPOLV) output.

Set CHAN Analog Output

Examples

To apply a current of 15 mA at the current output of channel 22, enter

```
DEF CHAN(22) = DCOUT
CHAN(22) = 0.015
```

To apply a voltage of -2.9V on the bipolar output of channel 101, enter

```
DEF CHAN(101) = BIPOLV
CHAN(101) = -2.9
```

See Also

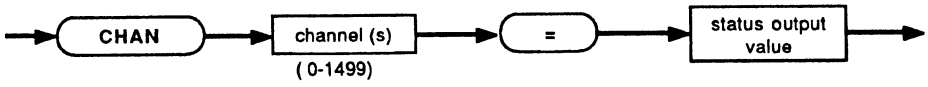
Section 2, Analog Output

Set CHAN
Set Channel
(Status Output)

Format

CHAN(<channels>) = <status output value>

Syntax Diagram



Description

This command sets a status output channel either on (logic "1") or off (logic "0"). Any non-zero value is interpreted as a logic "1". The actual output may differ if a channel function is used.

Example

To set 25 bits to logic "1", enter:

```
CHAN(200..224) = 1
```

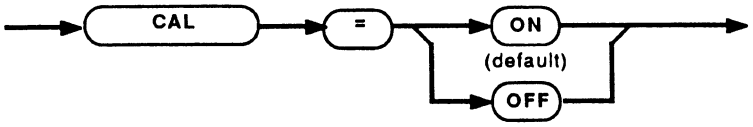
See Also

Section 6f, Status Output

Format

CAL = ON | OFF

Syntax Diagram



Description

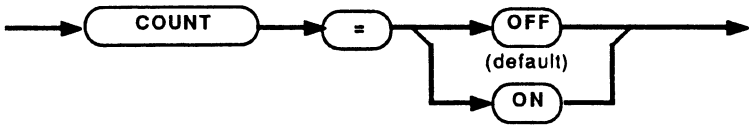
This variable sets auto-calibration of A/D converters "ON" or "OFF". The default is "ON".

When CAL is "ON" recalibration of A/D converter(s) is automatically performed at 10-minute intervals. When CAL is "OFF" this feature is turned off, allowing for uninterrupted measurement cycles.

Format

COUNT = ON | OFF

Syntax Diagram



Description

This variable can be set to "ON" or "OFF". The default is "OFF".

When "ON", the first line returned in response to a SEND CHAN command indicates the number of measurement channels being returned. When COUNT is "OFF" the first line of a returned SEND CHAN command measurement is an actual measurement. COUNT also affects Scan Record output in a similar way. Count is sent only when in the computer mode.

Example

After receiving the commands:

```
MODE = COMP
COUNT = ON
SEND CHAN(0..2)
```

Set COUNT

Helios could yield a response similar to:

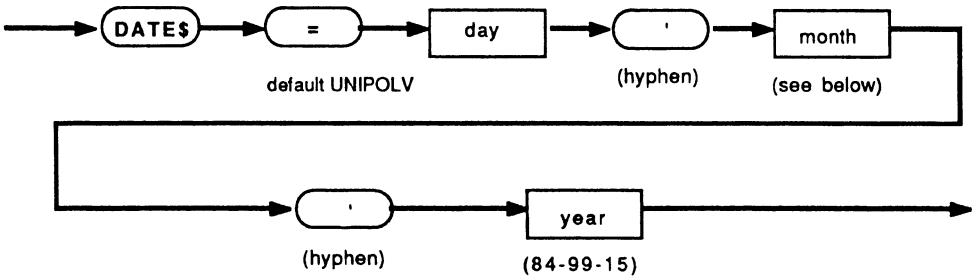
```
3.00000E+00
1.12345E+00
0.00000E+00
-3.87654E+02
```

The first returned value, "3.00000E+00", indicates the number of channel measurements being returned by this SEND command. Being the first number returned distinguishes this value from an actual measurement. If COUNT is set to "OFF", this number of channels is not included in the response.

Format

DATE$ = <day>-<month>-<year>

Syntax Diagram



Description

This variable represents the system date. Once set, the internal clock keeps track of the date. Leap years are handled automatically.

Set DATE$

To set the date, enter

DATE$ = <day>-<Month>-<year>

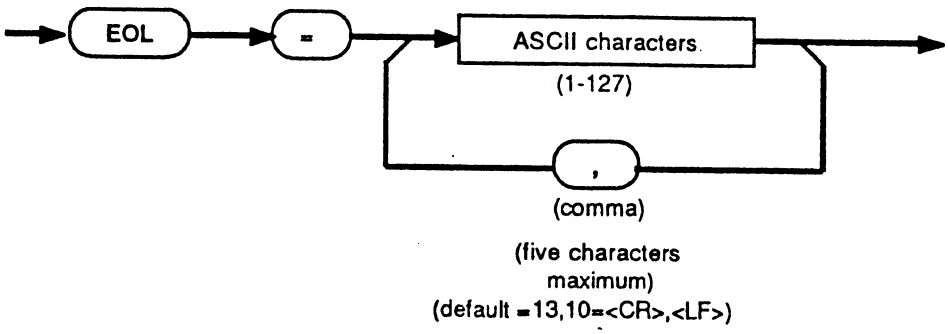
where <day> is 0-31, <Month> is a month keyword, and <year> is number from "84" to "99" or between "00" and "15". The keyword for each month is:

JAN = January	JUL = July
FEB = February	AUG = August
MAR = March	SEP = September
APR = April	OCT = October
MAY = May	NOV = November
JUN = June	DEC = December

Format

EOL = <character value>[,<character value>...]

Syntax Diagram



Description

The EOL system variable is appended to each line sent from the Computer Front End (in computer or terminal mode) to the host computer.

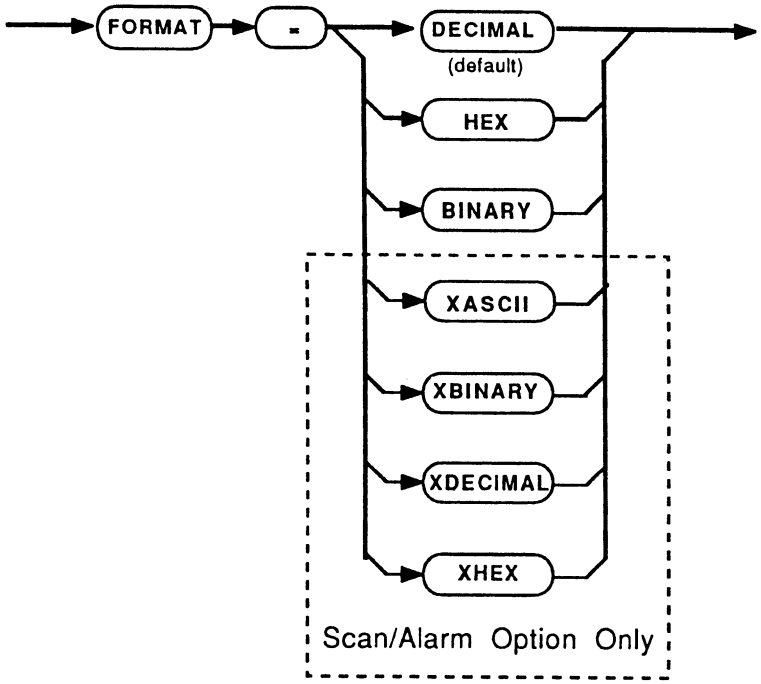
The <character value> parameters are the decimal values for the ASCII characters, in order, that are appended to each line. A maximum of five characters, separated by commas, are allowed.

The default EOL value is 13, 10 (representing carriage return, line feed). Characters 1 through 127 can be set; NUL (decimal 0) cannot be set.

Format

```
FORMAT = DECIMAL|HEX|BINARY|XASCII*|XBINARY*|XDECIMAL*|XHEX*

     * Scan/Alarm Option Only
```

Syntax Diagram



There is no relationship between the FORMAT system variable and the FORMAT parameter of the LABEL CHAN statement.

Set FORMAT

Description

This variable determines the format in which various measurements are returned in response to commands. Three formats are always available: decimal, binary or hexadecimal. With the Scan/Alarm option, extended ASCII, extended decimal, extended binary, and extended hexadecimal are also available. The system default is decimal.

DECIMAL FORMAT

The decimal format (DECIMAL) is a general purpose format and should be supported by most hosts. It consists of an ASCII representation of a measurement in the following generic form,

<s><x>.<xxxxx><E><+ | -><yy><EOL>

where <s> is a space or minus, <x> is a digit between 0 and nine, and <yy> is the exponent. Each measurement requires 12 bytes plus the end-of-line sequence.

HEXADECIMAL FORMAT

In hexadecimal format, each measurement value is sent as 8 hexadecimal characters, followed by the end-of-line character sequence. Measurement values are represented in Helios as 32 bit floating-point numbers, which conform to the IEEE standard for single-precision numbers. Each hexadecimal character represents 4 bits of the floating point number. The first hexadecimal character represents bit 0 to 3, etc. When the Helios system variable EOL has its default value (EOL=13,10), each measurement sent requires 10 bytes of output as illustrated below.

Character	Bits Represented
1	0 - 3
2	4 - 7
3	8 - 11
4	12 - 15
5	16 - 19
6	20 - 23
7	24 - 27
8	28 - 31
9	<CR>
10	<LF>

(characters 1 - 8 take the value 0 - F)

BINARY FORMAT

Binary format (BINARY) is also a direct representation of the IEEE standard format for single-precision floating-point numbers. Four bytes are sent directly to the host, allowing for the quickest transfer of data to the host. When sent, each byte is comprised of the following bits:

Byte 1 = bits 0 through 7
Byte 2 = bits 8 through 15
Byte 3 = bits 16 through 23
Byte 4 = bits 24 through 31

- Bit 0 is the sign bit (S). If set to 1, the number is negative.
- Bits 1 through 8 represent the binary exponent (E) offset by +126.
- Bits 9 through 31 represent the 23-bit mantissa (Y). Note that the mantissa is normalized (shifted to the left to eliminate leading zeros and the first one bit).

Example

Illustrated below is the translation of an IEEE binary-formatted number to decimal format.

SIGN BIT	OFFSET EXPONENT	MANTISSA (without hidden bit)
0	10000010	0100000 00000000 00000000 00000000
0	10000008	9 . . 31

Since the sign bit is zero, the number is positive. The binary exponent is given by:

Binary Exponent = Offset Exponent - Offset

= 10000010 (binary) - 126

= 130 - 126

= 4

The mantissa is given by:

hidden bit

Mantissa = 1.010 (binary)

= .625

Finally the decimal representation of the number is:

Decimal Number = $.625 * 2^4$

= 10

When sending binary formatted data to the IBM-PC*, care should be taken to account for the differences in floating-point representations. There are two common floating-point formats used on the IBM-PC: the Microsoft* floating-point format and the IEEE floating-point format. In each case, conversion of floating-point representations is required.

The IBM-PC stores the least significant bits in the first byte, while just the opposite is true for Helios. So, for IBM-PC computer languages that use the IEEE standard, convert Helios binary formatted numbers to IBM-PC formatted numbers by reversing the byte order. Some of the computer languages that use the IEEE standard are Microsoft C, Microsoft QuickBASIC* 3.0 (if the PC has a math coprocessor), Turbo Pascal, and Turbo BASIC.

The byte order must also be reversed for the Microsoft floating-point format. Also, the Microsoft floating-point format uses an exponent offset of +128, instead of +126; the sign bit is bit 8 instead of bit 0; and the exponent is in bits 0 to 7, instead of 1 to 8. Some of the computer languages which use the Microsoft floating-point format are IBM* compiled BASIC and Microsoft QuickBASIC 2.0.

* IBM and IBM PC are registered trademarks of IBM Corporation

* Microsoft and QuickBASIC are registered trademarks of Microsoft Corporation

XASCII FORMAT (Scan/Alarm Option)

The XASCII format is a general purpose format intended to be used in TERMinal mode. The following example shows the text output by the Helios I with Scan/Alarm option when the XASCII format has been selected:

chan (<nnn>) <value> <status><EOL>
where<value> is <s><x>.<xxxxx>E<+|-><yy>

<nnn> is the channel number in decimal, <s> is a space or minus,<x> and <y> are digits between 0 and 9, and <status> is a status message that indicates the status of the measurement value.

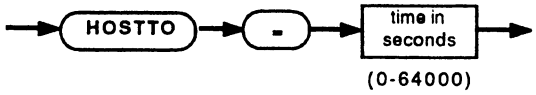
XBINARY, XDECIMAL, and XHEX FORMATS (Scan/Alarm Option)

These formats represent numbers the same way as BINARY, DECIMAL, and HEX formats. For measurements, the channel number precedes the channel status, followed by the channel value, respectively.

Format

HOSTTO = <time interval>

Syntax Diagram



Description

This variable allows the user to set the Host Timeout value in seconds. If the host did not send any character during the specified time, then all information on alarms that change status is sent to the printer port. A timeout value of zero indicates that this feature is turned off (default condition).

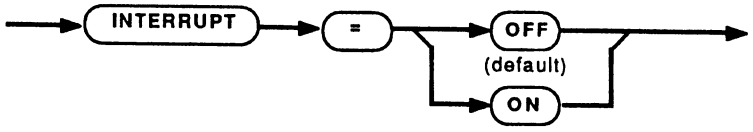
Example:

HOSTTO = 120 <CR>	Timeout after 2 minutes of no reception.
HOSTTO = 0 <CR>	Timeout feature is disabled.

Format

INTERRUPT = ON | OFF

Syntax Diagram



Description

This variable is used to enable or disable reporting of changes of Helios status to the host. If the variable is set ON, any change of system status is automatically reported to the host. This is accomplished by asynchronously transmitting the new value of the STATUS system variable (in decimal format), followed by the end-of-line sequence. Default is off.

Example:

Interrupt the host for any change in Helios status:

INTERRUPT = ON <CR>

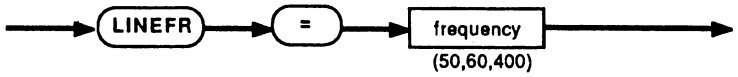
NOTE

Care must be taken when using this function in a multidrop mode. Multiple Helios Front Ends could try to return status information at the same time, causing a data collision.

Format

LINEFR = 50 | 60 | 400

Syntax Diagram



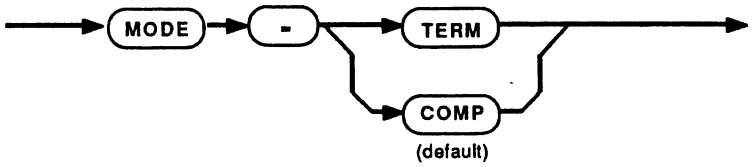
Description

The AC power line frequency is set in order for the A/D converters to provide the maximum noise rejection. A frequency of 50, 60 or 400 Hz can be assigned. The default frequency is determined by the 50/60 Hz switch on the Computer Interface Assembly. The line frequency does not affect the internal clock, which is crystal controlled. A valid LINEFR value causes the A/D converters to be calibrated correctly.

Format

MODE = COMP | TERM

Syntax Diagram



Description

This variable determines whether Helios operates in terminal mode (MODE=TERM) or computer mode (MODE=COMP). Setting MODE affects the way Helios responds to commands. When MODE=COMP, Helios responses are compact and easily read by computers. When MODE=TERM, Helios responses are verbose and easily read by humans. Computer mode is the default mode.

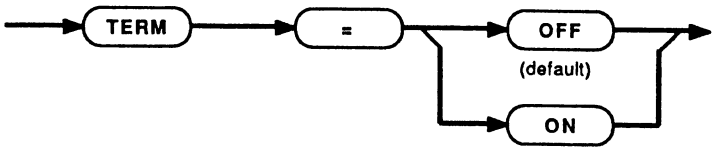
See Also

Section 4

Format

TERM = ON | OFF

Syntax Diagram



Description

The setting of this system variable is only effective in computer mode. When TERM is set to ON, a "!" character and <EOL> are appended to the data returned by the SEND and LIST commands.

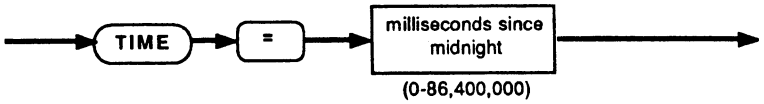
NOTE

All examples in this manual assume that the system variable TERM is in the default setting of OFF.

Format

TIME = <number of milliseconds since midnight>

Syntax Diagram



Description

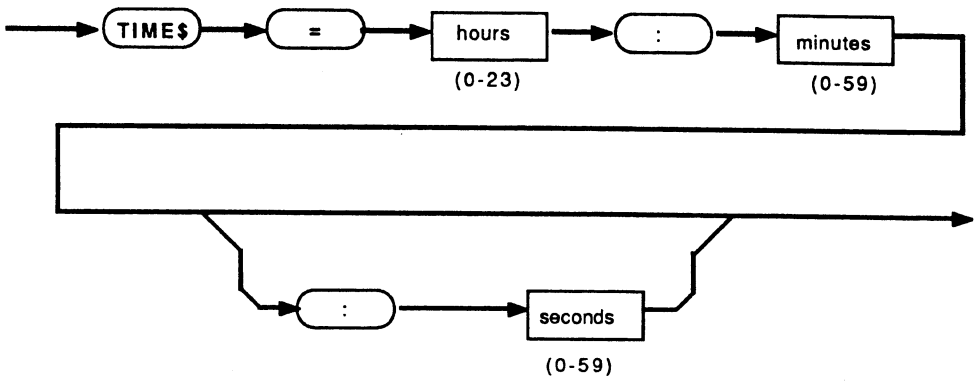
This variable allows the user to assign a starting time to the internal clock representing the number of milliseconds since midnight.

Since the system has only one internal clock, setting TIME changes the TIME$ setting.

Format

TIME$ = <hours>:<minutes>[:<seconds>]

Syntax Diagram



Description

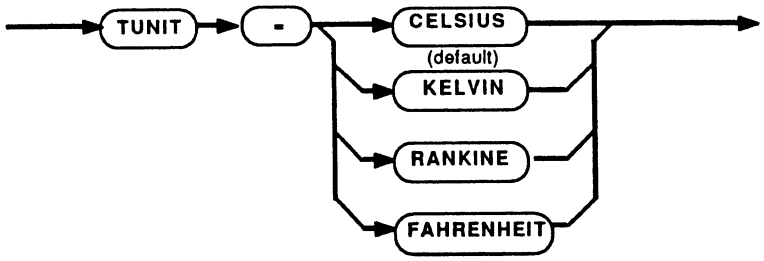
This variable is used to set the internal time in the more conventional form of hours (0-23), minutes (0-59) and seconds (0-59). If <seconds> is omitted, it is assumed to be 0.

Since the system has only one internal clock, setting TIME$ changes the TIME setting.

Format

TUNIT = CELSIUS | FAHRENHEIT | KELVIN | RANKINE

Syntax Diagram



Description

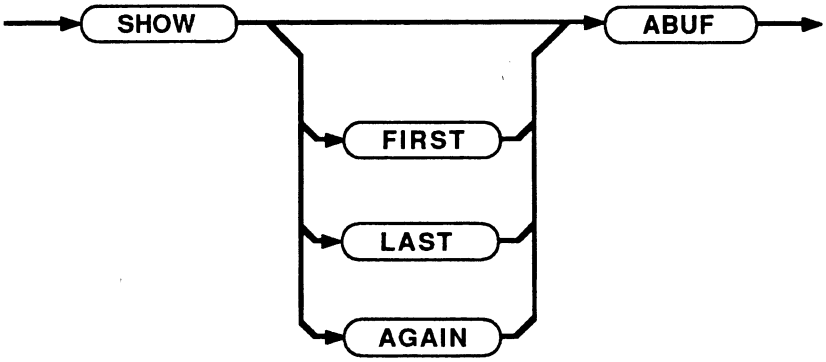
This variable selects the temperature units in which temperature readings (from thermocouples and RTDs) are returned. Four options are available: Celsius, Fahrenheit, Rankine and Kelvin. The instrument defaults to Celsius.

SHOW ABUF
SHOW FIRST|LAST|AGAIN ABUF
Show Alarm Buffer Data (Scan/Alarm Option)

Format

```
SHOW ABUF
SHOW FIRST|LAST|AGAIN ABUF
```

Syntax Diagram



SHOW Alarm Buffer Data
Scan/Alarm Option

Description

This command can be used in any of the following ways:

- SHOW ABUF

  This is a relative command that sends the next newer record in the alarm buffer, depending on the position of the previously sent record. The oldest record is sent if no other SHOW ABUF command has been used or if all the records have already been sent. If a SHOW command has been used already, the starting point for the SHOW ABUF next record may have changed. For example, if SHOW ABUF follows SHOW FIRST ABUF, the next record will be one newer than the oldest.

  The SHOW ABUF command is identical to the SEND ABUF command, except that it does not remove the retrieved record from the alarm buffer. The format of the returned record depends on the setting of the system variable FORMAT.

  If the last buffer record has been transmitted, the SHOW command will return an end of buffer response and will wrap around to the start (i.e., the oldest record) of the buffer.

- SHOW FIRST ABUF

  Send the oldest record in the ABUF.

- SHOW LAST ABUF

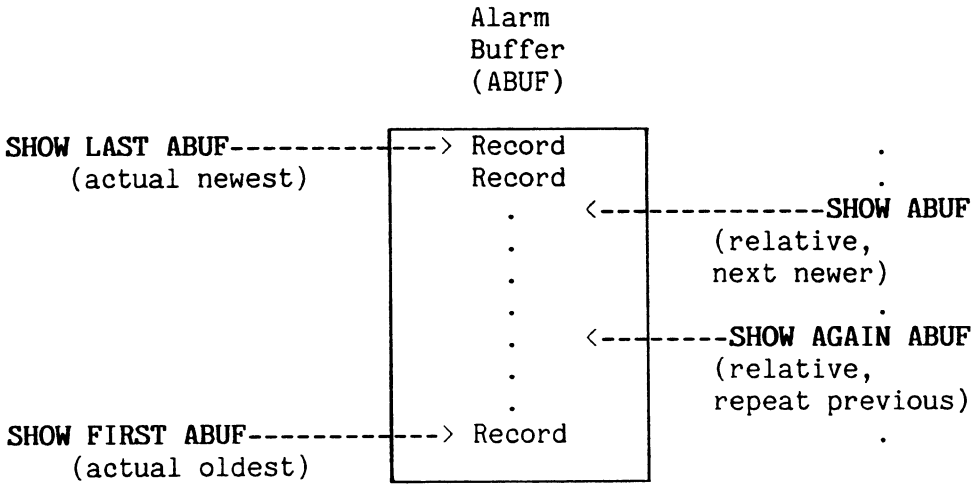
  Send the newest record in the ABUF.

o SHOW AGAIN ABUF

Repeat the most recently shown alarm buffer record. If the applicable record has already been overwritten with new data, the following error message is returned:

"No previous record available"

The following chart represents an alarm buffer containing ten records and illustrates which records are accessed with the various SHOW commands.

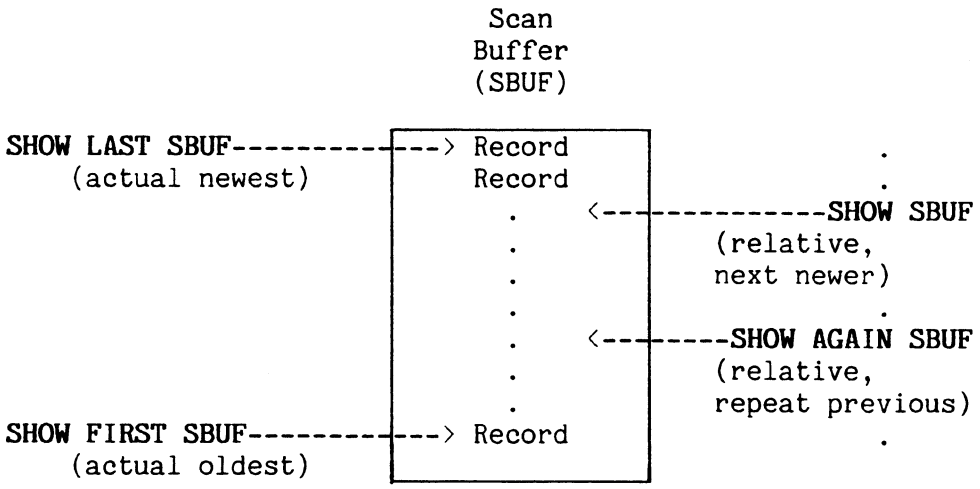


o SHOW AGAIN SBUF(1)

Repeat the most recently shown scan buffer record. If the applicable record has already been overwritten with new data, the following error message is returned:

"No previous record available"

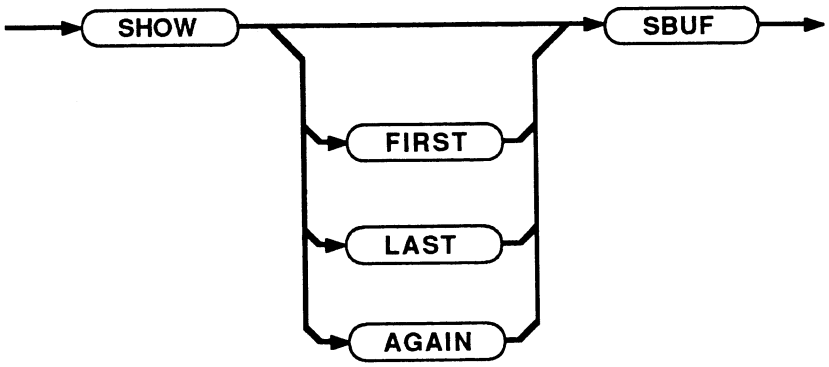
The following chart represents a scan buffer containing ten records and illustrates which records are accessed with the various SHOW commands.



Format

```
SHOW SBUF(<scan buffer number>)
SHOW FIRST|LAST|AGAIN SBUF(<scan buffer number>)
```

Syntax Diagram



Description

Various forms of the SHOW SBUF command are listed below. Note that scan buffer number (1) is shown as an illustration, but numbers (0), (2), or (3) could also be used.

SHOW Scan Buffer Data
Scan/Alarm Option

- SHOW SBUF(1)

  Send the next record in the scan buffer. The record sent is the next newer record (beginning with the oldest record) if no other SHOW command has been used. The record accessed may also be relative, in that a record previously accessed with one of the SHOW SBUF commands becomes the starting point in defining the next newer record. For example, if SHOW SBUF follows SHOW FIRST SBUF, the next record will be one newer than the oldest.

  The SHOW SBUF command does not remove the retrieved record from the scan buffer, but is otherwise identical to the SEND SBUF command

  If the last buffer record has been transmitted, the show command returns an end-of-buffer response and wraps around to the start (i.e., the oldest record) of the buffer. Returned record format depends on the system variable FORMAT setting.

- SHOW FIRST SBUF(1)

  Send the oldest record in SBUF(1).

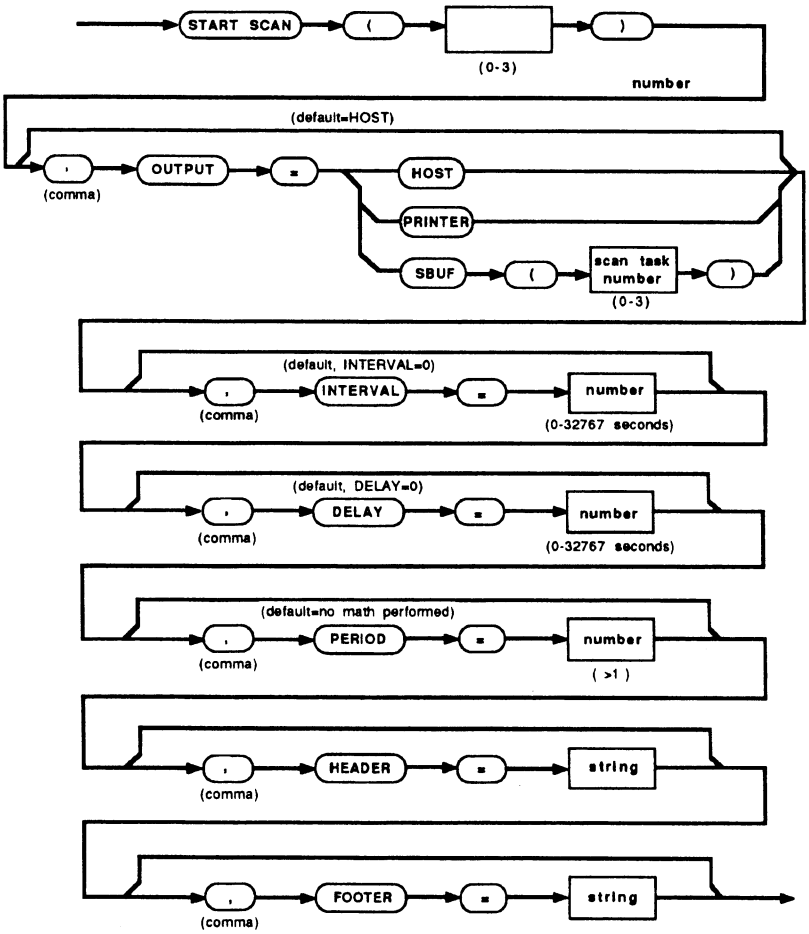
- SHOW LAST SBUF(1)

  Send the newest record in SBUF(1).

Format

```
START SCAN(<scan task number>) [,OUTPUT=HOST | PRINTER |
SBUF(<scan task number>)] [,INTERVAL=<seconds>]
[,DELAY=<seconds>] [,PERIOD=<number of scans>]
[,HEADER=<string>] [,FOOTER=<string>]
```

Syntax Diagram



START SCAN Task
Scan/Alarm Option

Description

This command starts execution of a scan task. A scan task is a program that executes on Helios and measures a set of channels on a periodic basis. Measurement data from a scan task is sent to an output device, which may be the Helios host computer port, the Helios printer port, or a scan buffer in Helios memory.

Parameters includable in the START SCAN statement are:

- INTERVAL

  This parameter establishes the time (in seconds) between successive scans. If no INTERVAL is specified, continuous scanning occurs.

- DELAY

  This parameter specifies the time in seconds before the initial scan is executed.

- PERIOD

  This parameter sets the number of scan cycles to be used by the math functions MIN, MAX, TOT, and AVG. To allow for meaningful computations, the number of scan cycles specified should always be greater than 1. If no PERIOD parameter is defined, no MIN, MAX, TOT, or AVG functions are performed.

- HEADER
  FOOTER

  Header and footer strings are used with the printer port only. Each string contains a maximum of 128 characters formed from any combination of:

  1. Quoted character strings. Quote marks do not count in 128-character limit.

  2. ASCII character decimal codes (not in quotes). Each code counts as one character.

  In addition, the header only can be appended with current date and time with:

  /t

  /d

  A semi-colon (;) must separate all character strings, character codes, and time/date specifiers. Semi-colons are not part of the 128-character limit.

  If HEADER is not specified in the START SCAN statement, the default header remains in effect. The default shows scan group, time, and date, as described under SEND SBUF.

There are three commands for using scan tasks: DEF SCAN, START SCAN and STOP SCAN. The DEF SCAN command assigns a set of channels to a scan task; START SCAN starts the execution of a scan task; and STOP SCAN terminates the execution of a scan task.

For a scan buffer, definitions are handled with the DEF SBUF command, and reads are handled with the SEND SBUF command or one of the SHOW SBUF commands.

Scan tasks must be defined before they can be executed. When using a scan buffer to store scan data, the scan task must be defined before the scan buffer is defined, because defining a scan task erases any existing definition of the associated scan buffer.

Up to four scan tasks may be defined and executed. Scan tasks are identified by their scan task number, which may be 0, 1, 2, or 3. When executing multiple scan tasks simultaneously, scheduling conflicts are resolved by scan task priority. The scan task priority is determined by the scan task number, with lower numbers having higher priority.

The priority of concurrent scans is based on the scan task number. Only one task runs at a time, with lower numbers having precedence.

NOTE

SCAN TASK(0), with no interval specified, runs continuously and will prevent execution of any other tasks.

Examples

The command:

```
START SCAN(1),OUTPUT=SBUF(1),INTERVAL=60,
HEADER="GENERATOR NUMBER 1";/t;/d
```

starts scan task(1), sends data to scan buffer(1), schedules scans every 60 seconds, and includes a header showing GENERATOR NUMBER 1, the time, and the date.

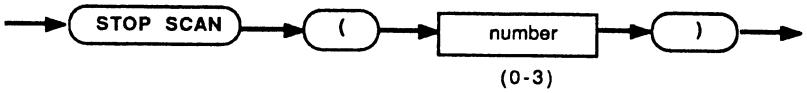
See Also

DEF SCAN	SEND SBUF
DEF SBUF	STOP SCAN
SHOW SBUF	

Format

STOP SCAN(<scan task number>)

Syntax Diagram



Description

This command allows the user to stop a previously started scan task.

Example

The command:

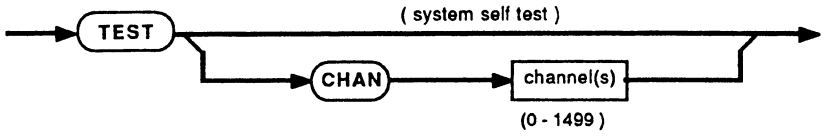
STOP SCAN(2) <CR>

stops scan task number 2.

Format

TEST [CHAN(<channels>)]

Syntax Diagram



Description

This command causes the Computer Front End to perform a system-wide self test or a self test on designated channels. The Computer Front End will operate if a self-test error has been reported; however, operation may be unreliable.

If specific channels are not indicated, a system-wide self test is performed. When a system-wide self test is performed, the interface hardware (i.e., the read only memory (ROM), random access memory (RAM) and the serial link universal asynchronous receiver transmitter (UART)) are checked.

If a self test is performed on a channel list, the designated channels are tested, implied hardware assemblies are put through a test procedure, and an error code or message is returned.

The format in which error messages are returned depends on the MODE system variable setting.

TEST System or Designated Channel

COMPUTER MODE

In computer mode, self-test failures are reported in the format:

? <error number><EOL>

where <error number> is one of the error numbers listed in Section 8.

TERMINAL MODE

In terminal mode, self-test failures are reported in the format:

? <error message><EOL>

where <error message> is one of the error messages listed in Section 8.

See Also

Section 8: Error Messages

Section 6
Measurement Reference

CONTENTS

Analog Output 6a-1
Current Measurements 6b-1
Digital/Status Inputs 6c-1
Frequency Measurements 6d-1
Resistance Measurements 6e-1
Status Outputs 6f-1
Strain Measurement 6g-1
Temperature Measurement Using RTDs 6h-1
Temperature Measurement Using Thermistors 6i-1
Temperature Measurement Using Thermocouples 6j-1
Totalizing Measurement 6k-1
Voltage Measurement - Alternating 6l-1
Voltage Measurement - Direct 6m-1

Section 6A
Analog Output
UNIPOLV, BIPOLV, DCOUT, PVOUT

INTRODUCTION

The Computer Front End can produce two types of analog outputs: direct voltage or dc current. This section explains use of the Computer Front End mainframe and required option assemblies in generating these two outputs. Additional information can be found in Section 3B in the discussion of the Analog Output (-170) assembly.

Direct Voltage Output

A direct voltage output is available to control devices requiring a continuously variable voltage. The Computer Front End Analog Output can supply a unipolar source (0V to 10V) or a bipolar source (-5V to 5V). Applications might include voltage controlled power supplies, process controllers, or 0 to 5 volt actuators.

Current Output

A current output allows for control of devices requiring a continuously variable current. Outputs from 4 mA to 20 mA are available. Applications could include current-controlled power supplies, process controllers, or 4 to 20 mA actuators.

Analog Output

REQUIRED HARDWARE

Applications involving analog voltage or current outputs require the Analog Output (-170) assembly. This assembly can be installed in either the Computer Front End mainframe or the 2281A Extender Chassis. Each -170 assembly provides four independent output channels with three sets of output terminals per channel.

Installation for any of the required assemblies is detailed in Section 3B of this manual. Reference each assembly by its option number (-170).

As an overview, installation requires the following actions:

- Address Selection

  Address selection switches establish the hundreds and tens designations for the first channel in a range of four successive channels. These switches are accessible through the rear panel of the Analog Output and can be set at any time.

- Wiring Connections

  For each channel, the connections determine the type of output (direct current control, current control as a process variable, bipolar voltage, or unipolar voltage).

- Physical Installation

  The Analog Output interfaces with the serial link and, therefore, can be installed in either the Computer Front End mainframe or the 2281A Extender Chassis.

USING THE COMMANDS

General

The DEF CHAN statement is used in defining a channel (or group of channels) for one of four types of analog output. In this statement, the channels must fall within the range set by the address selection switches. Also, the defined channel type should correspond to the Analog Output assembly wiring configuration.

For example, if the channel selection switches are set for 1 and 0 (meaning 100), and unipolar voltage wiring connections have been made, the following definition can be made for a range of four channels:

```
DEF CHAN(100..103) = UNIPOLV
```

Using the commands requires two steps. First, the channel number(s) and the associated channel type (BIPOLV, UNIPOLV, DCOUT, or PVOUT) are defined. A DEF CHAN statement is used for this purpose.

NOTE

UNIPOLV is the default setting.

Second, the output value is assigned separately using the CHAN statement. The assigned output value corresponds directly with the output voltage or current when any of the following modes of operation are selected:

- BIPOLV (bipolar voltage from -5 to +5V)
- UNIPOLV (unipolar voltage from 0 to +10V)
- DCOUT (current from 4 to 20 mA)

When the PVOUT mode is selected, the assigned value represents percent of range (0 to 100), corresponding to a span from 4 mA to 20 mA. Some examples follow:

Assigned	Actual
0	4 mA
50	12 mA
100	19.995 mA

Any assigned value less 0 causes an illegal value error message (code 01). Any assigned value greater than 100 causes 19.995 mA to be set.

Command Examples

Use the following examples to familiarize yourself with the Analog Output commands. First, define channels 100 and 101 for dc current output:

```
DEF CHAN(100..101) = DCOUT
```

Next, set the output level for these channels to 19.5 mA:

```
CHAN(100..101) = 0.0195
```

Now, change the output level to 16 mA:

```
CHAN(100..101) = 0.016
```

Set the remaining channels for this Analog Output for process variable output. This specifies output current or voltage as a percentage of the available range.

```
DEF CHAN(102..103) = PVOUT
```

Next, set the output level to 60%. For current, 60% of range is 13.6 mA. For voltage, 60% is 6V for UNIPOLV and 1V for BIPOLV.

```
CHAN(102..103) = 60
```

Finally, return the set output for any of these channels.

```
SEND CHAN(103)
```

The response for this channel would be:

```
6.00000E+01
```

PUTTING IT ALL TOGETHER

The following example can be typed in directly from a terminal (TERM mode) or included in a computer program (COMP mode). Refer to Section 4 under "Operating the Front End from a Terminal/Computer" for more detailed information. Also, Appendix 9A provides guidelines for use with specific types of host computers.

```
MODE = TERM
FORMAT = DECIMAL
DEF CHAN (0..3) = BIPOLV
CHAN (0..3) = 4.0
SEND CHAN (0..3)
```

This example assumes that the Analog Output address is set to 00. It commands the Front End to operate in terminal mode, sets system variable FORMAT, and defines channels 0 through 3 for an analog output voltage in the range of -5V to +5V. The CHAN command then sets the output to +4.0V.

The SEND CHAN command is used to monitor the set value received by the Analog Output assembly. However, this command does not indicate the output actually being made from the Analog Output. To verify the output, connect a measuring device (such as a DMM) to the actual outputs.
If the response is "9.99999E+37", an error has occurred. Enter the LIST ERROR command to retrieve the associated error message. If necessary, refer to Section 8 for additional error message information.

Section 6B
Current Measurement
DCIN

INTRODUCTION

About This Section

This section explains use of the Computer Front End and associated option assemblies for obtaining current readings. Detailed information about the physical installation of the Computer Front End mainframe and related options is provided in Section 3.

Current Measurement

The Current Input Connector accommodates inputs from 0 to 64 mA on a maximum of 20 channels. This range covers the useful range of standard current transmitters. Since this type of transmitter is often used to translate the output of another transducer (pressure, fluid flow, etc) to a current output, the current measurement function can serve a multitude of applications.

Standard current transmitters output a current value proportional to the physical parameter being measured. This sensor type usually outputs a value of from 1 to 5 mA, 4 to 20 mA, or 10 to 50 mA across its measurement range. Scaling and conversion used by the Computer Front End are optimized to measure current values within these ranges.

Current Measurement

REQUIRED HARDWARE

Applications involving current measurement require the following option assemblies:

-161	High Performance A/D Converter
-162	Thermocouple/DC Volts Scanner
-171	Current Input Connector

The High Performance A/D Converter (-161) provides high accuracy analog to digital conversion of scanner inputs. At least one A/D Converter must be installed in the Computer Front End Measurement Front End when analog measurements are being made.

The Thermocouple/DC Volts Scanner (-162) is a plug-in, 20-channel thermocouple and multi-voltage range relay scanner. The scanner links the A/D Converter to external measurement points.

The Current Input Connector (-171) routes a maximum of 20 current input channels to the Thermocouple/DC Volts Scanner.

Installation for any of the option assemblies is detailed in Section 3B of this manual. Reference each option assembly by its option number (-161, -162, or -171).

As an overview, installation requires the following actions:

- Addressing

  Addresses are determined by the both the position of the Thermocouple/DC Volts scanner relative to the A/D Converter (-161) and the address switch settings on that A/D Converter.

- Wiring Connections

  For each channel, HI and LO connections must be made so that current flows into the HI terminal and out of the LO terminal.

- Physical Installation

  Each Current Input Connector attaches to a Thermocouple/DC Volts Scanner. Each connector/scanner interfaces with the serial link and can be installed in either the Computer Front End mainframe or the 2281A Extender Chassis.

USING THE COMMANDS

General

One input range (64 mA) is available for current inputs. Each current input channel (or group of channels) is specified with the DCIN parameter in a DEF CHAN statement.

```
DEF CHAN(0..5, 8, 9) = DCIN
```

An interpolation table, relating dc current input values to output values in other units, can be called from this definition, allowing for conversion from units of current to other engineering units.

The measurement is made with the SEND CHAN command.

Command Examples

Let's augment the previous DEF CHAN statement with an interpolation table. First, establish the table as a sequence of input/output value pairs. An actual output is linearly interpolated (or extrapolated) from values found in the table.

```
DEF TABLE(1)=<input>,<output>/<input>,<output>/  ....
```

Next, call the interpolation table from a channel definition statement.

```
DEF CHAN(0..5, 8, 9) = DCIN, CHFN=TABLE(1)
```

For example, a pressure transmitter may have a dc current output range from 4 mA (at 0 psi) to 20 mA (at 500 psi). Interpolation table values can be entered to correlate current to psi.

```
DEF TABLE(1) = 0.004,0/0.02,500
```

The table can be called for channels measuring direct voltage:

```
DEF CHAN(0..5, 8, 9) = DCIN, CHFN = TABLE(1)
```

Now, measure these channels with the SEND CHAN command:

```
SEND CHAN(0..5, 8, 9)
```

The actual unit-of-measurement (psi in this case) can be appended to the returned output value within the computer's program.

PUTTING IT ALL TOGETHER

The following example can be typed in directly from a terminal (TERM mode) or included in a computer program (COMP mode). Refer to Section 4 under "Operating the Front End from a Terminal/Computer" for more detailed information. Also, Appendix 9A provides guidelines for use with specific types of host computers.

```
MODE = TERM
FORMAT = DECIMAL
DEF CHAN(0..19) = DCIN
SEND CHAN(0)
```

This example assumes that the High Performance A/D Converter (-161) address is set to 0 and that a direct current source is connected to the HI and LO terminals for channel 0 on the Current Input Connector (-171). It commands the Front End to operate in terminal mode, defines system variable FORMAT, and defines analog input channels 0 through 19 for direct current measurement. The resulting measurement is made on channel 0 with the SEND CHAN command.

Current Measurement

If 60 mA is measured, the returned reading is:

6.00000E-02

If the response is "9.99999E+37", an error has occurred. Enter the LIST ERROR command to retrieve the associated error message. If necessary, refer to Section 8 for additional error message information.

Section 6C
Digital/Status Inputs
BINARY, BCD/STATIN

INTRODUCTION

About This Section

This section explains use of the Computer Front End and associated option assemblies in obtaining digital or status inputs. Detailed information about the physical installation of the Computer Front End mainframe and related options is provided in Section 3.

Digital Inputs

The digital input function is a logic input for reading BCD (binary coded decimal) or straight binary data from sensors and instruments. Digital inputs can be provided by simple system instruments and by such things as position sensors and event counters.

Status Inputs

The status input function is a logic input for reading status (on/off) conditions from sensors, switches, and instruments. Status inputs are used to sample the state of one-bit inputs. They are used to determine if something is on or off, open or closed, enabled or disabled.

Digital/Status Inputs

REQUIRED HARDWARE

Applications involving digital or status inputs require the following option assemblies:

-168	Digital I/O Assembly
-179	Digital/Status Input Connector

The Digital I/O Assembly allows the Computer Front End to exchange information with a digital peripheral device. Four types of data exchange are possible: Alarm or Status Output; Status Input; BCD Input; and Binary Input.

The Digital/Status Input Connector can be used for the mutually exclusive functions providing BCD digital input, binary digital input, or status input information to the Computer Front End. This connector functions as a plug-in appendage to the Digital I/O Assembly, providing up to 20 input lines.

Installation for any of the required assemblies is detailed in Section 3B of this manual. Reference each option assembly by its option number (-168 or -179).

As an overview, installation requires the following actions:

- Address Selection

  With the connector detached, set the address switches on the Digital I/O Assembly. See Section 3B (-168).

- Input Format

  Make jumper connections for status, binary, or BCD inputs. See Section 3B (-179).

- Handshake Connections

  For digital inputs, make handshake terminal connections for the desired handshake method. Refer to Section 3B (-179).

- Wiring Connections

  Make necessary external connections to SIGNAL and RETURN terminals.

- Physical Installation

  Attach the Digital/Status Input Connector to a Digital I/O Assembly installed in the Front End or an Extender Chassis.

USING THE COMMANDS

General

Digital/status inputs require a DEF CHAN command line to specify the channel (or range of channels) and the input type (STATIN, BCD, or BINARY).

Command Examples

Use a DEF CHAN command to define a group of twenty status input channels:

```
DEF CHAN  (200..239) = STATIN
```

Use a SEND CHAN command to monitor the status inputs:

```
SEND CHAN(200..239)
```

PUTTING IT ALL TOGETHER

The following example can be typed in directly from a terminal (TERM mode) or included in a computer program (COMP mode). Refer to Section 4 under "Operating the Front End from a Terminal/Computer" for more detailed information. Also, Appendix 9A provides guidelines for use with specific types of host computers.

```
MODE = TERM
FORMAT = DECIMAL
DEF CHAN(0..19) = STATIN
SEND CHAN (0..19)
```

This example assumes that a Digital/Status Input Connector (-179) has been installed on a Digital I/O Assembly (-168) set for address 00. It commands the Front End to operate in terminal mode, sets system variable FORMAT, and defines digital input channels 0 through 19 for one-bit status inputs. The resulting measurements are monitored by the SEND CHAN command.

Verify status input responses by shorting some otherwise disconnected input channels. For example, short Signal and Return terminals on channels 7 through 13. Also, short terminal 21, Signal to Return. Leave channels 0 through 6 and 14 through 19 open.

For channels 7 through 13, the response should be:

0.00000E+00

The response for the remaining channels should be:

1.00000E+00

If the response is "9.99999E+37", an error has occurred. Enter the LIST ERROR command to retrieve the associated error message. If necessary, refer to Section 8 for additional error message information.

INTRODUCTION

About This Section

This section explains the use of the Computer Front End for measuring frequency. Detailed information on installing the Computer Front End and its options is found in Section 3.

Frequency Measurement

Frequency is defined as the number of events that occur in a given time period. Frequency is expressed in hertz. Frequency measurements can be used to determine the linear or rotational speed of objects, the flow rate of fluids, and the oscillation rate of electrical signals.

Frequency is measured by counting events for a known time period. The measurement represents the average frequency observed during the sampling time. In the Computer Front End, the measurement time is about two-thirds of a second.

A transition between one voltage state and another constitutes an event. The boundary between a high and low voltage state may be different for different types of signals. The Computer Front End counts high-to-low transitions.

Frequency Measurements

REQUIRED HARDWARE

For frequency measurements, the following is needed:

-167 Counter/Totalizer

Each Counter/Totalizer option supports six frequency measurement channels.

The installation instructions for the Counter/Totalizer are found in Section 3B of this manual. Consult these instructions as necessary.

Hardware Preparation

The Counter/Totalizer adjustments allow for measurement of a variety of signal types. The reference voltage and input deadband are adjustable. These adjustments define the high and low voltage thresholds of the input.

The Counter/Totalizer also supports an event counting (totalizing) function. Debouncers and input pull-up adjustments are provided for event counting measurements. These adjustments are normally not used when measuring frequency.

To prepare a Counter/Totalizer channel for frequency measurement, perform the following steps. Refer to Figure 7e-1.

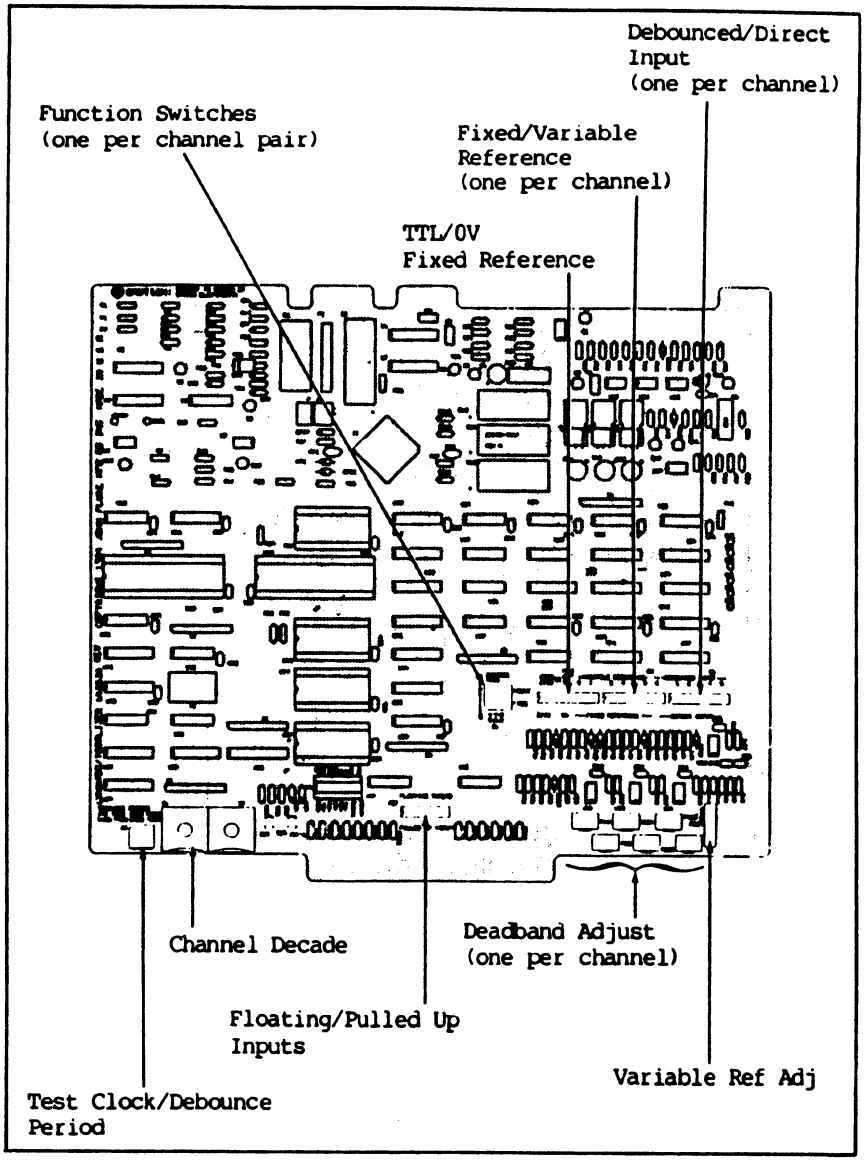


Figure 7e-1. Counter/Totalizer Adjustments

Frequency Measurements

- o FREQ Function

  Move the channel function switch to the FREQ position. Notice that the channels are grouped in pairs. There are three pairs of channels: channels 0 and 1, channels 2 and 3, and channels 4 and 5. Both channels in a pair must have the same function.

- o Direct Input

  Move the debounced/direct input switch to the DIRECT INPUT position. This turns off the debouncer. Since it alters the shape of the input signal, the debouncer can introduce errors during frequency measurements. Also, frequencies above 125 Hz cannot be measured with the debouncer on.

- o Pulled-Up Inputs

  Move the floating/pulled-up resistor network to the FLOATING position. Pulled-up inputs are necessary when counting contact closures. They are usually not needed for frequency measurements.

- o Addressing

  Set the hundreds and tens address switches to the first address for the group of six channels.

Adjustments

Figure 7e-2 shows how input voltage levels are detected by the Counter/Totalizer. The reference voltage defines the boundary between the high and low voltage states of the input signal. Deadband prevents input noise from being detected. As shown in the figure, the reference voltage and deadband define the high and low input voltage thresholds.

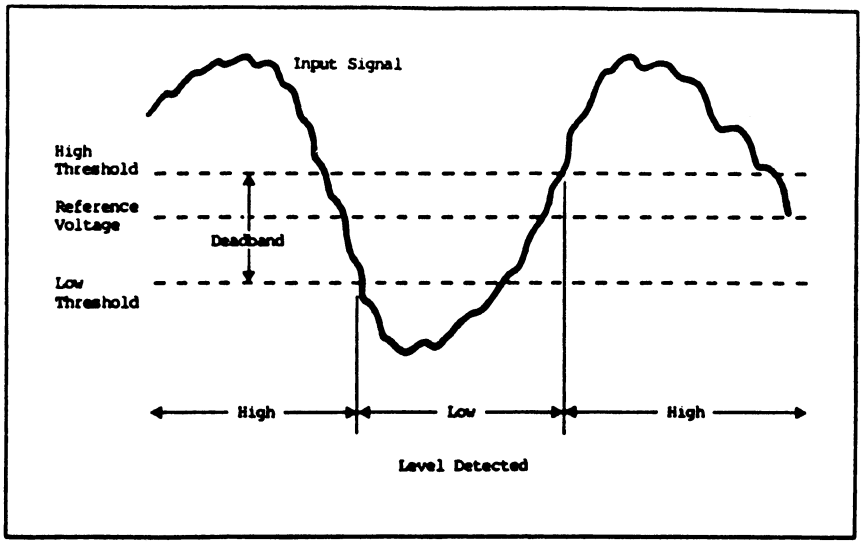


Figure 7e-2. Input Level Detection

On the Counter/Totalizer assembly, the reference voltage and deadband are adjustable. For each channel, a switch selects either a fixed or variable reference voltage. There is one variable reference on the assembly, adjustable from -10 to +10 volts. There is also one fixed reference, which is selectable for 0 volts or 1.4 volts (TTL level). The deadband is adjustable from 0 to 3 volts for each channel.

ADJUSTING REFERENCE VOLTAGE

To choose the proper reference voltage, follow these guidelines:

- If the input signal is centered around 0 volts, select the 0 volt fixed reference.
- If the input signal is TTL compatible, select the TTL fixed reference.

- If the input signal is neither of the above, select the variable reference. To adjust the variable reference voltage, connect a voltmeter to the variable reference terminal and one of the return terminals on the rear panel connector. Using a small screwdriver, turn the variable reference adjustment screw until the desired voltage is displayed by the voltmeter.

ADJUSTING DEADBAND

To adjust the input deadband, there are several approaches. Use the method most suitable for your application.

- Method 1. For TTL signals, turn the deadband adjustment screw counterclockwise until it stops. Then turn the screw clockwise to the position marked TTL on the rear panel.

- Method 2. Connect the signal to be measured to one of the Counter/Totalizer input terminals, as for normal operation. Turn the appropriate deadband adjustment screw counterclockwise until it stops. Sample the channel and turn the deadband screw clockwise until a stable reading is obtained.

- Method 3. Temporarily select the 0 volt fixed reference for the channel in question. Remove any connections to the input terminal. Connect a voltmeter to one of the return terminals and to the threshold output terminal for this channel. Disregarding the polarity of the threshold voltage, turn the appropriate deadband adjustment screw until the threshold is one-half the desired deadband voltage. Restore the reference voltage to its original setting.

To ensure accurate measurements, adjust the deadband for each channel as high as possible.

CHECKING THRESHOLD VOLTAGES

The combination of reference voltage and deadband determines the high and low threshold voltages. To check the threshold levels, use the following procedure:

- Connect a voltmeter to one of the return terminals and to the threshold output terminal for the channel in question. Connect the test clock output to the channel input terminal.
- Turn the test clock switch to position 0 (+14 volt output) and read the low threshold on the voltmeter.
- Turn the test clock switch to position 1 (-15 volt output) and read the high threshold on the voltmeter.

Connections

The terminal assignments for the Counter/Totalizer connector are listed on the rear panel. The maximum input voltage is ±15V dc or ac peak.

The six channels on a Counter/Totalizer assembly are isolated from the Computer Front End chassis and from ground but not from each other. The return lines on the input connector are common. All return lines must be connected to the same voltage.

USING THE COMMANDS

General

The DEF CHAN statement is used in defining pairs of frequency measurement channels. A conflict with some hardware settings on the Counter/Totalizer Board must not be introduced.

- First, each pair must consist of consecutive even and odd channels, corresponding to those selected on the function switch (Figure 7e-1).

- Second, the channels defined should fall within the range set by the channel decade switches (Figure 7e-1). Note that these switches establish the hundreds and tens designations for a range of channels.

Command Examples

Keeping these two rules in mind, let's define a pair of frequency measurement channels. If the function switch is set for FREQ on channels 0 and 1, and the channel decade switches are set for 1 and 0 (meaning 100), you can make the following definition:

```
DEF CHAN(100, 101) = FREQ
```

To measure these channels, enter a SEND CHAN command:

```
SEND CHAN(100, 101)
```

To ensure that the input signals are detected accurately, the Counter/Totalizer input thresholds must be properly adjusted. These and other adjustments are described earlier in this section.

Resistance Measurements

The Computer Front End measures resistance by passing a stable current through the resistor or sensor, and measuring the voltage that results. Appropriate conversions are then made to the sensed voltage and the output is displayed as a resistance reading.

REQUIRED HARDWARE

Resistance measurement applications require one of two option assembly configurations.

The -161 High Performance A/D Converter, which provides high accuracy analog-to-digital conversion of scanner inputs, is used in either configuration.

Installation of the required assemblies is detailed in Section 3B of this manual, where the options can be referenced by their three-digit numbers.

Configuration A

The first configuration employs the following two option assemblies in addition to the A/D Converter:

-163	RTD/Resistance Scanner
-177	RTD/Resistance Input Connector

This configuration provides the most accurate and repeatable resistance readings with the lowest cost per channel. Each RTD/Resistance Scanner and Connector set provides current excitation and measurement for 20 resistance channels. This configuration is intended for applications more exclusively involving resistance measurements.

The RTD/Resistance Scanner configuration also provides lead-wire compensation for performing accurate 3-Wire resistance measurements.

INTRODUCTION

About This Section

This section explains the use of the Computer Front End and associated option assemblies for obtaining resistance readings. Detailed information regarding the physical installation of the Computer Front End mainframe and options is provided in Section 3.

Resistance Measurement

Resistance measurements, with or without conversion to other measurement units such as position or temperature, are directly supported by the Computer Front End.

Measurements can be made with the Computer Front End to determine resistance, or to determine the value of another directly related parameter. Many slide wire pots, non-standard RTDs, and other sensors with variable resistance outputs can be used to indicate temperature, position, and other physical parameters.

Several types of variable resistance transducers are discussed in greater detail in:

- 6G: Strain Measurements
- 6H: Temperature Measurement Using RTDs
- 6I: Temperature Measurement Using Thermistors

Out-of-Range Conditions

The Counter/Totalizer is guaranteed to measure frequencies down to 2 hertz. Frequencies below 2 hertz cause a response of "9.99999E+37", signifying that an error has occurred.

The Counter/Totalizer is guaranteed to measure frequencies up to 400 kilohertz. Overrange conditions are not detected. When the input frequency exceeds 400 kilohertz, erroneous readings may be returned.

PUTTING IT ALL TOGETHER

The following example can be typed in directly from a terminal (TERM mode) or included in a computer program (COMP mode). Refer to Section 4 under "Operating the Front End from a Terminal/Computer" for more detailed information. Also, Appendix 9A provides guidelines for use with specific types of host computers.

```
MODE = TERM
FORMAT = DECIMAL
DEF CHAN (0..5) = FREQ
SEND CHAN (0)
```

This example assumes that the Counter/Totalizer (-167) address is set for 00, its channel function switches set to the FREQ position, the debounce/direct input switches set to Direct Input, and the floating/pulled-up resistor network moved to the Floating position. It commands the Computer Front End to operate in terminal mode, sets the system variable FORMAT, and defines channels 0 through 5 for frequency measurement. The resulting measurement is made on channel 0 with the SEND CHAN command.

Frequency Measurements

To verify a returned measurement, wire the test clock output on the Counter/Totalizer rear panel connector to the channel zero input terminal. The terminal assignments for the connector are listed on the rear panel. Since the test clock output and the channel inputs use the same ground, it is not necessary to wire a return line.

Using a small screwdriver, move the test clock switch to position 2 (100 kHz). Measure the channels input (SEND CHAN (0)) and verify a reading of:

1.00000E+05

If the response is "9.99999E+37", an error has occurred. Enter the LIST ERROR command to retrieve the associated error message. If necessary, refer to Section 8 for additional error message information.

Installation is covered in Section 3B for each option assembly being used. Briefly, these steps include:

- Select the Measurement Mode

  Set jumpers W1 and W2 on the RTD/Resistance Scanner for the desired measurement mode.

- Addressing

  Addresses are determined by the both the position of the RTD/Resistance Scanner (-163) relative to the A/D Converter (-161) and the address switch settings on that A/D Converter.

- Physical Installation

  The RTD/Resistance Input Connector attaches to the RTD/Resistance Scanner.

- External Connections (see Section 3B, -177)

  4-Wire (4W) Measurement Mode
  Two sense and two excitation wires must be connected to each channel. Lead-wire or reed switch resistances do not affect readings.

  3-Wire Accurate (3WA) Measurement Mode
  One sense and two excitation wires must be connected to each channel. Equal lead-wire resistances are compensated for. Reed switch resistances do not affect readings. Ten channel returns are internally connected together.

  3-Wire Isolated (3WCM) Measurement Mode
  One sense and two excitation wires must be connected to each channel. Equal lead-wire resistances are compensated for. One reed switch resistance error affects readings.

Resistance Measurements

Configuration B

The second configuration supports a wider mix of both resistance and other measurement applications. Excitation and measurement can be provided for several types of 4-Wire resistance output sensors by the following assemblies:

-162	Thermocouple/DC Volts Scanner
-176	Voltage Input Connector*

* Any other input connector supporting direct voltage measurement can be used here. These include: -160 AC Volts Input Connector and -175 Isothermal Input Connector.

-164	Transducer Excitation Module
-174	Transducer Excitation Connector

The -162 Thermocouple/DC Volts Scanner is a plug-in, 20 channel, thermocouple and direct voltage, reed relay scanner contained on a single pcb. This selects and conditions one channel at a time for conversion by the A/D Converter. Connections to the Scanner can be made through a Voltage Input, Isothermal Input, or AC Voltage Input Connector. The A/D, Scanner, and Connector measure the direct voltage generated across the resistance to be measured.

The -164 Transducer Excitation Module is used to energize either the resistance sensors with an excitation current or the resistance bridge configurations with an excitation voltage. Used in conjunction with the -174 Transducer Excitation Connector, each -164 provides five current sources that can excite up to four channels per source, and one voltage source that can excite bridge configurations.

Installation is covered in Section 3B for each option assembly being used. Briefly, these steps include:

- Addressing

  The addresses for resistance measurement channels are determined by the measurement hardware. Therefore, both the position of the Thermocouple/DC Volts Scanner (-162) relative to the A/D Converter (-161) and the address switch settings on that A/D Converter set the address.

- Voltage/Current Excitation Jumper

  Each group of four channels must be configured for voltage or current output by correctly positioning the respective jumper on the Transducer Excitation Connector (-174). Refer to the connector decal for details.

- Physical Installation

  The Transducer Excitation Module/Connector (-164/-174) and the Thermocouple/DC Volts Scanner/connector (-162/-175,-176, or -160) should be installed one-above-the-other to facilitate interconnections. Overall installation considerations are discussed in Section 3B.

- External Connections

  Configuration B resistance measurements are performed with the system connections shown in Section 3B for the -174 connector.

USING THE COMMANDS

General

The DEF CHAN statement is used to set-up a channel or group of channels for measuring resistance transducers.

CONFIGURATION A

For Configuration A, three ranges (256, 2048 and 64000 ohms) are available. The range selected is again determined by the MAX parameter, with the default range being 64 kilohms. The channel definition uses the following format:

DEF CHAN(channels)=RESIST, MAX=(anticipated high value)

CONFIGURATION B

For Configuration B, two ranges (64 and 512 ohms) are available. In specifying the highest anticipated reading, the optional MAX parameter also determines the appropriate range. If the anticipated high reading is within the lower range, that range is selected. If no MAX parameter is specified, the default (512 ohm) range is used. The same channel definition format is used.

Interpolation Tables

At times, the resistance value returned by the Computer Front End may not be in the units or in the form that will eventually be used by the computer. A transfer function must be used to convert such a reading.

This function can be provided by the computer program. Where the formula is known, this method may be all that is necessary.

But the transfer formula may not be known. Some types of transducers are only provided with a table of input and output values. The Computer Front End's interpolation table function can then be used as a transfer function.

An interpolation table allows for user-specified input-to-output value relationships. When an actual input falls between two table input values, a linear interpolation is used to determine the output. If the input falls outside table values, a linear extrapolation is used to determine the output.

A complete discussion of interpolation tables is found in Section 5.

Command Examples

Let's define channels 30 through 37 for resistance measurement with an anticipated maximum reading of 300 ohms. For Configuration A, the 2048 ohm range is used. For Configuration B, the 512 ohm range is used. In the same statement, call the interpolation table previously defined.

```
DEF CHAN(30..39) = RESIST, MAX = 300
```

Now, measure the resistance on the defined channels.

```
SEND CHAN(30..39)
```

If the reading is greater than allowed in the specified range (as determined by the maximum anticipated value), "9.99999E+37" is returned. This signifies that an out of range error has occurred.

PUTTING IT ALL TOGETHER

The following example can be typed in directly from a terminal (TERM mode) or included in a computer program (COMP mode). Refer to Section 4 under "Operating the Front End from a Terminal/Computer" for more detailed information. Also, Appendix 9A provides guidelines for use with specific types of host computers.

```
MODE = TERM
FORMAT = DECIMAL
DEF CHAN (0..19) = RESIST
SEND CHAN (0)
```

This example assumes that the High Performance A/D Converter (-161) address is set to 0 and that a resistance is connected to either the RTD/Resistance Input Connector (-177) (Configuration A used) or the Transducer Excitation Connector (-174) (Configuration B used). It commands the Computer Front End to operate in terminal mode, sets system variable FORMAT, and defines analog input channels 0 through 19 for resistance measurement. Since no MAX parameter has been specified, the highest resistance range (Configuration A = 64 kilohm range, Configuration B = 512 ohm range) is used. The resulting measurement are is made on channel 0 with the SEND CHAN command.

For example, a 330 ohm resistor applied to the inputs should be measured as:

```
3.30000E+02
```

If the response is "9.99999E+37", an error has occurred. Enter the LIST ERROR command to retrieve the associated error message. If necessary, refer to Section 8 for additional error message information.

Section 6F
Status Outputs
STATOUT

INTRODUCTION

About This Section

This section explains use of the Computer Front End and associated option assemblies for making status outputs. Detailed information about the physical installation of the Computer Front End mainframe and related options is provided in Section 3.

Status Output

The Status Output control function is a single-bit logic state output. Status outputs are used for such activities as opening and closing relays, turning indicator lights on and off, or opening and closing valves. Status outputs can also be wired to provide logic inputs to other devices.

REQUIRED HARDWARE

Applications involving status outputs require the following option assemblies:

-168	Digital I/O Assembly
-169	Status Output Connector

The Digital Input/Output Assembly allows the Computer Front End to exchange information with a digital peripheral device. Four types of data exchange are possible: Alarm or Status Output; Status Input; BCD Input; and Binary Input.

Status Outputs

The Status Output Connector attaches to the Digital I/O Assembly (-168). It can send 20 single-bit output signals from the Digital I/O to external control points or terminals. Each output is individually selectable and can be used either to drive lamps and relays or change logic levels.

Installation for either assembly is detailed in Section 3B of this manual. Reference each option assembly by its option number (-168 or -169).

As an overview, installation requires the following actions:

- Address Selection

  With the connector detached, set the address switches on the Digital I/O Assembly. See Section 3B (-168).

- Wiring Connections

  On the Status Output Connector, make necessary external connections to OUTPUT and RETURN terminals and, if used as a relay driver, to the appropriate CLAMP terminal.

- Physical Installation

  Attach the Status Output Connector to a Digital I/O Assembly installed in the Front End or an Extender Chassis.

USING THE COMMANDS

General

Setting up status output channels involves the DEF CHAN command to specify the channel (or group of channels) and type. The CHAN statement is used separately to define the output value (1 or 0). Any non-zero value is interpreted as "1".

The output can be checked with the SEND CHAN command.

Command Examples

Let's define channels 20 through 29 as status outputs.

```
DEF CHAN(20..29) = STATOUT
```

Now, set the outputs for this block of channels to logic "1".

```
CHAN(20..29) = 1
```

If you want to change the output value, enter:

```
CHAN(20..29) = 0
```

Use the SEND CHAN command to check the last value set for a specified group of status outputs.

```
SEND CHAN(20..29)
```

PUTTING IT ALL TOGETHER

The following example can be typed in directly from a terminal (TERM mode) or included in a computer program (COMP mode). Refer to Section 4 under "Operating the Front End from a Terminal/Computer" for more detailed information. Also, Appendix 9A provides guidelines for use with specific types of host computers.

```
MODE = TERM
DEF CHAN(0..19) = STATOUT
CHAN(0..19) = 0
SEND CHAN(0..19)
```

This example assumes that a Status Output Connector (-169) is wired so that its terminals can be accessed with a digital multimeter. The connector is installed on a Digital I/O Assembly set for address 00. The example commands the Computer Front End to operate in terminal mode, defines channels 0 through 19 for status outputs, and sets the channel outputs for logic zero. The SEND CHAN command verifies only the output value last received by the Computer Front End through the "CHAN(channels)=0/1" command.

To verify actual status outputs, a digital multimeter should be used at the output terminals. Use a DMM set for either the diode checking range or the ohms range. Connect the DMM Volt/Ohm (red) lead to the channel OUTPUT terminal and the common (black) lead to the RETURN terminal. When the output is set for zero, a high resistance (greater than 20 megohms) should be found on each channel.

Now send the commands:

```
CHAN(0..19) = 1
SEND CHAN(0..19)
```

Verify that the returned value is a "one" and that the resistance measured by the DMM is lower (less than 9 megohms).

If either response is "9.99999E+37", an error has occurred. Enter the LIST ERROR command to retrieve the associated error message. If necessary, refer to Section 8 for additional error message information.

INTRODUCTION

About This Section

This subsection explains the concept of strain and its measurement by the Computer Front End. Detailed information regarding the physical installation of the Computer Front End mainframe and options is provided in Section 3.

Strain Measurement

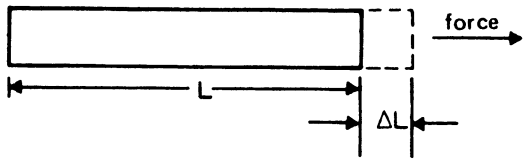
Strain is the measurement of the deformity of an object subjected to an external force. This type of measurement is valid up to the elastic limit of the object being stressed. Strain gauges are widely used in such measurements as:

- Weight: load cells are commonly used to weigh heavy objects.
- Pressure: pressure gauges are actually strain gauges mounted on a diaphragm that deforms in a predictable manner under pressure.
- Fluid Level: the fluid level in a tank can be measured using a strain gauge mounted on a support leg of the tank.

STRAIN MEASUREMENT

General

The force deforming a body can cause an increase or a decrease in a dimension of that body. Any increase is considered positive and is termed tensile strain. A decrease is negative and is called compressive strain. Strain is normally expressed as the ratio of the change in dimension over the original dimension (the ratio itself is a dimensionless number.) See Figure 6g-1. Strain is defined by the following equation:

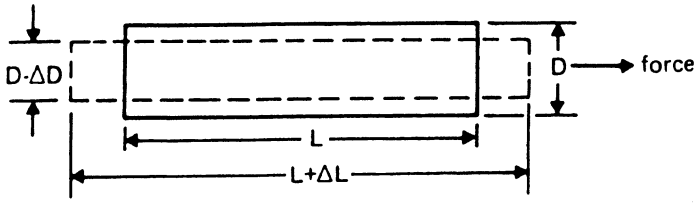


$$\varepsilon = \Delta L / L$$

Figure 6g-1. Strain

Poisson's Ratio

When a material is stressed, it expands along the axis of the applied force and it contracts along an axis at a right angle to the applied force. The negative ratio of axial strain to perpendicular strain is called the Poisson ratio. The Poisson ratio is a constant that is a characteristic of the material. See Figure 6g-2.



$$\epsilon_t = \frac{\Delta D}{D} \qquad \epsilon_L = \frac{\Delta L}{L}$$

$$\upsilon = - \epsilon_T / \epsilon_L$$

Figure 6g-2. Poisson Ratio

Resistive Strain Gauges

The resistive strain gauge is the most common variety. It is composed of a serpentine of metal film on a thin piece of plastic. This arrangement is highly sensitive to strain in the longitudinal direction, but relatively insensitive to strain in the perpendicular direction. The resistive strain gauge, when bonded to the material under test, changes resistance as the test material undergoes deformation.

Strain Measurement

Gauge Factor

The degree of change (resistance to strain) is expressed as the sensitivity of the gauge (or "gauge factor"). It is the calibration constant for the strain gauge. The gauge factor, K, varies with the material used in the gauge, the temperature, and the stress. K is defined as:

$$K=(\Delta R/R) / (\Delta L/L)$$

Substituting ϵ for $\Delta L/L$, the general equation for a resistive strain gauge becomes:

$$\epsilon = \Delta R/R * (1/K)$$

Typical gauge factor values range from 2.0 to 4.0.

Micro Strain

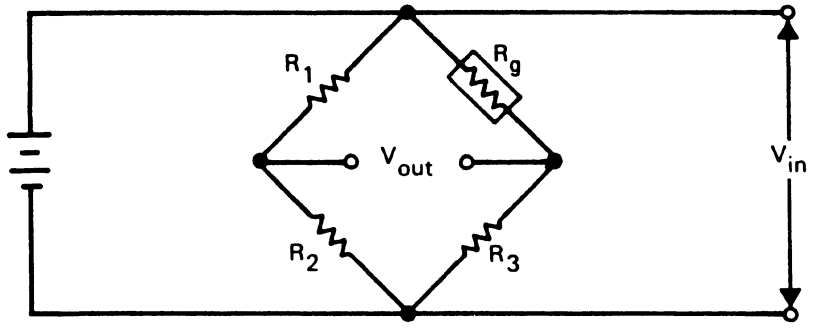
Strain is typically measured with a resolution of 1.0E-6 (one micro strain). Remember that strain is expressed as a ratio of the change in length divided by the original length. It is a dimensionless measurement.

If a strain gauge has a resistance of 120 ohms and a gauge factor of 2, one micro strain amounts to 0.24 milliohms change in resistance. Resolving 0.2 milliohms out of 120 ohms requires very precise instrumentation.

Measurement Techniques

Special techniques are used to measure the incremental change in resistance caused by strain.

A Wheatstone bridge (Figure 6g-3) offers one method of measuring these small resistance changes. As strain occurs, Vout changes in proportion to the change in gauge resistance. The relationship of this resistance change to Vin is non-linear. However, within the range of interest, a linear equation can very closely approximate accurate results.



Where: Vin is the input voltage to the bridge
Rg is the resistance of strain gauge
R1, R2, R3 are bridge completion resistor
Vout is the bridge output voltage

Figure 6g-3. Wheatstone Bridge

Strain Measurement

A 1/4 bridge configuration exists when one arm of the bridge is active (Rg) and the other arms are either fixed value resistors or unstrained gauges. Vout is a function of Vin, R1, R2, R3, and Rg as seen in the following equation:

$$V_{out} = V_{in} * (R3/(R3 + R_g) - R2/(R1 + R2))$$

When R1/R2 = Rg/R3, the bridge is balanced and Vout becomes zero. Referring back to the gauge factor equation, it can be seen that the quantity to be measured is the fractional change in gauge resistance from unstrained to strained).

In a manual strain measurement system, the bridge circuitry is usually modified by the addition of a balancing resistor. Stresses induced in the strain gauge when it is bonded to the tested material are nulled (balanced) out by the balancing resistor when the gauge is in its unstrained condition. While this method is often satisfactory for single-point measurements, the number of manual adjustments for balanced bridge methods becomes cumbersome in multichannel systems.

A two-measurement system solves the manual-adjustment problem. The first (initial) measurement is made after the strain gauge has been mounted, but before it has been subjected to strain. Subsequent measurements are then subtracted from the initial measurement.

Anatomy of a Measurement

The equation for Vout can be rewritten as the ratio Vout to Vin:

$$V_{out}/V_{in} = (R3/(R3 + R_g) - R2/(R1 + R2))$$

This equation is relevant for both unstrained and strained gauge conditions. With the unstrained value of gauge resistance defined as Rg and the change due to strain defined as , the strained value of gauge resistance is Rg + . The effective value of resistance in each bridge arm is the sum of all resistances in that arm. Lead wires, printed circuit board traces, and interconnects may all contribute to this effective resistance. As long as these resistances remain constant between the strained and unstrained readings (and are relatively small compared to the gauge resistance), the measurement is not affected. Later, we will introduce a term to compensate for these resistances.

The difference between the Vout/Vin ratio in the unstrained state and in the strained state requires a new term, Vr.

$$V_r = (V_{out}/V_{in})_{strained} - (V_{out}/V_{in})_{unstrained}$$

By substituting the resistor values that correspond to the two Vout/Vin terms into this equation, an equation for can be derived.

$$\Delta R_g/R_g = -4V_r/(1 + 2V_r)$$

When combined with the equation for gauge factor (K), strain can be defined in terms of Vr and K. This equation describes the ideal behavior of a strain gauge over a wide range of conditions:

$$\varepsilon = -4V_r/K(1 + 2V_r)$$

This equation can be modified as follows to compensate for conditions where there are significant lead wire and termination resistances.

$$\varepsilon = -4V_r/K(1 + 2V_r) * (1 + R_L/R_g)$$

where: Rl = total of all lead resistances
Rg = gauge resistance

In practice, factors such as gauge hysteresis and "creep" limit restrict the useful range of most resistive strain gauges. In such cases, the Vr term in the denominator is very small and can be ignored. The 1/4 bridge equation can thereby be simplified to:

$$\varepsilon = -4V_r/K * (1 + R_L/R_g)$$

REQUIRED HARDWARE

Applications involving strain measurement require the following option assemblies:

-164	Transducer Excitation Module
-174	Transducer Excitation Connector
-161	High Performance A/D Converter
-162	Thermocouple/DC Volts Scanner
-176	Voltage Input Connector

These assemblies are documented in Section 3B. They can be categorized within two logical functions: excitation and measurement.

Excitation Hardware

The Transducer Excitation Module (-164) is used to energize resistive strain gauges with an excitation voltage. It is used in conjunction with the Transducer Excitation Connector (-174). Together, each 164/174 set provides 20 channels of output.

Measurement Hardware

The High Performance A/D Converter (-161) provides high accuracy analog to digital conversion of scanner input voltages. At least one A/D Converter must be installed in the Computer Front End.

The Thermocouple/DC Volts Scanner (-162) is a plug-in, 20-channel thermocouple and multi-voltage range relay scanner contained on a single pwb. The scanner operates as a self-calibrating analog data multiplexer, linking the A/D Converter to external measurement points. It accepts a variety of analog inputs, depending on the type of connector in use.

The Voltage Input Connector (-176) or Isothermal Input Connector (-175) routes a maximum of 20 direct voltage input channels to the Thermocouple/DC Volts Scanner. The AC Voltage Input Connector (-160) can also be used to route 10 direct voltage input channels.

Installation Summary

A constant voltage power supply (the Transducer Excitation Module) furnishes Vin. The Thermocouple/DC Volts Scanner is used to measure Vout. The voltage output of the unbalanced gauge is measured before and after the strain is applied: the Computer Front End performs the required calculations.

Installation is covered in Section 3B for each option assembly being used. Briefly, these steps include:

Strain Measurement

- Addressing

  The addresses for strain measurement channels are determined by the measurement hardware. Therefore, both the position of the Thermocouple/DC Volts Scanner (-162) relative to the A/D Converter (-161) and the address switch settings on that A/D Converter set the address.

- Voltage Excitation Jumper

  Each group of four channels must be configured for voltage output by correctly positioning the respective jumper on the Transducer Excitation Connector (-174). Refer to the connector decal for details.

- Physical Installation

  The Transducer Excitation Module/Connector (-164/-174) and the Thermocouple/DC Volts Scanner/connector (-162/-175,-176, or -160) should be installed one-above-the-other to facilitate interconnections. Overall installation considerations are discussed in Section 3B.

- External Connections

  Strain measurements are performed with the system connections shown in the following wiring diagrams (Figures 6g-4 through 6g-6).

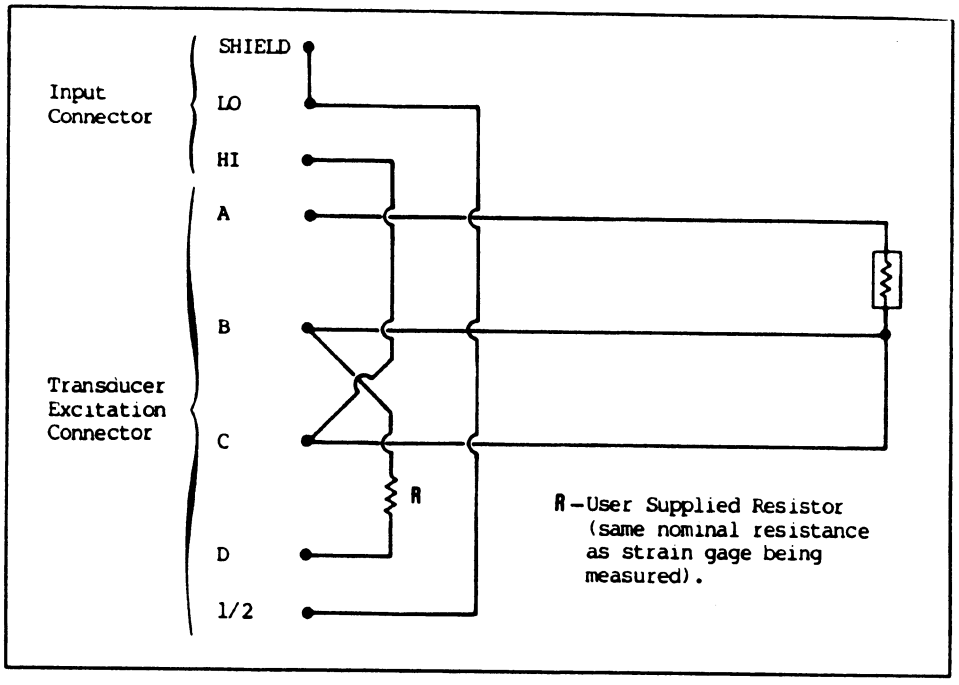


Figure 6g-4. Quarter Bridge Connections

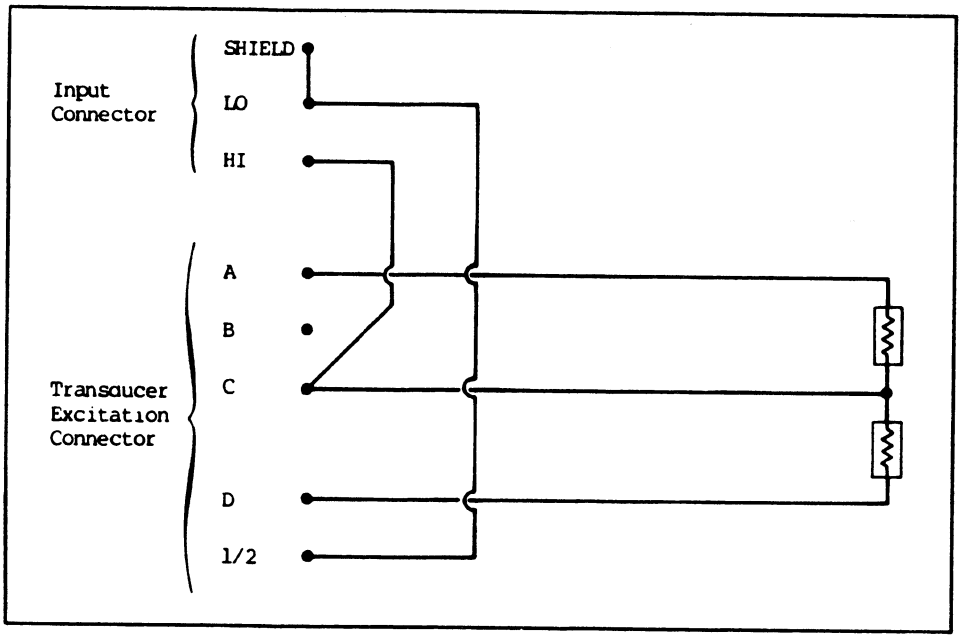


Figure 6g-5. Half Bridge Connections

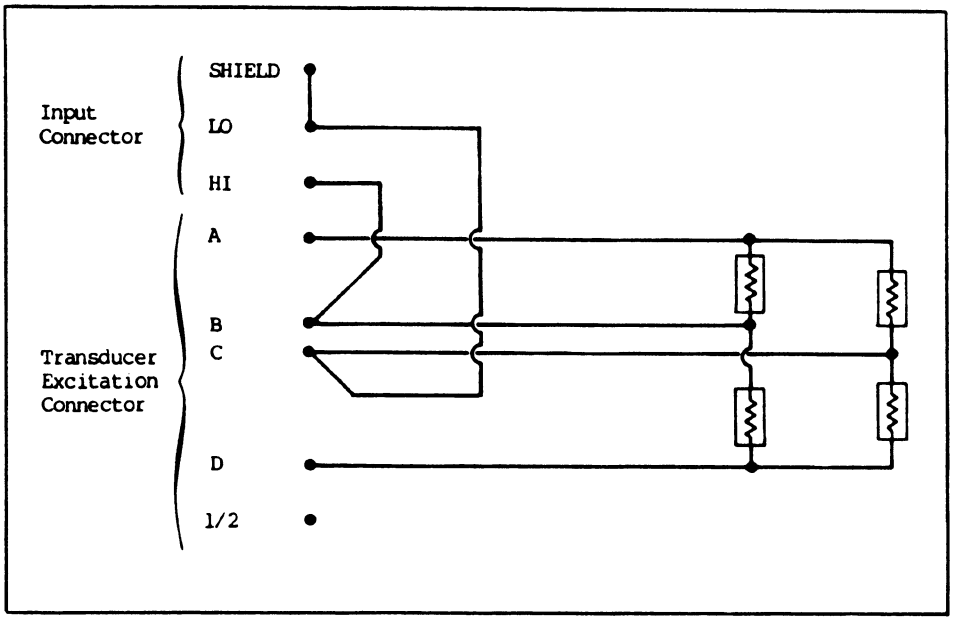


Figure 6g-6. Full Bridge Connections

USING THE COMMANDS

General

Channel definitions for strain measurement can be more involved than those used for other types of measurement. There are six parameters to define (STRAIN, TYPE, K, NU, VINIT, VEXC, RANGE). The STRAIN type must be defined, but settings for each of the remaining five parameters are necessary only if values other than the defaults are required. Table 6g-1 describes these five parameters.

Table 6g-1. Strain Parameters

Parameter	Description	Default
K	Gauge Factor	2.0
NU	Poisson ratio	0.2
VINIT	Initial voltage measured	0.0
VEXC	Excitation voltage	4.0
RANGE	Measurement range	LO

If no default values are used, the definition statement must be entered in the following format:

DEF CHAN(channels) = STRAIN, TYPE = (0,1,2,3,4, or 5), K = (number), NU = (number), VINIT = (number), VEXC = (number), RANGE = HI

If the default values for K, NU, VINIT, VEXC, and RANGE are correct, the following syntax is adequate:

DEF CHAN(channels) = STRAIN, TYPE = (0,1,2,3,4, or 5)

And any combination of parameters between these two extremes is possible.

Strain Initialization

The first step in any strain measurement involves a direct voltage reading of the unstrained configuration. This establishes the value of VINIT, one of the parameters mentioned above. For this measurement, make a separate direct voltage definition for the channel in question. Since the unstrained voltage is a small value, specify the most sensitive range. Use the following command line:

```
DEF CHAN(channel) = DVIN, MAX = .06
```

Now, monitor the unstrained reading with SEND CHAN(channel). Then, specify any response other than 0 (the Vinit default) in the strain definition (VINIT = (response)).

Bridge Configuration TYPE

The six bridge configurations available for strain measurement are summarized in Table 6g-2 and illustrated in Figures 6g-7 through 6g-12.

NOTE

The following symbols are used in Figures 6g-7 through 6g-12:

	measured micro strain
V_{meas}	measured gauge voltage (mV)
V_{init}	measured gauge voltage in unstrained condition (mV)
υ	Poisson's ratio
V_{ex}	excitation voltage
K	gauge factor

Table 6g-2. Strain Bridge Configurations

TYPE	Description
0	Quarter Bridge (Figure 6g-7) The quarter bridge configuration can be used where there is a single active strain gauge.
1	Half Bridge with Equal and Opposite Strains (Figure 6g-8) This half bridge arrangement involves two active strain gauges, both with equal and opposite strains.
2	Half Bridge with One Principle and One Poisson Strain (Figure 6g-9) This half bridge arrangement involves two active strain gauges, one aligned with maximum principle strain, one aligned with Poisson strain.
3	Full Bridge with Two Pairs of Equal and Opposite Strains (Figure 6g-10) The full bridge configuration allows for four active strain gauges with pairs subjected to equal and opposite strains.
4	Full Bridge with Two Principle Strains and Two Poisson Strains (Figure 6g-11) This configuration allows for four active gauges, two aligned with maximum principle strain, two aligned with Poisson strain.
5	Full Bridge with Two Principle Strains and Two Poisson Strains (Figure 6g-12) This configuration also allows for four active gauges, two aligned with maximum principle strain, two aligned with Poisson strain.

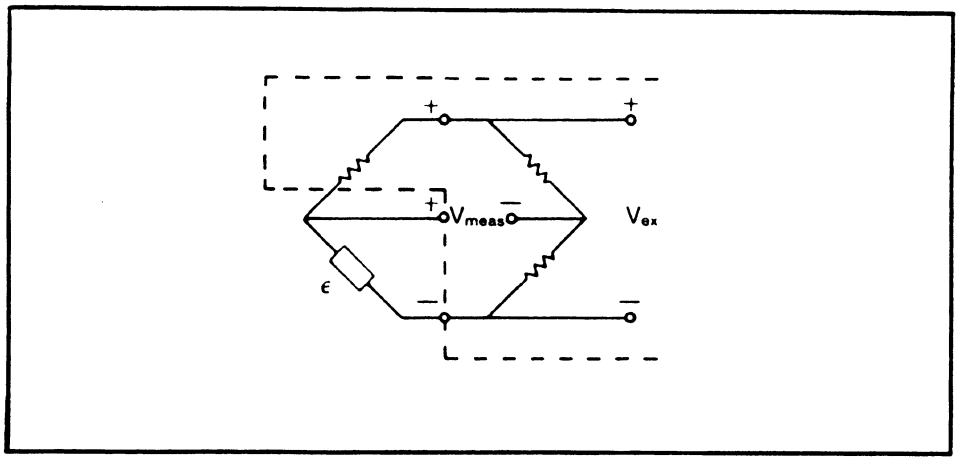


Figure 6g-7. Quarter Bridge Configuration 0

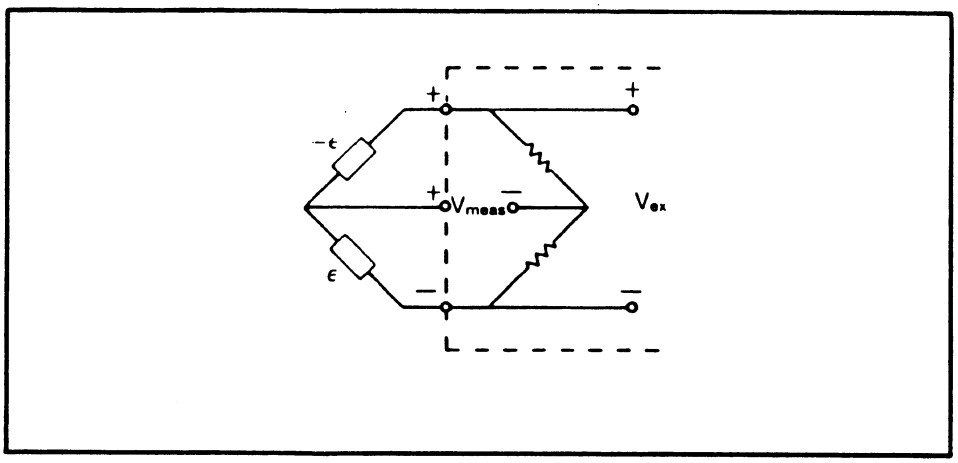


Figure 6g-8. Half Bridge Configuration 1

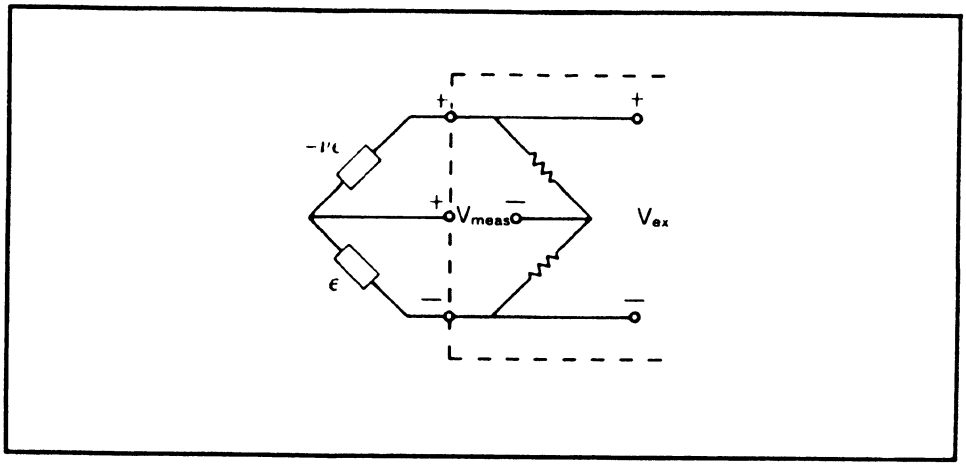


Figure 6g-9. Half Bridge Configuration 2

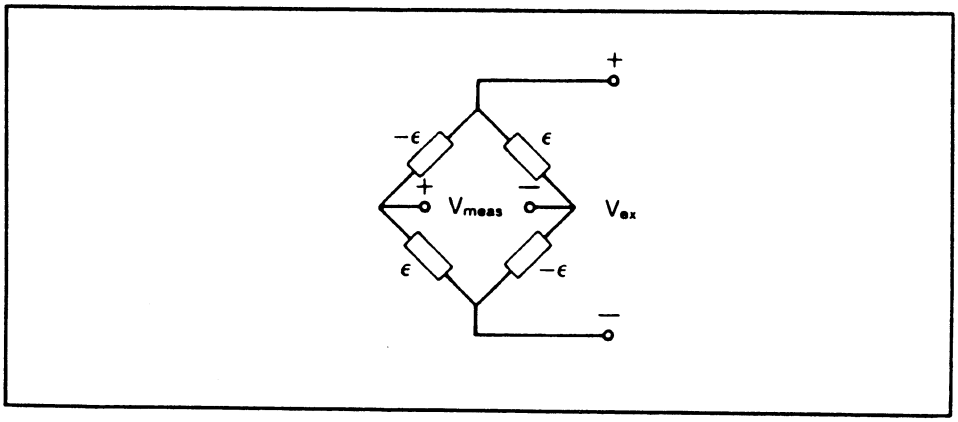


Figure 6g-10. Full Bridge Configuration 3

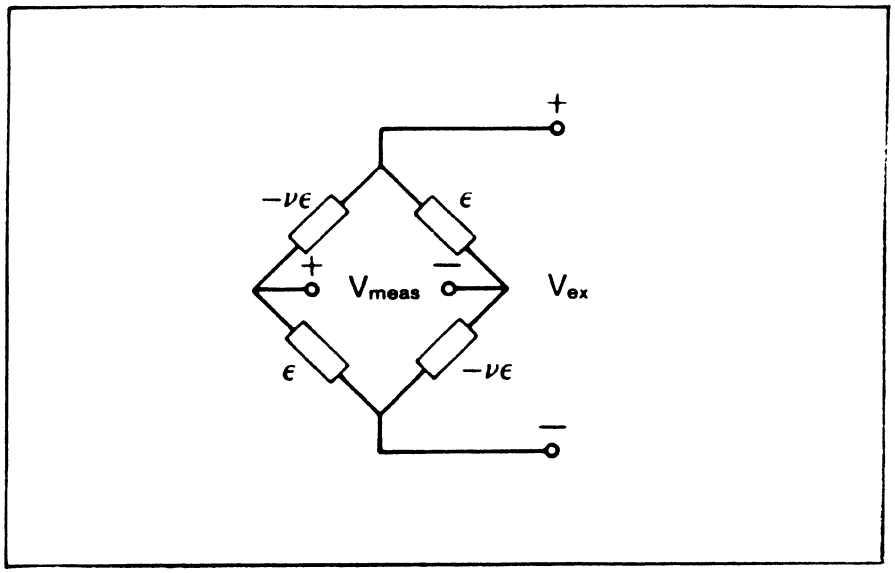


Figure 6g-11. Full Bridge Configuration 4

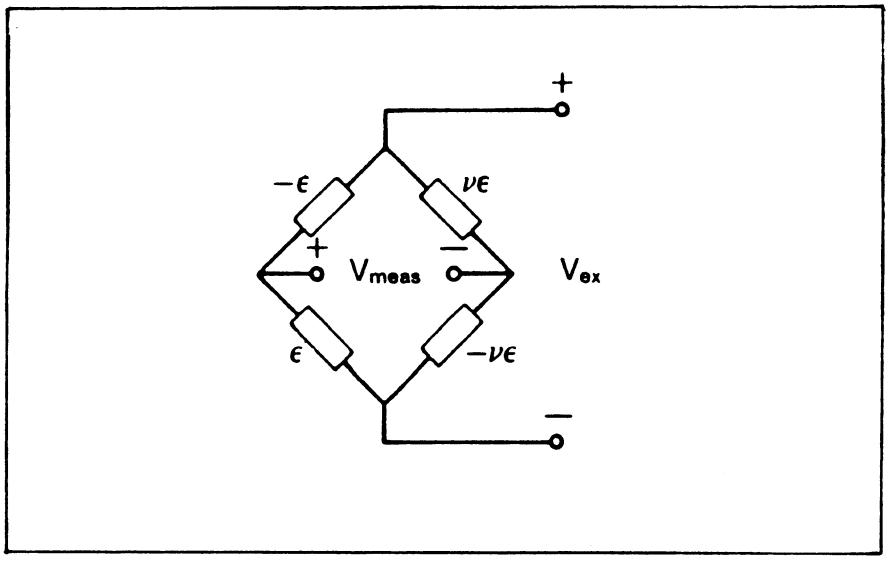


Figure 6g-12. Full Bridge Configuration 5

Command Examples

Let's set up a strain measurement in a half-bridge configuration for channel 0. The first step involves a direct voltage measurement of this channel in the unstrained state.

```
DEF CHAN(0) = DVIN, MAX = .06
```

Now, identify the initialization voltage, VINIT, by monitoring this reading.

```
SEND CHAN(0)
```

Let's assume that the response is 1.00000E-4, or 0.0001 volts. Since this differs from the initialization voltage default value (0), VINIT must be specified in the strain definition statement as follows:

```
DEF CHAN(0) = STRAIN, TYPE = 2, VINIT = 0.0001
```

Monitor the strain measurement with:

```
SEND CHAN(0)
```

If other strain parameters differ from the default values, a strain definition might look as involved as this:

```
DEF CHAN(0) = STRAIN, TYPE = 2, K = 2.1, NU =
0.25, VINIT = 0.01, VEXC = 4.5, RANGE = HI
```

PUTTING IT ALL TOGETHER

The following example can be typed in directly from a terminal (TERM mode) or included in a computer program (COMP mode). Refer to Section 4 under "Operating the Front End from a Terminal/Computer" for more detailed information. Also, Appendix 9A provides guidelines for use with specific types of host computers.

```
MODE = TERM
FORMAT = DECIMAL
DEF CHAN(0..19)=STRAIN, TYPE=1, VEXC=2.0, VINIT=0.025
SEND CHAN(0)
```

This example assumes that the High Performance A/D Converter (-161) address is set to 0 and that a half-bridge (Configuration 1) strain circuit is wired to the Transducer Excitation Connector (-174) and channel 0 of the Voltage Input Connector (-176). It commands the Computer Front End to operate in terminal mode, sets system variable FORMAT, and defines analog input channels 0 through 19 for configuration 1 strain measurement.

Additional parameters in the DEF CHAN statement set the excitation voltage (VEXC) and initial voltage measured (VINIT) to non-default values.

The resulting measurement is made on channel 0 with the SEND CHAN command.

If the measured strain is 5000 microstrain, the response would be:

```
5.00000E-03
```

If the response is "9.99999E+37", an error has occurred. Enter the LIST ERROR command to retrieve the associated error message. If necessary, refer to Section 8 for additional error message information.

INTRODUCTION

About This Section

This section explains the use of the Computer Front End and associated option assemblies for obtaining RTD temperature readings. Detailed information regarding the physical installation of the Computer Front End mainframe and related options is provided in Section 3.

RTD Temperature Measurement

This type of temperature measurement employs a resistance-temperature detector (RTD). RTDs, which are usually larger and more expensive than thermocouples, are frequently used where accuracy and repeatability are important because they exhibit greater accuracy and stability.

The resistance of an RTD varies directly with the RTD sensor temperature. Passing a current through this resistance generates a proportional voltage that can be accurately translated into a temperature reading.

Temperature Measurement Using RTDs

Most RTD types have temperature sensing elements that are made of platinum. Several other materials can be used in RTDs, but platinum remains the most popular and accurate type. Each type of RTD requires a unique algorithm for converting the measured resistance into temperature. This capability is provided by the Computer Front End operating software which contains conversion algorithms for platinum and copper RTDs. Conversion algorithms for other platinum RTD types can be implemented using the Computer Front End's user-defined RTD functions.

REQUIRED HARDWARE

RTD temperature measurement applications require either one of two option assembly configurations.

The High Performance A/D Converter, -161, must be used in both configurations to provide high accuracy analog-to-digital conversion of RTD, thermistor, or resistance measurements. At least one A/D Converter must be installed in the Computer Front End or the 2281A Extender Chassis.

Configuration A

The first configuration employs the following two option assemblies:

-163	RTD/Resistance Scanner
-177	RTD/Resistance Input Connector

This configuration provides the most accurate and repeatable RTD readings with the fewest restrictions and lowest cost per channel. Each RTD/Resistance Scanner/Connector set provides current pair excitation and signal multiplexing for 20 RTD, thermistor, and/or resistance channels. These two assemblies are intended for use in applications more exclusively involving RTD, thermistor, and resistance measurements.

The RTD/Resistance Scanner configuration also provides lead-wire compensation for performing accurate 3-Wire resistance measurements.

Installation is covered in Section 3B for each option assembly being used. Briefly, these steps include:

- Select the Measurement Mode

  Set jumpers W1 and W2 on the RTD/Resistance Scanner for the desired measurement mode.

- Addressing

  Addresses are determined by the both the position of the RTD/Resistance Scanner (-163) relative to the A/D Converter (-161) and the address switch settings on that A/D Converter.

- Physical Installation

  The RTD/Resistance Input Connector attaches to the RTD/Resistance Scanner.

- External Connections

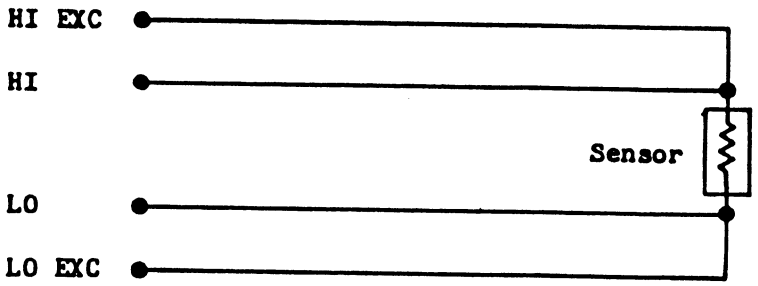
  4-Wire (4W) Measurement Mode
  Two sense and two excitation wires must be connected to each channel. Lead-wire or reed switch resistances do not affect readings. See Figure 6h-1.

Temperature Measurement Using RTDs

3-Wire Accurate (3WA) Measurement Mode
One sense and two excitation wires must be connected to each channel. Equal lead-wire resistances are compensated for. Reed switch resistances do not affect readings. Ten channel returns are internally connected together; therefore, the RTDs must be electrically isolated. See Figure 6h-2.

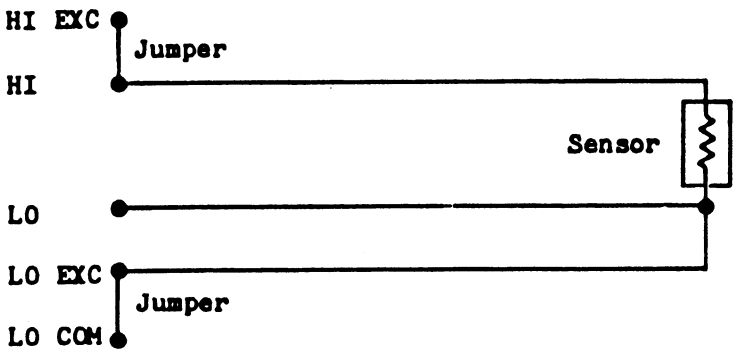
3-Wire Isolated (3WCM) Measurement Mode
One sense and two excitation wires must be connected to each channel. Equal lead-wire resistances are compensated for. One reed switch resistance error affects readings. See Figure 6h-3.

Where lead-wire errors are negligible, 2-Wire measurements can be made by setting the scanner to operate in 4-Wire mode, and wiring the -177 input connector properly.



This is the most accurate measurement mode.

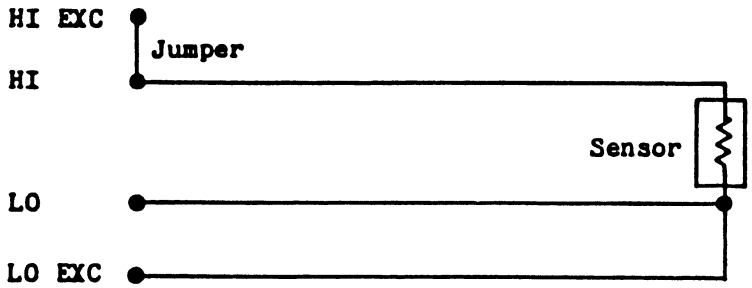
Figure 6h-1. Wiring: 4-Wire, Configuration A



Ensure that the HI and LO EXC lead wires have the same length, composition, and resistance.

Use this 3-Wire configuration if at all possible. Note that the LO COM's of ten channels, (e.g., 0 to 9) are connected together inside the connector pwb.

Figure 6h-2. Wiring: 3-Wire Accurate, Configuration A



Ensure that the HI and LO EXC lead wires have the same length, composition, and resistance.

This is much less accurate than the 3WA mode for all but large (high-kilohm) resistance measurements.

Figure 6h-3. Wiring: 3-Wire Isolated, Configuration A

Configuration B

The second configuration supports a wider mix of applications, providing both current and voltage excitation that will support the measurement of 4-Wire RTDs and transducers in bridge arrangements. For example, both strain gauges and 4-Wire RTDs can be measured with the following set of option assemblies:

-162	Thermocouple/DC Volts Scanner
-176	Voltage Input Connector (or other direct voltage measuring connector)
-164	Transducer Excitation Module
-174	Transducer Excitation Connector

The -162 Thermocouple/DC Volts Scanner is a 20 channel, thermocouple and voltage, signal multiplexing and conditioning scanner. This scanner allows the A/D Converter to make external direct voltage measurements on four ranges. Connections to external inputs are made through a Voltage Input, Isothermal Input, or AC Voltage Input (which also supports ten direct voltage channels) Connector. The scanner and connector measure the voltages generated across the RTDs in this configuration.

The Transducer Excitation Module, -164, is used to energize the RTDs with an excitation current or the bridge configurations with a voltage. The -174 Transducer Excitation Connector provides connections for accessing the five current sources for exciting up to 4 channels per source, or the one voltage source, for exciting the resistances to be measured.

Temperature Measurement Using RTDs

Installation is covered in Section 3B for each option assembly being used. Briefly, these steps include:

- Addressing

  The addresses for RTD measurement channels are determined by the measurement hardware. Therefore, both the position of the Thermocouple/DC Volts Scanner (-162) relative to the A/D Converter (-161) and the address switch settings on that A/D Converter set the address.

- Voltage/Current Excitation Jumper

  Each group of four channels must be configured for voltage or current output by correctly positioning the respective jumper on the Transducer Excitation Connector (-174). Refer to the connector decal for details.

- Physical Installation

  The Transducer Excitation Module/Connector (-164/-174) and the Thermocouple/DC Volts Scanner/connector (-162/-175,-176, or -160) should be installed one-above-the-other to facilitate interconnections. Overall installation considerations are discussed in Section 3B.

- External Connections

  Configuration B RTD measurements are performed with the system connections shown in the in Figures 6h-4 through 6h-6.

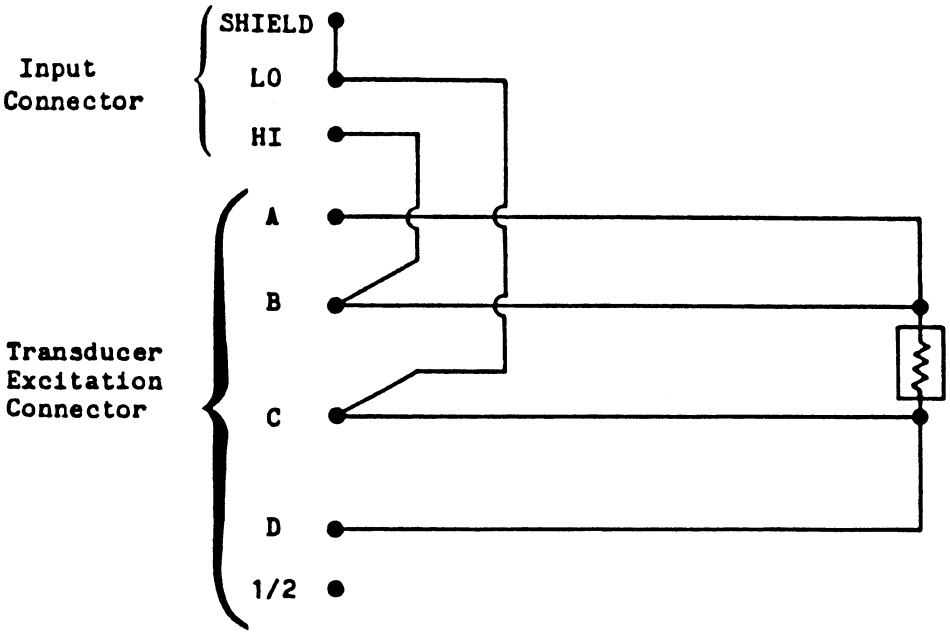


Figure 6h-4. Wiring: 4-Wire, Configuration B

Temperature Measurement Using RTDs

The 4-wire method in Figure 6h-5 uses the +4V, constant voltage supply present on the Transducer Excitation Module. A bridge configuration, with the RTD as the unbalancing factor, is created.

- For 100 ohm Pt RTDs, suggested resistors would be 40 kilohms ±0.1% with 5ppm temperature coefficient wire-wound resistors. For other resistors, the resistance value should be sufficiently high so that the initial unbalancing effect of the RTD in one of the legs is relatively small. For example, with 40 kilohm resistors, there is 1 part in 400 difference between the two legs.

- For 10 ohm Cu RTDs, 4 kilohm resistors should be used to establish the unbalanced bridge.

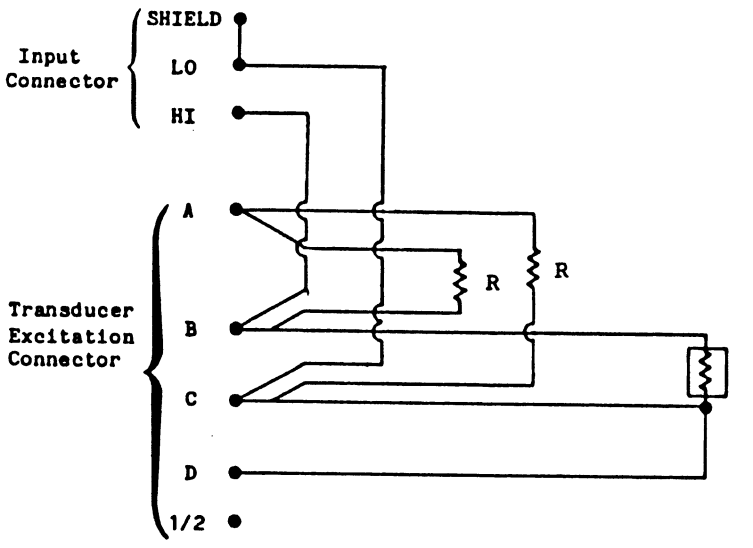
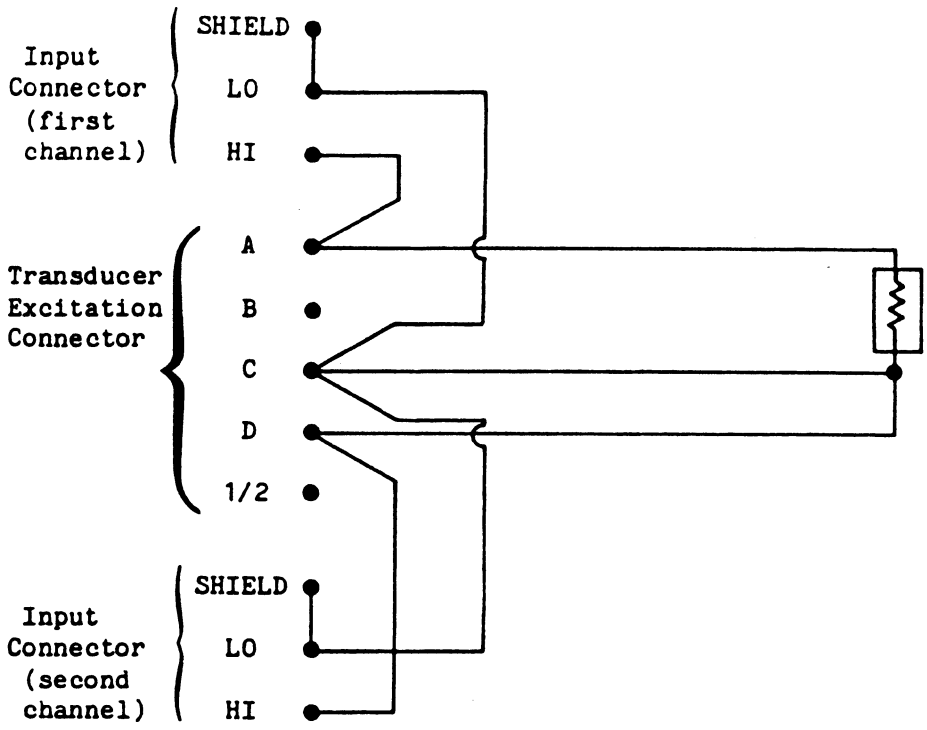


Figure 6h-5. Wiring: 3-Wire, Constant Voltage, Configuration B



This method uses the constant current supply in the Transducer Excitation Module. Two voltage measurement channels are employed to remove the effects of lead resistance. One channel measures both the lead resistance and the RTD, and another input channel is used to measure only the lead resistance. The difference between the two channels represents the resistance of the RTD. This difference is then linearized.

Figure 6h-6. Wiring: 3-Wire, Constant Current, Configuration B

USING THE COMMANDS

General

The channel definition (DEF CHAN) statement establishes the TYPE of RTD being measured on a channel or group of channels. TYPE can be set to DIN385 (100 ohms platinum), CU10 (10 ohms copper), or USER (user defined).

DEF CHAN(channels) = RTD, TYPE = [DIN385, CU10, or USER]

- For DIN385 and CU10, The Front End performs calculations automatically, and no further parameters need be set.

- For USER, constants R0, ALPHA, DELTA, and C4 can be set. Default values are used for any constants not so specified. The default constants are:

  R0 = 100.00
  Alpha = 385.0E-3
  Delta = 1.45
  C4 = 1.19619E-13

  Once set, user-defined constants persist through re-definition of the original channel. Only a re-definition of the constant or use of the RESET command changes a user-defined constant.

HI range (maximum 600 ^{o}C) or LO range (maximum 425^{o}C) can be specified. HI is useful with 100-ohm platinum RTDs, but yields less measurement resolution. If HI is used, the channel definition would look like:

DEF CHAN(channels) = RTD, TYPE = [DIN385, CU10, or USER], RANGE = HI.

The SEND CHAN command can be used to obtain an RTD reading. Measurements are returned in units set by the TUNIT system variable (Celsius, Fahrenheit, Kelvin, or Rankine).

SEND CHAN(channels)

Command Examples

Let's define a group of 20 channels for measurements using a 100-ohm platinum RTD. Anticipated temperatures approach 600°C.

DEF CHAN(0..19) = RTD, TYPE = DIN385, RANGE = HI

Next, define another group of 20 channels for user-defined RTD measurements. The ALPHA constant differs from the default ALPHA value.

DEF CHAN(20..39) = RTD, TYPE = USER, ALPHA = 3.92E-3,

Note that the four RTD constants remain at their system default values until specifically changed in the channel definition statement. In this example, Alpha is changed, but R0, DELTA, and C4 remain at respective default settings of 100.0, 1.45, and 1.19619E-13.

Now, monitor measurements for all 40 channels:

SEND CHAN(0..39)

If necessary, check the TUNIT setting with:

SEND TUNIT

PUTTING IT ALL TOGETHER

The following example can be typed in directly from a terminal (TERM mode) or included in a computer program (COMP mode). Refer to Section 4 under "Operating the Front End from a Terminal/Computer" for more detailed information. Also, Appendix 9A provides guidelines for use with specific types of host computers.

```
MODE = TERM
FORMAT = DECIMAL
TUNIT = CELSIUS
DEF CHAN(0..19) = RTD, TYPE = DIN385
SEND CHAN(0)
```

This example assumes that the High Performance A/D Converter (-161) address is set to 0, that the jumpers on the RTD/Resistance Scanner (-163) are positioned to 4-Wire mode, and that a variable resistor (substituting for an RTD) is connected to channel 0 on the RTD/Resistance Input Connector (-177).

The example commands the Computer Front End to operate in terminal mode, sets system variables FORMAT and TUNIT, and defines channels 0 through 19 for DIN 385 RTD measurements. The resulting measurement is made on channel 0 with the SEND CHAN command.

If the variable resistor is set to 100 ohms (representing 0°C), the SEND CHAN(0) command yields:

0.00000E+00

With the resistor set to 212 ohms (representing 300°C), SEND CHAN(0) yields:

3.00000E+02

If the response is "9.99999E+37", an error has occurred. Enter the LIST ERROR command to retrieve the associated error message. If necessary, refer to Section 8 for additional error message information.

INTRODUCTION

About this Section

Thermistors are a commonly-used type of variable resistance transducer. The resistance of thermistors varies greatly with temperature, thereby providing a means of making reliable temperature measurements over a range of -100 to +300°C.

This subsection explains the use of the Computer Front End and associated option assemblies for obtaining thermistor temperature readings. Additional information can be found in:

- Section 3: Installation of the Computer Front End mainframe and option assemblies (-161, -163, -177).
- Section 6E: Resistance Measurements (Configuration A only) describes techniques employed for Thermistor Temperature Measurement.

Temperature Measurements Using Thermistors

Thermistor Temperature Measurements

Thermistors that are to be measured in bridge configurations, while not specifically covered in this subsection, can be implemented using techniques presented here and in the resistance measurements subsection.

Thermistors exhibit a large temperature coefficient of resistance when compared to other resistance temperature sensors. A large decrease in resistance usually results from a small increase in thermistor temperature, providing a measurement resolution not available with other temperature transducers.

A thermistor's resistance is often determined by passing a known current through it and measuring the resulting voltage drop, as is done by the Computer Front End. The Front End converts this resistance measurement into a temperature reading.

REQUIRED HARDWARE

Thermistor temperature measurement applications require the following option assemblies:

-161	High Performance A/D Converter
-163	RTD/Resistance Scanner
-177	RTD/Resistance Input Connector

Each RTD/Resistance Scanner/Connector selects, excites, and conditions 20 channels. In addition to supporting 4-Wire measurements, this configuration provides lead-wire compensation for performing accurate 3-Wire resistance measurements.

Installation is covered in Section 3B for each option assembly being used. Briefly, these steps include:

- Select the Measurement Mode

  Set jumpers W1 and W2 on the RTD/Resistance Scanner for the desired measurement mode.

- Addressing

  Addresses are determined by the both the position of the RTD/Resistance Scanner (-163) relative to the A/D Converter (-161) and the address switch settings on that A/D Converter.

- Physical Installation

  The RTD/Resistance Input Connector attaches to the RTD/Resistance Scanner.

- External Connections

  4-Wire (4W) Measurement Mode
  Two sense and two excitation wires must be connected to each channel. Lead-wire or reed switch resistances do not affect readings.

  3-Wire Accurate (3WA) Measurement Mode
  One sense and two excitation wires must be connected to each channel. Equal lead-wire resistances are compensated for. Reed switch resistances do not affect readings. Ten channel returns are internally connected together.

  3-Wire Isolated (3WCM) Measurement Mode
  One sense and two excitation wires must be connected to each channel. Equal lead-wire resistances are compensated for. One reed switch resistance error affects readings.

Temperature Measurements Using Thermistors

Where lead-wire resistances are very small in comparison with the resistance being measured, as may be true with high resistance thermistors, 2-Wire measurements can be made by setting the scanner to operate in 4-Wire mode, and wiring the -177 input connector properly.

Refer to the -177 option in Section 3 for input wiring diagrams and instructions.

USING THE COMMANDS

General

Thermistor temperature is measured as a resistance that is converted into meaningful temperature units by either:

- The host computer

  A mathematical equation can used in the computer program when a conversion formula is provided by the thermistor manufacturer.

- The Computer Front End

  The Computer Front End interpolation table capabilities can be employed when a table of temperature versus resistance is available.

Use a channel definition to specify thermistor measurement on a channel or group of channels. Since thermistors vary greatly in resistance, the scanner ranges to be used must be chosen to match. Three ranges are provided:

256 ohms
2048 ohms
64 kilohms

Refer to the temperature versus resistance table for the thermistor to be used, and examine the overall possible resistance range for that thermistor as well as the anticipated temperature range of the environment to be measured. Considering both of these variables, set an appropriate MAX parameter value. MAX represents the maximum anticipated value. Its value causes automatic selection of the lowest possible of the three ranges.

```
DEF CHAN(10..12) = RESIST, MAX = 300
```

When known, a conversion formula for the thermistor type can be entered as part of the computer program. When a formula is not known, the following interpolation table approach must be used.

An interpolation table can be used to convert resistance measurements into temperature readings. The table comprises a set of data points that describe the non-linear resistance versus temperature behavior of the thermistor being used.

A maximum of 100 interpolation tables can be defined by the user. Contents for each table are entered as pairs of numbers. Each pair comprises an input value (entered in ascending order), followed by an output value (order determined by related input). Although a minimum of two pairs must be entered, the maximum number is limited only by available memory.

A sampled input falling between two table input values results in an linearly interpolated output. An input falling outside table input values results in a linearly extrapolated output.

The DEF TABLE command is used for entering interpolation table values. The form (input),(output)/(input),(output)/... is used. Start each new line for the same table with "DEF TABLE(n) = /(input),(output)/..."

Temperature Measurements Using Thermistors

For thermistors, input is defined as the resistance of the thermistor in resistance range units (e.g., kilohms on the 64 kilohm range). Output is in temperature units. For example, a resistance of 10.25 kilohms (measured on 64 kilohm range) that corresponds to a 25°C temperature reading requires that one table entry be 10.25,25.

Interpolation tables are fully described in Section 5.

Command Examples

A thermistor temperature measurement definition always requires specifying items (1) and (2) below, and may require items (3) and (4).

1. The channel, or group of channels, performing the measurement. E.g., DEF CHAN(0..9)

2. The type of measurement (=RESIST)

3. If necessary, specify the range. Use the MAX parameter. If no MAX parameter is used, the default range (64 kilohms) is used. Use MAX = 200 (specifying the 256 ohm range).

4. If an interpolation table is used, call that table. CHFN=TABLE(0)

If used, an interpolation table must be defined prior to making the channel definition. Enter the thermistor's resistance versus temperature characteristics into the specified interpolation table. Each table entry represents an input resistance figure (in ohms) and a corresponding output temperature figure (in any temperature unit desired). Note that the input figures must be entered in ascending order. To avoid confusion, it is probably best to specify the output temperature in the same units as established for the system (Celsius, Fahrenheit, Rankine, or Kelvin).

Now, let's define an interpolation table, using eleven resistance input to temperature output correlations:

```
DEF TABLE(0) = /132.26,105 /136.09,104 /140.07,103
DEF TABLE(0) = /144.20,102 /148.41,101 /152.75,100
DEF TABLE(0) = /157.35,99 /161.99,98 /166.87,97
DEF TABLE(0) = /171.89,96 /177.16,95
```

Now, we can make the full channel definition:

```
DEF CHAN(0..9) = RESIST, MAX = 200, CHFN = TABLE(0)
```

To measure these channels, use:

```
SEND CHAN(0..9)
```

PUTTING IT ALL TOGETHER

The following example can be typed in directly from a terminal (TERM mode) or included in a computer program (COMP mode). Refer to Section 4 under "Operating the Front End from a Terminal/Computer" for more detailed information. Also, Appendix 9A provides guidelines for use with specific types of host computers.

```
MODE = TERM
FORMAT = DECIMAL
TUNIT = CELSIUS
DEF TABLE(1)=200,40/300,37/500,30/800,20/1000,15
DEF CHAN(0..19)=RESIST,MAX=2000,CHFN=TABLE(1)
SEND CHAN(0)
```

This example assumes that the High Performance A/D Converter (-161) address is set to 0, that the jumpers on the RTD/Resistance Scanner (-163) are positioned to 4-Wire mode, and that a variable resistor (substituting for a thermistor) is connected to channel 0 on the RTD/Resistance Input Connector (-177).

Temperature Measurements Using Thermistors

The example commands the Computer Front End to operate in terminal mode and sets system variables FORMAT and TUNIT. The DEF TABLE command creates a table for the conversion of measured inputs to returned readings. The DEF CHAN command defines channels 0 through 19 for resistance measurement on the 2048 ohm range and assigns table 1 to linearize the measured input. The resulting measurement and conversion is accomplished with the SEND CHAN command.

If the variable resistor is set to 1000 ohms, the SEND CHAN(0) command should yield a reading of:

1.500000E+01

If the variable resistor is set to 200 ohms, the SEND CHAN(0) command should return a reading of:

4.00000E+01

If the response is "9.99999E+37", an error has occurred. Enter the LIST ERROR command to retrieve the associated error message. If necessary, refer to Section 8 for additional error message information.

INTRODUCTION

About This Section

This section explains use of the Computer Front End and associated option assemblies for obtaining thermocouple temperature readings. Detailed information about the physical installation of the Computer Front End mainframe and related options is provided in Section 3.

Thermocouple Temperature Measurement

Thermocouple temperature measurement is frequently used. Thermocouples are relatively rugged and can measure a wide range of temperatures.

This application can use linearizations for any of the following 11 standard thermocouples: JNBS, KNBS, RNBS, SNBS, TNBS, BNBS, CHOS, ENBS, NNBS, JDIN, TDIN.

Thermocouple measurements involve an input from a thermocouple-type temperature sensor. This input is converted to degrees Fahrenheit, Celsius, Kelvin, or Rankine (depending on the TUNIT system variable).

THERMOCOUPLE TEMPERATURE MEASUREMENTS

Thermocouples are very useful temperature measurement sensors. Various types are available for temperatures from cryogenic to above the melting point of steel.

A thermocouple is made of two dissimilar metal conductors. The thermocouple loops shown in Figure 6j-1 are each made up of two such conductors (A and B). Loop (a) shows a thermocouple loop in its simplest form. Conductors A and B are joined twice, creating a thermocouple. The current flow in this loop is related to the temperature difference between reference temperature TR and measurement temperature TM. Measuring this current presents a problem: any connection between a measurement circuit (usually made of copper) and the thermocouple loop would form additional thermocouples.

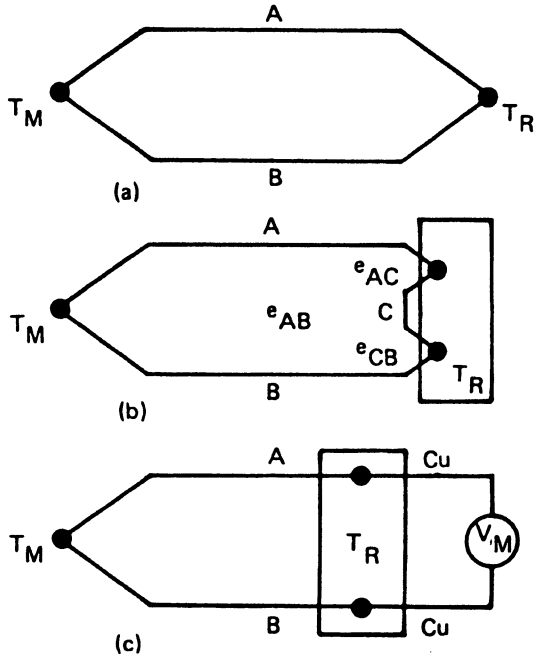


Figure 6j-1. Thermocouple

Loop (b) shows a circuit with connections to an additional material (C). As long as junctions C-A and C-B remain at the same temperature, no additional thermocouples are created. Electrical connections can thereby be made to measure the thermal emf. This is shown in loop (c). The Computer Front End reads a voltage (VM) related to the difference between TM and TR; temperatures and gradients in the copper (C) have no effect. If TR and the emf per degree are known, TM can be determined. The measurement function is nonlinear and unique for each combination of metals used in thermocouple construction.

The Computer Front End automatically performs the thermocouple measurement process. This process includes the following steps:

- Two measurements (VM and TR) are taken.
- Since the thermocouple is usually terminated at a temperature different from zero degrees C, the measured voltage (VM) is compensated using the reference temperature (TR) measurement.
- This compensated voltage is converted to temperature using the voltage/temperature characteristics for the type of thermocouple.

The Computer Front End satisfies these requirements in one of two ways. First, if the thermocouple is terminated at the Isothermal Input Connector (-175), compensation and linearization are performed automatically. Second, if the thermocouple is externally terminated, the external reference junction temperature can be defined to achieve the same result.

For either method, the returned reading can be specified in temperature or compensated millivolts. For compensated millivolts, the built-in thermocouple linearizations are not applied.

Temperature Measurement Using Thermocouples

REQUIRED HARDWARE

Applications involving thermocouple readings require the following option assemblies:

-161	High Performance A/D Converter
-162	Thermocouple/DC Volts Scanner
-175	Isothermal Input Connector

The High Performance A/D Converter (-161) provides high accuracy analog-to-digital conversion of scanner input voltages. At least one A/D Converter must be installed in the Computer Front End or the 2281A Extender Chassis to provide thermocouple input capabilities.

The Isothermal Input Connector contains the necessary hardware to ensure that the thermocouple connections and reference temperature sensor are at the same temperature. The reference temperature sensor portion of the connector is used to measure the temperature of the thermocouple terminations.

The Thermocouple/DC Volts Scanner (-162) is a plug-in, 20-channel thermocouple and multi-voltage range relay scanner. The scanner links the A/D Converter to external measurement points through the connector.

Installation for any of the option assemblies is detailed in Section 3B of this manual. Reference each option assembly by its option number (-161, -162, or -175). Briefly, installation procedures include:

- Addressing

  Addresses are determined by the both the position of the Thermocouple/DC Volts Scanner (-162) relative to the A/D Converter (-161) and the address switch settings on that A/D Converter.

- Physical Installation

  The Isothermal Input Connector mates with the Thermocouple/DC Volts Scanner. This 20 channel, multi-range relay scanner selects the proper input channel for the High Performance A/D Converter.

- Thermocouple Connections

  Each input channel uses three lines (HIGH, LOW, SHIELD) on the input connector. The thermocouple is connected across the HIGH and LOW input lines as follows:

  LOW: the RED wire on the thermocouple is the negative lead and must be attached to the LOW terminal.

  HIGH: the wire color of the positive lead varies with the type of thermocouple. The color appropriate for a given thermocouple is defined in Table 6j-1.

  SHIELD: If the thermocouple has a shield, it must be connected here. If the thermocouple has no shield (two wires only), a jumper must be connected between LOW and SHIELD.

USING THE COMMANDS

Internal Reference Junction Measurements

Usually, the Isothermal Input Connector is used as the reference junction. Each connector supports 20 sets of thermocouple terminals.

Thermocouples terminated at the Isothermal Input Connector use permanently stored temperature compensation and voltage/temperature linearization algorithms.

The Computer Front End only needs to know what type of thermocouple is connected to the channel. The conversion algorithms to support 11 thermocouple types are handled internally. These thermocouples are further described in Table 6j-2.

Use the channel definition statement to define the channels and the thermocouple TYPE. For example, designate channel 100 for automatic compensation and linearization of a "K" type thermocouple.

```
DEF CHAN(100) = TC, TYPE = KNBS
```

To read the channel 100 measurement, enter:

```
SEND CHAN(100)
```

The returned reading is in the system temperature units TUNIT (Celsius, Fahrenheit, Kelvin, or Rankine). To check the TUNIT value in effect:

```
SEND TUNIT
```

To change to a different value:

```
TUNIT = FAHRENHEIT (or other)
```

External Reference Junction Measurements

Sometimes, the Isothermal Input Connector reference junction will not be used. The thermocouples are then attached to the HI and LOW terminal pairs with copper wires from the external reference junction.

Setting up an externally terminated measurement requires an additional definition for the reference junction temperature (RJTEMP) parameter. This must be done in the same units as specified by the system temperature unit (TUNIT). If necessary, use the SEND TUNIT command for verification.

Use the channel definition statement to define channels 40 through 59 for external termination, measuring temperature with T-type thermocouples. The external junction temperature is defined as 23.4 degrees (in system temperature units).

```
DEF CHAN(40..59) = TC, TYPE = TDIN, RJTEMP = 23.4
```

PUTTING IT ALL TOGETHER

The following example can be typed in directly from a terminal (TERM mode) or included in a computer program (COMP mode). Refer to Section 4 under "Operating the Front End from a Terminal/Computer" for more detailed information. Also, Appendix 9A provides guidelines for use with specific types of host computers.

```
MODE = TERM
FORMAT = DECIMAL
TUNIT = FAHRENHEIT
DEF CHAN(0..19) = TC, TYPE = KNBS
SEND CHAN(0)
```

This example assumes that the High Performance A/D Converter (-161) address is set to 0 and that a KNBS type thermocouple is connected to channel 0 on the Isothermal Input Connector. It commands the Computer Front End to operate in terminal mode, sets system variables FORMAT and TUNIT, and defines analog input channels 0 through 19 for KNBS type thermocouple measurement. The resulting measurement is accomplished on channel 0 by the SEND CHAN command and converted into a degrees Fahrenheit reading.

For example, if the measured temperature is 23°C, the returned reading would be:

```
7.34000E+01
```

If the response is "9.99999E+37", an error has occurred. Enter the LIST ERROR command to retrieve the associated error message. If necessary, refer to Section 8 for additional error message information.

Table 6j-1. Thermocouple Lead Wire Color Code

ANSI Designation	Lead Material Positive (+)	Negative (-)	Color of Positive Lead
J	Iron	Constantan	White
K	Chromel	Alumel	Yellow
T	Copper	Constantan	Blue
E	Chromel	Constantan	Purple
R	Platinum	Platinum (13% Rhodium)	Black
S	Platinum	Platinum (10% Rhodium)	Black
C (W5Re/ W26Re)	Tungsten (5% Rhenium)	Tungsten (26% Rhenium)	White
B	Platinum (30% Rhodium)	Platinum (6% Rhodium)	Gray

Table 6j-2. Thermocouple Temperature Ranges and Applications

Select	Type	Parameter	Usable Range (°C)
J	JNBS	NBS J	-200 to 760
	(Can be used in oxidizing, reducing, inert, or vacuum atmospheres.)		
K	KNBS	NBS K	-225 to 1350
	(Should not be used in reducing or sulphurous atmospheres. Can only be used in vacuum for short time until calibration shifts.)		
T	TNBS	NBS T	-230 to 400
	(Can be used in oxidizing, reducing, inert, or vacuum atmospheres.)		
E	ENBS	NBS E	-250 to 838
	(Can be used in oxidizing or inert atmospheres. Should not be used in reducing or vacuum atmospheres.)		
R	RNBS	NBS R	0 to 1767
S	SNBS	NBS S	0 to 1767
B	BNBS	NBS B	200 to 1820
N	NNBS	NISIL-NICROSIL	-250 to 400
C	CNBS	W5Re/W26Re	0 to 2315
V	TDIN	DIN T	-200 to 600
H	JDIN	DIN J	-200 to 900

INTRODUCTION

About this Section

This section explains how to use the Computer Front End for counting events. Detailed information on installing the Computer Front End and its options is found in Section 3.

Totalizing Measurement

To the electronic circuitry in the Computer Front End an event is a transition between one voltage state and another. Event-counting is commonly used on production lines for counting items, and in monitoring the flow of gasses or liquids.

The Computer Front End counts events by detecting the transitions from a high to a low voltage state. The boundary between these states may vary for different types of signals, so the hardware includes adjustments that accomodate different signal levels.

Totalizing Measurement

HARDWARE DESCRIPTION

To count events, the following option is needed:

-167 Counter/Totalizer

Each Counter/Totalizer option supports six event counting channels.

The installation instructions for the Counter/Totalizer are found in Section 3B of this manual. Consult these instructions as necessary.

Hardware Preparation

The Counter/Totalizer adjustments allow for measurement of a variety of signal types. The reference voltage and input deadband adjustments define the high and low voltage thresholds of the input. Debouncers and input pull-ups allow accurate counting of contact closures.

The terminal assignments for the Counter/Totalizer connector are listed on the rear panel. The maximum input voltage is plus or minus 15 volts dc or ac peak.

CAUTION

The six channels on a Counter/Totalizer assembly are isolated from the Computer Front End chassis and from ground but not from each other. The return lines on the input connector are common. All return lines must be connected to the same voltage.

To prepare a Counter/Totalizer for event-counting, refer to Figure 6k-1 and perform the following steps for event-counting channels:

- COUNT Function

  Move the channel function switch to the COUNT position. Notice that the channels are grouped into three pairs: channels 0 and 1, channels 2 and 3, and channels 4 and 5. Both channels in a pair must have the same function.

- Debounced Input

  Set the position of the debounced/direct input switch. For counting contact closures, move the switch to the DEBOUNCED INPUT position. This turns the debouncer on.

  For counting events signaled other than by the closing of a contact, move the switch to the DIRECT INPUT position. This turns the debouncer off. In this configuration, the input signal is fed directly into the counter.

- Floating/Pulled-Up Input

  Note the position of the floating/pulled-up resistor network. For counting contact closures, move the resistor network to the PULLED UP position. In this configuration, each channel input is connected through a pull-up resistor to the positive power supply on the Counter/ Totalizer assembly. If you are using DIRECT INPUT, move the resistor network to the FLOATING position.

- Addressing

  Set the hundreds and tens address switches to the first address for the group of six channels.

Totalizing Measurement

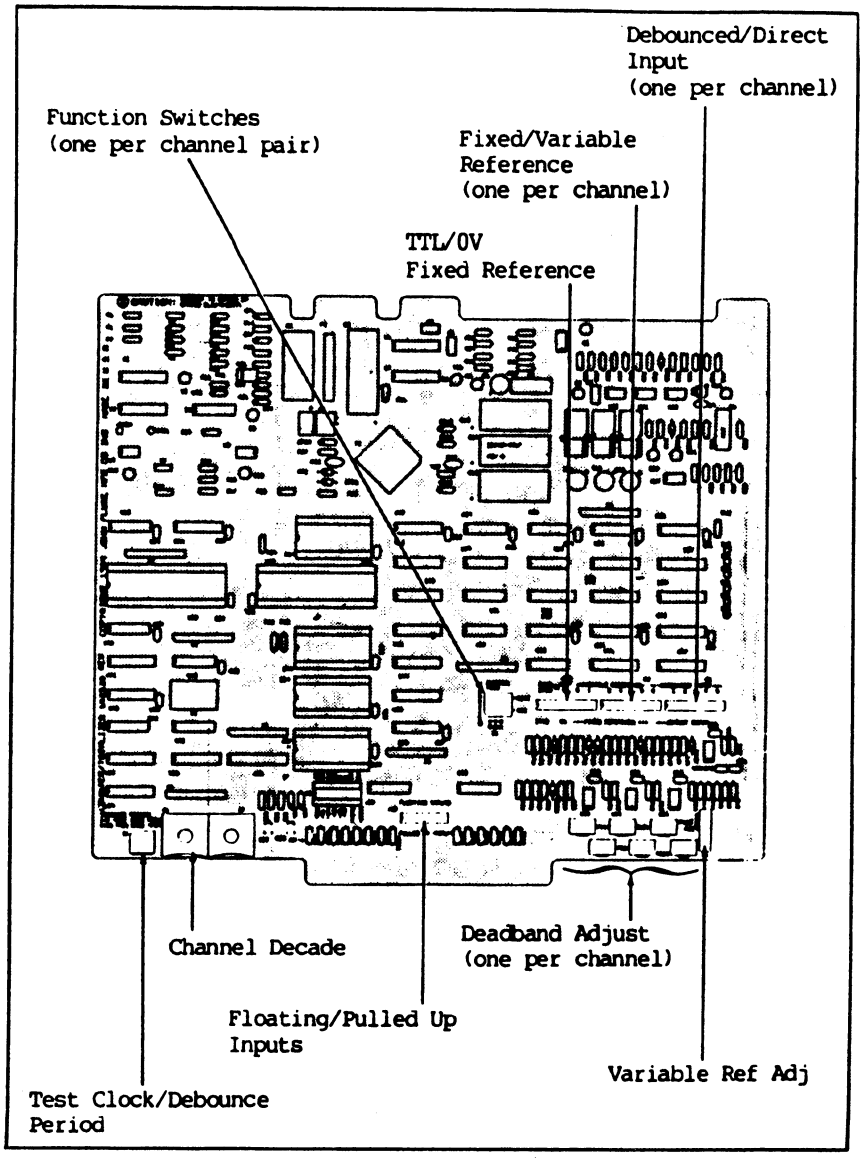


Figure 6k-1. Counter/Totalizer Adjustments

Adjusting Input Thresholds

To ensure that the input signals are detected accurately, the Counter/Totalizer input thresholds must be properly adjusted. Figure 6k-2 shows how input voltage levels are detected by the Counter/Totalizer. The reference voltage defines the boundary between the high and low voltage states of the input signal. Deadband prevents input noise from being counted as events. As shown in the figure, the reference voltage and deadband define the high and low input voltage thresholds.

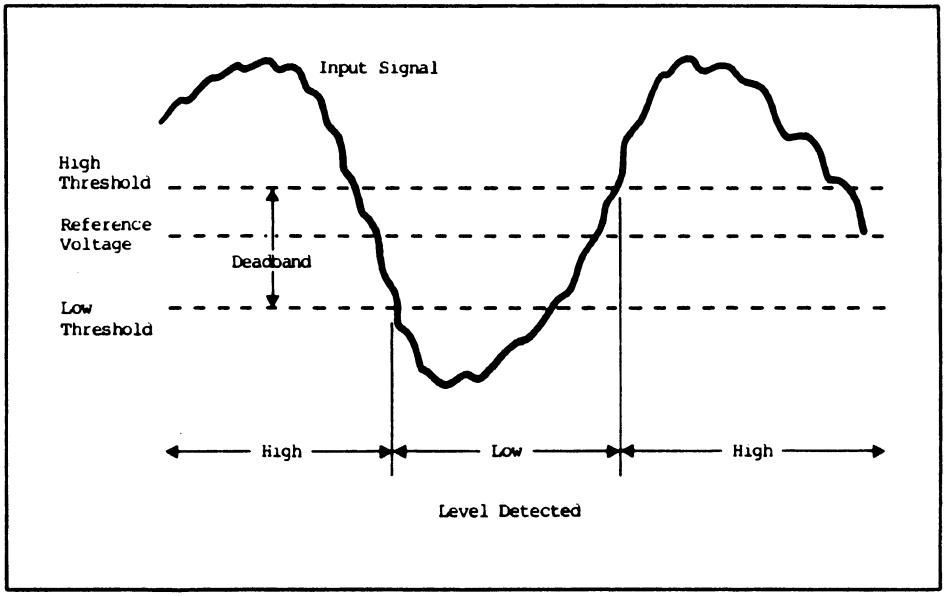


Figure 6k-2. Input Level Detection

Totalizing Measurement

On the Counter/Totalizer assembly, the reference voltage and deadband are adjustable. For each channel, a switch selects either a fixed or variable reference voltage. There is one variable reference on the assembly, adjustable from -10 to +10 volts. There is also one fixed reference, which is selectable for either 0 volts or 1.4 volts (TTL level). The deadband is adjustable from 0 to 3 volts for each channel.

Adjusting Reference Voltage

To choose the proper reference voltage, follow these guidelines:

- If the input signal is centered around 0 volts, select the 0 volt fixed reference.

- If the input signal is TTL compatible, select the TTL fixed reference.

- If the input signal is neither of the above, select the variable reference. To adjust the variable reference voltage, connect a voltmeter to the variable reference terminal and one of the return terminals on the rear panel connector. Using a small screwdriver, turn the variable reference adjustment screw until the desired voltage is displayed by the voltmeter.

- If the input is a contact closure, and the input pull-ups are being used to pull the input voltage to a high level, select the variable reference and adjust it to 7 volts. This level is half way between the high and low input voltages. (When the contacts are closed, the input is 0 volts. When the contacts are open, the input is pulled to +14 volts.)

Adjusting Deadband

Use the input deadband adjustment method most suitable for your application.

- Method 1. For TTL signals, turn the deadband adjustment screw counterclockwise until it stops. Then turn the screw clockwise to the position marked TTL on the rear panel.

- Method 2. When counting contact closures, the deadband adjustment is not important. Instead, the debouncer must be used. See the paragraphs that follow on using the debouncer.

- Method 3. Temporarily select the 0 volt fixed reference for the channel in question. Remove any connections to the input terminal. Connect a voltmeter to one of the return terminals and to the threshold output terminal for this channel. Disregarding the polarity of the threshold voltage, turn the appropriate deadband adjustment screw until the threshold is one-half the desired deadband voltage. Restore the reference voltage to its original setting.

- Method 4. This method can be used when the input signal has a steady frequency. Set the function switch for the channel in question to FREQ. Set-up the channel to the frequency function. Connect the signal to the channel input terminals, as for normal operation. Turn the appropriate deadband adjustment screw counterclockwise until it stops. Sample the channel and turn the deadband screw clockwise until a stable frequency reading is obtained. Return the channel to the COUNT function.

To ensure accurate measurements, adjust the deadband for each channel as high as possible.

Totalizing Measurement

Checking Threshold Voltages

The combination of reference voltage and deadband determines the high and low threshold voltages. To check the threshold levels, use the following procedure:

- Connect a voltmeter to one of the return terminals and to the threshold output terminal for the channel in question. Connect the test clock output to the channel input terminal.

- Turn the test clock switch to position 0 (+14 volt output), and read the low threshold on the voltmeter.

- Turn the test clock switch to position 1 (-15 volt output), and read the high threshold on the voltmeter.

Using the Debouncer

Relays, switches, and other mechanical devices frequently exhibit contact bounce when their contacts are opened or closed. In an event-counting application, contact bounce can cause extra, unwanted events to be counted. To prevent this, each Counter/Totalizer channel supports a debounce feature. The debouncer eliminates counting errors due to mechanical contact bounce.

Figure 6k-3 illustrates debouncer operation. When a debounced input is selected, the input signal must remain stable longer than the debounce period before a new input level will be recognized. There are three debounce periods available: 4 ms, 20 ms, and 80 ms. The debounce period is selected by turning a switch.

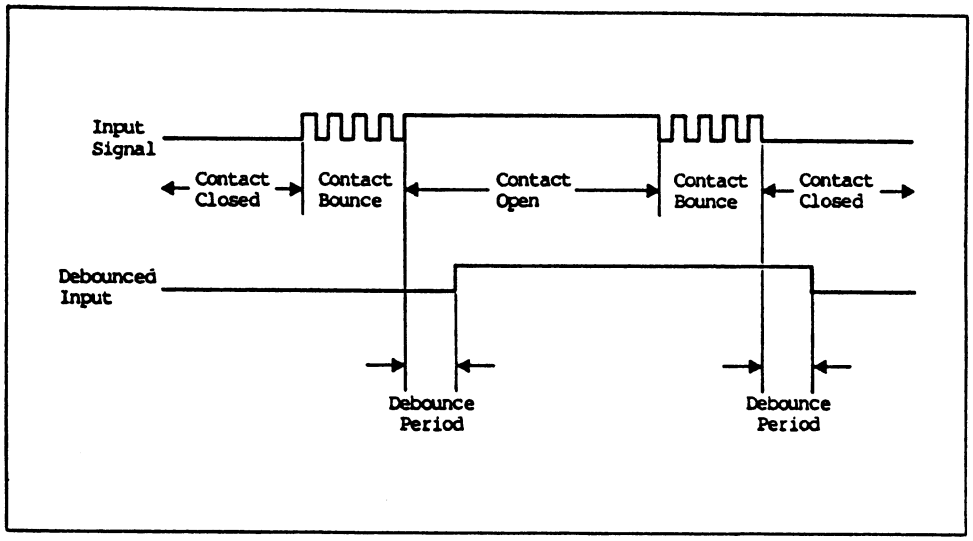


Figure 6k-3. Debouncer Operation

To set up the debouncer, use the following steps:

- Verify that the Counter/Totalizer has been configured properly for counting contact closures. The debounced/direct input switch for the channel in question should be in the DEBOUNCED INPUT position. The floating/pulled-up resistor network should be in the PULLED UP position. The reference voltage switch for the channel should be set to VARIABLE REFERENCE, with the reference adjusted to 7 volts.

- Using a small screwdriver, turn the debounce period switch to position 0 (4 MSEC).

- Move the channel function switch to the COUNT position.

- Connect the channel input terminal to one contact. Connect the return terminal to the other contact.

- Set-up the channel to the event-counting function and sample the channel. Open and close the contact and notice the change in the sampled channel value. Increase the debounce period, if necessary, until each contact closure is counted only once.

USING THE COMMANDS

General

The DEF CHAN statement is used in defining pairs of totalizing measurement channels. A conflict with some hardware settings on the Counter/Totalizer Board must not be introduced.

- First, each pair must consist of consecutive even and odd channels, corresponding to those selected on the function switch (Figure 6k-1).

- Second, the channels must fall within the range set by the channel decade switches (Figure 6k-1). Note that these switches establish the hundreds and tens designations for a range of channels.

For example, if the function switch is set for TOTAL on channels 2 and 3, and the channel decade switches are set for 1 and 0 (meaning 100), the following definition can be made:

```
DEF CHAN(102, 103) = TOTAL
```

An event count can be obtained by entering two successive SEND CHAN commands:

```
SEND CHAN(102)
SEND CHAN(102)
```

The first command (at t1) returns the count total at that point. Since the time of any SEND CHAN command prior to this may not be known, ignore this initial count. The second command (at t2) returns the count accumulated since the first command. Each additional command returns only the count since the previous command. These incremental counts can then be manipulated within the host computer program.

To prevent overrange readings, keep the interval between readings short. At its maximum counting rate of 400 kilohertz, a Counter/Totalizer channel must be monitored at least once every 20 seconds to ensure valid readings.

Command Examples

Let's set up a totalizing channel and take some counts. First, use a channel definition to set up one or more pairs of channels for event counting.

```
DEF CHAN(100..103)=TOTAL
```

Now, since the totalizer is already running, clear the count for one channel:

```
SEND CHAN(100)
```

Ignore this initial response (t0).

Then, after the desired interval (less than 20 seconds), enter:

```
SEND CHAN(100)
```

This time (t1), the response equals only the counts since the previous (in this case - initial) measurement. Assuming 230 counts were made in this t0-t1 interval, the t1 response is:

2.30000E+02

At t2, use SEND CHAN(100) again. This interval (t1-t2) yields 738 counts, and the t2 response is:

7.38000E+02

The t1 and t2 responses can then be used to find the total count from t0 to t2 (= t1 + t2).

```
---------|-----|----------------|----------------------
         t0    t1               t2

-discard-|-230-|    - 738 -     |
```

PUTTING IT ALL TOGETHER

The following example can be typed in directly from a terminal (TERM mode) or included in a computer program (COMP mode). Refer to Section 4 under "Operating the Front End from a Terminal/Computer" for more detailed information. Also, Appendix 9A provides guidelines for use with specific types of host computers.

```
MODE = TERM
FORMAT = DECIMAL
DEF CHAN(0..5) = TOTAL
SEND CHAN(0)
```

This example assumes that the Counter/Totalizer (-167) address is set for 00, the channel function switches are set to the COUNT position, the debounce/direct input switches are set to Debounce, and the floating/pulled-up resistor network is moved to the Floating position.

The example commands the Computer Front End to operate in terminal mode, sets the system variable FORMAT, and defines channels 0 through 5 for totalizing measurements. The resulting measurement is made on channel 0 with the SEND CHAN command.

A sample reading can be obtained by wiring the test clock output on the Counter/Totalizer rear panel connector to the channel 0 input terminal. The terminal assignments for the connector are listed on the rear panel. Since the test clock output and the channel inputs use the same ground, it is not necessary to wire a return line.

Using a small screwdriver, move the test clock switch to position 3 (50HZ W/BOUNCE). Make repeated measurements of the channel 0 input by entering a SEND CHAN(0) command every five seconds. Ignore the first response. Each successive response represents the accumulated count since the preceding SEND CHAN(0) command. In this example, responses of approximately 250 counts should be returned. This response appears as:

2.50000E+02

If the response is "9.99999E+37", an error has occurred. Enter the LIST ERROR command to retrieve the associated error message. If necessary, refer to Section 8 for additional error message information.

Section 6L
Voltage Measurement - Alternating
AVIN

INTRODUCTION

About This Section

This section explains use of the Computer Front End and associated option assemblies for making alternating voltage readings. Detailed information about the physical installation of the Computer Front End mainframe and related options is provided in Section 3.

Alternating Voltage Measurement

The alternating voltage capability of the Computer Front End is suitable for measuring low frequency (45 to 450 Hz) sine wave voltage signals. Power line sampling is the most common use of the alternating voltage measurement function.

REQUIRED HARDWARE

In addition to the standard Computer Front End mainframe, the following three option assemblies are required for alternating voltage measurements:

-161	High Performance A/D Converter
-162	Thermocouple/DC Volts Scanner
-160	AC Volts Input Connector

The High Performance A/D Converter (-161) provides high accuracy analog-to-digital conversion of scanner input voltages.

Voltage Measurement - Alternating

The Thermocouple/DC Volts Scanner (-162) is a plug-in, 20-channel thermocouple and multi-voltage range relay scanner. The scanner links the A/D Converter to external measurement points.

The AC Voltage Input Connector provides terminal connections for routing 20 voltage input channels to the scanner. Of these 20 channels, ten are designated for alternating voltage inputs. The remaining ten are designated for direct voltage inputs. The AC Voltage Input Connector attaches to the scanner; it can be installed or removed without removing the scanner.

Installation for any of the option assemblies is detailed in Section 3B of this manual.

As an overview, installation requires the following actions:

- Addressing

  Addresses are determined by the both the position of the Thermocouple/DC Volts scanner relative to the A/D Converter (-161) and the address switch settings on that A/D Converter.

- Wiring Connections

  For each channel, make connections to the HI and LO terminals.

- Physical Installation

  Each AC Volts Input Connector attaches to a Thermocouple/DC Volts Scanner. Each connector/scanner interfaces with the serial link and can be installed in either the Computer Front End mainframe or the 2281A Extender Chassis.

USING THE COMMANDS

General

Alternating voltage measurement set-up requires no more than assigning the appropriate function to the desired channel or group of channels. The range is preset at 250V rms. Any combination of channels can be monitored with the SEND CHAN command.

Command Example

For example, the following command would be used to define a block of ten alternating voltage input channels.

```
DEF CHAN(40..43) = AVIN
```

NOTE

Alternating voltage can be measured on those channels distinguished by an even-numbered tens digit (21, 49, 84, etc). Thus, any of the first 10 channels in a block of 20 can be defined as "AVIN".

Sample any of these channels with the SEND CHAN command.

```
SEND CHAN(40..43)
```

PUTTING IT ALL TOGETHER

The following example can be typed in directly from a terminal (TERM mode) or included in a computer program (COMP mode). Refer to Section 4 under "Operating the Front End from a Terminal/Computer" for more detailed information. Also, Appendix 9A provides guidelines for use with specific types of host computers.

```
MODE = TERM
FORMAT = DECIMAL
DEF CHAN(0..9) = AVIN
SEND CHAN(0)
```

This example assumes that the High Performance A/D Converter (-161) address is set to 0 and that an alternating voltage source is connected to the HI and LO terminals for channel 0 on the AC Voltage Input Connector (-160). It commands the Computer Front End to operate in terminal mode, sets system variable FORMAT, and defines analog input channels 0 through 9 for an alternating voltage measurement. The resulting measurement is made on channel 0 with the SEND CHAN command.

For example, if an rms value of 132V at a frequency of 60 Hz is measured, the returned value is:

```
1.32000E+02
```

If the response is "9.99999E+37", an error has occurred. Enter the LIST ERROR command to retrieve the associated error message. If necessary, refer to Section 8 for additional error message information.

Section 6M
Voltage Measurement - Direct
DVIN

INTRODUCTION

About this Section

Sensors outputting a dc voltage are commonly encountered in the measurement environment.

This section explains use of the Computer Front End and associated option assemblies for obtaining dc voltage readings. Detailed information about the physical installation of the Computer Front End mainframe and related options is provided in Section 3.

Direct Voltage Measurement

Direct voltage measurement is a relatively simple use of the Computer Front End. Numerous applications require dc voltage measurement. For example, many industrial sensors output 0 to 5 volts to indicate 0% to 100% of the measured parameter.

Voltage Measurement - Direct

REQUIRED HARDWARE

In addition to the standard Computer Front End mainframe, the following option assemblies are required for dc voltage measurements.

-161	High Performance A/D Converter
-162	Thermocouple/DC Volts Scanner

One of the following connector assemblies is required:

-176	Voltage Input Connector (recommended)
-160	AC Voltage Input Connector (10 direct voltage channels)
-175	Isothermal Input Connector (20 direct voltage channels)

The High Performance A/D Converter (-161) provides high accuracy analog-to-digital conversion of scanner input voltages.

The Thermocouple/DC Volts Scanner (-162) is a plug-in, 20-channel thermocouple and multi-voltage range relay scanner. The scanner links the A/D Converter to external measurement points.

The Voltage Input Connector provides terminal connections for routing 20 direct voltage input channels to the scanner. This assembly attaches to the scanner: it can be installed or removed without removing the scanner.

Installation for any of the option assemblies is detailed in Section 3B of this manual. Reference each option assembly by its option number (-161, -162, or -176/-160/-175).

As an overview, installation requires the following actions:

- Addressing

  Addresses are determined by the both the position of the Thermocouple/DC Volts scanner relative to the A/D Converter (-161) and the address switch settings on that A/D Converter.

- Physical Installation

  The input connector (-175, -176, or -160) attaches to a Thermocouple/DC Volts Scanner.

- Wiring Connections

  For inputs to the Voltage Input Connector or the Thermocouple Input Connector, each input channel includes three lines (HIGH, LOW, SHIELD). The voltage is measured across HIGH and LOW. The following considerations apply to use of SHIELD:

  1. To provide maximum protection from common-mode noise voltages, attach SHIELD to LOW at the point of measurement. Use a shield line from the Computer Front End connector to the measurement point.

  2. To provide maximum rejection of radio frequency interference (RFI) or electro-magnetic interference (EMI), attach SHIELD to LOW at the connector with as short a wire as possible.

  3. SHIELD must never be left disconnected or connected to HIGH or the chassis ground. For more information, see Fluke Application Bulletin AB-20 concerning guarded signal measurements.

USING THE COMMANDS

General

A direct voltage input channel is set-up with a DEF CHAN command line. This specifies the channel number (or group of channel numbers).

Optionally, the range can be set-up with the MAX parameter (at the end of the DEF CHAN statement). MAX specifies the maximum expected value; the Computer Front End then selects the lowest possible range that will accommodate that expected value. Ranges available include: 64 mV, 512 mV, 8V, and 64V. If no MAX designation is made, the 64V range is selected.

Any combination of channels can be monitored with the SEND CHAN command.

Command Example

Let's set channels 20 through 29 for dc voltage input, using the 8V range. We'll set the range with the MAX parameter, specifying a maximum anticipated voltage of 0.8 volts. Since this voltage is out-of-range for the 512 mV range, the lowest range available is 8V.

```
DEF CHAN(20..29) = DVIN, MAX = 0.8
```

Now, make a measurement on any of these channels using the SEND CHAN command.

```
SEND CHAN(20..29)
```

PUTTING IT ALL TOGETHER

The following example can be typed in directly from a terminal (TERM mode) or included in a computer program (COMP mode). Refer to Section 4 under "Operating the Front End from a Terminal/Computer" for more detailed information. Also, Appendix 9A provides guidelines for use with specific types of host computers.

```
MODE = TERM
FORMAT = DECIMAL
DEF CHAN(0..19) = DVIN, MAX = 0.4
SEND CHAN (0)
```

This example assumes that the High Performance A/D Converter (-161) address is set to 0 and that a DC voltage source (350 mV) is connected to the HIGH and LOW terminals for channel 0 on the Voltage Input Connector (-176). Also, it is assumed that the SHIELD terminal is shorted to the LOW terminal and that proper polarity has been observed. The example commands the Computer Front End to operate in terminal mode, sets the system variable FORMAT, and defines analog input channels 0 through 19 for a direct voltage measurement on the 512 mV range.

The resulting measurement is made on channel 0 with the SEND CHAN command. If 350 mV is measured, the returned reading will be:

```
3.50000E-01
```

If the response is "9.99999E+37", an error has occurred. Enter the LIST ERROR command to retrieve the associated error message. If necessary, refer to Section 8 for additional error message information.

Section 7
Maintenance

CONTENTS

INTRODUCTION 7-1
SETTING THE LINE VOLTAGE 7-1
FUSE REPLACEMENT 7-6
FAN FILTER CLEANING 7-6
GENERAL CLEANING 7-7
SERVICE INFORMATION 7-8

INTRODUCTION

Most operator maintenance does not require direct access to the interior of the Computer Front End. Only the procedure to change the line voltage setting requires the unit to be opened. Do not perform this procedure unless you are qualified to do so and thoroughly understand the task before beginning. All other maintenance that requires access to the Computer Front End interior is covered fully in the Service Manual.

SETTING THE LINE VOLTAGE

WARNING

THE FOLLOWING PROCEDURE REQUIRES ACCESS TO THE INTERIOR OF THE COMPUTER FRONT END. DO NOT PERFORM THIS PROCEDURE UNLESS YOU ARE QUALIFIED TO DO SO. LETHAL VOLTAGES MAY EXIST WITHIN THE UNIT.

The power input setting is normally marked on the rear panel of the Computer Interface Module, just above the power input connector. If there is no mark in either box, or if the box is marked for a voltage other than the one you will be using, use the following procedure to gain access to the internal setting.

1. Turn the Computer Front End power switch to OFF.

2. Remove the ac input line cord from the power source and from the Computer Front End.

3. Remove the four phillips-head screws indicated in Figure 7-1 below.

4. See Figure 7-2. Slide the Module out by grasping the finger indentation in the fan filter hole and slide it straight back and out.

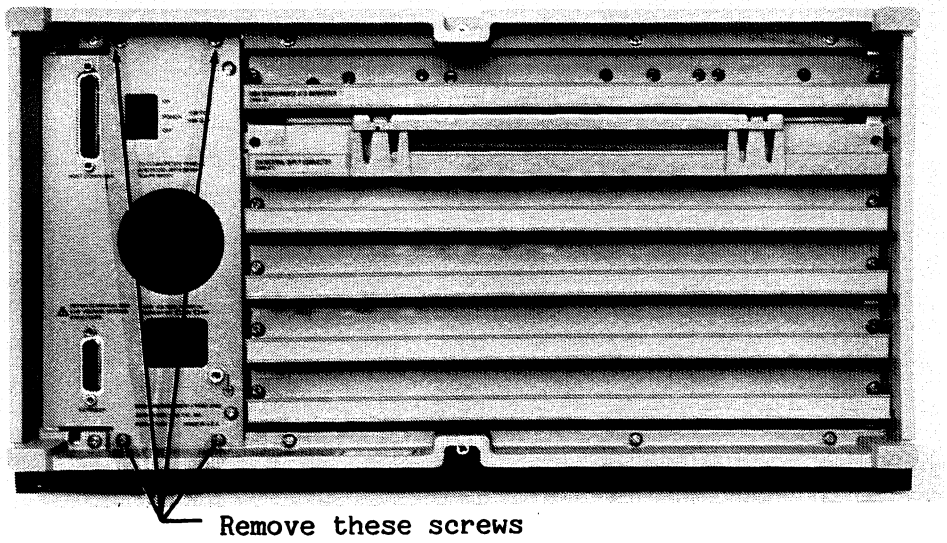


Figure 7-1. Power Supply Removal Screws

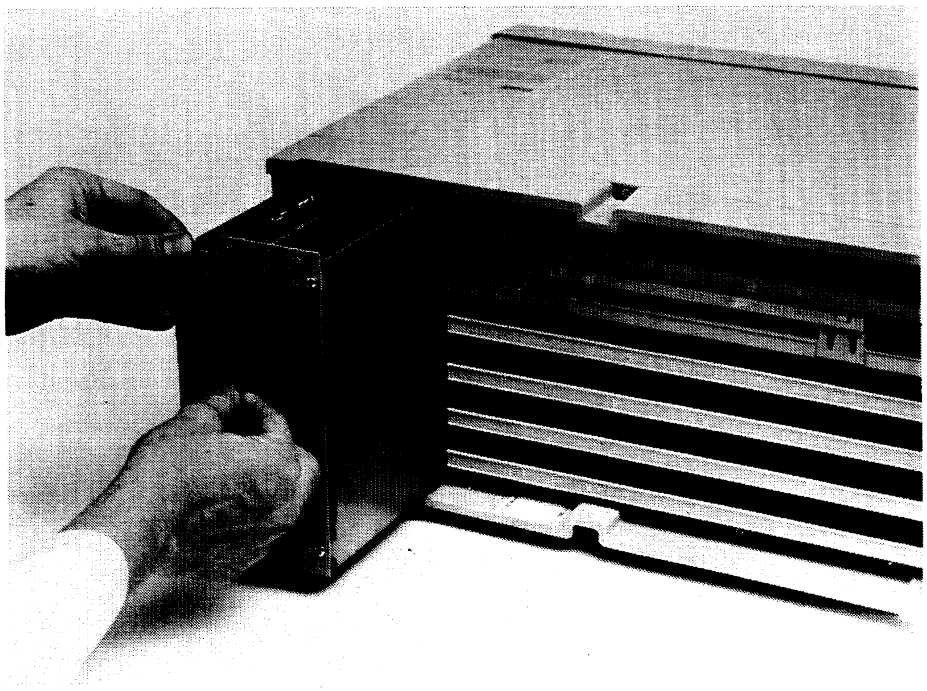


Figure 7-2. Removing the Computer Interface Module

5. Refer to Figure 7-3 to locate the Line Power Voltage Pins. To select 180-264V operation, connect the wire to the pin marked 220V. For 90-132 operation, place the wire on the pin labeled 110V.

NOTE

It is not necessary to change the power input fuse when changing the power supply operating voltage.

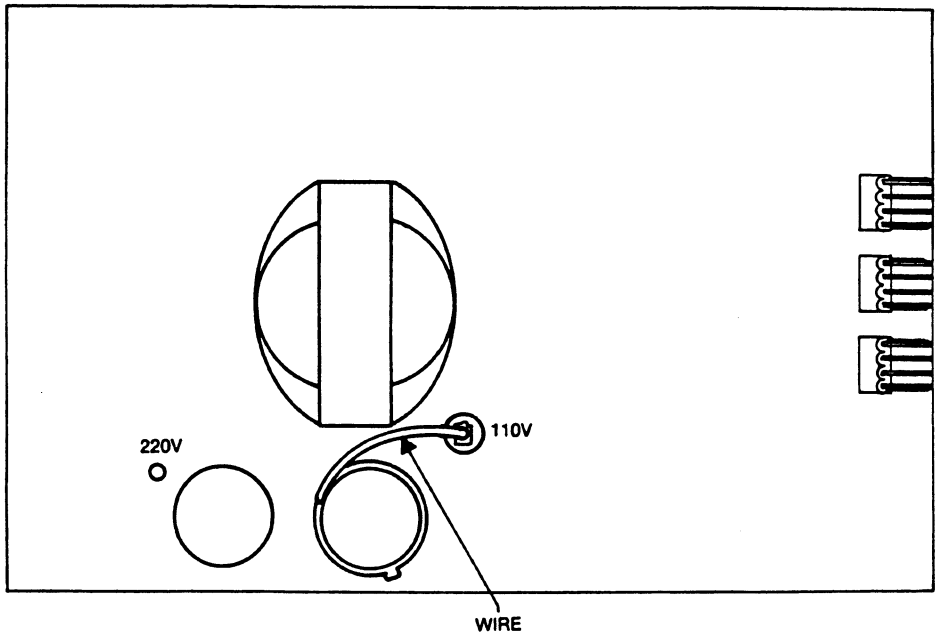


Figure 7-3. Line Power Voltage Pins

6. While the unit is open, locate the Line Frequency Selection Switch (S3-8) and ensure that it is in the proper position to match the local line frequency. If it is not, change it's position before continuing. For 50 Hz operation, place S3-8 in the 0 position (toward card edge). For 60 Hz Operation, place it in the 1 position.

7. Properly mark the power setting on the outside of the unit after changing the line power voltage.

8. Slide the Computer Interface Module back into the Front End, and reinstall the phillips-head screws.

FUSE REPLACEMENT

The fuse is located on a clip-type holder on the power supply assembly, in the corner to the right of the 110V voltage selection pin. When replacing the fuse use the same value (2.0A @ 250V).

To check or replace the fuse, first turn the power OFF. Then remove the Computer Interface Module as described previously in this section. Use a slotted screwdriver or adjustment tool to remove the fuse. After checking or replacing the fuse, reassemble the unit and test its operation.

FAN FILTER CLEANING

Clean the fan filter any time it is visibly contaminated. If the unit is operated too long with a dirty air filter, heat buildup inside could damage sensitive electronic components.

To clean the filter, pinch the center and pull directly out. Clean with warm soapy water and rinse thoroughly before replacing.

GENERAL CLEANING

CAUTION

Disconnect the battery before cleaning the Computer Front End. Also, do not use aromatic hydrocarbons (such as naphthalene) or chlorinated solvents (such as carbon tetrachloride) for cleaning. They may damage plastic materials used in the instrument.

- Handle the assemblies by their edges rather than by their connector pins. Skin oils can contaminate the assembly and degrade measurement accuracy.

- Improper handling can also cause instantaneous or delayed electrostatic discharge damage. The yellow "Static Awareness" sheet in the front of the Service Manual explains some of the hazards of static electricity to sensitive components.

- Do not use a static-inducing vacuum brush to clean assemblies. Possible electrostatic discharge can damage sensitive components.

Clean the Computer Front End periodically to remove dust, grease, and other contamination. The Front End case may be cleaned using a soft cloth dampened with a mild solution of detergent and water. Dry the case after cleaning.

If visual inspection reveals significant contamination on printed circuit board surfaces, the assembly can be cleaned with low pressure (<20 psi) air. If air is not available, clean the assembly with commercial water-based cleaning equipment.

If commercial water-based cleaning equipment is not available, clean the assembly by holding it under warm, running water. Observe the following precautions when using water-based cleaning equipment:

1. Read all precautions listed above under General Cleaning.

2. Remove all assembly shielding covers and separate any relay piggy-back assemblies.

3. In areas with exceptionally hard water, use either deionized or distilled water for a final wash to remove ions left by the hard water wash.

4. Dry all assemblies thoroughly. Use a low-temperature drying chamber or an infrared drying rack with a temperature range between 100 and 120 ^{o}F (38 to 46 ^{o}C) if available.

5. If a drying chamber or infrared drying rack is not available, air-dry the assembly at room temperature for a minimum of 48 hours before reassembling.

6. Use a mixture of 70% isopropyl alcohol and 30% water and a lint-free cloth to clean edge-connector contacts. Never use an eraser to clean connector contacts; it might generate static or abrade the gold plating on the contacts.

SERVICE INFORMATION

For additional maintenance and servicing information, refer to the Helios I Computer Front End Service Manual.

Section 8
Error Messages

CONTENTS

Introduction 8-3
What to Do About an Error 8-4
Error Information 8-5

INTRODUCTION

If the command line you have sent cannot be carried out, the Computer Front End returns error information. Usually, this means that some part of the command line must be changed to match the format expected by the Front End. It may also mean that command line instructions conflict with the Front End's hardware configuration, or that an illegal value has been entered. A complete listing of error codes and explanations is presented at the end of this section.

If Terminal Mode is activated, a brief message describing the error condition is returned. For example, if a channel number not falling between 0 and 1499 is specified, this is returned:

?Not a valid channel

This information is returned as a numerical error code when Computer Mode is in use. The same error would then be:

?02

If an option assembly is not installed, or is incorrectly installed or wired, SEND CHAN(channels) evokes the following response:

9.99999E+37

When this general error indication occurs, gather more error information by sending: LIST ERROR.

WHAT TO DO ABOUT AN ERROR

Most errors result from a command line that is either syntactically wrong or attempts to do something that is just not possible. You may need additional description of the error code (Computer Mode) or error message (Terminal Mode). Full descriptions are provided at the end of this section.

Suppose the problem cannot be resolved by changing the command line. This situation suggests a hardware problem: a measurement connection to the Front End may be faulty, a measurement sensor may be defective or trying to sense something out of its range, or a problem may exist with the Front End and its connections to the Terminal/Computer.

At this point, it's generally best to gather all available error history. Do this in Terminal Mode: the returned information will be in descriptive English. Use the LIST ERROR command to return errors that occurred during execution of a SEND command.

Use the TEST command to check out any suspected channel or group of channels.

ERROR INFORMATION

The following list relates the two-digit error code (as seen in Computer Mode) to an error message (as seen in Terminal Mode). Further description is then provided for each type of error.

01 Illegal value

The output value set for an analog output channel is out of range. Select a value permissible in the selected analog output mode:

BIPOLV	-5 to +5
UNIPOLV	0 to +10
DCOUT	0.004 to 0.020
PVOUT	0 to 100

02 Not a valid channel

A channel number other than 0 through 1499 was specified (0 through 999 for Scan/Alarm Option).

03 Incompatible channel

The channel is not capable of doing what you command. For example, an output value cannot be assigned to an analog input channel, and a thermocouple input cannot be defined on a Counter/Totalizer channel. Check that the command line does not conflict with either other programming instructions or with hardware settings.

04 Channel not available

A definition or operation was attempted on a channel for which no hardware is installed in the system. Check that related hardware is correctly installed.

05 No device reply

An error occurred while trying to communicate with an I/O device (or no I/O device is installed).

06 Illegal bridge type

In a strain definition statement, a bridge type number other than 0 through 5 was specified.

07 System error

The system could not handle an unexpected error condition.

08 Bad frequency

A LINEFR value assignment other than 50, 60, or 400 was attempted.

09 Device error

A channel has failed the self test routine initiated with the TEST command. This is usually caused by a hardware problem.

10 Channel not defined.

A reading from an undefined channel was attempted. Define that channel, or read a properly defined channel.

11 Illegal channel function

An illegal table number was specified. A maximum of 100 tables (0-99) can be established.

12 **Bad table**

An illegal entry was made during a table definition. This error will occur if only one entry pair is specified, or if the required format for entering pairs is not followed.

13 **No channel function**

An attempt was made to use a channel function that was not defined.

14 **Not enough memory**

The amount of memory for channel or table definitions is insufficient. Use SEND MEMSIZ to verify memory remaining.

15 **Out of range**

The measured input exceeds the programmed range. If possible, specify a higher range in the channel definitions.

16 **Open TC**

A temperature measurement was attempted with an open or improperly connected thermocouple.

17 **Illegal BCD**

A BCD digit greater than 9 was present on one or more digit fields of a digital input.

18 **No convergence**

The user-defined RTD constants do not allow for resolution of the temperature calculation.

19 **Over temperature**

The temperature is outside the specified range for the thermocouple or RTD being used.

20 **ROM failed**

A bad ROM or faulty ROM control circuit was detected during the system self test. The system will continue operating, but results may be unpredictable.

21 **RAM failed**

During the system self test, a bad RAM or faulty RAM control circuit was detected. The system will continue operating, but results may be unpredictable.

22 **SL UART failed**

A problem with the serial link UART was detected during the system self test. The system will continue operating, but results may be unpredictable.

23 **Bad parameter**

An unexpected or illegal parameter was specified. Check command reference information in Section 5.

24 **Too many parameters**

More than 20 items were specified in a channel list.

25 **Bad date**

An assignment to DATE$ did not meet the syntax specification.

26 **Bad time**

An assignment to TIME$ or TIME did not meet the syntax specification.

27 **No such command**

An unknown command was detected.

28 **Bad syntax**

The command line does not meet syntax requirements. Check command reference information in Section 5.

29 **Bad channel range**

A channel range was incorrectly specified. For example, this error occurs if CHAN(20..10) is sent.

30 **Table not defined**

A reference to an undefined interpolation table was attempted.

31 **Illegal poly definition**

A polynomial channel function has not been properly defined.

32 **Bad scan task**

An illegal scan task number has been specified.

33 **Bad buffer**

An illegal buffer number has been specified.

34 **Scan task not defined**

A reference has been made to an undefined scan task.

35 **Buffer not defined**

A reference has been made to an undefined buffer.

36 **Bad alarm channel**

An illegal alarm channel has been specified.

37 **OVERLAY failed**

A problem with the overlay manager was detected during the system selftest. The Helios I system will continue operating; however, results might be unpredictable.

38 **No previous record available**

This error occurs when a SHOW AGAIN ABUF or SHOW AGAIN SBUF command has been used, but the previous record that has already been overwritten and is no longer available.

39 Illegal channel label

The channel label string defined in a LABEL CHAN statement exceeds 12 characters, contains one or more non-printable characters, or is not enclosed in quotation marks.

40 Illegal channel units in label

The UNITS string defined in a LABEL CHAN statement exceeds six characters.

41 Illegal channel format in label

Legal channel formats, specified in a LABEL CHAN statement, are: F0, F1, F2, F3, F4, F5, E0, E1, E2, E3, E4, and E5.

42 Illegal channel ctrl sequence in label

The CTRL string defined in a LABEL CHAN statement exceeds eight decimal codes, or a semi-colon (;) has been omitted between decimal codes.

43 Illegal number in label

This error pertains to the use of the NUMBER parameter with the LABEL CHAN command. Make sure that the number of pound signs (#) used in the label string is compatible with the maximum number of digits required by NUMBER.

44 Illegal scan header

The HEADER defined in a START SCAN statement exceeds 128 characters or is incorrectly stated. A header may consist of any combination of strings (enclosed by quotation marks) and ascii decimal codes. Each character within the quotation marks and each decimal code (one, two, or three-digit) counts in the 128-character total. Further, decimal codes and quoted strings must be separated with semi-colons (;).

45 Illegal scan footer

The FOOTER defined in a START SCAN statement exceeds 128 characters or is incorrectly stated. Error code 44 syntax rules also apply to this error code.

46 Illegal scan period count

The PERIOD parameter established in a START SCAN statement is less than 2. For meaningful computation of MAX, MIN, AVG, or TOT functions, 2 or more scan cycles (periods) must be specified.

47 SQR less than 0

The square root function (SQR) has been applied to an input value less than 0.

Section 9
Appendices

CONTENTS

Configuring Your Computer 9a-1

Serial Data Reference 9b-1

ASCII Character Set 9c-1

Power-On and Reset Routines 9d-1

Sales and Service Centers 9e-1

Glossary 9f-1

Programming Example (Scan/Alarm) 9g-1

Appendix 9a
Configuring Your Computer

CONTENTS

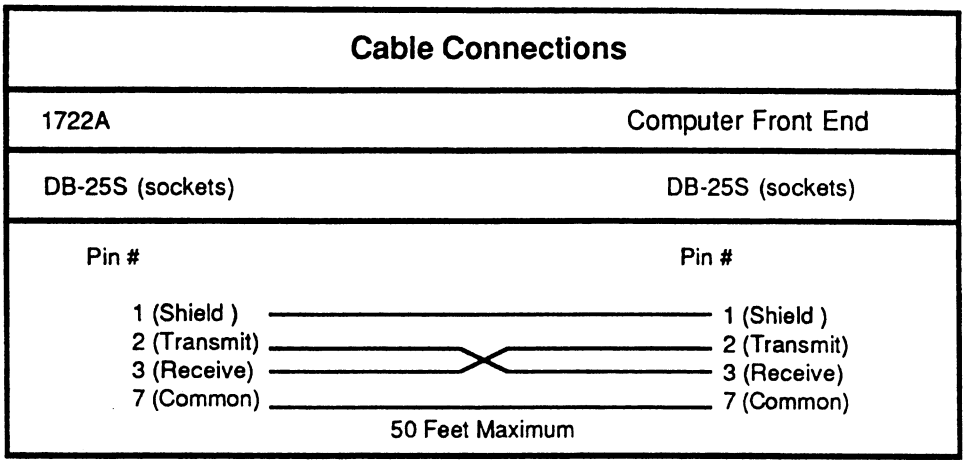
Fluke 1722A Instrument Controller
and 1752A Data Acquisition System 9a-3

IBM PC* and PC-XT Personal Computer 9a-7

TRS-80* Model 100 Lap-Top Computer 9a-9

*IBM PC is a trademark of IBM Corporation.
*TRS-80 is a trademark of The Tandy Corporation.

FLUKE 1722A and 1752A



Note: Use Fluke Y1702, Y1703 Or Y1705 Null Modem Cables

1. Verify that the Front End is configured correctly to factory settings (see Section 3).

2. Connect the Front End to the KB1: port of the Fluke 1722A or 1752A using a null modem cable, Fluke Y1702 or equivalent, as illustrated above.

3. Power up the Front End.

4. Power up the 1722A or 1752A. Insert the System Disk and enter FDOS (the FDOS> prompt displays).

5. Enter the SET Utility Program by typing:

   SET <RETURN>

6. When the SET> prompt appears, type in the following:

   KB1:,BR 9600,DB 8,SB 1,EOL 10, EOF 26, SI E,SO E TO 10 <RETURN>

7. Verify the configuration of KB1: by typing:

   LI <RETURN>.

The display should show the following list:

DEVICE	KB1:
BAUD RATE	9600
DATA BITS	8
PARITY	NONE
STOP BITS	1
END OF LINE	10
END OF FILE	26
STALL INPUT	ENABLED
STALL OUTPUT	ENABLED
TIME OUT	10

8. To exit SET, type EX <RETURN>. When the FDOS> prompt returns, enter BASIC by typing BASIC <RETURN>.

9. When the BASIC prompt **Ready** appears, enter the interactive editor by typing EDIT <RETURN>. Type in the following program:

```
10  PRINT CHR$(27)+"[2J";\CLOSE ALL
20  OPEN "KB1:" AS NEW FILE 1
30  OPEN "KB1:" AS OLD FILE 2
40  PRINT #1, "MODE=COMP"
50  INPUT #2,A$
60  IF A$<>"!" THEN GOTO 50
70  PRINT #1, "SEND TIME$"
80  INPUT #2,A$
90  PRINT CPOS(7,30),"The time is ";A$
100 END
```

10. Type <CTRL/C> to exit the BASIC editor. To save the program on disk, type:

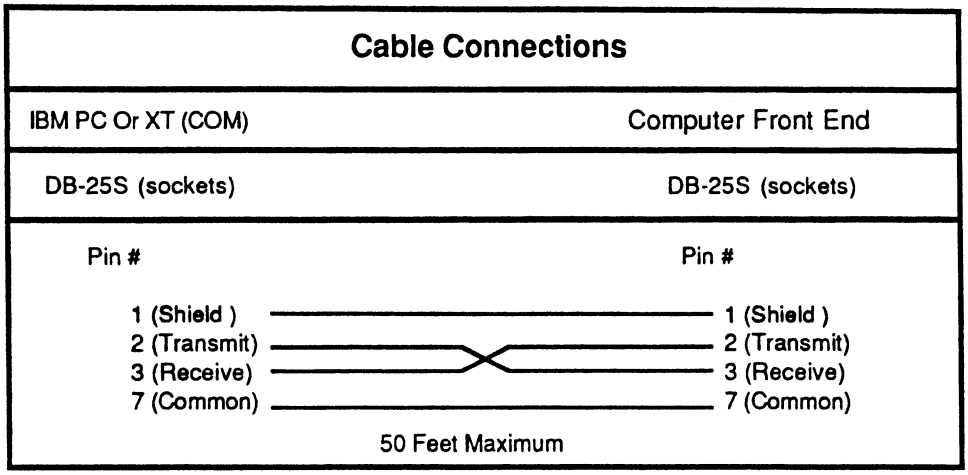
```
SAVE 'HCLI.TST' <RETURN>
```

11. To execute the program, type RUN <RETURN>. The time will display on the center of the screen.

Here are line-by-line comments of this program:

```
10  Clears the screen and closes all files.
20  Opens RS-232 port for output
30  Opens port for input
40  Puts the Front End in computer mode.
50  Flushes the buffer until...
60  ...it contains "!"
70  Commands the Front End to send the time.
80  Inputs TIME$ to the buffer.
90  Prints the time information in the middle of
    the display.
```

IBM PC and PC-AT Personal Computers



Note: Use Fluke Y1702, Y1703 Or Y1705 Null Modem Cables

1. Verify that the Front End is configured correctly to factory settings (see Section 3).

2. If you have an IBM PC, an optional RS-232 serial interface must be installed and selected as COM1. The PC-XT comes standard with COM1.

3. Connect the Front End to the personal computer with a null modem cable, Fluke Y1702 or equivalent, as illustrated above.

4. Power up the Front End.

5. Insert a DOS disk into drive A and power up the personal computer. When you see the A> prompt, type BASICA and enter the following program. The program establishes communication with the Front End, retrieves the variable VERSION$ (the software version) from the Front End, and displays it on the IBM PC screen.

```
10  CLEAR
20  CLS
30  CLOSE
40  OPEN "COM1:9600,N,8,1,CS,DS,CD" AS #1
50  PRINT #1, "MODE=COMP"
60  INPUT #1, A$
70  IF A$<>"!" THEN GOTO 60
80  PRINT #1, "SEND VERSION$"
90  INPUT #1, A$
100 PRINT "The firmware is ";A$
101 END
```

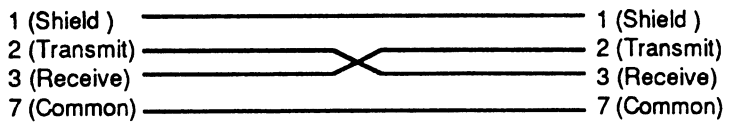
Here are line-by-line comments of this program:

```
10  Initializes memory.
20  Clears the screen
30  Closes all files
40  Opens RS-232 port for output
     (9600 baud, 8 data bits, no parity, etc.)
50  Puts the Front End in computer mode.
60  Flushes the buffer until...
70  ...it contains "!"
80  Commands Front End to send the firmware version.
90  Inputs VERSION$ to the buffer.
100 Prints the version.
```

TRS-80 Model 100 Lap-Top Computer

Cable Connections

TRS-80-100	Computer Front End
DB-25P (pins)	DB-25S (sockets)
Pin #	Pin #



50 Feet Maximum

Note : There is no standard Fluke cable for this computer.

Communicating in the Terminal Mode

1. Verify that the Front End is configured correctly to factory settings (see Section 3).

2. Connect the Front End to the TRS-80-100 with a cable as illustrated.

3. Power up the Front End.

4. Power up the TRS-80-100 and press <F8> as required to arrive at the Main Menu. A BASIC prompt will appear in the upper left corner of the screen.

5. Use the cursor keys to move the cursor to **TELCOM** and press <enter>.

6. Press <F3> and type 88N1E <enter> to set the TRS-80-100 port characteristics. Press <F4> to enter the terminal mode.

7. Type mode=term <enter> on the TRS-80-100 keyboard. The Front End should respond by displaying the prompt **HCLI>** on the TRS-80-100 screen.

The HCLI> prompt indicates that the TRS-80-100 and the Front End are communicating bi-directionally. The Front End commands described in Section 5 of this manual can now be typed in at the keyboard.

Communicating from BASIC

The following program establishes communication with the Front End, retrieves the variable TIME$ from the Front End, and displays it on the Model 100 screen.

```
10  CLS:CLEAR
20  OPEN "COM:88N1E" FOR OUTPUT AS 1
30  OPEN "COM:88N1E" FOR INPUT AS 2
40  PRINT #1, "MODE=COMP"
50  INPUT #2, A$
60  IF A$<>"!" THEN GOTO 50
70  PRINT #1, "SEND TIME$"
80  INPUT #2, A$
90  PRINT @ 125, "The time is ";A$
100 END
```

Here are line-by-line comments of this program:

```
10   Clears display, initializes memory.
20   Opens the RS-232 port for output (9600 baud, 8
     data bits, no parity, etc.)
30   Opens the port for input - same parameters as
     output.
40   Puts the Front End in computer mode.
50   Flushes the buffer until...
60   ...it contains "!"
70   Commands the Front End to send the time.
80   Inputs TIME$ to the buffer.
90   Positions the cursor and prints the time
     information.
```

Appendix 9b
Serial Data Reference

CONTENTS

What is Serial Data? 9b-1

Timing and Speed 9b-1

Character Format 9b-2

Parity 9b-3

Circuit Connection 9b-4

Multipoint 9b-6

Message Transfer 9b-7

WHAT IS SERIAL DATA?

Bit serial data is digital information represented as groups of bits (high and low states, representing ones and zeros), sent over one line, one bit at a time.

TIMING AND SPEED

Serial data can be transmitted in two different timing formats, synchronous and asynchronous. Synchronous, or message framed data, uses start and stop characters to mark the beginning and end of each message block. Individual characters in the message are sent one after the other, without any special bits separating them. Asynchronous data is also called character framed data, because it has start and stop bits separating each character, so each character is transmitted as an independent unit. The Computer Front End serial interface operates only using asynchronous timing.

The speed of serial data is expressed in bits per second, or baud. Although baud means the rate of actual state changes per second, it is often used interchangeably with bit rate. The Computer Front End serial interface can send and receive data at all the following bit rates:

110	2400
300	4800
600	9600 (Factory Setting)
1200	19200

CHARACTER FORMAT

Information is sent to and from the Computer Front End serial interface in the form of ASCII (American Standard Code for Information Interchange) coded characters. Figure 9b-1 shows the format of a single asynchronous serial character. Each character begins with one start bit (low), then seven or eight data bits (the ASCII character), then an optional parity bit, and finally one or two stop bits (high).

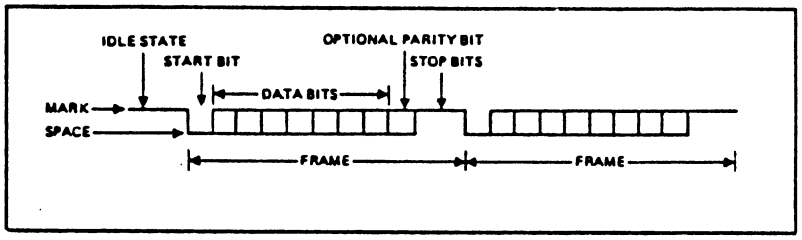


Figure 9b-1. An Asynchronous Serial Character

Reception of the start bit tells the receiving station that the next seven (or eight, depending on a switch setting) bits represent an ASCII coded character (transmitted least significant bit first). The start bit is always a single low bit (zero).

The stop bit tells the receiving station that it has reached the end of the character. The stop bit is high, and so is the idle state of the line. A stop bit may be immediately followed by the start bit for the next character, or may just return the line to its idle state (if it belongs to the last character to be transmitted). You can select a stop bit of one or two bits in length, to match the Serial Interface to the requirements of various host computers and interfaces. Instructions for setting the CHARACTER FORMAT switch (S2) are given in Section 3, Installation and Setup.

PARITY

The parity bit follows the seven or eight data bits of the ASCII-coded character. The parity bit is an error detection device, and can be configured in three ways:

- Parity Off

  When parity is turned off, the interface does not transmit a parity bit, and does not expect to receive one. The stop bit immediately follows the last data bit of the character.

- Even Parity

  Even parity means that the parity bit, when appended to the binary digits of the ASCII-coded character, yields an even number of one-bits.

- Odd Parity

  Odd parity means that the parity bit, when appended to the binary digits of the ASCII-coded character, yields an odd number. For example, the ASCII code for the letter "a" is:

  0010 0001

  If odd parity were being used, the code transmitted would be:

  0010 0001 1

Instructions for setting the parity switch segments of the CHARACTER FORMAT switch (S2) are given in Section 3, Installation and Setup.

The information in this section is an introduction to serial data communication using the Computer Front End serial interface. Detailed instructions regarding system circuit connections, interface configuration, and operation are found in Sections 3 and Appendix 9a, Configuring Your Computer.

CIRCUIT CONNECTION

The first step in data transfer between two or more computers involves the electrical circuit connection. The connection can be either direct-connect (over a dedicated hard-wired line) or switched service (over a telephone line). The network can be two-point, with just the host computer and the Computer Front End or multipoint (also called multi-drop), with one host computer and several Front Ends.

The Computer Front End can be remotely accessed by a host computer in the following types of networks:

- RS-232-C direct-connect, two-point
- RS-232-C with modems over a dedicated line, two-point
- RS-232-C with auto-answer modems (switched service)
- RS-422 direct-connect, two-point
- RS-422 direct-connect, multipoint (up to ten Front Ends)

The RS-232-C interface can be used in either switched service or direct-connect networks. However, the RS-422 interfaces can only be direct-connected. The same interface connector is used for both RS-232-C and RS-422 communications.

Using RS-232-C, a direct-connect circuit is made with a Null-Modem Cable. In systems using RS-422, a direct-connect circuit is made with twisted-pair shielded cable.

Multipoint switched-service networks with auto-answer modems (RS-232-C only), are really switched two-point networks, as each modem remains disconnected from the circuit until its own telephone number is dialed. Connection occurs in a switched-service system (RS-232-C interface) with auto-answer modems when the line attached to the modem rings. This happens as follows:

1. The modem at the host end dials the number for a particular Front End to establish a link with that Computer Front End.

2. The line at the Front End rings, and the interface detects signal CE (Ring Indicator) high.

3. The Serial interface responds by asserting CD (Data Terminal Ready) high. This tells the auto-answer modem to answer the line, establishing a connection.

This is an overview of the RS-232-C switched service connection procedure. In RS-422 multipoint systems without modems, addresses are set on the ADDRESS switch (S3) on the Computer Interface assembly. Switch settings and circuit connections are covered in Section 3, Installation and Setup.

MULTIPOINT

In a multipoint direct-connect system (RS-422), each Front End in the system has a unique address. Up to ten Front Ends may be connected in such a system. Each Front End in the system is assigned an address from zero to nine, as set on the ADDRESS switch (S3) on the Computer Interface Module. After one Computer Front End is addressed, the other Front Ends remain idle until there is another address sequence.

In a two-point network, there is no establishment procedure, since there is only one Computer Front End. In a multipoint network, however, a logical connection must be established between the host and one Front End.

The host establishes an RS-422 communication link between itself and a particular Computer Front End in a multipoint network as follows:

1. The host sends an address character followed by the Enquiry character, ENQ. The address character is the mathematical sum of the address (0 - 9) and ASCII-coded character "0" (ASCII decimal 48).

2. When a Front End detects its address sequence, it responds by echoing its address character followed by the Acknowledge character, ACK, causing establishment to occur.

NOTE

When using a multipoint system, make sure that only one Front End is addressed at a time. Perform the termination sequence prior to addressing any Front End.

An addressed Front End can be unaddressed by sending a <DLE> <EOT> character sequence or an <EOT> character. A single <EOT> disconnects the Front End from the host, but any pending output is retained until reconnected.

MESSAGE TRANSFER

Introduction

Once a connection has been established, messages can be exchanged between the Computer Front End and the host, using various data channel protocols and message transfer protocols.

Data Channel Protocols

The RS-422 interface has dedicated lines for transmitting and receiving messages. The data transfer lines for the RS-232-C interface, however, can be configured in different ways: direct-connect or with modems, and full duplex or half duplex. Half-duplex communication is not implemented in the Computer Front End.

In full-duplex mode, each modem transmits data on a carrier wave of a different frequency, allowing two data channels to exist on the same line. Figure 9b-2 shows how the available bandwidth of a voice-grade telephone line is occupied by the two data channels in full duplex.

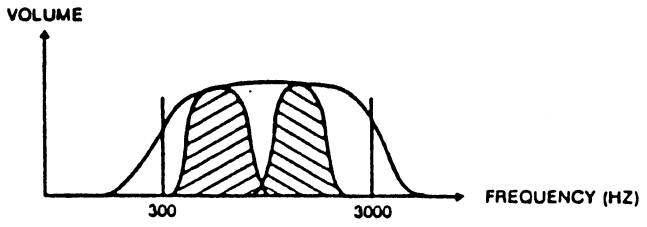


Figure 9b-2. Full-Duplex Data Channels

Message Transfer Protocols

This describes, starting with the simplest communication method, each message transfer protocol used by the Computer Front End. This information is included to introduce the user who is new to serial communication to the available alternatives in message transfer protocols. MESSAGE TRANSFER switch (S2) settings are given in Section 3, Installation and Setup.

Table 9b-1 shows the ASCII characters mentioned in this manual, with their corresponding decimal values. For a complete table of ASCII characters, see Appendix 9c.

Table 9b-1. ASCII Mnemonics and Decimal Equivalents

ASCII Mnemonic	Decimal Value
ACK	6
DLE	16
ENQ	5
EOT	4
XOFF (CTRL/S)	19
XON (CTRL/Q)	17
CTRL/C	3
DEL	127

Simple Terminal 1

During communication between two devices, one of them, device A, transmits characters to device B, and device B transmits characters to device A. This is called simple terminal protocol. With simple terminal protocol there is no data flow control mechanism and no mechanism for the recovery of character errors detected by the parity bit. This communication method is selected when the XON-XOFF switch (S3-7) on the Computer Interface Module is set to position 0 (DISABLED). This communication method is called ST1, for Simple Terminal 1.

Simple Terminal 2

At low transmission speeds, Simple Terminal 1 is adequate. However, if device B is unable to receive and process characters as fast as A can send them, information is lost. Device B avoids this problem by sending a flow control character to tell device A to stop transmitting until it catches up.

In Simple Terminal 2 message transfer protocol, special characters (XON and XOFF) are transmitted by the receiver to control the flow of data. When the host computer is receiving data using Simple Terminal 2 protocol, and its buffer becomes almost full, it sends the XOFF (transmit off) character to the Front End. The reception of XOFF causes the Front End to halt. This is done to avoid overwriting, and thereby losing, characters. When the computer has processed incoming characters until its buffer is nearly empty, it tells the transmitter to resume the flow of data by sending the XON (transmit on) character. This protocol is selected when S3-7 on the Computer Interface Module is set to position 1, ENABLE. When XON-XOFF flow control is enabled, the protocol is called ST2, for Simple Terminal 2.

Appendix 9c
ASCII Character Set

ASCII CHAR.	DECIMAL	OCTAL	HEX	BINARY 7654 3210	DEV. NO.
NUL	0	000	00	0000 0000	
SQH	1	.001	01	0000 0001	
STX	2	002	02	0000 0010	
ETX	3	003	03	0000 0011	
EOT	4	004	04	0000 0100	
ENQ	5	005	05	0000 0101	
ACK	6	006	06	0000 0110	
BELL	7	007	07	0000 0111	
BS	8	010	08	0000 1000	
HT	9	011	09	0000 1001	
LF	10	012	0A	0000 1010	
VT	11	013	0B	0000 1011	
FF	12	014	0C	0000 1100	
CR	13	015	0D	0000 1101	
SO	14	016	0E	0000 1110	
SI	15	017	0F	0000 1111	
DLE	16	020	10	0001 0000	
DC1	17	021	11	0001 0001	
DC2	18	022	12	0001 0010	
DC3	19	023	13	0001 0011	
DC4	20	024	14	0001 0100	
NAK	21	025	15	0001 0101	
SYN	22	026	16	0001 0110	
ETB	23	027	17	0001 0111	
CAN	24	030	18	0001 1000	
EM	25	031	19	0001 1001	
SUB	26	032	1A	0001 1010	
ESC	27	033	1B	0001 1011	
FS	28	034	1C	0001 1100	
GS	29	035	1D	0001 1101	
RS	30	036	1E	0001 1110	
US	31	037	1F	0001 1111	

ASCII CHAR.	DECIMAL	OCTAL	HEX	BINARY 7654 3210	DEV. NO.
SPACE	32	040	20	0010 0000	0
!	33	041	21	0010 0001	1
"	34	042	22	0010 0010	2
#	35	043	23	0010 0011	3
$	36	044	24	0010 0100	4
%	37	045	25	0010 0101	5
&	38	046	26	0010 0110	6
'	39	047	27	0010 0111	7
(	40	050	28	0010 1000	8
)	41	051	29	0010 1001	9
*	42	052	2A	0010 1010	10
+	43	053	2B	0010 1011	11
,	44	054	2C	0010 1100	12
-	45	055	2D	0010 1101	13
.	46	056	2E	0010 1110	14
/	47	057	2F	0010 1111	15
0	48	060	30	0011 0000	16
1	49	061	31	0011 0001	17
2	50	062	32	0011 0010	18
3	51	063	33	0011 0011	19
4	52	064	34	0011 0100	20
5	53	065	35	0011 0101	21
6	54	066	36	0011 0110	22
7	55	067	37	0011 0111	23
8	56	070	38	0011 1000	24
9	57	071	39	0011 1001	25
:	58	072	3A	0011 1010	26
;	59	073	3B	0011 1011	27
<	60	074	3C	0011 1100	28
=	61	075	3D	0011 1101	29
>	62	076	3E	0011 1110	30
?	63	077	3F	0011 1111	

ASCII CHAR.	DECIMAL	OCTAL	HEX	BINARY 7654 3210	DEV. NO.
@	64	100	40	0100 0000	0
A	65	101	41	0100 0001	1
B	66	102	42	0100 0010	2
C	67	103	43	0100 0011	3
D	68	104	44	0100 0100	4
E	69	105	45	0100 0101	5
F	70	106	46	0100 0110	6
G	71	107	47	0100 0111	7
H	72	110	48	0100 1000	8
I	73	111	49	0100 1001	9
J	74	112	4A	0100 1010	10
K	75	113	4B	0100 1011	11
L	76	114	4C	0100 1100	12
M	77	115	4D	0100 1101	13
N	78	116	4E	0100 1110	14
O	79	117	4F	0100 1111	15
P	80	120	50	0101 0000	16
Q	81	121	51	0101 0001	17
R	82	122	52	0101 0010	18
S	83	123	53	0101 0011	19
T	84	124	54	0101 0100	20
U	85	125	55	0101 0101	21
V	86	126	56	0101 0110	22
W	87	127	57	0101 0111	23
X	88	130	58	0101 1000	24
Y	89	131	59	0101 1001	25
Z	90	132	5A	0101 1010	26
[	91	133	5B	0101 1011	27
\	92	134	5C	0101 1100	28
]	93	135	5D	0101 1101	29
^	94	136	5E	0101 1110	30
_	95	137	5F	0101 1111	

ASCII CHAR.	DECIMAL	OCTAL	HEX	BINARY 7654 3210	DEV. NO.
`	96	140	60	0110 0000	0
a	97	141	61	0110 0001	1
b	98	142	62	0110 0010	2
c	99	143	63	0110 0011	3
d	100	144	64	0110 0100	4
e	101	145	65	0110 0101	5
f	102	146	66	0110 0110	6
g	103	147	67	0110 0111	7
h	104	150	68	0110 1000	8
i	105	151	69	0110 1001	9
j	106	152	6A	0110 1010	10
k	107	153	6B	0110 1011	11
l	108	154	6C	0110 1100	12
m	109	155	6D	0110 1101	13
n	110	156	6E	0110 1110	14
o	111	157	6F	0110 1111	15
p	112	160	70	0111 0000	16
q	113	161	71	0111 0001	17
r	114	162	72	0111 0010	18
s	115	163	73	0111 0011	19
t	116	164	74	0111 0100	20
u	117	165	75	0111 0101	21
v	118	166	76	0111 0110	22
w	119	167	77	0111 0111	23
x	120	170	78	0111 1000	24
y	121	171	79	0111 1001	25
z	122	172	7A	0111 1010	26
{	123	173	7B	0111 1011	27
|	124	174	7C	0111 1100	28
}	125	175	7D	0111 1101	29
~	126	176	7E	0111 1110	30
	127	177	7F	0111 1111	

	Battery Power Lost	RESET ALL	Power-Up RESET	
Self test, report errors		X	X	
Set-up per I/F switches	X			X
Calendar to 01-Jan-84	X			
Time to 00:00:00 hours	X			
Clear error log	X	X		X
Clear interpolation table	X	X	X	
Reset/initialize options	X	X	X	X
Calibrate A/D Converters (default line freq)	X	X		
Calibrate A/D Converters (line freq)			X	X
Set system variables defaults	X	X		
Build/rebuild system channel list	X	X	X	X
Return prompt to host computer (HCLI or !)		X	X	

Appendix 9e
Sales and Service Centers

NORTH AMERICAN SERVICE CENTERS

JOHN FLUKE MFG. CO.,INC.
Bill Fetrow, Service Manager
P.O. Box C9090
Everett, WA 98206
206-356-5560

CENTRAL REGION
Bruce Hunt
Regional Customer Support Manager
1150 W. Euclid Ave.
Palatine, IL 60067
312-705-0500
FAX: (312) 705-1505

WESTERN REGION
Mike Nagy
Regional Customer Support Manager
2020 N. Lincoln St. (ZIP 91504)
P.O. Box 7366
Burbank, CA 91510
213-849-4641
FAX: 213-846-7949

EASTERN REGION
Ed Bader
Regional Customer Support Manager
West 75 Century Rd.
P.O. Box 930
Paramus, NJ 07653-0930
201-262-9550
FAX: 201-262-0948

FLUKE TECHNICAL CENTER
Jeff Crooks, Service Manager
2020 N. Lincoln St. (ZIP 91504)
P.O. Box 7366
Burbank, CA 91510
213-849-4641
FAX: 213-846-7949

FLUKE TECHNICAL CENTER
Dick Katsch, Service Manager
2300 Walsh Avenue, Bldg. K
Santa Clara, CA 95051
408-727-8121
TWX: 910-338-0121

FLUKE TECHNICAL CENTER
Ron Vidick, Service Manager
14180 East Evans Ave.
Aurora, CO 80014
303-695-1000
TWX: 910-320-2986

FLUKE TECHNICAL CENTER
Duane Smith, Service Manager
1150 W. Euclid Ave.
Palatine, IL 60067
312-705-0500
FAX: 312-705-1505

FLUKE TECHNICAL CENTER
Al Keating, Service Manager
West 75 Century Rd.
P.O. Box 930
Paramus, NJ 07653-0930
201-262-9550
FAX: 201-262-0948

FLUKE TECHNICAL CENTER
Phil Raup, Service Manager
5640 Fishers Lane
Rockville, MD 20852
301-770-1576
FAX: 301-770-1365

FLUKE TECHNICAL CENTER
Walt Witko, Service Manager
940 N. Fern Creek Avenue
Orlando, FL 32803
305-896-4881
TWX: 810-850-0185

ALLAN CRAWFORD ASSOCIATES LTD.
Herb Duval, Service Coordinator
5835 Coopers Avenue
Mississauga, Ontario L4Z 1Y2
416-890-2010

FLUKE TECHNICAL CENTER
Johnnie Winters, Service Manager
1801 Royal Lane, Suite 307
Dallas, TX 75229
214-869-0311
TWX: 214-869-9637

FLUKE TECHNICAL CENTER
Dave Tattrie, Field Service Manager
Middlesex Technology Center
900 Middlesex Turnpike
Building 8
Billerica, MA 01821
617-663-2400
TWX: 710-332-8876

ALLAN CRAWFORD ASSOCIATES LTD.
Marcel Raymond, Service Supervisor
7018 Cote de Liesse
St. Laurent, Quebec H4T 1E7
514-731-8564

ALLAN CRAWFORD ASSOCIATES LTD.
Tom Donaway, Service Supervisor
#14 1935 30th Ave. N.E.
Calgary, Alberta T2E 6Z5
403-230-1341

INTERNATIONAL
DIRECT SERVICE ORGANIZATIONS

FLUKE (HOLLAND) B.V.
P.O. Box 2269
5600 CG Eindhoven
Netherlands
Tel: 31-40-458045
Tlx: (844) 51846
Fax: 31-40-457515

FLUKE (BELGIUM) N.V./S.A.
Guido van Waas, Service Manager
Rue de Geneve 6
1140 Brussels, Belgium
Tel: 32-2-2164090
Tlx: (846) 26312

FLUKE (GB) LTD
Len Millard, Customer Support Mgr.
Ken Garner, Service Manager
Colonial Way
Watford, Herts WD2 4TT
England
Tel: 44-923-40511
Tlx: (851) 934583
Fax: 44-923-25067

FLUKE (DEUTSCHLAND) GmbH
Jons Hegemann, Service Manager
Oskar-Messter-Strasse 18
Postfach 11 53
8045 Ismaning
West Germany
Tel: 49-89-9605240
Tlx: (841) 0522472
Fax: 49-89-9605166

FLUKE (NETHERLANDS) B.V.
Andre Wolters, Service Manager
Gasthuisring 14
P.O. Box 115
5000 AC Tilburg
The Netherlands
Tel: 31-13-352455
Tlx: (844) 52683

JOHN FLUKE MFG. CO., INC.
JAPAN BRANCH
Norio Fujii, Service Manager
1-1-11 Hamamatsucho
Minato-ku, Tokyo 105, Japan
Tel: 81-3-434-0181
Tlx: (781) 2424331 FLUKJPJ
Fax: 81-3-434-0170

INSTRIMPEX - FLUKE SERVICE CENTER
Boon Tin Choi, Service Manager
57, Xisi Dong Da Jie
Xicheng-qu
Beijing
People's Republic of China
Tel: 86-01-65-7281

INTERNATIONAL SERVICE REPRESENTATIVES

WALTER REKIRSCH ELEKTRONISCHE GERATE GMBH & CO.
Hubert Schrenk, Service Manager
Vertrieb KG
H. Obachgasse 28
1220 Vienna, Austria
Tel: 43-222-235555
Tlx: (847) 134759

TAGE OLSEN A/S
Villy Henriksen, Service Manager
Ballerup Byvej 222
2750 Ballerup
Denmark
Tel: 45-1 or 2-658111
Tlx: (855) 35293 TOAS DK

ELECTRONIC ENGINEERING LIAISON OFFICE
Faisal L. Kadri, Managing Director
P.O. Box 2891 Horreya
11361 Heliopolis, Cairo
Egypt
Tel: 20-2-695705
Tlx: (927) 22782

AMTEST ASSOCIATES LTD.
John Adamson, Service Manager
Clarence House
31 Clarence Street
Staines, Middlesex TW18 4SY
England
Tel: 44-784-63555
Tlx: (851) 928855 AMTEST G

INSTRUMENTARIUM ELEKTRONIIKKA
Helge Bergstrom, Service Manager
P.O. Box 64, Vitikka 1
02631 ESPOO 63
Finland
Tel: 358-0-5281
Tlx: (857) 124426 HAVUL SF

M.B. ELECTRONIQUE S.A.
Serge Pison, Service Manager
606, Rue Fourney, P.O. Box 31
78530 BUC, France
Tel: 33-1-39-56-81-31
Tlx: (842) 695414

HELLENIC SCIENTIFIC REPRESENTATIONS
Mr. Savvas, Service Manager
11, Vrassida Street
Athens 612, Greece
Tel: 30-1-7211140
Tlx: (863) 219330

R.D.T. ELECTRONICS ENGR., LTD.
Joseph Adir, Customer Support Mgr.
P.O. Box 43137
Tel Aviv 61430
Israel
Tel: 972-3-483211
Tlx: (922) 371452 RDT IL
Fax: 972-3-492190

SISTREL S.p.A.
Giorgio Albertini, Service Manager
Via Pelizza da Volpedo 59
20092 Cinisello Balsamo
Milan, Italy
Tel: 39-2-6181893
Tlx: (843) 334643

MORGENSTIERNE & CO. A/S
Finn Schjerven, Service Manager
Konghelletgate 3
P.O. Box 6688 - Rodelokka
Oslo 5, Norway
Tel: 47-2-356110
Tlx: (856) 71719

DECADA ESPECTRAL
Equipamentos de Electronica e Cientificos, SARL
Luis Mourao, Service Manager
Av. Bombeiros Voluntarios
Lote 102B, Miraflores/Alges
1495 Lisboa, Portugal
Tel: 351-1-2103420
Tlx: (832) 15515

EQUIPOS Y SISTEMAS S.A. (ESSA)
Tomas Fernandez, Service Manager
C/Apolonio Morales, 13-B
Madrid 16, Spain
Tel: 34-1-458-0150
Tlx: (831) 42856 EYS E

KALIBER AB
Magnus Tibell, Service Manager
P.O. Box 4443
S-16204 Vallingby, Sweden
Tel: 46-8-380350
Tlx: (854) 14077 TIAB S
Fax: 8-38-05-03

TRACO ELECTRONIC AG
Jorg Stampfli, Service Manager
Jenatschstrasse 1
8002 Zurich, Switzerland
Tel: 41-4-201-0711
Tlx: (845) 815570 TRCOCH

ERKMAN ELECTRONIK ALETLER
Suheyl Erkman, Manager
Ticaret Anonim Sirketi
Necatibey Cad 92/3
Karakoy, Istanbul, Turkey
Tel: 90-11-441546 or 447651
Tlx: (821) 24399

INTERNATIONAL SERVICE REPRESENTATIVES

COASIN S.A.
Alberto Vento, Mgr. Electronics Lab
Virrey del Pino 4071
Buenos Aires, Argentina
Tel: 54-1-522-5248 or 3485
Tlx: (390) 22284 COASN AR

ELMEASCO INSTRUMENTS PTY LTD.
John Weismantel, Service Manager
P.O. Box 30
Concord, N.S.W. 2137
Australia
Tel: 61-2-736-2888
Tlx: (790) ELSCO AA25887
FAX: 61-2-733663

ELMEASCO INSTRUMENTS PTY LTD.
John Weir, Service Manager
12 Maroondah Hwy
P.O. Box 623
Ringwood, Victoria 3134
Australia
Tel: 61-3-879-2322
Tlx: (790) AA30418 ELTENT
FAX: 61-3-879-4310

ELMEASCO INSTRUMENTS PTY LTD.
Dick Grieff, Service Manager
G.P.O. Box 2360
Brisbane, Queensland 4001
Australia
Tel: 61-7-369-8688
TLX: (790) AA44062 ELMQLD

HI-TEK ELECTRONICA LTDA.
Victor Camarena, Service Manager
Al. Amazonas 422, Alphaville,
Barueri
CEP 06400, Sao Paulo, Brazil
Tel: 55-11-421-5477
Tlx: (391) 1135589

INTRONICA CHILE LTDA.
Guardia Vieja 241
Santiago 9, Chile
Tel: 56-2-2321886,2324308
Tlx: (332) 346351 INTRON CK

SISTEMAS E INSTRUMENTACION, LTDA.
Jorge Berman, Director
Carrera 13, No. 37-43, Of. 401
Ap. Aereo 29583
Bogota DE, Colombia
Tel: 57-232-4532
Tlx: (396) 45787 COASN CO

PROTECO COASIN CIA., LTDA.
Andy Williams, Service Manager
P.O. Box 228-A
Ave. 12 de Octubre 2285 y Orellana
Quito, Ecuador
Tel: 593-2-529684 or 526759
Tlx: (393) 2865 PROTEC ED

SCHMIDT & CO. (H.K.) LTD.
S.H. To, Service Manager
18/FL., Great Eagle Centre
23 Harbour Road
Wanchai, Hong Kong
Tel: 852-5-8330251
Tlx: (780) 74766 SCHMC HX
Fax: (852) 5-8918754

HINDITRON SERVICES PVT. LTD.
Ashutosh Parasnis, Service Manager
1st Floor, 17-B, Mahal Industrial Estate
Mahakali Road, Andheri East
Bombay 400 093, India
Tel: 6300043 or 6300527
Tlx: (953) 11-73448 HIPL IN

HINDITRON SERVICES PVT. LTD.
Field Service Centre
8th Main Road
33/44-A Raj Mahal Vilas Extn.
Bangalore - 560 080, India
Tel: 91-812-33139 or 367289
Tlx: (953) 845741 HSPL IN

HINDITRON SERVICES PVT. LTD.
15 Community Centre
Panchshila Park
New Delhi 110 017, India
Tel: 011-661869
Tlx: (953) 031-61458 HCPL IN

HINDITRON SERVICES PVT. LTD.
Srinath Complex Ltd., 5th Fl.
1-1-58/1 to 1-1-58/11
Sarojini Devi Road
Secunderabad 500 003, India
Tel: 821117
Tlx: (953) 155-333 PCO IN

P.T. DWI TUNGGAL JAYA SAKTI
Daniel Kristanto, Service Manager
P.O. Box 4435
Wisma Harapan Bldg., 14th Flr.
Jl. Jend. Sudirman Kav. 34
Jakarta Pusat
Indonesia
Tel: 62-21-584685
Tlx: (796) 47308 DIJS IA

MYOUNG CORPORATION
Dong Wha Lee, Service Manager
Rm# 1501, Sinsong Bldg.
25-4 Yeouido-dong, Young Deung PO-KU
Seoul 150, Korea
Tel: 82-2-784-9942
Tlx: K24283 Myoung

MECOMB MALAYSIA Sdn. Bhd.
S.A. Ng., Manager
P.O. Box 24
46700 Petaling Jaya
Selangor, Malaysia
Tel: 60-3-743422
Tlx: (784) MA37764 MECOMB

MEXICANA DE ELECTRONICA INDUSTRIAL, S.A. (MEXEL)
Luis Cruz, Service Manager
Diagonal No. 27
Entre Calle de Eugenia Y Ave
Colonia del Valle
C.P. 03100, Mexico
Tel: 90-5-660-4323
Tlx: (383) 1771038 FAIRME

NORTHROP INSTRUMENTS & SYSTEMS LTD.
Information Technology Group
Mark Bennett, Regional Service Mgr.
459 Kyber Pass Road, Newmarket
Private Bag, Newmarket
Auckland 1, New Zealand
Tel: 64-9-501-801, 501-219
Tlx: (791) NZ21570 THERMAL

NORTHROP INSTRUMENTS & SYSTEMS LTD.
Information Technology Group
R.W. Hoy, Nat'l Group Service Mgr.
First Floor, Northrop Bldg.
189-191 Willis Street
P.O. Box 2406
Wellington, New Zealand
Tel: 64-4-856-658
Tlx: (791)3380 A/B NZ3380 NORTHAC

INTERNATIONAL OPERATIONS (PAK), LTD.
Iqbal Rauf Khan, Sales Manager
505 Muhammadi House
I.I. Chundrigar Road
P.O. Box 5323
Karachi, Pakistan
Tel: 92-21-221127, 239052
Tlx: (952)24494 PIO PK

IMPORTACIONES & REPRESENTACIONES ELECTRONICAS SA
Julio Bravo, Service Manager
Avda Franklin D. Roosevelt 105
Lima 1, Peru
Tel: 51-14-288650
Tlx: (394) 25663 PE IREING

SPARK RADIO AND ELECTRONICS CORP.
Frank Atienza, General Manager
Greenhills P.O. Box 610
Metro-Manila Zip, 3113
Philippines
Tel: 63-2-775192
Tlx: (722) 27901 RLA PH

RANK O'CONNOR'S SINGAPORE (PTE) LTD.
Ong Ee Lin, Service Manager
98 Pasir Panjang Road
Singapore 0511
Republic of Singapore
Tel: 65-4737944
Tlx: OCONSIN RS21023

PROTEA PNI
Les Wesson, Service Manager
746 Sixth Street, Wynberg
P.O. Box 39127
Bramley 2018
Republic of South Africa
Tel: 27-11-786-3647
Tlx: 4-24409 SA
Fax: 27-11-786-1807

---

a/d converter

Analog-to-Digital Converter. A circuit used to convert information in analog form (such as voltage or current measurements) into digital form.

ADC

See a/d converter.

address

The channel number that represents an I/O channel.

analog

The representation of numerical quantities that do not have discrete values but that are continuously variable. Electrical measurements are analog in nature until converted into digital signals by an a/d converter. See digital.

ANSI

American National Standards Institute; an industry supported U.S. organization that primarily serves to coordinate and publish technical standards requested by its members.

ASCII

American Standard Code for Information Interchange; ASCII is a standardized code set of 128 characters, including upper and lower case alphabet, numerals, and a set of control characters (line feed, carriage return, etc.)

baud

Originally used to express the capabilities of a telegraph transmission facility in terms of "modulation rate per unit of time." For practical purposes, it is now used interchangeably with "bits per second" as a unit of measure for data flow.

BCD

Binary Coded Decimal; BCD is a digital data format in which each digit of a decimal (base 10) number is represented in order, by its binary equivalent. For example, the decimal number 597 is represented as (0101 1001 0111) in BCD. See binary.

binary

The base two number system; binary numbers are made up of ones and zeros. The least significant digit represents one, the next digit represents twos, the next digit represents fours, and so on with each digit of the binary number corresponding to the next higher exponent of two. See also BCD.

bit

The smallest element of a binary number; a bit (contraction of "binary digit") either represents a high or a low state (one or zero, also mark or space).

bridge

In a measuring system, an instrument in which part or all of its circuit measures one or more electrical quantities. Quarter-, half-, and full-bridge strain gauges can be used. See microstrai strain gauge.

CCITT

Comite Consulatif International Telegraphic et Telephonique; an international organization concerned with devising and proposing standards for international telecommunications.

CD

Carrier Detect; RS-232-C, line 8. This signal is sent by DCE to tell DTE that a suitable carrier is present at the DCE. See also DTE, DCE.

Counter/Totalizer

An option assembly that measures frequency and totalizes event occurrences.

CTS

Clear to Send; RS-232-C line 5. Sent by DCE to DTE when it is ready to accept data. See also DCE, DTE.

current shunt

Traditionally, a precision, low-value resistor placed across an ammeter's terminals to increase its range. The Computer Front End uses a current shunt resistor in the input circuitry of each channel of the current input connector. The shunt resistor allows the current input to develop a voltage that the Analog to Digital Converter can measure.

DCE

Data Communication Equipment; the RS-232-C term for computer equipment that sends or receives data. Modems are examples of DCE. The other type of computer equipment specified by RS-232 is DTE, Data Terminal Equipment.

default

The value or state selected by system software (or firmware) when the user doesn't specify one.

digital

A circuit or device concerned only with high or low states (or pulses), generating a logical or numerical result. Digital computers, calculators, and digital watches use digital circuitry. See analog.

DSR

Data Set Ready; RS-232-C line 6. Indicator from DCE to DTE that a suitable line connection has been made, that all preliminary line protocol is complete, and that it is ready for data transfer. See also DCE, DTE.

DTE

Data Terminal Equipment; the RS-232-C Standard term for computer equipment where digital information originates or terminates. The Computer Front End, terminals, and computers are examples of DTE. The other type of computer equipment specified by RS-232-C is DCE, Data Communication Equipment.

DTR

Data Terminal Ready; RS-232-C line 20. Sent by DTE to DCE when it is ready to transfer data.

EIA

Electronic Industries Association; the organization that devises electrical and data communication standards including RS-232-C and RS-422.

floating point

A numerical notation useful for computer calculations. In the Computer Front End, the resolution of a floating point number is 7 digits, and its range is up to 38 places either side of the decimal. When the decimal point is out of range of the displayed digits, the number is displayed in exponential form (E+mn or E-mn, where mn represents the number of places the decimal point must be moved; + for right and - for left).

frequency

The number of cycles-per-second (Hertz) of an alternating signal. Can be measured using the Counter/Totalizer Option (-167).

gauge factor

A strain gauge parameter, gauge factor specifies the characteristics of the strain gauge material being used.

GND

Ground; RS-232-C line 1. A chassis connection intended for the cable shield. Not to be used for signal reference.

interface

A hardware and software connection of a device to a system.

interference

The presence of undesirable energy in a circuit, caused by electrostatically or electromagnetically coupled external circuits.

I/O

Input/Output.

isothermal

An area of equal temperature. The Thermocouple Input Connector (-175) uses an alloy isothermal terminal block to stabilize and equalize input lead temperatures.

microstrain

The unit of strain measured by a strain gauge.

modem

A transmitter and receiver of digital data. One modem receives data from an attached computer terminal and sends the data on a modulated carrier signal to another modem. The other modem demodulates the received carrier and sends the recovered data to another computer terminal.

overrange

The state indicated by a measurement instrument when an input signal is greater (or lower) than the range that the instrument can measure.

serial link address

Address for a serial link device. The address range is manually set on the A/D Converter, Analog Output, and Digital I/O Assemblies.

serial link device

An assembly performing an output or measurement input function. There are positions (horizontal slots) for six such devices in each the Computer Front End.

serial port

A connection point on a computer that is used to transfer information in a serial manner. Data transmission through a serial port in the Computer Front End is in the form of asynchronous ASCII codes.

shield input

The input lead on various Computer Front End options that can be grounded or connected to the low lead at a measurement point to reduce interference. The shield input is attached to the braided shield wire surrounding the conductor in the cable.

signal ground

A conductor establishing electrical ground reference potential for all transmitting circuits in a communications network.

strain gauge

A resistive transducer the electrical output of which is proportional to the amount it is deformed under stress or strain. Strain gauge circuits use fixed precision resistors and resistors bonded to a surface to be mechanically loaded, in quarter-, half-, or full-bridge configuration. See also bridge, gauge factor, microstrain.

thermocouple

A pair of dissimilar conductors joined together, forming form a junction that generates a voltage when the opposite conductors are at different temperatures. The Computer Front End has provisions for 12 different types of thermocouples.

transducer

A device that converts energy from one form to another. An example of a transducer is a strain gauge.

XMT

Transmitted Data, RS-232-C line 2. The line that carries the stream of serial data from DTE to DCE. See also RS-232-C, serial data, DCE, DTE.

X-OFF

CTRL/S or DC3 ASCII code (decimal 19); sent by the receiving station to halt transmission from the sending station when information is coming too fast for the receiver to process. When able to receive more information, the receiving station sends X-ON to restart the transmitting station. See also X-ON.

X-ON

CTRL/Q or DC1 ASCII code (decimal 17); sent by the receiving station to cause the transmitting station to resume transmission of data after being halted by an X-OFF command. See also X-OFF.

```
START SCAN(1),OUTPUT=SBUF(1),INTERVAL=60
```

Start Scan (1) with an interval of 60 sec.

```
START SCAN(2),OUTPUT=SBUF(2),INTERVAL=10,DELAY=120
```

Start Scan (2) with an interval of 10 sec. but wait for two minutes before starting the second scan. Store data from both scans in their respective buffers.

```
SEND ABUF
```

Check if alarm conditions have been detected.

```
SEND SBUF(1)
```

Send the first buffer record of scan task 1 to the terminal and remove it from the buffer.

```
SHOW SBUF(2)
```

Send the first record of scan task 2 to the terminal but do not remove it from the buffer

```
STOP SCAN(1)
STOP SCAN(2)
```

Stop the scan tasks.

parity

A method of error detection that uses one extra bit for each unit of information (such as a character). The parity bit is set to one or zero so that the total number of one-bits in the byte is even or odd, depending on the type of parity in use.

Poisson's ratio

A strain gauge parameter; the ratio of the lateral strain to the longitudinal strain in a specimen subjected to a longitudinal stress.

port

A connection point used for data transfer. See interface.

protective ground

The common chassis ground that is connected to earth ground through the ground wire in the line power cord. See also signal ground.

REC

Received Data, RS-232-C line 3. This line carries the stream of serial data from DCE to DTE. See also serial data, DCE, DTE.

RET

Return; RS-232-C line 7. A signal return line that serves as a zero voltage reference point for all other signals.

RFI

Radio Frequency Interference; see interference.

RS-232-C

A digital communications standard agreed upon by participating manufacturers of data communication equipment for the transfer of serial digital data between data communication equipment (DCE) and data terminal equipment (DTE). The Computer Front End is a DTE device. The standard is published and maintained by the Electronic Industries Association, 2001 Eye Street, N.w., Washington, D.C. 20006. See also DCE, DTE, serial data.

RTD

Resistance Temperature Detector; a device with a resistance that varies predictably with changes in temperature. Made of various materials, with platinum the most popular and accurate.

RTS

Request To Send; RS-232-C line 4. The signal from DTE to DCE when it has data to transmit. See also DTE, DCE.

scanner

A type of option used by the Computer Front End to select a desired analog input channel for measurement.

serial data

Information transmitted one bit at a time over a single line at a predefined bit rate (baud). See also baud.

serial link

Internal Computer Front End bus between controller and option assemblies.

Appendix 9g
Programming Example
Scan/Alarm

This section contains a programming example intended only to demonstrate the use of the Scan/Alarm Functions.

```
RESET ALL                          Resets the whole system.

MODE = TERM                        Select the TERMinal Mode.

SEND MEMSIZ                        Check how much memory is
                                   available.

DEF CHAN(0..9)=TC,TYPE=KNBS,CHFN=POLY(0,5,20)

                                   Define channels 0..9 as
                                   thermocouple inputs with
                                   polynomial coefficients 0,
                                   5 and 20.

DEF CHAN(10..19)=DVIN, HIHI=1.5, LOLO=0.8, HI=1.30,
                                   LO=1.20, HYST=15

                                   Define channels 10..19 as
                                   Direct Volt Inputs with four
                                   limits and hysteresis.
```

9g/Programming Example
Scan/Alarm

```
DEF SCAN(1)=CHAN(0..9)
DEF SCAN(2)=CHAN(10..19)
```

Define two scan tasks, one for each group of channels.

```
DEF SBUF(1)=10
```

Define buffer for measurement data. Reserve memory for 10 records.

```
DEF SBUF(2)=20
```

Define buffer for measurement data. Reserve memory for 20 records

```
DEF ABUF=15
```

Define an alarm buffer. Reserve memory for 15 alarm messages.

```
LIST SCAN(1)
LIST SCAN(2)

LIST SBUF(1)
LIST SBUF(2)

LIST ABUF
```

Check if everything is correct

&, 4-13

AC Voltage Measurement, 2-42, 61-1
AC Volts Input Connector, 3b-15
ASCII Character Codes, 9c-1
Abort (<CTRL>/C, Decimal 3), 4-12
Accessories, 1-9
Address Assignment, 3b-13
Addressing Scheme, 3b-12
Alarm Limits, 5-23
Analog Output, 3b-67, 5-29, 6a-1

Battery Charging, Non-Volatile Memory, 1-12

CAL, 5-123
COUNT, 5-125
Cabling Connections, 3a-22
Cabling to the Host Computer, 1-13
Channel Function, 5-13, 5-27
Channel Numbers, 5-16
Character Buffering, 4-21
Cleaning, Fan Filter, 7-6
Cleaning, General, 7-7
Command Format, 4-4
Command Reference, General Use, 5-6
Command Responses, 4-15
Command Set Summary, 4-5
Communicating with the Front End, 1-15
Communication Character Buffering, 4-21
Communication Links, Implementation, 4-20
Communication Switches, 3a-26, 3a-9
Communications Format, 1-14
Computer Mode, 1-16

Computer Mode, 4-16, 5-69
Computer Mode, Command Responses, 4-18
Computer Mode, Initializing, 4-17
Configuration Summary, 3a-8
Configuring Your Computer, 9a-1
Configuring the Front End, 3a-3
Connecting to Your Computer or Terminal, 1-11
Counter/Totalizer Input, 5-31
Counter/Totalizer, 3b-45
Current Input Connector, 3b-73
Current Measurements, 6b-1

DATE$, 5-127
DEF ABUF, 5-21
DEF CHAN
DEF Command
DEF SBUF, 5-57
DEF SCAN, 5-59
DEF TABLE, 5-61
DLE + EOT, 4-13
Definition (DEF) Command, 4-6
Delete (Decimal 127), 4-12
Digital I/O Assembly, 3b-53
Digital I/O, 5-33
Digital/Status Input Connector, 3b-117
Digital/Status Inputs, 6c-1
Direct Connection, 3a-16
Direct Current Input, 5-35
Dual Function Interface Connector, 3a-12

ENQ, 4-13
EOL, 5-129
EOT, 4-13
Error Buffers, Communications, 4-24
Error Information, 8-5
Error Messages, General, 8-4
Extender Cable Connectors, 3b-145
Extender Cable, 3b-143
Extender Chassis, 1-4, 3b-137

Fan Filter Cleaning, 7-6
FORMAT, 5-131
Frequency Measurements, 6d-1
Fuse Replacement, 7-6

Getting Started - Introduction, 1-2
Getting Started - Setup, 1-10
Glossary, 9f-1

HOSTTO, 5-137
High Performance A/D Converter, 3b-21
Host Computer Connection, 3a-12

INTERRUPT, 5-139
Isothermal Input Connector, 3b-93

LABEL CHAN, 5-64-1
LINEFR, 5-141
LIST ABUF, 5-65
LIST CHAN, 5-67
LIST Command, 4-9
LIST ERROR, 5-79
LIST SBUF, 5-83
LIST SCAN, 5-85
LIST TABLE, 5-89
Line Power Voltage Selection, 3a-3
Line Voltage Setting, 7-1

MODE, 5-143
Mainframe, 1-4
Mainframe, Placement, 3a-1
Mainframe, Rack Mounting, 3a-2
Measurement System, 1-4
Modem (Auto-Answer)
    Communication, 3a-17
    Cabling, 3a-18
    Linking, 3a-19
    Two-Point Direct-Connect, 3a-18
    Two-Point, Dedicated Line, 3a-18
Modem Communication, 3a-16
Multipoint Configurations, 3a-23

Non-Volatile Memory Battery Charging, 1-12
Notation Conventions, 5-6
Numeric Representation, 5-17

Option Assemblies, 1-6
Option Categories, 3b-7
Option Loading, 3b-6
Option Requirements, 3b-4
Options, General, 3b-1

Placement, 3a-1
Power Requirements, Additional, 3b-9
Power Supply, 3b-149
Power Up and Reset Routines, 9d-1
Printer Port Connection (Scan/Alarm), 3a-26
Protocols, Data Channel, 3a-16

RESET ABUF, 5-95
RESET ALL, 5-93
RESET CHAN, 5-93
RESET Command, 4-10
RESET SBUF, 5-95
RESET, 5-93
RS-232-C Cables, 3b-171
RS-232-C Printer Port Signal Descriptions, 3a-27
RS-232-C Signal Descriptions, 3a-12
RS-422 Cable Connections, 3a-22
RS-422 Multipoint Configuration, 3a-23
RS-422 Signal Descriptions, 3a-19
RS-422 Two-Point Configuration, 3a-22
RTD/Resistance Input Connector, 3b-109
RTD/Resistance Scanner, 3b-33
Rack Mounting, 3a-2
Repeat ("!") Command, 4-11
Resistance Input, 5-37
Resistance Measurements, 6e-1

SEND ABUF, 5-97
SEND CHAN, 5-103
SEND Command, 4-10
SEND SBUF, 5-109
SEND Value of System Variable, 5-113
SHOW ABUF, 5-153
SHOW FIRST|LAST|AGAIN ABUF, 5-153
SHOW FIRST|LAST|AGAIN SBUF, 5-155
SHOW SBUF, 5-155
START SCAN, 5-157
STOP SCAN, 5-161
Sales and Service Centers, 9e-1
Scan/Alarm Option, 1-8, 2-30, 3b-129, 3c-3, 4-24
Scan/Alarm Printer Port, 3a-26
Serial Data Reference, 9b-1
Serial Link Cable Length, 3b-11
Service Information, 7-8
Set CHAN, Analog Output, 5-119
Set CHAN, Status Output, 5-121
Set Command, 4-7
Special Characters, 4-11
Specifications
    -160 AC Voltage Input Connector, 2-9
    -161 High Performance A/D Converter, 2-10
    -162 Thermocouple/DC Volts Scanner, 2-11
    -163 RTD Scanner, 2-13
    -164 Transducer Excitation Module, 2-15
    -167 Counter/Totalizer, 2-17
    -168 Digital I/O, 2-19
    -169 Status Output Connector, 2-20
    -170 Analog Output Module, 2-21
    -171 Current Input Connector, 2-23
    -174 Transducer Excitation Connector, 2-24
    -175 Isothermal Input Connector, 2-25
    -176 Voltage Input Connector, 2-26
    -177 RTD/Resistance Input Connector, 2-27
    -179 Digital/Status Input Connector, 2-29
    -201 Scan/Alarm Option, 2-30

Specifications (continued)
    AC Voltage Measurement, 2-42
    DC Current Measurement, 2-43
    DC Voltage Measurement, 2-41
    Interface, 2-4
    Mainframe, 2-3
    Resistance Measurement, 2-44
    Strain Measurement, 2-49
    Temperature Measurement Using RTDs, 2-33
    Temperature Measurement Using Thermocouples, 2-31
Stall and Unstall(<CTRL>/S and <CTRL>/Q) 4-12
Status Output Connector, 3b-59
Status Outputs, 6f-1
Strain Input, 5-39
Strain Measurement, 6g-1
Syntactic Elements, 5-13
Syntax Diagrams, 5-8
System Considerations, 3b-2
System Variables, 4-8

TERM, 5-145
TEST Command, 4-11, 5-163
TIME$, 5-149
TIME, 5-147
TUNIT, 5-151
Temperature Input - RTD, 5-45
Temperature Input - TC, 5-49
Temperature Measurement
    Using RTDs, 6h-1
    Using Thermistors, 6i-1
    Using Thermocouples, 6j-1
Terminal Mode, 1-16, 4-14, 5-77
Testing, Mainframe Installation, 3c-1
Testing, Option Assembly, 3c-3
Testing, Scan/Alarm, 3c-3
Thermocouple/DC Volts Scanner, 3b-27
Timeouts, 4-23
Totalizing Measurement, 6k-1
Transducer Excitation Connector, 3b-79
Transducer Excitation Module, 3b-39
Turning On the Computer Front End, 1-17

Unpacking, 1-10

Voltage Input Connector, 3b-101
Voltage Input, 5-53
Voltage Measurement - Alternating, 6l-1
Voltage Measurement - Direct, 6m-1

Y1060 RS-422 Multipoint Connector, 3b-170
Y2044 Rack Slide Kit, 3b-159
Y2045 Rack Mount Kit, 3b-165
Y2047 Multi-Connector/Adapter, 3b-169