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TempScan/1000

High Speed Temperature Measurement System

USER'S MANUAL

IOtech, Inc • 25971 Cannon Road • Cleveland, Ohio 44146 • (216) 439-4091

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TempScan/1000
User's Manual

Part #199-0920
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IOtech, Inc • 25971 Cannon Road • Cleveland, Ohio 44146 • (216) 439-4091

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Introduction

1.1 General Description

The TempScan/1000 is a high speed temperature measurement system which gathers temperature data from up to 992 sensors No external signal conditioning, multiplexors, or custom cables are required The TempScan/1000 was designed with an extreme amount of flexibility to meet the needs of the most demanding temperature measurement applications

Physically, the TempScan/1000 can measure up to 32 differential input channels and can easily be expanded up to 992 channels via a "master/slave" architecture, wherein a single TempScan/1000 unit can be connected to as many as 15 expansion chassis Each slave (Exp/10) is identical in size to the master unit and is configurable for either 32 or 64 channels of thermocouple inputs

Thermocouple linearization is performed using lookup tables which are faster and more accurate than calculated polynomial equations Support for B, E, J, K, R, S, X, N (14 and 28 gauge) and T thermocouple types are standard In addition, two custom lookup tables of up to 256 points each may be stored in NVRAM for use with user-defined thermocouples

Each input channel may be configured as any thermocouple type or as a millivolt input

Temperature values may be returned in units of °C, °F, °K, °R, or mV Data formatting options include ASCII or, for high speed applications, binary format

For monitoring temperature trends, an optional time stamp is available in absolute time

Although the TempScan/1000 can acquire temperature readings at a rate of 960 channels/second, it may also be programmed by the user to acquire data at specified time intervals using the HH MM SS S format For the ultimate in flexibility, the user can program separate pre- and post-trigger sample rates For example, the TempScan/1000 can be programmed to sample data once per hour and then sample once per second when channel 2 reaches 70°C

If your application necessitates gathering large amounts of data, options are available for expanding the standard 256kB of memory to 1MB, 4MB, or 8MB Readings may then be transferred at greater than 300 kbytes per second over the IEEE-488 bus or up to 9,600 baud using its standard RS-232/422 port

Statistics such as high, low, and last are available for each channel for data reduction In addition, up to 32 alarms may be programmed using the programmable high and low limits for each channel

The TempScan/1000 accepts three types of scanning modules the TempTC/32 (thermocouple card), the TempRTD/16 (RTD card) or the TempV/32 (volts card) These scanning modules plug into any slot on a TempScan/1000 master or slave unit Since many system requirements specify a combination of temperature and analog inputs, the TempV/32 eliminates the need for synchronizing separate and possibly incompatible A/D measuring instruments or boards

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1.2 Available Accessories

Additional accessories that can be ordered for the TempScan/1000 include

Exp/10	Two Slot expansion chassis accepts any combination of scanning modules and includes rack-mount kit and master/slave cable (CA-35-1)
TempTC/32	Thermocouple scanning module (32 channels)
TempV/32	Analog voltage scanning module (32 channels)
TempRTD/16	3- or 4-wire RTD scanning module (16 channels)
TempMEM1	500K reading (1 Mbyte) memory option
TempMEM4	2M reading (4 Mbyte) memory option
TempMEM8	4M reading (8 Mbyte) memory option
LTNPC	Labtech Notebook for PCs
CA-7-3	Shielded IEEE 488 cable, 6 ft
CA-85	PC Serial port (25 pin sub D) to TempScan/1000 (RS-232) cable, 6 ft
CA-86	PC/AT serial port (9 pin sub D) to TempScan/1000 (RS-232) cable, 6 ft

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1.3 Specifications

TEMPSCAN/1000

Number of Slots· 1

Number of Channels: Up to 32 differential thermocouple or voltage inputs

Channel Attributes. High and low setpoints, hysteresis values for high and low setpoints

Acquisition Speed 960 channels per second

Channel Update Rate: 60 times per second (60Hz) 50 times per second (50Hz)

Scan Sequence· Channels may be programmed in any combination of channel list (1,2,3,) or channel range (1-10)

Scan Interval. Absolute time between scans (hh mm ss s),
min = 00 00 00 0, max = 99 59 59 9
Note Specifying a value of 00 00 00 0 results in no delay between channel scans

Programmable Triggering Immediate (command), Level (temperature or voltage), absolute time of day, alarm condition, IEEE GET, IEEE TALK, external TTL trigger

Temperature-Level Trigger: Programmable value for any one channel

TTL Trigger Programmable for rising or falling edges

Pre-Trigger Count Programmable integer (< memory size -1)

Post-Trigger Count Programmable integer

Digital Filtering: Average 16 samples at 50/60 Hz for line cycle noise

ALARMS & DIGITAL I/O

Number of Digital Inputs: 8 bits, TTL level compatible

Number of Digital Outputs· 32 bits, TTL level compatible

Connector. 50 pin D-connector, mating connector supplied

Alarm Conditions May be detected by SRQ or (SPOLL or U command)

Alarm Update Rate· Alarms are updated whenever a channel assigned to an alarm is measured

Note The 32 TTL outputs can be set or cleared via program control

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DATA STORAGE & FORMAT

Storage. 128K reading (256 Kbyte) standard, optional 500 K reading (1 Mbyte), 2M reading (4 Mbyte), 4M reading (8 Mbyte)

Data Formats ASCII and binary, binary format returns a 16-bit compensated and linearized temperature value (0 1°C/bit), user programmable for hi/low byte or low/hi byte, Note High speed DMA transfers are binary format only

Statistical Parameters Hi, lo, and last available per channel

Time Stamp. Available for each scan group and for each channel's hi, lo, and last parameters Time Format. Relative time (hh mm ss sss), absolute time (hh mm ss sss) or absolute date and time (dd/mm/yy hh mm ss sss)

IEEE 488 INTERFACE

Implementation SH1, AH1, T6, TE4, L4, LE4, SR1, PP0, RL0, DC1, DT1, C0, E1

Programmable Parameters· Alarm set points, thermocouple type, temperature units, trigger level, pre-trigger and post-trigger scan interval, trigger mode, SRQ mask, scan count, pre-trigger count, digital input, digital output, real time settings, data output format, and terminators

Data Transfer Speed· up to >300 Kbytes/s

Connector. Standard IEEE 488 connector with metric studs

RS-232/422 INTERFACE

Baud Rates 300, 600, 1200, 2400, 4800 and 9600

Data Bits. 8

Stop Bits: 1

Parity. Even, Odd, None

Handshaking· RTS/CTS, XON/XOFF (for ASCII transfers only)

GENERAL

Front Panel Indicators LEDs for alarm, scanning, talk, listen, srq, error, send, receive, power, and trigger status

Power. 105-125 or 210-250 VAC, 50/60 Hz, 20 VA max

Warm-Up 1 hour to rated accuracy

Environment. 0° to 50°C, 0 to 95% RH (non-condensing) to 35°C, linearly derate 3% RH/°C from 35°C to 50°C

Dimensions: 425mm wide x 305mm deep x 45mm high (16 75" x 12" x 1 75")

Weight· 3 62 kg (8 lbs)

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Rear Panel:

IEEE-488 Connector: Standard IEEE-488 connector with metric studs

RS-232/422 Connector Male DB-9

Master/Slave Port Female DB-25

Digital I/O & Alarms Female DB-50 (32 Alarms, 8 digital inputs, 10 ground pins)

Trigger Input· BNC

Trigger Output BNC

Configuration Switches IEEE/488 or RS-232/422, IEEE address, handshake, parity, baud rate

AC Power

Power Switch

CALIBRATION

Calibration of cold junction sensor Software control of calibrated thermocouple using the TEMPCAL program (Calibration performed for each card in the system)

Voltage Calibration· Software control of gain and offset

Calibration Constants. Stored in NVRAM

Exp/10 EXPANSION CHASSIS

Number of Slots: 2

Number of Channels Up to 64 differential voltage or thermocouple inputs, accepts any combination of two TempTC/32 and TempV/32 scanning modules

Front Panel Indicators. LEDs for scanning, error, power

Power. 105-125 or 210-250 VAC, 50/60 Hz, 20 VA max

Environment 0° to 50°C, 0 to 95% RH (non-condensing) to 35°C, linearly derate 3% RH/°C from 35° to 50°C

Dimensions: 425mm wide x 305mm deep x 45mm high (16 75" x 12" x 1 75")

Weight· 2 53 kg (5 5 lbs)

Rear Panel.

Configuration Switches DIP switch for setting slave ID

Master/Slave Port Female DB-25 (2)

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TEMPCARD/32 THERMOCOUPLE INPUT CARD

Number of Channels 32 differential, programmable by channel as specific thermocouple type or 100mV full scale input

Input Types. J, K, T, E, R, S, B, N, custom thermocouple, and millivolts

Input Connectors Screw Terminal

Thermocouple Wire #20 AWG recommended (#18 AWG maximum)

Temperature Range & Accuracy

Type	Range	Accuracy*	Resolutions
J	-100° to +760°C -200° to -100°C	±0 5°C ±0 8°C	0 10°C 0 20°C
K	-100° to +1372°C -200 to -100°C	±0 6°C ±0 8°C	0 10°C 0 20°C
T	-100° to +400°C -200 to -100°C	±0 5°C ±0 8°C	0 15°C 0 25°C
E	-100° to +1000°C -200 to -100°C	±0 7°C ±0 9°C	0 10°C 0 20°C
N	-100°C to +1300°C -200 to -100°C	±0 6°C ±0 9°C	0 15°C 0 20°C
R	0 0° to 1780°C	±2 0°C	0 40°C
S	0 0° to 1780°C	±2 0°C	0 40°C
B	+350° to 1820°C	±2 0°C	0 50°C

* 18° to 28°C, 1 year Includes cold junction compensation Excludes thermocouple errors

ϕ - Typical

Temperature Units: °C, °F, °K, °R mV

Fault Detection: Open T/C may be detected by a software query

Cold Junction Sensors: One for every 8 input channels

Linearization. Look-up table (varies by thermocouple type), look-up table supports two user-defined custom T/C types of up to 256 points each Look-up tables are stored in battery backed up memory

Maximum Allowable Input: ±25Vrms

Channel to Digital Low Isolation· 500V max

Channel to Channel Isolation. ±10V peak

Temperature Coefficient <(0 1 x rated accuracy)/°C

Digital Filtering Averages 16 samples at 50/60 Hz for line cycle noise

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Voltmeter Range/Resolution ±100mV/3 25 uV

Voltmeter Accuracy: ±(0 06% + 3 counts)

Voltmeter Units Volts, counts

TEMPRTD/16 RTD SCANNING MODULE

Number of Input. 16 (3 or 4 wire)

Input Connectors· Screw Terminal

Temperature Range & Accuracy.

Type	Range	Accuracy	Resolution
100Ω platinum	-100°C to +630°C	±0 2°C	0 1°C
	-270°C to -100°C	±0 4°C	0 2°C

Excitation Current <1 mA peak

Temperature Coefficient <(0 1 x rated accuracy)%/°C

Temperature Units. °C, °F, °K, °R, and counts

TEMPV/32 ANALOG VOLTAGE SCANNING MODULE

Number of Input. 32 differential

Input Connectors Screw Terminal

Range/Resolution

Range	Resolution
±100 mV	3 1212 µV/BIT
±1 V	31 2121 µ V/BIT
±5 V	156 0606 µV/BIT
±10 V	312 1211 µV/BIT

Accuracy. ±(0 06% + 3 counts)

Digital Filtering Averages 16 samples at 50/60 Hz for line cycle noise

Temperature Coefficient· <0 01%/°C

Input Impedance: 1MΩ typ

Input bias Current· 40nA maximum

Common Mode Rejection 100dB typ

Maximum Allowable Input: 25Vrms max

Channel to Digital Low Isolation 500V max

Channel to Channel Isolation: ±10V peak

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1.4 Abbreviations

The following IEEE 488 abbreviations are used throughout this manual

addr n	IEEE bus address "n"
ATN	Attention line
CA	Controller Active
CR	Carriage Return
DCL	Device Clear
GET	Group Execute Trigger
GTL	Go To Local
LA	Listener Active
LAG	Listen Address Group
LF	Line Feed
LLO	Local Lock Out
MLA	My Listen Address
MTA	My Talk Address
PPC	Parallel Poll Configure
PPU	Parallel Poll Unconfigure
SC	System Controller
SDC	Selected Device Clear
SPD	Serial Poll Disable
SPE	Serial Poll Enable
SRQ	Service Request
TA	Talker Active
TAD	Talker Address
TCT	Take Control
term	Terminator
UNL	Unlisten
UNT	Untalk
*	Unasserted

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Installation & Configuration

2.1 Inspection

The TempScan/1000 components were carefully inspected prior to shipment When you receive your temperature measurement system, carefully unpack all items from the shipping carton and check for any obvious signs of physical damage which may have occurred during shipment Immediately report any damage to the shipping agent Retain all shipping materials in case you must return the unit to the factory

Every TempScan/1000 is shipped with the following items

- TempScan/1000 High-Speed Temperature Measurement System
- TempScan/1000-900 User's Manual
- TempScan/1000-610 Programmed Disk in IBM Format
- TempScan/1000-006 Accessory Kit, including

  CN-18-50 Digital I/O mating connector (DB-50)

  CA-1 Power Cable

  FE-1 Rubber Feet (4)

  EN-6 Rack Ears (2)

  HA-41-6 Rack Screws (4)

  FU-1- 25 1/4 Amp Replacement Fuse (for 220 volt operation)

2.2 Front Panel Indicators

Ten indicator lights on the front panel of the TempScan/1000 display the status of the temperature measurement system The function of each indicator is described below

ALARM	ON when an alarm has occurred and will remain on until alarm condition is cleared OFF when no alarm condition exists
TRIGGER	Flashing when ARMed (waiting for a trigger), ON when triggered, OFF when data collection is finished Also turned OFF by IEEE DCL or SDC
SCAN	ON when the TempScan/1000 is storing a channel scan in its internal buffer

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SEND	ON when transmitting data to the serial interface (for RS-232/422 operation only)
RECEIVE	ON when receiving data from the controlling computer (for RS-232/422 operation only)
TALK	ON when the TempScan/1000 is in the Talker state, OFF when the TempScan/1000 is in the Idle or Listener state (for IEEE 488 operation only)
LISTEN	ON when the TempScan/1000 is in the Listener state, OFF when the TempScan/1000 is in the Idle or Talker state (for IEEE 488 operation only)
SRQ	ON when the TempScan/1000 has generated a Service Request (SRQ), OFF when no SRQ is pending Refer to the SRQ Mask (Mn) command for more information (for IEEE 488 operation only)
ERROR	ON when an error has occurred, OFF when no error condition exists See the Error Query (E?) command for more information
POWER	ON when power is applied to the TempScan/1000 and the power switch on the back panel is in the on position (depressed) OFF if power is not present

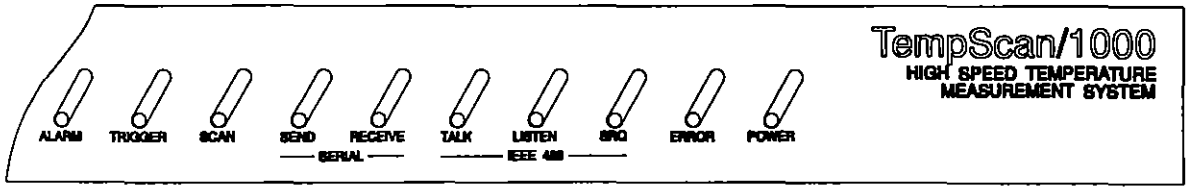


Figure 2 1: TempScan/1000 Front Panel

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2.3 TempScan/1000 Rear Panel Controls and Connectors

Two switches, seven connectors and a plug-in board on the rear panel of the TempScan/1000 provide power, IEEE 488 addressing, triggering, and I/O connections The function of each is described below

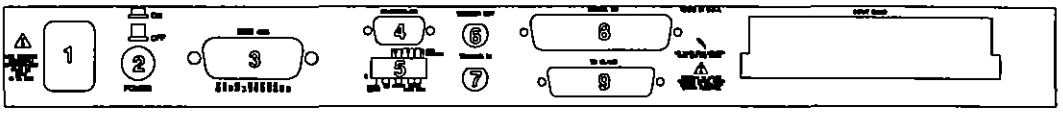


Figure 2 2· TempScan/1000 Rear Panel

1.	Power Connector	Provides power for the TempScan/1000 (110/220 VAC)
2.	POWER Switch	Used to turn power to the TempScan/1000 ON and OFF When pressed in, the power is ON When out, the power is OFF
3	IEEE 488 Connector	Connector for the IEEE 488 interface
4.	RS-232C/422 (DB-9) Connector	Serial port for operation at remote distances from controlling computer, supports 300 to 9,600 baud using RTS/CTS or XON/XOFF handshaking
5	DIP Switch	Used for selecting IEEE or RS-232/422 communication and respective parameters (IEEE 488 Address, RS-232/422 handshaking, parity and Baud Rate)
6	TTL OUTPUT	BNC TTL Scan output signal occurs for each channel scan, used for synchronizing other equipment with TempScan/1000 acquisition
7	TRIGGER INPUT	BNC Trigger input for initiating and/or stopping acquisition with TTL input signal

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8	Alarms & Digital I/O Connector	DB50 connector offers easy access to Alarms and Digital I/O (32 digital outputs and 8 digital inputs)
9	Master/Slave Port	Master/Slave port connects to TempScan/1000 slave units to support applications up to 992 channels

2.4 Exp/10 Rear Panel Controls and Connectors

The Exp/10 expansion chassis contains the panel controls and connectors described below

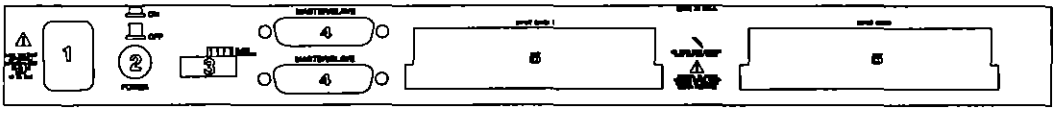


Figure 2.3 Exp/10 Rear Panel

1	Power Connector	Internally configurable for either 105-125 or 210-250 VAC, 50/60Hz, plus fuse circuit breaker
2	POWER Switch	Used to turn power to the Exp/10 ON and OFF When pressed in, the power is ON When out, the power is OFF
3	DIP Switch	Used for selecting Exp/10 slave ID
4	Master/Slave (DB-25) Connector	Provides connection from the TempScan/1000 to the other Exp/10 chassis
5	Shielded Enclosure	Accepts any combination of scanning modules (TempTC/32, TempV/32 or TempRTD/16)

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2.5 Internal Configuration

The internal configuration of a TempScan/1000 consists of setting the line voltage, replacing fuses, enabling/disabling the watchdog timer and optionally, installing expanded memory boards The TempScan/1000 temperature measurement system has a factory default to operate at 110 volts and IEEE 488 bus address 7 However, the unit may be operated at 110 or 220 V AC and the IEEE 488 bus address can be changed To change the operating voltage, it is necessary to open the enclosure The IEEE 488 address can be changed from the rear panel Before modifying any of these items, disconnect the power cord from the power line and disconnect any input or output connections from the rear panel of the TempScan/1000

Line voltage must be set for 110 or 220 VAC to match the power being supplied to the TempScan/1000 If the line voltage is changed, the fuse must also be changed See Figure 2 4 for fuse and line voltage switch locations

WARNING

Disconnect the power cord from the power line and from the TempScan/1000 prior to disassembly

Never open the TempScan/1000 case while it is connected to the power line. Internal voltage potentials exist that could cause personal injury

To avoid injury, de-energize attached circuits, then disconnect the TempScan/1000 from other equipment and the power line before changing the internal configuration of the TempScan/1000

To open the unit, place the TempScan/1000 on a flat surface Remove the six screws on top of the case and remove the top cover Reverse this procedure to reassemble the unit

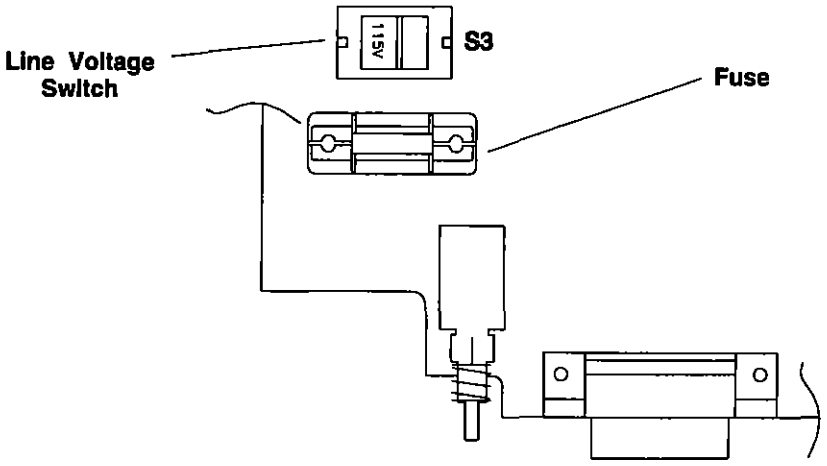


Figure 2 4. Line Voltage Switch and Fuse Location

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2.5.1 Line Voltage Selection

The TempScan/1000 can be operated from 90-125 or 210-250 VAC, 50-60 Hz The interface was shipped from the factory set for the operating voltage marked on the label placed over the rear panel line cord jack If this setting is not appropriate for the power to be supplied to the unit, the setting of the internal voltage switch (S3) and the power fuse must be changed to avoid damage to the unit The locations of S3 and the fuse are shown in Figure 2 4

CAUTION

A fuse with a rating higher than that specified may cause damage to the instrument and may pose a fire hazard If the instrument repeatedly blows fuses, locate and correct the cause of the trouble before replacing the fuse

1 The line voltage selection switch (S3) is located next to the power supply transformer on the right rear of the bottom circuit board Insert the tip of a small screwdriver into the slot of the switch and slide the switch until it clicks into place with the desired line voltage visible

2 Install a power line fuse appropriate for the line voltage The fuse is located next to the internal line voltage switch (S3) Pull upward on the plastic fuse housing to remove the entire housing with the fuse inside Select a fuse with the proper rating (see following table)

Line Voltage	Fuse Type
90-125V	½ A 250V, Slo Blo, 3AG
210-250V	¼ A 250V, Slo Blo, 3AG

3 Open the fuse housing by pushing up on the tab on the bottom of the housing

4 Replace the fuse and close the housing Replace the fuse housing in the fuse holder Make sure the fuse snaps into place

5 Make note of the new voltage setting for later reference and carefully re-assemble the unit

2.5.2 Watchdog Timer Enable/Disable (JP4)

This 3 pin header allows the elective use of the MultiScan watchdog timer function If enabled, the effect of the *R command is a full power-on reset where the MultiScan hardware components will be initialized to their power-up state If disabled, the *R command will only perform a software reset by restarting at location 0 The default setting is Watchdog Timer Enabled

To enable, place the shunt jumper in the enabled position as shown below To disable, place the jumper in the disabled position shown below

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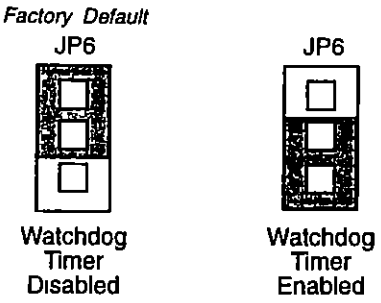


Figure 2 5· Watchdog Timer Settings

2.5.3 Calibration Jumper (JP10)

The calibration jumper clip should only be installed when the calibration password has been lost Installing this clip will allow the changing of the calibration password (via the *K command) without the TempScan/1000 being in calibration mode Refer to Section 7 1 1 for details on calibration mode and passwaord and instructions on installing the calibration jumper clip

2.5.4 Expanded Memory Options

The TempScan/1000 can accommodate up to 8Mbytes of memory, which is ideal for both high-speed and long-term data logging Measurements can be stored in memory and read out by a controlling computer as time permits Readings may be transferred at up to 300 kbytes per second over the IEEE 488 bus or up to 9,600 baud using the unit's standard RS-232/422 port

The TempScan/1000 provides three options for expanding the standard 256kB of memory to 1MB (TempMEM1), 4MB (TempMEM4), or 8MB (TempMEM8) To install a memory option into the unit, it is necessary to perform the following steps

1 Disconnect the power cord from the power line and from the TempScan/1000 Disconnect any IEEE 488 or digital I/O cables prior to disassembly

WARNING

Never open the TempScan/1000 case while it is connected to the power line. Internal voltage potentials exist which could cause personal injury or death.

2 Place the TempScan/1000 on a flat surface Remove the six screws on top of the case and remove the top cover

3 Located on the main PC Board Assembly are SIMM memory module connectors JP8 and JP7 Install your memory option according to the instructions in the table below Refer to Figure 2 6 for assistance

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MEMORY OPTION	INSTRUCTIONS
TempMEM1 (1MB)	Remove 256 KB module from JP7 and insert 1 MB module
TempMEM4 (4MB)	Remove 256 KB module from JP7 and insert 4 MB module
TempMEM8 (8MB)	Remove 256 KB module from JP8 and insert 4 MB modules into JP8 and JP7

4 Replace the top cover and screws

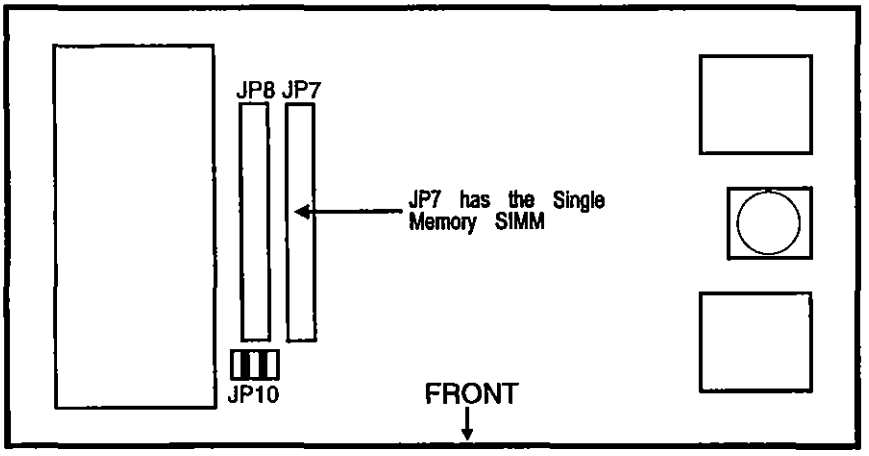


Figure 2 6: TempScan/1000 Expanded Memory Options

2.6 Configuring the Communication Interface

The TempScan/1000 is equipped with a high-speed IEEE 488 interface and an RS-232/422 interface The unit's IEEE interface is useful in laboratory applications and enables real-time transfers of acquired data to the host computer's hard drive for inexpensive mass storage Its RS-232/422 interface is ideal in applications that require the placement of instrumentation at remote distances from the controlling computer, such as process and environmental control

The TempScan/1000 can be set up with RS-232/422 or IEEE 488 interfacing Each unit's system configuration is set by switches accessible from its rear panel The switches select which command set is to be used, RS-232/422 or IEEE 488, and the operation parameters for both

The rear panel switches are read only during power on or reset and should be set before applying power Figure 2 7 shows the factory default settings for the rear panel switches The table after the diagrams shows the options for the switches Additional switch settings are shown in the following sections describing IEEE 488 bus or RS-232C configuration

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To modify any of these defaults, change the switch settings using a small screwdriver The enclosure does not need to be opened to change the switches

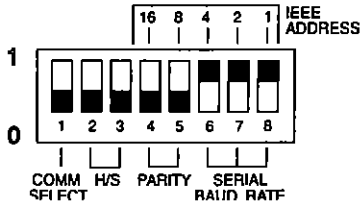


Figure 2 7· TempScan/1000 Default Switch Settings

TempScan/1000 Rear Panel Switches				
SWITCH #	**LABEL**	**SETTINGS**	**IEEE 488**	**RS-232/422**
1	COMM SELECT	1 RS-232/422 0 IEEE 488		
2,3	HANDSHAKE (H/S)	00 No Handshake 01 Software Handshake only (XON/XOFF) 10 Hardware Handshake only (RTS/CTS) 11 Both Hardware/Software Handshake		X
4, 5	IEEE ADDRESS or PARITY	RS-232/RS-422. 00 No Parity 01 Odd Parity 10 Even Parity 11 N/A		X
6,7,8	IEEE ADDRESS or BAUD RATE	RS-232 000 300 baud 001 600 baud 010 1200 baud 011 2400 baud 100 4800 baud 101 9600 baud 110 N/A 110 N/A 111 N/A		

CAUTION

At 9600 baud, hardware handshaking and possibly software handshaking may be required to maintain serial performance.

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2.6.1 IEEE 488 Configuration

This section describes the configuration for TempScan/1000s that will be commanded through the IEEE 488 bus All IEEE 488 bus devices, including the TempScan/1000 must have an IEEE 488 bus address The switches labeled IEEE ADDRESS are used for this purpose

The bus address can be set from 0 through 30 and is read only at power on or reset The address is selected by simple binary weighting The switch labeled 1 is the least significant bit, 16 is the most significant bit The factory default is address 7 Figure 2 8 shows the factory default IEEE 488 bus address setting Note if address 31 is selected, it defaults to address 30 because the IEEE 488 standard has reserved address 31

This switch is read only when power is applied to the unit and should be set before applying power Change the switch settings using a small screwdriver The enclosure does not need to be opened to change the switch settings

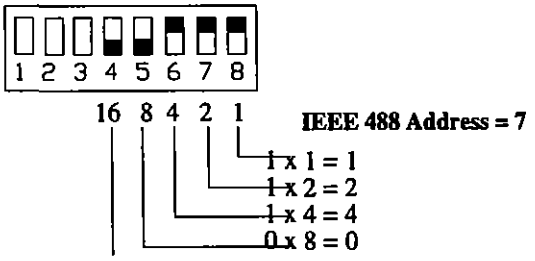


Figure 2 8. IEEE 488 Bus Address Setting (default)

2.6.2 RS-232/422 Configuration

Alternatively, the TempScan/1000 can be controlled through its serial port connector The serial port is capable of operating with either RS-232 or RS-422 electrical characteristics Complete serial port configuration is accomplished by using both hardware jumpers and switch settings Hardware jumpers, located on the main board behind each serial connector, are used to to configure the port electrically as either RS-232 or RS-422 Switch settings determine the baud rate, stop bits, parity, and handshake

2.6.2.1 RS-232/422 Configuration Jumpers

To open the TempScan/1000, first place it on a flat surface Then remove the six screws on top of the case and remove the top cover

WARNING

Never open the TempScan/1000 case while it is connected to the AC line Internal voltage potentials exist which could cause personal injury or death

Located in front of the serial port connector is a set of connectors with configuration jumpers

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The serial port is capable of operating with either RS-232 or RS-422 electrical characteristics This selection is done via a set of hardware jumpers located on the main board behind the serial connector A twelve position jumper plug must be inserted in one of the two available positions for proper operation These jumpers are factory set to configure the port for RS-232 levels as illustrated in Figure 2 9

If configured for RS-422, the port's Receive Data (RxD) and Clear to Send (CTS) input lines may optionally be terminated with a 100 ohm resistor Termination resistors are selected by positioning the two flea clips (JP14, JP15) located behind each serial connector towards the front panel, or upper position These jumpers are factory set to the unterminated position, towards the rear panel

Figure 2 9 illustrates the port 1 jumpered in RS-232, RS-422 unterminated, and RS-422 terminated with 100 ohm resistor (left to right) NOTE When using RS-422 in a single ended configuration, ports must be unterminated for proper operation NOTE Termination jumpers have no effect when port is configured for RS-232 operation

To reconfigure the serial port for RS-422 operation, remove the twelve position configuration jumper and reinsert it so that the center socket is now connected to the left socket as viewed from the rear of the unit If single-ended operation is desired, move the two flea clips to the position farthest from the serial port connectors

Once the jumper(s) have been repositioned for your particular application, make note of the new jumper settings for later reference and carefully reassemble the unit

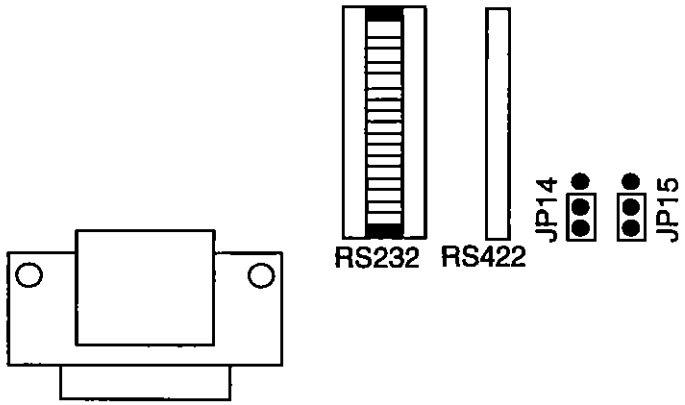


Figure 2.9: View of Configuration Jumpers

2.6.2.2 Serial Port Pin Connectors

The TempScan/1000 is equipped with one DB-9S connector on its rear panel and requires a DB-9P mating connector The TempScan/1000's connector is configured as an IBM AT when RS-232 levels are selected and Macintosh II/SE/Plus when RS-422 levels are selected

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The tables below list the RS-232 and RS-422 pin connections A description of each of the signals follows the tables

RS-232 Serial Port Pin Connectors

PIN	DESCRIPTION	INPUT/OUTPUT
1	No connection	
2	Receive Data (RxD-)	Input
3	Transmit Data (TxD-)	Output
4	No connection	
5	Ground	
6	No connection	
7	Request to send (RTS+)	Output
8	Clear to send (CTS+)	Input
9	No connection	

RS-422 Serial Port Pin Connectors

PIN	DESCRIPTION	INPUT/OUTPUT
1	Ground	
2	Request to send positive (RTS+)	Output
3	Request to send negative (RTS-)	Output
4	Transmit Data positive (TxD+)	Output
5	Transmit Data negative (TxD-)	Output
6	Clear to send positive (CTS+)	Input
7	Clear to send negative (CTS-)	Input
8	Receive data positive(RxD+)	Input
9	Receive data negative(RxD-)	Input

SIGNAL	DESCRIPTION
RxD Receive Data (input)	This pin accepts serial data sent by an RS-232 or RS-422 device The serial data received is expected to match the word length, baud rate, stop bits, and parity configuration of the particular port This signal is low true

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RxD+ Receive Data (input)	This pin accepts serial data sent by an RS-422 device It functions identically to RxD- except that its polarity is inverted This signal is high true
TxD- Transmit Data (output)	This pin transmits serial data to an RS-232 or RS-422 device The serial data received is sent with the word length, baud rate, stop bits, and parity configured for the particular port This signal is low true
TxD+ Transmit Data (output)	This pin transmits serial data to an RS-422 device The pin functions identically to TxD- except that its polarity is inverted This signal is high true
CTS+ Clear To Send (input)	The CTS+ input is used as a hardware handshake line to prevent the TempScan/1000 from transmitting serial data to an RS-232 or RS-422 device when it is not able to accept it When RTS/CTS handshaking is selected , the TempScan/1000 will not transmit data out TxD+ while this signal is un-asserted (low) If XON/XOFF or no handshaking is selected, the CTS+ line is ignored when transmitting data
CTS- Clear To Send (input)	The CTS- input is used as a hardware handshake line with RS-422 devices The pin functions identically to CTS+ except that its polarity is inverted This signal is low true
RTS+ Request To Send (output)	The RTS+ output is used as a hardware handshake line to prevent an RS-232 device from transmitting serial data to the TempScan/1000 when it is not able to accept it When automatic RTS/CTS handshaking is selected , the TempScan/1000 will assert (high) the RTS+ signal when greater than 4096 memory locations are available in its internal buffers If available memory drops below 4096 bytes, the TempScan/1000 un-asserts (low) the RTS+ signal
RTS Request To Send (output)	The RTS- output is used as a hardware handshake line with RS-422 devices The pin functions identically to RTS+ except that its polarity is inverted This signal is low true
GND Ground	This signal sets the ground reference point for the other RS-232/422 input and output signals

2.6.2.3 RS-232/422 Configuration Switches

The switch settings required for RS-232/422 operation are as follows

The switch labeled COMM SELECT must be up (1) The down (0) position is reserved for IEEE 488 communication This sets the unit for RS-232/422

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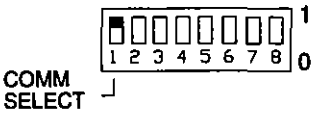


Figure 2.10 Set for RS-232/422 Operation

When the RS-232 port is used, the type of handshaking must be selected by the switches labeled H/S TempScan/1000 offers the options of no handshaking, XON/XOFF, RTS/CTS or both XON/XOFF and RTS/CTS handshaking Figure 2 11 shows the switch settings for each option

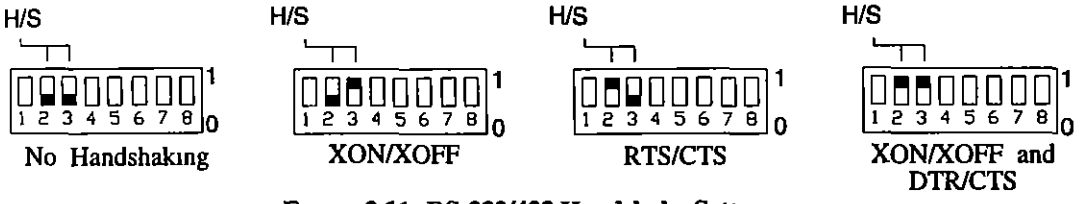


Figure 2.11: RS-232/422 Handshake Settings

The parity must be selected using the switches labeled PARITY TempScan/1000 provides for no parity, odd or even parity Figure 2 12 shows the switch settings for each option

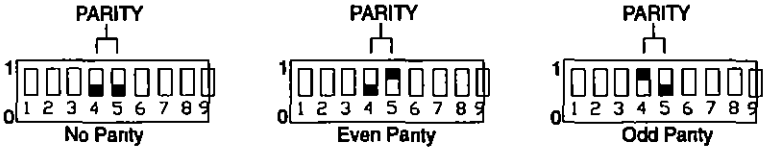


Figure 2 12. RS-232/422 Parity Settings

The baud rate is selected using the switches labeled RS-232/422 BAUD RATE The available baud rates are 300, 600, 1200, 2400, 4800, and 9600 The settings for each are shown in Figure 2 13

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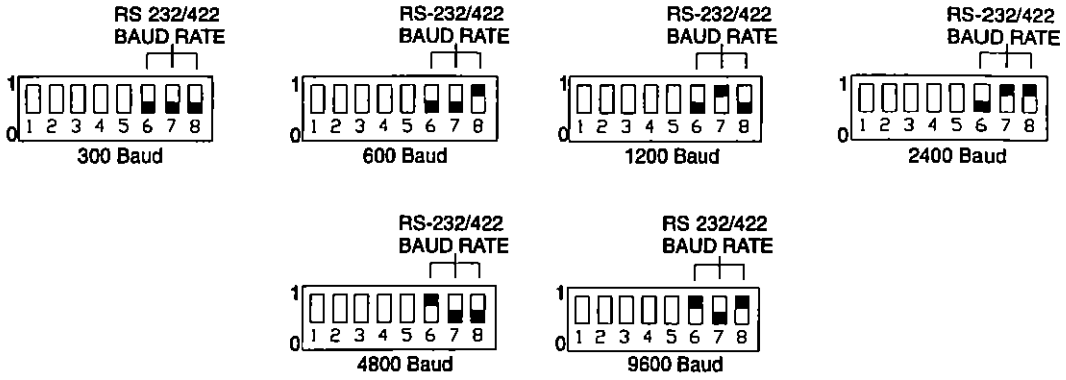


Figure 2 13 RS-232/422 Baud Rate Settings

2.7 Digital Input/Output Lines

The TempScan/1000 has eight digital input lines and thirty-two digital output lines available on a rear panel DB-50 connector These lines can be output and/or input using TempScan/1000 commands

2.7.1 Logic Levels

Each digital output line will drive five (5) standard TTL loads All digital input lines are one-eighth (0 125) TTL loads All inputs are protected against damage from high static voltages Normal precautions should be taken to limit the input voltages to –0 3 to +5 3 volts All digital I/O lines are referenced to digital ground (Pins 33-42)

WARNING

Exceeding these levels will cause damage to the TempScan/1000 unit which is not covered by the warranty

2.7.2 Digital I/O Port Pinouts

The pinouts of the TempScan/1000 Digital I/O connector are detailed in the figure and the tables below

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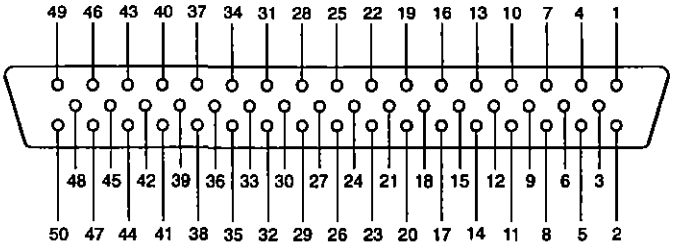


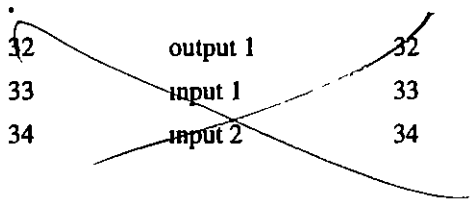
Figure 2 14· DB50 Female Connector Pinouts

DB-50 PIN	SIGNAL	DB-50 PIN	SIGNAL
1	output 1	17	output 17
2	output 2	18	output 18
3	output 3	19	output 19
4	output 4	20	output 20
5	output 5	21	output 21
6	output 6	22	output 22
DB-50 PIN	**SIGNAL**	**DB-50 PIN**	**SIGNAL**
7	output 7	23	output 23
8	output 8	24	output 24
9	output 9	25	output 25
10	output 10	26	output 26
11	output 11	27	output 27
12	output 12	28	output 28
13	output 13	29	output 29
14	output 14	30	output 30
15	output 15	31	output 31
16	output 16	32	output 32

Pins 33 - 42 are grounds

DB-50 PIN	INPUT/OUTPUT	ALARM #
1	output 1	1
2	output 2	2
3	output 3	3

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2.8 Scanning Modules

The TempScan/1000 and the Exp/10 expansion chassis both accept three kinds of optional scanning modules which can measure thermocouples, voltages and RTDs

Each scanning module fits into a metal, shielded enclosure inside the unit to keep noise outside and maintain a constant internal temperature A foam-padded strain relief cushions the wires as they exit the rear panel

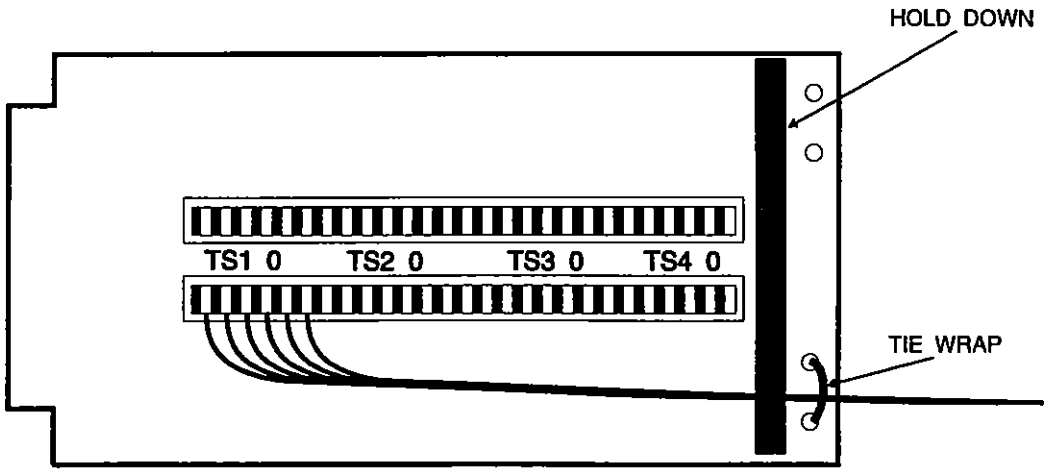


Figure 2.15. TempTC/32 Scanning Module Installation

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2.8.1 Input Bias Currents and Ground Reference Registers

TempTC/32 & TempV/32 Users

For differential input configuration, each input must have biasing currents A certain amount of current must be flowing into the differential inputs or else capacitance-induced noise will make the inputs appear as noise

The low side of each differential input channel is provided with a switchable 10kΩ resistor to analog common This allows a current path when no current is flowing due to no common ground connections or a high impedance input source

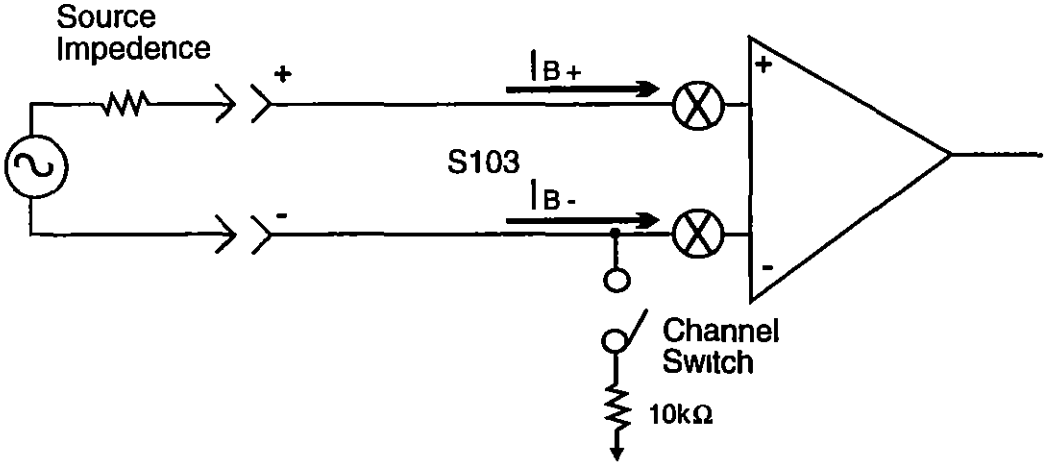


Figure 2.16. Input Bias Currents Diagram

With no common ground connection, closing the switch connects a 10kΩ resistor between the (L) input and ground and provides a common mode impedance

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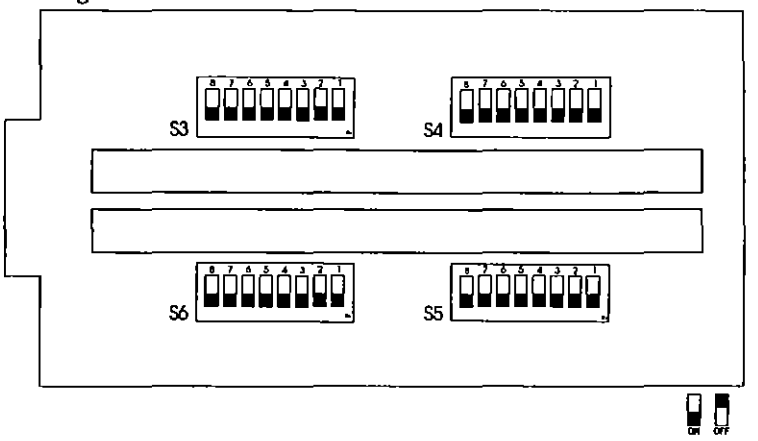


Figure 2 17 TempTC/32 & TempV/32 Switch Settings

Figure 2 17 displays the factory default dip switch settings for the TempTC/32 and TempV/32 scanning modules Valid settings for specific channels are described in the table below

Channel	Switch	Channel	Switch
1	S6-8	17	S5-8
2	S6-7	18	S5-7
3	S6-6	19	S5-6
4	S6-5	20	S5-5
5	S6-4	21	S5-4
6	S6-3	22	S5-3
7	S6-2	23	S5-2
8	S6-1	24	S5-1
9	S3-8	25	S4-8
10	S3-7	26	S4-7
11	S3-6	27	S4-6
12	S3-5	28	S4-5
13	S3-4	29	S4-4
14	S3-3	30	S4-3
15	S3-2	31	S4-2
16	S3-1	32	S4-1

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2.8.2 TempTC/32 Thermocouple Scanning Module

The TempTC/32 thermocouple scanning module contains 32 differential input channels, each of which may be configured as any thermocouple type or as a millivolt input Temperature values may be returned in units of °C, °F, °K, °R, or mV

This scanning module contains screw terminal sockets for quick and easy input connections Connections are made by inserting the thermocouple wire into a screw terminal socket Straps are provided on each plug-in board to keep thermocouple wires from all 32 channels organized and manageable before they exit the rear panel

2.8.3 TempV/32 Voltage Scanning Module

The TempV/32 scanning module contains 32 differential input channels and is capable of measuring analog input signals on any of four programmable ranges ±2 5, ±25V and ±250V

Since many system requirements specify a combination of temperature and analog inputs, the TempV/32 eliminates the need for synchronizing separate and possibly incompatible A/D measuring instruments or boards

2.8.4 TempRTD/16 Voltage Scanning Module

The TempRTD/16 scanning module supports 16 channels of 3- or 4-wire RTDs Measurements may be returned in units of °C, °F, °K, °R For proper hook-up, please refer to the following connection diagram

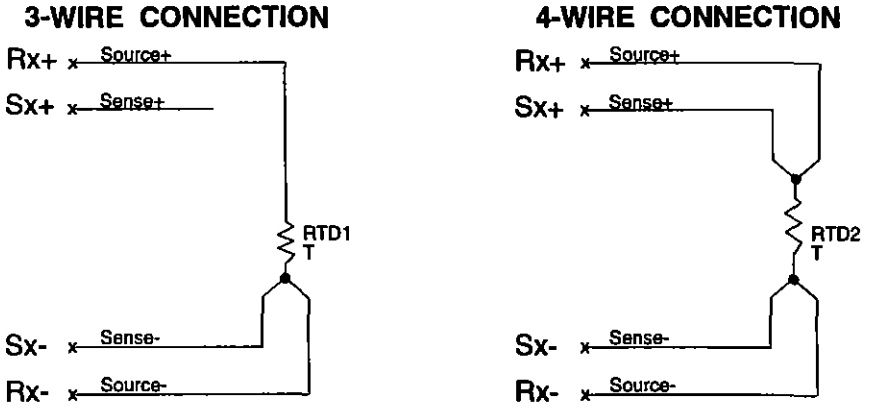


Figure 2.18. Connecting 3-wire or 4-wire RTDs

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2.9 Channel Expansion

The TempScan/1000 can easily be expanded up to 992 channels This is accomplished via a master/slave architecture wherein a main or "master" TempScan/1000 unit can be connected to as many as 15 expansion chassis Each expansion chassis, Exp/10, is identical in size to the master unit and configurable for either 32 or 64 channels of thermocouple inputs Exp/10 expansion chassis accept the same scanning module cards as the master unit

The Exp/10 expansion chassis can only be controlled by a TempScan/1000 Exp/10 units have no digital I/O or alarms included Expansion channels can, however, be programmed to stimulate the alarms located on the TempScan/1000 From the programmer's perspective, channels are accessed in the same fashion as channels in the base unit When the master unit detects the presence of expansion chassis during its power-on sequence, it makes the additional channels available to the programmer The U8 command is available to query the TempScan/1000 for the total number of channels in a system

2.9.1 Configuring Multiple Units

This section describes the configuration required for TempScan/1000 to be used in master/slave operation Note the master unit in a master/slave system configuration must be a TempScan/1000 (it cannot be an Exp/10) The system setup with the cable options is shown in Figure 2 18

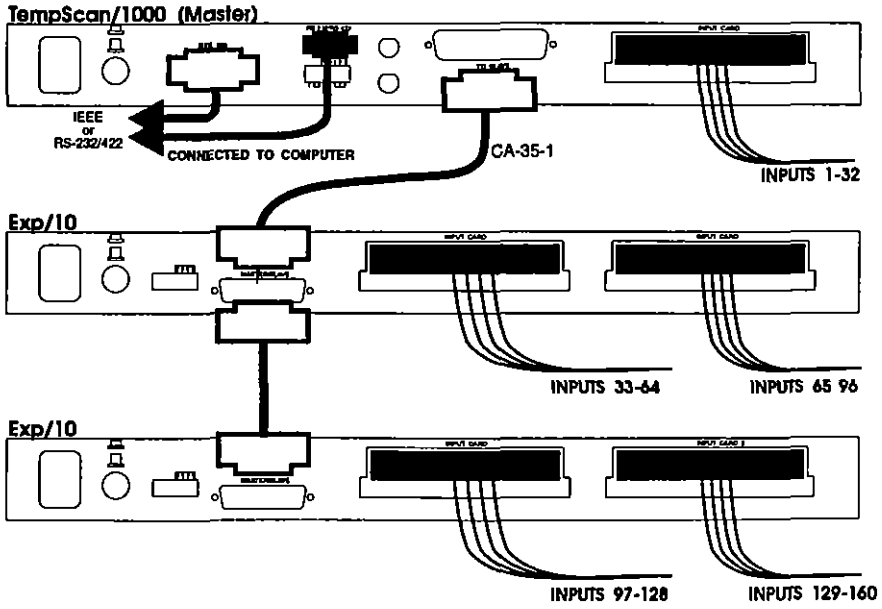


Figure 2 19: Multiple Unit Cable Configuration

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Each slave unit must be assigned a unique expansion chassis address The expansion chassis address can be set from 1 through 8 The address is selected by simple binary weighting The switch labeled 1 is the least significant bit, 15 is the most significant bit The factory default is address 1, as shown Figure 2 20 below

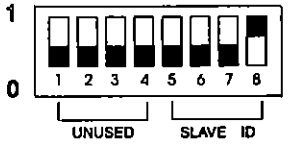


Figure 2 20. Slave Switch

Caution

If two or more expansion chassis with the same address are connected together, their operation, and the operation of other attached units, is unspecified and may cause errors during operation Address 0 is not allowed because it is reserved for the TempScan/1000.

2.9.2 Channel Assignment

The channels in the Exp/10 expansion chassis are treated as extended channels in the TempScan/1000 master The first channel in the first expansion chassis is channel 33, with channels 1 - 32 always in the TempScan/1000 The first channel in the second scanning module card of the first slave unit is channel 65 Refer to Figure 2 20 for all of the channel identifiers (1-24)

The order of the expansion chassis is set up using switches on the back panel of the Exp/10 unit as described in the previous section Even if a card slot is left empty in the master or slaves(s), the channel assignments are those shown in Figure 2 20 If a 16-channel module is installed, the TempScan/1000 system still assigns 32 channels to the card slot with the upper 16 channels ignored For example, if an RTD scanning module is installed in Logical unit 2, channels 33-48 will be assigned while channels 49-64 will be ignored

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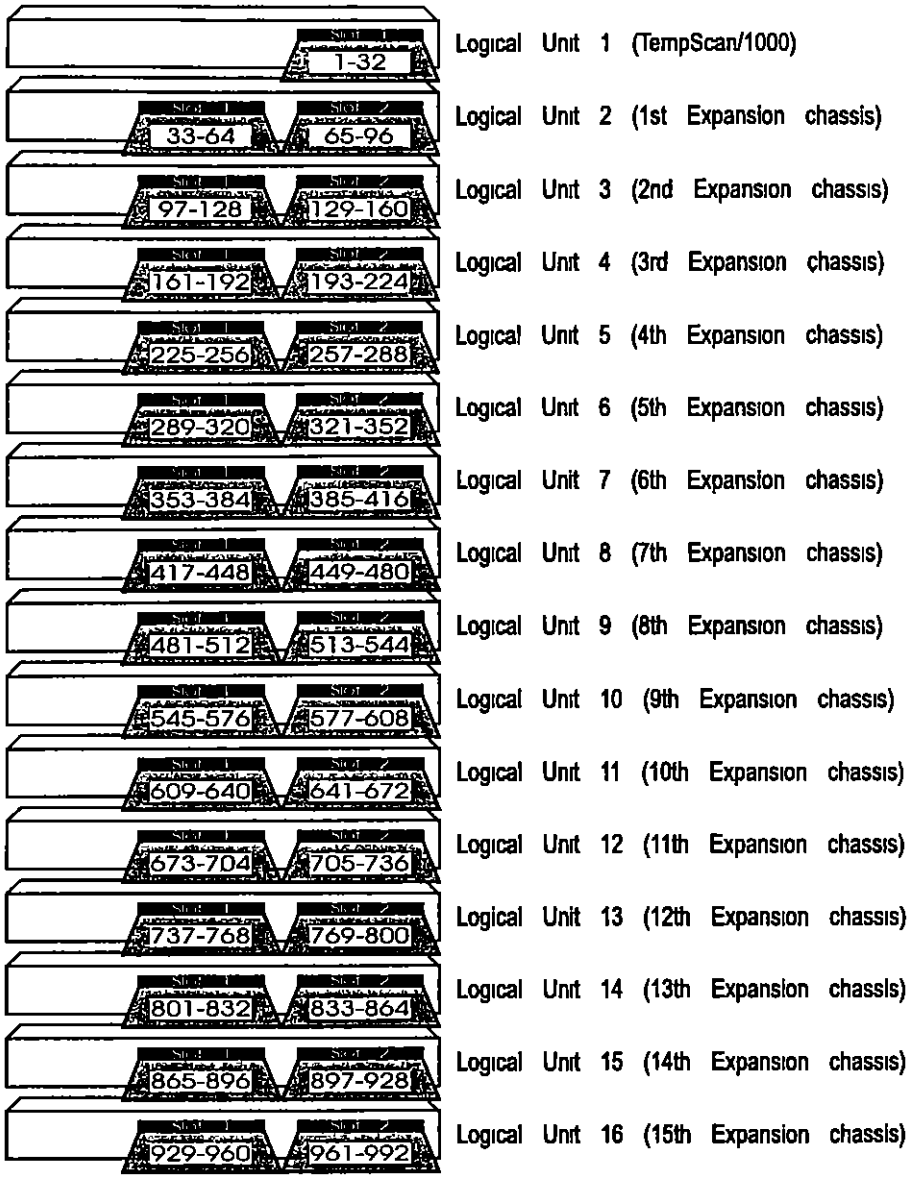


Figure 2 21· Channel Assignments

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2.10 External TTL BNC Connectors

The rear panel provides two external trigger BNC connectors The BNC TTL Scan output is used for synchronizing equipment with the TempScan/1000 The TempScan/1000 can be programmed to trigger on a positive-going or negative-going TTL level edge Any TTL level signal may be used as a trigger pulse A trigger pulse may also be used to generate a Service Request When a scan is logged into the acquisition buffer, the TTL output signal is pulsed Refer to the timing diagram in the figure below

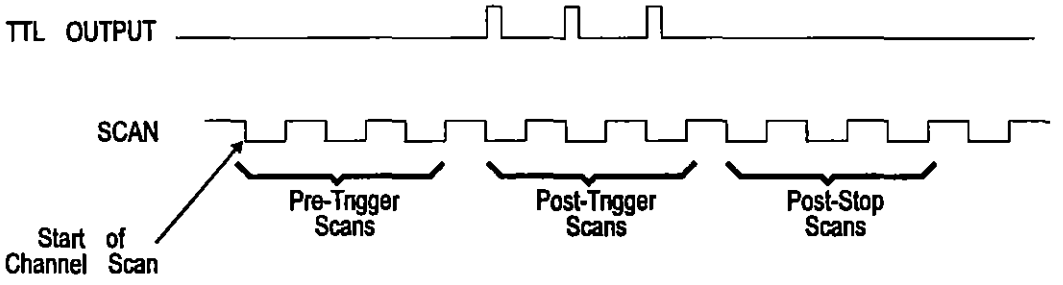


Figure 2.22. BNC TTL Trigger Timing Diagram

2.11 Hardware Installation

The TempScan/1000 includes accessories for rack or bench use

2.11.1 Rack Mount

If rack mount installation is required, remove the two plastic screws from the predrilled holes on each side of the unit Only remove the screws from the set of holes that will be toward the front of the rack (the unit can be mounted with the front or rear panel facing the front of the rack fixture)

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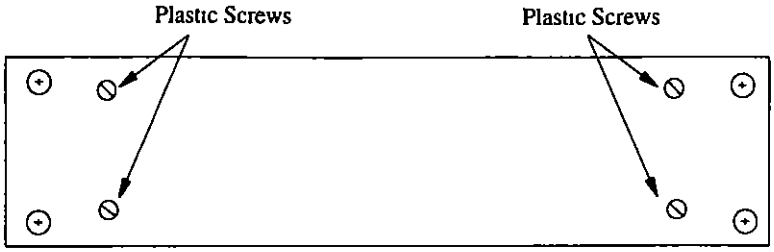


Figure 2 18: Rack Installation (Side View)

Install the two rack ears using the enclosed screws as shown in Figure 2 19

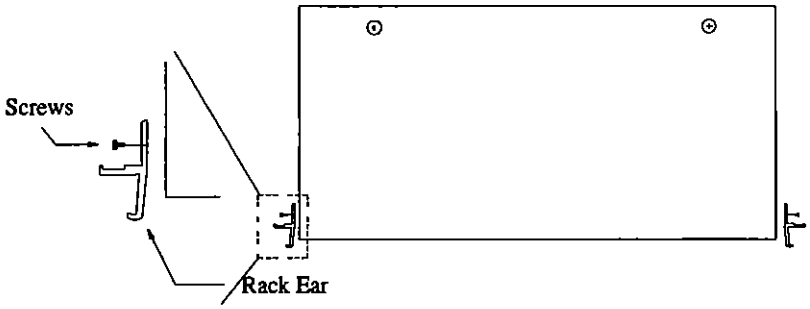


Figure 2 19 Installing Rack Ears (Top View)

2.11.2 Bench Top

If bench installation is required, install the self-adhesive rubber feet on the bottom of the unit approximately one inch from each corner

2.12 Power-Up

At initial power-up or on the Reset command (*R), the TempScan/1000 performs automatic self-tests to ensure that it is fully functional The indicator lights on the TempScan/1000 front panel show any errors if they occur Possible error conditions and their corresponding indicator lights patterns are shown in the following table Any pattern not shown is an internal error that is not field-serviceable - contact the factory If ERROR is on by itself, there is a configuration error due to setup information in NVRAM Check the error using the Error Query (E?) command

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Failure	Talk	Listen	SRQ	Error	Power
General H/W Failure	o	o	o	o	o
(U22) ROM Invalid	•	•	•	⊗	o
(U21) ROM Checksum Error	•	•	o	⊗	o
(U22) ROM Checksum Error	•	o	•	⊗	o
NVRAM Error	o	•	•	⊗	o
Dynamic RAM Error	o	o	•	⊗	o
Interprocessor COM Error	o	o	o	⊗	o

o = Indicator light on • = Indicator light off ⊗ = Indicator light flashing

If no problems are found, the indicator lights go off and the TempScan/1000 will begin its power-up initialization This self-test is performed each time the unit is powered up regardless of whether power-on was caused by the power switch or the Power-On Reset (*R) command During initialization, the TempScan/1000 self test performs the following

- Checks for errors at power-up
- Checks the flag in the NVRAM to determine if it should power-up with factory default settings or a user-defined configuration
- Loads appropriate registers with corresponding values in NVRAM
- Checks a flag to see if alarms should be enabled at power-up, if so, enables them
- Loads channel configuration registers
- Loads program sequencer with appropriate channel configurations
- Resets computations processor to begin acquiring scans

The self-test will take approximately 5 seconds to complete, after which the TempScan/1000 is ready for normal operation

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2.13 Software Installation

The TempScan software installation consists of two steps making a backup copy and installing the user selected TempScan files The software is installed through Microsoft Windows Note that any previous installation of the TempScan drivers should be removed before installing a new version

The TempScan software contains Temp Windows, which is a Windows application for operating the TempScan/1000 hardware For example, this application can be used to configure all of the operational parameters of the hardware and to arm the TempScan unit See Chapter 5 for more information on Temp Windows' capabilities

2.13.1 Making a Backup Copy

The following steps describe making a backup copy of the release disks

1 Boot up the system according to the manufacturer's instructions

2 Type the command CD\ to go back to your system's root directory

3 Place TempScan release disk into Drive A (or whatever floppy disk drive you are installing from)

4 Type DISKCOPY A A and follow the instructions given by the DISKCOPY command

This process may require swapping the release and backup disks several times

2.13.2 Windows Installation

The Temp Windows install program copies the user selected TempScan files and creates a Windows program group and icons

1 To begin installation, put the TempScan Disk into your floppy disk drive From the program manager, choose File/Run to run the TempScan **SETUP.EXE** file

2 The Windows Setup dialog box displays the "Install To" directory location Click OK to choose the default or type another path if you want to install to a different location

3 From the next dialog box, select the TempScan options to be installed (shown in the figure below) After the options have been selected, the bottom of the screen will display the amount of hard disk space required for the installation and the amount of disk space remaining after installation Make sure there is room available for installation before continuing

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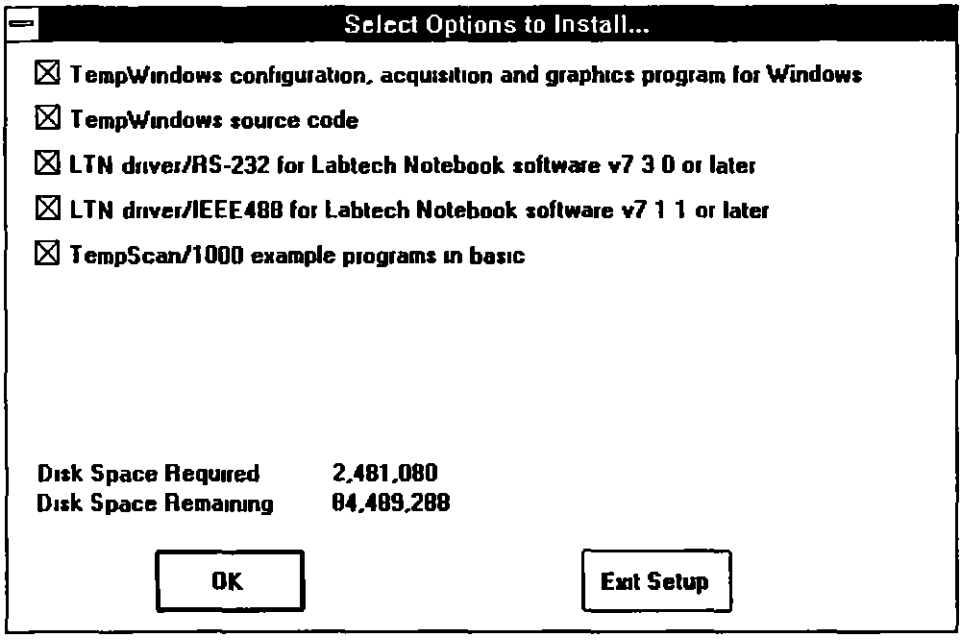


Figure 2 23 TempScan/1000 Installation Options

4 Choose the options you wish to install and select OK Dialog boxes will guide you through the remainder of the installation

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TempScan/1000 Operation

3.1 Overview

The primary function of the TempScan/1000 is to scan and digitize transducer signals, typically thermocouples Most all of the TempScan/1000's features are programmable, allowing the user to change settings and configurations from the controlling computer

The command set of the TempScan/1000 provides access to all of the unit's programmable features Issuing commands to the TempScan/1000 changes its internal state and its operating configuration Most of the unit's operating states have a default value If no commands are sent to alter its original state, the default value will be used Only if the default settings are not desired is it necessary to send commands to the TempScan/1000

The TempScan/1000 may be configured with up to 32 channels which can be expanded to provide up to 992 input channels via the addition of slave unit(s) with a master/slave architecture A master TempScan/1000 unit can be connected to as many as 15 Exp/10 expansion chassis Each is identical in size to the master unit and configurable for either 32 or 64 channels of inputs In addition, the TempScan/1000 and the Exp/10 both accept three kinds of optional scanning modules (plug-in cards) for measurement of thermocouples, voltage and RTDs

Once the number of channels and channel type are established, the TempScan/1000 requires a scan interval The user can configure up to two scan intervals to determine the frequency at which the scans are acquired For example, the unit can be programmed to sample data once per hour and then, when a specific channel reaches a limit condition, to sample data once per second Note that the maximum speed at which the TempScan/1000 scans the channels is dependent on the number of channels configured for use and how the channels are sequenced within a scan The table below shows how the number of channels configured affects the scan rate

To collect and buffer scans, it is also necessary to configure the acquisition and trigger parameters The unit can be configured to begin and end data logging on a user-specified event such as TTL signal, temperature level, IEEE GET, an alarm condition, or upon the completion of a specified number of readings

Some of the TempScan/1000's more advanced features include the use of alarms and the High/Low/Last registers The unit offers 32 digital alarm outputs that are activated via user-specified input channels and alarm conditions on a per channel basis The TempScan/1000 updates alarmed output channels in real-time at its standard 960 channel per second rate, and can be configured to either alert the host computer of active alarm conditions or update alarm outputs when communicating with the host computer

The High/Low/Last (HLL) registers are an alternative method of querying the TempScan/1000 for channel data Independent of triggering and scan interval configuration, the HLL registers are constantly updated with new values at the maximum scan rate and can be queried at any time

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For those users interested in a quick start, this chapter now begins by describing the minimum requirements for acquiring temperature readings This is accomplished by using many of the unit's default configuration settings The remainder of this chapter explains the steps required to use the TempScan/1000's basic and advanced features, in addition to providing various informative topics

3.2 Memory Allocation

Each TempScan/1000 comes equipped with standard 256K memory Three options for additional memory are available 1Meg, 4Meg, or 8Meg

Whatever the option, the TempScan/1000 will automatically allocate its memory for optimal use according to its current configuration TempScan/1000 memory is broken into two main regions

- High/Low/Last Data Registers (only configured channels)
- Acquisition Data Buffer

These regions are allocated as shown the figure below

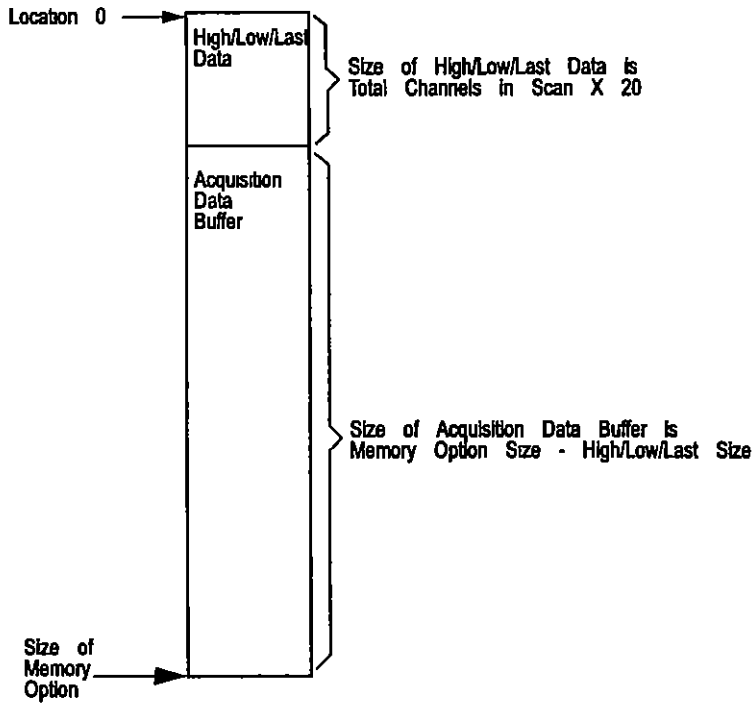


Figure 3.1: TempScan/1000 Memory Allocation

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When channels are configured, the TempScan/1000 will calculate how much memory will be needed for the High/Low/Last Registers The memory allocated to High/Low/Last is

```
20 X (number of channels)
```

The remaining memory is then allocated to the Acquisition Buffer For example, if the memory option is 256K (262144 bytes) and the number of configured channels is 992 (X 20) then the amount allocated to the acquisition buffer would be

262144	Total Memory (256K)
-19840	HLL (992 x 20)
242304	Acq Buffer Allocation (236 6K)

The disposition of the HLL Registers and Acquisition Buffer is described in later sections

3.3 Minimum Requirements

On initial power-up the TempScan/1000 is not scanning its channels Although most of the user-settable configuration states have associated defaults, a few items must be configured by the user before scanning begins

To get the TempScan/1000 to begin scanning its channels, the controlling computer must perform two operations configure each channel and select the channels that are included in the scan Refer to the figure below for a depiction of a channel scan and scan interval

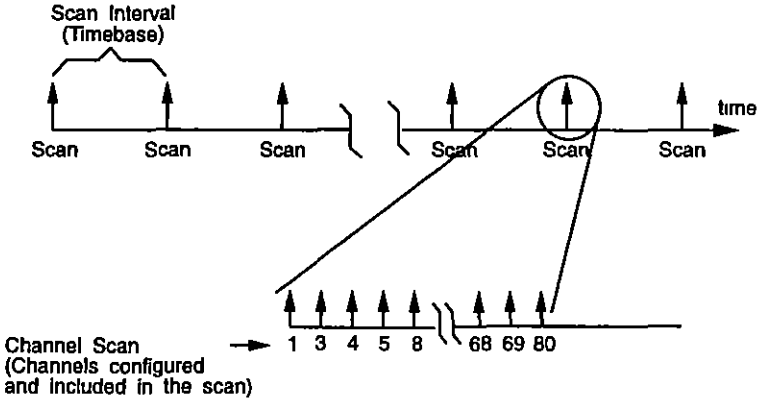


Figure 3 2 Channel Scan and Scan Interval Definition

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After following these steps, the alarms and the High/Low/Last Registers are now being updated at the maximum possible scan rate The scans are not, however, being placed in the Acquisition Buffer

```
PRINT#1,"OUTPUT07, C1-32,1X"    'Configure master channels 1-4 with Type J TC
```

Inspecting the unit's High/Low/Last Registers shows the temperature values for the configured channels

```
PRINT#1,"OUTPUT07 U4X"          ' Query HLL registers for the configured channels
PRINT#1,"ENTER07"               ' Get the response
INPUT A$                        ' Screen shows
+1450 20S12 23 21 7,03/24/93+0850 20S12 35 09 3,03/24/93, +0950 30
+0450 20S02 00 29 5,03/24/93+0057 60S10 35 00 4,03/24/93, +0250 60
-0045 50S11 03 51 7,03/24/93-0110 10S12 55 09 1,03/24/93, -0050 80
+0150 70S03 39 01 2,03/24/93-0085 20S05 25 17 3,03/24/93, +0010 90
```

To begin storing scans in the unit's Acquisition Buffer at a programmed scan rate, it is necessary to follow these four steps

1 Configure each channel with the desired type (Described in Sections 3 3 1 and 3 3 2)

2 Select the scan intervals (Described in Section 3 3 3)

3 Select the acquisition parameters (Described in Section 3 3 4)

4 Select the trigger parameters (Described in Section 3 3 5)

After step 4, the TempScan/1000 will be armed and waiting for the trigger When the trigger is satisfied, the TempScan/1000 will begin to collect and store scans in Acquisition Buffer

```
PRINT#1,"OUTPUT07, C1-4,1X"          ' Configure master channels 1-4 with Type J
                                       TC
PRINT#1,"OUTPUT07,I00 01 00 0,00 00 01 0X"' Configure normal timebase to 1 minute,
                                       acquisition timebase to 1 second
PRINT#1,"OUTPUT07,Y100,1000,0X"      ' Set pre-trigger scan count to 100 and post-
                                       trigger to1000 scans
PRINT#1,"OUTPUT07,T1,8,0,0X"         ' Configure start event to trigger on command
                                       and stop event to stop post-trigger count
                                       (TRIGGER LED should pulse)
PRINT#1,"OUTPUT07,@X"                ' Trigger the acquisition Acquisition scans
                                       should now be collected until 1000 post-
                                       trigger scans have been collected (TRIGGER
                                       LED should be on)
```


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3.3.1 Configuring Channels

Configuring a channel is the process of describing the channel transducer to the TempScan/1000 By doing so, the configured channel becomes part of the channel scan

The TempScan/1000 performs several sophisticated calculations on the raw voltage before supplying it to the controlling computer To perform such calculations, the TempScan/1000 must know the transducer type

The TempScan/1000 and its expansion chassis, the Exp/10, accepts three kinds of scanning modules, allowing users to create systems of up to 992 channels with any combination of scanning modules The modules are as follows

Module	Description
TempTC/32	The thermocouple (T/C) scanning module contains 32 differential input channels
TempV/32	The volts scanning module contains 32 differential input channels and is capable of measuring analog input signals on any of four programmable ranges ±10 V, ±5 V, ± 1V, ± 0 1V
TempRTD/16	The RTD scanning module contains 16 differential input channels

The TempScan/1000's modularity eliminates the need for synchronizing separate and possibly incompatible A/D measuring instruments or boards—an important consideration because many temperature measurement systems require a combination of thermocouples, RTDs, and analog inputs

The TempScan/1000 is capable of sensing the scanning module type that is plugged into its own slot or one of its expansion chassis When configuring a channel, the configuration parameters must match the scanning module type For example, a volts type cannot be assigned to a channel on a thermocouple module, and a thermocouple (T/C) type cannot be assigned to a channel on a volts module If the user attempts to configure a channel number that is of the wrong type or does not exist, a channel configuration error will be logged in the Error Source Register (shown in Figure 3 16) Associated with each channel is the channel number and type, and optionally the high and low alarm setpoints and the setpoint hysteresis The minimum channel configuration required is to assign a channel type for a single channel or a range of channels The following section describes how to configure the possible channel types Alarms will be covered later in this chapter

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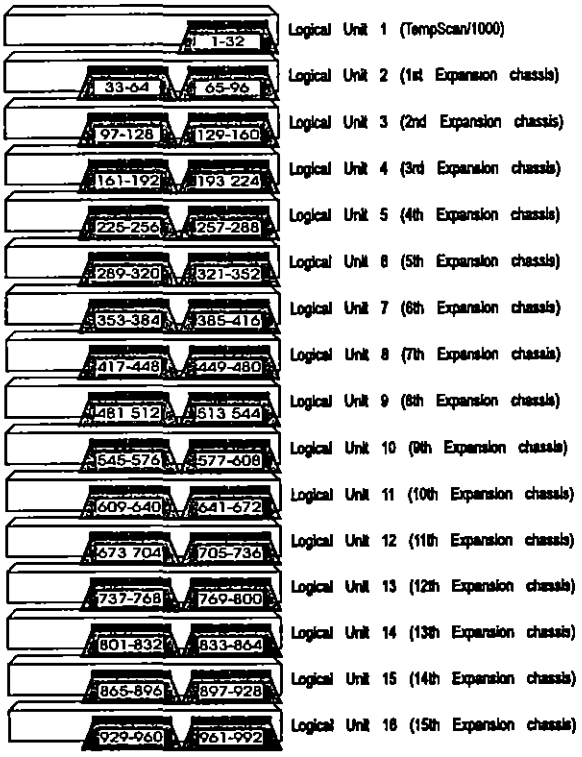


Figure 3 3: Master/Slave Channel Assignments

3.3.1.1 Configuring Thermocouple Channels

In order to begin configuring input channels, the user must first specify the channel type If the TempTC/32 scanning module is to be used, thirty-two differential thermocouple inputs are provided This card can be used in both TempScan/1000 and Exp/10 expansion chassis In configuring thermocouple (T/C) channels, all that is required is to assign each channel to a particular T/C type Support for B, E, J, K, R, S, T and N (14 and 28 gauge) thermocouple types are standard 100 mV volts type with and without Range error detection is also supported Channel type can be defined using the Configure Channel (C) command for a single channel or a range of channels Channels not included in the channel scan do not have to be configured

IMPORTANT

The channel configuration cannot be changed while the trigger is armed or an acquisition is taking place

If your T/C is not a standard type, it can be assigned to a custom T/C type This is accomplished through the use of custom linearization lookup tables Section 3 17 explains how custom tables can be defined

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In addition to channel type, each channel in the scan channel can optionally have a high and low alarm level and hysteresis associated with it The TempScan/1000 alarms allow the unit to produce an internal event when the value of a channel is outside of desired limits These alarm events can be used as trigger or stop events, or as a stimulus for TTL-level signals on the TempScan/1000 back panel Section 3 4 contains more information on using alarms

The following example demonstrates how to assign T/C types to channels on a TempTC/32 card plugged into the TempScan/1000

```
PRINT#1 "OUTPUT07, C 1-32, 1 X"        'Continuous channels 1-32 with JTC
```

3.3.1.2 Configuring Volts Channels

If the TempV/32 scanning module is to be used, the TempScan/1000 will measure voltages providing a programmable range per channel To configure the channels on a TempV/32, use the C command to assign a range to each channel on the card Note the type parameter is what distinguishes the channel as a volts channel Support for ± 1V, ±1V, ±5V, and ±10V ranges are standard Channels not included in the channel scan do not have to be configured The TempV/32 can be used in both TempScan/1000 and expansion chassis

3.3.1.3 Configure RTD Channels

If the TempRTD/16 scanning module is to be used, 16 RTD inputs are provided This card can be used in both the TempScan/1000 and Exp/10 expansion chassis In configuring RTD channels, all that is required is to assign each channel to either a 3-wire or 4-wire RTD type Note For any given RTD card, channel numbers 17-32 are not used Channel types can be defined using the configure channel (C) command for a single channel or a range of channels Channels not included in the channel scan do not have to be configured

3.3.2 Configuring a Scan

Although as many as 992 channels may be included in the TempScan/1000 system when 15 expansion chassis are attached, only those channels configured in the channel scan are collected and available to the controlling computer Channels are always scanned in ascending order, regardless of the sequence input by the user The same configuration is used in reading channel data through the High/Low/Last Registers or the Acquisition Buffer, as discussed later in this chapter

Scan configuration is also accomplished using the Configure Channels (C) command This command allows up to 992 channels to be specified by either individually assigning channels or entering a range of channels The 992 possible channels can be configured in any sequence, however the scan will be ordered sequentially by the TempScan/1000 Note Channels cannot be accessed randomly as part of a channel scan

Refer to Section 3 12 for details about the impact of scan configuration on the maximum sample rate

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3 3.3 Configuring the Scan Interval

The scan interval is the frequency at which the scans are acquired It can be programmed (via the I command) from a 99 hour period down to as fast as the unit can run under the current channel configuration The normal scan interval can be programmed in increments of 1 of a second

The TempScan/1000 has two distinct scan intervals The first is the "normal" scan interval This scan interval is used when the TempScan is collecting scans before the start event has occurred or after stop event has occurred These two regions are called pre-trigger scans and post-stop scans, respectively The second scan interval is the "acquisition" scan interval This interval is used when the TempScan/1000 is acquiring scans after the start event has occurred but before the stop event has occurred This region is referred to as post-trigger scans

The I command is used to set these two scan intervals For example, the following command

```
I00 00 10 0,00 00 00 1
```

would set the scan interval to once every ten seconds and set the post-trigger scan interval to once every tenth of a second As mentioned earlier, the scan interval can be set to run as fast as the current unit configuration will allow This is referred to as "fast mode" Each of the two scan intervals can be configured as such by specifying 00 00 00 0 as the argument for the I command for the desired timebase interval For example, the following command

```
I00 00 10 0,00 00 00 0
```

will set the normal scan interval to once every ten seconds and the post-trigger interval will be set to fast mode The two scan intervals may be queried any time via the I? software command

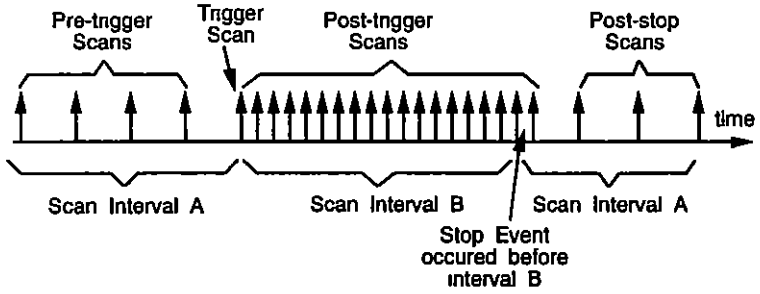


Figure 3 4: TempScan/1000 Scan Intervals

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As mentioned earlier, if fast mode is specified the TempScan/1000 will collect scans as fast as the current configuration will allow This requires some explanation since the rate at which scans are collected while the unit is in fast mode may vary greatly depending upon the number of channels configured as well as the disposition of those configured channels The disposition of the channels refers to density of the total channels configured within the system, in other words, how many channels are skipped over The disposition of channels and its effect on the channel scan rate is covered under Section 3 12 of this manual For this discussion, however, we will consider only configurations in which all configured channels are adjacent to each other The following table shows how the fast mode scan rate is affected by such configurations

Number of Channels	Per Channel Scan Rate (Hz)			
	60 Hz		50 Hz	
	Hz	mSec	Hz	mSec
1-16	60	16 67	50	20
17-32	30	33 34	25	40
33-48	20	50 00	16 7	60
49-64	15	66 67	12 5	80
65 80	12	83 33	10	100
81-96	10	100 00	8 3	120
97-112	8 6	116 67	7 1	140
113-128	7 5	133 33	6 25	160
785-800	1 2	833 33	1 0	1000
945-960	1 0	1000 00	83	1200
961-976	98	1016 67	82	1220
977-992	97	1033 33	81	1240

3.3.4 Configuring an Acquisition

To collect and buffer scans, it is necessary to configure an acquisition An acquisition can consist of the following components

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Component	Description	Required
Pretrigger	Scans taken before the trigger is satisfied	No
Post-trigger	Scans taken between the trigger and the stop event	Yes*
Post-stop	Scans taken after the stop event	No

* However, if the post-trigger is set to 0, the trigger scan is collected (1 scan) but no post scans are collected

These components constitute a Trigger Block in the internal memory Every Trigger Block has one and only one trigger point The following figure describes a trigger block

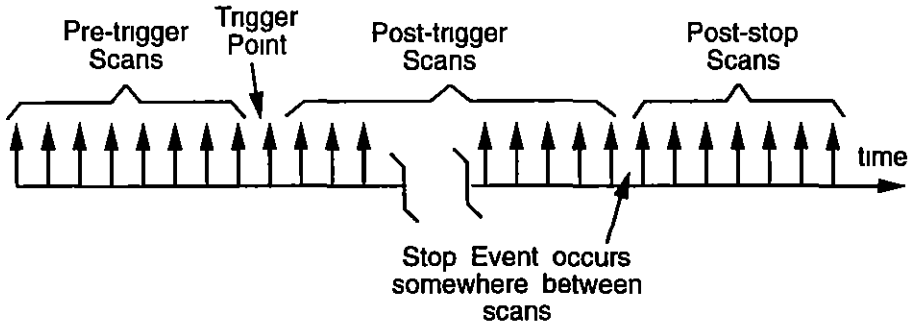


Figure 3 5: TempScan/1000 Trigger Blocks

3.3.4.1 Pre-Trigger State

The Pre-Trigger State is defined as the period after the TempScan/1000 has been configured to collect an acquisition (via the T command) and before the actual trigger event occurs While the unit is in this state the TRIGGER LED will flash As in any other acquisition state the alarms and their associated outputs will be updated at the fastest rate possible under the current channel configuration

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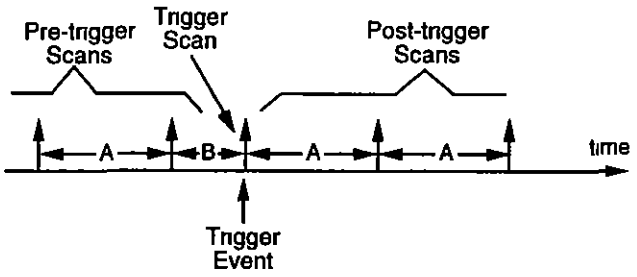


Figure 3 6 Trigger without Synchronization

It is during this state in which the TempScan/1000 may be configured to collect Pre-Trigger data This may be accomplished by specifying a non-zero value for the pre-trigger count parameter of the Set Counts (Y) command (see Command Reference Chapter) The pre-trigger count value coupled with the current channel configuration, however, cannot exceed the total amount of available memory

If the pre-trigger count is set to a non-zero value, the TempScan/1000 will begin sampling Pre-Trigger data at the rate specified by the current normal scan interval (I command) immediately after the Trigger Configuration (T) command is issued When the trigger event occurs, the Pre-Trigger data portion of the Trigger Block will contain the most recent Pre-Trigger scans The number of Pre-Trigger scans collected will depend upon when the trigger event occurs If the trigger event occurs before the number Pre-Trigger scans collected at least equals the specified pre-trigger count the number of Pre-Trigger scans will be the number of scans collected to that point Otherwise, the number of Pre-Trigger scans will be the number specified by the pre-trigger count parameter of the Set Counts (Y) command If it is not desired to collect any Pre-Trigger data while in the Pre-Trigger state the pre-trigger count parameter of the Set Counts (Y) command may be set to zero

Pre-Trigger data may not be accessed while the TempScan/1000 is in the Pre-Trigger state The Pre-Trigger data for a particular trigger block is not made available to be read until the specified trigger event occurs

There are two ways to determine if the unit is in the Pre-Trigger state First, visually check the TRIGGER LED If it is flashing then the unit is in the Pre-Trigger state Second, the user can query the Status Byte (STB) register and check the Triggered Bit If not set and the acquisition has been configured then the unit is in the Pre-Trigger state When the specified trigger event occurs the TempScan/1000 exits the Pre-Trigger state and enters the Post-Trigger state

The Trigger Configuration (T) command has a "synchronization" parameter that allows the user to specify if the trigger point is to be synchronized to the pre-trigger (normal) scan interval If set, the trigger point will occur on the next "tick" of the pre-trigger (normal) scan interval Otherwise the trigger point will occur at the point at which it is detected For example, assume a pretrigger of 10 scans and a sample rate of 1 scan/minute If a trigger event takes place 20 seconds after a scan, a recorded trigger point will happen on the next scan, 40 seconds later

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3.3.4.2 Post-Trigger State

The Post-Trigger state is the period between the occurrence of the trigger event and the occurrence of the stop event While the unit is in this state the TRIGGER LED will be on As in any other acquisition state the alarms and their associated outputs will be updated at the fastest rate possible under the current channel configuration

During the Post-Trigger state the unit will collect Post-Trigger data at the rate specified by the acquisition scan interval specified by the Scan Interval (I) command Post-Trigger scans will be collected at this rate until the stop event occurs The number of scans collected during the Post-Trigger state is not restricted by the internal buffer size The TempScan/1000 can collect scans in the post-trigger state indefinitely if the controlling computer is capable of reading data out of the acquisition buffer fast enough to prevent a buffer overrun

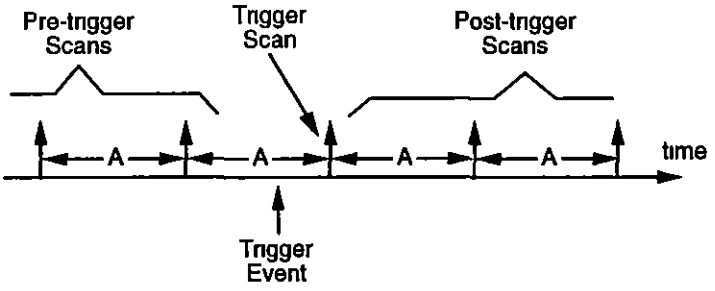


Figure 3.7. Trigger with Syncronization Flag On

The Post-Trigger state may be detected by querying the Triggered Bit of the Status Byte (STB) Register and the Stopped Bit of the Event Status Register (ESR) The TempScan/1000 is in the Post-Trigger state if and only if the Triggered Bit of the STB is set and the Stopped Bit of the ESR is not set The unit will exit the Post-Trigger state when the stop event occurs

3.3.4.3 Post-Stop State

The Post-Trigger state is the period between the occurrence of the stop event and the completion of the acquisition While the unit is in this state the TRIGGER LED will be on As in any other acquisition state the alarms and their associated outputs will be updated at the fastest rate possible under the current channel configuration

The TempScan/1000 will only enter this state when a non-zero value of the post-stop count parameter of the Set Counts (Y) command has been specified If this is the case, upon the occurrence of the stop event the unit will enter the Post-Stop state and collect the specified number of post-stop scans

When the specified number of post-stop scans have been collected the unit will terminate the current acquisition and return to a non-acquiring state If, however, the post-stop count

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parameter of the Set Counts (Y) command is zero the unit will return immediately to a non-acquiring state upon the occurrence of the stop event (unless the auto-rearm feature is used)

The Post-Stop state may be detected by querying the Stopped and the Acquisition Complete bits of the Event Status Register (ESR) The TempScan/1000 is in the Post-Stop state if and only if the Stopped Bit of the ESR is set and the Acquisition Complete Bit of the ESR is not set The unit will exit the Post-Stop state when the specified number of post-stop scans have been collected When this occurs the Acquisition Complete Bit of the ESR will be set and the unit will return to a non-acquiring state (unless the auto-rearm feature is used)

3.3.5 Trigger and Stop Events

The programmed system events are the driving force behind any acquisition The trigger event signals the end of the pretrigger and the beginning of the post-trigger, the stop event signals the end of the post-trigger and the beginning of the post-stop

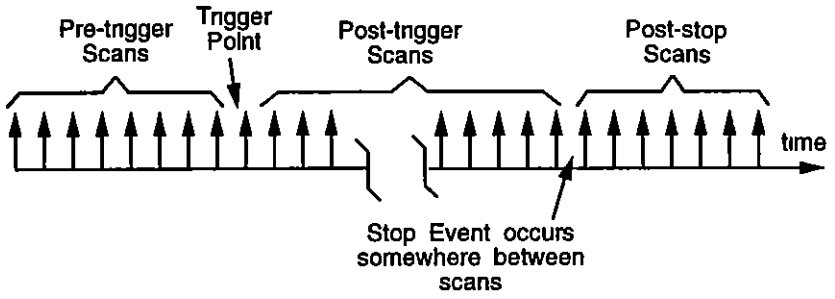


Figure 3.8. TempScan/1000 Trigger and Stop Events

In addition to the pre-trigger (normal) scan interval, a secondary post-trigger (acquisition) scan interval can be assigned This would allow scans during the post-trigger and post-stop states to be collected faster or slower than those in the pretrigger One application for this secondary scan interval is when events after the trigger require faster sampling than those before the trigger, such as during alarm conditions

The TempScan/1000 can be configured to start data acquisition on one of many trigger sources The Trigger Configuration (T) command is used to set the source of the trigger (GET, Talk, etc), the trigger start and stop event, a pre-trigger count and/or post-stop count if used, the direction of the trigger source level if used (rising or falling edge), and whether the Auto-Rearm flag is enabled

If the Auto-Rearm feature is in use, the unit will immediately begin looking for another trigger event once a stop event and post-stop event is detected If the feature is not in use, a T command must be issued after a stop event before the unit can begin looking for a trigger However, using Auto-Rearm does not allow the user to change the trigger configuration between triggers, the initial configuration will be used until Auto-Rearm is disabled To disable Auto-Rearm, a T command must be issued with the flag set to zero Data will still

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be available after the T command is issued Refer to the Command Reference section for details

In order for an acquisition to take place, the unit must have a trigger event and can be assigned a Stop Event This allows different stimuli to begin and end an acquisition The Trigger Start and Stop Event sources can be chosen from any of the following

EVENT	START/STOP	DESCRIPTION
External TTL (rising or falling)	Start and/or Stop Event	When External TTL Level is specified as a trigger source (T6 or T7), a TTL level signal on the external trigger connector (rear panel BNC) will generate a trigger The external trigger is edge sensitive, and triggering on the rising edge or falling edge can be specified
Selected temperature channel (rising or falling)	Start and/or Stop Event	When a selected channel is specified, data collection is started when the level for the selected channel has been crossed (either rising or falling) as the user defined with the L command
GET (Not applicable for RS-232/422 applications)	Start and/or Stop Event	When GET is selected as the trigger source (T2), data collection is started whenever the IEEE 488 Group Execute Trigger (GET) command is sensed on the IEEE 488 bus and the TempScan/1000 is addressed to LISTEN
Talk (Not applicable for RS-232/422 applications)	Start and/or Stop Event	When TALK is selected as the trigger source (T3) , data collection will be started when the TempScan/1000 is addressed to TALK
'@' character	Start and/or Stop Event	When @ is selected as the trigger source, the command trigger ("@") generates a trigger when the Trigger Source is set for a command trigger (T1)
Alarm (on or off)	Start and/or Stop Event	When alarm is selected as a trigger source, the acquisition will start or stop when any channel goes into or out of an alarm condition
Absolute time	Start and/or Stop Event	When absolute time is specified, data collection is started when the real time clock time of day equals the programmed time
Count (post-trigger)	Start and/or Stop Event	When count is selected as the Stop Event, scans are collected until the specified number of post-trigger scans (specified by the Y command) have been collected, at which time the post-trigger Acquisition will stop and the post-stop Acquisition will begin (if it is configured)

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3.3.6 The Acquisition Buffer

The acquisition buffer is a FIFO buffer In other words, the oldest data to be written into the buffer is the first data to be read from the buffer when a read operation is performed The buffer may be broken up into one or more "trigger blocks" Each of these trigger blocks defines an acquisition and each may be of variable length Trigger blocks are allocated sequentially and the scans within the Trigger Blocks are written and read sequentially In other words, it is not possible to randomly access a Trigger Block or a scan within a trigger block When a read operation is performed the scan that is read is the oldest scan in the oldest trigger block currently defined Figure 3 9 shows a sample acquisition buffer with 5 trigger blocks each of which has a variable amount of scan data

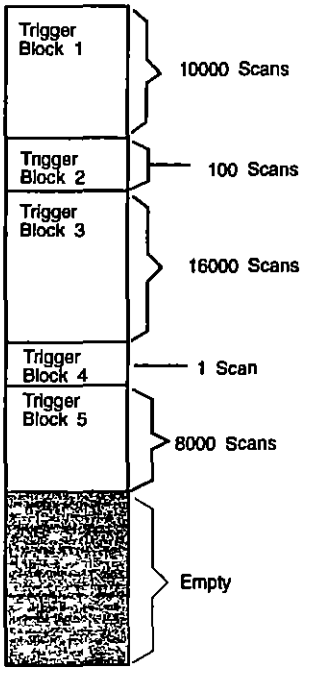


Figure 3 9 Sample Acquisition Buffer Configuration

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3.3.7 Trigger Block Organization

Each Trigger Block in the buffer has an associated trigger block descriptor The trigger block descriptor is used by internal processes for Acquisition Buffer maintenance The management of this trigger block descriptor is totally transparent to the user and, as such, the contents of this descriptor is of no concern to the user However, since the trigger block descriptor does take up memory it will have an indirect affect on some user defined processes For instance, the 75% limit condition and the buffer overrun condition will happen on a fewer number of scans as the number of trigger blocks increases

A trigger block becomes defined when the configured trigger start event occurs Once the start event occurs the data within the trigger block (including any pre-trigger data) is available to be read, even though the trigger block may not yet be complete Scan data is read and written to the trigger block in a FIFO fashion As the controller requests buffered scan data, the TempScan/1000 supplies the oldest available scan After the scan is supplied that scan is no longer available from the TempScan/1000 There is no mechanism to allow jumping around in the buffer or going back to a scan that had already been read by the controller

Reading the oldest scan automatically advances the read pointer in the current trigger block so that the next scan, if acquired, is immediately available

Since scans are written into the trigger block sequentially, the trigger scan may appear at any location within the trigger block The TempScan/1000 will automatically convert these physical scan locations to logical scan locations where the trigger scan is always oriented at location 0 The placement of the trigger scan at the origin facilitates the quick interpretation of the read pointer and gives a frame of reference for other locations within the trigger block All trigger block pointers are relative to the trigger scan Hereafter, in this manual, discussions will assume references to logical trigger blocks only

The U6 command (for a more complete description see Section 3 3 6 on interrogating the acquisition buffer) may be used to query the current read trigger block For example the U6 response for Figure 3 10 (assuming it was the only trigger block) would be

```
PRINT#1,"OUTPUT 07, U6X"          ' Get status of current read trigger block
PRINT#1,"ENTER 07"                ' Get the response
INPUT A$                          ' Screen shows
0000001,0001234,-0000076,12 34 54 200,03/23/93,00000767,12 54 12 900,
03/24/93,00001156,01
```

The previous response indicates that the first available scan is -0000076, which is a pre-trigger scan This scan can be retrieved by performing the following

```
PRINT#1,"OUTPUT 07,R1X"           ' Get the -0000076 scan
PRINT#1,"ENTER 07"                ' Get the scan
```


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```
INPUT A$                                ' Screen shows (4 channels configured)
+1234 50-0234 20+0984 00+0323 30
PRINT#1,"OUTPUT 07, U6X"                ' Now get status of current read trigger block
PRINT#1,"ENTER 07"                      ' Get the response
INPUT A$                                ' Screen shows
000001,001233,-
0000075,12 34 54 200,03/23/93,00000767,12 54 12 900,03/24/93,00001156,01
```

Notice that the current read pointer has now advanced to pre-trigger location -0000075 and that the total scan count has been decremented to 001233

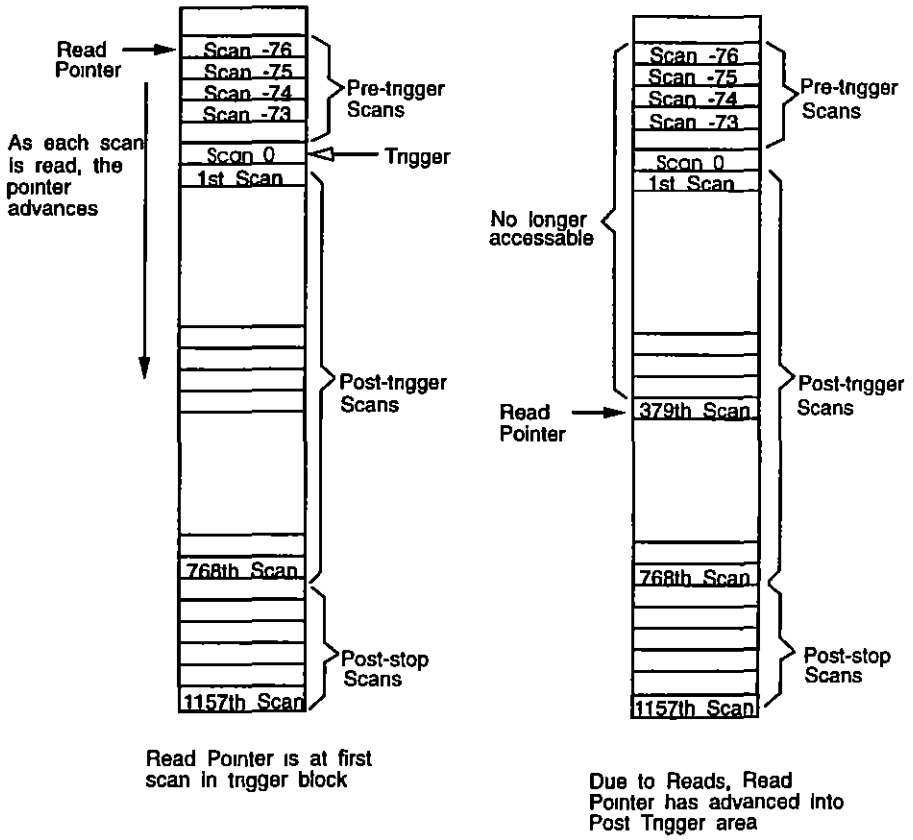


Figure 3 10 Trigger Block Read Operations

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To retrieve data after a trigger event has occurred, the TempScan/1000 provides multiple query functions The R command can be used to read the last scan in the data buffer (R1), the last block in the data buffer (R2) or all the data available (R3) The U6 command will query the current trigger block for a variety of information, such as the trigger block number, current scan in block, the scan number that trigger occurred, etc See the U command description in the Command Reference section for details

3.3.8 Multiple Trigger Blocks

Through the Auto-Rearm capability of the TempScan/1000, it is possible to capture more than one trigger block in the unit's Acquisition Buffer Each trigger block would contain one and only one trigger point

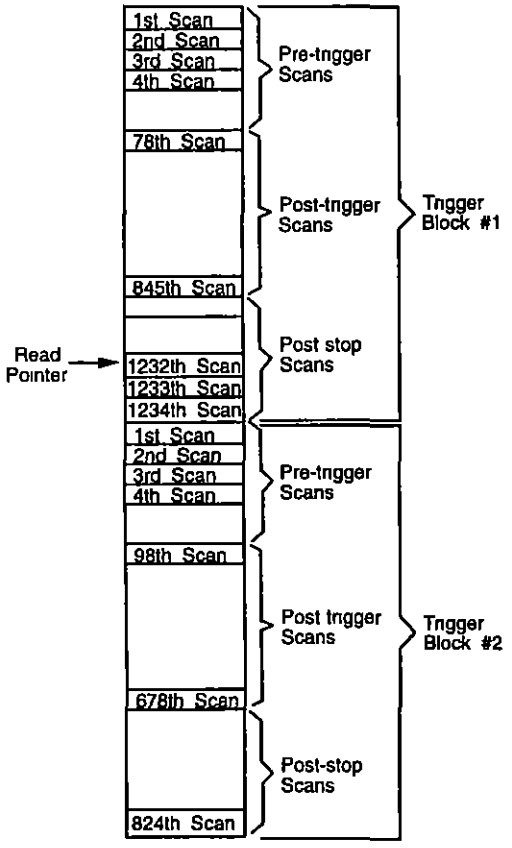


Figure 3.11 TempScan/1000 Multiple Trigger Blocks

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These trigger blocks are stacked end-to-end in the buffer, as the last reading of the first trigger block is read by the controller, the next scan to be read will be from the second trigger block The trigger can only be re-armed after a trigger block has been completed If the Auto-Rearm feature is not in use, a T command must be issued to re-arm the TempScan/1000 for acquisition

It is important to note Auto-Rearm does not allow the user to change the configuration while armed To stop Auto-Rearm, the user must issue a T command with the flag set to zero

If Auto-Rearm is selected, another acquisition will take place on the next trigger without any controller intervention This allows TempScan/1000 to store several acquisitions contiguously in its internal memory The buffer locations of the trigger points and their associated time tags can be found in the Buffer Status String The read pointer is always on the oldest trigger block so requests for pointer status will always correspond to the trigger block available to be read The next trigger, however, must be initiated AFTER the previous acquisition was completed Otherwise, a trigger overrun will occur

Additional information about triggering and trigger error conditions can be found in Section 3 13

3.3.9 Acquisition Buffer Interrogation

Note that in the following sections, the "current trigger block" always refers to the trigger block that is currently being read

The current status of the acquisition buffer may be interrogated at any time by issuing the Buffer Status String (U6) command As mentioned earlier, the U6 command is a user query command which will return information regarding the current state of the acquisition buffer The acquisition buffer holds scan data that has been initiated by one or more trigger events This data is held in trigger blocks within the buffer Each trigger block defines one acquisition that has taken place The trigger blocks may be variable in length The Buffer Status String command provides the interface in which the current acquisition buffer configuration may be queried

The Buffer Status String (U6) command returns the following fields

Number of Trigger Blocks Available	This field represents the total number of trigger blocks currently contained within the buffer A block need not be complete to be included in this total, it only needs to be current trigger If there are no trigger blocks available, then Blocks Available will be 0000000

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Number of Scans Available	This field represents the total number of scans available at the the time the U6 command was issued It should be noted that pre-trigger data is not available to the user until the defined trigger event has taken place This total represents the total number of scans available across all trigger blocks in the acquisition buffer If there are no scans available in the buffer, then Scans Available will be 0000000
Current Read Pointer	This field represents the current position within the current trigger block This pointer is relative to the trigger point, which is always oriented at location 0 If, pre-trigger scans are being read, the Current Pointer will be less than 0 Likewise, if post-trigger scans are being read, the Current Read Pointer will be greater than 0 If the current scan to be read is the trigger scan, then the Current Read Pointer will be 00000000 If the Current Read Pointer is undefined its value will be -0999999
Trigger Time and Date Stamp	This field represents the Time/Date that the trigger event occurred for the current trigger block This field takes on the same format as other time/date trigger stamp fields described elsewhere in this manual If the trigger event has not occurred, then this field will have the value 00 00 00 00,00/00/00
Stop Event Pointer	This field represents the location in the current trigger block that the stop event occurred This pointer will always be relative to the trigger point with the trigger point always oriented at location 0 Since the stop event must always occur after the trigger event this pointer will always be greater than 0 If the stop event has not yet occurred at the time of the U6 query, this field will have the value of -0999999
Stop Event Time and Date Stamp	This field represents the Time/Date that the stop event occurred for the current trigger block This field takes on the same format as other time/date stamp fields described elsewhere in this manual If the stop event has not yet occurred at the time of the U6 query, then this field will have the value 00 00 00 00,00/00/00

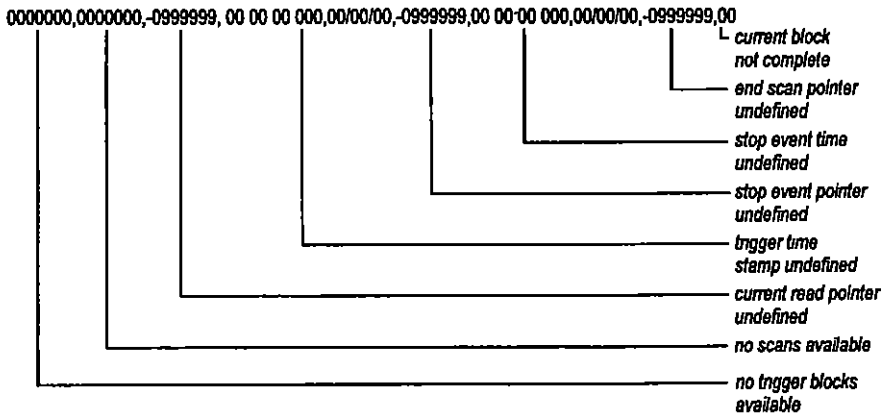
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End Scan Pointer	This field represents the location in the current trigger block that the end scan occurred This pointer will always be relative to the trigger point Since the end scan must always occur after the trigger event this pointer will always be greater than 0 If the end scan has not yet occurred at the time of the U6 query, this field will have the value of -0999999 This field will always be the same as the Stop Scan Pointer unless a post-stop count is specified (Y command) in which case the End Scan Pointer will be greater than the Stop Event Pointer by the value of the post-stop count
Block Status	This field represents the status of the current trigger block If the current read block is not yet completely written then the value of this field will be 00 If the current trigger block has been completely written and has terminated normally the value will be 01 If, however, the current trigger block has prematurely terminated (because of user intervention) the value will be 02

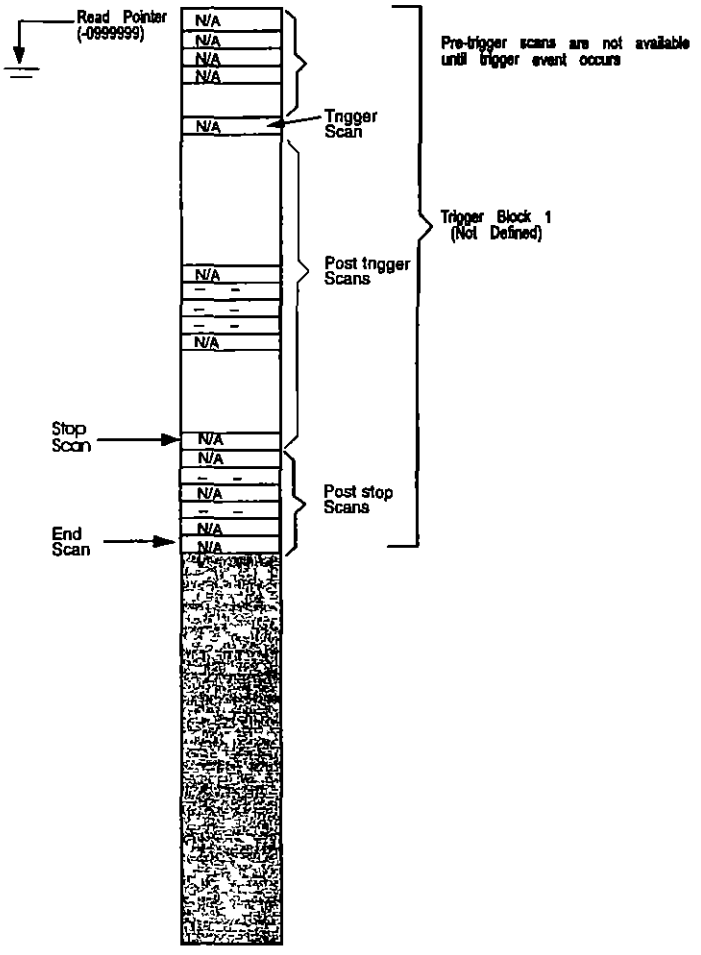
It should be noted that trigger blocks are not assigned a trigger block number per se The trigger block numbers referred to in the subsequent examples are relative to the read and write blocks respectively The current trigger block always refers to the trigger block that is currently being read

For example, the current read trigger block is always trigger block 1 Conversely, the current write trigger block is always the value of Blocks Available in the Buffer Status String With this in mind, the following are some examples of Buffer Status String responses

The following represents a U6 response when the acquisition buffer is empty

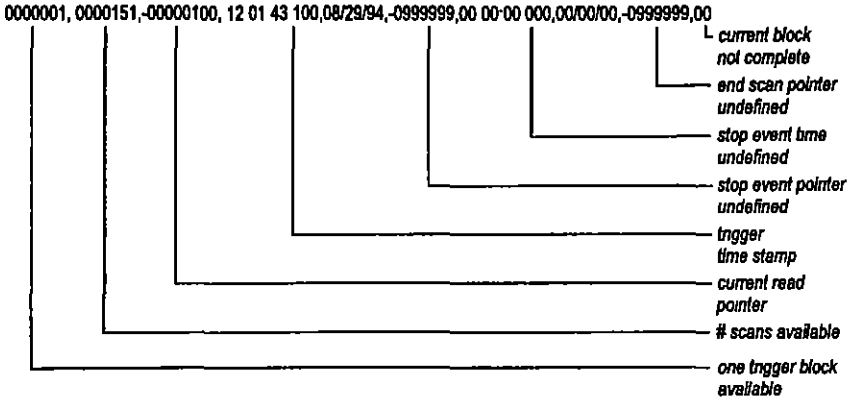


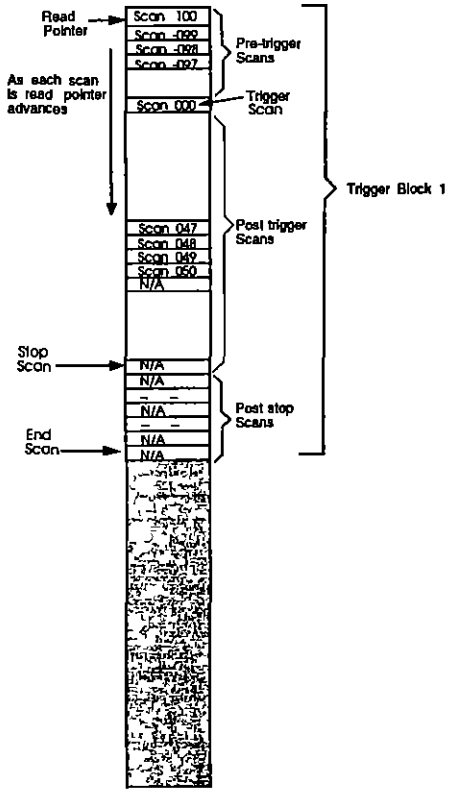
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The following shows an acquisition that has been triggered but the stop event has not yet occurred

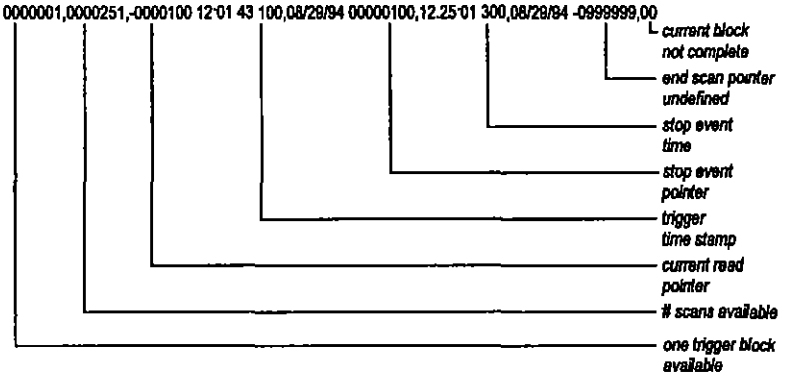


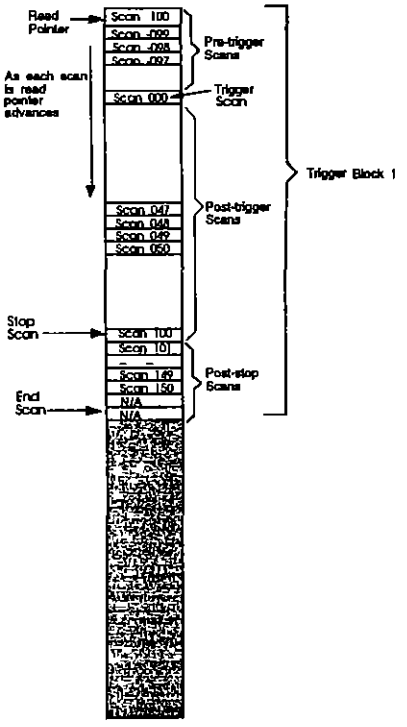


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The previous figure shows that the trigger for the current trigger block has occurred and that the Current Read Pointer is located at the first available pre-trigger scan -00000100 It also shows that an additional 50 post-trigger scans are available

The following diagram shows an acquisition that has been triggered, the stop event has occurred but the end scan has not

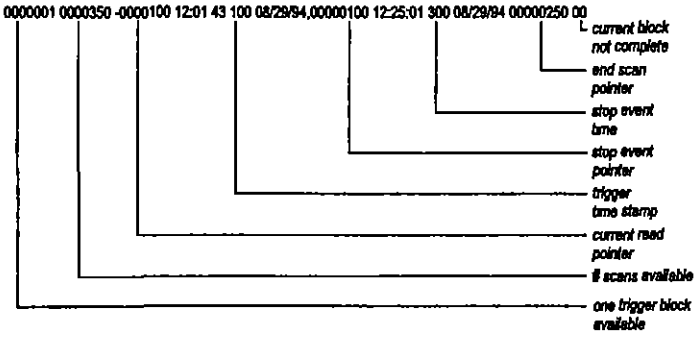


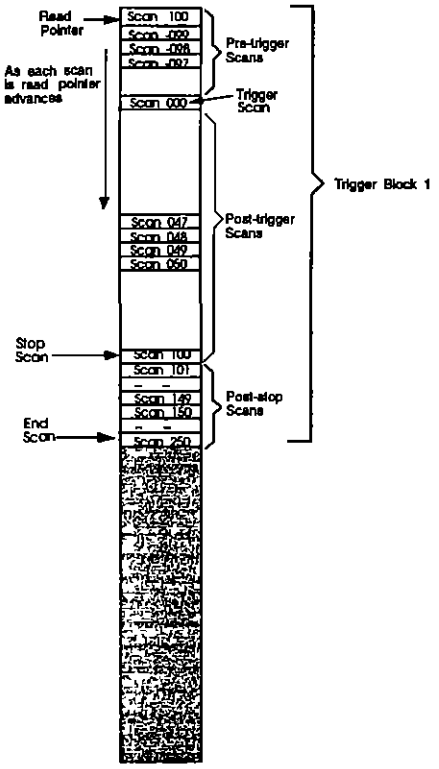


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Note in the previous figure that the trigger for the current trigger block has occurred and that the Current Read Pointer is located at the first available pre-trigger scan -00000100 It also shows that the stop event has occurred and there are 100 post-trigger scans available and, in addition, there are 50 post-stop scans available

The following shows an acquisition that has been triggered, the stop event has occurred and the end scan has also occurred



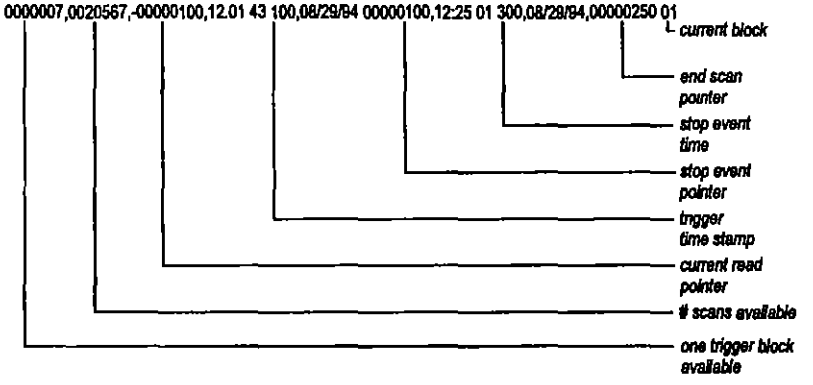


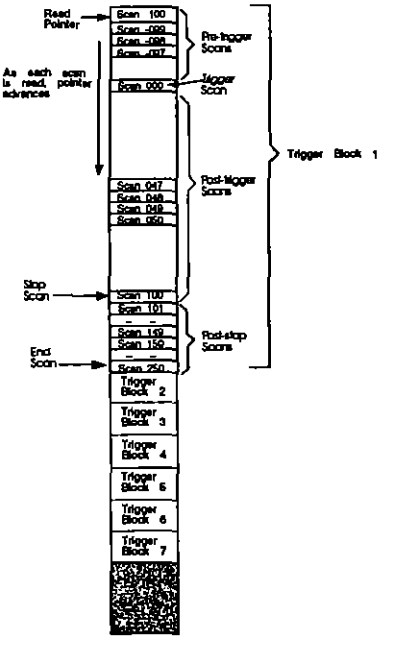
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The previous figure shows that the trigger for the current trigger block has occurred and that the Current Read Pointer is located at the first available pre-trigger scan -00000100 It also shows that the stop event has occurred and there are 100 post-trigger scans available

In addition, it shows that the end scan occurred and that there are 50 post-stop scans available It also shows that the trigger block is now complete

The following diagram shows, essentially, the same as the previous example Except, note that the acquisition buffer now contains more than one trigger block

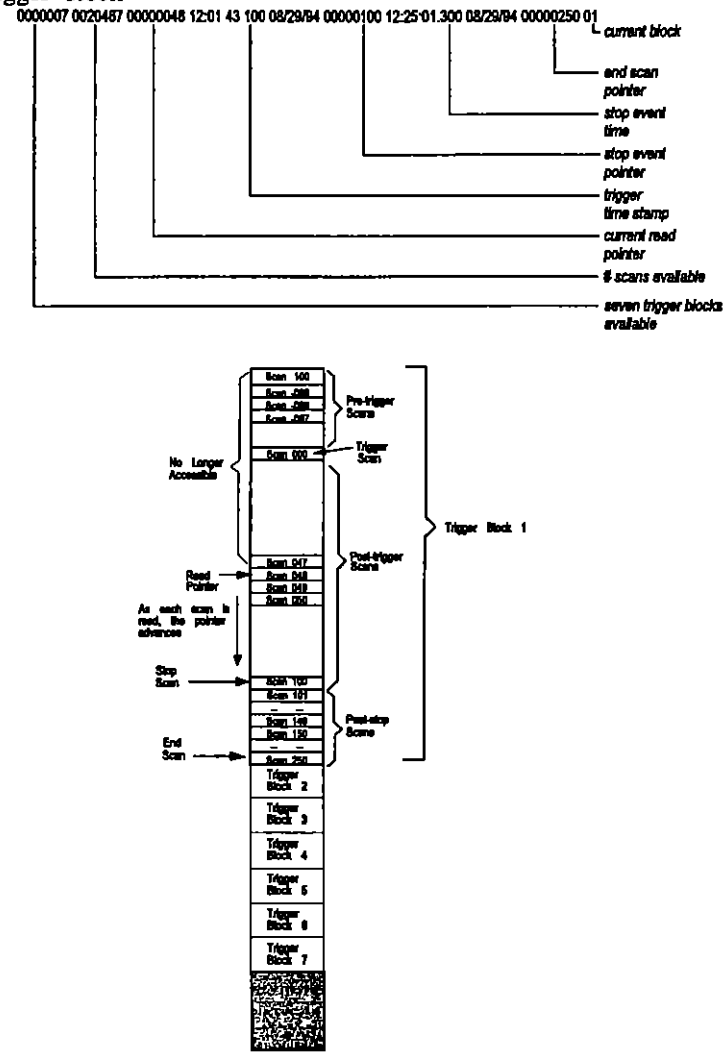




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The above shows that the acquisition buffer now contains 7 acquisition blocks and that the current trigger block is 6 blocks behind the block that is currently being acquired Also note that the Scans Available (0020567) now represents all scans currently in the buffer, not just in the current block (To determine the total number of scans available in the current trigger block take the total "distance" between the Current Read Pointer and the End Scan)

The next example is the same as the previous example, except scans have been read from the current trigger block

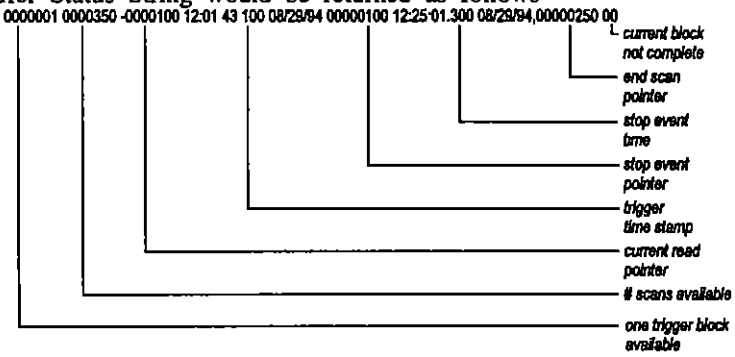


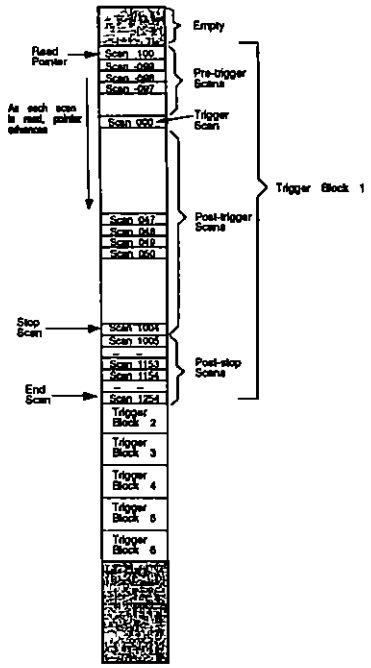
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The previous figure shows that all the pre-trigger data has been read from the current trigger block and the Current Read Pointer is located at 48 in the post-trigger

Now suppose that we wish to read the rest of the trigger block 1 of the buffer defined in the previous example

We could perform this by reading out one scan at a time by performing iterative R1 commands Or, we could issue one R2 command and receive all the data in the current trigger block In any event, if we were to perform a U6 after reading the entire trigger block, the Buffer Status String would be returned as follows





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Notice that the Blocks Available field has been decremented and that the current trigger block is now the next trigger block and that the Current Read Pointer is at location -100 (in the pre-trigger) of that block

3.3.10 Reading the Acquisition Buffer

The three previous sections discussed, briefly, how the acquisition buffer may be accessed and read However, in this section the methods by which the acquisition buffer is read will be discussed in more detail

As mentioned earlier the Acquisition Buffer is organized as a FIFO As such all data read from the Acquisition Buffer will be the oldest available data Furthermore, once the data has been read from the buffer it is no longer available In other words, upon completion of a read operation the data associated with the read operation will be deleted

The Read Acquisition Buffer (R) command is the command by which Acquisition Buffer data is read Using this command the user may read anywhere from one scan to all the scan data currently resident in the buffer This command has the following valid forms

`R1` Read the oldest scan available

`R2` Read the oldest trigger block available

`R3` Read all available scan data

When an `R` command is issued to the TempScan the TempScan performs as follows First, the TempScan checks to see that the request can be fulfilled The request may not be fulfilled if either no channels are configured or the amount of scan data requested is not available If either of these is true a Conflict Error will be posted The `R1` and `R3` commands require that at least one scan be available and the `R2` command requires that at least one complete trigger block be available If the request can be fulfilled, however, the requested scan data is moved from the Acquisition Buffer to the Output Queue where it will wait until the controller initiates the transfer

The Scan Available bit in the Status Byte (STB) Register can be used to determine whether or not the Acquisition Buffer is empty This bit is set when at least one scan is available in the buffer The Buffer Status String (U6) command may also be used to retrieve more detailed information about the state of the Acquisition Buffer

The following are simple examples to illustrate the uses and effects of all three `R` command types

The `R1` command will read the oldest scan in the oldest trigger block For instance

```
PRINT#1,"OUTPUT07, U6X"          ' Request the current status of the Acquisition Buffer
PRINT#1,"ENTER07"                ' Retrieve it
INPUT A$                         ' Screen shows
0000006,0020216,-
00000100,12 51 43 100,03/24/93,00000100,01 53 01 300,03/24/93,00000250,01
```


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The above response indicates that there are 6 trigger blocks currently defined in the Acquisition Buffer and there are 20216 total scans in the buffer Furthermore, it shows that the current read pointer is at the -100 scan in the first trigger block Now to retrieve that scan perform the following

```
PRINT#1,"OUTPUT07,R1X"          ' Request the oldest scan
PRINT#1,"ENTER07"               ' Retrieve it
INPUT A$                        ' Screen shows (4 channels are configured)
+0234 20-0019 40+0001 40+0023 60
PRINT#1,"OUTPUT07, U6X"         ' Request the current status of the Acquisition Buffer
PRINT#1,"ENTER07"               ' Retrieve it
INPUT A$                        ' Screen shows
0000006,0020215,-
00000099,12 51 43 100,03/24/93,00000100,01 53 01 300,03/24/93,00000250,01
```

Notice that after reading the scan there are now 20215 scans in the buffer and the current read pointer is now at scan -99

The R2 command will read the oldest available trigger block in the Acquisition Buffer For instance, continuing with the previous example

```
PRINT#1,"OUTPUT07, U6X"         ' Request the current status of the Acquisition
                                  Buffer
PRINT#1,"ENTER07"               ' Retrieve it
INPUT A$                        ' Screen shows
0000006,0020215,-
00000099,12 51 43 100,03/24/93,00000100,01 53 01 300,03/24/93,00000250,01
```

The above response indicates that there are 6 trigger blocks currently defined in the Acquisition Buffer and there are 20215 total scans in the buffer Furthermore, it shows that the current read pointer is at the --99 scan in the first trigger block and that there are 350 scans in this trigger block Now to retrieve that trigger block perform the following

```
PRINT#1,"OUTPUT07,R2X"          'Request the oldest trigger block
PRINT#1,"ENTER07"               ' Retrieve it
INPUT A$                        ' Screen shows (4 channels x 350 scans) 1400
                                  readings
+0234 20-
0019 40+0001 40+0023 60
PRINT#1,"OUTPUT07, U6X"         ' Request the current status of the Acquisition Buffer
```


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```
PRINT#1,"ENTER07"                ' Retrieve it
INPUT A$                         ' Screen shows
0000005,0019865,-
00000100,02 15 34 100,03/24/93 00000100,04 51 10 300,03/24/93,00000250,01
```

Notice that there are now only 5 trigger blocks in the buffer and that there are now only 19865 scans in the buffer Also note that the current read pointer is at the beginning of what was the next trigger block That trigger block is now the current trigger block

The R3 command will read all available data within the Acquisition Buffer For instance, continuing with the previous example

```
PRINT#1,"OUTPUT07, U6X"          ' Request the current status of the Acquisition Buffer
PRINT#1,"ENTER07"                ' Retrieve it
INPUT A$                         ' Screen shows
0000005,0019865,-
00000100,02 15 34 100,03/24/93,00000100,04 51 10 300,03/24/93,00000250,01
```

The above response indicates that there are 5 trigger blocks currently defined in the Acquisition Buffer and there are 19865 total scans in the buffer Furthermore, it shows that the current read pointer is at the -100 scan in the first trigger block and that there are 351 scans in this trigger block Now to retrieve all the scan data within the buffer

```
PRINT#1,"OUTPUT07,R3X"           ' Request all scan data in the buffer
PRINT#1,"ENTER07"                ' Retrieve it
INPUT A$                         ' Screen shows (4 channels x 19865 scans)
                                 79460 readings
+0234 20-
0019 40+0001 40+0023 60
PRINT#1,"OUTPUT07, U6X"          ' Request the current status of the Acquisition
                                 Buffer
PRINT#1,"ENTER07"                ' Retrieve it
INPUT A$                         ' Screen shows
0000000,0000000,-9999999,00 00 00 000,00/00/00,-0999999,00 00 00 000,00/00/00,-
0999999,00
```

Notice that the Buffer Status String is null indicating that the Acquisition Buffer is completely empty

For more information on using the R command refer to the Command Reference chapter

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These are the required steps for operating the TempScan/1000 For more information on any of the commands referenced, see the Command Reference section of this manual The remainder of this chapter covers how to use advanced features of the TempScan/1000 as well as various informative topics

3.3.11 Scan Time Stamping

As mentioned in the previous sections, the content of each scan contains one reading for each defined channel Optionally, time stamping of each scan can be enabled with the *T command *T1 enables time stamping while *T0 disables time stamping An example of the *T command is as follows

Without time stamping (default).

```
PRINT#1, "OUTPUT07,R3X"  'Request all scan data in buffer
PRINT#1, "ENTER07"       'Retrieve it
INPUT A$

+0234 20-0019 40+0001 40+0023 60
```

With time stamping.

```
PRINT#1, "OUTPUT07,*T1X"  'Enable time stamping
PRINT#1, "OUTPUT07,R3X"   'Request all scan data in buffer
PRINT#1, "ENTER07"        'Retrieve it
INPUT A$
HH MM SS MIL,MM/DD/YYR+0234 20-0019 40+0001 40+0023 60
(MIL = milliseconds, R= reading separator)
```

Note that time stamping is not valid when the output format is binary

3.3.12 Scan Alarm Stamping

For further monitoring and analysis of alarm conditions, the states of the 32 alarm outputs can be optionally stamped to each scan in real time Alarm stamping can be enabled with the A#1 command and disabled with the A#0 command Refer to the A# command description for further details An example of the A# command is as follows

Without Alarm Stamping (default):

```
PRINT#1, "OUTPUT07,A#0X"        ' Disable alarm stamping

                                ' Configure and start an acquisition

PRINT#1, "OUTPUT07,R1X"         ' Request the next scan in the buffer
PRINT#1, "ENTER07"              ' Retrieve it
```


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```
INPUT A$                          '
    +0234 20-0019 40+0001 40+0023 60
```

With Alarm Stamping:

```
PRINT#1, "OUTPUT07,A#1X"          ' Enable alarm stamping

                                  ' Configure and start an acquisition

PRINT#1, "OUTPUT07,R1X"           ' Request the next scan in the buffer
PRINT#1, "ENTER07"                ' Retrieve it
INPUT A$                          '
```

Alarm 15 ON↓ ↓ Alarm 21 ON

```
    +0234 20-0019 40+0001 40+0023 60 005 128 32 66
```

Alarms 0 & 2 ON↑ *↑Alarms 30 & 25 ON*

Note that alarm stamping is not valid in burst mode

3.4 Configuring Alarms

The TempScan/1000 alarms allow the unit to produce an internal event when the value of a channel is outside of user-defined limits These alarm events can be used as trigger or stop events, or as a stimulus for TTL-level signals on the TempScan/1000 back panel

To use alarms, the channels in question must be part of the channel scan Once the channels are configured and made part of the scan, the alarms are active No trigger or scan interval assignment is required Alarming is totally independent of buffered operations

3.4.1 Alarm Setpoints

Each channel has an associated high and low setpoint Setpoints are defined as part of a channel configuration using the C command These setpoints create the "envelope" that constitutes the channel's normal operating range

If the channel value goes above the high setpoint or below the low setpoint, the channel is in the alarm state If any channel configured by the (C) command is in the alarm state, a system alarm event is posted For example, if the trigger source is on "Alarm," this alarm event would cause a trigger

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3.4.2 Digital Alarm Outputs

If desired, an alarm event for a specific channel can be used as a stimulus for a digital output signal (TTL) on the back panel of the TempScan/1000 This signal can be used to set off an audible alarm (user-supplied) or signal another device of the occurrence of the alarm condition

Thirty-two digital alarm outputs are available on the TempScan/1000 back panel Although analog input channels on the expansion chassis can be used to stimulate alarms, no digital output signals are available on the expansion chassis Regardless of the number of expansion chassis connected, 32 digital alarm outputs are available

The Assign Alarm Output (A command) may be used to assign alarm conditions of various channels to one of the 32 digital TLL level outputs located on the back panel The user can tie as many alarm conditions as he wants to any digital output To configure alarm conditions to drive the digital output lines, use the C and A commands The C command determines the high and low setpoints and hysteresis of the alarm condition The A command assigns an input channel alarm to a digital output

The following shows how to configure alarms and alarm digital outputs for 32 channels on the TempScan/1000

```
PRINT #1 "OUTPUT07  C1-32, 1, -1000 0, +1000 0, 10 0X"
```

Setup channels 1-32, type J,low setpoint = -1000 0°C high setpoint = +1000 0, hysteresis = 10 0°C

```
PRINT #1 "OUTPUT07  A1, 1X"
```

Assign alarm channel 1 to Digital Output 1

```
PRINT #1 "OUTPUT07  A2, 2X"
```

Assign alarm channel 2 to Digital Output 2

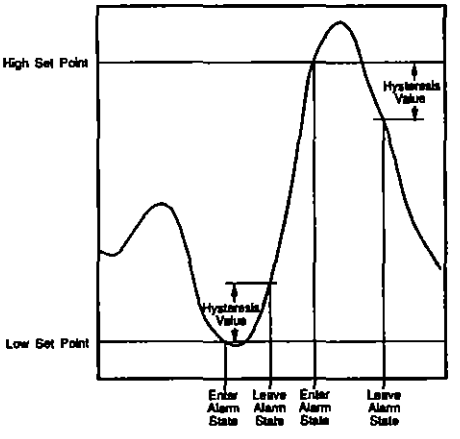


Figure 3 12 TempScan/1000 Alarms and Setpoints

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3.4.3 Setpoint Hysteresis

To avoid threshold transition problems, a hysteresis value can also be programmed A hysteresis value provides a range for an alarm condition After the alarm setpoint is exceeded, the signal must drop below the setpoint by the hysteresis value before the alarm is reset For example, assume a channel has alarm setpoints of 100 and -100, and a hysteresis of 10 The TempScan/1000 would remain in an alarm condition until the setpoint fell below 90 or above -90 depending on which of the two setpoints triggered the alarm

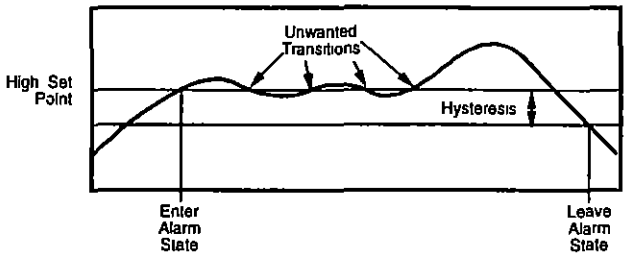


Figure 3 13· TempScan/1000 Setpoint Hysteresis

3.4.4 Comparing Buffered Data to Alarm Status

Unless scans are being collected at the maximum possible frequency, the alarm system may detect alarm conditions that will not appear in the collected data

Since the alarms are being updated at the maximum scan frequency, which may be considerably faster than the programmed scan interval, an alarm condition may be detected even though no such value can be found in the buffered data

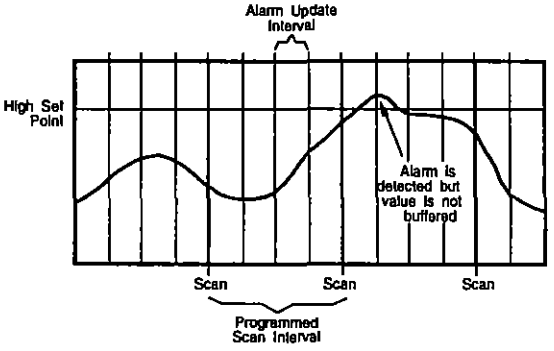


Figure 3 14. Alarm Data vs Buffered Data

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If such a situation is not desired, increasing the scan frequency will decrease the possibility of such an event At the maximum scan frequency, this situation is guaranteed not to occur

3.5 Digital I/O Operation

The TempScan/1000 has eight digital input lines and thirty-two digital output lines available on a rear panel DB50 connector The digital output can be controlled either "automatically" via the alarm settings or manually using the Set Digital Outputs (O) command To determine the digital output state, use the O? command

The Set Digital Outputs (O) command allows the user to enter a specific bit for each output and specify whether the output should be cleared (logic false) or set (logic true) Refer to the Command Reference section of this manual for details

Each digital output line will drive five (5) standard TTL loads All digital input lines are one-eighth (0 125) TTL loads All inputs are protected against damage from high static voltages Normal precautions should be taken to limit the input voltages to –0 3 to +5 3 volts All digital I/O lines are referenced to digital ground (Pin 20)

The pinouts of the TempScan/1000 Digital I/O connector are described in Section 2 7 2 of the Installation chapter

3.6 Using the High/Low/Last (HLL) Registers

The High/Low/Last (HLL) registers are an alternative method of getting channel data from the TempScan/1000 Independent of the triggering and scan interval configuration, the HLL registers are constantly updated with new values at the maximum scan rate At any time, the HLL registers can be queried for channel values

The minimum requirement for activating the HLL system is to configure the channels and the channel scan using the (C) command No other commands are required The returned data will be in the engineering unit and format (ASCII or binary) defined by the user Data formats are described in Section 3 7

3.6.1 What is Contained in the HLL Registers

The HLL Registers contain the following for each channel that is configured

- The High Reading for the channel
- The Time/Date Stamp of the High Reading
- The Low Reading for the channel
- The Time/Date Stamp for the Low Reading
- The Last (or most current) Reading for the channel

As mentioned earlier, all that is needed to initiate HLL updating is to configure the desired channel(s) HLL Registers will only be updated for those channels configured Furthermore, only HLL Registers for channels that are configured may be accessed by the user For

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instance, if channels 1,5 and 13 have been configured only these channels' HLL Registers are updated and only these channels' HLL Registers may be accessed by the user

The High and Low readings for each actively configured channel may be cleared These values are cleared in any of the following ways

- The TempScan/1000 is powered on
- A new channel configuration is issued
- Explicitly clearing them by command (discussed in the next section)

When the High and Low values are cleared their associated Time/Date Stamps are cleared as well After the clear, the new High and Low values, along with their associated Time/Date Stamp, will be initialized on the next updating of the HLL Registers

3.6.2 Accessing the HLL Registers

The HLL Registers may be accessed via commands issued from the controller These commands may be used to access any or all the HLL contents of configured channels as well as providing a means to clear the High and Low readings along with their associated Time/Date Stamps The commands are briefly described as follows

`U4`	Read HLL Registers for all configured channels
`U5`	Read HLL Registers for all configured channels and reset the High and Low values
`U13`	Read Last for all configured channels
`R#`	Read Last for channel(s) specified

The HLL registers contain the highest and lowest values of the channel since it was last cleared and the last value read, for each channel in the channel scan

Two queries are available to read the HLL registers `U4` and `U5` The `U4` command requests the HLL data, while `U5` requests the HLL data then clears and resets the high and low value to the last value If not cleared, the high and low will be maintained

All HLL data will be sent to the controller in the order dictated by the scan configuration, and in the format specified by the Data Format command (F) The HLL data is retrieved in the following sequence *high* (the high reading), *ht* (the high time/date stamp), *low* (the low reading), *lt* (the low time stamp), and *last* (the last reading) The Query Terminator (Q) command may be used to specify a response terminator between each channel of the HLL response and the Format (F) command may be used to specify the format in which the HLL Registers are output

The following examples show how these commands are used to configure and query the HLL Registers

The first example shows how to configure and query all the HLL registers and how the HLL terminator can be used to control the flow of the HLL response output

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```
PRINT#1,"OUTPUT07 F0,0 Q1,1,0,0, 0X"  ' Set format to ASCII degrees C with
                                      ' HLL terminator of CR LF/ EOI
PRINT#1,"OUTPUT07 C1-2 1C10,1C15,1X"  ' Configure four channels (1,2,10 and 15)
                                      ' After an indiscriminate amount of time
PRINT#1,"OUTPUT07 U4X"                ' Query the current HLL settings
PRINT#1,"ENTER07"                     ' Get HLL for channel 1
INPUT A$                              ' Screen shows
+1450 20S12 23 21 700,03/24/93+0850 20S12 35 09 300,03/24/93, +0950 30
PRINT#1,"ENTER07"                     ' Get HLL for channel 2
INPUT A$                              ' Screen shows
+0450 20S02 00 29 500,03/24/93+0057 60S10 35 00 400,03/24/93, +0250 60
PRINT#1,"ENTER07"                     ' Get HLL for channel 10
INPUT A$                              ' Screen shows
-0045 50S11 03 51 7,03/24/93-0110 10S12 55 09 1,03/24/93, -0050 80
PRINT#1,"ENTER07"                     ' Get HLL for channel 15
INPUT A$                              ' Screen shows
+0150 70S03 39 01 200,03/24/93-0085 20S05 25 17 300,03/24/93, +0010 90
```

In the above example, notice that only those channels configured (1,2,10 and 15) were returned in the response

The next examples shows how to reset the High and Low values along with their associated Time/Date Stamps It also shows the effect of specifying no HLL response terminator

```
PRINT#1,"OUTPUT07 F0,0 Q1,0,0,0, 0X"  ' Set format to ASCII degrees C with HLL
                                      ' terminator of None
PRINT#1,"OUTPUT07 C1-4,1X"            ' After an indiscriminate amount of time
PRINT#1,"OUTPUT07 U5X"                ' Query and reset the current HLL settings
PRINT#1,"ENTER07"                     ' Get the response
INPUT A$                              ' Screen shows
+1450 20S12 23 21 700,03/24/93+0850 20S12 35 09 300,03/24/93, +0950 30
+0450 20S02 00 29 500,03/24/93+0057 60S10 35 00 400,03/24/93, +0250 60
+0045 50S11 03 51 700,03/24/93-0110 10S12 55 09 100,03/24/93, -0050 80
```


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```
+0150 70S03 39 01 200,03/24/93-0085 20S05 25 17 300,03/24/93, +0010 90
                                        ' Notice that only one ENTER returned the
                                        ALL HLL data
PRINT#1,"OUTPUT07 S?X"                  ' Now Get the current time
PRINT#1,"ENTER07"
INPUT A$                                Screen shows S13 20 00 1,03/24/93
PRINT#1,"OUTPUT07 U4X"                  ' Now, again query the HLL settings
PRINT#1,"ENTER07"                       ' Get the response
INPUT A$                                ' Screen shows
+0980 20S13 20 01 700,03/24/93+0959 20S13 20 09 300,03/24/93, +0975 80
+0260 70S13 20 29 500,03/24/93+0245 60S13 20 00 400,03/24/93, +0257 60
-0047 50S13 20 51 700,03/24/93-0051 10S13 20 09 100,03/24/93, -0049 80
-0047 50S13 20 51 700,03/24/93-0051 10S13 20 09 100,03/24/93, -0049 80
+0015 70S13 20 01 200,03/24/93+0008 20S13 20 17 300,03/24/93, +0010 40
```

In the above example notice that issuing the U5 command causes the High and Low values and their associated Time/Date Stamps to be reset

The next example shows how to read only the Last readings

```
PRINT#1,"OUTPUT07 F0,0 Q1,1,0,0, 0X"    ' Set format to ASCII degrees C with
                                        ' HLL terminator of CR LF/ EOI
PRINT#1,"OUTPUT07 C1-4,1X"              ' Configure four channel (no setpoints)
PRINT#1,"OUTPUT07, U13X"                ' Just get the Last channel readings
PRINT#1,"ENTER07"                       ' Get Last reading for channel 1
INPUT A$                                ' Screen shows
+0950 30
PRINT#1,"ENTER07"                       ' Get Last reading for channel 2
INPUT A$                                ' Screen shows
+0250 60
PRINT#1,"ENTER07"                       ' Get Last reading for channel 3
INPUT A$                                ' Screen shows
-0050 80
```


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```
PRINT#1,"ENTER07"                    ' Get Last reading for channel 4

INPUT A$                             ' Screen shows

+0010 90
```

Notice that since a HLL response terminator was specified that each channels Last reading had to be ENTERed separately

The next examples shows the same as the previous example except that no HLL response terminators are specified and the format has been changed to degrees F

```
PRINT#1,"OUTPUT07 F0,0 Q1,0,0,0, 0X"  ' Set format to ASCII degrees C with
                                      ' HLL terminator of None

PRINT#1,"OUTPUT07 C1-4,1X"           ' Configure four channel (no setpoints)

PRINT#1,"OUTPUT07, U13X"             ' Just get the Last channel readings

PRINT#1,"ENTER07"                    ' Get Last readings for channels 1-4

INPUT A$                             ' Screen shows

+1743 08+0483 08- 0059 44+0051 62
```

Notice that there are no HLL channel terminators and that the readings are now in degrees F

The next example shows how changing the channel type can effect the output of HLL queries

```
PRINT#1,"OUTPUT07 F0,0 Q1,1,0,0, 0X"  ' Set format to ASCII degrees C with
                                      HLL terminator of None

PRINT#1,"OUTPUT07 C1-4,11X"          ' Configure four channel (no setpoints)
                                      to VOLTS

PRINT#1,"OUTPUT07, U13X"             ' Just get the Last channel readings

PRINT#1,"ENTER07"                    ' Get Last reading for channels 1-4

INPUT A$                             ' Screen shows

+00 0045603+00 0000895- 00 0080087+00 0090865
```

Notice that even though the format was degrees C since the channels have been configured to be VOLTS channels, the response is in VOLTS

The next example shows how to retrieve Last readings for a subset of the configured channels

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```
PRINT#1,"OUTPUT07 F0,0 Q1,1,0,0,0X"  ' Set format to ASCII degrees C with
                                     ' HLL terminator ' of CR LF/ EOI

PRINT#1,"OUTPUT07 C1-4,1X"           ' Configure four channel (no setpoints)

PRINT#1,"OUTPUT07, R#2-3X"           ' Just get the Last reading for channels
                                     2 and 3

PRINT#1,"ENTER07"                    ' Get Last reading for channel 2

INPUT A$                             ' Screen shows

+0250 60

PRINT#1,"ENTER07"                    ' Get Last reading for channel 3

INPUT A$                             ' Screen shows

-0049 50
```

3.6.3 Comparing Buffered Data to HLL Data

Unless scans are being collected at the maximum possible frequency, the HLL system may detect alarm conditions that will not appear in the collected data

Since the HLL registers are being updated at the maximum scan frequency, which may be considerably faster than the timebase, an out-of-limits condition may be detected even though no such value can be found in the buffered data

If such a situation is not desired, increasing the scan frequency will decrease the possibility of such an event At the maximum scan frequency, this situation is guaranteed not to occur

3.7 Data Format

Readings from the TempScan/1000 are output in the format configured by the user The Data Output Format (F) command determines the engineering unit and whether an ASCII format, binary format or a raw data count is to be used

Options for the engineering units are Degrees F°, Degrees C°, Degrees Rankine, Degrees Kelvin or Volts Four basic data formats are available ASCII, binary with high byte first, binary with low byte first, or an unconverted ASCII representation of the count for a particular channel

3.7.1 Data Input Formats

The Data Formats (F) command determines the format of only some of the data input from the controller Input data comes in the form of command parameters from the controller The command parameters over which the F command determines their format are the high, low

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setpoints and the hysteresis parameters for the Channel Configuration (C) command and the Set Trigger Level (L) command These are the only command parameters over which the Data Format (F) command has control These command parameters cannot be issued in binary format If binary format is specified by the F command these parameters will be interpreted as Engineering Units

These parameters will always be interpreted as Engineering Units as currently defined by the Engineering Units argument of the F command except when the Counts format is specified When the Counts format is specified these parameters are interpreted as Counts For additional information see the following sections on the different format types and the command reference section on the F command

If Counts or Binary format is specified as the format, then the Engineering Units parameter of the F command is ignored

Examples.

```
PRINT#1,"OUTPUT07, F0,0X"      ' Interpret C and L command parameters as
                               ' Engineering Units -- Degrees C

PRINT#1,"OUTPUT07,F1,1X"       ' Interpret C and L command parameters as
                               ' Engineering Units (Even though binary is specified) -
                               ' Degrees F

PRINT#1,"OUTPUT07,F3,3X"       ' Interpret C and L command parameters as Counts
                               ' (Counts format is specified)
                               ' (Note that Engineering Units parameter is ignored)
```

3.7.2 Data Output Formats

Data Output formats differ slightly from data input formats in that binary formats may be used for Channel Data Channel Data is the only output data which may use the binary format (if it is specified) Channel Data is defined as data originating from the High/Low/Last (HLL) Registers or the Acquisition Buffer The commands that initiate Channel Data output are the R, R#, U4, U5 and U13 commands However, Channel Data may also be output as Engineering Units and Counts

As in the case of Data Input Formats all other types of output will be in Engineering Units unless Counts is specified However, there are only 3 command queries which need to follow the F command format in this fashion They are C?, L? and U8 command queries

If Counts or Binary format is specified as the format, then the Engineering Units parameter of the F command is ignored

Examples.

```
PRINT#1,"OUTPUT07, F0,0X"      ' Output C?, L?,U8 as well as R,R#,U4,U5 and U13 in
                               ' Engineering Units -- Degrees C

PRINT#1,"OUTPUT07,F1,1X"       ' Output R,R#,U4,U5 and U13 as binary
                               ' Output C?,L? and U8 as Engineering Units --
                               ' Degrees F
```


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```
PRINT#1,"OUTPUT07, F3,3X"
```
' Output C?, L?,U8 as well as R,R#,U4,U5 and U13 in Counts (Note that Engineering Units parameter is ignored)

All commands and data sent to the TempScan/1000 are in ASCII (although the engineering unit may vary) Only data supplied by the TempScan/1000, such as time/date stamps for High/Low/Last registers, may be in binary format Both the IEEE 488 and RS-232/422 interfaces support data retrieval in ASCII and, for high speed applications, in binary format End of Reading and End of Scan terminators are not used with binary data transfers For the IEEE 488 interface, EOI is asserted on the last byte

3.7.3 Engineering Units

The engineering unit is an important factor in determining the data format for the different channel types The selected unit affects the number of decimal places used by either the ASCII or binary formats and is used in temperature conversion formulas

Thermocouples

The TempScan/1000 uses a default system unit of degrees Centigrade Therefore, the resolution of returned data, independent of configured temperature units, is 0 1°C The binary format also returns data in degrees Centigrade The default binary format returns two bytes of 2's complement binary data with user selecting low/high byte or high/low byte

If the ASCII data format is selected, the controller can select temperature units This requires the conversion of degrees Centigrade to configured temperature units Conversion to degrees Fahrenheit, degrees Rankine, and degrees Kelvin are via the following formulas

Fahrenheit	F = (9/5)C + 32
Rankine	R = (9/5)C + 491 69 (R = F + 459 69)
Kelvin	K = C + 273 16

Where degrees Centigrade -3276 7 ≤ C ≤ +3276 7

Volts Card

The default TempScan/1000 system units and resolution are dependent on the volts range

Range	Resolution
±100 mV	3 1212 µV/bit
±1V	31 2121 µV/bit
± 5V	156 0606 µV/bit
± 10V	312 1211 µV/bit

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The default binary format returns 2 bytes of 2's complement binary data with the user selecting low/high byte or high/low byte

3.7.3.1 Engineering Units Data Format

If the Engineering Units data format is selected, the TempScan/1000 will supply data in format appropriate for the configured channel type This ASCII data format for temperature, volts, time/date and scan interval is described below

Temperature·

For channels configured as thermocouples, all ASCII readings will be returned in the format which corresponds with the engineering unit selected The formats are as follows

Centigrade	XXXX XX
Fahrenheit	XXXX XX
Rankine	XXXX XX
Kelvin	XXXX XX

where X is an ASCII digit

Volts:

For Volts channels all ASCII readings will be of the form

±XX XXXXXXXXX where X is an ASCII digit

For example, if the Engineering Units format is selected, the returned data will be in the following format

Range	Example
1 Volts	00 XXXXXXXXX volts
1 Volt	0X XXXXXXXXX volts
5 Volts	0X XXXXXXXXX volts
10 Volts	XX XXXXXXXXX volts

Time/Date.

Time/Date values will have the following ASCII format

hh mn ss t,mm,dd,yy where

hh (00≤ hh ≤ 23) is the hour

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mn (00≤ mn≤ 59)	is the minute
ss (00< ss< 59)	is the seconds
t (00< t<=9)	is the tenth of seconds
mm (01<=mm<=12)	is the month
dd (valid by month)	is the day
yy (00<=yy<=99)	is the year

Time/Date Stamp

Time/Date stamp output values occur within HLL and acquisition buffer output queries Time/Date stamp output values will have the following ASCII format

`hh mm ss mss,mm,dd,yy` where

hh (00<=hh<=23)	is the hour
mn (00<=mn<=59)	is the minute
ss (00<=ss<=59)	is the second
mss (000<=mss <= 999)	is the milliseconds
mm (01<=mm<=12)	is the month
dd (valid by month)	is the day
yy (00<=yy<=99)	is the year

For example

`01 25 20 600,12/12/92` Reads 20 and 6 tenths seconds after 1 25 AM on dd/mm/yy

Scan Interval:

Scan Interval formats will have the following ASCII format

`hh mm ss t`

For example

`00 01 00 0` Scan interval of 1 minute

3.7.4 Binary Data Format

Only High/Low/Last register and acquisition output data, may be in binary format Binary formatted data can be output in either highbyte/lowbyte or lowbyte/highbyte format

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Time/Date Stamp.

If binary format is selected, the High/Low/Last register values will also include time/date stamps When outputting the High/Low/Last registers for either highbyte/lowbyte or lowbyte/highbyte, the time/date stamp will have the following format

`hmstMDY` where each letter is a byte represented by

`h`	- *hours*
`m`	- *minutes*
`s`	- seconds
`t`	- *tenths*
`M`	- *months*
`D`	- *days*
`Y`	- *years*

So a typical High/Low/Last will have the following binary format (each letter is a byte of data)

`HHhmstMDYLLhmstMDYll` where `HH`-high, `LL`-low,`ll`-last

3.7.5 Counts Data Format

The Counts data format is a format that is characterized by an ASCII integer number from -32038 8444 to +32038 8444 that represents a compensated or raw value as it would be interpreted from the A/D converter This value would be dependent upon the channel type which has been specified for the channel in question The Counts format closely follows the channel type that has been specified For example, if the channel type for channel 16 is type 1 (Type J TC with CJ compensation and linearization) then the Counts format output value for this channel would also have been CJ compensated and linearized Conversely if channel 16 would be type 31 (Raw A/D data) then the Counts format output value for this channel would also be raw Both temperature and volts readings will be represented by a bipolar 16-bit value of the form ±xxxxx Time/Date stamp format is the same as specified in Section 3 7 4

The Counts format is both a valid input (C and L command) format and a valid output format (`R, R#, U4, U5, U8, U13, C?` and `L?` command queries)

3.7.5.1 Configuring Power-Up State

The TempScan/1000 has an internally stored factory default configuration This factory default configuration may be recalled at any time or the TempScan/1000 may be configured to power up with this default configuration

During normal operations the factory defaults may be recalled by issuing the Restore Factory Defaults (`*F`) command When this command is processed the TempScan/1000 will load the factory default configuration and will operate accordingly This command, however, may not be issued while an acquisition is currently configured

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The TempScan/1000 normally is configured to power up with the last known configuration at the time that it was powered down (or at the time that a `*R` is issued) The TempScan/1000, however, may be configured to always power up with the factory default configuration This is done by issuing the Power up Settings (`*S1`) command The unit may be returned to powering up under the last known configuration by issuing an `*S0` (power up under last-known configuration) command

> **Note Configuring the TempScan/1000 to power up under the factory defaults or recalling the the factory default settings will not affect pre-existing calibration factors of the TempScan/1000 or its slave units**

The following table lists the execution steps and effects when the TempScan is configured to power up under the factory default configuration

Step	Command	Effect
1	Q7,0,0,0,0	Set general response Term to CR-LF/EOI All others to None
2	V0	Set the User Term to ASCII code 00 (Hex) NUL
3	F0,0	Set the data format to Engr Units -- Degrees C
4	M0	Set SRQ (SRE) Mask to 000
5	N0	Set Event Status Enable (ESE) to 000
6	*C	Un-configure all channels
7	Y0,0,0	Set acquisition counts to all 0
8	I00 00 00 1,00 00 00 1	Set both timebase intervals to 0 1 seconds
9	L1, 0,0	Un-configure level
10	T0,0,0,0	Un-configure acquisition triggering

3.8 Queries

The TempScan/1000 provides many ways to query the unit for specific information Most commands have a corresponding query command which responds with the configuration or mode of a previously executed command In addition, the U Status commands can be used at any time (without interfering with normal operation) to return information about the various TempScan/1000 conditions

3.8.1 Query (?) Commands

Most commands have a corresponding query command formed by appending a question mark (?) to the command letter Query commands place their responses into the output queue until the controller retrieves them They respond with the present configuration or mode of a

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previously executed command When appropriate, the response from a query command is in the form of a command string which, if it were executed, would put the the unit into the configuration it was in when the query was executed For instance, the response to the User Terminator query command `V?X` is in the form

```
Vuser (where 0<=user<=255)
```

This response is in the form of the User Terminator (V) command and, if it is sent to the TempScan, it would set the User Terminator to the same value that it had when the query was issued Query responses are always fixed-length strings in a pre-defined format

Any number of query commands can be combined into one string to create a specialized status command that responds with only the information of interest for a given application

Query commands are immediate their responses are generated as soon as they are interpreted, before any other commands, including the Execute (X) command For example

```
PRINT#1,"OUTPUT07, V1 X V? X"      ' Get the response of current User Terminator
PRINT#1,"ENTER07"                  ' Retrieve response
INPUT A$                           ' Screen shows  V1
PRINT#1,"OUTPUT07, V0 X V? X"      ' Change User Terminator and get response
PRINT#1,"ENTER07"                  ' Retrieve response
INPUT A$                           ' Screen shows V0
PRINT#1,"OUTPUT07, V4 V? X"        ' Change User Terminator and Get response - No
                                   intermediate X command
PRINT#1,"ENTER07"                  ' Retrieve response
INPUT A$                           ' Screen shows V0 User Terminator  Response is still
                                   V0 because V? was executed before V4 since V? is
                                   an immediate  and  V4 is a deferred command
PRINT#1,"OUTPUT07, V? X"           ' Get User Terminator response
PRINT#1,"ENTER07"                  ' Retrieve response
INPUT A$                           ' Screen shows new User Terminator -- V4
```

Even though query commands generate their response as soon as they are interpreted, they must still be followed by an Execute (X) command for proper termination For more information on command execution, refer to the Command Reference chapter of this manual

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3.8.2 U Status Commands

Status commands are used to return information about various conditions of the TempScan/1000 The status of the TempScan/1000 may be read at any time without interfering with normal operation Any error conditions, except Calibration Errors, are cleared after the status string is read by the controller Calibration errors are cleared when the TempScan/1000 is calibrated

Status strings are returned when the TempScan/1000 is next addressed to Talk The terminators used and the use of the End or Identify (EOI) line can be changed with the Q commands

If the TempScan/1000 is configured to trigger on Talk, requesting a status report (U command) will not cause the TempScan/1000 to trigger

The table below outlines the information available through the U commands See the Command Reference section for details and examples

U COMMAND	DESCRIPTION
U0	Causes the TempScan/1000 to return a fixed-length status message string The status message shows the current options in use for each command
U1	Causes the TempScan/1000 to return a decimal number from 000 to 255 This number is the decimal equivalent of the binary information on the digital input lines on the rear panel card edge digital I/O connector
U2	Returns information in the Calibration Status Register
U3	Returns system settings similar to invoking a combination of the following query commands F?I?L?P?Q?S?T?Y?
U4	Returns high/low/last register data in the current data format for each channel defined by the (C) command, such as the high reading, the high time stamp, the low reading, the low time stamp, and the last reading
U5	Returns the same information as U4 but resets the current high/low for all channels
U6	Returns the following current trigger block information the trigger block #, current read scan in block, current write scan in block, the trigger time/date stamp, the scan # that stop occurred, the scan number that end of acquisition occurred, and the block completed flag
U7	Returns the channels that have been assigned alarm output in the form of Achan, output where 992 ≤ chan ≥ 1, and 32 ≤ output ≥ 1
U8	Returns the channel settings for each configured channel
U9	Returns the digital input values corresponding to each of the eight digital inputs
U10	Returns memory size in the form mmmmm, where m is each digit in the memory size (Kbytes)

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U11	Returns the channel number associated with each alarm output
U12	Returns the last date the unit was calibrated in the form 12 54 00 9,01/28/93
U13	Returns the last scan read
U14	Returns card ID's
U15	Returns product information in the form Manufacturer, TempScan/1000, 0, v r, where v is the version and r is the revision
U18	Returns the contents of the system register

3.9 Status and Event Reporting

The TempScan/1000 has several internal registers dedicated to status and event reporting functionality These registers cover a wide range of internal error and event conditions Each of these registers covers a particular aspect of event reporting responsibility These registers are briefly defined as follows

Calibration Status Register (CSR)	Indicates any error conditions during calibration
Error Source Register (ESC)	Indicates any general error conditions with the unit
Event Status Register (ESR)	Indicates special 'events' that have occurred in the unit
Status Byte Register (STB)	Indicates critical operation events

In addition, the TempScan/1000 employs two additional registers which may be used to configure how the above status reporting registers are to operate These registers are

Event Status Enable (ESE)	A mask for the Event Status Register (ESR)
Service Request Enable (SRE)	A mask for the Status Byte Register (STB)

These registers are all eight-bit registers where each bit represents a certain condition, event or error The contents and operation of each of these registers is described in subsequent sections

Each of these registers may be accessed via a command issued by the controller The status registers CSR, ESC and ESR are Read/Clear-Only registers in that they may only be read and cleared by the controller The read operations on these registers is a destructive read thereby clearing the register as it is read These registers can only be written to by internal TempScan/1000 operations The STB register is a Read-Only register in that it can only be read by controller This register can only be cleared or written to by the internal processes of the TempScan/1000 The mask registers ESE and STB, however, are Read/Write/Clear registers in that they may be written and cleared as well as read by the controller The following table show how each of these registers may be accessed

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Register	Access	Read Cmd	Write Cmd	Clear Cmd
CSR	Read/Clear	U2	N/A	U2
ESC	Read/Clear	E?	N/A	E?
ESR	Read/Clear	U0	N/A	U0
STB	Read	U1 (SPOLL)	N/A	N/A
ESE	Read/Write/Clear	N?	N*mmm*	N0
SRE	Read/Write/Clear	M?	M*mmm*	M0
* The *mmm* defines contents of the register to be written				

3.9.1 Theory of Operation

Figure 3 16 shows the general operation and relationship between the status reporting and mask registers Each register is part of a hierarchy of registers where operations on higher registers will affect the contents of lower registers in the chain This hierchanal approach provides the ability to have varying levels of status reporting The lowest levels give general status information while the higher levels give more details of the particular events in question

At the lowest level in this chain is the Status Byte Register This register may be accessed real-time by the controller via a SPOLL (IEEE-488 only) command This allows quick response of certain critical operational status conditions contained in the Status Byte Register (STB) However, since this register is the lowest register in the chain, every other status register in the system, either directly or indirectly, has access to the STB register via the Event Status Register Bit (ESB) in the STB register This gives these other status registers the ability (although not detailed) to quickly report their status to the controller

The Event Status Enable (ESE) Register may be used to define which bits in the Event Status Register will be mapped into the Event Status Register Bit (ESB) in the STB The bits in the ESE represent an exact image of the bits in the ESR When a condition is set in the ESR its image bit is checked in the ESE If enabled the ESB bit in the STB is set

The Service Request Enable (SRE) register may be used to define those conditions in the STB which will generate a Service Request (SRQ) The bits in the SRE represent an exact image of the bits in the STB accept for Service Request Bit When a condition is set in the STB its image bit is checked in the SRE If enabled the TempScan/1000 will generate a Service Request (SRQ)

In the same fashion that the setting of events or conditions affects the lower levels of registers in the chain, the clearing of events or conditions in the higher level registers also causes the clearing of those affected conditions in the lower level registers

The following sections describe in detail the contents and operation of these registers More information on these registers can also be found in the Command Reference section under the `M,N,U` and `E?` commands relating to these registers

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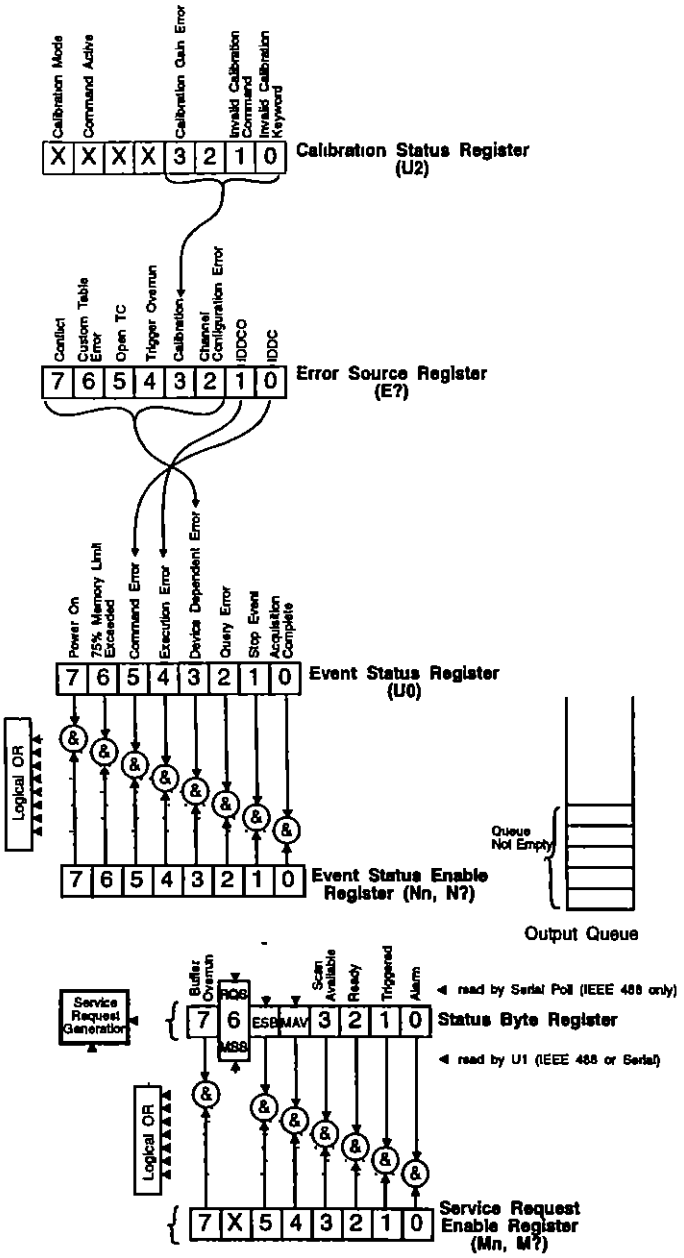


Figure 3 15. TempScan/1000 Status Reporting Registers

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3.9.2 Calibration Status Register

The calibration status register indicates which calibration errors, if any have occurred The individual errors are described in the U2 command Any calibration error will be mapped into the Calibration Status which maps to the Calibration Error bit in the Error Source Register

3.9.3 Error Source Register

The error source register indicates which errors, if any, have occurred The individual errors are described in the E? command

When an error occurs, it sets the appropriate bit in the error source register This in turn sets a bit in the event status register as shown in Figure 3 16

3.9.4 Event Status Register

The event status register indicates which events, if any, have occurred Its bits, and the event that set them, are as follows

Bit 0	Acquisition Complete?	Set when acquisition operation has been completed An acquisition is complete when the TempScan/1000 has finished the current acquisition The bit will be cleared when a new acquisition is configured through the T command
Bit 1	Stop Event	Set when the pre-trigger count specified in the trigger configuration (by the T command) has been satisfied This bit is cleared when a new acquisition is configured either through the Trigger Configuration (T) command or when the unit is rearmed via the auto rearm mode
Bit 2	Query Error	Set when the controller has attempted to read from the TempScan/1000 when no response is present or pending, or when a response has been lost because the controller has sent a new query before reading the response to a prior query
Bit 3	Device Dependent Error	Set when a conflict error has occurred A conflict error is generated when a command cannot execute correctly because it would interfere with other commands or settings
Bit 4	Execution Error	Set when one of several errors has occurred during the execution of a command
Bit 5	Command Error	Set when a command syntax error is detected

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Bit 6	75% Limit Exceeded	Set when the Acquisition Buffer has been filled to at lease 75% of its capacity The bit is cleared when the amount of data in the Acquisition Buffer falls below 75% of its capacity
Bit 7	Power On	Set on power-on or system reset (*R)

The event status register is read with the U0 command The contents of the ESR are cleared after the U0 command is satisfied

3.9.5 Event Status Enable Register

The event status enable register controls which events, if any, are to be reflected in the status byte register As shown in Figure 3 16, the bits of the event status register are logically ANDed with the corresponding bits of the event status enable register, and the resulting bits are logically ORed together in the status byte register The event status enable register does not affect the event status register, it only affects the ESB bit of the status byte register The event status enable register is set and interrogated with the Nn command

3.9.6 Status Byte Register

The TempScan/1000 sets the Message Available bit (MAV) in the Status Byte Register to determine if data can be read by the controller This is the only status reporting register which requires RS-232/422 interface users to use a different read command than IEEE 488 interface users

The TempScan/1000 status byte register contains the following active bits

Bit Location	Value	Description
DIO1 (LSBit)	1	Alarm
DIO2	2	Trigger Detected
DIO3	4	Ready
DIO4	8	Scan Available
DIO5	16	Message Available
DIO6	32	Event Status Register Bit (ESB)
DIO7	64	Service Request Bit
DIO8 (MSBit)	128	Buffer Overrun

All bits in the serial poll status byte register are cleared by either a *R command, which returns the TempScan/1000 to its power-up default conditions, or a read of the serial poll status byte register via the Status command U1 The ESB in the Serial Poll Status Register is also cleared by these operations The Command Error, Execution Error and Device Dependent Error are also cleared with an Error Query (E?) command

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DIO1	Alarm	Set when the TempScan/1000 has sensed a valid alarm condition It is cleared whenever the alarm condition no longer exists
DIO2	Trigger Detected	Set when the TempScan/1000 has detected the trigger condition and will be cleared when the acquisition is complete or the trigger has been reconfigured
DIO3	Ready	Set when the TempScan/1000 is ready to process another command It is cleared when the TempScan/1000 is processing a command line This bit should be examined with a serial poll prior to issuing a new command line This allows any detected errors to be traced to the specific command line containing the error If all the setup information for a specific TempScan/1000 operation is included in one line, this bit also indicates when all processing is done and the X command is completed This ensures that the TempScan/1000 is done processing all state changes before initiating any further activity
DIO4	Scan Available	Set when at least 1 acquisition scan is available in the acquisition buffer to be read Cleared when there are no scans available in the buffer to be read
DIO5	Message Available (MAV)	Set when the output queue is not empty It is cleared when the output queue is empty This bit reflects whether any command responses are still in the output queue
DIO6	Event Status register Bit (ESB)	Reflects the logical OR of all the bits in the Event Status Register (ESR) ANDed with their equivalent enable bits in the Event Status Enable (ESE) register If this bit is set, at least one bit in the ESR is set and has its corresponding enable bit in the ESE set The status command U0 can be issued to read the ESR See the following for more information on ESR and ESE
DIO7	Service Request Bit (SRQ)	Set when the TempScan/1000 is requesting service It is cleared when an SPOLL is performed
DIO8	Buffer Overrun	Set if a buffer overrun occurs It is cleared when the buffer becomes empty by either reading out the contents of the buffer or performing a Reset (*B) of the buffer

3.9.7 Service Request Enable Register

The service request enable register controls which bits of the status byte register are to be reflected in the Request for Service and Master Summary Status bits of the status byte register As shown in Figure 3 16, the bits of the status byte register are logically ANDed with the corresponding bits of the service request enable register The resulting bits are logically ORed together to form the master summary event status bit (MSS) in the status byte register and to control the request for service (RQS) bit in that register The service request enable register does not affect the status byte register, it only affects the MSS and

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RQS bits of the status byte register The event status enable register is set and interrogated with the Mn command

3.10 IEEE 488 Serial Poll Response

The Serial Poll Status Byte is sent when a serial poll (SPoll) command is received over the IEEE 488 bus from the active controller Although these bits are always set to indicate the status of TempScan/1000, they do not generate an SRQ on the IEEE 488 bus unless the corresponding enable bit in the Service Request Enable (SRE) register has been set with the Mn command Below is a description of each bit in the Serial Poll Status Byte Register

Bit Location	Value	Description	Bit
DIO1 (LSBit)	1	Alarm	1
DIO2	2	Trigger Detected	2
DIO3	4	Ready	3
DIO4	8	Scan Available	4
DIO5	16	Message Available (MAV)	5
DIO6	32	Event Status Register Bit (ESB)	6
DIO7	64	Service Request Bit	7
DIO8 (MSBit)	128	Buffer Overrun	8

All bits in the serial poll status byte register are cleared by either a *R command, which returns the TempScan/1000 to its power-up default conditions, or a read of the serial poll status byte register via the Status command U1 The ESB in the Serial Poll Status Register is also cleared by these operations The Command Error, Execution Error and Device Dependent Error are also cleared with an Error Query (E?) command

DIO1	Alarm	Set when the TempScan/1000 has sensed a valid alarm condition It is cleared whenever the alarm condition no longer exists
DIO2	Trigger Detected	Set when the TempScan/1000 has detected the trigger condition and will be cleared when the acquisition is complete or the trigger has been reconfigured
DIO3	Ready	Set when the TempScan/1000 is ready to process another command It is cleared when the TempScan/1000 is processing a command line This bit should be examined with a serial poll prior to issuing a new command line This allows any detected errors to be traced to the specific command line containing the error If all the setup information for a specific TempScan/1000 operation is included in one line, this bit also indicates when all processing is done and the X command is completed This ensures that the TempScan/1000 is done processing all state changes before initiating any further activity
DIO4	Scan Available	Set when at least 1 acquisition scan is available in the acquisition buffer to be read Cleared when there are no scans available to be read

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DIO5	Message Available	Set when the output queue is not empty It is cleared when the output queue is empty This bit reflects whether any command responses are still in the output queue
DIO6	Event Status register Bit (ESB)	Reflects the logical OR of all the bits in the Event Status Register (ESR) ANDed with their equivalent enable bits in the Event Status Enable (ESE) register If this bit is set, at least one bit in the ESR is set and has its corresponding enable bit in the ESE set The status command U0 can be issued to read the ESR See the following for more information on ESR and ESE
DIO7	Service Request Bit (SRQ)	Set when the TempScan/1000 is requesting service It is cleared when an SPoll is performed
DIO8	Buffer Overrun	Set if a buffer overrun occurs It is cleared when the buffer becomes empty by either reading out the contents of the buffer or performing a Reset (*B) of the buffer

3.11 Using Status Reporting Registers

As mentioned earlier the status reporting registers are organized in a hierarchical structure with the lower level registers containing more general information and the higher level registers containing more detailed information about particular events In general, the lowest level register, the Status Byte Register (STB) contains information that may require more immediate action from the controller in that events contained in this register tend to be more time critical

However, as mentioned earlier, other registers may access the STB via the ESB bit This allows any condition within the status reporting register hierarchy to have access to the STB and therefore Serial Poll and Service Request functionality

The following is an example to show, in brief, how the status reporting register hierarchy works

```
PRINT#1,"OUTPUT07,N0X N16 X"      ' Configure ESB in the STB to be set when a
                                  Device Dependent Error occurs
PRINT#1,"OUTPUT07,M0 X M32 X"     ' Configure SRQ when the ESB in the STB occurs
```

Now the TempScan/1000 is configured so that when any Device Dependent Error occurs the unit will issue a Service Request (SRQ) to the controller When the SRQ occurs the controller may perform the following sequence to determine the exact cause of the Service Request

```
PRINT#1,"OUTPUT07,E?X"            ' Query the ESC to determine the cause of the
                                  error
PRINT#1,"ENTER07,                 ' Get the response
INPUT A$                          ' Screen shows E016 This is a calibration error
```


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```
PRINT#1,"OUTPUT07,U2X"          ' Query the CSR to determine the cause of the
                                ' calibration error
PRINT#1,"ENTER07,               ' Get the response
INPUT A$                        ' Screen shows E002 This is a calibration Gain
                                error
PRINT#1,"OUTPUT07,U0X"          ' Now query the ESR (reading ESC should have
                                cleared it)
PRINT#1,"ENTER07,               ' Get the response
INPUT A$                        ' Screen shows 000 -- Device Dependent Error
                                no longer there
PRINT#1,"SPOLL07                ' Screen shows 4 -- ESB bit no longer set (only
                                Ready is set)
```

In the above example notice that the clearing of the higher level registers cleared the bits in the lower level registers that were associated with the root cause of the condition

3.12 Minimum Scan Interval

An important aspect of channel configuration is the number of channels configured within a "channel block" The TempScan/1000 groups the 992 channels into channel blocks Each channel block contains 4 channels For example, the first channel block contains channels 1 through 4, the second, channels 5 through 8, etc , as shown in the table below The increased density of a channel block, that is the greater the number of channels configured, the better the sampling rate will be

The minimum scan interval is the fastest time in which the system can accumulate scans This interval is dependent on the number of channels and the range of the channel numbers selected The variable in determining the minimum scan interval is the number of "non-empty 4-channel blocks" For example, if channels 1, 2, 3, 4, 5, 7, 15, 100, 101 are selected, then there are 5 non-empty 4-channel blocks The table below demonstrates how to determine the number of non-empty channel blocks based on the channel configuration Note the table only shows 30 of the possible 248 channels blocks

In Use?	Block	Channels	In Use?	Block	Channels	In Use?	Block	Channels
√	1	**1,2, 3, 4**		11	41,42, 43, 44		21	81,82, 83 84
√	2	**5**, 6, **7**, 8		12	45, 46, 47, 48		22	85, 86, 87 88
	3	9, 10, 11, 12		13	49, 50, 51,52		23	89, 90 91 92
√	4	13, 14, **15** 16		14	53, 54, 55, 56		24	93, 94, 95, 96
	5	17 18 19, 20		15	57, 58, 59, 60	√	25	97 98, 99, **100**

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	6	21,22, 23,2 4		16	61,62 63 6 4	√	26	**101** 102, 103 104
	7	25, 26, 27 28		17	65 66 67, 68		27	105 106, 107 108
	8	29, 30 31, 32		18	69, 70, 71 72		28	109, 110 111 112
	9	33, 34 35 36		19	73 74 75, 76		29	113 114, 115 116
	10	37, 38, 39 40		20	77, 78, 79 80		30	117, 118 119, 120

Once the number of non-empty channel blocks is determined, we can calculate the minimum scan interval The formula for performing this calculation depends on whether a 50Hz or 60Hz line cycle is being used

For a 60Hz line cycle,

scan interval = 16 67ms * next highest integer ((# non-empty 4-channel blocks)/4)

For a 50Hz line cycle,

scan interval = 20 00ms * next highest integer ((# non-empty 4 channel blocks)/4)

For example, the minimum scan interval calculation of the channel sequence described in the table @ 60 Hz is

```
    16 67 ms  * next highest integer(5/4)
=   16 67 ms  * 2
=   33 33 ms
```

Note the high/low/last registers, the alarms, and the level event (if programmed) are all updated at the maximum scan rate or once every minimum scan interval independent of any other timebase configuration

The TempScan/1000 has a programmable sampling rate from 1 scan/100hrs to minimum scan interval for a 60 Hz line-cycle system Although the TempScan/1000 can acquire temperature readings at a rate of 960 channels/second, it may also be programmed by the user with the Timebase Configuration (I) command to acquire data at specified time intervals using the HH MM SS S format

3.13 Trigger Latency

Each trigger source has an associated latency This is the time between the actual trigger and its recognition by the TempScan/1000

The following latency times are only representative of the time between when the trigger is detected and when the trigger has been processed Hardware latency times and ISR servicing of other tasks at the time of the trigger event but before the trigger is detected are not accounted for In other words, these times may be offset as much as the hardware latency times, in addition to the amount of time that the longest uninterrupted ISR takes to process

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TRIGGER SOURCE	LATENCY (avg)	OBSERVED VARIATION
External Triggers (TTL Rising, TTL Falling)	610 95µs	2 10µs
Selected Temperature Range	N/A	N/A
GET (IEEE only)	645 6µs	3 10µs
TALK (IEEE only)	780 53µs	12 00µs
'@" character	2 255 ms	620 00µs
Alarm	N/A	N/A
Absolute Time	44 5µs	27 0µs
Count (post-trigger)	45 9µs	28 5µs

When using a channel level or alarm as the trigger source, the trigger latency is dependent on the number of channels Regardless of the programmed timebase, the TempScan/1000 constantly scans the configured channels for the occurrence of a channel level trigger Therefore, the maximum trigger latency is equal to the period of the maximum scan rate

3.14 Trigger Overrun

A trigger overrun condition exists if more than one trigger start event or more than one trigger stop event occurs during one trigger acquisition This is flagged and notification is given, but no other action is taken The trigger overrun bit in the Error Source Register (ESE) is set The user may query (with the `E?` command) the Error Source Register to determine if a trigger overrun has occurred

3.15 Buffer Overrun

The TempScan/1000's internal buffer will wrap around if the controlling computer cannot read the data out of the buffer before it is completely full This situation is called "buffer overrun " It prevents new data from being lost and keeps the scan rate consistent, but it also overwrites the oldest data

Although registered as an error, depending on the application, a buffer overrun may be a part of normal operation

For example, if a TempScan/1000 with 256 Kbytes of memory was configured to scan 16 channels at a one minute interval, the buffer would fill and an overrun would occur in about 5 6 days Regardless of how long the TempScan/1000 is left unattended after that point, it will always maintain the newest 5 6 days of scans

There are two cases of buffer overrun One when only one trigger block is in the buffer, and secondly, when multiple trigger blocks are in the buffer

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If a buffer-overrun occurs, it may be detected by querying the Status Byte (STB) by either a SPOLL (IEEE 488 only) or a U1X command (IEEE 488 and RS-232/422)

1 IEEE 488

```
PRINT#1, "SPOLL 07"
INPUT #2, S%
IF (S% and 128 = 128) THEN
   PRINT "Buffer Overrun Occurred"
ENDIF
```

2 IEEE 488 and RS-232/422

```
PRINT#1, "OUTPUT07, U1X"
PRINT#1, "ENTER07"
INPUT #2, S%
IF (S% and 128 = 128) THEN
   PRINT "Buffer Overrun Occurred"
ENDIF
```

3.15.1 Buffer Overrun With One Trigger Block

When only one trigger block is in the buffer, a buffer overrun will erase the entire pretrigger (See Figure 3 17 below) If the controller was reading pretrigger data from the buffer, the next scan read will be the trigger point

If no pretrigger was configured or the pretrigger has already been read, a buffer overrun will only erase the oldest scan in the buffer If the scan being erased is currently being read, the contents of the read scan will be in error If an overrun condition is detected by the controller during a read operation, any further reading must be considered corrupt until a buffer reset is issued This can be done by either resetting the buffer with a *B command and/or reading the remaining data out of the buffer until it is clear

3.15.2 Buffer Overrun With Multiple Trigger Blocks

When more than one trigger block is in the buffer, a buffer overrun will erase the oldest trigger block If the block being erased is currently being read, the block read will be terminated and the read pointer will be advanced to the start of the next block Again, if an overrun condition is detected by the controller during a read operation, any further reading must be considered corrupt until a buffer reset is issued This can be done by either resetting the buffer with a *B command and/or reading the remaining data out of the buffer until it is clear

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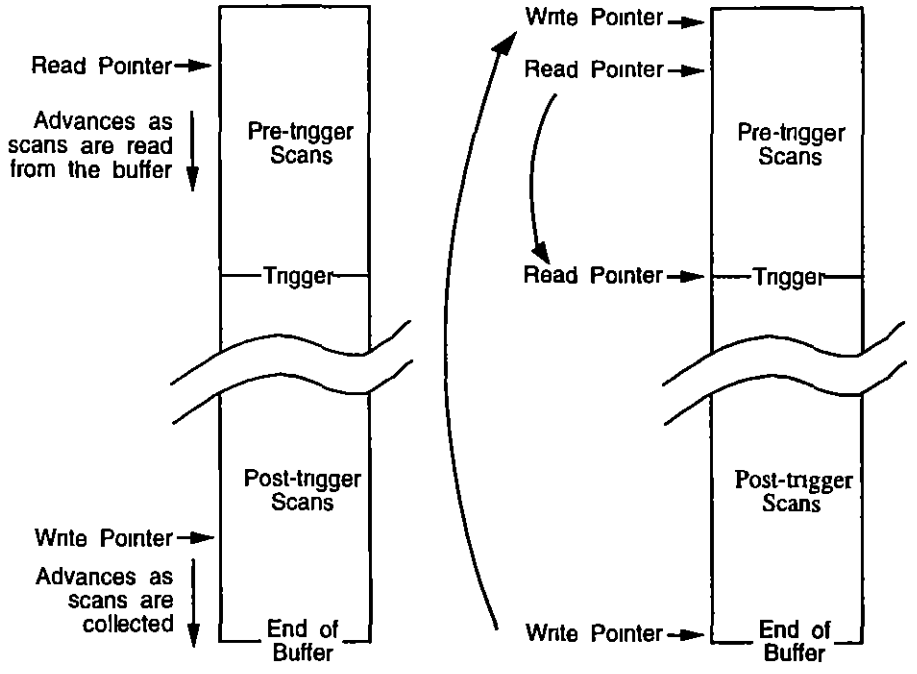


Figure 3 16. Buffer Overrun

3.16 Real Time Clock

TempScan/1000 contains a battery-backed real-time clock which is programmably set and read The real time clock has a resolution of 1mS The clock is set at the factory in Eastern Standard time (U S) The time and date are used to tag the trigger point in each trigger block and HLL register This data is incorporated into the Acquisition Buffer Refer to Section 3 3 9 or more information on Acquisition Buffer Interrogation

3.17 Custom Thermocouple Types

In order to explain how the TempScan/1000 handles custom channel types, some background information is required This section first explains how the TempScan/1000 performs temperature conversions From this process, it will be shown how other types of conversions using custom channel types can be derived

In order to meet the TempScan/1000's requirement of scanning 960 channels per second it was necessary to design a very fast way of converting raw a/d data to units as specified by the channel type This was accomplished by generating intervals via straight line approximations of the conversion curve where the error is insignificant and creating a table which contained these intervals and their corresponding slopes and offsets to convert the raw a/d input

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For each channel, the TempScan/1000 converts raw a/d input to units as specified by the channel's type This is accomplished by two steps

1 First, since the raw A/D input of the channel has been 'cold junction compensated', the temperature at the junction has been subtracted off, including the ambient temperature Hence, the first step is to add the ambient temperature back in This is accomplished by reading the raw A/D input of the cold junction sensor associated with the channel input, converting it to the same units as the channel type input by linearizing it via a linearization lookup table, and then adding the result to the original raw A/D input of the channel

2 Next, the modified raw A/D input of the channel is converted to the desired output units (most likely tenth's of degrees C) by linearizing it via another linearization lookup table

To use input types other than those which are predefined, the TempScan/1000 can be programmed with custom linearization lookup tables These tables can be entered via the `D`, `W`, and `Z` commands The `D` command is used to define the table by assigning the table number and allocating memory The `W` command defines the element and sets the table pointer While the `Z` command loads the entry with its values (See the Command Reference section for details and examples)

Briefly, the contents of a custom table are as follows custom table number, PGA, low limit, high limit, number of entries and entries (interval limit, slope and offset) The table below details valid entries for defining these fields

FIELD	VALID ENTRY	DESCRIPTION
Custom table number	100 - 110 228 - 238	100-110 for custom channel type tables 228-238 for custom temperature sensor tables NOTE For any one channel, table # for the channel type +128 must match the table # for the temperature sensor
Card Type	0-2	0-T/C 1-Volts 2-RTD card
PGA	0 - 7	PGA gain for new channel Enter 0 if temperature sensor table PGA = 0 For all types on T/C card PGA = 1 100 mv volts channel PGA = 2 1 volt volts channel PGA = 3 5 volt volts channel PGA = 4 10 volt volts channel PGA = 0 3 Wire RTD PGA = 1 4 Wire RTD
Low limit	16 bit 2's complimented integer	Minimum valid value for raw a/d

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High limit	16 bit 2's complimented integer	Maximum valid value for raw a/d
Number of entries	0 - 256	0 implies delete table
Entries. Interval limit	16 bit 2's comp integer	Upper limit of interval, i e , if raw a/d value is less than or equal to this, use this slope and offset
Slope	4 byte fixed point 2's comp value X XXX Max value 127 999	Linearization slope Enter long integer slope * 2^{24}
Offset	4 byte fixed point 2's comp value XX XX Max value 32767 99	Linearization offset Enter long integer offset * 2^{8}

Refer to the custom table command descriptions for programming examples on creating and entering custom tables

3.17.1 Custom Table Variations

To create and activate custom tables, follow the instructions which correspond to the table options you have defined

Channel Conversion With Temperature Sensor Adjustment (Normal).

1 Enter both the channel type table and the cold junction table as described above

2 Activate by entering the custom type # via the C command

Channel Conversion Without Temperature Sensor Adjustment·

1 Enter only the channel type table The TempScan/1000 will automatically know not to perform temperature sensor adjustment

2 Activate by entering the custom type # via the C command

No Channel Conversion and No Temperature Sensor Adjustment.

1 Activate by entering the custom type # via the C command If no custom tables are entered or defined for a given table #, the TempScan/1000 will automatically know to return raw A/D counts

Note In all cases always activate with the Channel type table #. I.e , never activate with the temperature sensor table #.

3.18 Open Thermocouple/Range Error Checking

The TempScan/1000 has built-in facilities for detecting open thermocouple and range errors, one in hardware and two in software

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- In hardware, the thermocouple cards contain circuitry to detect open thermocouples
- In software, software detection routines exist to sense if the input a/d maxes out and to detect if an input exceeds the linerization limits

If an open thermocouple/range error is detected, the Error Status Register will be set denoting that this particular error condition exists

The offending channel(s) can be determined by reading their values If a channel is in error, its value will be

±3276 7	if temperature channel (assuming units of °C)
±32 767	if Volts channel

Note. Open thermocouple/range error checking is only performed on channels previously activated by the C command

3.19 Software Digital Filtering

As a standard feature, the TempScan/1000 employs an advanced software digital filter to ensure quiet and accurate thermocouple input This feature is enabled as part of the factory default settings However, this feature can be disabled in order to increase reaction response time by using the *W0 command Digital filtering can subsequently be re-enabled with the *W1 command

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TempScan/1000 Examples

This chapter walks through the example programs that are supplied on the release disk under the EXAMPLES directory Although written in QuickBasic, the program logic and the TempScan/1000 device-dependent commands apply to all languages and computers

The first group of examples use the IEEE-488 bus through the Personal488 interface to communicate with the TempScan/1000 Each one of these programs begins with a short preamble which opens the driver and substantiates communications

After the driver is opened, commands are issued to the driver through character strings in quotes

QuickBasic's PRINT and INPUT commands are used to communicate with the driver The driver commands used most commonly are ENTER, OUTPUT, and SPOLL ENTER gets data from the selected device, OUTPUT sends data to the selected device, and SPOLL is an abbreviation for Serial Poll which retrieves an 8-bit status response from the selected instrument

The syntax of the ENTER command is "`ENTER addr`", where `addr` is the IEEE-488 address of the instrument Right after the ENTER command, the QuickBasic INPUT function must be used to bring the data into a language variable

The syntax of the OUTPUT command is "`OUTPUT addr,out_data`", where `addr` is the IEEE-488 address of the instrument, and `out_data` is the string of characters to send to the device

The syntax of the SPOLL command is "`SPOLL addr`", where `addr` is the IEEE-488 address of the instrument Right after the SPOLL command, the QuickBasic INPUT function must be used to bring the data into a language variable

In all of the IEEE-488 examples, the TempScan is at IEEE-488 address 07

4.1 Reading High/Low/Last Status

The following program is HLL32 BAS in the examples directory It will configure 32 channels, collect the high/low/last data, and post it on the screen

Although not necessary, it is good practice to reset the TempScan/1000 at the beginning of your application by sending it the "`*R`" command then waiting a few seconds

```
PRINT #1, "OUTPUT 07,*RX"
SLEEP 4
```

To be certain that the reset was successful and the device is ready, serial poll the device until the proper status is returned

```
WHILE (S% AND 4) = 0
```


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```
    PRINT #1, "SPOLL 07"
    INPUT #2, S%
WEND
```

The C command will be used to configure a range of channels from 1 to 32 as T-type thermocouples

```
PRINT #1, "OUTPUT 07,C1-32,3X"
```

The next three lines tell the user to hit a key to start the acquisition The program will not proceed until a key is pressed

```
PRINT "The TempScan is collecting High/Low/Last for all 32 channels"
PRINT "Hit a key to start or stop retrieving HLL data   "
WHILE INKEY$ = "" WEND
```

Until another key is pressed to exit the loop, the U4 command is issued and the high/low/last data is collected The OUTPUT command sends U4 to the device, the ENTER command requests the data, then QuickBasic's LINE INPUT gets the data from the IEEE-488 driver and places it in the variable U$ The FOR loop extracts the data for the individual channels from the string U$ and places them on the screen

```
WHILE INKEY$ = ""
    PRINT #1, "OUTPUT 07,U4X"
    PRINT #1, "ENTER 07"
    LINE INPUT #2, U$
    FOR i = 1 TO 32
       PRINT "High, Low and Last readings of Channel", i
       PRINT MID$(U$, (i * 66) - 65, 66)
    NEXT i
WEND
```

Time and date information is also available in the high/low/last data

4.2 Reading High/Low/Last Data from T/C and Volts Cards

The following program is HLL64 BAS in the examples directory It will configure 32 temperature and 32 volts channels then collect the high/low/last data and post it on the screen

Although not necessary, it is good practice to reset the TempScan/1000 at the beginning of your application by sending it the "*R" command then waiting a few seconds

```
PRINT #1, "OUTPUT 07,*RX"
```


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```
SLEEP 4
```

To be certain that the reset was successful and the device is ready, serial poll the device until the proper status is returned

```
WHILE (S% AND 4) = 0
    PRINT #1, "SPOLL 07"
    INPUT #2, S%
WEND
```

The C command will be used twice to configure a range of channels from 1 to 32 as T-type thermocouples and a range of channels from 33 to 64 as +/- 10 volt inputs

```
PRINT #1, "OUTPUT 07,C1-32,3X"
PRINT #1, "OUTPUT 07,C33-64,14X"
```

The next three lines tell the user to hit a key to start the acquisition The program will not proceed until a key is pressed

```
PRINT "The TempScan is collecting High/Low/Last for all 64 channels   "
PRINT "Hit a key to start or stop collecting HLL data   "
WHILE INKEY$ = ""  WEND
```

Until another key is pressed to exit the loop, the U4 command is issued and the high/low/last data is collected The OUTPUT command sends U4 to the device, the ENTER command requests the data, then the QuickBasic's LINE INPUT gets the data from the IEEE-488 driver and places it in the variable U$

The FOR loop extracts the data for the individual channels from the string U$ and places them on the screen Since format of the volts data is subtly different than that of the temperature data, two different FOR loops must be used to extract the channels data

```
WHILE INKEY$ = ""
    PRINT #1, "OUTPUT 07,U4X"
    PRINT #1, "ENTER 07"
    LINE INPUT #2, U$
    FOR i = 1 TO 32
        PRINT "High, Low and Last readings of Channel", i
        PRINT MID$(U$, (i * 66) - 65, 66)          'Extract temperature date
    NEXT i
    FOR i = 1 TO 32
        PRINT "High, Low and Last readings of Channel", i + 32
        PRINT MID$(U$, (32 * 66) + (i * 78) - 77, 78) 'Extract volts data
```


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```
    NEXT i
WEND
```

4.3 Acquiring Pre-Trigger and Post-Trigger Data at Different Rates

The following program is SLOW_ACQ BAS in the examples directory It will configure 64 temperature channels and then collect data as soon as it becomes available and post it on screen

Although not necessary, it is good practice to reset the TempScan/1000 at the beginning of your application by sending it the "*R" command then waiting a few seconds

```
CLS  PRINT "The Tempscan is resetting  "
PRINT #1, "OUTPUT 07,*RX"
SLEEP 4
```

To be certain that the reset was successful and the device is ready, serial poll the device until the proper status is returned

```
WHILE (S% AND 4) = 0
    PRINT #1, "SPOLL 07"
    INPUT #2, S%
WEND
```

The C command will be used twice to configure a range of channels from 1 to 32 as Type J thermocouples and a range of channels from 33 to 64 as Type K thermocouples

```
PRINT #1, "OUTPUT 07,C1-32,1X"
PRINT #1, "OUTPUT 07,C33-64,2X"
```

The Y command is used to configure the number of scans to take while in the different acquisition states In this example, 30 scans are taken while in the pre-trigger state, 1 while in the post-trigger state, and 200 while in the post-stop state The post-trigger count is only valid when the stop event, set by the T command is set to Counted This application does not use Counted, so this parameter is ignored

```
PRINT #1, "OUTPUT 07,Y30,1,200X"
```

The I command sets the time between scans in hours-minutes-seconds format The TempScan/1000 can have two separate scan intervals, one that is used in the post-trigger state, and one that is used in all other states This example sets up the post-trigger scan interval to 0 3 seconds (3 33Hz), and the pre-trigger and post-stop scan intervals to 1 second (1Hz)

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```
PRINT #1, "OUTPUT 07,I00 00 01 0,00 00 0 3X"
```

The T command sets up the trigger parameters for the acquisition In this example, the start event is an '@' character sent by the controller and the stop event is also an '@' character The auto-rearm flag is set to 0 (off), so that the TempScan will not re-arm itself for another acquisition after this acquisition is complete The synchronization flag is also off, so the TempScan/1000 will not re-synchronize itself to the trigger point when the start event begins When the TempScan encounters the X command, it will be armed and start the collection of the pre-trigger data

```
PRINT #1, "OUTPUT 07,T1,1,0,0X"
```

The next four lines, prompt the user to hit a key to trigger the TempScan When a key is hit, the '@' character is sent, which is the system's start event

```
PRINT "The Tempscan is collecting pretriggered data and is ready for a
trigger   "
PRINT "Press a key to trigger the start of Acquisition   "
WHILE INKEY$ = "" WEND
PRINT #1, "OUTPUT 07,@X"
```

While in the post-trigger state our application will first check for a scan to be available by serial polling the device and comparing the response with an 8 If a scan is available, the R1 command tells the TempScan/1000 to send the oldest scan to the controller ENTER requests the response data from the device QuickBasic's INPUT command places the retrieved data into the variable READINGS$

Since the acquisition is slow and the buffer in the TempScan can be made very large, your program can go off to other "foreground" tasks while the TempScan/1000 is acquiring data, and only occasionally query the unit and collect its data

```
'Upload data as it becomes available
PRINT "The program is currently collecting data as it becomes avail-
able   "
PRINT "Hit a key to stop Acquisition   "
i = 0
WHILE INKEY$ = ''
    i = i + 1
    S% = 0
    WHILE ((s% and 8) <>8)              'Is scan available?
        PRINT #1, "SPOLL 07"
        INPUT #2, S%
    WEND
    PRINT #1, "OUTPUT 07,R1X"           'Ask for one scan
    PRINT#1, "ENTER 07"
    INPUT#2, READING$
```


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```
   LOCATE7, 1  PRINT "The scan", i, "was   ", READING$
WEND
```

After a key has been pressed, the program proceeds to the next block where the '@' character is issued again, ending the post-trigger state and entering the post-stop state

```
PRINT #1, "OUTPUT 07,@X"
```

Now the collection of the post-stop data begins by querying for new scans and requesting the data The program is done when the acquisition is complete

```
i=0
WHILE INKEY$=""
   i=i+1
   s%=0
   WHILE ((S% AND 8) <> 8)
      PRINT #1, "SPOLL07"
      INPUT #2, S%
   WEND
   PRINT #1, "OUTPUT07,R1X"
   PRINT #1, ENTER 07"
   INPUT #2, READING$
   LOCATE 7, 1  PRINT "The scan ",i was ', READING$
   PRINT #1, "OUTPUT07,UOX
   PRINT #1,  ENTER07"
   OUTPUT #2, U%
   if U%=1 then END
WEND
```

4.4 Acquiring Pre-Trigger and Post-Trigger Data at the Same Rate

The following program, FAST_ACQ BAS, in the examples directory will set up the TempScan/1000 for fast acquisition then bring the values into the controller after the acquisition is complete From a logic standpoint, the difference between this and SLOW_ACQ is that this program reads blocks of data instead of one scan at a time This method is usually more efficient in case of fast scan intervals

Although not necessary, it is good practice to reset the TempScan/1000 at the beginning of your application by sending it the "*R" command then waiting a few seconds

```
CLS  PRINT "The Tempscan is resetting   "
PRINT #1, "OUTPUT 07,*RX"
```


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```
SLEEP 10
```

To be certain that the reset was successful and the device is ready, serial poll the device until the proper status is returned

```
S% = 0
WHILE (S% AND 4) = 0
    PRINT #1, "SPOLL 07"
    INPUT #2, S%
WEND
```

The C command will be used twice to configure a range of channels from 1 to 32 as Type T thermocouples and a range of channels from 33 to 48 as Type K thermocouples

```
PRINT #1, "OUTPUT 07,C1-32,3X"
PRINT #1, "OUTPUT 07,C33-48,2X"
```

The Y command is used to configure the number of scans to take while in the different acquisition states In this example, 50 scans are taken while in the pre-trigger state, 100 while in the post-trigger state, and 200 while in the post-stop state The post-trigger count is only valid when the stop event, set by the T command is set to Counted This application does not use Counted, so this parameter of 100 is ignored

```
PRINT #1, "OUTPUT 07,Y50,100,200X"
```

The I command sets the time between scans in hours-minutes-seconds format The TempScan/1000 can have two separate scan rates, one that is used in the post-trigger state, and one that is used in all other states This example sets up both scan intervals to 0 1 seconds (10Hz)

```
PRINT #1, "OUTPUT 07,I00 00 00 1,00 00 00 1X"
```

The T command sets up the trigger parameters for the acquisition In this example, the start event is a rising level of an input channel as specified by the L command The stop event is a falling level of an input channel as it passes through the level specified by the L command The auto-rearm flag is set to 0 (off), so that the TempScan will not re-arm itself for another acquisition after this acquisition is complete The synchronization flag is also off, so the TempScan/1000 will not re-synchronize itself to the trigger point when the start event begins When the TempScan/1000 encounters the X command, it will be armed and start the collection of the pre-trigger data

The L command in this example specifies the trigger channel as channel 1 at a level of 20 degrees with a hysteresis of 0 degrees The L command is relevant only when the start or stop event is a channel level

```
PRINT #1, "OUTPUT 07,L1,20 0,0X T4,5,0,0X"
```

After the X command has been received, the TempScan/1000 arms itself and, in this case, waits for the start event of channel 1 rising above 20 degrees The IEEE 488 Serial Poll

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command is used to query the TempScan/1000 as to the status of the acquisition An SPOLL value of 2 signifies that channel 1 has reached 20°

```
PRINT "The TempScan has not been triggered   "
PRINT "Waiting for Channel 1 to reach the trigger level   "
WHILE (S% AND 2) <> 2
    PRINT #1, "SPOLL 07"
    INPUT #2, S%
WEND
PRINT "A Start Trigger event has been detected   "
PRINT "Waiting for a stop Trigger event   "
```

Using the event status register command "U0X", we now wait until acquisition complete event which includes the stop event

```
WHILE (U% AND 1) <> 1
    PRINT #1, "OUTPUT 07,U0X"
    PRINT #1, "ENTER 07"
    INPUT #2, U%
WEND
PRINT "The Acquisition is now complete"
```

During or after the acquisition has been completed, the internal buffer can be queried for the amount of data available for transfer The U6 command will return the trigger block number, the current scan number, the current read pointer, the trigger time/date stamp, the scan number where the stop event occurred, the stop time/date stamp, the scan number of the end of the trigger block, and the block complete flag

This example uses the last parameter in the return string as an indicator of how much data is available to transfer to the controller QuickBasic's MID$ function extracts 6 characters from the string U$ starting at character 8

```
PRINT #1, "OUTPUT 07,U6X"                'Ask for trigger block info
PRINT #1, "ENTER 07"
LINE INPUT #2, U$
PRINT U$
UA$ = MID$(U$, 8, 6)
UA% = VAL(UA$)
PRINT UA%
PRINT #1, "The TempScan collected ", UA%, " scans of data"
```

The R1 command is used to request one scan from the unit Using the variable UA% calculated from the previous step, all of the data is transferred to the controller

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```
FOR i = 1 TO UA%
    PRINT #1, "OUTPUT 07,R1X"
    PRINT #1, "ENTER 14"
    INPUT #2, SCAN$
    PRINT "Scan ", i, " is  "
    PRINT SCAN$
NEXT i
```

4.5 Operating Alarms

The following program, ALARM2 BAS, in the examples directory will set up the alarm system of the TempScan/1000

Although not necessary, it is good practice to reset the TempScan/1000 at the beginning of your application by sending it the "*R" command then waiting a few seconds

```
CLS  PRINT "The Tempscan is resetting  "
PRINT #1, "OUTPUT 07,*RX"
SLEEP 10
```

To be certain that the reset was successful and the device is ready, serial poll the device until the proper status is returned

```
S% = 0
WHILE (S% AND 4) = 0
    PRINT #1, "SPOLL 07"
    INPUT #2, S%
WEND
```

The C command is used to configure multiple channels as part of the scan group and to assign them a type Additionally, the alarm parameters are used to activate the alarms for those channels

After the C command is issued, the TempScan/1000 is now completely armed for alarming In our example, levels above 18 or below 1 will cause a system alarm

If the intent of the application was to use alarm levels to trigger an acquisition, only the following line would be required to arm the alarms to satisfy the trigger and/or stop events

```
PRINT #1, "OUTPUT 07,C1-32,3,1,18,0X"
```

In addition to causing an internal system alarm state, the alarm conditions can also be attached to any one of the 32 digital output lines The A command is used to assign the input channels to the digital alarm bit The following line attaches channels 1 and 2 to digital output line number 1 in an OR'd fashion

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```
PRINT #1, "OUTPUT 07,A1-2,1X"    'Assign channels 1 & 2 to alarm 1

S% = 0
WHILE (S% AND 4) = 0
PRINT #1, "SPOLL 07"
INPUT #2, S%
WEND
```

Using the string returned by the O? query, which gets the status of the digital output lines, the alarm state can be detected since bit 1 of the digital output was mapped into alarm channel 1 and 2 This example shows alarm detection handling when 2 or more channels have to be muxed into one single digital output bit The "U11X" command shows each individual channel alarm status

```
WHILE INKEY$ = ""
    PRINT #1, "OUTPUT 07,O?X"
    PRINT #1, "ENTER 07"
    LINE INPUT #2, O$
    IF MID$(O$, 2, 3) = "001" THEN
        PRINT "Channel 1 OR 2 is in Alarm condition "
        PRINT #1, "OUTPUT 07,U11X"
        PRINT #1, "ENTER 07"
        LINE INPUT #2, A$
        PRINT A$
        IF MID$(A$, 5, 1) = "1" THEN
              PRINT "The Tempscan's CH 1 is now in an Alarm condition   "
        ELSE
              PRINT "The Tempscan's CH 1 is not in an Alarm condition   "
        END IF
        IF MID$(A$, 11, 1) = "1" THEN
              PRINT "The Tempscan's CH 2 is now in an Alarm condition   "
        ELSE
              PRINT "The Tempscan's CH 2 is not in an Alarm condition   "
        END IF
    END IF
WEND
```


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4.6 Using the IEEE 488 SRQ with Alarms

The following program, ALAR2SRQ BAS, in the examples directory will set up the alarm system of the TempScan/1000 then use the IEEE 488 Service Request signal to asychronously service the event

Although not necessary, it is good practice to reset the TempScan/1000 at the beginning of your application by sending it the "*R" command then waiting a few seconds

```
CLS  PRINT "The Tempscan is resetting  "
PRINT #1, "OUTPUT 07,*RX"
SLEEP 4
```

To be certain that the reset was successful and the device is ready, serial poll the device until the proper status is returned

```
WHILE (S% AND 4) = 0                'Wait for Ready
    PRINT #1, "SPOLL 07"
    INPUT #2, S%
WEND
```

The Personal488 IEEE 488 driver and interface card provides a means for QuickBasic to asynchronously service the IEEE 488 SRQ interrupt through its ON PEN GOSUB command When an SRQ is detected by the Personal488 interface, program control is automatically vectored to the subroutine named in the ON PEN GOSUB command To activate this feature in the Personal488 driver, the command ARM SRQ must be sent to the driver

```
ON PEN GOSUB AlarmHandler
PEN ON
PRINT #1, "ARM SRQ"
```

The M1 command instructs the unit to assert the SRQ signal when it is in an alarm state

```
PRINT #1, "OUTPUT 07,M1X"
```

The C command is used twice to configure multiple channels as part of the scan group and to assign them a type Additionally, the alarm parameters for channels one and two are used to activate the alarms for those channels Although 32 channels are included in the scan group, only 2 are armed for alarming

After the C command is issued, the TempScan/1000 is now completely armed for alarming In our example, levels above 25 or below 1 for channels 1 or 2 will cause a system alarm Since the M1 command has already been issued, this will also result in an IEEE 488 SRQ assertion

If the intent of the application was to use alarm levels to trigger an acquisition, only the following 2 lines would be required to arm the alarms to satisfy the trigger and/or stop events

```
PRINT #1, "OUTPUT 07,C1-32,3X"
PRINT #1, "OUTPUT 07,C1-2,3,1,25,0X"
```


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In addition to causing an internal system alarm state, the alarm conditions can also be attached to any one of the 32 digital output lines The A command is used to assign the temperature input channel to the digital alarm bit

```
PRINT #1, "OUTPUT 07,A1,1X"       'Assign channel 1 to alarm 1
PRINT #1, "OUTPUT 07,A2,2X"       'Assign channel 2 to alarm 2
PRINT #1, "OUTPUT 07,A3,3X"       'Assign channel 3 to alarm 3
```

The example now processes a loop waiting for a key press to exit If an SRQ is detected by the IEEE 488 driver, program control will be automatically vectored to the AlarmHandler subroutine, then returned to the wait loop again

```
PRINT "The program is continuously detecting Alarms    "
PRINT "Hit a key to Quit   "
WHILE INKEY$ = ""  WEND

END
```

In the alarm service routine, the unit is first SPOLL'd to clear the SRQ signal Using the string returned by the O? query, which gets the status of the digital output lines, the channel number that is in the alarm state can be identified

The O? query command returns the following string representing all 4 ports digital output status

```
   Oxxx, xxx, xxx, xxx
```

```
AlarmHandler
   LOCATE 5, 1
   PRINT "An Alarm condition has been detected   "
   PRINT #1, "SPOLL 07"
   INPUT #2, S%
   PRINT #1, "OUTPUT 07,O?X"
   PRINT #1, "ENTER 07"
   LINE INPUT #2, A$
   PRINT A$
   A% = VAL(MID$(A$, 2, 3))
   IF A% = 1 THEN PRINT "Alarm on CH1 only"
   IF A% = 2 THEN PRINT "Alarm on CH2 only"
   IF A% = 3 THEN PRINT "Alarm on CH1 & 2 "
RETURN
```


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4.7 Collecting Data in Binary Format

The following program, BIN_ACQ BAS, in the examples directory will set up the TempScan/1000 then collect the channel readings in a binary format rather than the default ASCII format This is inherently faster than ASCII format, but the data must be deciphered after it is collected to yield temperature values

Although not necessary, it is good practice to reset the TempScan/1000 at the beginning of your application by sending it the "*R" command then waiting a few seconds

```
CLS  PRINT "The Tempscan is resetting  "
PRINT #1, "OUTPUT 07,*RX"
SLEEP 4
```

To be certain that the reset was successful and the device is ready, serial poll the device until the proper status is returned

```
WHILE (S% AND 4) = 0
    PRINT #1, "SPOLL 07"
    INPUT #2, S%
WEND
```

The C command will be used twice to configure a range of channels from 1 to 16 as Type J thermocouples and a range of channels from 33 to 48 as Type K thermocouples

```
PRINT #1, "OUTPUT 07,C1-16,3X"
PRINT #1, "OUTPUT 07,C33-48,2X"
```

The Y command is used to configure the number of scans to take while in the different acquisition states In this example, 400 scans are taken while in the pre-trigger state, 100 while in the post-trigger state, and 200 while in the post-stop state The post-trigger count is valid since the stop event, set by the T command will be set to Counted later in the program

```
PRINT #1, "OUTPUT 07,Y400,100,200X"
```

The I command sets the time between scans in hours-minutes-seconds format The TempScan/1000 can have two separate scan rates, one that is used in the post-trigger state, and one that is used in all other states This example sets up both scan intervals to 0 0 seconds, which is interpreted a "go as fast as possible"

```
PRINT #1, "OUTPUT 07,I00 00 00 0,00 00 00 0X"
```

The T command is used to set the trigger, or start event, to the "@" character sent by the controller The stop event is set to Counted The auto-rearm flag is set to 0 (off), so that the TempScan will not re-arm itself for another acquisition after this acquisition is complete The synchronization flag is also off, so the TempScan will not re-synchronize itself to the trigger point when the start event begins When the TempScan encounters the X command, it will be armed and start the collection of the pre-trigger data

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```
PRINT #1, "OUTPUT 07,T1,8,0,0X"
```

After the '@' character is sent, the IEEE 488 Serial Poll command is used to query the TempScan as to the status of the acquisition An SPOLL value of 2 signifies that the TempScan/1000 has encountered the start event

```
PRINT "The TempScan is currently collecting pretrigger data   "
PRINT "The TempScan has not been triggered   "
PRINT "Hit a key to start a trigger event   " WHILE INKEY$ = "" WEND
PRINT #1, "output07,@X"
WHILE (S% AND 2) <> 2
   PRINT #1, "SPOLL 07"
   INPUT #2, S%
WEND
PRINT "A Start Trigger has been detected   "
PRINT "Waiting for acquisition complete   including Post and Post-Stop
Scans"
```

Using the event status register command "U0X", we now wait until the acquisition complete event which includes the stop event

```
WHILE (E% AND 1) <> 1
   PRINT #1, "OUTPUT 07,U0X"
   PRINT #1, "ENTER 07"
   INPUT #2, E%
WEND
PRINT "The Acquisition is now complete"
```

Before reading the data, the F command is sent, instructing the TempScan/1000 to return the data in a binary format where every value will be 2 bytes in length This command could have been issued anytime after the initial reset and stays in effect until the unit is reset again or another F command is issued

```
PRINT #1, "OUTPUT 07,F0,1X"
```

During or after the acquisition has been completed, the internal buffer can be queried for the amount of data available for transfer The U6 command will return the trigger block number, the current scan number, the current read pointer, the trigger time/date stamp, the scan number where the stop event occurred, the stop time/date stamp, the scan number of the end of the trigger block, and the block complete flag

This example uses the last parameter in the return string as an indicator of how much data is available to transfer to the controller QuickBasic's MID$ function extracts 6 characters from the string U$ starting at character 8

```
'Query the Tempscan for the # of scans available in the Buffer
PRINT #1, "OUTPUT 07,U6X"
```


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```
PRINT #1, "ENTER 07"
LINE INPUT #2, U$
PRINT U$
UA$ = MID$(U$, 9, 7)
UA% = VAL(UA$)
PRINT UA%
PRINT "The TempScan collected ", UA%, " scans of data"
```

After calculating the number of scans, an integer-type buffer is then prepared for the data The offset and segment pointers are supplied to the IEEE 488 driver so that the data can be transferred using DMA (direct memory access)

The R2 command instructs the TempScan/1000 to supply the entire block of data that is presently available

```
CHANNELS = 32
DIM BUFFER%(UA% * CHANNELS)
SE% = VARSEG(BUFFER%(0))
OF% = VARPTR(BUFFER%(0))
B& = UA% * CHANNELS * 2
PRINT "Total number of Bytes available  ", B&
PRINT #1, "OUTPUT 07,R2X"
PRINT "Uploading data  "
WHILE INKEY$ = ""  WEND
PRINT #1, "ENTER 07 #", B&, "BUFFER ", SE%, "  ", OF%, " DMA"
```

At the completion of the DMA transfer, the integer data is now in the buffer BUFFER% To convert the integer data into temperatures, a simple calculation is performed

```
BINARY DATA%/10 = °C
```

4.8 Collecting Binary-Formatted High/Low/Last Data

The following program, BIN_HLL BAS, in the examples directory will set up the TempScan/1000 to collect High/Low/Last channel readings in a binary format rather than the default ASCII format This is inherently faster than ASCII format, but the data must be deciphered after it is collected to yield temperature values

Although not necessary, it is good practice to reset the TempScan/1000 at the beginning of your application by sending it the "*R" command then waiting a few seconds

```
CLS  PRINT "The Tempscan is resetting  "
PRINT #1, "OUTPUT 07,*RX"
```


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```
SLEEP 4
```

To be certain that the reset was successful and the device is ready, serial poll the device until the proper status (ready) is returned

```
WHILE (S% AND 4) = 0
    PRINT #1, "SPOLL 07"
    INPUT #2, S%
WEND
```

The C command will be used twice to configure a range of channels from 1 to 32 as Type J thermocouples and a range of channels from 33 to 48 as volts channels on the 10 volt range

```
PRINT #1, "OUTPUT 07,C1-32,1X"
PRINT #1, "OUTPUT 07,C33-64,14X"
```

Before reading the data, the F command is sent, instructing the TempScan/1000 to return the data in a binary format where every value will be 2 bytes in length This command could have been issued any time after the initial reset and stays in effect until the unit is reset again or another F command is issued

```
PRINT #1, "OUTPUT 07,F0,1X"
```

Our example will use DMA to transfer the high/low/last data into the controller For this purpose, an array is dimensioned, then the offset and segment pointers are supplied to the IEEE 488 driver After the ENTER command has completed, the binary data will be in the string READS

```
CONST CHANNELS% = 64, BYTES = CHANNELS% * 20
DIM READS AS STRING * BYTES
S% = VARSEG(READS)
O% = VARPTR(READS)

WHILE INKEY$ = ""

 PRINT #1, "OUTPUT 07,U4X"
 PRINT #1, "ENTER 07 #", CHANNELS% * 20, " BUFFER ", S%, "  ", O%, " DMA"
 PRINT "High, Low and Last readings of all 64 channels  "
```

To convert the data into temperature and volts, the string must be parsed and decoded as follows

```
FOR i = 1 TO BYTES STEP 20
```


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```
    HIGH$ = STR$(CVI(MID$(READS, 1, 2)))            'High
    HOURh$ = STR$(ASC(MID$(READS, 1 + 2, 1)))       'Time
    MINh$ = STR$(ASC(MID$(READS, 1 + 3, 1)))
    SECh$ = STR$(ASC(MID$(READS, 1 + 4, 1)))
    TENTHh$ = STR$(ASC(MID$(READS, 1 + 5, 1)))
    MONh$ = STR$(ASC(MID$(READS, 1 + 6, 1)))        'Date
    DAYh$ = STR$(ASC(MID$(READS, 1 + 7, 1)))
    YEARh$ = STR$(ASC(MID$(READS, 1 + 8, 1)))

    LOW$ = STR$(CVI(MID$(READS, 1 + 9, 2)))         'Low
    HOUR1$ = STR$(ASC(MID$(READS, 1 + 11, 1)))      'Time
    MIN1$ = STR$(ASC(MID$(READS, 1 + 12, 1)))
    SEC1$ = STR$(ASC(MID$(READS, 1 + 13, 1)))
    TENTH1$ = STR$(ASC(MID$(READS, 1 + 14, 1)))
    MON1$ = STR$(ASC(MID$(READS, 1 + 15, 1)))       'Date
    DAY1$ = STR$(ASC(MID$(READS, 1 + 16, 1)))
    YEAR1$ = STR$(ASC(MID$(READS, 1 + 17, 1)))

    LAST$ = STR$(CVI(MID$(READS, 1 + 18, 2)))       'Last

    PRINT HIGH$ + HOURh$ + MINh$ + SECh$ + TENTHh$ + MONh$ + DAYh$ + YEARh$
    PRINT LOW$ + HOUR1$ + MIN1$ + SEC1$ + TENTH1$ + MON1$ + DAY1$ + YEAR1$

NEXT 1
```

To convert integers into temperatures, the following calculation is performed

```
BINARY DATA%/10 = °C
BINARY DATA%/3000 = Volts
```

4.9 Using Auto-Rearm to Capture Multiple Trigger Blocks

The following program, BLK_ACQ.BAS, in the examples directory will set up the TempScan/1000 for auto-rearm, which rearms the unit for another trigger event as soon as the present acquisition has been completed

Although not necessary, it is good practice to reset the TempScan/1000 at the beginning of your application by sending it the "*R" command then waiting a few seconds

```
CLS   PRINT "The Tempscan is resetting   "
PRINT #1, "OUTPUT 07,*RX"
SLEEP 4
```


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To be certain that the reset was successful and the device is ready, serial poll the device until the proper status is returned

```
WHILE (S% AND 4) = 0
    PRINT #1, "SPOLL 07"
    INPUT #2, S%
WEND
```

The C command will be used twice to configure a range of channels from 1 to 17 as Type J thermocouples and a range of channels from 33 to 48 as Type K thermocouples

```
PRINT #1, "OUTPUT 07,C1-16,1X"
PRINT #1, "OUTPUT 07,C33-48,2X"
```

The Y command is used to configure the number of scans to take while in the different acquisition states In this example, 1000 scans are taken while in the pre-trigger state, 20 while in the post-trigger state, and 10 while in the post-stop state The post-trigger count is valid since the stop event, set by the T command, is set to Counted

```
PRINT #1, "OUTPUT 07,Y1000,20,10X"
```

The I command sets the time between scans in hours-minutes-seconds format The TempScan/1000 can have two separate scan rates, one that is used in the post-trigger state, and one that is used in all other states This example sets up the pre-trigger and post-stop scan intervals to 0 3 seconds (3Hz), and the post-trigger interval to 0 0, which makes the units sample as fast as possible during the post-trigger period

```
PRINT #1, "OUTPUT 07,I00 00 00 3,00 00 00 0X"
```

The T command sets up the trigger parameters for the acquisition In this example, the start event is the '@' character issued by the controller The stop event is Counted The auto-rearm flag is set to 1 (on), so that the TempScan will re-arm itself for another acquisition after this acquisition is complete The synchronization flag is also off, so the TempScan/1000 will not re-synchronize itself to the trigger point when the start event begins When the TempScan/1000 encounters the X command, it will be armed and start the collection of the pre-trigger data

```
PRINT #1, "OUTPUT 07,T1,8,1,0X"
```

The B command is used to set the buffer terminators for the data that is transferred to the controller Both the scan and trigger block terminators are set to LF (linefeed)

```
PRINT #1, "OUTPUT 07,B7,7X"
```

The FOR loop will read 5 trigger blocks, each consisting of a trigger point

```
FOR i = 1 TO 5
```

The first lines of code within the FOR loop ask the user to trigger the unit, then the last line sends an '@' character to the unit

```
    PRINT  PRINT "The TempScan's Block ", i, " has not been triggered   "
    PRINT "It is currently collecting the Pretrigger data specified   "
```


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```
PRINT "Press any key to send a start trigger event "
WHILE INKEY$ = "" WEND
PRINT #1, "OUTPUT 07,@X"
```

Using the U6 query, the controller gets the trigger block string, which, amoung other things, supplies the block complete flag, indicating the state of the present trigger block The block is marked complete when the last post-stop scan is recorded into the buffer

```
PRINT "Waiting for completion of Block ", i, "  "
DO
    PRINT #1, "OUTPUT 07,U6X"
    PRINT #1, "ENTER 07"
    LINE INPUT #2, U$
    UA$ = MID$(U$, 86, 2)
LOOP UNTIL UA$= "1"

PRINT "The TempScan is done with Block", i, " and has re-armed itself "
```

Using the U$ string which still contains the trigger block status string, the number of scans available in the buffer is calculated The R2 command is then used to retrieve the data in the TempScan/1000's internal buffer

```
'Query the Tempscan for the # of scans available in the Buffer
   UAT$ = MID$(U$, 9, 7)
   PRINT UAT$
   PRINT "The TempScan collected a total of ", VAL(UAT$), " scans"
   UA$ = MID$(U$, 18, 7)
   PRINT UA$
   PRINT "Pre-Triggered scans  ", VAL(UA$)
   UA$ = MID$(U$, 47, 8)
   PRINT "Post-Triggered scans  ", VAL(UA$)
   UAS$ = MID$(U$, 77, 8)
   PRINT "Post-stop-Triggered scans  ", VAL(UAS$) - VAL(UA$)

'Upload Block
   PRINT "Uploading trigger block", i
   PRINT #1, "OUTPUT 07,R2X"
   FOR c = 1 TO VAL(UAT$)
      PRINT #1, "ENTER 07"
      LINE INPUT #2, SCAN$
   NEXT c
```


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```
    PRINT "Block ", i, " is read "

NEXT i
```

After all 5 trigger blocks have been collected, the unit is disarmed by sending the T command

```
PRINT #1, "OUTPUT 07,T0,0,0,0X"
```

4.10 Using a Custom Thermocouple Table

The following program, CUST_TC BAS, will configure the TempScan/1000 for a custom thermocouple type The custom T/C table can be used to translate raw voltage values into any linear or non-linear engineering unit or function

Although not necessary, it is good practice to reset the TempScan/1000 at the beginning of your application by sending it the "*R" command, then waiting a few seconds

```
CLS  PRINT "The Tempscan is resetting  "
PRINT #1, "OUTPUT 07,*RX"
SLEEP 4
```

To be certain that the reset was successful and the device is ready, serial poll the device until the proper status is returned

```
WHILE (S% AND 4) = 0
    PRINT #1, "SPOLL 07"
    INPUT #2, S%
WEND
```

The D command defines the number of the table being created, the card type and the setting of the programmable gain amplifier (PGA) The low and high limit and the number of entries in the table are also defined by the D command During the acquisition, the TempScan/1000 interpolates between the defined points in the table For non-linear transfer functions, the more entries in the table, the smoother the curve

```
PRINT #1, "OUTPUT 07,D101,0,0,-20000,+20000,10X"
```

The W and Z commands work together to first select the pointer into the table, then place an entry at the pointer

```
PRINT #1, "OUTPUT 07,W101,0 X"
FOR i = 1 TO 10  PRINT #1, "OUTPUT 07,ZLIMIT(i), SLOPE(i), OFFSET(i)X
```

The C command is used to configure a scan group and set the channels to the custom T/C table

```
PRINT #1, "OUTPUT 07,C1-32,101X"
```

All other commands operate as with any other T/C type

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Using TempWindows

TempWindows is a Microsoft Windows application for operating the TempScan/1000 hardware No programming knowledge is required to operate this application TempWindows is a graphical Microsoft Windows application that allows users to set up an application to acquire data and save it directly to disk TempWindows provides the following capabilities

- Set up all of the analog input parameters then acquire and save the data to a disk file
- Configure and arm the alarm section for operation
- View the present value of selected channels in either numerical or graphical form
- Launch PostView, an independent application that allows the user to graphically view the waveforms recorded by TempWindows

TempWindows is written in Visual Basic, with the source code provided on the disk The file TEMPWIN MAK is the VB project file Users are encouraged to alter the source code to provide additional functionality and enhancements

NOTE Although the TempWindows source code can be viewed in Visual Basic, it cannot be modified without the VisuaLab and Visual Architect ToolKit VisuaLab is available from IOtech, Inc (Phone 216-439-4091) Visual Architect is available from FarPoint Technologies, Inc (Phone 804-378-0432)

The TempWindows executable and source files are copyrighted software, owned solely by IOtech, Inc IOtech grants the purchaser a limited license to alter the source files to produce an enhanced or modified version of TempWindows for operating the TempScan/1000 This license does not, however, allow the licensee to modify the TempWindows source files to operate data acquisition hardware other than the TempScan/1000 from IOtech

5.1 Application Startup

To install TempWindows, go to the Windows program manager to run a file Direct the program manager to the SETUP file included in the TempWindows subdirectory on the installation diskette This install program will also create a TempWindows icon

NOTE To run the TempWindows application, the VBX and DLL files in the TEMPWIN directory must be in your computer's PATH This can be achieved by using the SETUP utility or by manually copying these files into your WINDOWS or WINDOWS\SYSTEM directory

To launch the application, double click the TempWindows icon A dialog box will appear asking whether or not you want to open an existing setup TempWindows holds many user-configured parameters that can be saved to disk If you have created such a disk file, answering *Yes* will open a file selection dialog box where you can select your file If this is the first time you have used this application, no saved setups will be available, select *No*

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If a configuration file is selected, no further dialog boxes will appear, all the required setup information will be extracted from the configuration file

If no configuration file is used, the next dialog prompts the user to choose a real TempScan/1000 or a simulated instrument If the hardware is not available and you just want to try out the software, select *Simulated Instrument* The Simulated Instrument allows all of the functions of the software to be exercised without any hardware installed If the TempScan/1000 hardware is connected and switched on, select *Real TempScan/1000*

If the Real TempScan/1000 was selected, an additional dialog box will appear, prompting the user to select either the IEEE 488 or Serial interface

TempWindows will attempt to find the TempScan/1000 on the specified interface If the hardware is found, the application's main window is opened If no hardware is found, the user is alerted and the application is opened with the controls disabled

To try again, click the desired interface type under the Interface menu If the TempScan/1000 hardware still cannot be identified by the software, check your cabling and the DIP switch settings on the rear panel of the TempScan/1000

5.2 TempWindows Components

The main TempWindow screen displays as follows

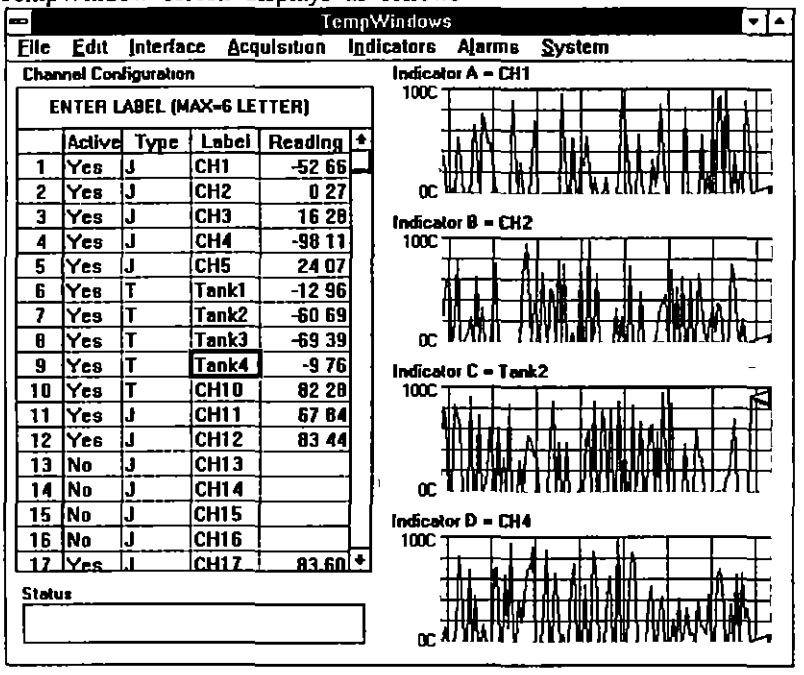


Figure 5 1 Channel Configuration Spreadsheet

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5.2.1 Analog Input Spreadsheet

The Channel Configuration spreadsheet, shown in Figure 5 1, allows the inputs to be configured and included in the scan group When the application first identifies the TempScan/1000 hardware, it also queries the hardware for the number of channels connected and the channel types TempWindows will only allow channels that are identified at present to be configured

The first column holds the channel number This column is static and cannot be altered by the user The second column, labeled "Active", allows the user to include or exclude the channel from the scan group The third column, labeled "Type", allows the user to set the gain, the thermocouple type or the RTD configuration for the selected channel The column called "Label" allows the user to assign a 6 character mnemonic label to a channel The last column provides channel feedback when Enable Spreadsheet Readings is selected under the Acquisition menu

This spreadsheet operates much like a standard accounting spreadsheet Placing your cursor into any cell, except for the cells in the "Reading" column, allows the user to alter the contents of that cell Selecting a range of cells within a column allows all of the selected cells to be altered simultaneously Clicking a column heading will select the entire column The area above the spreadsheet shows the choices for the selected cell The Edit menu contains commands that operate on the spreadsheet

5.2.2 Indicator Section

The Indicator section in the main window provides visual feedback on the present state of the selected channel From the Indicator menu item, the indicators can be set up to be charts, dials, digital, or bar graphs Also from the Indicator menu item, the *Assign Indicators* item allows the indicators to be assigned to any channel configured as Active Until the indicators are assigned to a channel, they will not produce a result

To enable the indicators, select *Enable Indicators* under the Acquisition menu Once enabled, some of the setup functionality of TempWindows will be disabled since the TempScan/1000 cannot be reconfigured during an acquisition To turn the indicators off, select *Enable Indicators* again from the Acquisition menu A check mark next to the menu item indicates whether it is enabled or disabled

Updating the indicators is a low-priority task which is attended to when other higher-priority tasks are not busy As a consequence, the update rate of the indicators is not tied to the configured acquisition rate The update takes place when ever time allows Due to this process the indicators will not necessarily contain all of the acquired data

5.2.3 The Acquisition Configuration Window

To configure an acquisition to disk, select *Configure* under the Acquisition menu Refer to Figure 5 2 The acquisition configuration window contains a section that allows the user to set up the acquisition events, the timing of the acquisition, and the file specifications

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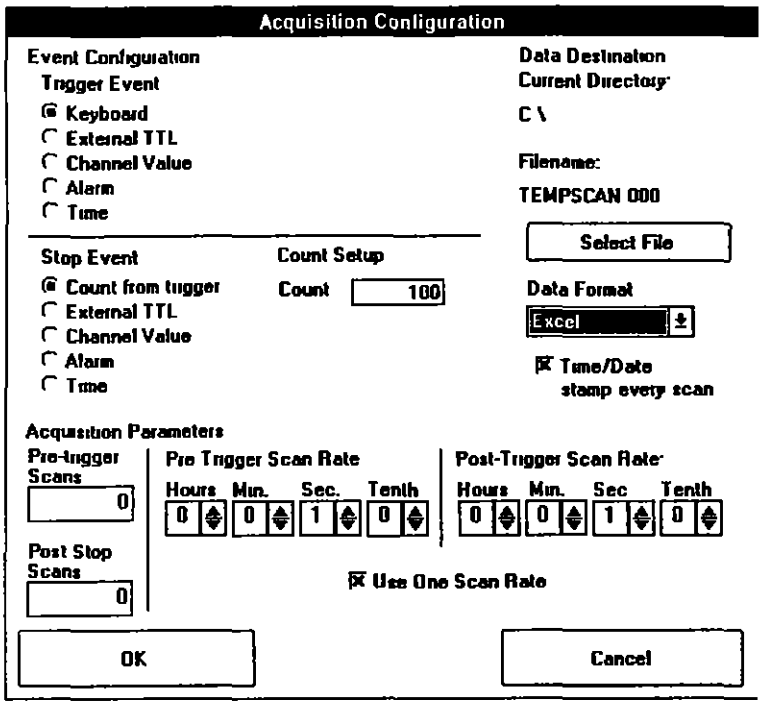


Figure 5 2 Acquisition Configuration Window

The Event Configuration section provides controls for setting the trigger and stop events Some of the controls in this section bring up more controls when they are selected All controls come up with default values to simplify operation

Data Destination is the file name for the saved data A file name can be typed in directly or the *Browse Files* button can be pressed to open a file selection dialog box The selected file will be placed directly into the filename field

The bottom section sets up the pre-trigger count and the acquisition timebase The timebase is set by choosing the scan period in hours/minutes/seconds/tenths The fastest selectable scan rate is 0 1 seconds, or 10Hz, but depending on the number of channels in the scan group, it may be possible to scan faster To scan at the fastest speed possible, set the scan period to all zeros (00 00 00 0) See Section 3 3 3 of the user manual for an explanation of the two timebase operation of the TempScan/1000

A checkbox labeled "Time/Date Stamp Every Scan" allows the user to select whether or not each scan will be prefaced by time/date information in the ASCII file This feature is not supported for binary files

Press *OK* to accept the parameters Once the acquisition is started, these parameters cannot be altered

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To start the acquisition that is configured in the Acquisition Configuration window, select *Arm* under the Acquisition menu To stop the acquisition prematurely, select *Disarm* under the same menu

The data is stored in the disk file as the acquisition is taking place The file is periodically closed by TempWindows so that little or no data is lost in case of a power outage

5.3 The Menu Items

The remainder of this chapter describes the options controlled through the menu bar at the top of the main TempWindow screen (Refer to Figure 5 1)

5.3.1 File

The File menu provides three basic functions

Save	Save the existing configuration for later recall
Load	Load a saved configuration
Exit	Leave the TempWindows program

5.3.2 Edit

The Edit menu includes the following functions

Make All Channels Inactive	This command places a "No" in the Active field of all of the channels If your channel scan includes only a few channels, it may be easier to make all of the channels inactive, then turn on only those few channels that you want
Make All Channels Active	This command places a "Yes" in the On field of all of the channels
Go Up To Next Available Channel	If some channel locations are not present due to missing channel boards in slaves or missing slaves, holes in the Channel Configuration spreadsheet will be present To jump over holes in the spreadsheet, use Go Up To Next Available Channel and Go Down
Go To Channel	This command pops up a dialog box which requires a channel number For hardware configurations that contain hundreds of channels, this is a quick way to get around
Fill Down	When multiple cells within a column are selected, this command take the top-most selected cell and copies its contents in the selected cells below This operation is only valid in the *Active* and *Type* columns

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5.3.3 Interface

The Interface menu includes the following functions

IEEE 488 Address	Brings up a dialog box prompting the user to select the IEEE 488 address of the TempScan/1000 After an address is selected, TempWindows opens a new session with the TempScan/1000 hardware and attempts to communicate with it If the hardware is found, the application's main window is opened If no hardware is found, the user is alerted and the application is opened with the controls disabled
RS-232 Parameters	Brings up a dialog box prompting the user to specify the serial communication parameters of the TempScan/1000 TempWindows then opens a new session with the TempScan/1000 hardware and attempts to communicate with it If the hardware is found, the application's main window is opened If no hardware is found, the user is alerted and the application is opened with the controls disabled
Simulated Device	This command opens a TempWindows session but does not attempt to communicate with TempScan/1000 hardware Instead, the application simulates the interaction between the software and the hardware If TempWindows is presently attached to real TempScan/1000 hardware, this command will close that session

5.3.4 Acquisition

The Acquisition menu includes the following functions

Configuration	This command pops up the Acquisition Configuration window, which allows the user to set the desired parameters of an input acquisition
Arm	This command arms the hardware for an acquisition to disk When the trigger is satisfied, the acquisition begins No acquisition parameters can be altered during the acquisition
Disarm	This command stops the acquisition to disk and disarms the hardware
Stop All	This command disarms the acquisition, the spreadsheet readings, and the indicators
Enable Indicators	This command starts the indicators running If the chart is already running, this command stops it Make certain that the indicators have been assigned a channel through the Assign Indicators item under the Indicators menu before enabling them

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Enable Spreadsheet Readings	This command reads the inputs and puts the numeric values in the spreadsheet in the "Reading" column If it is already enabled, this command disables it

5.3.5 Indicators

The Indicators menu includes the following functions

Assign Indicators	Invokes the Indicator Assignment window allowing the user to assign any channel marked as Active to any indicator
Chart, Bar, Dial, Digital	This command sets up the indicators in one of four modes

5.3.6 Alarms

The Alarms menu includes the following functions

Configure	Opens the Alarm Configuration window allowing the high and low setpoints and the alarm hysteresis to be assigned to the desired channels Once a high or low setpoint is associated to a channel, that channel is armed for alarming If a digital output bit is also associated, that bit will go high when the specified channel is in the alarm state
Check Status	To view the present condition of the alarm sub-system, select this item

5.3.7 System

The System menu includes the following functions

System Inventory	This command brings up a non-modal dialog box that shows which channels have been detected as installed, and what type they are
Units	This command sets the system-wide temperature units for TempWindows
TempScan Error Status	This command opens a dialog window that displays the error status of the TempScan/1000 hardware Quering the TempScan will clear the error and the front panel LED See Figure 5 3

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Set TempScan Time/Date	Select this command to open a dialog box that reads the non-volatile time & date from the TempScan Use the Spin Controls and the "Set" button to change the time and date See Figure 5 4

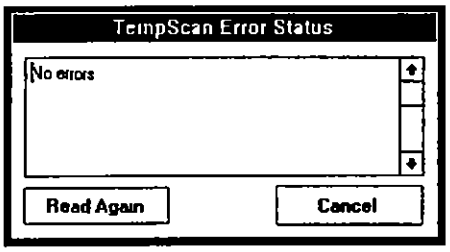


Figure 5 3 Temp Scan Error Status

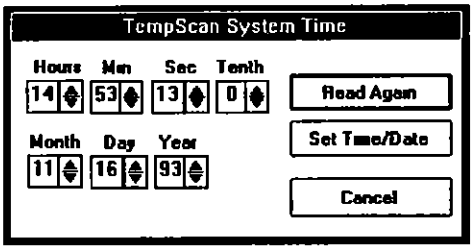


Figure 5 4· TempScan Time/Date

5.3.8 Dynamic Data Exchange (DDE)

The DDE menu includes one command for sending temperature data to an Excel spreadsheet

To perform Dynamic Data Exchange (DDE) between TempWindows and an Excel spreadsheet, launch both applications From the TempWindows menu, select "*Attach To Excel* " under the DDE menu item In the dialog box that pops up, enter the name of the Excel spreadsheet that will receive the data An untitled spreadsheet in Excel is given a default name of "SHEET*x*", with *x* representing a number If the sheet has been named during the Excel Save operation, it will typically have a name like "MYSHEET XLS" Once the name is entered in the TempWindows dialog box, click *OK* If an error dialog box comes up, it is probably due to an incorrect sheet name, or Excel is not running

After TempWindows and Excel are "linked," data is transferred from TempWindows to the Excel spreadsheet while the data is being stored to disk Configure an acquisition and select

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Arm under the Acquisition menu to collect data and send it to a disk file and the Excel spreadsheet

The data placed in the Excel spreadsheet will be posted starting at the currently selected cell, with each channel occupying one column, and each scan occupying one row The DDE operation will automatically move the selected cell down one row everytime a new scan is posted If you select a new cell in the spreadsheet while the data is being collected, the new scans will be posted starting at the newly selected cell position

The DDE operation will overwrite cells needed for channel data Since each channel occupies a column position, the number of channels in the TempScan/1000's scan group will dictate how many columns will be overwritten starting at the selected cell If channels 1 through 10 are enabled in TempWindows, and a cell in column 3 of the spreadsheet is selected, each scan will occupy columns 3 through 13

Enabling DDE does not disable writing to disk While DDE is enabled, the data is still being posted to the disk file DDE can be enabled and disabled while the acquisition is taking place If it is enabled during an acquisition, all data collected from that moment forward will be posted in the spreadsheet If DDE is disabled during the acquisition, the spreadsheet will stop updating, but the data is still being stored to the disk file

If the spreadsheet or Excel is closed while a DDE link is open, TempWindows will register an error when it attempts to post the next scan and the acquisition will be terminated

5.4 Using PostView

PostView is an independent application that allows the user to graphically view the waveforms recorded by TempWindows As the data file is being created by the acquisition application, a descriptor file used by PostView is also created PostView can be launched independently or launched from TempWindows's PostView menu Multiple sessions of PostView can be invoked concurrently to view multiple data files Note that on-line help is available within this application

To view a data file from within PostView, select *Open* under the File menu A File Open dialog box provides a means of selecting a TempWindows data file To place channel waveforms into the window, select the number of charts from 1 to 16 under the *Number of Charts* menu item Selecting *N* number of charts will automatically place the first *N* channels in the charts Use the *Channel Select List Box* next to the chart to associate a different channel with the chart

When PostView is launched from TempWindows, it automatically opens the file selected as the destination file in those applications To view other files, use *Open* under the File menu

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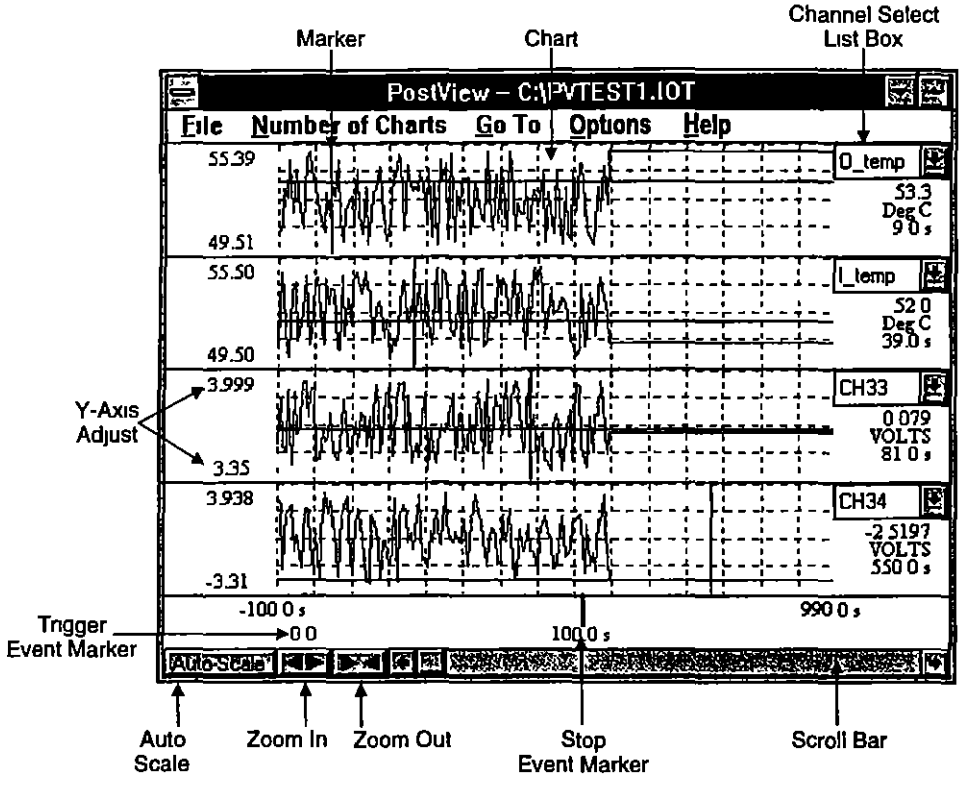


Figure 5.5. PostView Charts

Zoom In.

The Zoom In button halves the visible timebase, showing less of the waveform For example, if 10 seconds of information is visible, clicking the Zoom In button will show 5 seconds

Zoom Out:

The Zoom Out button doubles the visible timebase, showing more of the waveform For example, if 10 seconds of information is visible, clicking the Zoom Out button will show 20 seconds

Scroll Bar

The Scroll Bar allows the waveforms to be scrolled right or left The Scroll Bar has 5 active areas for scrolling the waveforms, as shown in the figure below

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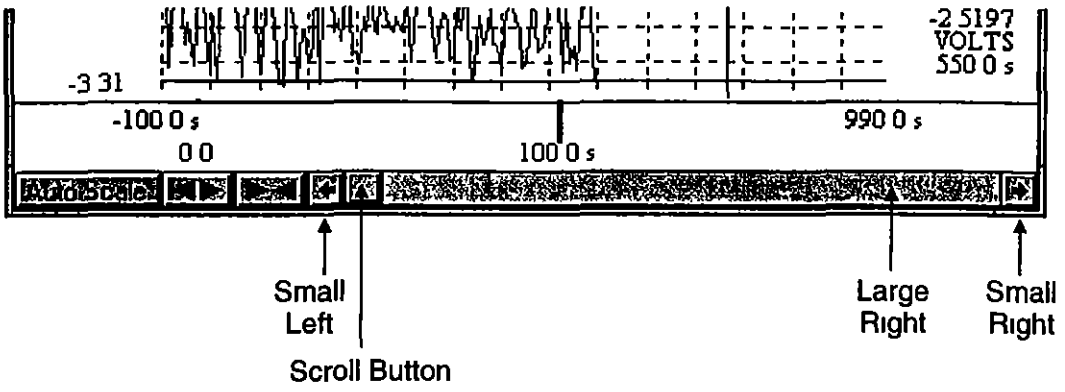


Figure 5 6. PostView Scroll Bar Functions

The Small Left and Small Right scroll the waveforms left and right approximately 20% The Large Left and Large Right scroll the waveforms left and right approximately 80% The Scroll button shows the relative location of the visible region of the waveforms and can be dragged along the scroll bar to any location desired

Y-Axis Adjust.

The Y-Axis Adjust fields show the chart's minimum and maximum for every visible chart in the engineering units shown Clicking the Auto Scale button automatically adjusts the Y-Axis Adjust fields To adjust any chart's minimum or maximum, place the cursor in the desired Y-Axis Adjust field and type in a new value

Channel Select List Box.

Each chart has a Channel Select List Box to allow the user to assign any of the available channels to that chart The Channel Select List Boxs contain labels that were assigned to the recorded channels by TempWindows

Auto Scale:

Clicking the Auto Scale button adjust the Y-Axis labels so that the visible waveform fills 90% of the chart's range

Markers·

Each chart contains a marker that shows the numerical values of time and magnitude at its present location in the waveform The Markers start out at the far left of every chart, showing the time and magnitude of the first visible point The left mouse button allows the user to

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drag the marker of each chart independently The right mouse button moves the markers from all of the charts synchronously

The Options menu contains a function which allows markers to be turned on and off by the user When a check appears in front of this item, its associated indicator is on or visible Selecting the menu item toggles the indicator (and the check mark) on and off

Trigger Event Marker

The Trigger Event Marker on the time axis shows the location of the trigger point

Stop Event Marker

The Stop Event Marker on the time axis shows the location of the stop point

5.4.1 PostView Menu Items

5.4.1.1 File

The File menu provides two basic functions

Open	Open a data file created by TempWindows PostView automatically detects whether the file contains ASCII or binary data
Print Window	Print the present PostView window

5.4.1.2 Number of Charts

The Number of Charts menu provides one basic function

1-16	After a data file has been opened, the number of desired charts can be selected You can also use this menu selection to change the number of charts displayed

5.4.1.3 Go To

The Go To menu provides four basic functions

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Trigger point	Automatically scrolls the waveforms so that the trigger point (t = 0) is in view
Scan Number	Automatically scrolls the waveforms so that the desired scan number is in view This menu selection invokes a dialog box which displays the number of scans in the file
Time	Automatically scrolls the waveforms so that the desired time is in view
Percentage	Automatically scrolls to the desired percent of the data file For example, selecting 50% would display a waveform segment from the middle of the data file

5.4.1.4 Options

The Options menu provides two basic functions

Grids (Ctrl-G)	Allows grids to be turned off and on for all visible graphs When a check appears in front of an item, its associated indicator is on or visible
Markers (Ctrl-K)	Allows markers to be turned off and on for all visible graphs When a check appears in front of an item, its associated indicator is on or visible

5.4.1.5 Help

The Help menu provides three basic functions

Contents	The initial PostView help screen provides an overview and listing of the help file contents A single topic can be selected for quick access to help information
Search	Type a word or select one from the Show Topics list for quick access to help information
How to Use Help	Provides instructions on how to use a Windows Help system

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5.4.2 The PostView Timebase

PostView automatically detects the timebase of the data file and shows the time in the X-Axis labels in seconds

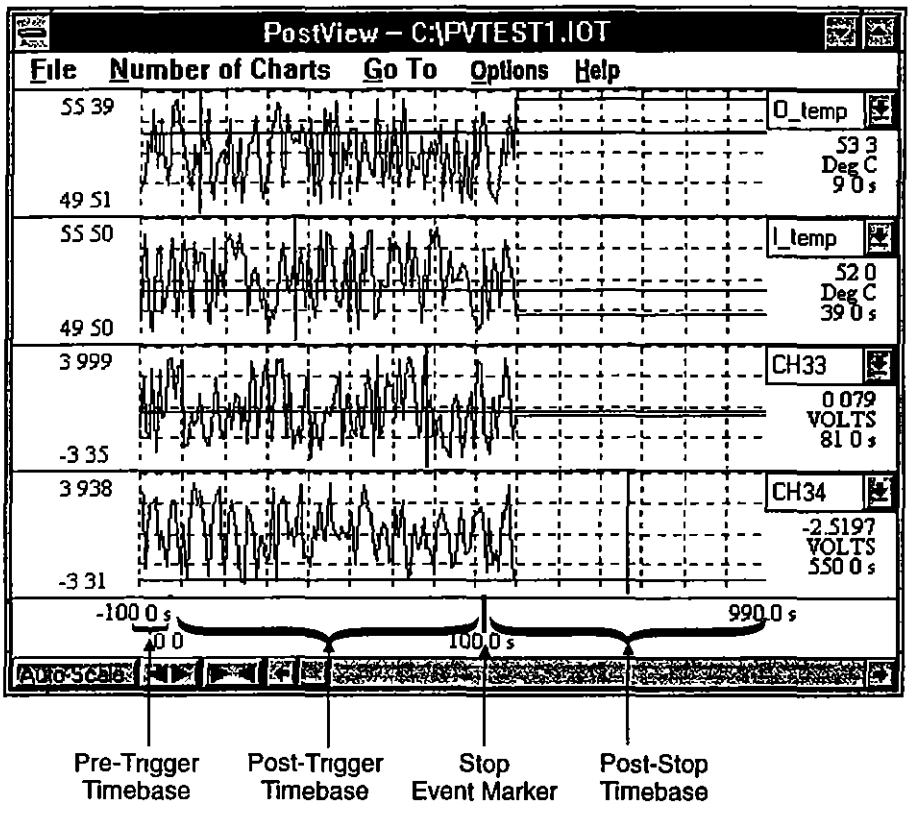


Figure 5 7· Multiple Timebases

Timebase for TempWindows:

Accessing all of the MultiScan/1200's acquisition capabilities, TempWindows can create files containing multiple timebases, pre-trigger, post-trigger, and post-stop data PostView accommodates all of these features, as shown in the following figure

For TempWindows data files, the trigger point (t = 0) may not be the first point in the data file If pre-trigger scans are available, they will be shown prior to the trigger point and labeled with negative time numbers

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If post-stop data is available (scans collected after the Stop Event), they are displayed after the Stop Event marker

If a dual timebase was used when collecting the data, PostView will show a discontinuity in the time axis when the timebase changes When a dual timebase is used, the post-trigger scans are collected at one frequency while the pre-trigger and post-stop scans are collected at another

Data File Accessibility for TempWindows

PostView can access TempWindows files at any time -- even while the acquisition is taking place If PostView reaches the end of a file while TempWindows is still collecting data, PostView will automatically display the new data as it becomes available

Note. For fastest display of waveforms, select binary data storage in TempWindows

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Command Reference

6.1 Introduction

The following pages provide the command set for the TempScan For each command, the command name and a descriptive name for the command are given

TYPE refers to the part of the system that the command acts upon The TempScan has the following defined types

Channel	Refers to those commands which affect channel configuration and/or acquisition
Buffer	Refers to those commands which affect the buffer operations and/or pointers
Acquisition	Refers to those commands which affect how the scans/channels are acquired
System	Refers to those commands which affect general system functionality
Calibration	Refers to those commands which affect TempScan/1000 Calibration

EXECUTION refers to the point in time which an interpreted command is executed

Immediate	Indicates that the command will be executed immediately upon successful parsing of the command and TempScan/1000 parameters
Deferred	Indicates that the command will be saved and will later be executed upon successfully parsing and executing an Execute (X) command

6.2 TempScan/1000 Command Set Index

The following index is categorized by general function of the TempScan/1000, and is intended to aid you in finding a specific command description while executing the functions

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6.3 Command Examples

This chapter provides programming examples for each TempScan/1000 command Although written in QuickBasic, the program logic and the TempScan/1000 device-dependent commands apply to all languages and computers

These examples use the IEEE-488 bus through the Personal488 interface to communicate with the TempScan/1000 After the driver is opened, commands are issued to the driver through character strings in quotes

QuickBasic's PRINT and INPUT commands are used to communicate with the driver The driver commands used most commonly are ENTER, OUTPUT, and SPOLL ENTER gets data from the selected device, OUTPUT sends data to the selected device, and SPOLL is an abbreviation for Serial Poll which retrieves and 8-bit status response from the selected instrument

The syntax of the ENTER command is "`ENTER addr`", where `addr` is the IEEE-488 address of the instrument Right after the ENTER command, the QuickBasic INPUT function must be used to bring the data into a language variable

The syntax of the OUTPUT command is "`OUTPUT addr,out_data`", where `addr` is the IEEE-488 address of the instrument, and out_data is the string of characters to send to the device

The syntax of the SPOLL command is "`SPOLL addr`", where `addr` is the IEEE-488 address of the instrument Right after the SPOLL command, the QuickBasic INPUT function must be used to bring the data into a language variable

In all of the IEEE-488 examples, the TempScan is at IEEE-488 address 07

6.4 Command Interpretation

As commands are received by TempScan/1000, they are interpreted in the order in which they are received Some commands are immediate, which means they immediately take effect

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Other commands are deferred, and have no effect on device operation until the execute command (X) is interpreted

An example of an immediate command is Set Digital Outputs (On), which immediately chooses the the digital output line which is being referred to The immediate commands are @,*B, *F, *K, *R, *S,A#, E, K, O, S, U, W, X, Z and all queries

An example of a deferred command is Data Format (F), which determines the input and output format used for channel data when X is interpreted As deferred commands are interpreted, their desired effects are recorded in internal temporary registers As additional deferred command are interpreted, their effects are added to these registers, possibly overwriting earlier command's effects Finally, when X is interpreted, the temporary registers are examined in the execution order described below If two deferred commands that do not affect the same function are received before the execute command, they take effect in the execution order described below If a deferred command is sent multiple times within a command line, the last occurrence of the command will take precedence (Note that a command line is terminated by the X) For example, if F1,1 F1,3X is sent, the data output format will be as specified by the F1,3X command The F1,1 command is overridden and never takes effect

If an error is detected during command processing, commands are ignored up through and including the next execute command Thus any immediate commands after the error, as well as all deferred commands, are ignored For example, the command line T1,1,0,0 O216,0,25,255 AA T3,7 K20 X containing the error AA only executes the O0, because it is an immediate command that occurred before the error The deferred commands T1,1,0,0 and T3,7,0,0 and the immediate command K20 after the error, have no effect

Deferred commands help reduce the effects of errors and improve synchronization of command execution The primary advantage of deferred commands is that they are executed as a group, either all or none If any errors occur, deferred commands have no effect and the device is left in a consistent state instead of a partially modified, inconsistent state

The deferred commands are *C, A, C, D, E?, F, G, H, I, J, L, M, N, P, Q, R, S, T, and Y

6.5 Command Execution Order

The immediate commands (@,*B, *F, *K, *R, *S, E, K, O, S, U, W, X, Z and all queries) take effect immediately when they are interpreted Even so, they must be followed by an X command to terminate the command string for correct operation For example K000001

The deferred commands do not take effect until after the X is interpreted At that time, they are executed as described below

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6.5.1 Deferred Command Execution Order

Deferred commands are not executed until the X command has been successfully parsed and interpreted Upon interpretation of the X command the order of execution of all deferred commands is as follows

Q - Set Query Terminators
V - Set User Terminators
F - Set Data Format
D - Define Custom Table
M - Set SRQ Mask
N - Set Event Mask
C - Configure Channels
A - Assign Alarm Output
L - Set Level Trigger
Y - Set Counts
I - Timebase Configuration
T - Set Trigger Configuration
@ - Trigger

This ordering ensures that the configuration of acquisitions takes place before any data is acquired The T command is performed last since data acquisition may begin once T has been defined

6.6 Syntax Rules

Commands are identified by a single letter (A through Z), at-sign (@) or an asterisk (*) followed by an single letter

6.6.1 Case Sensitivity

Commands may be entered in upper or lower case

Example

A1,1X is interpreted the same as a1,1X

6.6.2 Spaces

White space, which consists of all ASCII values of 32 and below and includes the space, tab, new-line and carriage-return characters, is generally allowed anywhere between commands

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and command arguments White space is not allowed in the middle of command options (for instance, 1 2 3 is not the same as 123)

6.6.3 Multiple Parameters

If more than one parameter is used for a command, they must be separated by a comma or white space

Example

```
Q4,1,1,0,0
```

or

```
Q4 1 1 0 0
```

6.6.4 Command Strings

Commands may be sent individually or in a string with other commands

Example

These four lines of a program

```
PRINT#1,"OUTPUT07,C1, 1X"
PRINT#1,"OUTPUT07,A1, 1X"
PRINT#1,"OUTPUT07,C2, 2X"
PRINT#1,"OUTPUT07,A2, 2X"
```

have the same effect as the single line

```
PRINT#1,"OUTPUT07,  C1, 1A, 1 C2,2 A2, 2 X"
```

6.6.5 Execute (X)

Deferred commands are interpreted and processed as they are received However, they require the Execute (X) command to be issued in order to be executed

If multiple system commands are used in the same string, each use of the command must be followed by the Execute (X) command The immediate Port Select (Pn) command and deferred port commands do not have to be followed by X when used in the same string

Example

To clear the SRQ mask and then set it for SRQ on trigger

```
PRINT#1,"OUTPUT10,M000 X M002 X"
```


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To configure channels 1-32 for temperature and 33-64 for volts, using one command string

```
PRINT#1,"OUTPUT07,C1-32, 1C33-64, 11X"
```

The immediate commands do not require an Execute command to be processed For more detail on deferred and immediate command types, refer to Section 6 4

6.6.6 Fixed Formats

Any query command or Un command returns a fixed format For instance, any option that can range up to 65,535 always returns five digits, so zero would be returned as 00000 In the following command descriptions, leading zeros are included They are not, however, required when entering the command

6.6.7 Conflict Errors

Some combinations of commands and parameters can be sent to the TempScan/1000 that are out of range for a particular configuration or inconsistent with other commands For instance, specifying a scan interval (I command) to less time than the TempScan/1000 can acquire scans results in a conflict error

```
PRINT#1,"OUTPUT07,C1-992,I00 00 00 0, 00 00 00 0X"
```

A conflict error lights the ERROR indicator light on the front panel and returns an E4 when queried with the Error Query (E?) command Some conflict errors result in a default value for a conflicted command For instance, in the example shown above, the scan interval defaults to the fastest possible scan interval for the number of defined channels

6.7 TempScan/1000 Commands

The TempScan/1000 commands, in alphabetical order, are described on the following pages

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Trigger On Command @

Type: Acquisition

Execution: Immediate

`@` Trigger upon Receipt of `@`

When start or stop event (`T` command) is set to 1 (trigger on command) this command will start or stop the acquisition accordingly The trigger command is used as a trigger source and follows the same rules as other trigger sources as defined by the `T` command This command is valid only when an acquisition is configured where either the start and/or stop event is defined as trigger on command If this command is issued when the acquisition is not configured for stop and/or start trigger on command an error condition will occur

Example

```
PRINT#1,  "OUTPUT07,T1,1,0,0X"    ' Configure an acquisition with both start
                                   and stop trigger being trigger on command
PRINT#1,  "OUTPUT07,  @X"         ' Start the acquisition
SLEEP  10                         ' Wait 10 seconds to collect data
PRINT#1,"OUTPUT07,  @X"           ' Stop the acquisition
```


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Flush Acquisition Buffer *B

Type Buffer

Execution Immediate

*B Flushes the Acquisition buffer

The Flush Acquisition Buffer command will flush any data currently in the acquisition buffer Upon execution of this command all data currently in the acquisition buffer will be deleted and is unavailable to be read This command should only be used when it is determined that the data in the acquisition buffer is no longer needed or may be corrupt Once this command is executed, data in the acquisition buffer is irrevocably lost

Example

```
PRINT#1,"SPOLL07"                    ' Serial Poll the TempScan/1000
INPUT#2,  S%                         ' Get the Serial Poll response
IF  (S%  AND  128)  =  128  THEN     ' Check for Buffer Overrun
PRINT#1,"OUTPUT07,  *BX"             ' Data may be corrupt, flush the acquisition
                                       buffer
ENDIF
```


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Clear Channel Config *C

Type Channel

Execution Deferred

*C Clear channel configuration will unconfigure all channels

This command will clear out the channel configuration so that no channels are configured After this command has been performed channel readings will be not be updated, therefore no HLL or acquisition buffer updates will be performed until a new configuration is entered via the C command This command may be used when the present configuration is no longer acceptable and the user wishes to reconfigure channels from scratch

Example

```
PRINT#1,"OUTPUT07,  *CX"            ' Clear all channels configuration
PRINT#1,"OUTPUT07,  C1,  1X"        ' Configure channel 1 of TC type J
```


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Restore Factory Settings *F

Type: System

Execution: Immediate

*F Restore factory default settings

The Restore Factory Defaults command may be used to restore the TempScan/1000 to the same configuration it had when it left the factory Issuing this command will cause the TempScan/1000 to load the factory default configuration into the working configuration thereby placing the unit into a known default configuration state similar to the one it had at the time it left the factory The factory default configuration is defined in Section 3 7 5 1

This command may not be issued while an acquisition is configured since it will cause certain settings upon which the acquisition depends to change Issuing this command while an acquisition is configured will cause a Conflict Error to occur

Note: Issuing *F command will cause any previously defined configuration to be irrevocably lost. The calibration factors for the unit and its slaves, however, will remain intact. Also note that custom tables will be erased

Example:

```
PRINT#1,"OUTPUT07,Q?T?Y?X"      ' Retrieve some current configuration settings
PRINT#1,"ENTER07"               ' Get the settings
INPUT  A$                       ' Screen shows
                                Q1,7,7,7,0T0,3,0,0,Y000100,001000,000000
PRINT#1,"OUTPUT07,*FX"          ' Restore factory default configuration
PRINT#1,"OUTPUT07,Q?T?Y?X"      ' Retrieve some current configuration settings
PRINT#1,"ENTER07"               ' Get the settings
INPUT  A$                       ' Screen shows
                                Q1,0,0,0,0T0,0,0,0,Y000000,000000,000000
```


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Set RTD Gain Calibration Reference *G

Type Calibration

Execution Immediate

*Greference point
: Set the RTD Gain Calibration Reference Point to 'reference point' ohms
reference point is a real number of the form xxx xx

G?
: Query the current setting of the RTD Gain Calibration Reference Point

RTD Gain Calibration requires a precision resistance source to be applied to channel 1 of each RTD card being calibrated The factory default reference resistance (invoked with reference point = 0 00) is 384 4 ohms (830°C) The TempScan/1000 allows the user to change the reference resistance prior to calibrating the gain This is useful if individual calibration labs have different precision resistance sources, and when temperature measurement exclusivity at lower temperatures can be made even more accurate by calibrating at a lower reference point For a complete description of calibrating the TempScan/1000, see the Calibration chapter of this manual

Example.

```
PRINT#1,"OUTPUT07,*G247 04X"     ' Set the RTD Gain Calibration reference point
                                 to 247 04 ohms (400°C)
PRINT#1,"OUTPUT07,K12345X"       ' Enter calibration mode
                                 ' Short out channel 1 on RTD card in master
                                 unit
PRINT#1,"OUTPUT07,H1X"           ' Calibrate offset for RTD card in master unit.
                                 ' Apply precision resistence of 247 04 ohms on
                                 channel 1 of RTD card in master unit.
PRINT#1,"OUTPUT07,G1, 17X"       ' Calibrate gain for 4-wire RTD for RTD card
                                 in master unit
                                 ' Remove precision voltage
PRINT#1,"OUTPUT07,EX"            ' End calibration mode
```


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Change Calibration Keyword *K

Type: Calibration

Execution: Immediate

*K	Changes the calibration keyword, where nnnnn represents the keyword with n being a single digit

This command is only valid while the TempScan/1000 is in Calibration Mode The *K command allows the changing of the Calibration Keyword which is a user-defined password The new keyword must be a five-digit decimal number Once the keyword is set, it will, thereafter, be used by the Enter Calibration Mode command (K) to determine entry into Calibration Mode

If the new keyword becomes lost or forgotten, the Enter Calibration Mode command can be overridden by the calibration jumper as described in Section 7 1 1 1

Note: This is the only command which allows the calibration jumper to override the Enter Calibration Mode command.

Refer to Chapter 7 for detailed instructions on calibrating the TempScan/1000

Example:

```
PRINT#1,   "OUTPUT07,K12345X"      ' Enter Calibration Mode Keyword='12345'
PRINT#1,   "OUTPUT07,U2X"          ' Check for Keyword Error
PRINT#1,   "ENTER07"
INPUT#2,   C%                      ' Get the Calibration Status Register

IF  (C%  AND  1)  THEN
PRINT,"ERROR--INVALID  KEYWORD
SLEEP  5                           ' If so, wait until keyword check jumper is disabled
PRINT#1,   "OUTPUT07,*K67890X"     ' Enter new Keyword = '67890'
ENDIF
PRINT#  1  "EX"                    ' End Calibration Mode
```


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Power-On Reset *R

Type System

Execution. Immediate

*R Power-On Reset Equivalent to a hardware reset

This command has the same effect on the TempScan/1000 as removing and re-applying power All data in data buffers and configuration are erased

Note because the *R command performs a full power-on reset, 3 or 4 seconds are required before you can communicate with the TempScan/1000 A total of at least five seconds is required before normal operations can take place

If the watchdog timer is enabled, the *R command performs a full power-on reset where the TempScan hardware components will be initialized to their power-up state If, however, the watchdog timer is not enabled, the *R only performs a software reset by starting at location 0 See Section 2 5 2 for more information on the watchdog timer

The IEEE 488 bus commands Device Clear (DCL and SDC) do not have this effect They clear only the command input buffer, the output queue, any pending commands

Note: Issuing *S1 command and then power-cycling the unit or issuing *R command will cause any previously defined configuration to be irrevocably lost. The calibration factors for the unit and its slaves, however, will remain intact.

Example.

```
PRINT#1,"OUTPUT07,*RX"          ' Restore power-on settings to TempScan/1000
SLEEP4                          ' Wait 4 seconds to restore communication
WHILE (S% and 4) = 0            ' Keep checking the serial poll response of the
  PRINT #1, "SPOLL07"           ' TempScan/1000 unit until it is Ready, meaning
  INPUT#2,S%                    ' that bit 4 is asserted
WEND
```


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Power Up Settings *S

Type: System

Execution: Immediate

*Smode Specify the configuration with which the TempScan/1000 will power up mode may have the following values
0 - Power up under last known configuration (default)
1 - Power up under factory default configuration

Specifying mode to be 0 will cause the TempScan/1000 to load its last known configuration when it is powered on or a *R command is issued The last known configuration will be exactly the same as the configuration it had when it was last powered down or a *R command issued Specifying this mode will insure that the TempScan/1000 will always come up with the configuration which has most recently been defined Using this mode is convenient if it is undesirable to re-configure the unit every time it is powered up or a *R command is issued

Specifying mode to be 1 will cause the TempScan/1000 to load the factory default configuration when it is powered on or when a *R command is issued Using this mode is the same power-cycling the unit then issuing the *F command The factory defaults settings are defined in Section 3 7 5 1

Note. Issuing *S1 command and then power-cycling the unit or issuing *R command will cause any previously defined configuration to be irrevocably lost. The calibration factors for the unit and its slaves, however, will remain intact.

Example:

```
PRINT#1,"OUTPUT07,Q?T?Y?X"      ' Retrieve some current configuration settings
PRINT#1,"ENTER07"               ' Get the settings
INPUT  A$                       ' Screen shows
                                Q1,7,7,7,0T1,3,0,0,Y000100,001000,000000
PRINT#1,"OUTPUT07,*S1X"         ' Configure unit to power up with factory
                                defaults
PRINT#1,  "OUTPUT07,*RX"        ' Reset the TempScan/1000
SLEEP(5)                        ' Wait for the TempScan/1000 to reset
PRINT#1,"OUTPUT07,Q?T?Y?X"      ' Retrieve some current configuration settings
PRINT#1,"ENTER07"               ' Get the settings
INPUT  A$                       ' Screen shows
                                Q1,0,0,0,0T0,0,0,0,Y000000,000000,000000
```


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Scan Time Stamping *T

Type System

Execution: Immediate

`*Tstate` Specify whether or not scan time stamping will be enabled `state` may have the following values
0 - Disable scan time stamping (default)
1 - Enable scan time stamping

This command, when enabled, will append a time/date time stamp to each scan being sent by the TempScan unit to the interface The time stamp format is HH MM SS MIL,MM/DD/YY where MIL = milliseconds Refer to section 3 3 11 for details

Note: This feature is only valid for non-binary output modes.

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Software Digital Filtering *W

Type. System

Execution· Deferred

*Wmode Specify whether or not digital filtering for thermocouple cards will be enabled mode may have the following values
0 - Disable software digital filtering
1 - Enable software digital filtering (default)

The TempScan/1000 uses an advanced digital filter to ensure quiet and accurate thermocouple input This feature is enabled as part of the factory default settings The *W0 command can be used to disable the filtering and allow for increased reaction response time Digital filtering can subsequently be re-enabled with the *W1 command

Note· This feature is only valid for thermocouple cards

Example:

```
PRINT#1,"OUTPUT07, *W0X"        ' Disable software filtering
PRINT#1,"OUTPUT07, *W1X"        ' Enable software filtering
```


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Assign Alarm Output A

Type System

Execution Deferred

`Achans,output`
: Set Alarm Condition where `chans` is the channel(s) to assign to the digital `output` `chans` may be in two forms `channo` (for a single channel where 1 <= `channo` <= 992) or `firstno-lastno` (for a range of channels where 1 <= `firstno,lastno` <= 992)

  Set Alarm output where `output` (0 <= `output` = 32) is the digital output number to associate the the channel(s) with

`A?`
: Alarm Pattern Query Response is `Achans,output` where `chans,output` are defined as above

The Assign Alarm Output command may be used to assign a particular channel, or range of channels, alarm condition(s) to a particular digital output This command provides a means by which internal alarm conditions may be sensed by external devices via the 32 TTL-level digital outputs located on the back panel of the TempScan/1000

To use alarms, the channels in question must be part of the channel scan Once the channels are configured (by using the `C` command) and made part of the scan, the alarms are active No trigger or timebase assignment is required Alarming is totally independent of buffered operations

If it is desired, an alarm event for a specific channel can be used as a stimulus for a digital output signal on the back panel of the TempScan/1000 by using the `A` command to assign the channel to digital output This signal can be used to set off an audible alarm or signal another device of the occurrence of the alarm condition

To unassign a digital alarm condition, use 0, which is the null output number Assigning the null output number to a channel(s) will disassociate the channel(s) from any digital output

Thirty-two digital signals are available on the TempScan/1000 back panel Although analog input channels on the slave units can be used to stimulate alarms, no digital output signals are available on the slave units Regardless of the number of slaves connected, 32 external alarm signals are available

A channel programmed with alarm setpoints will not generate an alarm unless it is over a setpoint when the scan occurs For example, if a channel goes above then below an alarm threshold in-between scans, it will not be detected or posted

Alarm detection will generate an SRQ User can then issue an alarm query (`A?`) which will return a four byte image of the 32 alarm outputs

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Example:

```
PRINT#1,"OUTPUT07,C1-32,1,-100 0,100 0,1 0X"
                                    ' Configure channels 1 through 32
PRINT#1,"OUTPUT07,A1,1X"            ' Assign channel 1 alarm to digital output channel 1
PRINT#1,"OUTPUT07,A2-16,2X"         ' Assign channels 2 through 16 alarms to digital
                                    ' output channel 2
PRINT#1,"OUTPUT07,A17-25,3X"        ' Assign channels 17 through 25 alarms to digital
                                    ' output channel 3
PRINT#1,"OUTPUT07,A26-32,32X"       ' Assign channels 26 through 32 alarms to digital
                                    ' output channel 32
```


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Scan Alarm Stamping A#

Type System

Execution Immediate

`A#state`

Specify whether or not scan alarm stamping will be enabled state may have the following values
0 - Disable scan alarm stamping (default)
1 - Enable scan alarm stamping

This command (when enabled) will append the alarm state to the end of each scan as it occurs

1 The alarm status consists of 32 bits A_{31} A_0 with a "1" signifying alarm on and a "0" signifying alarm off

2 In Binary Low-High mode, 4 bytes will be appended as follows

Byte 1 A_7 - A_0

Byte 2 A_{15} - A_8

Byte 3 A23 - A_{16}

Byte 4 A_{31} - A_{24}

3 Binary High-Low mode, 4 bytes will be appended as follows

Byte 1 A_{15} - A_8

Byte 2 A_7 - A_0

Byte 3 A_{31} - A_{34}

Byte 4 A23 - A16

4 In Asc mode, 12 bytes will be appended as follows

DwwwDxxxDyyyDzzz

Where D = User Terminator

www = Decimal equivalent of A7 - A_0

xxx = Decimal equivalent of A15 - A_8

yyy = Decimal equivalent of A23 - A_{16}

zzz = Decimal equivalent of A_{31} - A_{24}

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Example.

```
PRINT#1,"OUTPUT07,A#1X"          ' Enable alarm stamping
PRINT#1,"OUTPUT07,A#0X"          ' Disable alarm stamping
```


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Configure Channels C

Type: Channel

Execution Deferred

`Cchans, type[,[lowsp],[highsp],[hyst]]`
Configure the channels for the TempScan/1000 and its slave units where `chans` and `type` are **required** arguments and `lowsp`, `highsp` and `hyst` are optional

`C?` Channel Configuration Query Response is `Cchans, type[,[lowsp],[highsp],[hyst]]` as defined above

The C command is used to configure the channels and add them to the scan group for the TempScan/1000 and its slave units

The `chans` argument is the channel(s) to configure with the subsequent arguments `chans` may be in two forms `channo` (for a single channel where 1 <= `channo` <= 992) or `firstno-lastno` (for a range of channels where 1 <= `firstno,lastno` <= 992)

And `type` is the type to assign to those channels See the channel definition tables on how to select the appropriate channel types

The optional arguments `lowsp`, `highsp` and `hyst` are the low setpoint, high setpoint and hysteresis values, respectively These arguments are only needed if it is desired to configure alarms on the specified channel(s) The format for these optional arguments follow the rules for readings input defined under the Format (F) Command

The channel `type` is used by the TempScan to determine how a certain channels readings are to be interpreted Because of this fact, defining the channel type is critical to the proper configuration of the channel Each channel must be assigned a channel type in order for it to be included in the scan group Likewise, assigning a channel type of 0 will remove that channel from the scan group

The following definitions show the channel types that may be defined

Null Type:

The null channel type is type **0** Assigning a channel to the null type will remove the channel from the scan group

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Thermocouple Types·

	Type J	Type K	Type T	Type E	Type R	Type S	Type B	Type N (14 Gauge)	Type N (28 Gauge)	100 M V w/ H/W range checking	100 M V w/o H/W range checking
Normal Operation	1	2	3	4	5	6	7	8	9	10	11
*Same as normal but without temperature sensor adjustment	21	22	23	24	25	26	27	28	29	N/U	N/U
*Without temperature sensor adjustment (i e raw A/D input of the T/C type)	31	32	33	34	35	36	37	38	39	N/U	N/U
*Temperature sensor values only, linearized	41	42	43	44	45	46	47	48	49	N/U	N/U
*Temperature sensor values only, without linearization (ie raw A/D input of the temperature sensors)	51	52	53	54	55	56	57	58	59	N/U	N/U

* For trouble-shooting purposes only, not to be used in normal operation In addition, these special types are valid only in degrees C

Volts Card Types:

	Range			
	100 mV	**1V**	**5V**	**10V**
Type	11	12	13	14

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RTD Card Types·

	3-WIRE RTD	4-WIRE RTD
Normal Operation	16	17
Raw A/D Input	18	19

Custom Types

Custom Types may be used, but these custom types must first have custom lookup tables defined before a custom type may be assigned to a particular channel Types 100-110 are reserved for this purpose These types correspond to the custom table number assigned during custom table creation and definition Refer to Section 3 16 for details on custom tables and parameter specifications

Reserved Types·

Reserved types are types that are reserved to the internal processes of the TempScan These reserved types include

```
15,  20,  30  40,  50
60-99
11-127
```

NOTE Specifying a reserved type will cause an error

It should be noted that, since the Configure Channels command is a deferred command, the channel(s) will not actually be configured until the Execute (X) command is processed And since the configuring of channels takes a good deal of processor time it is recommended that as many Configure Channels commands should be placed on one command line as possible This will avoid unnecessary processing time overhead when configuring many channels

Example·

```
PRINT#1,  "OUTPUT07,  F0,0X"          ' Set Data Format to Engr Units --
                                        Degrees C
PRINT#1,  "OUTPUT07,*C"               ' Clear current channel configuration
PRINT#1,"OUTPUT07,C1,1,-100 0,1       ' Configure channel for TC type J with
00 0,0 5"                               low setpoint of -100 0C and high setpoint
                                        of 100 0C and hysteresis of 0 5C
PRINT#1,"OUTPUT07,C33-34,11"          ' Configure channels 33 and 34 for
                                        VOLTS type (100 mV range) and no
                                        setpoints
PRINT#1,"OUTPUT07,C65,2"              ' Configure channel 65 for TC type K
                                        with no setpoints
```


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```
PRINT#1,"OUTPUT07,X"          ' Execute the above configuration (The
                              TempScan/1000 is now scanning the above
                              configuration)
PRINT#1,"OUTPUT07,  U13X"     ' Get the Last readings of configured
                              channels
PRINT#1,"ENTER07"             ' Retrieve response
INPUT  A$                     ' Screen shows
                              +0034 40-0103 00+0012 30+0004 60
```


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Define Custom Table D

Type System

Execution Deferred

`Dt,c,p,l,h,e`

Defines a custom table where `t` is the table number to be defined, `c` is the card type, `p` is the PGA value, `l` is the low limit, `h` is the high limit and `e` is the number of entries

`D?` Table Definition Query Response is `Dt,c,p,l,h,e` as defined above

To use input types other than the predefined types, the TempScan/1000 can be programmed with custom linearization lookup tables The Define Table command is used to specify the contents of a custom table The `D` command parameters are used to assign the table number, allocate memory for the new table and assign values which are common through the table structure

For custom channel type tables, use a table number in the range of 100-110 For custom cold junction tables, use a range of 228-238 Note for any one channel, the table number for the channel type +128 must match the table number for the cold conjunction table

This command is used in conjunction with the Set Table Entry Pointer (`W`) and Load Current Entry (`Z`) commands Refer to Section 3 16 for custom table details and parameter specifications

Note. To delete a custom table, enter 0 (zero) for number of entries.

Example.

```
PRINT#1,   "OUTPUT07,D101,0,0,-20000,20000,5X"
                                                  ' Define table #101 with
                                                  1 T/C card type
                                                  2 PGA of 0
                                                  3 Low limit of -20,000
                                                  4 High limit of 20,000
                                                  5 5 entries
PRINT#1,   "OUTPUT07,D102,0,0,0,0,0X"             ' Delete table #102
PRINT#1,   "OUTPUT07,D?X"                         ' Return current custom table
                                                  definition
PRINT#1,   "ENTER07"
LINE  INPUT  #2,  A$
PRINT  A$
```


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End Calibration Mode E

Type. Calibration

Execution Immediate

E Terminate Calibration Mode

To use this command the TempScan/1000 must be in Calibration Mode The End Calibration Mode command is then used to take the TempScan/1000 out of Calibration Mode Once this command has been executed the TempScan/1000 will no longer be in Calibration Mode and the Enter Calibration Mode command (K) must be issued to re-enter Calibration Mode

Example.

```
PRINT#1,  "OUTPUT07,K12345X"        ' Enter Calibration Mode
                                    ' Apply precision voltage
PRINT#1,  "OUTPUT07,H545X"          ' Will calculate offsets for slave #9, card #1
                                    ' Wait for command to complete
                                      (Refer to Section 7 1 1 4)
                                    ' Apply precision voltage of -50 0 mV
PRINT#1,  "OUTPUT07,G545,1X"        ' Calibrate negative gain for thermocouple
                                    ' onslave #9, card #1
                                    ' Wait for command to complete
                                      (Refer to Section 7 1 1 4)
                                    ' Apply precision voltage of +50 0 mV
PRINT#1,  "OUTPUT07,G545,1X"        ' Calibrate positive gain for thermocouple
                                    ' onslave #9, card #1
                                    ' Wait for command to complete
                                      (Refer to Section 7 1 1 4)
                                    ' Apply temperature of 90 0°C
PRINT#1,  "OUTPUT07,J21,2,90 0X"    ' Calibrate cold junction offset for channel 21
                                    ' on the Master Unit Card
                                    ' Wait for command to complete
                                      (Refer to Section 7 1 1 4)
                                    ' Remove precision voltage
PRINT#1,  "OUTPUT07,EX"             ' End Calibration Mode
```


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Error Status E?

Type System

Execution Deferred

E? Error Status Query is used to determine the present error condition of the TempScan/1000 After execution of the Error Query command, the unit responds with one of the following error codes

E000 No error has occurred

E001 Invalid device dependent command (IDDC) Due to a command syntax error

E002 Invalid device dependent command option (IDDCO) A command parameter was out of range or missing

E004 A Channel Configuration Error, E004, indicates that a channel has been inappropriately configured, either because the channel is not present or because the specified channel type is not compatible with the card type installed

E008 A Calibration Error, E008, occurs when the card calibration has failed or has been inappropriately calibrated

E016 A Trigger Overrun Error, E016, occurs when more than one trigger event occurs for a given trigger state or when a non-expectant trigger event occurs

E032 An Open TC Error or Range Error, occurs when the hardware circuitry detects an open thermocouple, or when the software detects the A/D input has maxed out or exceeded its linearization

E064 Custom Table Error, E064, indicates that a Custom Table has been inappropriately defined or has not been loaded properly This error usually occurs because Custom Table is out of memory or the inappropriate specification of the Custom Table Location Pointer (K command)

E128 A Command Conflict Error, E128, indicates the issuance of a command that is in conflict with other commands that have been issued or the current configuration This error usually occurs when a command is issued that cannot be performed because of the current state of the TempScan/1000 For instance, if the Timebase Interval (I command) is issued during an acquisition (tstart 0)

The Error Status query is used to determine the present error condition of the TempScan/1000 When an error has occurred, the error indicator light on the front panel of the TempScan/1000 turns on

After execution of the Error Status query, most error conditions are cleared Error conditions may also be cleared by issuing a U0 (Event Status) command to the TempScan/1000 The ERROR light will remain on until an E? or U0 command is executed to clear the error condition

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Examples.

```
PRINT#1,"CLEAR07"              ' Reset the TempScan/1000

PRINT#1,"OUTPUT07,E?X"         ' Request error status

PRINT#1,"ENTER07"

INPUT#2,A$

PRINT A$                       ' Display shows E000, no errors have occurred

PRINT#1,"OUTPUT07,K3 X"        ' Send an illegal command option to the TempScan/1000
                               ' (Note ERROR indicator light turns on)

PRINT#1,"OUTPUT07,E?X"         ' Request error status (ERROR light turns off)

PRINT#1,"ENTER07"

INPUT#2,A$

PRINT A$                       ' Display shows E02 (Invalid Device Dependent
                               ' Command Option)
```


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Data Format F

Type System

Execution Deferred

`Fengr,format`
: Configures the input and output data format for the TempScan/1000 where `engr (0 <= engr <= 4)` is the engineering units and `f (0 <= format <= 3)` is the reading format

`F?`
: Response Format Query responds with `Fengr, format` as defined above

The Format command configures the input and output data format for data input to/output to/from the TempScan/1000 The Reading Format (F command) requires two arguments The first is the engineering units, the second is the reading format

The engineering units is used by the TempScan to perform the necessary conversions to the raw data to place the data in the type of engineering units which user desires to work in The valid engineering units are as follows

0 - Degrees Celsius (default)
1 - Degrees Fahrenheit
2 - Degrees Rankin
3 - Degrees Kelvin
4 - Volts

The format is used by the TempScan to place the readings in a format which the user desires to work with The valid reading formats are

0 - Engineering Units (default)
1 - Binary (Low Byte/High Byte)
2 - Binary (High Byte/Low Byte)
3 - Counts (ASCII)

When the TempScan is inputting or outputting data it first references the current reading format If the reading format is 0 (Engineering Units), it will then reference the current settings of the engineering units and then perform the necessary conversion

Data Input Formats:

The Data Formats (F) command determines the format of readings input from the controller However, the only readings input from the controller come in the form of command parameters and there are only two commands which take readings as parameters, the Channel Configuration (C) and the Set Trigger Level (L) commands These are the only command parameters over which the Reading Format (F) command has control

With both the C and L command the F command may determine the format of the hysteresis parameter The F command may also determine the high and low setpoint format in the C command

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The reading parameters for the C and L commands cannot be issued in binary format If binary format is specified by the F command these parameters will be interpreted as Engineering Units

These parameters will always be interpreted as Engineering Units (as currently defined by the Engineering Units argument of the F command) except when the Counts format is specified When the Counts format is specified, these parameters are interpreted as Counts For additional information on the different format types, see Section 3 7

If readings are interpreted as Counts or Binary format then the engineering unit parameter of the F command is ignored

Data Output Formats.

Data output formats differ slightly from data input formats in that binary formats may be used for Channel Data Channel Data is the only output data which may use the binary format (if it is specified) Channel Data is defined as data originating from the High/Low/Last (HLL) Registers or the Acquisition Buffer The commands that initiate Channel Data output are the R, R#, U4, U5 and U13 command However, Channel Data may also be output as Engineering Units and Counts

Data output formats for command queries will follow the same rules as data input formatting As in the case of data input formats, all readings output will be in Engineering Units unless Counts is specified However, there are only 3 command queries which need to follow the F command format in this fashion They are C?, L? and U8 command queries

It also should be noted that readings are only converted to the specified engineering units if the associated channel type is a channel that supports those engineering units For example if the specified channel is a volts channel and the engineering units is 0 (degrees C), the reading will be interpreted as volts, not a temperature in degrees C

The following table shows the effect of the Data Formats command on readings input/output formats for the commands and queries over which it has control

READING FORMATS				
Command	**Engr. Units (0)**	**Binary (L/H) (1)**	**Binary (H/L) (2)**	**Counts (3)**
C	Engr Units	Engr Units	Engr Units	Counts
C?	Engr Units	Engr Units	Engr Units	Counts
L	Engr Units	Engr Units	Engr Units	Counts
L?	Engr Units	Engr Units	Engr Units	Counts
U8	Engr Units	Engr Units	Engr Units	Counts
U4	Engr Units	Binary (L/H)	Binary (H/L)	Counts
U5	Engr Units	Binary (L/H)	Binary (H/L)	Counts
U13	Engr Units	Binary (L/H)	Binary (H/L)	Counts

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R	Engr Units	Binary (L/H)	Binary (H/L)	Counts
R#	Engr Units	Binary (L/H)	Binary (H/L)	Counts

When Binary formats are specified, it should be noted that the HLL, Scan and Block terminator do not apply

INPUT DATA FORMATS				
	ENGINEERING UNITS	BINARY		**COUNT**
		Highbyte/Lowbyte	**Lowbyte/Highbyte**	
Temperature	°C *xxxx xx* °F *xxxx xx* °R *xxxx xx* °K *xxxx xx*	N/A	N/A	±*xxxxx*
Volts	±*xx xxxxxxxx*	N/A	N/A	±*xxxxx*
Time/Date	*hh mm ss t,mm/dd/yy*	N/A	N/A	N/A
Timebase	*hh mm ss t*	N/A	N/A	N/A
Legend.	where *x* = ASCII digit	where *h* = hours *m* = minutes *s* = seconds *t* = tenths *M* = months *D* = days *Y* = years		

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OUTPUT DATA FORMATS				
	ENGINEERING UNITS	**BINARY**		**COUNT**
		Highbyte/Lowbyte	**Lowbyte/Highbyte**	
Temperature	°C *xxxx xx* °F *xxxx xx* °R *xxxx xx* °K *xxxx xx*	*h/l*	*l/h*	±*xxxxx*
Volts	±*xx xxxxxxxx*	*h/l*	*l/h*	±*xxxxx*
Time/Date	*hh mm ss t,mm/dd/yy*	*hmstMDY*	*hmstMDY*	*hh mm ss t,mm/dd/yy*
Timebase	*hh mm ss t*	N/A	N/A	N/A
Legend.	where *x* = ASCII digit	where *h* = hours *m* = minutes *s* = seconds *t* = tenths *M* = months *D* = days *Y* = years	where *h* = high order byte *l* = low order byte	where *x*=ASCII digit

Refer to Section 3 7 of the Operations chapter for more examples of these data formats

Example

```
PRINT#1,   "OUTPUT07 F0,0X"                    ' Set the units to Degrees C and format to
                                               ' engineering

PRINT#1, "OUTPUT07, C1,1,-100 0,100 0,         ' Setpoints and hysteresis are interpreted as
1 0X"                                          ' degrees C

PRINT#1,   "OUTPUT07,   U4X"                   ' Retrieve High/Low/Last readings

PRINT#1,   "ENTER07"                           ' Returned readings are in engineering
                                               ' degrees C

LINE  INPUT  #2,  A$

PRINT  A$

PRINT  #1,   "OUTPUT07,F1,1X"                  ' Set the units to Degrees F and format to
                                               ' binary low/high
```


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```
PRINT #1, "OUTPUT07,C1,1,-100 0,100 0,      ' Setpoints and hysteresis are interpreted as
1 0X"                                       ' degrees F

PRINT  #1,  "OUTPUT07,U4X"                  ' Retrieve High/Low/Last readings

PRINT  #1,  "ENTER07"                       ' Returned readings are in binary low/high
                                            ' format

LINE  INPUT  #2,  A$

PRINT  A$
```


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Calibrate Channel Gain G

Type: Calibration

Execution: Immediate

`Gchannel,type`

Calibrate Channel Gain where `channel` is a channel number and `type` is the channel type both as specified in Chapter 7

The Calibrate Channel Gain command is used to calibrate the correction gain constants for a given slide-in card The channel gain value is necessary in order for the internal firmware to accurately interpret readings coming from the input channels This command will take the parameters channel number and the channel type and will calculate the gain based on the present channel input voltage

Note. To achieve correct results, this command must be issued twice. First with a negative input voltage and then with a positive input voltage. See Section 7 1 for details.

Each time the command has been issued, the precision voltage source must remain at its value until the trigger LED stops flashing

The channel type parameters are defined in Section 7 1

For a complete description for calibrating the TempScan/1000 see the section on calibrating the TempScan/1000

Example:

```
PRINT#1,   "OUTPUT07,K12345X"     ' Enter Calibration Mode
                                  ' Apply negative precision voltage
PRINT#1,   "OUTPUT07,G513,1"      ' Calculate negative gain for thermocouple card
                                  ' on slave 8, card 2
                                  ' Wait for command to complete
                                  (Refer to Section 7 1 1 4)
                                  ' Apply positive precision voltage
PRINT#1,   "OUTPUT07,G513,1"      ' Calculate positive gain for thermocouple card
                                  ' on slave 8, card 2
                                  ' Wait for command to complete
                                  (Refer to Section 7 1 1 4)
                                  ' Remove precision voltage
PRINT#1,   "OUTPUT07,EX"          ' End Calibration Mode
```


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Calibrate Channel Offset H

Type Calibration

Execution Immediate

`Hchannel`

Calibrate Channel Offset where `channel` is a channel number as specified in Section 7 1

The Calibrate Channel Offset command is used to calibrate the correction offset constants for a given slide-in card The channel offset values are necessary in order for the internal firmware to accurately interpret readings coming from the input channels This command will take the channel number as a parameter and calculate the offsets based on the present channel input voltage

Note. To achieve correct results, a precision voltage source of 0 0 millivolts must be applied to the desired channel before performing this command See Section 7 1.

After the command has been issued, the precision voltage source must remain at its value at least until the trigger LED stops flashing in order to achieve accurate results For a complete description for calibrating the TempScan/1000, see Chapter 7

Example

```
PRINT#1,   "OUTPUT07,K12345X"   ' Enter Calibration Mode
                                ' Apply precision voltage of 0 0 millivolts
PRINT#1,   "OUTPUT07,H513X"     ' Calculate offsets for slave 8, card 2
                                ' Wait for command to complete
                                  (Refer to Section 7 1 1 4)
                                ' Remove precision voltage
PRINT#1,   "OUTPUT07,EX"        ' End Calibration Mode
```


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Set Scan Interval I

Type· Acquisition

Execution: Deferred

`Inorm,acq`
: Sets the two configurable scan intervals of the TempScan/1000 where `norm` and `acq` are the normal and acquisition scan intervals which have the form

  `hh mm ss t` where 0<=hh<=23, 0<=mm<=59, 0<=ss>=59 and 0<=t<=9

`I?`
: Scan Interval Query can be used to query the two scan intervals at any time Response is `Inorm,acq` as described above

The TempScan/1000 has two distinct scan intervals The first is the "normal" scan interval The normal scan interval is used when the TempScan is collecting scans before the start trigger has occurred or after stop trigger has occurred Scans in these two regions are called pre-trigger scans and post-stop scans, respectively The second scan interval is the "acquisition" interval This scan interval is used when the TempScan is acquiring scans after the start trigger has occurred but before the stop event has occurred Scans in this region are referred to as post-trigger scans

The `norm` and `acq` arguments represent the normal and acquisition scan intervals, respectively

The `I` command is used to set these two scan intervals The scan interval can be set to run as fast as the current unit configuration will allow This is referred to as "fast mode" Each of the two scan intervals can be configured as such by specifying 00 00 00 0 as the argument for the desired scan interval

When the `I` command is interrogated by the TempScan, the TempScan will determine, by examining its current channel configuration, if it is capable of running at the desired interval If the TempScan determines that it is not capable of running at the desired interval it will automatically enable fast mode for the interval(s) in question It will also issue a Conflict Error to inform the user that it is not running at the user specified interval

The scan interval can be programmed from a 24 hour period to a 1 second period in increments of 1 second If a scan interval of zero is programmed, the interval will default to fast mode Likewise, if a scan interval is programmed less than the TempScan/1000 is capable of running at, the interval will default to fast mode

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Example

```
PRINT#1,                                  ' Set normal scan interval to once every
OUTPUT07,I01 00 00 0,00 00 00 0X          ' hour and acquisition interval to fast
                                          ' mode
PRINT#1,   OUTPUT07,I?X                   ' Query the current scan intervals

PRINT#1,   ENTER07                        ' Screen shows I01 00 00 0,00 00 00 0

LINE  INPUT  #2,  I$

PRINT  I$
```


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Calibrate Cold Junction Offset J

Type: Calibration

Execution: Immediate

`Jchannel,type,reference temperature`

Calibrate Cold Conjunction offset where channel is a channel number as specified in Section 7 1 3, type is the `channel` type and `reference temperature` is the temperature currently being applied to the selected channel

The Calibrate Cold Junction Offset command is used to calibrate the cold junction offsets for cold-junction compensation of the thermocouple signals Each thermocouple input channel has associated with it one of these temperature sensors Although calibrated at the factory, these temperature sensors are subject to component aging which may affect their accuracy as time goes on

The function of the Calibrate Cold Junction Offset command is to allow the adjusting of the internal firmware to compensate for the affects of component aging

The Calibrate Cold Junction Offset command accepts as parameters the channel with which to calibrate the sensor, the thermocouple type associated with the channel and the target temperature to which the sensor will be calibrated

Since there are four cold junction temperature sensors associated with 32 temperature input channels, it is necessary to select four channels Each channel is associated with one of the four cold junction temperature sensors in order to calibrate all cold junction temperature sensors on a given card

Note· Four separate channels on each card must be supplied with an accurate thermocouple signal of known warm junction temperature

The channel type parameter is the same channel type that is used with the Channel Configuration (C) command and must be in the range of 1-9

After the command has been issued, the applied thermocouple signal must remain at its value until the trigger LED stops flashing to achieve accurate results

For a complete description for calibrating the TempScan/1000, see Chapter 7

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Example

```
PRINT#1,   "OUTPUT07,K12345X"          ' Enter Calibration Mode
                                       ' Apply precision temperature
PRINT#1,   "OUTPUT07,J801,2,101 7X"    ' Compute cold junction offset for the
                                       ' temperature sensor associated with
                                       ' the type K thermocouple on channel
                                       ' 1 on slave 13, card 1 @ 101 7
                                       ' degree C
                                       ' Wait for command to complete
                                         (Refer to Section 7 1 1 4)
                                       ' Remove precision temperature
PRINT#1,   "OUTPUT07,EX"               ' End calibration mode
```


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Enter Calibration Mode K

Type: Calibration

Execution. Immediate

`Kkeyword`

Enter Calibration Mode if keyword is correct `keyword` is in the form nnnnnn where n is a single digit

`K?` Calibration Query returns `Kkeyword`, as defined above

The Enter Calibration Mode command places the TempScan/1000 into Calibration Mode While in Calibration Mode the TempScan/1000 may be calibrated using any of the defined calibration commands In addition, all other TempScan/1000 commands are valid during Calibration Mode However, if the TempScan/1000 is not in Calibration Mode, none of the defined calibration commands are valid and if these commands are issued to the TempScan/1000 an error condition will be generated

The K command requires, as a parameter, a pre-defined keyword This keyword must match the existing keyword definition in order to enter Calibration Mode If the keyword is not the correct keyword Calibration Mode will not be entered and no calibration commands processed

Note If the keyword becomes lost or forgotten a new keyword can be issued with the *K

Example.

```
PRINT#1,  "OUTPUT07,K12345X"          ' Enter Calibration Mode Keyword='12345'
PRINT#1,  "OUTPUT07,U2X"              ' Check for Keyword Error
PRINT  #1,  "ENTER07"
INPUT#2,  C%                          ' Get the Calibration Status Register
IF  (C%  AND  1)  THEN                ' Is there a keyword error?
PRINT,"ERROR--INVALID  KEYWORD
HALT                                  ' If so, stop execution
ENDIF
                                      ' Apply precision voltage of 0 0 millivolts
PRINT#1,  "OUTPUT10,H513X"            ' Calculate offset for slave 8, card 2
```


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```
                                    ' Wait for command to complete
                                      (Refer to Section 7 1 1 4)
                                    ' Wait until trigger LED stops flashing

                                    ' Apply negative precision voltage
PRINT#1,   "OUTPUT10,G513,1X"       ' Calculate negative gain for slave 8, card 2
                                    ' Wait for command to complete
                                      (Refer to Section 7 1 1 4)
                                    ' Apply positive precision voltage
PRINT#1, "OUTPUT10,G513,1X"         ' Calculate positive gain for slave 8, card 2
                                    ' Wait for command to complete
                                      (Refer to Section 7 1 1 4)
                                    ' Remove precision voltage
PRINT# 1, "EX"                      ' End Calibration Mode
```


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Set Trigger Level L

Type: Channel

Execution: Deferred

`Lchan,level,hyst`
: Set the level to be used when the start or stop trigger event is set to Trigger on Above Level or Trigger on Below Level `chan` (1<=`chan` <=992) is the channel on which to test the level condition `level` is the level which readings are tested against to determine if the level has been exceeded The `hyst` value is hysteresis value to be associated with the specified level

`L?`
: Query Trigger Level may be used to query the current level setting Response is `Lchan,level,hyst` where `chan,level` and `hyst` are defined as above

This command simply sets the level against which the testing of channel readings should be performed The Trigger Configuration (T) command should be used to configure whether the level condition should be tested for going above the specified level or below the specified level Note this command is only valid for trigger start/stop events of T4 and T5

The level is the value, which, if exceeded (by going above or below it as defined), should generate a trigger event The hysteresis value is the value that, in aggregate with the level, is used to test whether the level condition still persists The level condition will persist until the channel readings no longer exceed the level as specified Further, in order to come out of the level condition, the channel readings must not exceed the aggregate of the level and hysteresis values

The format for the `level` and `hyst` arguments follow the rules for readings input defined under the Format (F) Command and in Section 3 7

Example

```
PRINT#1,   "OUTPUT07,F0,0X"          ' Set the format to be degrees C in
                                     ' engineering format

PRINT#1,                             ' Set the level channel to be channel
"OUTPUT07,L1,1000 0,10 0X"           ' 1 at a level 1000 0 degrees C with a '
                                     hysteresis of 10 0 degrees C

PRINT#1,   "OUTPUT07,L?X"            ' Read the current level setting

PRINT#1,   "ENTER07"                 ' The screen shows L001,+1000 0,+0010 0

LINE  INPUT  #2,  L$

PRINT  L$

PRINT#1,   "OUTPUT07,T4,5,0,0X"      ' Set the TempScan to start on channel
                                     ' going above the level and to stop on
                                     ' the channel going below the level
```


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SRQ Mask M

Type System

Execution Deferred

Mnnn	SRQ Mask Query uses the IEEE 488 Service Request (SRQ) mechanism to inform the IEEE 488 bus controller of the following conditions
M000	Power-on Default Mask Value
M001	SRQ on Alarm
M002	SRQ on Trigger Event
M004	SRQ on Ready
M008	SRQ on Scan Available
M016	SRQ on Message Available (MAV)
M032	SRQ on Event Detected
M128	SRQ on Buffer Overrun
M?	SRQ Mask Query Response is Mnnn where nnn is one of the condition codes

The SRQ Mask command uses the IEEE 488 Service Request (SRQ) mechanism to inform the IEEE 488 bus controller of the existence of several conditions These conditions are described in detail below Multiple conditions can be enabled simultaneously If multiple conditions are contained within the same command string, each SRQ Mask command should be proceeded by an Execute (X) command The resulting SRQ Mask register value is the logical ORed value of the individual values sent Alternately, the entire value of all the desired conditions may be sent within one SRQ Mask command The programmed SRQ Mask remains enabled until the receipt of a M0 command or the detection of a Device Clear (DCL) or Selected Device Clear (SDC)

Mnnn	SRQ Mask Query uses the IEEE 488 Service Request (SRQ) mechanism to inform the IEEE 488 bus controller of the existence of several conditions These conditions are described below
M000	This is the power-on default mask value It disables the TempScan/1000 from generating service requests by clearing the entire mask to zero
M001	SRQ on Alarm Sending this command will enable the TempScan to generate an SRQ when it has recognized that one or more channels has gone into alarm condition (See the C command on how to configure an alarm condition)
M002	SRQ on Trigger Sending this command allows the TempScan/1000 to generate a service request when it has detected a valid trigger from the programmed trigger source

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`M004` SRQ on Ready This command causes a service request to be generated when the TempScan/1000 has completed executing a set of commands from the IEEE 488 bus controller This is used to allow the bus controller to attend to other bus matters while the TempScan/1000 is changing its internal state

`M008` SRQ on Scan Available Sending this command will cause the TempScan to generate an SRQ when at least one scan is available to be read in the acquisition buffer

`M016` SRQ on Message Available (MAV) Sending this command will cause the TempScan to generate an SRQ when there is data available in the output queue to be read

`M032` SRQ on Event Detected Sending this command will cause the TempScan to generate an SRQ when at least one of the defined events (See the `N` command on how to define events) in the Event Status Register has occurred

`M128` SRQ on Buffer Overrun Sending this command will cause the TempScan to generate an SRQ when it has detected that an overrun of the acquisition buffer has occurred

Example:

```
PRINT#1, "OUTPUT07,M0X"          ' Clear the SRE
PRINT#1, "OUTPUT07,M1 X  M2 X"   ' Set the TempScan to SRQ on Alarm or
                                   Trigger
PRINT#1, "OUTPUT07,M?X"          ' Read the current SRE
PRINT#1, "ENTER07"               ' Computer screen shows M003
LINE  INPUT  #2,  M$
PRINT  M$
```


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Event Mask N

Type System

Execution Deferred

N0	Clear Event Mask
N1	Acquisition Complete
N2	Stop Event
N4	Query Error
N8	Device Dependent Error
N16	Execution Error
N32	Command Error
N64	75% Buffer Full
N128	Power On
N?	Event Mask Query Response is Nnnn where nnn is where (n>=000, n<=255)

This command directly sets the Event Status Enable Register (ESE) ESE determines which conditions in the Event Status Register (ESR) are enabled to generate Event Status register Bit (ESB) in the Serial Poll Status Register See Section 3 10 on the TempScan/1000 Serial Poll Model for complete details

N0	Multiple ESR bits can be enabled simultaneously by issuing them separately or by combining them in one command string The programmed event enables remain set until a Clear Event Mask (N0) command is sent or the controller sends a *R command
N1	Sending the Acquisition Complete (N1) command allows the setting of the ESB if the TempScan has determined that the configured acquisition has completed
N2	Sending the Stop Event (N2) command allows the setting of the ESB when the pre-defined stop event of a configured acquisition has occurred
N4	A query error (N4) is set when an attempt is made to read data from the output queue when no data are present or data in the output queue were lost Data may be lost when too many data are requested to be buffered in the queue (for example, issuing multiple commands to return data without ever reading them)
N8	A device dependent error (N8) is set when a conflict in programmed parameters is detected This is also referred to as a conflict error
N16	An execution error (N016) is set when a parameter exceeds valid limits for a particular command This is also referred to as Invalid Device Dependent Command Option (IDDCO) error

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N32	A command error (N032) is set when an illegal command is sent to the TempScan/1000 This is also referred to as Invalid Device Dependent Command (IDDC) error
N64	A Buffer 75% Full Sending the N64 command will allow the setting of the ESB when the TempScan has determined that the acquisition buffer is at least 75% full
N128	A power on (N128) is set whenever TempScan/1000 is first powered up or a *R is issued

Example:

```
PRINT#1,  "OUTPUT07,N0  X"     ' Clear the ESE
PRINT#1,  "OUTPUT07,N?  X"     ' Read ESE
PRINT#1,  "ENTER07"            ' Computer screen shows N000
LINE  INPUT  #2,  N$
PRINT  N$
PRINT#1,  "OUTPUT07,N1N2X"     ' Set enable ESB setting on pre-trigger count
                               ' satisfied or acquisition complete
PRINT#1,  "OUTPUT07,N?  X"     ' Read ESE
PRINT#1,  "ENTER07"            ' Computer Screen shows N003
LINE  INPUT  #2,  N$
PRINT  N$
PRINT#1,  "OUTPUT07,M32  X"    ' Set SRQ on Event Detected (ESB) SRQ will
                               ' now be generated when pre-trigger count is
                               ' satisfied or the acquisition completes
```


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Set Digital Outputs O

Type System

Execution Immediate

`Obank1,bank2,bank3,bank4`
Set Digital Outputs will set the digital outputs or output range where each argument is a bit map of the corresponding 8-bit bank (`0 <= bankn <= 255, bankn = 999`)

`O?` Digital Output Query returns the current state of the digital output as `Obank1,bank2,bank3,bank4`

The Set Digital Outputs command may be used to force any of the 32 digital outputs (separated into four 8-bit banks) on the TempScan/1000 to a certain setting

The bank to digital output mapping is as follows

Bank	Digital Output
1	1-8
2	9-16
3	17-24
4	25-32

Each argument represents the desired bit mapping for the corresponding bank of digital outputs The argument is a decimal number, which, when converted to binary format is the desired settings for that bank of digital outputs For example, an argument of 201 for bank2 would be interpreted in binary as 11001001 (with '1' as active high and '0' as active low) This would affect the digital outputs of bank 2 as follows

Digital Outputs							
9	10	11	12	13	14	15	16
high	high	low	low	high	low	low	high

It should be noted that the setting of a bank will force the digital outputs to the specified setting regardless of the current state of the digital outputs (such as if an alarm has been assigned to the output)

If it is desired to not affect a certain bank (maybe because it is being used for alarm outputs), a value of 999 can be used for the argument for that bank This will effectively 'mask off' that bank from being updated

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The TempScan/1000 has eight digital input lines and thirty-two digital output lines available on a rear panel DB50 connector The digital output can be controlled either "automatically" via the alarm settings or manually using the Set Digital Outputs (O) command To determine the digital output state, use the U Status commands

The Set Digital Outputs (O) command allows the user to enter an output range and specify whether the output should be cleared (logic false) or set (logic true) This command will force the specified digital output to the specified condition A "1" will drive the corresponding digital output(s) high Likewise a "0" will drive the corresponding digital output(s) low

Each digital output line will drive five (5) standard TTL loads All digital input lines are one-eighth (0 125) TTL loads All inputs are protected against damage from high static voltages Normal precautions should be taken to limit the input voltages to –0 3 to +5 3 volts All digital I/O lines are referenced to digital ground (Pin 20) The pinouts of the TempScan/1000 Digital I/O connector are described in Section 2 7 2 of the Installation chapter

Example:

```
PRINT#1,  "OUTPUT07,O?X"          ' Get the current state of the digital outputs
PRINT#1,  "ENTER07"               ' Screen shows O128,255,065,024
LINE  INPUT  #2,  N$
PRINT  N$
PRINT#,                           ' Set banks 1,3 and 4
"1OUTPUT07,O0,999,76,234X"
PRINT#,  "1OUTPUT07,O?X"          ' Get the current state of the digital outputs
PRINT#1                           ' Screen shows O000,255,076,234 (note
                                  ' that bank 2 did not change)
LINE  INPUT  #2,  O$
PRINT  O$
```


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Program Trigger Times P

Type Channel

Execution Deferred

`Pstart,stop`
: Program Trigger Times where `start` and `stop` are the start and stop absolute times, respectively and who have the format of the standard time/date stamp (H MM SS TempScan/1000,mm/dd/yy) as described in section 3 6 2

`P?`
: Programmed Time Query provides the current start and stop times in the form `Pstart,stop`

The Program Trigger Times command may be used to set the trigger start and/or stop times for an acquisition that is configured for start and/or stop on Absolute Time as configured by the Trigger Configuration (T) command

The Program Trigger Times command is to be used in concert with the Trigger Configuration command when it is desired to begin and/or stop an acquisition on certain times and/or dates The values of the start and stop times are only used when the start and/or stop events have been configured for Absolute Time

If only the start time is needed the `stop` argument should be set to 00 00 00 0,00/00/00 Likewise if only the stop time is needed the `start` argument should be set to 00 00 00 0,00/00/00

In addition to the ability to start/stop on a particular time/date the TempScan has the ability to stop/stop at a particular time, independent of the date If the date for the start/stop time is of no concern then the date portion of the time/date field should be set to 00/00/00 In this way the TempScan can start or stop an acquisition at a particular time regardless of the date This feature is particularly useful when using the auto-rearm feature of the TempScan since it will allow the collection of data at a particular time each day without user intervention

Example

```
PRINT#1, "OUTPUT07, S12 54 00 0,01/01/93X"

                                    ' Set the TempScan/1000S internal
                                    clock
PRINT#1, "OUTPUT07, P01 00 00,0,01/01/93,02 00 00 0,01/01/93X"

                                    ' Set start(1 00 am) and stop(2 00 am)
                                    acquisition times
PRINT#1, "OUTPUT07, T9,9,0,0X"      ' Configure for start/stop on Absolute
                                    Time
```


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Query Terminator Q

Type: System

Execution. Deferred

`Qresponse,hll,scan,block,separator`
Set the query terminators with the parameters described below

`Q?` Terminator Query will query the terminator settings where the response has the form `Qresponse,hll,scan,block,separator`

The Query Terminators command is used to set the query terminators, where `response` is response terminator for general purpose queries issued by the controller These queries are queries that do not request High/Low/Last or Acquisition Buffer data This terminator is used in all query responses unless the query references data in the High/Low/Last registers or the Acquisition Buffer These types of queries have separate terminators as described below

The `hll` argument specifies the channel terminator to be used for queries which request data residing in the High/Low/Last registers When this terminator is specified the terminator will be inserted between each channels response when a High/Low/Last register query request is made The queries that request High/Low/Last register data are `U4`, `U5`, `U13`, `R#`

The `scan` argument specifies the terminator which will follow each scan that is output when a query request is made for Acquisition Buffer data When a query request is made for Acquisition Buffer data this terminator will be used to terminate each scan as it is output to the interface This will be true except for the last scan in the block In this case the trigger block terminator (see below) will be used to terminate the scan and the block The only query command which requests Acquisition Buffer data is the `R` command

The `block` argument specifies the terminator which will follow each trigger block that is output when a query request is made for Acquisition Buffer data When a query request is made for Acquisition Buffer data this terminator will be used to terminate each trigger block as it is output to the interface This terminator will be in effect during Read Buffer Data commands (R) commands It should be noted that the last scan in the trigger block to be output will be terminated by the defined trigger block terminator rather than the scan terminator

Each of the above arguments may be defined as follows

Type	IEEE-488	Serial
0	None	None
1	CR LF/EOI	CR LF
2	CR LF	CR LF
3	LF CR/EOI	LF CR
4	LF CR	LF CR

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5	CR/EOI	CR
6	CR	CR
7	LF/EOI	LF
8	LF	LF
9	USER/EOI	USER
10	USER	USER

Where Type is the argument and where USER is the user defined terminator as defined by the User Terminator (V) command

The fifth argument, `separator`, specifies whether or not a separator character should be placed between each returned reading in the buffer scan data This field will be in effect during Read Buffer Data (R) commands The value of this field is interpreted as follows

0 - Place no separators in returned buffered scan data when it is read

1 - Place a separator, whose value is determined by the current User Terminator (V command) setting into the returned buffer data when it is read

The following table summarizes terminator usage with all possible commands in ASCII mode No terminators are used in binary mode

Command	Response	HLL	Scan	Block	Separator
R1X			X		o
R2X			o	X	o
R3X			o	X	o
R#nX			X		
R#n-mX		o	X		
U4X		o	X		
U5X		o	X		
U13X		o	X		
All others	X				

Legend **X** - the terminator is asserted at the end of the response
o - the terminator is asserted within the reponse to separate channel and scan readings
if blank - the terminator does not affect the command

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Example.

```
PRINT#1,"OUTPUT07,C1-4,1X"        ' Configure four channels (Type J)
PRINT#1,"OUTPUT07,F0,0X"          ' Configure Engr Units Degrees C
PRINT#1,"OUTPUT07,Q7,7,0,0,0X"    ' Set the normal and the HLL terminators to
                                  LF/EOI and the scan and block terminators
                                  to None
PRINT#1,"OUTPUT07,Q?X"            ' Get the current query terminators
PRINT#1,"ENTER07"                 ' Screen shows Q07,07,00,00,00
PRINT#1,"OUTPUT07,U13X"           ' Request the Last readings
PRINT#1,"ENTER07"                 ' Get reading for channel 1
INPUT#1  A$                       ' Screen shows +0104 20
PRINT#1,"ENTER07"                 ' Get reading for channel 2
INPUT#1  A$                       ' Screen shows +0010 40
PRINT#1,"ENTER07"                 ' Get reading for channel 3
INPUT#1  A$                       ' Screen shows - 0064 10
PRINT#1,"ENTER07"                 ' Get reading for channel 4
INPUT#1  A$                       ' Screen shows +0006 30
PRINT#1,"OUTPUT07,Q7,7,0,0,0X"    ' Set the response  to LF/EOI
                                  ' and the HLL, scan and block terminators
                                  to None
PRINT#1,"OUTPUT07,U13X"           ' Request the Last readings
PRINT#1,"ENTER07"                 ' Get readings for channels 1-4  Screen
                                  shows
+0104 20
+0010 40
-0064 10
+0006 30
```


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Read Buffered Data R

Type Buffer

Execution. Deferred

`Rtype`	Read scan data from the acquisition buffer where `type` is the type of data request being made
`R?`	Query the Data Buffer returns the contents of the data buffer as defined above

The Read Buffered Data command may be used to extract scan data from the acquisition buffer

The type argument may be defined as follows

1 - Read the oldest scan currently residing in the acquisition buffer

2 - Read the oldest complete trigger block currently residing in the acquisition buffer

3 - Read all the scan data that currently resides in the acquisition buffer

This command may only be used to extract data from the acquisition buffer which has been collected as a result of an acquisition that has been previously configured (See the Trigger Configuration (T) command in this section)

Since the buffer of the TempScan/1000 is organized as a FIFO, the Read Buffer Data command will always read the oldest data available in the buffer first As the controller requests buffer scan data, the TempScan/1000 supplies the oldest available scan After the scan is supplied, that scan is no longer available As scan data is read from the acquisition buffer the data is removed from the buffer and, thereafter, may not be reference or read

These commands operate as follows When a Read Buffer Data (R) command is interpreted the requested scan data (if it exists) is moved, one scan at a time, from the Acquisition Buffer to the output queue where it will wait in state until the user removes it Once the data is removed from the output queue, the next Read Buffered Data command may be issued

For each of these commands, if the appropriate amount of scan data is not in the acquisition buffer at the time these commands are issued a Conflict Error will result

The Scan Available bit in the Status Byte (STB) register may be queried or Serial Polled to determine if there is any buffer scan data available For a more complete description of how much data is available in the acquisition buffer at any particular time the U6 (Buffer Status String) command may be issued

The Set Query Terminators (Q) command determines the format for the terminators for acquisition buffer data For additional information regarding the acquisition buffer terminators see the Set Query Terminators (Q) command in this section

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Example:

```
S% = 0                              ' Wait for a scan
While (S% and 8) = 0
PRINT#1 "SPOLL07"
INPUT#2, S%
WEND
PRINT#1,"OUTPUT07,R1X"              ' Get the scan
PRINT#1,"ENTER07"
LINE INPUT#2, A$
```


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Read Last Readings R#

Type System

Execution Deferred

`R#chans`

Queries Last reading from the HLL Registers for specified channel(s), `chans` is the desired channel or range of consecutive channels to read

The Read Last Readings command allows the user to query the Last reading from the HLL Registers for specified channel(s) The chans argument may have the form

`chans`	For a single channel (where 1 <= `chans` <= 992)
`firstno-lastno`	For a range of channels (where 1 <= `firstno,lastno` <= 992)

This command will return a subset of the Query Last (U13) command It allows the specifying of specific channels within the current channel configuration This command is useful for querying specific channels without having unwanted channels returned The response to this command takes the same form as the U13 command, whereby each reading conforms to the reading output format specified by the Data Format (F) command In addition, each channel is terminated by the HLL terminator as specified with the Q command

If the specified channel, or a range of channels, is not currently defined in the scan group as configured by the Channel Configuration (C) command a Conflict Error will be flagged

Example:

```
PRINT#1,"OUTPUT07,C1-32,1X"          ' Configure channels 1-32 for TC Type J
PRINT#1,"OUTPUT07,F1,0X"             ' Set format for engineering units degrees F
PRINT#1,"OUTPUT07,R#32X"             ' Get the Last reading for channel 32
PRINT#1,"ENTER07"                    ' Screen shows
+0103 20                             ' (channel 32 is 103 2 C)
LINE  INPUT  #2,  R$
PRINT  R
PRINT#1,"OUTPUT07,R#1-4X"            ' Get the Last readings for channels  1-4
PRINT#1,"ENTER07"                    ' Screen shows
-0003 70+0005 60+0010 20+0024 40     ' (channel 1 is -3 7 C, channel 2 is 5 6 C,
                                     ' channel 3 is 10 2C,
LINE  INPUT  #2,  R$
PRINT  R#
```


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Set Real Time Clock S

Type: System

Execution: Immediate

`Stime` Set Real Time clock where `time` is the desired setting for the current time and date

`S?` Real Time Clock Query returns `Stime` where time will have the format as specified for the standard time/date stamp output format

The Set Real Time Clock command is used to set the TempScans internal real-time clock The time argument follows the same format as the standard time/date stamp input format as specified in Section 3 7 2

The Set Real Time Clock command is used to set the battery backed internal real-time clock of the TempScan/1000 In order for the time/date stamped data to be accurate, the internal real-time clock must be set to an accurate time/date Once set, however, the battery-backed real-time clock will remember the current time, even when powered-off

Example:

```
PRINT#1, "OUTPUT07, S 14 00 00 0, 4/30/93X"   ' Current date and time
```


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Trigger Configuration T

Type Acquisition

Execution Deferred

`Tstart,stop,re-arm,sync`
: Trigger Configuration is used to configure an acquisition of scan data where `start` and `stop` arguments are the start and stop events, respectively, for the acquisition The `re-arm` argument is a flag to determine if the unit should continue acquiring after the first acquisition completes And the `sync` argument is a flag which determines if the TempScan should synchronize the acquisition events with the internal timebases (see `I` command)

`T?`
: Trigger Configuration Query returns `Tstart,stop,ream,sync` where `start,stop,ream` and `sync` as described above

The Trigger Configuration command is used to configure an acquisition of scan data `start` and `stop` arguments are the start and stop events, respectively, for the acquisition The valid values of the `start` and `stop` arguments are defined below The `re-arm` argument is a flag to determine if the unit should continue acquiring after the first acquisition completes And the `sync` argument is a flag which determines if the TempScan should synchronize the acquisition events with the internal timebases (see `I` command) Both the `re-arm` and `sync` arguments are flags and, as such, require a '1' to turn the given feature on and a '0' to turn the given feature off

The start acquisition event determines the way in which an acquisition is signaled to begin Likewise, the stop acquisition event determines the way in which an acquisition is signaled to terminate This signal to stop or start on a certain event will, at times, be referred to as a "trigger" There are a number of ways to define these events/triggers The valid acquisition events are defined as follows

Start/Stop Trigger Definitions

Trigger Type	Event/Trigger
0	None - Event Not Defined
1	Trigger on Command(See "@" command)
2	Trigger on GET (IEEE-488 only)
3	Trigger on Talk (IEEE-488 only)
4	Trigger on Channel Above Level (L command)
5	Trigger on Channel Below Level (L command)
6	Trigger on TTL Signal Rising
7	Trigger on TTL Signal Falling

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8	Trigger on Count (Y command)
9	Trigger on Alarm Turning On (C command)
10	Trigger on Alarm Turning Off (C command)
11	Trigger on Absolute Time (P command)

The Trigger Configuration command is the central command which controls how an acquisition is to be configured Upon execution of this command the TempScan enters the acquiring mode This will be indicated on the front panel by the flashing of the TRIGGER light If a pre-trigger has been configured (via the Y command), then the sampling for pre-trigger data will begin at this time

Since the Trigger Configuration command controls the configuration of an acquisition all other acquisition dependent commands should be sent before the Trigger Configuration command is sent to the TempScan The commands which should be sent to the TempScan prior to the Trigger Configuration command will depend on the desired start and/or stop triggers For instance, if configuring for Trigger on Command it would not be necessary to send the Set Trigger Level (L) command The following is list of trigger types and their associated required prior issue commands

Trigger Type	**Pre-Trig/Post Stop**	**Required Prior Issue Commands**
1	yes	I,Y
1	no	I
2	yes	I,Y
2	no	I
3	yes	I,Y
3	no	I
4	yes	I,Y,L
4	no	I,L
5	yes	I,Y,L
5	no	I,L
6	yes	I,Y
6	no	I
7	yes	I,Y
7	no	I
8	--	I,Y

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9	yes	I,Y,C,A (A is optional)
9	no	I,C,A (A is optional)
10	yes	I,Y,C,A (A is optional)
10	no	I,C,A (A is optional)
11	yes	I,Y,P
11	no	I,P

It should be noted that if the start and stop triggers are of different types, a combination of the start and stop prior issue commands is required

The Trigger Configuration Command is used to configure the manner in which scans are to be acquired It sets the sources to determine when an acquisition is to be initiated and when it is to be terminated It also determines how these acquisition sources are to be (if at all) synchronized with the internal scan intervals (`I` command) Likewise, it may allow the acquisition to re-enable itself (with the same configuration) after the initial acquisition has been terminated

The first parameter, `start`, defines the event that is to take place in order for the TempScan/1000 to begin acquiring scans This event is referred to as the Start Trigger When the TempScan/1000 has recognized that a Start Trigger has been encountered it will begin acquiring scans at that point The first of these scans, the Start Trigger scan, will be time/date stamped for later reference Also, when the Start Trigger is recognized the Triggered Bit (02) of the Status Byte will be set and the TRIGGER light on the front panel will turn on

The second parameter, `stop`, defines the event that is to take place in order for the TempScan/1000 to stop acquiring scans This event is referred to as the Stop Trigger When the TempScan/1000 has recognized that a Stop Trigger has been encountered it will stop acquiring scans at that point (unless post-stop count is defined, see `Y` command) The last scan collected, the StopTrigger scan, will be time/date stamped for later reference Also, when the Stop Trigger is recognized the Trigger Bit (02) of the Status Byte will be cleared and the TRIGGER light on the front panel will turn off

The third parameter, `re-arm`, determines if, after the initial acquisition, the acquisition should be re-enabled automatically If this parameter is set then after the Stop Trigger is recognized and the acquisition terminated a new acquisition (with the same configuration) will be enabled automatically In other words, after the termination of the previous acquisition the TempScan/1000 will immediately begin another acquisition of the same configuration Otherwise, if the parameter is not set, new acquisitions will remain disabled after the initial acquisition has terminated

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The fourth parameter, `synchronization`, determines if the Start Trigger should be synchronized with the internal Pre-Trigger Scan Interval (`I` Command) value If the Pre-Trigger Count (`Y` Command) is defined this parameter will be examined to determine if the Start Trigger should be synchronized with the internal Pre-Trigger Timebase Interval If so, then the Start Trigger, regardless of what point in time it occurred, will be synchronized with the next occurrence of the Pre-Trigger Scan Interval 'tick' In other words, if the real Start Trigger occurs between Pre-Trigger Scan Interval 'ticks' then the acquisition will not begin until the next 'tick' of the Pre-Trigger Scan Interval Otherwise, the acquisition will begin as soon as the Start Trigger is encountered

Setting the `start` parameter to 0 will disable the acquiring of scan, this may be performed at any time during or after an acquisition The `start` parameter will automatically be set to 0 upon the termination of an acquisition unless the `re-arm` flag is set to 1

Setting the `stop` parameter to 0 will have the same effect as setting the `stop` parameter to 1 (Stop on Count) with Post-Stop Count (`Y` Command) set to 0 In both cases, the Start Trigger scan will be collected and the acquisition immediately terminated

Example.

```
PRINT#1,   "OUTPUT07,   I12 00 00 0,00 01 00 0X"
                                        ' Collect scans once every 12 hours then
                                        when Start Trigger occurs collect them
                                        once every minute
PRINT#1,   "OUTPUT07,Y100,10000,0X"
                                        ' Set pre-trigger count to 100, post-trigger
                                        count to 10000 and define no post-stop
                                        count
PRINT#1,   "OUTPUT07,T1,7,0,1X"         ' Start Trigger on @ command, Stop
                                        Trigger on post-trigger count (10000) and
                                        synchronize the Start Trigger to the pre-
                                        trigger timebase interval
PRINT#1,   "OUTPUT07,@X                 ' Issue Start Trigger (acquisition may
                                        begin as much as 12 hours from now
                                        because we synchronized with pre-trigger
                                        timebase interval)
```


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User Status U

Type System

Execution Immediate

`Urequest`

Provides information about internal conditions to the TempScan and makes them available to the user where `request` is an integer number describing the requested information

Status commands are used to return information about various conditions of the TempScan/1000 Refer to the table below for a description of the possible request types

REQUEST TYPE	DESCRIPTION
U0	Query and clear Event Status Register (ESR)
U1	Query the Status Byte Register (STB)
U2	Query and clear Calibration Status Register (CSR)
U3	Query system settings
U4	Query current High/Low/Last registers
U5	Query and clear current High/Low/Last
U6	Query Buffer Status String
U7	Query assigned alarm outputs
U8	Query configured channels
U9	Query digital inputs
U10	Query memory option (in Kbytes)
U11	Query current alarm channels
U12	Query last calibration time/date
U13	Query last scan read
U14	Query card IDs
U15	Query product information

The status of the TempScan/1000 may be read at any time without interfering with normal operation Any error conditions, except Calibration Errors, are cleared after the status string is read by the controller Calibration errors are cleared when the TempScan/1000 is calibrated

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Status strings are returned when the TempScan/1000 is next addressed to Talk The terminators used and the use of the End or Identify (EOI) line can be changed with the Q and V commands

If the TempScan/1000 is configured to trigger on TALK, requesting a status report will not cause the TempScan/1000 to trigger

The following paragraphs provide more detailed information about the U responses

U0 Reads and clears the Event Status Register (ESR) (See Section 3 9 for details on status reporting) It responds with

001 - Acquisition Complete
002 - Stop Event
004 - Query Error
008 - Device Dependent Error
016 - Execution Error
032 - Command Error
064 - 75% Buffer Full
128 - Power-On

U1 Read the Status Byte register (STB) The response to this request is the same as in an IEEE-488 Serial Poll except that bit 6 carries the Master Summary Status (MSS) rather than the Request for Service The Status Byte register is a read-only register whose bits correspond to those of the Service Request Enable (SRE) register with the addition of bit value 64 which responds with the Master Summary Status The Master Summary Status bit indicates whether or not this device needs service It responds with

001 - Alarm
002 - Triggered
004 - Ready
008 - Scan Available
016 - Message Available
032 - Event Detected
128 - Buffer Overrun

U2 Read and clear the Calibration Status Register (CSR) The response to this request is the current contents of the Calibration Status Register This register contains information regarding the calibration of the TempScan and any errors encountered while attempting to calibrate the unit It responds with

001 - Invalid Calibration Keyword
002 - Invalid Calibration Command
008 - Calibration Gain Error (Gain > or = 2)
128 - In Calibration Mode (Cleared only by the E command)

U3 Query the current system settings This command responds with the equivalent of the following

F?I?L?P?Q?S?T?Y?

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U4 Reads the current High/Low/Last data for all configured channels Refer to Section 3 7 2 for the format of the High/Low/Last response

U5 Reads and resets the High/Low/Last data This command performs exactly like the U4 command except that it clears out the current High and Low readings for all of the configured channels

U6 Reads the Buffer Status String The buffer status string contains current information regarding the current state of the acquisition buffer

The current status of the acquisition buffer may be interrogated at any time by issuing the Buffer Status String (U6) command As mentioned earlier, the U6 command is a user query command which will return information regarding the current state of the acquisition buffer The acquisition buffer holds scan data that has been initiated by one or more trigger events This data is held in trigger blocks within the buffer Each trigger block defines one acquisition that has taken place The trigger blocks may be variable in length The Buffer Status String command provides the interface in which the current acquisition buffer configuration may be queried

The Buffer Status String (U6) command returns the following fields

Blocks Available	This field represents the total number of blocks currently contained within the buffer The total represents the total number of blocks that have been triggered A block need not be complete to be included in this total, it only needs to be triggered This field also represents the number of trigger blocks that the read block is behind the current write block If there are no blocks available, then Blocks Available will be 0000000
Scans Available	This field represents the total number of scans available at the the time the U6 command was issued It should be noted that pre-trigger data is not available to the user until the defined trigger event has taken place This total represents the total number of scans available across all blocks in the acquisition buffer If there are no scans available in the buffer, then Scans Available will be 0000000
Current Read Pointer	This field represents the current position within the current read block This pointer is relative to the trigger point which is always oriented at location 0 In other words if, currently, pre-trigger scans are being read the Current Pointer will be less than 0 Likewise, if post-trigger scans are currently being read the Current Read Pointer will be greater than 0 If the current scan to be read is the trigger scan, then the Current Read Pointer will be 00000000 If the Current Read Pointer is undefined its value will be -0999999

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Trigger Time Stamp	This field represents the Time/Date that the trigger event occurred for the current read block This field takes on the same format as other time/date stamp fields described elsewhere in this manual If the trigger event has not occurred, then this field will have the value 00 00 00 00,00/00/00
Stop Scan Pointer	This field represents the location in the current read block that the stop event occurred This pointer will always be relative to the trigger point with the trigger point always oriented at location 0 Since the stop event must always occur after the trigger event this pointer will always be greater than 0 If the stop event has not yet occurred at the time of the U6 query, this field will have the value of -0999999
Stop Time Stamp	This field represents the Time/Date that the stop event occurred for the current read block This field takes on the same format as other time/date stamp fields described elsewhere in this manual If the stop event has not yet occurred at the time of the U6 query, then this field will have the value 00 00 00 00,00/00/00
End Scan Pointer	This field represents the location in the current read block that the end scan occurred This pointer will always be relative to the trigger point with the trigger point always oriented at location 0 Since the end scan must always occur after the trigger event this pointer will always be greater than 0 If the end scan has not yet occurred at the time of the U6 query, this field will have the value of -0999999 This field will always be the same as the Stop Scan Pointer unless a post-stop count is specified (Y command) in which case the End Scan Pointer will be greater than the Stop Event Pointer by the value of the post-stop count
Block Status	This field represents the status of the current read block If the current read block is not yet completely written then the value of this field will be 00 If the current read block has been completely written and has terminated normally the value will be 01 If, however, the current read block has prematurely terminated (because of user intervention) the value will be 02

It should be noted that trigger blocks are not assigned a trigger block number per se The trigger block numbers referred to in the U6 examples (in chapter 3) are relative to the read and write blocks, respectively

U7 Returns the input channel to digital output channel assignments in the form A? Achan, output for each channel that is currently assigned to a digital output

U8 Reads the current configuration settings for each channel configured in the TempScan This command returns the same information in as the C? command except that it returns it for all channels which are configured

U9 Read the Digital Inputs This command will read the current state of the digital inputs This function is performed by reading each of the eight digi-

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tal inputs converting each input to a binary (high is 1 and low is 0) and converting that aggregate binary 8-bit number into a decimal number The decimal number is then returned as the response The response has the form (000 <= response <= 255)

U10 Queries the installed memory option This command will return the amount of memory installed (in Kbytes)

The possible responses are

```
00256 - 256Kbyte option
01024 - 1 Meg option
04096 - 4 Meg option
08192 - 8 Meg option
```

U11 Queries any channels that may be in alarm condition The response is simply the number (in a 3 byte format) which is in alarm condition For example a response may be

```
001,008,013,026,812,990
```

U12 Reads the last calibration time/date stamp The response is the '#' (to distinguish it from other time/date stamps) appended with the time/date of the last calibration For example

```
#12 31 01 20,04/24/93
```

U13 Queries the last scan read

U14 Queries the card types defined in the system Returns the card ID for all 31 possible cards in the system Valid card IDs are

-1 - card not installed

0 - TC card

1 - Volts card

2 - RTD card

NOTE This command can only be issued when all channels are in an unconfigured state If any channel is configured, the system will issue a command conflict error in response to the U14 command

U15 Queries the product information The response to this command is the current product information including revision levels A typical response may be

```
IOtech,  TempScan1000,  1 0
```

U18 Queries the acquisition states and various system flags Returns an integer value <255 The bit mapping of the response is

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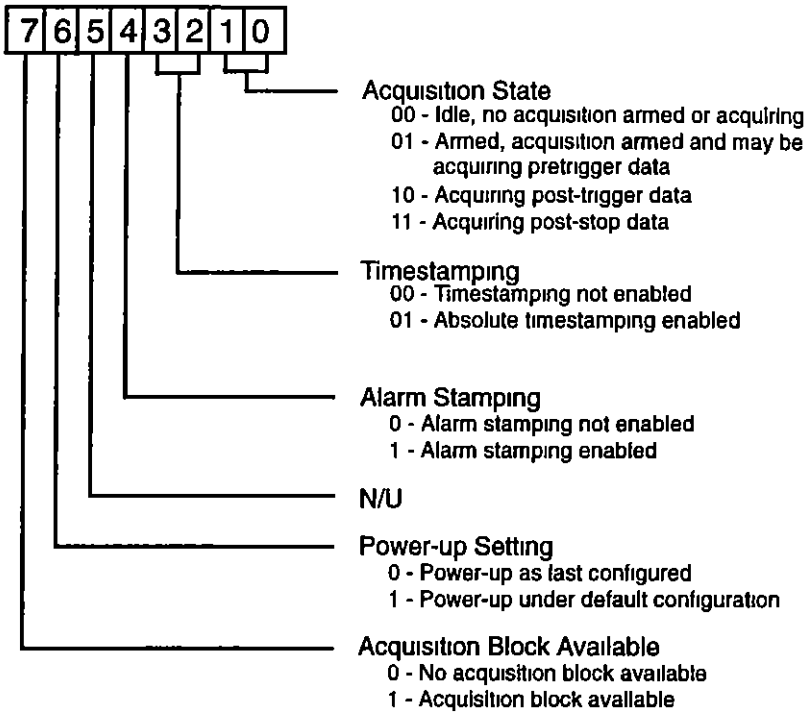


Figure 6 1. U18 Bit Mapping

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User Terminator V

Type System

Execution Deferred

Vn	Set user terminator where (n>=0, n<=255)
V?	Query User Terminator returns Vn as described above

The User Terminator command is used to set the User Terminator value to any character whose numeric value (ASCII value) is in the range 0 to 255 The User Terminator may be used by the Q command to specify a user defined terminator for any of the defined terminator types or as a reading separator for the Read Buffered Data (R) command

Example

```
PRINT#1,   "OUTPUT07,Q1,0,1,1,1X"   ' Set the reading separator flag to be ON
PRINT#1,   "OUTPUT07,F0,0X"         ' Data format is engr units - degrees C
PRINT#1,   "OUTPUT07,V44X"          ' Set the User Terminator to be a comma
                                      (',')
PRINT#1,"OUTPUT07,C1-4,1X"          ' Configure channels 1-4 as TC type
PRINT#1,"OUTPUT07,I00 00 01 0,00    ' Configure scan interval
00+00"1
PRINT#1,"OUTPUT07,Y0,1000,0X"       ' Configure acquisition counts
PRINT#1,"OUTPUT07,T1,8,0,0X"        ' Configure acquisition, start is command
                                      stop is count
PRINT#1,"OUTPUT07,@X"               ' Trigger the acquisition
PRINT#1,"OUTPUT07,R1X               ' Read a Scan
PRINT#1,"ENTER07"                   ' Retrieve the Scan
INPUT   A$                          ' Screen shows
                                      +0020 30,+0023 80,+0034 90,+0013 50
PRINT#1,   "OUTPUT07,V58X"          ' Set the User Terminator to be a colon
                                      (' ')
PRINT#1,"OUTPUT07,R1X               ' Read a Scan
PRINT#1,"ENTER07"                   ' Retrieve the Scan
INPUT   A$                          ' Screen shows
                                      +0020 30 +0023 80 +0034 90 +0013 50
```


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Set Table Entry Pointer W

Type: System Immediate

Execution: Immediate

`Wt,i` Set Table Entry Pointer where `t` is the table number and where `i` (`i>` = 0, `i` <=255) is the desired location in the table

`W?` Returns `Wt,i` as defined above for the current entry pointer for the current table

To use input types other than the predefined types, the TempScan/1000 can be programmed with custom linearization lookup tables The Set Table Entry Pointer command sets the location pointer to a specified location in the custom table

This command is used in conjunction with the Define Table (`D`) and Load Current Entry (`Z`) commands to create custom tables Refer to the Operations chapter for details on setting up custom tables

Example.

```
PRINT#1,"OUTPUT07,W101,0X"      ' Set table pointers to the first entry in table 101
PRINT#1,"OUTPUT07,W101,5X"      ' Set table pointers to the sixth entry in table 101
PRINT#1,"OUTPUT07,W?X"          ' Return current table and entry pointer
```


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Execute X

Type System

Execution Immediate

X Execute preceding command string

Most commands are interpreted and processed as they are received but are not executed until the Execute (X) command is issued Commands sent without an X are stored in an internal buffer and are not executed until an X is received

While a command line is being interpreted, the front panel LEDs will not be updated These LEDs will only be updated when the TempScan/1000 is in a ready state In order to determine if the TempScan/1000 is in a ready state, perform a Serial Poll for the ready bit (4)

If multiple system commands are used in the same string, each use of the command must be followed by the Execute (X) command Any number of Execute commands may be inserted into the same command string

Example

```
PRINT#1,"CLEAR07"                    ' Clear the TempScan/1000
PRINT#1,"OUTPUT07,   *C"             ' Clear the current channel configuration
PRINT#1,"OUTPUT07,C1-16,1  C17,2  C18-32,3"
                                     ' Send channel configuration
PRINT#1,"OUTPUT07,U4"                ' Get HLL for the new channel
                                       configuration (ERROR Light turns ON)
PRINT#1,"OUTPUT07,X"                 ' Instruct the TempScan/1000 to execute
                                       its command input buffer Now the
                                       TempScan/1000 has its new channel
                                       configuration
PRINT#1,"OUTPUT07,E?X"               ' Find out what caused the error
PRINT#1,"ENTER07"                    ' Retrieve Error response
INPUT  A$                            ' Screen shows E128 -- Conflict Error
                                       due to fact that no channels were
                                       configured (C is deferred) when the U4
                                       was executed (U4 is immediate)
```


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Set Counts Y

Type. Acquisition

Execution: Deferred

`Ypre,post,stop`
: Set Acquisition counts where `pre` is the pre-trigger count, `post` is the post-trigger count and `stop` is the post-stop count

`Y?`
: Trigger Counts Query returns `Ypre,post,stop` where as defined above

The Set Counts command can be used to select a pre-, post-trigger, and post-stop count to define the size of the acquisition The pre-trigger count cannot exceed the memory size, but the post-trigger count can If the post-trigger count exceeds the memory size, it is the responsibility of the IEEE 488 controller to deplete the FIFO buffer as the data is being collected, or a buffer overrun error will occur A Post Stop Event Count can also be associated with an acquisition to collect a counted amount of samples after the Stop Event occurs

If a trigger is encountered before the pre-trigger count is satisfied, the TempScan/1000 will trigger but have fewer than the specified pre-trigger count in its buffer The Buffer Status String command can be used to query the box for the size of the pre-trigger

Example.

```
PRINT#1,   "OUTPUT07,Q1,0,1,1,1X" ' Set the reading separator flag to be ON
PRINT#1,   "OUTPUT07,F0,0X"       ' Data format is engr units - degrees C
PRINT#1,"OUTPUT07,C1-4,1X"        ' Configure channels 1-4 as TC type J
PRINT#1,"OUTPUT07,I00 00 01 0,0   ' Configure scan interval
0 00 00 1
PRINT#1,"OUTPUT07,Y100,1000,50X"  ' Configure acquisition counts
PRINT#1,"OUTPUT07,N0  N2  X"      ' Configure ESB to be set when Pre-
                                  trigger Count is satisfied
PRINT#1,"OUTPUT07,T1,8,0,0X"      ' Configure acquisition, start is command
                                  stop is count
S% = 0                            ' Wait for the pre-trigger count to become
WHILE (S% AND 32) = 0             satisfied
  PRINT#1,"SPOLL07"
  INPUT#2,S%
WEND
PRINT#1,"OUTPUT07,N0  N1  X"      ' Configure ESB to be set when
                                  acquisition is complete
```


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```
S% = 0                                  ' Wait for the acquisition to become
WHILE (S% AND 32) = 0                   complete
  PRINT#1,"SPOLL07"
  INPUT#2,S%
WEND

PRINT#1,"OUTPUT07,U6X"                  ' Get Block Status String

PRINT#1,"ENTER07"                       ' Retrieve the response

INPUT A$                                ' Screen shows

0000001,0001151,-0000100,10 02 02 0,04/24/93,00001000,10 23 30 0,04/24/93,000010
50,01

                                        ' Indicating that 100 pre-trigger scans were
                                        acquired
                                        ' 1000 post-trigger scans were acquired and
                                        ' 50 post-stop scans were acquired
```


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Load Current Entry Z

Type. System

Execution: Immediate

`Zl1,s1,o1`
: Load Current Entry where `l1` is given limit entry (a signed ASCII 16-bit integer), `s1` is given slope entry (a signed ASCII 32-bit integer), `o1` is given offset entry and where `1` is the current Table Index Pointer Upon execution of this command the Table Index Pointer will be incremented

`Z?`
: Query Table entry returns `Zl1,s1,o1` as described above for the current table at the entry pointed to by the current table's entry pointer

To use input types other than the predefined types, the TempScan/1000 can be programmed with custom linearization lookup tables The Load Current Entry command loads the custom table with its values (limit, slope and offset) This command is used in conjunction with the Define Table (D) and Set Table Entry Pointer (W) commands After data is loaded into the table using the Z command, the table location pointer is automatically incremented In addition, the table location pointer is initialized by the D command or can be set by the W command Refer to the Operations chapter for details on setting up custom tables

Example:

```
PRINT#1, "OUTPUT07,Z-12345, 18035507,31706X"
                                    'Load current entry with
                                    Limit = - 12345
                                    Slope = 1 075 (1 075 * 2^24)
                                    Offset = 123 85 (123 85 * 2^8)

                                    'Apply precision voltage
PRINT#1, "OUTPUT07,Z?X"             'Return current entry parameters
```


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Tempscan 1000

Calibration

7.1 Introduction

Although each TempScan/1000 system is calibrated prior to shipment from the factory, the TempScan/1000 features an optional calibration mode with specific commands for calibrating the offsets and gains The master chassis stores correction constants for offset and gain for each slide-in card in the system (up to 31 cards) These constants are preserved in nonvolatile memory and are unaffected by power outages Note that once calibrated, the slide-in cards are married to their current slot location until recalibration occurs

A special calibration program, CALIB BAS, is included on a disk provided with each TempScan/1000 This program allows the user to calibrate a TC, Volts or RTD card on the master unit This program can also be modified in order to calibrate cards within slave units Refer to the program comments for details

CAUTION

To insure accurate measurements from the TempScan/1000, calibration should only be performed by an authorized metrology lab Failure to do this may result in faulty performance and necessitate subsequent services of an authorized metrology lab.

NOTE

Calibration should not be performed unless the TempScan/1000 has been powered-on for at least one hour

7.1.1 Calibration Mode and Password

To perform calibration, the calibration mode must be enabled The Enter Calibration Mode command "K" enables calibration, where "pw" is the five-digit password currently configured for the unit The TempScan/1000 is shipped from the factory with a default password of "12345" The factory-installed calibration password can be modified by the "*Kpw" (Change Password) command, once calibration mode has been entered

Attempts to execute calibration commands without entry to calibration mode will result in a calibration status error

Calibration mode is ended by executing the "E" command

7.1.1.1 Lost Password

If the password is lost or forgotten, a new password can be entered by installing the CAL jumper clip inside the TempScan/1000 as described below, and executing the *Kpw command to change to a new password Note that the *Kpw command is available only if calibration

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mode has already been enabled by a previous Kpw command, or if the CAL jumper clip is in place

7.1.1.2 Installing Cal Jumper Clip:

Note This procedure should only be performed for a lost password

1 Switch off power and remove the line cord from the unit

2 Remove the screws from the top cover plate and lift the cover plate from the unit

WARNING

Make sure the AC power cord has been disconnected before removing the cover Dangerous AC voltages are present when the power cord is connected

3 Install a jumper clip on the JP-10 header (marked CAL) as shown in the figure below Replace the cover plate temporarily, reconnect the AC line cord, and execute the *Kpw command to enter a new password Turn off the unit, disconnect the line cord and remove the CAL jumper clip when password entry is complete

4 Replace the top cover plate and power cord and switch on the TempScan/1000 and any Exp/10 expansion chassis Allow the system to warm up for at least one hour before proceeding with calibration

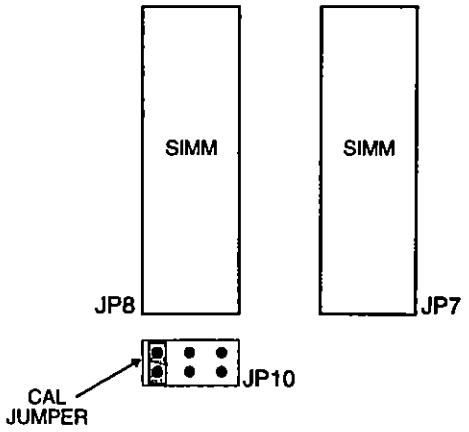


Figure 7 1 Installing the Cal Jumper Clip

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7.1.1.3 Calibration Mode Indicator

To denote whether or not calibration mode has been activated, bit 7 in the Calibration Status Register will be set after a valid K command has been executed This bit is cleared by the E command Refer to Section 3 9 1 and the U2 command for details

7.1.1.4 Calibration Command Active Indicators

Since the calibration commands require a few seconds to complete, the trigger LED will flash to indicate that a calibration command is active When this indicator is off, the next step in the procedure can be started

7.1.2 Thermocouple Card Gain/Offset Calibration

To begin, calibration mode must be enabled with the "Kpw" command

A precision voltage source must be applied to channel 1 of each scanning module of the system which is to be calibrated This voltage source must be able to supply highly-accurate voltage values from 0 to 100 millivolts The TempScan/1000 requires a voltage source with accuracy of ±0 05

Calibration commands refer to channel "n" (channel 1 of each card), as indicated in the following table

UNIT	CARD 1 CHANNEL	CARD 2 CHANNEL
TempScan/1000	1	N/A
Exp/10 #1	33	65
Exp/10 #2	97	129
Exp/10 #3	161	193
Exp/10 #4	225	257
Exp/10 #5	289	321
Exp/10 #6	353	385
Exp/10 #7	417	449
Exp/10 #8	481	513
Exp/10 #9	545	577
Exp/10 #10	609	641
Exp/10 #11	673	705

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Exp/10 #12	737	769
Exp/10 #13	801	833
Exp/10 #14	865	897
Exp/10 #15	929	961

1 Connect precision voltage source to the channel to be calibrated Use standard copper hookup wire **Do not use thermocouple wire**

2 Ensure software digital filtering is enabled Enter "*W1" if it is not

3 Offset calibration for channel "n"

Set calibration source to 0 0 millivolts Enter "Hn" Wait for command to complete (Refer to Section 7 1 1 4)

4 Gain calibration for channel "n"

Set source to -50 0 millivolts DC Enter "G n,1"

Wait for command to complete

Set source to +50 0 millivolts DC Enter "G n,1"

Wait for command to complete

Terminate calibration mode by executing the "E" command This completes thermocouple gain and offset calibration

7.1.3 Temperature Sensor Calibration Setup

The TempTC/32 has four on-card temperature sensors used for cold-junction compensation of the thermocouple signals When calibrating these cold junction sensors, four thermocouples must be attached to channels adjacent to the sensors On each card these four separate channels must be supplied with an accurate thermocouple signal of known warm-junction temperature This may be accomplished with an accurate thermocouple calibration source or by means of accurate measurement of the temperature of the existing thermocouple heat sources If a thermocouple calibration source is used, thermocouple wire of the appropriate type must be used to make the connection to the TempScan/1000 or Exp/10 expansion chassis

> **Note Although this is temperature sensor calibration, the thermocouple signal is applied to the channel input and does not imply attaching anything to the temperature sensor itself**

Due to the high-speed channel scanning circuitry in the TempScan/1000, a low impedance source, like a thermocouple, is required to eliminate inaccuracies due to charge injection Some thermocouple simulators have a high output impedance that may cause the TempScan/1000 to read their outputs inaccurately

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To ensure accurate calibration of the cold junction sensors, an accurate thermocouple placed in an ice bath, or ice-point device like the Omega model TRCIII ice point™ Reference Cell is recommended The thermocouple junction provides an excellent low impedance source for the measurement

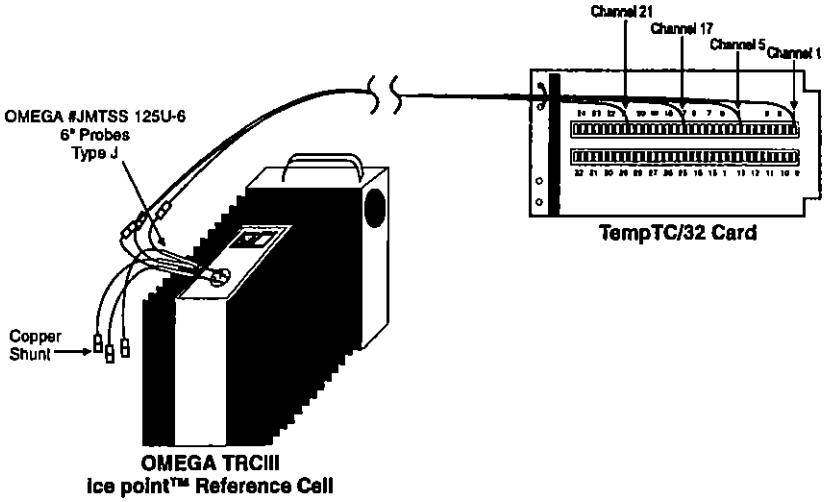


Figure 7 2 Cold Junction Sensor Calibration

If a temperature other than 0 degrees Celsius is desired, the following configuration can be used to simulate thermocouple temperatures

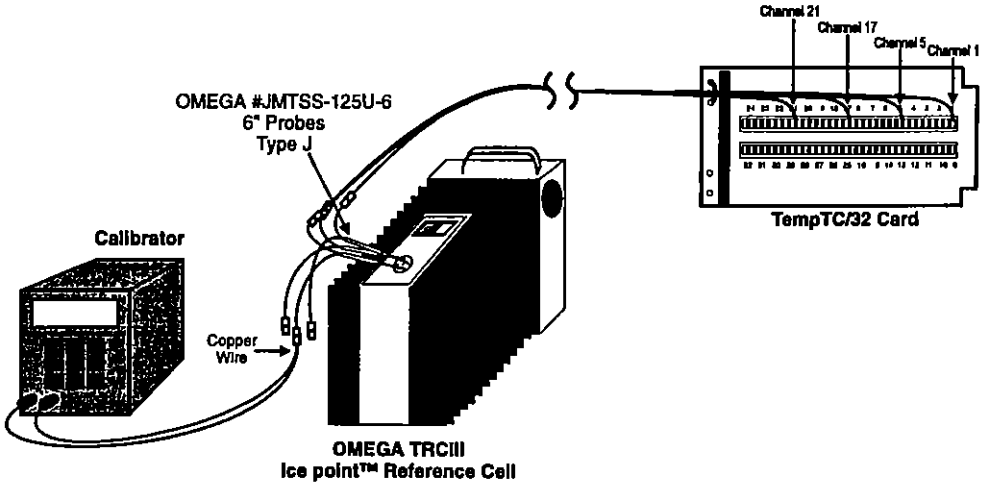


Figure 7 3. Non-Zero Calibration

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Using the standard voltage vs temperature table for the desired thermocouple, which is published by the National Technical Information Service (NTIS) of the U S Department of Commerce, a voltage corresponding to a temperature can be set on the voltage source

If a thermocouple simulator/calibrator is used, it must have an output impedance of less than 10 Ohms (should be a voltage source), similar to a real thermocouple For calibrators having a higher impedance, attaching a capacitor across its output as shown below should allow it to provide accurate temperature values to the TempScan/1000 The capacitor must be a low leakage film capacitor in the 3 3 to 4 7 µF range

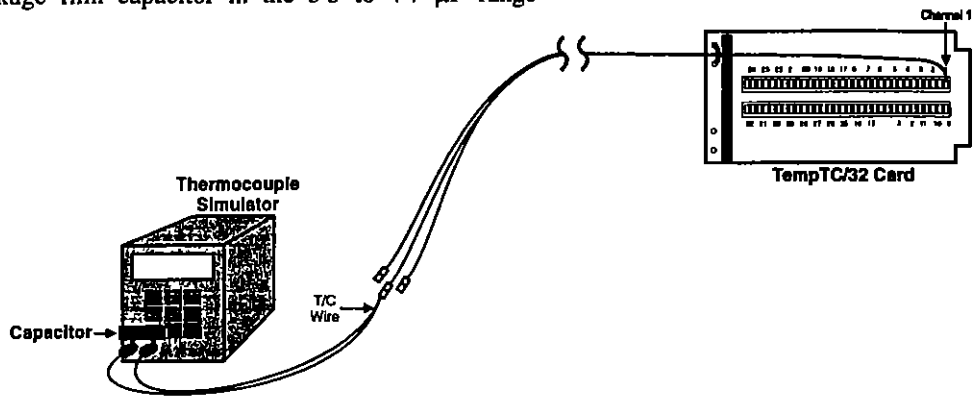


Figure 7 4. Calibration with High Impedance Calibrator

7.1.4 Temperature Sensor Calibration Procedure

Cold-junction calibration commands refer to channel "n", as indicated in the following table

UNIT	CARD 1 CHANNEL	CARD 2 CHANNEL
TempScan/1000	1, 5, 17, 21	N/A
Exp/10 #1	33, 37, 49, 53	65, 69, 81, 85
Exp/10 #2	97, 101, 113, 117	129, 133, 145, 149
Exp/10 #3	161, 165, 177, 181	193, 197, 209, 213
Exp/10 #4	225, 229, 241, 245	257, 261, 273, 277
Exp/10 #5	289, 293, 305, 309	321, 325, 337, 341
Exp/10 #6	353, 357, 369, 373	385, 389, 401, 405
Exp/10 #7	417, 421, 433, 437	449, 453, 465, 469

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UNIT	CARD 1 CHANNEL	CARD 2 CHANNEL
Exp/10 #8	481, 485, 497, 501	513, 517, 529, 533
Exp/10 #9	545, 549, 561, 565	577, 581, 593, 597
Exp/10 #10	609, 613, 625, 629	641, 645, 657, 661
Exp/10 #11	673,677,689,693	705,709,721,725
Exp/10 #12	737,741,753,757	769,773,785,789
Exp/10 #13	801,805,817,821	833,837,849,853
Exp/10 #14	865,869,881,885	897,901,913,917
Exp/10 #15	929,933,945,949	961,965,977,981

Command format "J n,m,XXXX X",
where n= channel, m=thermocouple type, XXXX X=temperature, in degrees C

Thermocouple	J	K	T	E	R	S	B	N14	N28
m	1	2	3	4	5	6	7	8	9

Prior to calibrating the temperature sensors, verify that software digital filtering is enabled If not, enable the filtering using the *W1 command

The J command must be entered for the specified four channels on each card to be calibrated

Example Card 1 of Exp/10 #13 has a type K thermocouple on channel 1, type J on channel 5, type E on channel 17, and type R on channel 32

Channel 1 is presently at 23 1 degrees C and channel 5 is at 24 8 degrees Channel 17 is at 23 7 degrees, and channel 21 is at 22 9 degrees

ENTER "J801,2,23 1"

Wait for command to complete (Refer to Section 7 1 1 4)

ENTER "J805,1,24 8 "

Wait for command to complete

ENTER "J817,4,23 7"

Wait for command to complete

ENTER "J821,5,22 9"

Wait for command to complete

Repeat above procedure for each thermocouple channel to be calibrated Terminate calibration mode with the "E" command This completes thermocouple card calibration

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7.1.5 Volts Card Gain and Offset Calibration

To begin, Calibration mode must be enabled with the Enter Calibration Mode (K) command

A precision voltage source must be applied to channel 1 of each scanning module of the system which is to be calibrated This voltage source must be capable of supplying highly-accurate voltage values from 100 millivolts to 10 volts The TempScan/1000 requires a voltage source with accuracy of +0 05

Calibration commands refer to channel "n" (channel 1 of each scanning module), as indicated in the following table

UNIT	CARD 1 CHANNEL	CARD 2 CHANNEL
TempScan/1000	1	N/A
Exp/10 #1	33	65
Exp/10 #2	97	129
Exp/10 #3	161	193
Exp/10 #4	225	257
Exp/10 #5	289	321
Exp/10 #6	353	385
Exp/10 #7	417	449
Exp/10 #8	481	513
Exp/10 #9	545	577
Exp/10 #10	609	641
Exp/10 #11	673	705
Exp/10 #12	737	769
Exp/10 #13	801	833
Exp/10 #14	865	897
Exp/10 #15	929	961

1 Connect precision voltage source to channel to be calibrated Use standard hookup wire **Do not use thermocouple wire**

2 Offset calibration for channel "n"

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Set source to 0 0 millivolts Enter "Hn" Wait for command to complete
(Refer to Section 7 1 1 4)

3 Gain calibration for channel "n"

100 mV range.

Set source to -100 0 millivolts DC

Enter "G n,11"

Wait for command to complete

Set source to +100 0 millivolts DC

Enter "G n,11"

Wait for command to complete

1 volt range.

Set source to -1 0 volts DC

Enter "G n,12"

Wait for command to complete

Set source to +1 0 volts DC

Enter "G n,12"

Wait for command to complete

5 volt range.

Set source to -5 0 volts DC

Enter "G n,13"

Wait for command to complete

Set source to +5 0 volts DC

Enter "G n,13"

Wait for command to complete

10 volt range.

Set source to -10 0 volts DC

Enter "G n,14"

Wait for command to complete

Set source to -10 0 volts DC

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Enter "G n,14"

Wait for command to complete

Repeat above procedure for each volts channel to be calibrated Terminate calibration mode with the "E" command This completes volts card gain and offset calibration

7.1.6 RTD Card Gain and Offset Calibration

To begin, Calibration mode must be enabled with the Enter Calibration Mode (K) command

Calibration commands refer to channel "n" (channel 1 of each scanning module), as indicated in the following table

UNIT	CARD 1 CHANNEL	CARD 2 CHANNEL
TempScan/1000	1	N/A
Exp/10 #1	33	65
Exp/10 #2	97	129
Exp/10 #3	161	193
Exp/10 #4	225	257
Exp/10 #5	289	321
Exp/10 #6	353	385
Exp/10 #7	417	449
Exp/10 #8	481	513
Exp/10 #9	545	577
Exp/10 #10	609	641
Exp/10 #11	673	705
Exp/10 #12	737	769
Exp/10 #13	801	833
Exp/10 #14	865	897
Exp/10 #15	929	961

1 Offset calibration for channel "n"

Short R1-, S1-, S1+, R1+ of channel "n" together

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Enter "Hn"

Wait for command to complete (Refer to Section 7 1 1 4)

2 Gain calibration for channel "n"

If 3-wire RTD's are being used, attach a precision 3-wire resistance source of xxx xx ohms to channel "n"

Enter "*G, xxx xx" 'Enter ohms being applied

Enter "Gn,16"

Wait for command to complete

If 4-wire RTD's are being used, attach a precision 4-wire resistance source of xxx xx ohms to channel "n"

Enter "*G, xxx xx" 'Enter ohms being applied

Enter "Gn,17"

Wait for command to complete

Repeat above procedure for each RTD card to be calibrated Terminate calibration mode with the "E" command This completes RTD card gain and offset calibration

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Character Codes and IEEE Multiline Messages

$00 0 NUL	$10 16 DLE	$20 32 SP 00	$30 48 0 16	$40 64 @ 00	$50 80 P 16	$60 96 SCG	$70 112 p SCG
$01 1 SOH GTL	$11 17 DC1 LLO	$21 33 ! 01	$31 49 1 17	$41 65 A 01	$51 81 Q 17	$61 97 a SCG	$71 113 q SCG
$02 2 STX	$12 18 DC2	$22 34 02	$32 50 2 18	$42 66 B 02	$52 82 R 18	$62 98 b SCG	$72 114 r SCG
$03 3 ETX	$13 19 DC3	$23 35 # 03	$33 51 3 19	$43 67 C 03	$53 83 S 19	$63 99 c SCG	$73 115 s SCG
$04 4 EOT SDC	$14 20 DC4 DCL	$24 36 $ 04	$34 52 4 20	$44 68 D 04	$54 84 T 20	$64 100 d SCG	$74 116 t SCG
$05 5 ENQ PPC	$15 21 NAK PPU	$25 37 % 05	$35 53 5 21	$45 69 E 05	$55 85 U 21	$65 101 e SCG	$75 117 u SCG
$06 6 ACK	$16 22 SYN	$26 38 & 06	$36 54 6 22	$46 70 F 06	$56 86 V 22	$66 102 f SCG	$76 118 v SCG
$07 7 BEL	$17 23 ETB	$27 39 ' 07	$37 55 7 23	$47 71 G 07	$57 87 W 23	$67 103 g SCG	$77 119 w SCG
$08 8 BS GET	$18 24 CAN SPE	$28 40 (08	$38 56 8 24	$48 72 H 08	$58 88 X 24	$68 104 h SCG	$78 120 x SCG
$09 9 HT TCT	$19 25 EM SPD	$29 41) 09	$39 57 9 25	$49 73 I 09	$59 89 Y 25	$69 105 i SCG	$79 121 y SCG
$0A 10 LF	$1A 26 SUB	$2A 42 * 10	$3A 58 26	$4A 74 J 10	$5A 90 Z 26	$6A 106 j SCG	$7A 122 z SCG
$0B 11 VT	$1B 27 ESC	$2B 43 + 11	$3B 59 27	$4B 75 K 11	$5B 91 [27	$6B 107 k SCG	$7B 123 { SCG
$0C 12 FF	$1C 28 FS	$2C 44 , 12	$3C 60 < 28	$4C 76 L 12	$5C 92 \ 28	$6C 108 l SCG	$7C 124 | SCG
$0D 13 CR	$1D 29 GS	$2D 45 – 13	$3D 61 = 29	$4D 77 M 13	$5D 93] 29	$6D 109 m SCG	$7D 125 } SCG
$0E 14 SO	$1E 30 RS	$2E 46 14	$3E 62 > 30	$4E 78 N 14	$5E 94 ^ 30	$6E 110 n SCG	$7E 126 ~ SCG
$0F 15 SI	$1F 31 US	$2F 47 / 15	$3F 63 ? UNL	$4F 79 O 15	$5F 95 _ UNT	$6F 111 o SCG	$7F 127 DEL SCG
ACG	UCG	LAG		TAG		SCG	

ACG = Addressed Command Group
UCG = Universal Command Group
LAG = Listen Address Group
TAG = Talk Address Group
SCG = Secondary Command Group

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Appendix B

B.1 Command Summary

Command	Code	Description
Trigger On Command	`@`	Trigger on receipt of an @
Flush Acquisition Buffer	`*B`	Flush any data currently in the acquisition buffer
Clear Channel Config	`*C`	Clear out the channel configuration so that no channels are configured
Restore Factory Settings	`*F`	Restore unit to factory configuration
Set RTD Gain Calibration Reference	`*Greference point`	Set RTD Gain Calibration `reference point` to specified number of ohms
	`G?`	Return present reference point setting
Change Calibration Keyword	`*K`	Allow changing of user-defined calibration password
Power-on Reset	`*R`	Equivalent to hardware reset
Power-up Settings	`*S0`	Power-up under last known configuration (default)
	`*S1`	Power-up under factory default configuration
Software Digital Filtering	`*W0`	Disable software digital filtering for thermocouple cards
	`*W1`	Enable software digital filtering for thermocouple cards (default)

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Assign Alarm Output	`A`	Set alarm condition with channels assigned to digital output
	`A?`	Returns channels assigned to digital output
Configure Channels	`Cchans,type[,[lowsp],[highsp],[hyst] ]`	Configure the channels for the TempScan and its slave units Channel(s) and type are required arguments, while lowsetpoint, high setpoint and hysteresis are optional
	`C?`	Returns current channel configuration
Define Custom Table	`Dt,c,p,l,h,e`	Define a custom table where `t` is the table number to be defined, `c` is the card type, `p` is the PGA value, `l` is the low limit, `h` is the high limit and `e` is the number of entries
	`D?`	Returns custom table selections
Error Status	`E?`	Returns present error condition of the TempScan/1000
	`E000`	No error has occurred
	`E001`	Invalid device dependent command (IDDC)
	`E002`	Invalid device dependent command option (IDDCO)
	`E004`	Channel configuration error
	`E008`	Calibration error
	`E016`	Trigger overrun
	`E032`	Open TC or Range Error
	`E064`	Custom table error
	`E128`	Command conflict error

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Data Format	`Fengr,format`	Configure the input and output formats `engr` is the engineering units Valid options are 0 - degrees Celsius (default) 1 - degrees Fahrenheit 2 - degrees Rankine 3 - degrees Kelvin 4 - Volts `format` places the readings in a format the user desires to work with Valid options are 0 - Engineering Units (default) 1 - Binary (Low Byte/High Byte) 2 - Binary (High Byte/Low Byte) 3 - Counts (ASCII)
	`F?`	Query the data format
Calibrate Channel Gain	`Gchannel,type`	Calibrate the correction gain constants for given option card where `channel` is a channel number and `type` is the channel type
Calibrate Channel Offset	`Hchannel`	Calibrate the correction offset constants for given option card where `channel` is a channel number
Set Scan Interval	`Inorm,acq`	Set the normal and acquisition scan intervals which have the form `hh mm ss t`
	`I?`	Return scan interval selection
Calibrate Cold Junction Offset	`Jchannel,type,reference temperature`	Calibrate the cold-junction offsets for cold-junction compensation of the thermocouple signals
Enter Calibration Mode	`Kkeyword`	Enter Calibration Mode if the keyword (which is the password) is correct
	`K?`	Returns `KKeyword`

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Set Trigger Level	`Lchan,level,hyst`	Sets the level against which the testing of channel readings should be performed
		`Chan` is the channel on which to test the level condition, `level` is the level which readings are tested against and `hyst` is the hysteresis level
	`L?`	Query the the current level settings
SRQ Mask	`M0000`	Power-on default mask value
	`M001`	SRQ On Alarm
	`M002`	SRQ On Trigger Event
	`M004`	SRQ On Ready
	`M008`	SRQ On Scan Available
	`M016`	SRQ on Message Available (MAV)
	`M032`	SRQ On Event Detected
	`M128`	SRQ on Buffer Overrun
	`M?`	SRQ Mask Query
Event Mask	`N0`	Clear event mask
	`N1`	Acquisition complete
	`N2`	Stop Event
	`N4`	Query Error
	`N8`	Device Dependent Error
	`N16`	Execution Error
	`N32`	Command Error
	`N64`	75% Buffer Full
	`N128`	Power On
	`N?`	Event Mask Query
Set Digital Outputs	`obank1,bank2,bank3,bank4`	
		Set any of the 32 digital outputs (separated into four 8-bit banks) to a specified setting
	`O?`	Return current state of digital output

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Program Trigger Times	`Pstart,stop`	Set the trigger start and/or stop times for an acquisition configured for start and/or stop on Absolute time
	`P?`	Provide current start and stop times in the form `Pstart,stop`
Query Terminator	`Qresponse,hll,scan,block,separator`	
	`Q1`	Set the query terminators with the following parameters `response` - response terminator `hll` - channel terminator `scan` - terminator which follows each scan output `block` - terminator which follows each trigger block output `separator` - whether or not a separator character should be used (0 or 1)
	`Q?`	Return current terminator settings
Read Buffered Data	`Rtype`	Read scan data from the acquisition buffer where `type` is the type of data request being made
	`R?`	Returns the contents of the data buffer
Read Last Readings	`R#chans`	Queries the last readings from the HLL Registers for specified channels
Set Real Time Clocks	`Stime`	Set the TempScan's internal real-time clock
	`S?`	Returns `Stime`
Trigger Configuration	`Tstart,stop,re-arm,sync`	

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	T1	Configure an acquisition of scan data with the following parameters `start` - start event `stop` - stop event `re-arm` - determine if the unit should continue acquiring after the first acquisition completes `sync` - determines if acquisition events should be synchronized with the internal timebases
	T?	Returns the present trigger configuration
User Status	U0	Query and clear the Event Status Register (ESR)
	U1	Query the Status Byte Register (STB)
	U2	Query and clear Calibration Status Register (CSR)
	U3	Query system settings
	U4	Query current High/Low/Last registers
	U5	Query and clear current High/Low/Last
	U6	Query the Buffer Status String
	U7	Query assinged alarm outputs
	U8	Query configured channels
	U9	Query digital inputs
	U10	Query memory option (in Kbytes)
	U11	Query current alarm channels
	U12	Query last calibration time/date
	U13	Query last scan read
	U14	Query card IDs
	U15	Query product information
User Terminator	V	Set the User Terminator value to any character whose numeric value (ASCII value) is in the range 0 to 255
	V?	Returns the present user terminator value

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Set Table Entry Pointer	`Wt,l`	Set the location pointer to a specified location in the custom table where `t` is the table number and `l` is the desired location in the table
	`W?`	Returns present table entry pointer
Execute	`X`	Execute preceding command string
Set Counts	`Ypre,post,stop`	Use to select a pre-, post-trigger, and post-stop count to define the size of the acquisition
	`Y?`	Return current Acquisition Count selection
Load Current Entry	$Zl_1s_1o_1$	Load the custom table with its values limit(l_1), slope(s_1) and offset(o_1)
	`Z?`	Returns the present custom table values for the current table at the entry pointed to by the current table's entry pointer
Query	`?`	Return the present configuration or mode of the command preceding the `?`

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Appendix C

C.1 TempScan/1000 Error Messages

E000	No error has occured
E001	Invalid device dependent command (IDDC) Due to a command syntax error
E002	Invalid device dependent command option (IDDCO) A command parameter was out of range or missing
E004	A Channel Configuration Error, E004, indicates that a channel has been inappropriately configured, either because the channel is not present or because the specified channel type is not compatible with the card type installed
E008	A Calibration Error, E008, occurs when the card calibration has failed or has been inappropriately calibrated
E016	A Trigger Overrun Error, E016, occurs when the card calibration has failed or has been inappropriately calibrated
E032	An Open TC Error or Range Error, occurs when the hardware circuitry detects an open thermocouple, or when the software detects the A/D input has maxed out or exceeded its linearization limits
E064	Custom Table Error, E064, indicates that a Custom Table has been inappropriately defined or has not been loaded properly This error usually occurs because Custom Table is out of memory or the inappropriate specification of the Custom Table Location Pointer (K command)
E128	A Command Conflict Error, E128, indicates the issuance of a command that is in conflict with other commands that have been issued or the current configuration This error usually occurs when a command is issued that cannot be performed because of the current state of the TempScan/1000 For instance, if the Timebase Interval (I command) is issued during an acquisition (tstart 0)

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