

DTS4050/16Tx
DTS4050/32Tx
DTS4050/64Tx

THERMOCOUPLE SCANNERS

HARDWARE AND SOFTWARE MANUAL
SOFTWARE VERSION 1.12



Scanivalve

PREFACE

WARNINGS, CAUTIONS AND NOTES



WARNING

The WARNING! symbol indicates that danger of injury for persons and the environment and/or considerable damage (mortal danger, danger of injury) will occur if the respective safety precautions are not taken.



CAUTION

The CAUTION ! symbol indicate danger for the system and material if the respective safety precautions are not taken.



The ESD note symbol indicates that proper precautions for handling Electrostatic Sensitive Devices needs to be taken when performing the related operation. This includes the use of grounded work surfaces and personal wrist straps to prevent damage to sensitive electronic components.

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2) On receipt of shipping instructions, forward the product, transportation prepaid. Repairs will be made and the product returned.

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IMPORTANT NOTICE

Please note that the product specifications and other information contained in this manual are subject to change without notice. Scanivalve Corporation makes an effort and strives to provide complete and current information for the proper use of the equipment. If there are any questions regarding this manual or the proper use of the equipment, contact Scanivalve Corporation.

CONTACT INFORMATION

If there are any questions or concerns regarding any Scanivalve product please do not hesitate to contact us at the following:

Scanivalve Corp.
1722 N. Madson Street
Liberty Lake, WA 99019
Telephone: (800)935-5151 (509)891-9970
Fax: (509)891-9481
scanco@scanivalve.com
www.scanivalve.com

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SECTION 1: SPECIFICATIONS

GENERAL SPECIFICATIONS

Size (WxHxD)*

| | |
|------|--|
| 16Tx | 6.19" x 5.12" x 13.5" (15.72cm x 13.00cm x 34.29cm) |
| 32Tx | 10.75" x 5.58" x 12.0" (27.31cm x 14.17cm x 30.48cm) |
| 64Tx | 10.75" x 5.58" x 23.32" (27.31cm x 14.17cm x 59.23cm) |

Weight

| | |
|------------------|---------------------|
| 16Tx: | 13.0 lbs (5.91 kg) |
| 16Tx panel jack: | 12.0 lbs (5.45 kg) |
| 32Tx: | 15.5 lbs (6.80 kg) |
| 32Tx panel jack: | 15.0 lbs (6.13 kg) |
| 64Tx: | 25.0 lbs (11.36 kg) |

Thermocouple Types

| | |
|-----------------|--------------------------|
| Screw Terminal: | B, E J, K, N, R, S and T |
| Panel Jack: | E, J, K, S and T |

Accuracy**

| | |
|------------------|--------|
| E, J, K, N and T | ±0.5°C |
| R and S | ±2.0°C |
| B | ±4.0°C |

UTR Accuracy

±0.1°C

A/D Resolution

22 Bit (each channel)

Data Output

°C, °F, °R, K, mVolts, Counts

Data Output Rate

| | |
|------|---------------------------|
| 16Tx | 40 samples/channel/second |
| 32Tx | 20 samples/channel/second |
| 64Tx | 10 samples/channel/second |

Communications

| | |
|----------|-------------------------------------|
| Ethernet | 100Base-T, TCP/IP or UDP |
| Serial | RS-232 (limited configuration only) |

Power Input

18-36Vdc

Power Requirements

Standard—No heater:

| | |
|-------|-------------------|
| 16Tx: | .58 Amps @ 28Vdc |
| 32Tx: | .83 Amps @ 28Vdc |
| 64Tx: | 1.45 Amps @ 28Vdc |

With Optional Heater:

| | |
|-------|------------------|
| 16Tx: | 1.6 Amps @ 28Vdc |
| 32Tx: | 4.8 Amps @ 28Vdc |

Common Mode Rejection

160 db @ 0-60Vdc

Channel to Channel Isolation

1000Vdc

Input/Output Isolation

600Vdc

Max Thermocouple Loop Resistance

300 Ω

ENVIRONMENT SPECIFICATIONS

Operating Temperature

| | |
|----------------|--------------------------------|
| Without Heater | -5 to 60 °C |
| With Heater | -20°C to 60°C (16 & 32Tx only) |

Humidity

| | |
|-----------|-----------------------------|
| Operation | 5 to 95% RH, Non-Condensing |
| Storage | 5 to 95% RH, Non-Condensing |

* All dimensions for screw-terminal variants

** System accuracy specifications are valid after a minimum of two hour warm up period. Accuracy does not include thermocouples, or thermocouple extension wires. The Panel Jack option reduces overall accuracy by a factor of two.

DTS4050/16Tx - SCREW TERMINAL OUTLINE DRAWING

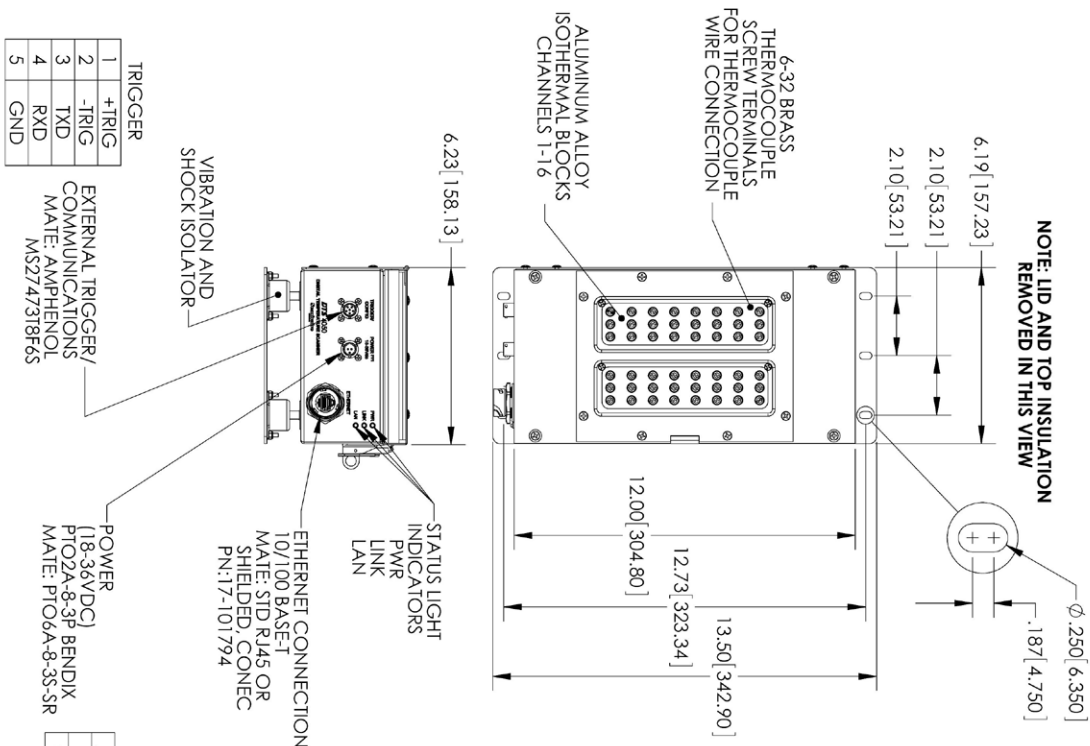
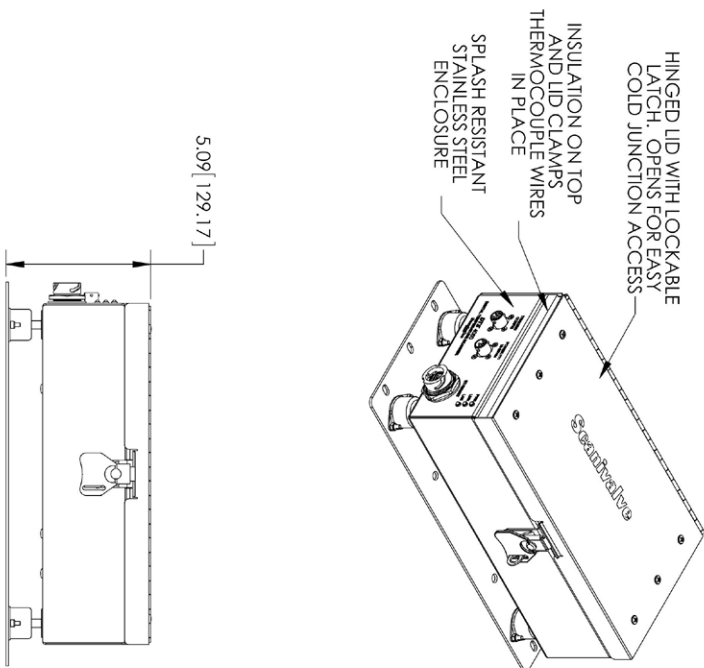


FIGURE 1.1 - PHYSICAL SPECIFICATION, DTS4050/16Tx, SCREW TERMINAL INPUTS



- NOTES:**
1. REFER TO 21395-X FOR DETAIL DRAWINGS.
 2. ALL DIMENSIONS IN INCHES [MM].
 3. INDIVIDUAL SHIELDED THERMOCOUPLE OPTION AVAILABLE.
 4. SUPPORTS K J.T.E.R & S TYPE THERMOCOUPLES.
 5. ALLOW A MINIMUM OF 7.00 IN [177.8 CM] VERTICAL CLEARANCE TO OPEN THE LID WHEN MOUNTING THIS UNIT.
 6. WEIGHT: 1.3lbs [5.9kg]

DTS4050/16Tx - PANEL JACK OUTLINE DRAWING

- NOTES:**
1. REFER TO 21395-X FOR DETAIL DRAWINGS.
 2. ALL DIMENSIONS IN INCHES [MM].
 3. INDIVIDUAL SHIELDED THERMOCOUPLE OPTION AVAILA
 4. SUPPORTS K,J,I,T,R & S TYPE THERMOCOUPLES.
 5. WEIGHT: 12lbs [5.45kg]

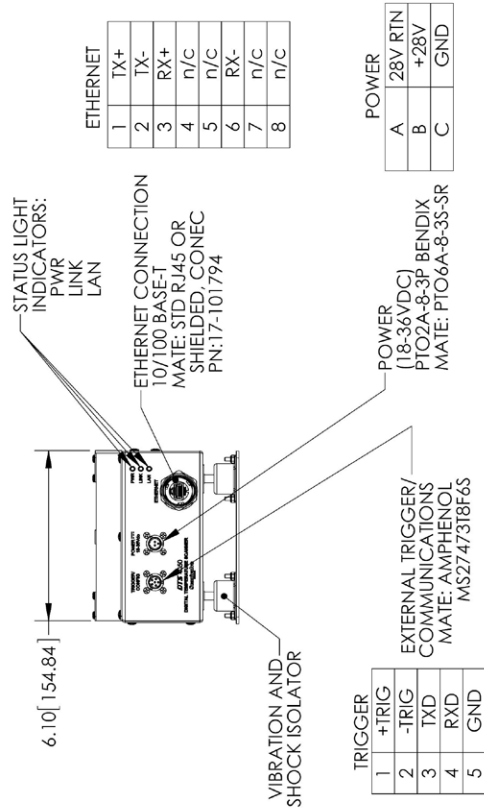
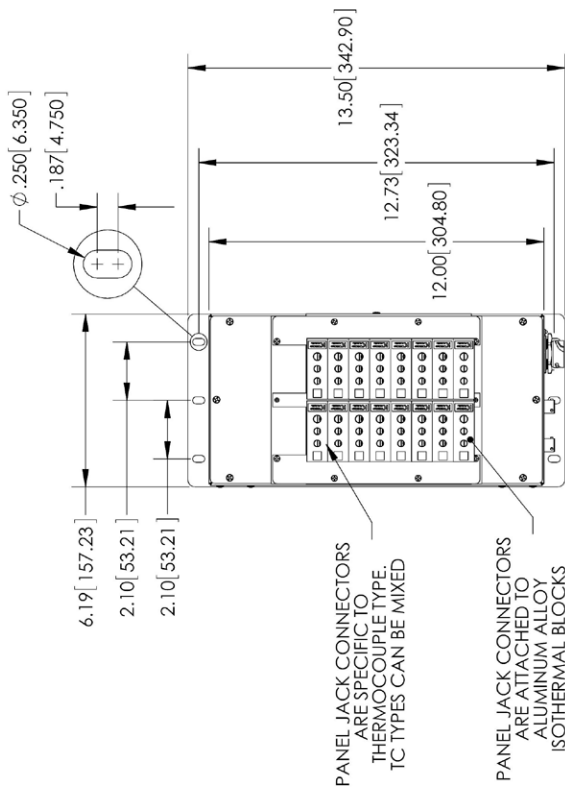
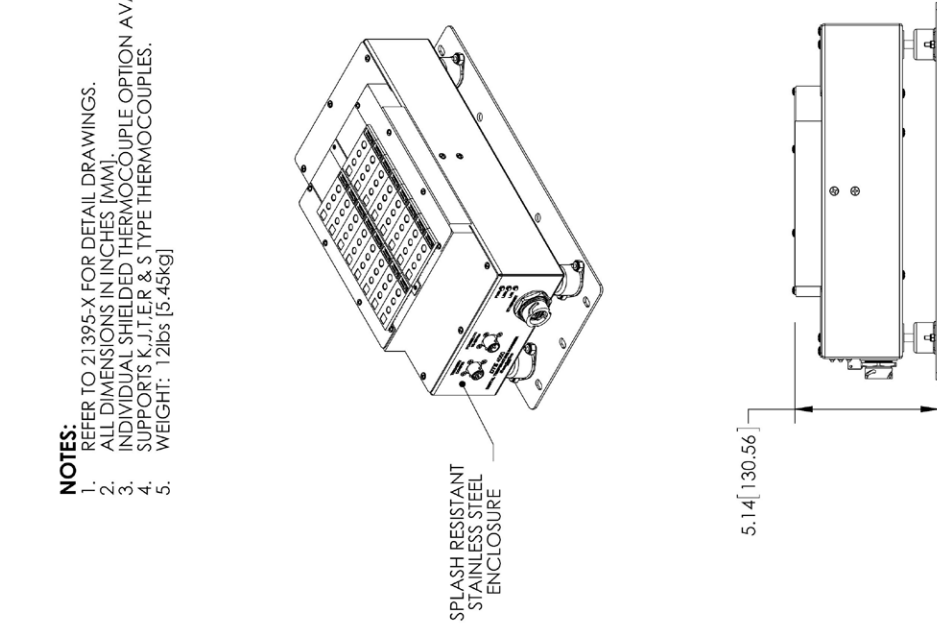


FIGURE 1.2 - PHYSICAL SPECIFICATION, DTS4050/16Tx, PANEL JACK INPUTS

DTS4050/32Tx - SCREW TERMINAL OUTLINE DRAWING

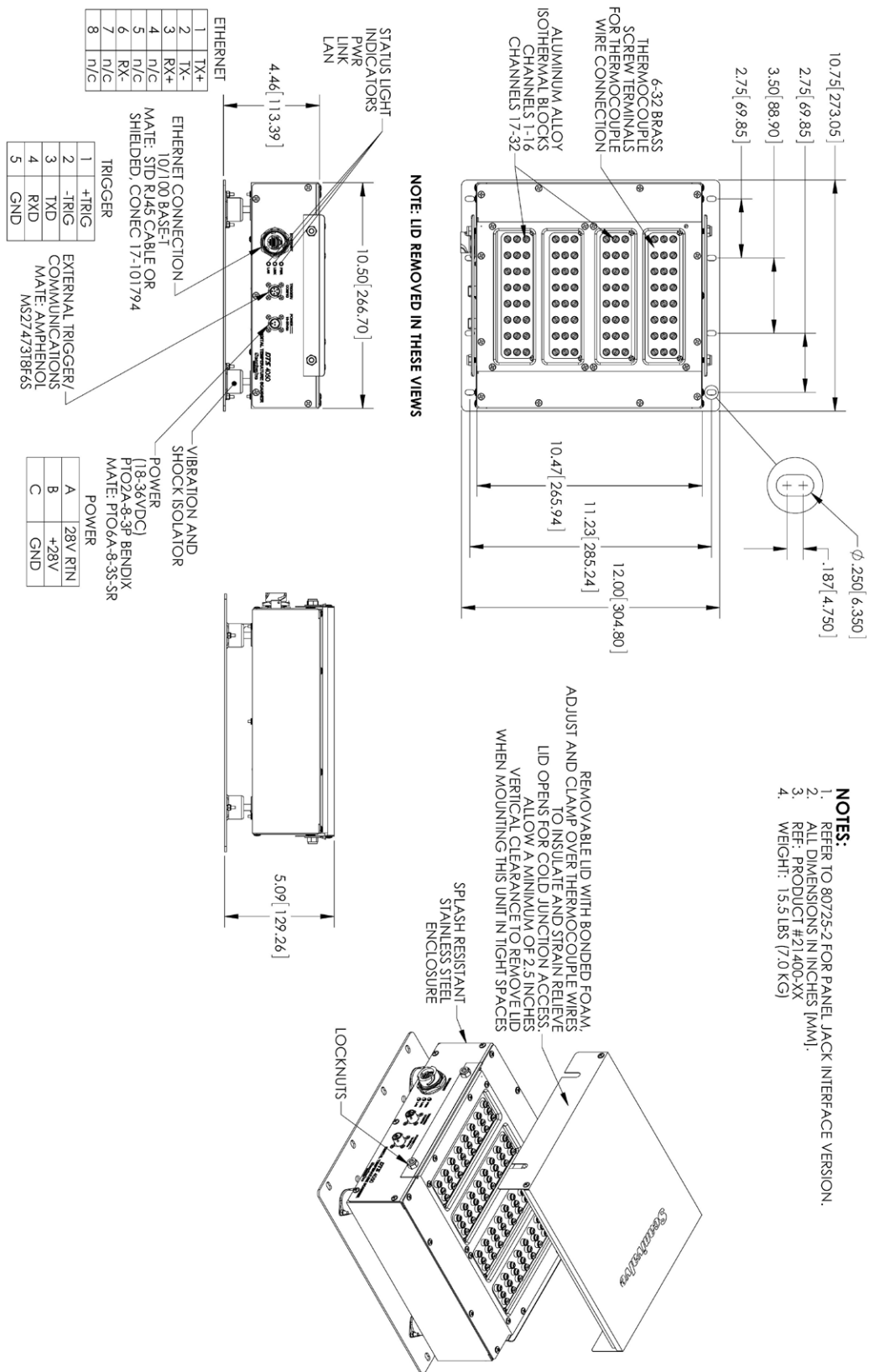


FIGURE 1.3 - PHYSICAL SPECIFICATION, DTS4050/32Tx, SCREW TERMINAL INPUTS

DTS4050/32Tx - PANEL JACK OUTLINE DRAWING

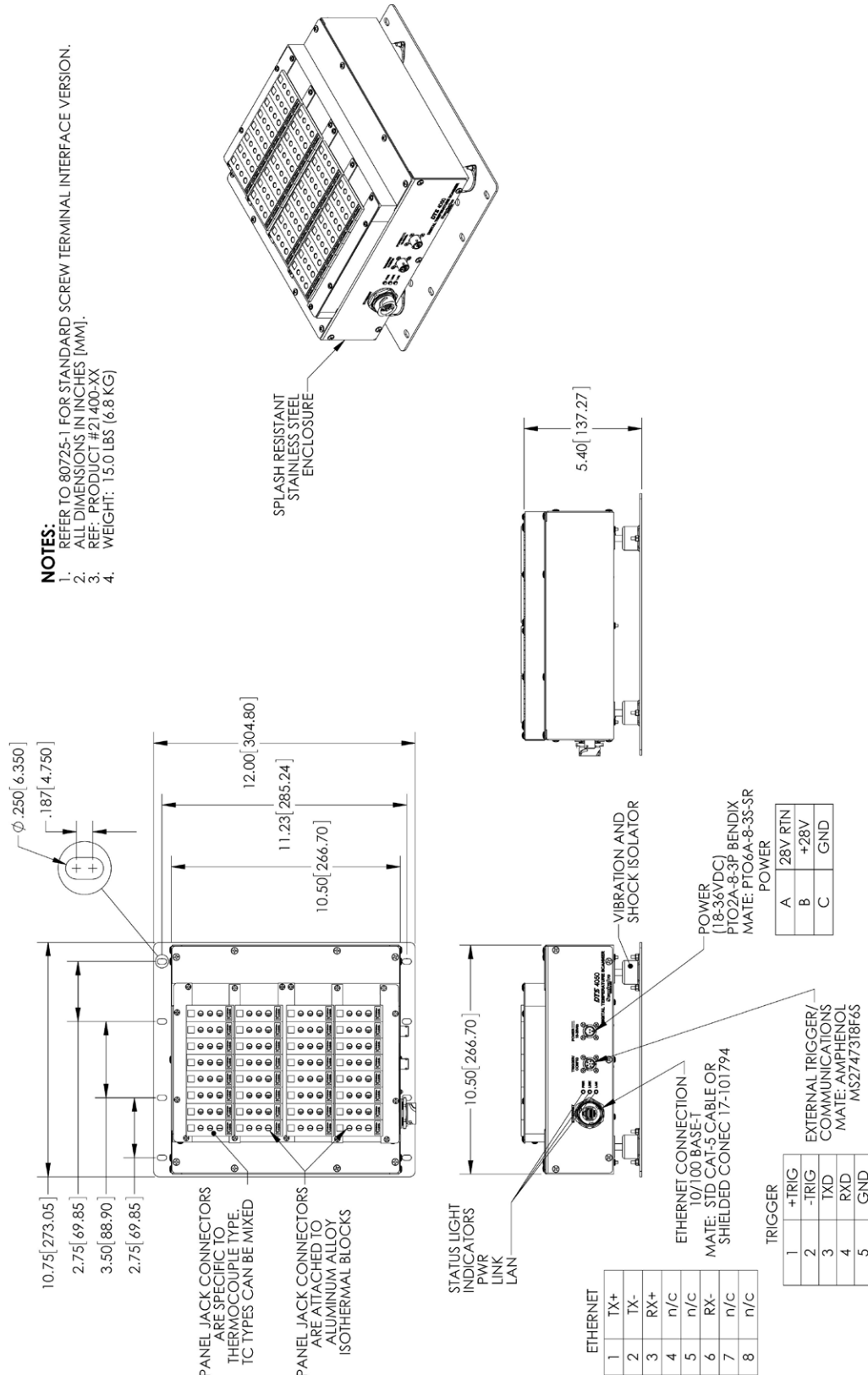


FIGURE 1.4 - PHYSICAL SPECIFICATION, DTS4050/32Tx, PANEL JACK INPUTS

SECTION 2: INTRODUCTION

GENERAL DESCRIPTION

The DTS4050 series thermocouple acquisition system represents the next generation of intelligent temperature scanning. This Digital Temperature Scanner incorporates 16, 32 or 64 pair of thermocouple inputs, a 22 bit A/D converter for each input channel, RAM and a DSP processor. The DTS is packaged in a rugged, shock mounted, stainless steel enclosure.

An Isothermal block is incorporated for the Uniform Temperature Reference (UTR), with a $\pm 0.1^\circ\text{C}$ accuracy. The temperature of each UTR block is measured using two PT100 RTDs. A single UTR block can act as the reference for 16 thermocouple inputs. NIST thermocouple tables for standard thermocouple types are stored in Flash Memory. The DSP processor uses these look-up tables to convert mV inputs to Engineering units. Temperature data may be output in $^\circ\text{C}$, $^\circ\text{F}$, $^\circ\text{R}$, K, mVolts, Counts. The DTS4050 total system error does not include extension wire and external connectors, or panel jacks.

Multiple standard thermocouple types may be used with this intelligent thermocouple scanner. The DTS4050 can accept grounded and un-grounded thermocouples.

MODULE CONFIGURATIONS

The DTS4050 is available in 16, 32 or 64 input versions. Several optional configurations are available in order to meet the requirements of specific tests.

SCREW TERMINAL

This is the standard configuration for all DTS4050 modules. Thermocouples are terminated at the DTS4050 with #6x32 brass screws into the UTR block. DTS4050 modules are available in versions that will accept 16, 32 or 64 shielded thermocouples. The top cover and insulation isolate the UTR from small temperature changes giving this unit the best accuracy.

PANEL JACK VERSION

DTS4050 modules may have panel jacks installed as an option in 16Tx and 32Tx version. This option uses either Omega TPJ series or UPJ series panel jack receptacles and is available for type E, J, K, S and T thermocouples only. This option reduces the overall accuracy of the module by a factor of two. This error may be calibrated out by the user using the Gain and Offset terms. Unused panel jacks must be plugged to prevent "cold spots" on the UTR which will cause errors.

PANEL MOUNT VERSION

DTS 4050/64Tx modules may be ordered in either the standard shock mount configuration or in an optional Panel mount configuration. The Panel Mount configuration is designed to be mounted in a standard 19 inch rack mount cabinet. The mounting ears may be reversed to facilitate the most convenient mounting configuration

HEATER OPTION

16 and 32 channel DTS4050 modules can be equipped with an internal heater for cold environment applications. The heater kit option increases the DTS4050's operational ambient temperature range to -20°C to 60°C by maintaining the internal temperature of the module at approximately $+20^\circ\text{C}$. With a heater installed, the power requirements for the DTS4050 module increase to:

| | |
|---------------|--------------|
| DTS4050/16Tx: | 1.6A @ 28Vdc |
| DTS4050/32Tx: | 4.8A @ 28Vdc |

The standard nominal power range of 18-36Vdc still applies. The power consumption of the module will decrease once the temperature of the module has stabilized.

ENVIRONMENTAL CONSIDERATIONS

DTS4050 modules are constructed with a rugged, corrosion resistant stainless steel case. This case is designed with withstand normal test cell, flight test, educational, light industrial or similar environments. The case is splash resistant but not water proof. If any moisture gets spilled or splashed on the DTS module, wipe it dry immediately to prevent damage to the module. The DTS module should not be mounted outdoors.

The DTS module is designed for rugged applications and incorporates shock mounts for vibration isolation and Bendix/Amphenol connectors for power and serial inputs as well as a Conec connector with optional protective shell for the Ethernet connection.

The DTS module should not be mounted in a location where it may be subjected to extreme temperature shifts or ambient temperatures outside of the specified operating range of the module. Pay careful attention to prevent any temperature "gradients" across the module as the UTR blocks must be at a completely consistent temperature. Keep in mind that the internal temperature of the module will run several degrees warmer than ambient temperature.

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SECTION 3: OPERATION

UNPACK & INVENTORY

When you first unpack the DTS module, begin by inspecting and inventorying the contents of the package. If any visible damage is immediately noticed or if any contents are missing, contact Scanivalve before proceeding. Standard modules are shipped with the following contents as a minimum:

1. DTS4050 module
2. Certificate of calibration
3. Full calibration report CD
4. DTS resource CD
5. Trigger/configuration cable connector
6. Power cable connector
7. Ethernet cable connector

MOUNTING

The DTS module comes with a mounting plate attached to the bottom using vibration dampers. This mounting plate accepts mounting hardware up to 1/4" (6.4mm) in diameter. The DTS module can be mounted in most orientations. Because the DTS Uniform Temperature Reference block (UTR) has two RTDs to measure the temperature, the DTS should NOT be mounted in an orientation that puts these RTDs vertical to each other. Mounting the DTS such that the RTDs are vertical to each other produces a temperature gradient across the UTR block that cannot be accurately represented by the two RTD readings. This is only a concern if the DTS is mounted "vertically," such as on a wall. If the DTS does need to be mounted vertically, then 16 channel units must be mounted with the connectors horizontal (left or right). 32 and 64 channel units must be mounted with the connectors vertical, on the top or bottom face. Additionally, ensure that the DTS module is mounted in an environment that conforms to the requirements described in "Environmental Considerations" on page 13.

A minimum clearance of 6.25" must be left above 16Tx module and 1.5" above 32Tx & 64Tx module in order to open or remove the insulating cover.



CAUTION! Mounting the DTS module inadequately or in an environment that does not conform to the recommendations can result in permanent damage to the module.

WARM-UP

After applying power to the DTS module, a minimum of two hours is required to allow the module temperature to become stable before collecting data. It is recommended

that if time allows, the warm-up period should be extended to three hours for most applications.

COMMUNICATIONS

The DTS module is designed primarily for Ethernet communications. This provides a means to configure the DTS module as well as scan and collect data from the module. A serial RS-232 port is also provided. The serial connection is designed to provide emergency communications should Ethernet communications not be available. Several important module variables can be configured through the serial port, but possibly the most important is the Ethernet IP address. If the IP address of the unit has been lost, a Serial connection is the only way to reset the IP address. See "Operating in Bootloader Mode" on page 85 for step by step instructions on entering the bootloader and change the module's IP address.

SERIAL COMMUNICATIONS

Every DTS4050 module has an RS-232 serial output. It is available through the 'Serial Communications/Trigger' connector on the front face of the module. The bulkhead connector for the 'Serial Communications/Trigger' connection on the module is an Amphenol JTP02RE8-6P. All DTS modules are shipped with a mating connector (Amphenol JTO6RE8-6SR) that can be used to fabricate a Serial Communications/Trigger cable. Alternately, a Serial Communication/Trigger cable can be ordered from Scanivalve using the Scanivalve part number 155829.

The wiring diagram for the RS-232 output is shown below. The cable wiring must connect the Tx output from the host computer to the Rx input of the DTS module. Also, the RX input of the host computer must connect to the Tx output of the DTS module.

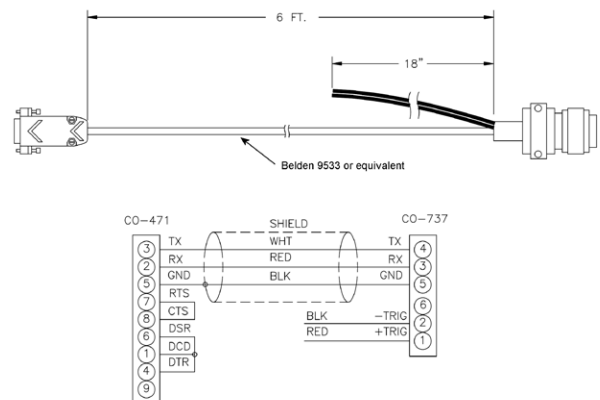


FIGURE 3.1 - SERIAL COMMUNICATION/TRIGGER CABLE

Settings for establishing a serial connection to the DTS module are as follows:

Bits per second: 9600 BAUD
 Data bits: 8
 Parity: none
 Stop bits: 1
 Flow control: none

The Serial Communications port also serves as the input for the external scan trigger. For more information on externally triggering scans, "Scanning With An External Trigger" on page 18.

For information on changing the boot parameters including the module's Ethernet IP address, see "Operating in Bootloader Mode" on page 85.

ETHERNET COMMUNICATIONS

A DTS4050 has one Ethernet connection, 10/100Base-T with MDIX auto-crossing. This is the primary means of communications with the DTS. All DTS modules use a Conec RJ45-IP67 series connector for the Ethernet connection. This connector offers the ability to use a standard RJ-45 Ethernet cable or, when needed the shield can be installed for a more rugged connection. Shielded Category 5E cable or better is recommended for all Ethernet connections.

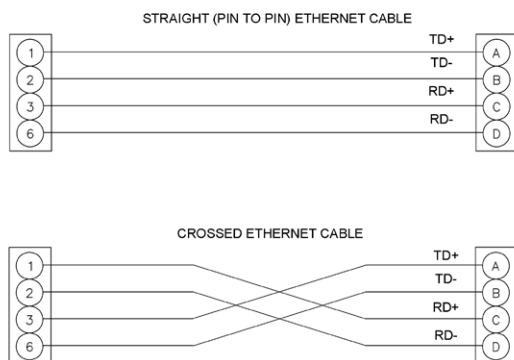


FIGURE 3.2 - 10BASE-T ETHERNET CABLES

Before an Ethernet connection can be established the IP address need to be configured. In order to be compatible, the IP address of the module and host computer must share the first two octets. The third and fourth octets of the IP address is variable, although it is recommended that the third octet also be shared between the host computer and the module.

Example of matching the first three octets (recommended):

Host computer: 191.30.80.100
 DTS module: 191.30.80.125

Example of matching the first two octets:

Host computer: 191.30.1.100
 DTS module: 191.30.80.125

The IP address of a Windows XP host computer can be changed under:

Control Panel -> Network Connections -> Local Area Network -> Properties -> Internet Protocol (TCP/IP) -> Properties.

The IP address of a Windows 7 host computer can be changed under:

Control Panel -> Network and Sharing Center -> Local Area Connection -> Properties -> Internet Protocol Version 4 (TCP/IPv4) -> Properties.

DTS modules are shipped with a preset IP address that uses the following format:

| | |
|---------------|----------------|
| DTS4050/16Tx: | 191.30.100.xxx |
| DTS4050/32Tx: | 191.30.105.XXX |
| DTS4050/64Tx: | 191.30.110.XXX |

Where "XXX" is the last three digits of the unit's serial number.

For information on changing the DTS module's IP address, see "Operating in Bootloader Mode" on page 85.

CLIENT/HOST OPTIONS

Once the module has been connected and the IP address has been configured, communications can be established with the DTS module. Communications can be made through several software packages including:

- PC - TCP/IP
- PC - UDP
- PC - ScanTel (Scanivalve PN: 155406-01)
- PC - LabVIEW Configuration Utility (Scanivalve PN: 155384-01)
- PC - LabVIEW Development Kit (Scanivalve PN: 155385-01)
- PC - OPC Server (Kepware PN: EX5-SCNVE-NA00)
- PC - Windows HyperTerminal

PC - TCP/IP

The user may write their own TCP/IP interface using the software specification portion of this manual. This interface should allow the user to:

- Issue commands to any or all DTS modules on the network.
- Display returned information or scan data from the DTS module(s).
- Write returned information or scan data to the client/host in TCP/IP format.
- Determine the addresses of DTS module(s) on the network.

PC - UDP

The user may write their own UDP interface using the software specification portion of this manual. This interface should allow the user to:

- Issue commands to any or all DTS modules on the network.
- Display returned information or scan data from the DTS module(s).
- Write returned information or scan data to the client/host in UPD format (no handshaking).
- Determine the addresses of DTS module(s) on the network.

PC - SCANTEL

ScanTel a free communications utility designed by Scanivalve to communicate with Scanivalve products including DTS modules. It is a text based, command line program that allows users to connect to a single DTS module and modify the configuration variables, upload or download coefficients and collect data in both TCP/IP and UDP format.

PC - LABVIEW CONFIGURATION UTILITY

The Scanivalve LabVIEW Configuration Utility is software package that offers a very intuitive and simple way to connect to and modify all of the DTS module's configuration variables. It also allows the user the ability to upload a configuration file and scan and collect data. The scanning and data collection is limited to 5Hz due to the graphic nature of the program. The LabVIEW Configuration Utility is based on a LabVIEW 2009 runtime which is included with the installation disk.

PC - LABVIEW DEVELOPMENT KIT

The Scanivalve LabVIEW Development Kit is for users desiring to customize a LabVIEW driver for DTS modules. The Development Kit is compatible with LabVIEW 8.2, 8.6 and 2009. The LabVIEW Configuration Utility is included with the Development Kit.

PC - OPC SERVER

Kepware has written an OPC Server driver to interface a PC running in an OPC environment with a 16 channel DTS module. The OPC server can be ordered directly from Kepware using the part number: EX5-SCNVE-NA00. This program is designed to operate in Windows 2000 or Windows XP.

PC - HYPERTERMINAL

HyperTerminal is a Windows program included as part of Windows 2000, XP and Vista Operating Systems. This program permits a user to connect to a single DTS module, modify the configuration variables, upload or download coefficients and collect data. HyperTerminal provides a means for both Serial RS-232 and Ethernet connections. It is a text based command line program.

SCANNING

Once the DTS module has been installed, powered up and allowed to thermally stabilize data can be collected. There are several configuration variables that effect how the DTS module scans and how the data is output. The scan rate is controlled by two variables: 'period' and 'average'. Alternately, these two variables can be set automatically using the 'rate' variable. The length of the scan sample is determined by the 'frames per scan' (FPS) variable and the data output format is determined by the 'format' variable. The DTS can be configured for 'free run' mode where after the 'SCAN' command is send the DTS module will scan continuously until the frames per scan (FPS) term is met, or it can be triggered to scan and output data upon receipt of a scan trigger (either external or a software trigger). The following is a brief list of common commands that effect how the DTS collects data.

| | |
|---------|-----------|
| AVG | RATE |
| BIN | PERIOD |
| CVTUNIT | TIME |
| EU | UNITS |
| FORMAT | XSCANTRIG |
| FPS | TYPE |

More information on all of these configuration variables can be found in "Section 5: Software" on page 25.

To initiate scanning, simply send the command: 'SCAN'. If a scan trigger is not being used, data will begin to be output from the DTS module over the Ethernet connection. This data can be collected and recorded using one of the options described in "Client/Host Options" on page 16. If a scan trigger is being used, after the 'SCAN' command is sent one frame of data will be output each time a scan trigger is received.

SCANNING WITH AN EXTERNAL TRIGGER

The DTS module can be triggered to scan with either a hardware or a software trigger. The DTS also incorporates a “trigger divider.” This function allows the unit to be paced at a rate slower than the input trigger rate. More information on the trigger input divider can be found in “Scan Trigger (XSCANTRIG)” on page 52.

HARDWARE TRIGGER

The external trigger input is optically isolated to prevent grounding problems. It is a TTL level, edge sensing device. It requires a minimum signal of 4.5 Vdc @ 6.5 mA. It may accept voltages as high as 15 Vdc. The external trigger will only be active if the XSCANTRIG variable is set to 1 or greater. When a ‘SCAN’ command is issued through the Ethernet connection, the module enters the scan mode and waits for a trigger. The module will return an averaged frame of data for each trigger pulse received. This will continue until the Frames Per Scan (FPS) term is met or until a ‘STOP’ command is issued. Trigger pulses are received through pins 1 (+Trig) and 2 (-Trig) of the ‘Serial Communications/Trigger’ connector on the front of the DTS module. More information on the ‘Serial Communications/Trigger’ connection can be found in “Serial Communications” on page 15.

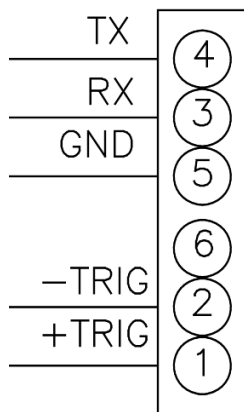


FIGURE 3.5 - TRIGGER WIRING

SOFTWARE TRIGGER

The software trigger will only be active if the software variable XSCANTRIG is set to 1 or greater. When a SCAN command is issued through the Ethernet connection, the module will enter the SCAN mode and wait for a trigger. An averaged frame of data will be output as soon as the TRIG command or a <TAB> character (9 HEX or Control I) is received. Data will be output with each successive trigger command. This will continue until the Frames Per Scan (FPS) variable value is met, or until a STOP command is issued.

DIP SWITCH SETTINGS

The processor board has 4 DIP switches that affect the operation of the software. These switches are only read at power up. Changes to the dip switches are not effective until the power is cycled or the unit is rebooted.

- SW1 - When this switch is on, the application automatically boots on power up. When this switch is off, the DTS4050 remains in the bootloader mode. Default is on.
- SW2 - When this switch is off, the boot loader will run in the debug mode. Debug output is directed to the serial port. Default is off.
- SW3 - This switch sets the device type for the boot-loader. On is for a DTS, off is for a DSA.
- SW4 - Spare.

“Figure 3.6 - DIP Switches” shows the DTS4050 end cover removed and the location of the DIP switches on the processor board. For all DIP switches, “on” is away from the board, towards the bottom of the DTS. (NOTE: this is the opposite of the labels on the switches.)

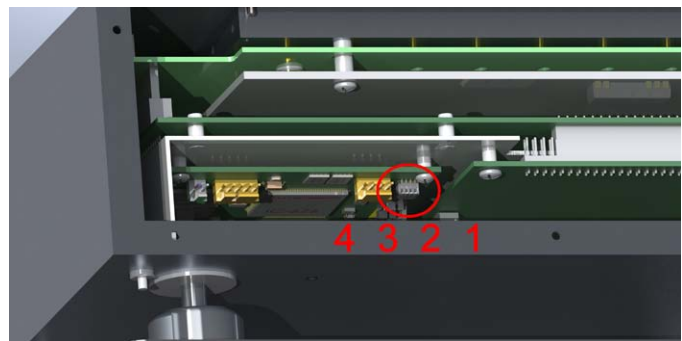


FIGURE 3.6 - DIP SWITCHES

DSP BOOT LOADER

The Scanivalve DSP Boot Loader permits a user to upload the DTS4050 application via FTP. The boot loader runs the FTP server. It has been tested on Mozilla ‘FileZilla’ and Windows Explorer drag and drop. Any additional file transfer protocols or additional FTP client support modification will be made solely to the application. For more information on bootloader operation, refer to “Operating in Bootloader Mode” on page 85.

FTP

The FTP server supports the following FTP commands prior to login:

- USER - Allows the user to enter the user’s name. Anonymous is allowed if the variable ALLOWANON is set to 1.
- PASS - Allows the user to enter the password.
- QUIT - Disconnects from the FTP server.

The FTP server supports the following FTP commands after login:

- RETR - Initiates a file transfer from the DTS to the host.
- STOR - Initiates a file transfer from the host to the DTS.
- PASV - Sets up data port so client can connect to server's port.
- LIST - Returns a directory listing of the files stored on the DTS.
- SIZE - Returns the size in bytes of the file.
- DELE - Deletes the file.
- NOOP - No operation. Mostly used by the client as an "are you still there" command.

ASCII format transfers are the only supported transfer type. Passive data connections are the only supported connection type. This allows data to be transferred without the server initiating a connection to the client. This could cause firewall problems.

BOOT LOADER AND APPLICATION FILE SYSTEM

Filenames are limited to the 8.3 format with no spaces allowed. Only one drive is supported. Because the DTS4050 does not have a time and date clock, all files created will have a date of Aug 8, 2008. No subdirectories are supported, however, if a file path is included in the file specification only the file name portion is used. The file will be written in the root directory of the drive. The disk drive will hold a maximum of 1024 files, or 4MB of data.

HOST COMMUNICATION

Commands are issued to the DTS4050 and response is returned via either the Ethernet port or the Config port. The boot loader returns the command information to the host that it received its command. That is, when the command is received from the network it is returned to the network. When it is received from the serial port, it is returned to the serial port. The SCAN function is not supported in Config/Serial operation. The network supports TCP/IP connection using Telnet or HyperTerminal.

COMMANDS

When a command is complete, a carriage return and line feed is returned.

The commands listed below are supported by the boot loader and the executable program, unless otherwise noted. They may be viewed and modified in the DTS4050 executable program.

- VER - Returns the version of the Boot Loader. NOTE: This command is specific to the boot loader only. It should not be confused with the VER command in the application.
- FDISK - Formats the Flash to all 1's.

LIST IP - Returns the settings of the IP group. This command is explained in detail in the software manual.

SET <parameter> - Set the indicated parameter.

IPADD <IP address> - Sets the IP address of the DTS. If the IPADD is changed, the power must be cycled to take effect.

SUBNET <mask> - Sets the subnet address of the DTS. If the SUBNET is changed, the power must be cycled to take effect.

MAC <MAC address> - Sets the MAC address for the DTS. If the MAC is changed, the power must be cycled to take effect.

LOGIN <user name> - Sets the user name for FTP login.

PASSWORD <password> - Sets the password associated for LOGIN.

LOGIN1 <user name> - Sets the user name 1 for FTP login.

PASSWORD1 <password> - Sets the password associated for LOGIN name1.

ALLOWANON <parameter> - Sets the FTP permission to accept anonymous connections.

APP <application file name> - Sets the file name of the application to run. This is the file name that is used when automatically running the application from the boot loader. It is also the file name used when using the RUN command. If this file is not found, an error is returned.

GW <gateway> - Sets the gateway, if used.

SAVEIP - Saves the configuration variables to the working directory. When an optional file name is entered, it saves the IP group settings to that file name.

TYPE <file name> - Types the contents of the file name.

LOAD <file name> - Loads the file name into the LIST IP configuration variables.

DIR - Lists the file on the FLASH chip.

DEL<file name> - Deletes the file name.

DIP - Reads and shows the settings of the DIP switches.

The following is returned: "DIP settings Auto Run Application 0 Debug 0 No Serial Host 0 Spare 0" where 1 indicates on, 0 indicates off. NOTE: This command is available in the boot loader only.

RUN - Runs the application named in the SET APP setting. NOTE: This command is available in the boot loader only.

IEEE-1588 PTP

The DTS4050 has a hardware supported slave implementation of the Precision Time Protocol defined by IEEE 1588-2008, otherwise known as PTP V2. This protocol is used to synchronize the DTS4050 internal clock over the Ethernet network.

The primary function of the PTP is to accurately schedule the DTS4050 acquisition and timestamp the data it transmits. It can also be used to timestamp an external trigger, such as an IRIG-B pulse rate signal.

The DTS4050 may be configured to start an acquisition at a future date and time. When a SCAN command is received, the DTS4050 schedules an event for the first frame and calculates the times of the subsequent frames of data based on the RATE setting. By configuring them identically, a number of DTS4050 units may be configured to start acquiring data synchronously.

The DTS4050 may also be configured to start an acquisition at a date and time in the past. This will cause the DTS4050 to start acquiring data at the next calculated time interval specified by the start time and RATE setting. For example, if the DTS4050 is configured with a start time of 9:00:00 today, and a very slow rate of one reading per minute, it will take data at an even one minute absolute time. If a SCAN command is received at 10:00:30, it will start taking data at 10:01:00.

There are practical limits to consider when using a scan start time that has passed. If the DTS4050 is configured with a start time at the beginning of the Epoch (1970/1/1 at midnight) it must calculate the time of the next frame over a very long span, resulting in significant rounding errors. The interval between readings and the accuracy of the time stamp will not be affected, but the data may not be taken at the expected absolute time. The solution is to specify a more recently passed start time.

The DTS4050 timestamps the data in either ASCII or binary data formats, when PTP is enabled. In addition, the binary packet includes the elapsed time since the last update from the grandmaster. From this, the user can detect when and if the grandmaster has gone offline. The user may enter an offset to adjust the PTP to reflect local time and/or adjust for leap seconds. The DTS4050 does not automatically adjust for leap seconds, but it does have a command to extract and display the leap second field of the PTP packets sent by the grandmaster. The format of the DTS4050 data packets can be found in "DTS Packet Definitions" on page 73.

The DTS4050 can output status information about the control loop that synchronizes the internal clock with the grandmaster. A line of data is output corresponding to each update from the grandmaster. The offset from master (OFM) is a good measure of how well the DTS4050 is synchronized with the grandmaster. For a complete explanation of the PTP status output see "List Precision Time Protocol" on page 39 and "Precision Time Protocol Variables (LIST PTP)" on page 61.

SECTION 4: HARDWARE

ELECTRICAL CONNECTIONS

ETHERNET CONNECTION

A DTS4050 has one Ethernet connection, 10/100Base-T with MDIX auto-crossing. This is the primary means of communications with the DTS. All DTS modules use a Conec RJ45-IP67 series connector for the Ethernet connection. This connector offers the ability to use a standard RJ-45 Ethernet cable or, when needed the shield can be installed for a more rugged connection. The bulkhead end of the connector is a Conec P/N: 17-101754 and the mating protective shell (optional) is a Conec P/N: 17-101794. The pinout of the connector is as follows:

| Pin | Description |
|-----|-------------|
| 1 | TD+ |
| 2 | TD- |
| 3 | RD+ |
| 4 | RD- |

Shielded Category 5E cable or better is recommended for all Ethernet connections. More information on the Ethernet connection can be found in "Ethernet Communications" on page 16.

TRIGGER/CONFIG CONNECTION

The external trigger/serial configuration connection on the DTS4050 serves a dual purpose. It is used primarily as an input source for a trigger signal, but can also be used to establish a serial connection with the unit in case an Ethernet connection cannot be established. The bulkhead connector used on the DTS is a Bendix JTO2RE8-6P, with the mate being a Bendix JTO1RE8-6S-SR. The pinout of the connector is as follows:

| Pin | Description |
|-----|-------------|
| 1 | +Trig |
| 2 | -Trig |
| 3 | TXD |
| 4 | RXD |
| 5 | Ground |

More information on the external trigger can be found in "Scanning With An External Trigger" on page 18. Information on when and how to use the serial connection can be found in "Serial Communications" on page 15.

POWER CONNECTION

The Power connection on the DTS4050 is a Bendix PTO2A-8-3P, with the mate being a Bendix PTO6A-8-3S-SR. The pinout of the connector is as follows:

| Pin | Description |
|-----|--------------|
| A | 28VDC Return |
| B | +28V |
| C | Ground |

The DTS4050 accepts input voltages ranging from 18-36VDC. Nominal power consumption is as follows:

DTS4050/32Tx: .60A @ 28Vdc

If an optional heater is installed, it is powered directly through the power connection with the unit power. It is the user's responsibility to ensure that sufficient power is provided to the unit in order for proper function.

THERMOCOUPLE INPUTS

SCREW TERMINAL CONNECTIONS

Standard configuration for 16, 32 and 64 channel DTS4050 modules is with screw terminal terminations for the thermocouple inputs. Thermocouples are terminated at the DTS4050 with #6x32 brass screws into the UTR block. Each input provides a +, - and a ground lug. The ground lug for each input is independently isolated. The DTS4050 has an internal, software controlled shield connection switch that can be configured by the operator to support a variety of thermocouple grounding scenarios. The maximum loop resistance for each thermocouple is 300 Ω . See "Thermocouple Type (TYPE)" on page 66 for more information on the shielding configurations supported.



FIGURE 4.1 - SCREW TERMINAL CONNECTIONS

PANEL JACK CONNECTIONS

16 and 32 channel DTS4050 modules may have panel jacks installed as an option. Panel jacks provide a very user-friendly interface for the thermocouple inputs. The DTS4050 panel jack option uses Omega TPJ series connectors. These are compatible with standard size OTP type, 3-prong connectors. This option is available for type E, J, K, and T Thermocouples only. This option reduces the overall accuracy of the module by a factor of two. This error may be calibrated out by the user using the Gain and Offset terms. Unused panel jacks must be plugged to prevent "cold spots" on the UTR which will cause errors.



FIGURE 4.2 - PANEL JACK CONNECTIONS (32Tx SHOWN)

INSULATION COVER (SCREW TERMINAL)

Screw terminal DTS modules are provided with an insulating cover. This cover is used to insulate to UTR and maintain a stable reference temperature. It also serves as a strain relief for the thermocouples. Any time it is possible/practical, the cover should be used. DTS4050/16Tx units have an integral hinged cover while 32Tx and 64Tx unit have a removable cover. It can be easily removed by loosening the four 1/4"x20 lock nuts and lifting the cover off vertically. A minimum of 2.5" of vertical clearance above the cover is required to remove it. When reinstalling the cover, slide it in place (with the pinch bars outside of the cover), firmly press down on the cover and tighten the four lock nuts.

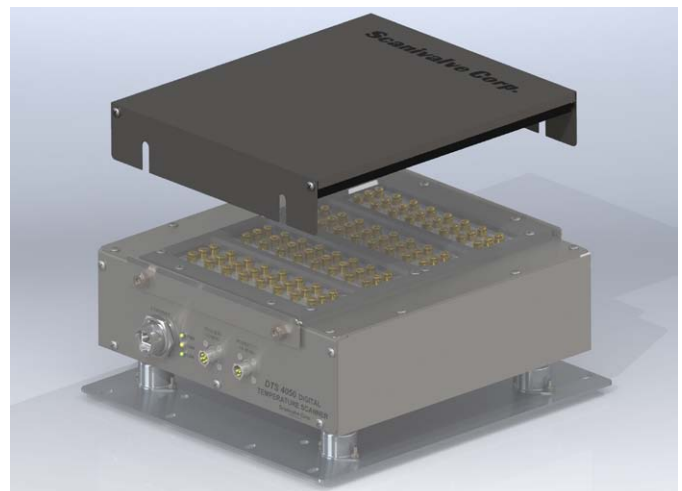


FIGURE 4.3 - INSULATING COVER (32Tx SHOWN)

THERMOCOUPLE GROUNDING SCENARIOS

DTS4050 modules provide input for shielded thermocouple wires and as such, can support multiple different thermocouple grounding scenarios. A software controlled shield connection switch is integrated into each input channel and can be individually set for each channel. The TYPE variable is used to determine whether the switch is open or closed. See "Thermocouple Type (TYPE)" on page 66 for more information about the software command. The following five grounding scenarios are supported by the DTS4050:

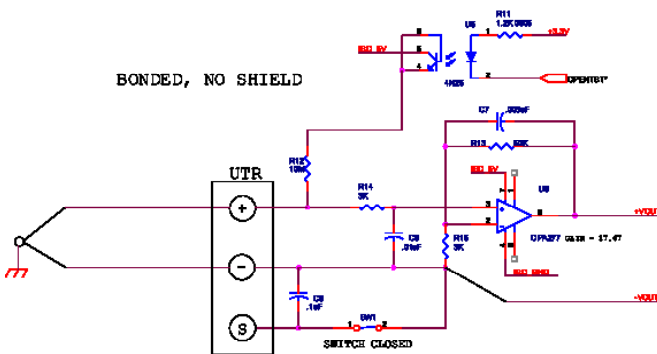


FIGURE 4.4 - BONDED THERMOCOUPLE, NO SHIELD

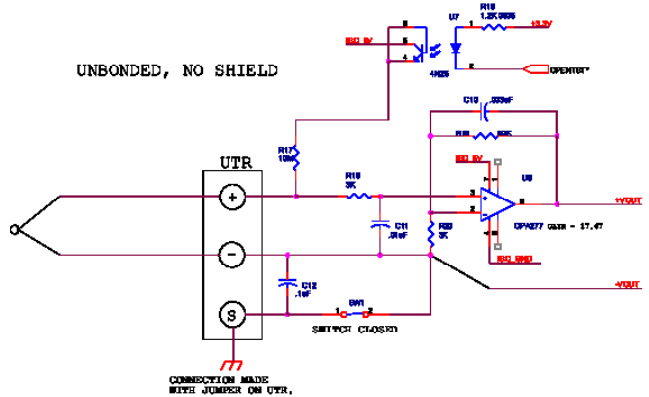


FIGURE 4.5 - UNBONDED THERMOCOUPLE, NO SHIELD

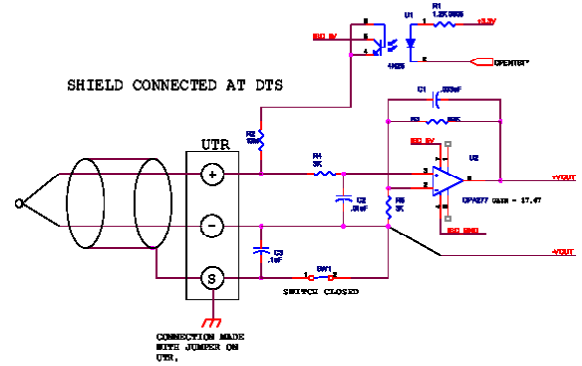


FIGURE 4.6 - SHIELDED THERMOCOUPLE, SHIELD CONNECTED AT DTS

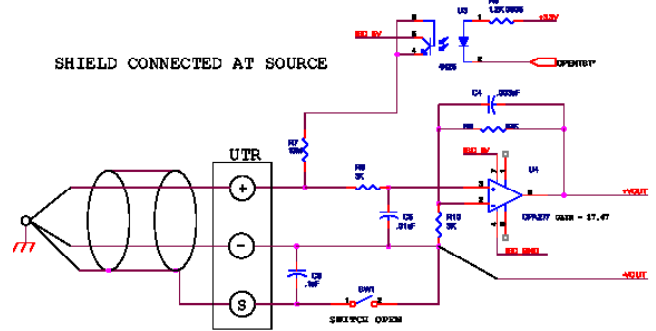


FIGURE 4.7 - SHIELDED THERMOCOUPLE, SHIELD CONNECTED AT SOURCE

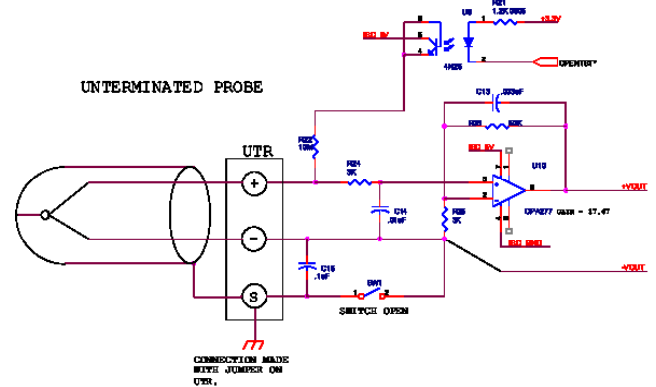


FIGURE 4.8 - UNTERMINATED PROBE THERMOCOUPLE

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SECTION 5: SOFTWARE

DTS CONTROL AND CONFIGURATION

The operation of the DTS is controlled by sending commands to each unit in the form of an ASCII string terminated by a CR or LF character. The DTS receives these commands over an Ethernet or serial physical interface. The DTS Ethernet server receives commands via TCP using the Telnet port 23. The serial interface is fixed to receive and transmit at 9600 baud, full duplex, no parity and 8 data bits.

In general, commands do one of the following: 1) Configure the DTS, 2) Return information about the DTS, or 3) Return temperature data.

Commands that configure the DTS do not return any information. Some commands that take longer to execute put the DTS into a mode until the command is complete.

Commands that return information about the DTS transmit that information back to the same device that requested it over the same physical interface. The term information is used to describe what the DTS returns as the result of non-scan commands. This information is always sent as ASCII strings with each line terminated with a CR or LF.

Commands that return temperature data cause the DTS to go into a Scan Mode. The term "data" is used to describe temperature data read as the result of a scan command. Depending on the configuration, the data may be returned in ASCII formatted with VT100 control characters, ASCII unformatted, or as binary packets. Binary data transfers are delivered across an additional binary transfer port in either UDP or TCP.

TCP TELNET SERVER

The DTS supports a Telnet server on port 23. Commands are received and transmitted according to the Telnet specification. All commands must be terminated properly with one of four options. The DTS will detect and adjust to the termination option being used.

The four options are:

- CR (ASCII 13)
- LF (ASCII 10)
- LF-CR (ASCII 10 - ASCII 13)
- CR-LF (ASCII 13 - ASCII 10)

UDP ID SERVER

The purpose of the UDP ID server is to respond to broadcast packets and return information about each DTS. This is useful in determining the IP address, and other information, of each DTS on a network.

All commands supported in the Telnet server are also supported by the UDP ID server. Command line terminators are the same as required by the Telnet server.

The UDP ID server receives commands on port 7000. Information is returned on port 7001. Formatted and unformatted scan data is not output over the UDP ID server. For more information about data routing see the Data Transfer section.

SERIAL COMMANDS

Commands may be transmitted to the DTS via a serial RS-232 interface. All commands supported in the Telnet server are also supported by the serial interface. Command line terminators are the same as required by the Telnet server.

Formatted and unformatted scan data is not output over the serial interface. For more information about data routing see the Data Transfer section.

DATA TRANSFER

Scan data is routed to different devices based on the configuration of the DTS. Some configurations are not allowed and produce errors. Refer to the chart below for the various output data routing.

DTS 4050 COMMAND AND DATA OUTPUT MATRIX

| Command Source | Command Output | Data Output | Bin | Host | Comment |
|------------------------------|--------------------|------------------|-----|-------|-------------------------------------|
| TCP / Telnet | TCP / Telnet | | X | X | Command returned to Telnet |
| TCP / Telnet (Scan) | | TCP / Telnet | 0 | X | ASCII Data to Telnet |
| TCP / Telnet (Scan) | | TCP to host <IP> | 1 | <IP>T | Binary TCP Data to IP Address |
| TCP / Telnet (Scan) | | UDP to host <IP> | 1 | <IP>U | Binary UDP Data to IP Address |
| Serial | Serial | | X | X | Command returned to Serial Port |
| Serial (Scan) | ERROR | | X | X | Serial data not supported |
| UDP ID (Port 7000) | UDP ID (Port 7000) | | X | X | ID Server command back to ID Client |
| UDP ID (Port 7000) (Scan) | ERROR | | X | X | ID Server data not supported |

COMMAND LIST**A/D CALIBRATION**

| | |
|-----------------------|--|
| Command | A/D CALIBRATION |
| Command Syntax | ADCAL |
| Arguments | None |
| Description | Commands the DTS to calibrate the A/D converters. The A/D converters are calibrated automatically at power up and whenever the period configuration variable is set. It is possible for errors in the conversion if the temperature of the DTS has changed significantly since power up. In this case, the A/D converters can be calibrated by issuing this command. |
| Returns | <nl> - end of line |
| Example | To calibrate the A/D converters after several hours of operation, the following command would be issued: ADCAL <CR> The A/D converters will be calibrated. The time depends upon the setting of CALAVG. If CALAVG is set to 1, the time will be several seconds. If CALAVG is set to 64 this can require several minutes. |
| Notes | It is recommended that a user check for A/D errors after the execution of this command. If an A/D times out or does not respond correctly, it will be disabled in software and an error will be logged. The error log is the only indication that this has occurred. The failed channel will only output 9999 readings. |

AUTO STATUS

| | |
|-----------------------|---|
| Command | AUTOSTATUS |
| Command Syntax | AUTOSTATUS <enable> AS <enable> (OPTIONAL) |
| Arguments | Enable - 0 or 1 |
| Description | If autostatus enable is set to 1, the DTS will automatically output the status of the DTS whenever the status changes. When set to 0, status can only be determined by issuing a STATUS command. The condition at power up and after a reboot is AUTOSTATUS disabled. |
| Returns | <nl> - end of line |
| Example | To enable automatic output of the DTS status, the following command would be issued: AUTOSTATUS 1 To disable automatic output of the DTS status, the following command would be issued: AUTOSTATUS 0 |
| Notes | AUTOTATUS was not set up as a configuration variable that could be saved to prevent conditions where the DTS would be talking on a network when it was not expected to be talking. An optional syntax is available. Either syntax will enable or disable Autostatus. |

BOOTLOADER VERSION

| | |
|-----------------------|--|
| Command | BOOTLOADER VERSION |
| Command Syntax | BLVER |
| Arguments | None |
| Description | Requests the version of the DTS4050 bootloader |
| Returns | <version string><n> |
| Example | To determine the version of DTS4050 bootloader software in use, type: BLVER<CR> The DTS module will return: Bootloader Version: 1.00 |

CLEAR

| | |
|-----------------------|--|
| Command | CLEAR |
| Command Syntax | CLEAR |
| Arguments | None |
| Description | Commands the DTS to clear any errors that have occurred. The errors are sent to the client in an ASCII Packet. ASCII Packets are described in a subsequent sections. |
| Returns | <n> - end of line |
| Example | To clear any errors listed in the ERROR Buffer, type: CLEAR <CR> The ERROR buffer will be cleared |

CLOSE HOST BINARY SERVER CONNECTION

| | |
|-----------------------|--|
| Command | CLOSE HOST BINARY SERVER CONNECTION |
| Command Syntax | CLOBIN |
| Arguments | None |
| Description | Commands the DTS to close the connection to the Host Binary Server. This command will only be accepted by the DTS when the DTS is in the READY mode. |
| Returns | <n> - end of line |
| Example | To close the connection to the Host Binary Server, type: CLOBIN <CR> The connection will be terminated |

CONNECT TO HOST BINARY SERVER

| | |
|-----------------------|---|
| Command | CONNECT TO HOST BINARY SERVER |
| Command Syntax | CONBIN |
| Arguments | None |
| Description | Commands the DTS to connect to the Host Binary Server configured through the HOST configuration variable. If the DTS is in the UDP mode or if a TCP connection is already established, an Error will be generated. This command will only be accepted when the DTS is in the READY mode. |
| Returns | <nI> - end of line |
| Example | <p>EXAMPLE 1 A DTS is not connected to a server, is not in the UDP mode and is in the READY mode. A CONBIN command is generated to open a connection to the Host. Type: CONBIN <CR> The DTS will be connected to the Host.</p> <p>EXAMPLE 2 A DTS is not connected to a server, is in the UDP mode and is in the READY mode. A CONBIN command is generated to open a connection to the Host. Type: CONBIN <CR> The DTS will not connect to the Host and an Error will be generated.</p> <p>EXAMPLE 3 A DTS is not connected to a server, is in the UDP mode and is in the SCAN mode. A CONBIN command is generated to open a connection to the Host. Type: CONBIN <CR> The DTS will not connect to the Host and an Error will be generated.</p> |

CORRECT RTD VOLTAGE TABLES

| | |
|-----------------------|--|
| Command | CORRECT RTD VOLTAGE TABLES |
| Command Syntax | ARPC <Reference Temperature> <RTD number> |
| Arguments | Reference Temperature - The indicated temperature of the standard RTD. Board - The RTD to be corrected. (1 to 8) |
| Description | This command calculates the voltage difference, in microvolts between the Reference RTD value and the voltage value of the RTDs in the board set entered in the command. The calculated value is stored in the ARPC variable for that board set. If ARPCON is set to 1, this value will be used to correct the board set RTD voltages before the Calander Van-Dusen correction is applied to the RTDs. The ARPC command may only be entered for the number of board sets installed. Board values outside the allowed number will result in an error. |
| Returns | <nI> - end of line |
| Example | <p>To calculate a correction for board 1 in a 16 channel module when the reference RTD is 29.95 degrees C:</p> <p>Type: ARPC 29.95 1<Enter></p> |
| Notes | This command will update the ARPC variables, but the data will not be saved until a SAVE command is issued. Scanivalve Corp recommends that a user verify that the correction generated is valid before issuing a SAVE command. The values stored in the ARPC variables will be lost if power is cycled before a SAVE command is executed. |

ENTER CHANNEL CALIBRATION SETPOINTS

| | |
|-----------------------|---|
| Command | ENTER CHANNEL CALIBRATION SETPOINTS |
| Command Syntax | PT <index> <volts> [channel] |
| Arguments | Index - The setpoint number, 0 to 7 for setpoints 1 to 8. Volts - The applied voltage. Channel - Optional: If not specified the setpoint voltage will be applied to all channels. |
| Description | This command syntax is only used when NUMTEMPMS is set to 0. This command enters the voltage correction to be applied at a given setpoint for one or more channels. The values for the setpoints do not have specific limitations. |
| Returns | <nl> - end of line |
| Example | To enter a value for setpoint 1 for all channels, type: PT 1 1.256<Enter> To enter a value for setpoint 2 for channel 9, type: PT 2 1.744 9<Enter> |
| Notes | This command syntax is used only if NUMTEMPMS is set to 0. The value of NUMTEMPMS MUST NOT be modified by an end user without detailed and specific training from Scanivalve Corp. If the value of NUMTEMPMS is modified after the unit has been calibrated, ALL current calibration coefficients will be LOST. |

ENTER RTD CALIBRATION SETPOINTS

| | |
|-----------------------|---|
| Command | ENTER RTD CALIBRATION SETPOINTS |
| Command Syntax | RPC <index> <volts> <board> |
| Arguments | Index - The setpoint number, 0 to 7 for setpoints 1 to 8. Volts - The applied voltage. Board - The A/D board, 1, 2, 3 or 4 |
| Description | This command enters the voltage correction to be applied at a given setpoint for the RTD=s. The values for the setpoints must be between 0.095 Vdc and 0.131 Vdc which represents temperatures from -13 " C to 80 " C . The voltage for board 1 must be inserted in the RTD1 input. The voltage for board 2 must be inserted in the RTD3 input. The voltage for board 3 must be inserted in the RTD5 input. The voltage for board 4 must be inserted in the RTD7 input. |
| Returns | <nl> - end of line |
| Example | To enter a value for setpoint 1 for the RTD=s on board 2, type: RPC 1 0.095 2<Enter> To enter a value for setpoint 2 for the RTD=s on board 1, type: RPC 2 0.998 1<Enter> |

ERROR

| | |
|-----------------------|---|
| Command | ERROR |
| Command Syntax | ERROR |
| Arguments | None |
| Description | Lists the errors that are stored and listed after a CLEAR. Only the first 72 errors will be listed. If more than 72 errors have occurred, the message: AERROR: Max Errors exceeded @will appear at the end of the list. |
| Returns | A list of errors in the following format: ERROR: error ERROR: error ERROR: error |
| Example | To read the contents of the Error Buffer, type: ERROR<Enter> The DTS will return the last 72 errors in the format: ERROR: QPKTS not 0 ERROR: Set parameter PPER invalid ERROR: Set parameter CLKOUT invalid ERROR: Invalid command st ERROR: AllowAnon value not 0 or 1 ERROR: AllowAnon value not found ERROR: Invalid command ist If no errors have been logged, the DTS will return: ERROR: No errors |

FILL

| | |
|-----------------------|---|
| Command | FILL |
| Command Syntax | FILL |
| Arguments | None |
| Description | Activates the setpoint data. If setpoints are configured, a FILL will be executed automatically at power-up. A FILL can be executed manually at any time. |
| Returns | <nl> - end of line |
| Example | To execute a FILL and activate the setpoints, type: FILL<CR> |

GET PTP TIME

| | |
|-----------------------|--|
| Command | GET PTP TIME |
| Command Syntax | GETTIME |
| Arguments | None |
| Description | Gets the current PTP time as used by the DTS. Time is adjusted by UTCOFFSET. |
| Returns | Time string in the format: Current Time year/month/day hour:minute:seconds sec xxxxxxxxxxx ns xxxxxxxxxxx |
| Example | To execute a GETTIME, type: GETTIME<CR> Returns: Current Time 2013/8/15 18:3:55.0 sec 1376589835 ns 633723603 |

GET UTC OFFSET

| | |
|-----------------------|--|
| Command | GET UTC OFFSET |
| Command Syntax | GETUTCO |
| Arguments | None |
| Description | Gets the current UTC offset. |
| Returns | The current UTC offset in seconds, UTC updated flag and Set when UTC offset is valid in the format: Current UTC Offset <seconds> <update> <valid> |
| Example | To execute a GETUTCO, type: GETUTCO<CR> Returns: Current UTC Offset 0 1 0 |

HOST BINARY SERVER COMMAND

| | |
|-----------------------|---|
| Command | HOST BINARY SERVER COMMAND |
| Command Syntax | HOST <command> |
| Arguments | Command - An ASCII command that would be recognized by the Host Binary Server. |
| Description | This command will pass a Host Binary Server command through the DTS to the Host Binary Server |
| Returns | <nl> - end of line |

ICE POINT OFFSET ADJUSTMENT

| | |
|-----------------------|--|
| Command | ICE POINT OFFSET ADJUSTMENT |
| Command Syntax | IPO <start channel> <end channel> |
| Arguments | <start channel> - the first channel to be adjusted. <end channel> - the last channel to be adjusted |
| Description | Commands the DTS to calculate and adjust the offset settings for the channels specified. If an end channel is not specified, only the start channel will be modified. This command assumes that 0 degrees C is applied to the specified channels. A SAVE command must be issued when this command is completed to make the changes permanent |
| Returns | <nl> - end of line |

LIST BOOTLOADER GROUP VARIABLES

| | |
|-----------------------|---|
| Command | LIST BOOTLOADER GROUP VARIABLES |
| Command Syntax | LIST IP |
| Arguments | None |
| Description | Lists the variables for the bootloader configuration from the Group IP. |
| Returns | <pre> SET IPADD <var> SET SUBNET <var> SET MAC <var> SET LOGIN <var> SET PASSWORD <var> SET LOGIN1 <var> SET PASSWORD1 <var> SET ALLOWANON <var> SET APP <var> SET GW <var> </pre> <var> - variable |
| Example | <p>To view the current Bootloader Group variable settings, type: LIST IP <CR> The DTS4050 will return the current bootloader variable settings, The could appear as follows:</p> <pre> SET IPADD 191.30.41.104 SET SUBNET 255.255.0.0 SET MAC 000.096.093.400.000.103 SET LOGIN Scanivalve SET PASSWORD Scanner SET LOGIN1 Scanivalve1 SET PASSWORD1 Scanner1 SET ALLOWANON 1 SET APP Dts4000.hex SET GW 10.0.0.1 </pre> |
| Notes | The variables in this group are NOT saved when a SAVE command is issued. They may be only saved by using the SAVEIP command. |

LIST CALIBRATION

| | |
|-----------------------|--|
| Command | LIST CALIBRATION |
| Command Syntax | LIST C |
| Arguments | None |
| Description | Lists the calibration configuration variables. |
| Returns | <pre> SET NUMCOEF <var> SET NUMPTS <var> SET CALAVG <var> SET NUMTEMP <var> </pre> <var> - variable |
| Example | <p>To view the calibration configuration variable settings, type: LIST C<CR> The DTS will return the calibration configuration variable settings, such as:</p> <pre> SET NUMCOEF 3 SET NUMPTS 8 SET CALAVG 4 SET NUMTEMP 0 </pre> |

LIST CHANNEL CORRECTION SETPOINTS

| | |
|-----------------------|---|
| Command | LIST CHANNEL CORRECTION SETPOINTS |
| Command Syntax | LIST P <channel> |
| Arguments | Channel - is any valid channel number from 0 to 16, 32 or 64 depending on the module type. |
| Description | Lists the calibration setpoints for the channel listed. If channel 0 is specified, the setpoints for all channels will be listed. |
| Returns | <pre> SET PT 1 0 <var1> <var2> SET PT 1 1 <var1> <var2> SET PT 1 2 <var1> <var2> SET PT 1 3 <var1> <var2> SET PT 1 4 <var1> <var2> SET PT 1 5 <var1> <var2> SET PT 1 6 <var1> <var2> SET PT 1 7 <var1> <var2> </pre> <p><var> - variable</p> |
| Example | <p>To view the calibration setpoints for channel 1: Type: LIST P 1<CR> The DTS returns:</p> <pre> SET PT 1 0 -0.010000 -275283 SET PT 1 1 0.000000 1288 SET PT 1 2 0.012000 333064 SET PT 1 3 0.024000 664759 SET PT 1 4 0.036000 996312 SET PT 1 5 0.048000 1327909 SET PT 1 6 0.060000 1659352 SET PT 1 7 0.070000 1935411 </pre> |
| Notes | <p>The values shown here are values a typical one module. The actual calibration setpoints in a different module may be different.</p> <p>This syntax is used only when NUMTEMPS is set to 0.</p> |

LIST CHANNEL CORRECTION SETPOINTS (MULTI-TEMPERATURE CALIBRATION)

| | |
|-----------------------|--|
| Command | LIST CHANNEL CORRECTION SETPOINTS (Multi-Temperature Calibration) |
| Command Syntax | LIST P [<type> <chan/board> <temp>] |
| Arguments | Type - T/C or RTD Chan/board - A single channel, 1 to 64 for T/C or 1 to 4 for RTD. A range of channels; start chan..end chan. Temp - a single temp, a range of temperature indexes; start temp..end temp. |
| Description | Lists the calibration setpoints with the following conditions: <ol style="list-style-type: none"> 1. If no variables are specified, the setpoints for all T/C and RTD channels will be listed. 2. If only T or R is specified, all T/C or all RTD channels will be listed. 3. If T or R and chan/board are specified, a single channel or range of channels for T/Cs or RTDs will be specified. 4. If T or R and chan/board and temp are specified, a single channel or range of channels, and a single temperature or range of temperatures |
| Example | To view the calibration setpoints for RTD channel 1 at 23 degrees C, type: LIST P R 1 23<CR> The DTS returns: SET PT 1 0 -0.010000 -275283 |
| Notes | The values shown here are values a typical one module. The actual calibration setpoints in a different module may be different. This syntax is used only when NUMTEMPS is set to 1 or greater. |

LIST CHANNEL DEFINITIONS

| | |
|-----------------------|--|
| Command | LIST CHANNEL DEFINITIONS |
| Command Syntax | LIST DEF <channel> |
| Arguments | Channel - is a valid channel number 1 through 64, depending on the module type. |
| Description | Lists the channel definitions for the specified channel. Only one channel may be specified at a time because of the size of the returned ASCII string. The definition for each channel may be 2048 bytes |
| Example | To view the calibration setpoints for channel 1, type: LIST DEF 1<CR> The DTS returns: SET DEF 1 < ASCII String up to 2048 bytes> |

LIST CONFIGURATION VARIABLES

| | |
|-----------------------|--|
| Command | LIST CONFIGURATION VARIABLES |
| Command Syntax | LIST A |
| Arguments | None |
| Description | Lists all of the configuration variables including calibration coefficients. |
| Example | To view or log the configuration variables, type: LIST A<CR> The DTS will return all configuration variables. |

LIST FILES

| | |
|-----------------------|---|
| Command | LIST FILES |
| Command Syntax | DIR |
| Arguments | None |
| Description | Lists the data files stored in the DTS4050 folder on the DTS4050 system flash chip. |
| Example | To list all data files stored on the DTS4050 system computer drive, type: DIRFILE<CR> The DTS will return a file list, typically similar to: <pre> -rw-r--r-- 1 1 217 Aug 1 2008 ip.cfg -rw-r--r-- 1 1 340999 Aug 1 2008 DTS4000.BIT -rw-r--r-- 1 1 610058 Aug 1 2008 Dts4000.hex -rw-r--r-- 1 1 221 Aug 1 2008 ptp.cfg -rw-r--r-- 1 1 25 Aug 1 2008 hw.cfg </pre> |

LIST GAIN

| | |
|-----------------------|--|
| Command | LIST GAIN |
| Command Syntax | LIST G |
| Arguments | None |
| Description | Lists the thermocouple gain correction assigned to the channel listed. |
| Example | To view the thermocouple gain settings in a 16 channel module, type: LIST G <CR> The DTS will return all of the thermocouple gain settings. They could appear as follows. <pre> SET GAIN 1 1.11 SET GAIN 2 1.01 SET GAIN 3 0.98 : : : : : : : : : : : : : : : : SET GAIN 13 1.06 SET GAIN 14 1.00 SET GAIN 15 0.99 SET GAIN 16 1.10 </pre> |

LIST IDENTIFICATION

| | |
|-----------------------|--|
| Command | LIST IDENTIFICATION |
| Command Syntax | LIST I |
| Arguments | None |
| Description | Lists the IDENTIFICATION configuration variables. |
| Example | To verify the general module configuration settings, type: LIST I<CR> The DTS will return: SET ECHO 0 SET AUTOCON 0 SET HOST 0 0 T SET HOSTCMD 0 SET TCMAXSLEW 50000 SET RTDMAXSLEW 64000 SET TITLE1 DTS4050/32Tx SET TITLE2 Version 1.00 SET PORT 0 |

LIST LABELS

| | |
|-----------------------|---|
| Command | LIST LABELS |
| Command Syntax | LIST LA |
| Arguments | None |
| Description | Lists the user-definable channel labels. |
| Example | To view the channel labels, type: LIST LA<CR> The DTS will return: SET LABEL 1 T/C1 SET LABEL 2 T/C2 SET LABEL 3 T/C3 : : : : : : : : : : : : : : : : SET LABEL 14 T/C14 SET LABEL 15 T/C15 SET LABEL 16 T/C16 |

LIST LIMITS

| | |
|-----------------------|---|
| Command | LIST LIMITS |
| Command Syntax | LIST LI |
| Arguments | None |
| Description | Lists the channel high and low limits for alarms |
| Example | <p>To verify the channel limit settings for a 16 channel module, type: LIST LI<CR> The DTS will return:</p> <pre> SET LIMIT 1 1 500.00 -50.00 SET LIMIT 2 1 500.00 -50.00 SET LIMIT 3 1 500.00 -50.00 : SET LIMIT 13 1 500.00 -50.00 SET LIMIT 14 1 500.00 -50.00 SET LIMIT 15 1 500.00 -50.00 SET LIMIT 16 1 500.00 -50.00 </pre> |

LIST NETWORK IDENTIFICATION

| | |
|-----------------------|--|
| Command | LIST IDENTIFICATION |
| Command Syntax | LIST ID |
| Arguments | None |
| Description | Lists the MODULE NETWORK IDENTIFICATION configuration variables to support the Network ID command. |
| Example | <p>To verify the Network Identification configuration settings, type: LIST ID<CR> The DTS will return:</p> <pre> SET IPADD <IP address> SET MODEL <Model/channels> SET SERNUM <Serial number> SET VER <Firmware Version> </pre> |
| Notes | <p>The variable VER are listed to display current setting only. It cannot be changed by the user from the LIST ID group.</p> <p>The variable IPADD will only be saved after the SAVEIP command is sent. The SAVE command will not save the IPADD variable.</p> |

LIST OFFSET

| | |
|-----------------------|---|
| Command | LIST OFFSET |
| Command Syntax | LIST O |
| Arguments | None |
| Description | Lists the thermocouple offset correction assigned to the channel specified. The OFFSET values are A/D counts. |
| Example | To view all of the thermocouple offset settings in a 16 channel module, type: LIST O <CR> The DTS will return the thermocouple offset settings. They could appear as follows: <pre> SET OFFSET 1 120 SET OFFSET 2 77 SET OFFSET 3 78 : : : : : : : : : : : : : : : : SET OFFSET 14 124 SET OFFSET 15 81 SET OFFSET 16 25 </pre> |

LIST PRECISION TIME PROTOCOL

| | |
|-----------------------|--|
| Command | LIST PRECISION TIME PROTOCOL |
| Command Syntax | LIST PTP |
| Arguments | None |
| Description | Lists the variables related to the Group PTP, Precision Time Protocol. |
| Example | To view all of the PTP settings, type: LIST PTP<CR> The DTS will return the current PTP settings. They typically appear as follows. <pre> SET PTPEN 0 SET TUNE 10 0.500000 500000 5 SET SLL 1 SET STAT 0 SET SST 0:0:0.000000 SET SSD 1971/1/1 SET UC 1 SET INTERVAL 100000 SET ADJDRIIFT 100 100000 SET UTCOFFSET 00:00:00 </pre> |
| Notes | The variables in this group are NOT saved when a SAVE command is issued. They may be only saved by using the SAVEPTP command. |

LIST RTD CORRECTION VALUES

| | |
|-----------------------|--|
| Command | LIST RTD CORRECTION VALUES |
| Command Syntax | LIST RPC <board> |
| Arguments | Board - The A/D board 1, 2, 3 or 4 |
| Description | Lists the RTD correction values |
| Example | <p>This command is used to verify the RTD correction values for each A/D board. To view the RTD correction values for A/D board 3, type: LIST RPC 3<CR></p> <p>The DTS will return:</p> <pre> SET RPC 3 0 0.095000 1271278 SET RPC 3 1 0.100000 1338897 SET RPC 3 2 0.105000 1406643 SET RPC 3 3 0.110000 1474311 SET RPC 3 4 0.115000 1542011 SET RPC 3 5 0.120000 1609718 SET RPC 3 6 0.125000 1677418 SET RPC 3 7 0.131000 1758718 </pre> |
| Notes | The values shown here are values for a standard module. The actual calibration setpoints for another module may be different. |

LIST RTD CONVERSION VALUES

| | |
|-----------------------|---|
| Command | LIST RTD CONVERSION VALUES |
| Command Syntax | LIST RTDP |
| Arguments | None |
| Description | Lists the RTD conversion values for all RTD channels. There will be two values for a 16 channel module, 4 values for a 32 channel module and 8 values for a 64 channel module |
| Example | <p>This command is used to verify the RTD correction values of the DTS, type: LIST RTD<CR></p> <p>A 64 channel DTS may return:</p> <pre> SET RTD 1 100.0000 3.908e-0-3 -5.775e-07 SET RTD 2 100.0000 3.908e-0-3 -5.775e-07 SET RTD 3 100.0000 3.908e-0-3 -5.775e-07 SET RTD 4 100.0000 3.908e-0-3 -5.775e-07 SET RTD 5 100.0000 3.908e-0-3 -5.775e-07 SET RTD 6 100.0000 3.908e-0-3 -5.775e-07 SET RTD 7 100.0000 3.908e-0-3 -5.775e-07 SET RTD 8 100.0000 3.908e-0-3 -5.775e-07 </pre> |
| Notes | The values shown here are values for an ideal module. The actual calibration setpoints may be different. |

LIST RTD CURRENT CONVERSION VALUES

| | |
|-----------------------|---|
| Command | LIST RTD CURRENT CONVERSION VALUES |
| Command Syntax | LIST RTDX |
| Arguments | None |
| Description | Lists the RTD current conversion values for all RTD channels. There will be two values for a 16 channel module, 4 values for a 32 channel module and 8 values for a 64 channel module. |
| Example | <p>This command is used to verify the RTD current correction values of the DTS. This variable corrects for errors in the RTD excitation circuit.</p> <p>Type: LIST RTDX<CR></p> <p>A 64 channel DTS will return:</p> <pre> SET RTDX 1 1.0000000 SET RTDX 2 1.0000000 SET RTDX3 1.0000000 SET RTDX 4 1.0000000 SET RTDX 5 1.0000000 SET RTDX 6 1.0000000 SET RTDX7 1.0000000 SET RTDX 8 1.0000000 </pre> |
| Notes | The values shown here are values for an ideal RTD excitation circuit. The actual values may be different. |

LIST SCAN VARIABLES

| | |
|-----------------------|---|
| Command | LIST SCAN VARIABLES |
| Command Syntax | LIST S |
| Arguments | None |
| Description | Lists the SCAN configuration variables. |
| Example | <p>This command is used to verify the general scan settings of the DTS, type: LIST S<CR></p> <p>The DTS will return:</p> <pre> SET PERIOD 1562.50000 SET AVG 4 SET FPS 0 SET XSCANTRIG 0 SET FORMAT 0 SET TIME 2 SET BIN 0 SET QPKTS 0 SET UNITS C SET RANGEV -9999.999 9999.999 SET RANGET -9999.99 9999.99 SET RATE 5.0000 </pre> |

LIST UTR CALIBRATION VARIABLES

| | |
|-----------------------|---|
| Command | LIST UTR CALIBRATION VARIABLES |
| Command Syntax | LIST U |
| Arguments | None |
| Description | Lists the RTD calibration configuration variables |
| Example | This command is used to verify the calibration configuration settings of the DTS, type: LIST U<CR> The DTS will return: SET RNUMCOEF 3 SET RNUMPTS 8 SET MAXDELTA 1.000000 SET ARPCON 0 SET ARPC 1 0.000 |
| Notes | The values shown here are values for a standard module. The actual calibration setpoints for a different module may be different. A 16 channel module will only display ARPC 1 and ARPC 2. A 32 channel module will display ARPC 1, ARPC 2, ARPC 3 and ARPC 4. A 64 channel module will display ARPC 1, ARPC 2, ARPC 3, ARPC 4, ARPC 5, ARPC 6, ARPC 7 and ARPC 8. |

OPEN THERMOCOUPLE TEST

| | |
|-----------------------|--|
| Command | OPEN THERMOCOUPLE TEST |
| Command Syntax | OTC |
| Arguments | None |
| Description | Commands the DTS to test for open thermocouples. The command causes a small current to be applied to each thermocouple. If a thermocouple is found to be open, an error is logged and bit 12 in the channel status element of the data packet is set to a 1 (1000Hex). Also, the channel status code for an open channel will be 2000 if scanning with FORMAT set to 0. This command is NOT performed automatically at power up. |
| Example | To test for open thermocouples, type: OTC<CR> To see the results of the test, type: ERROR<CR> If any thermocouple circuits are found open, an error will be logged in the error log. |

CLEAR ACCUMULATED PTP DATA

| | |
|-----------------------|--|
| Command | CLEAR ACCUMULATED PTP DATA |
| Command Syntax | PTPCLEAR |
| Arguments | None |
| Description | Clears the accumulated data in the histogram buffers and restarts sampling. |
| Example | To clear the accumulated date from the histogram buffer, type: PTPCLEAR<CR> The DTS module will return: <nl> |

DISPLAY PTP STATISTICS

| | |
|-----------------------|---|
| Command | DISPLAY PTP STATISTICS |
| Command Syntax | PTPSTAT |
| Arguments | None |
| Description | Displays the accumulated data in histogram form. |
| Returns | The histogram output is in the form: OFM, INTERVAL, <interval value>, <interval -6>, <interval -5>, <interval -4>, <interval -3>, <interval -2>, <interval -1>, <interval 0>, <interval 1>, <interval 2>, <interval 3>, <interval 4>, <interval 5>, <interval 6> |
| Example | To display the PTP statistics, type: PTPSTAT<CR> The DTS will return: OFM, INTERVAL, 100000, 114, 13, 10, 23, 21, 15, 36, 6, 12, 9, 23, 10, 129 |

REBOOT

| | |
|-----------------------|---|
| Command | REBOOT |
| Command Syntax | REBOOT RESTART (optional) |
| Arguments | None |
| Description | Commands the DTS to reboot. Any coefficients and configuration variables that have not been saved will be reset to the last saved values. |
| Example | To reboot from the network, type: REBOOT<CR> |
| Notes | The RESTART and the REBOOT command are identical and perform the same task |

SAVE

| | |
|-----------------------|---|
| Command | SAVE |
| Command Syntax | SAVE |
| Arguments | None |
| Description | Commands the DTS to save the RAM image of Non Volatile Memory(NVM). Any change to a configuration variable must be followed by a SAVE command if the change is to be permanent. |
| Returns | <nl> - end of line. |
| Example | To save the current configuration variable settings and conversion coefficients, type: SAVE<CR> |

SAVE BOOTLOADER VARIABLES

| | |
|-----------------------|--|
| Command | SAVE BOOTLOADER VARIABLES |
| Command Syntax | SAVEIP |
| Arguments | None |
| Description | Commands the DTS to save the current settings for the LIST IP variables from RAM into Non Volatile Memory (NVM). Any change to a configuration variable in the LIST IP group must be followed by a SAVEIP command if the change is to be permanent. |
| Returns | “WARNING: This action could cause network communication problem. Type SAVEIPCONFIRM to confirm the changes to the LIST IP group, or STOP to cancel the operation” <nI> - End of line. |
| Example | To save the current configuration of the LIST IP variables, type: SAVEIP<CR> The software will return the following message: “WARNING: This action could cause network communication problem. Type SAVEIPCONFIRM to confirm the changes to the LIST IP group, or STOP to cancel the operation” Type: SAVEIPCONFIRM<CR> to complete the save. |
| Notes | Changes to the bootloader configuration variables will not take effect until power is cycled, or a REBOOT command is issued. The SAVEIP command may require approximately 5 seconds to complete, depending on the configuration. DO NOT issue a RESTART command, or cycle power during this time. The SAVEIP operation has been completed when a caret (>) is returned. Normally, commands entered during this time would be ignored, but it is possible on rare occasions to cause the DTS4050 firmware to freeze. |

SAVE PTP VARIABLES

| | |
|-----------------------|--|
| Command | SAVE PTP VARIABLES |
| Command Syntax | SAVEPTP |
| Arguments | None |
| Description | Commands the DTS to save the current settings for the LIST PTP variables from RAM into Non Volatile Memory (NVM). Any change to a configuration variable in the LIST PTP group must be followed by a SAVEPTP command if the change is to be permanent. |
| Returns | <nI> - End of line. |
| Example | To save the current configuration settings from the LIST PTP group, type: SAVEPTP<CR> |

SCAN

| Command | SCAN | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|-----------------------|---|-------------|-------------|----------|------|-------------------------|---|------|---------------------|---|------|-----------------------|---|------|------------------------|---|------|-----------------------|---|------|------------------------|---|------|-------------------|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Command Syntax | SCAN | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Arguments | None | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Description | Commands the DTS to scan the thermocouples and send Scan packets to the client. Data are returned immediately if XSCANTRIG is set to 0. If XSCANTRIG is set to 1, data will be returned after a hardware trigger, or a software trigger. For more information on software triggers, refer to the SCAN TRIGGER command. For Hardware trigger requirements, refer to the Trigger Requirements section. | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Returns | <p>Scan data formatted by the setting of EU, BIN, and FORMAT. Refer to the examples for more information. When FORMAT is set to 0, a channel status code will be returned with the data for each channel. If multiple errors exist the code with the highest priority will be the only code displayed:</p> <table border="1"> <thead> <tr> <th>STATUS CODE</th> <th>DESCRIPTION</th> <th>PRIORITY</th> </tr> </thead> <tbody> <tr> <td>1000</td> <td>Channel A/D is disabled</td> <td>1</td> </tr> <tr> <td>2000</td> <td>Channel T/C is open</td> <td>2</td> </tr> <tr> <td>3000</td> <td>Channel is over range</td> <td>3</td> </tr> <tr> <td>4000</td> <td>Channel is under range</td> <td>4</td> </tr> <tr> <td>5000</td> <td>Channel is over limit</td> <td>5</td> </tr> <tr> <td>6000</td> <td>Channel is under limit</td> <td>6</td> </tr> </tbody> </table> <p>In addition to the “error” portion of the status code, the last digit in the code (or the only digit if a single digit code) is used to identify the thermocouple type that the channel is set to. The codes for the thermocouple types are:</p> <table border="1"> <thead> <tr> <th>CODE</th> <th>Thermocouple Type</th> </tr> </thead> <tbody> <tr> <td>0</td> <td>J</td> </tr> <tr> <td>2</td> <td>E</td> </tr> <tr> <td>4</td> <td>K</td> </tr> <tr> <td>6</td> <td>N</td> </tr> <tr> <td>8</td> <td>R</td> </tr> <tr> <td>A</td> <td>S</td> </tr> <tr> <td>C</td> <td>T</td> </tr> <tr> <td>E</td> <td>B</td> </tr> </tbody> </table> | STATUS CODE | DESCRIPTION | PRIORITY | 1000 | Channel A/D is disabled | 1 | 2000 | Channel T/C is open | 2 | 3000 | Channel is over range | 3 | 4000 | Channel is under range | 4 | 5000 | Channel is over limit | 5 | 6000 | Channel is under limit | 6 | CODE | Thermocouple Type | 0 | J | 2 | E | 4 | K | 6 | N | 8 | R | A | S | C | T | E | B |
| STATUS CODE | DESCRIPTION | PRIORITY | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 1000 | Channel A/D is disabled | 1 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 2000 | Channel T/C is open | 2 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 3000 | Channel is over range | 3 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 4000 | Channel is under range | 4 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 5000 | Channel is over limit | 5 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 6000 | Channel is under limit | 6 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| CODE | Thermocouple Type | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 0 | J | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 2 | E | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 4 | K | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 6 | N | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 8 | R | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| A | S | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| C | T | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| E | B | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| ...continued... | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |

| | |
|-----------------------|---|
| <p>Example</p> | <p>EXAMPLE 1 EU = 1 BIN = 0 FORMAT = 0. Data is scrolled and will be displayed as follows: Frame # <number> Time <time> <μs or ms> Rtd1 <temp> : : RtdMax <temp> Units <unit> <chan 1> <temp eu> <channel status code> : : : <chan Max> <temp eu> <channel status code></p> <p>EXAMPLE 2 EU = 0 BIN = 0 FORMAT = 0 Data is scrolled and will be displayed as follows: Frame # <number> Time <time> <μs or ms> Rtd1 <temp counts> RtdMax <temp counts> Units <unit> <chan 1> <temp counts> <channel status code> : : : <chan Max> <temp counts> <channel status code></p> <p>EXAMPLE 3 EU = 1 BIN = 0 FORMAT = 1 Data is scrolled in place and will be displayed as follows: Frame = <number> Time = <time> <μs or ms> Units = <unit> RTD1 <temp> RTDMax <temp> <chan> <temp eu> <chan><temp eu> <chan> <temp eu> <chan> <temp eu> <chan> <temp eu> <chan><temp eu> <chan> <temp eu> <chan> <temp eu> <chan> <temp eu> <chan><temp eu> <chan> <temp eu> <chan> <temp eu> : : : : : : : : <chan> <temp eu> <chan><temp eu> <chan> <temp eu> <chan> <temp eu></p> <p>EXAMPLE 4 EU = 0 BIN = 0 FORMAT = 1 Data is scrolled and will be displayed as follows: Frame = <number> Time = <time> <μs or ms> Units = <unit> RTD1 <counts>.....RTDMax <counts> <chan> <temp cts> <chan><temp cts> <chan> <temp cts> <chan> <temp cts> <chan> <temp cts> <chan><temp cts> <chan> <temp cts> <chan> <temp cts> <chan> <temp cts> <chan><temp cts> <chan> <temp cts> <chan> <temp cts> : : : : : : : : <chan> <temp cts> <chan><temp cts> <chan> <temp cts> <chan> <temp cts></p> <p style="text-align: center;">...continued...</p> |
|-----------------------|---|

| | |
|--------------|---|
| Notes | <p>The DTS4050 will use the current PTP time as the scan start time under two conditions:</p> <ol style="list-style-type: none"> 1) When the PTP system is disabled via the SET PTPEN 0 command. 2) When the current time has not been received from the PTP server since the DTS was powered up. Under this condition the DTS 4050 time will start at Jan 1 1970, 0:00:00.000 hours, or epoch 0 time. This most likely will happen when there is no PTP server on the network. If the DTS was enabled and then disabled after receiving a time set from the PTP time server, the DTS will keep time from the last clock setting from the PTP server. <p>When these two cases are not met, the DTS 4050 uses the start time set via the SET SST <time> and SET SSD <date> setting in the PTP group.</p> |
|--------------|---|

SCAN TRIGGER

| | |
|-----------------------|--|
| Command | SCAN TRIGGER |
| Command Syntax | TRIG |
| Arguments | None |
| Description | This command acts as a software trigger to the DTS. When XSCANTRIG is set to 1, an averaged frame of data will be output when the DTS receives the TRIG command or a <TAB> character code (9 HEX or Control I). This will continue until a STOP command is issued or the Frames per Scan variable is met. The data format will depend upon the setting of EU, BIN and FORMAT. |
| Example | <p>A scan command is executed with EU set to 1, BIN set to 0, XSCANTRIG set to 1, and FORMAT set to 0. The DTS will wait for a Hardware trigger, the TRIG command or a <TAB> character (9 HEX or Control I). When a frame is triggered, the data is scrolled and will be displayed as follows:</p> <pre> Frame # <number> Time <time> <µs or ms> Rtd1 <temp> : : RtdMax <temp> Units <unit> <chan 1> <temp eu> <channel status code> : : : <chan Max> <temp eu> <channel status code> </pre> <p>For information on other formats, refer to the “Scan” on page 45.</p> |

SET

| | |
|-----------------------|--|
| Command | SET |
| Command Syntax | SET <name> <value> |
| Arguments | <name> - the Configuration Variable to be set or modified. <value> - the value of that Configuration Variable |
| Description | Commands the DTS to set one of the many Configuration Variables. Configuration Variables are described in a subsequent section. |
| Returns | variable |
| Notes | Listing the Configuration Variables with the LIST command outputs the data in the format required by the SET command. This enables the user to upload data from a file that has been created by a LIST download. |

STATUS

| | | | | | | | | | | | | | | | | | | | | | | | |
|-----------------------|---|-------|---|-----|--|---------|--|------|---|-----|---|--------|---|-------|---|------|-----------------------------------|------|------------------------------|------|--|--------|------------------------------|
| Command | STATUS | | | | | | | | | | | | | | | | | | | | | | |
| Command Syntax | STATUS | | | | | | | | | | | | | | | | | | | | | | |
| Arguments | None | | | | | | | | | | | | | | | | | | | | | | |
| Description | <p>Commands the DTS to send a Status Packet to the client. The Status Packet is described in a subsequent section.</p> <p>The STATUS command may be entered at any time. This is one of the commands that will not generate an error if entered while the DTS is not READY. The DTS could return one of the following status descriptions:</p> <table> <tr> <td>ADCAL</td> <td>The DTS is calibrating the A/D converters</td> </tr> <tr> <td>CAL</td> <td>The DTS is executing a PT or RPT command</td> </tr> <tr> <td>INVALID</td> <td>The DTS is in an INVALID operating mode.</td> </tr> <tr> <td>LIST</td> <td>The DTS is outputting a configuration variable LIST</td> </tr> <tr> <td>OTC</td> <td>The DTS is testing for open thermocouples</td> </tr> <tr> <td>PERIOD</td> <td>The DTS is executing a SET PERIOD command</td> </tr> <tr> <td>READY</td> <td>The DTS is operating and ready to accept a command.</td> </tr> <tr> <td>SAVE</td> <td>The DTS is SAVING a configuration</td> </tr> <tr> <td>SCAN</td> <td>The DTS is in the SCAN mode.</td> </tr> <tr> <td>TYPE</td> <td>The DTS is setting the thermocouple type</td> </tr> <tr> <td>UPLOAD</td> <td>The DTS is UPLOADING a file.</td> </tr> </table> | ADCAL | The DTS is calibrating the A/D converters | CAL | The DTS is executing a PT or RPT command | INVALID | The DTS is in an INVALID operating mode. | LIST | The DTS is outputting a configuration variable LIST | OTC | The DTS is testing for open thermocouples | PERIOD | The DTS is executing a SET PERIOD command | READY | The DTS is operating and ready to accept a command. | SAVE | The DTS is SAVING a configuration | SCAN | The DTS is in the SCAN mode. | TYPE | The DTS is setting the thermocouple type | UPLOAD | The DTS is UPLOADING a file. |
| ADCAL | The DTS is calibrating the A/D converters | | | | | | | | | | | | | | | | | | | | | | |
| CAL | The DTS is executing a PT or RPT command | | | | | | | | | | | | | | | | | | | | | | |
| INVALID | The DTS is in an INVALID operating mode. | | | | | | | | | | | | | | | | | | | | | | |
| LIST | The DTS is outputting a configuration variable LIST | | | | | | | | | | | | | | | | | | | | | | |
| OTC | The DTS is testing for open thermocouples | | | | | | | | | | | | | | | | | | | | | | |
| PERIOD | The DTS is executing a SET PERIOD command | | | | | | | | | | | | | | | | | | | | | | |
| READY | The DTS is operating and ready to accept a command. | | | | | | | | | | | | | | | | | | | | | | |
| SAVE | The DTS is SAVING a configuration | | | | | | | | | | | | | | | | | | | | | | |
| SCAN | The DTS is in the SCAN mode. | | | | | | | | | | | | | | | | | | | | | | |
| TYPE | The DTS is setting the thermocouple type | | | | | | | | | | | | | | | | | | | | | | |
| UPLOAD | The DTS is UPLOADING a file. | | | | | | | | | | | | | | | | | | | | | | |
| Example | <p>If the STATUS command is entered while the DTS is on, but inactive, the DTS will return: Status: READY</p> <p>If the STATUS command is entered while the DTS is executing a SAVE command, the DTS will return: Status: SAVE</p> | | | | | | | | | | | | | | | | | | | | | | |

STOP

| | |
|-----------------------|---|
| Command | STOP |
| Command Syntax | STOP |
| Arguments | None |
| Description | Commands the DTS to abort the current operation and go into the READY mode. |
| Notes | |

VERSION

| | |
|-----------------------|--|
| Command | VERSION |
| Command Syntax | VER |
| Arguments | None |
| Description | Requests the version number of the DTS4000.hex firmware file. |
| Example | <p>To read the current software version in a 64 channel module, type: VER<CR></p> <p>The DTS returns: Version: DTS Scanivalve © 2004-2013 Ver 1.00 32 Channels H/W Ver 9</p> |

CONFIGURATION VARIABLES

Configuration Variables control the way the DTS functions. The Variables are assigned to one of several groups:

| | | |
|----------------------------|-------------------------------|----------------------|
| SCAN(S) | PRECISION TIME PROTOCOL (PTP) | THERMOCOUPLE(T) |
| IDENTIFICATION(I) | CHANNEL CORRECTION(P) | RTD CORRECTION(RPC) |
| NETWORK IDENTIFICATION(ID) | GAIN(G) | RTD CONVERSION(RTDP) |
| BOOTLOADER (IP) | OFFSET(O) | RTD CALIBRATION(U) |
| CHANNEL DEFINITION(DEF) | LABELS(LA) | |
| CALIBRATION(C) | LIMIT(LI) | |

Each variable is assigned a “data type” description.

SCAN VARIABLES (LIST S)**AVERAGE (AVG)**

| | |
|----------------------|--|
| VARIABLE | AVG <value> |
| VALID VALUES | 1 to 240 |
| DEFAULT VALUE | 4 |
| DATA TYPE | integer |
| DESCRIPTION | This sets the number of raw samples to acquire before producing a filtered output. |

BINARY (BIN)

| | |
|----------------------|---|
| VARIABLE | BIN <value> |
| VALID VALUES | 0 or 1 |
| DEFAULT VALUE | 0 |
| DATA TYPE | integer |
| DESCRIPTION | Sets the format of the data packet output. 1 = Binary 0 = ASCII |

FORMAT (FORMAT)

| | |
|----------------------|--|
| VARIABLE | FORMAT <value> |
| VALID VALUES | 0 or 1 |
| DEFAULT VALUE | 0 |
| DATA TYPE | integer |
| DESCRIPTION | Determines if data are to be scrolled on the display. ASCII Output only 0 - data are scrolled 1 - data are displayed in place, formatted for a VT100 terminal. |

FRAMES PER SCAN (FPS)

| | |
|----------------------|---|
| VARIABLE | FPS <value> |
| VALID VALUES | 0 to 4294967295 |
| DEFAULT VALUE | 0 |
| DATA TYPE | long integer |
| DESCRIPTION | Sets the number of averaged frames to send to the client. If a 0 is entered, the scan will continue until a STOP command is received. |

PERIOD (PERIOD)

| | | | | | | | | | | |
|----------------------|---|---------------|---|---------------|-------------|---|---------------|-------------|---|---------------|
| VARIABLE | PERIOD <value> | | | | | | | | | |
| VALID VALUES | 781 to 262144 µsec (64 Channel versions) 781 to 524288 µsec (32 Channel Versions) 781 to 1048576 µsec (16 Channel Versions) | | | | | | | | | |
| DEFAULT VALUE | 7812 | | | | | | | | | |
| DATA TYPE | float | | | | | | | | | |
| DESCRIPTION | Sets the interval between channel samples (inter-channel delay). The maximum settings for each version represent the rate limits when AVG is set to 1. The rate limits are: <table style="margin-left: 40px; border: none;"> <tr> <td>16 Channels</td> <td>-</td> <td>80 Hz/Channel</td> </tr> <tr> <td>32 Channels</td> <td>-</td> <td>40 Hz/Channel</td> </tr> <tr> <td>64 Channels</td> <td>-</td> <td>20 Hz/Channel</td> </tr> </table> | 16 Channels | - | 80 Hz/Channel | 32 Channels | - | 40 Hz/Channel | 64 Channels | - | 20 Hz/Channel |
| 16 Channels | - | 80 Hz/Channel | | | | | | | | |
| 32 Channels | - | 40 Hz/Channel | | | | | | | | |
| 64 Channels | - | 20 Hz/Channel | | | | | | | | |

QPKTS (QPKTS)

| | |
|----------------------|--|
| VARIABLE | QPKTS <value> |
| VALID VALUES | 0 |
| DEFAULT VALUE | 0 |
| DATA TYPE | integer |
| DESCRIPTION | This is a non-functioning variable left in place for legacy compatibility. |

TEMPERATURE RANGE OVER RANGE VALUES (RANGET)

| | |
|----------------------|---|
| VARIABLE | RANGET <low range temp value> <high range temp value> |
| VALID VALUES | -9999.99 to 9999.99 |
| DEFAULT VALUE | Low range temp value - -9999.99 High range temp value - 9999.99 |
| DATA TYPE | integer |
| DESCRIPTION | Sets the output when units is set to a temperature and the high and/or low range limits are exceeded. When a channel exceeds the low limit, the data display will be setting of the low range value and the channel status code will indicate 4000. When the high limit is exceeded, the data display will be setting of the high range value and the channel status code will indicate 3000. |

VOLTAGE RANGE OVER RANGE VALUES (RANGEV)

| | |
|----------------------|---|
| VARIABLE | RANGEV <low range volt value> <high range volt value> |
| VALID VALUES | -9999.99 to 9999.99 |
| DEFAULT VALUE | Low range temp value - -9999.99 High range temp value - 9999.99 |
| DATA TYPE | integer |
| DESCRIPTION | Sets the output when units is set to volts and the high and/or low range limits are exceeded. When a channel exceeds the low limit, the data display will be setting of the low range value and the channel status code will indicate 4000. When the high limit is exceeded, the data display will be setting of the high range value and the channel status code will indicate 3000. |

SCAN RATE (RATE)

| | |
|----------------------|--|
| VARIABLE | RATE <value> |
| VALID VALUES | .01 to 40 (16 channel), .01 to 20 (32 channel), .01 to 10 (64 channel) |
| DEFAULT VALUE | Depends on the number of channels |
| DATA TYPE | float |
| DESCRIPTION | <p>Calculates and modifies the setting of PERIOD to give a data output rate in samples per channel per second. The setting of AVG is included in the calculation but is not modified. Conversely, if PERIOD is modified, RATE will be updated to show the data rate based on that setting of PERIOD. If AVG is modified, the value of RATE will be updated to show the new data rate, but PERIOD will not be modified. If the calculated RATE exceeds the maximum allowed for a DTS Version, the rate will not change and an ERROR will be logged.</p> <p>Rate is calculated by the formula:</p> $\text{Data Rate} = \frac{1}{\text{Period} \times \text{Number of Channels} \times \text{Average}}$ |

TIME STAMP (TIME)

| | |
|----------------------|--|
| VARIABLE | TIME <value> |
| VALID VALUES | 0, 1, 2 |
| DEFAULT VALUE | 0 |
| DATA TYPE | integer |
| DESCRIPTION | <p>Determines the format of the relative time stamp.</p> <p>0 - No time stamp 1 - Time stamp with data presented in microseconds 2 - Time stamp with data presented in millisecond</p> |

UNITS (UNITS)

| | |
|----------------------|--|
| VARIABLE | UNITS <value> |
| VALID VALUES | see "description" |
| DEFAULT VALUE | 0 |
| DATA TYPE | string |
| DESCRIPTION | <p>Engineering Unit conversion type. This can be :</p> <ul style="list-style-type: none"> A - Volts (Vdc) corrected by the RTD voltage C - degrees Celsius (°C) F - degrees Fahrenheit (°F), K - Kelvin (°K) M - Mixed (T/C data in raw, RTD data in °C) R - Rankin (°R) V - Volts (Vdc) Raw uncorrected 0 - Zero (Raw Counts) |
| NOTES | <p>The setting of UNITS affects the RTD temperature units.</p> <p>ASCII Output (BIN = 0): When UNITS is set to 0, the RTD temperature is in A/D counts. When UNITS is set to A, C, F, K, R or V the RTD temperature is in degrees C.</p> <p>Binary Output (BIN = 1): When UNITS is set to 0, the RTD temperature is in A/D counts When UNITS is set to any other value, the RTD temperature is in °C.</p> |

SCAN TRIGGER (XSCANTRIG)

| | |
|----------------------|--|
| VARIABLE | XSCANTRIG <code> |
| VALID VALUES | 0 to 254 |
| DEFAULT VALUE | 0 |
| DATA TYPE | integer |
| DESCRIPTION | <p>Sets the External Trigger as the Frame Trigger.</p> <ul style="list-style-type: none"> 0 - The internal clock is the frame trigger 1 - The external trigger is the frame trigger 2 to 254 - The external trigger is the frame trigger. The external trigger timing will be divided by the number entered. |
| NOTES | <p>The External Trigger may be a hardware trigger or a Software Trigger. The hardware trigger is a pulse 4.5 to 15 volts at 6.5 mA. The software trigger is a Tab(Control I) character.</p> <p>EXAMPLE: If XSCANTRIG is set to 2, the triggering will be whatever the input rate is divided by 2. If the trigger rate is 10 Hz, the DTS will be triggered at a 5 Hz rate. If XSCANTRIG is set to 10 and the trigger rate is 10 Hz, the DTS will be triggered at a 1 Hz rate.</p> |

CHANNEL CORRECTION VARIABLES (LIST P)

NOTE: The PT variable on this page is used only if NUMTEMPS is set to 0. If NUMTEMPS is set to 1 or greater, the PT variable on the next page should be used. Please refer to the description of the NUMTEMPS variable in the Calibration Variable Group for more detailed information on THE NUMTEMPS variable.

PT (PT)

| VARIABLE | PT <channel> <index> <volts applied> <counts applied> |
|----------------------|---|
| VALID VALUES | Channel - 0 to 16, 32 or 64 Index - 0 to 7 Volts Applied - any valid number Counts Applied - any valid number |
| DEFAULT VALUE | Channel - 0 Index - 0 Volts Applied - 0 Counts Applied - 0 |
| DATA TYPE | Channel - Integer Index - Integer Volts Applied - float Counts Applied - Integer |
| DESCRIPTION | This is the list of setpoints used to calibrate each channel. If zero (0) is entered, all channels will be returned. |
| NOTES | <p>The PT variable on this page is used only if NUMTEMPS is set to 1 or greater. If NUMTEMPS is set to 0, the PT variable on the previous page should be used. Please refer to the description of the NUMTEMPS variable in the Calibration Variable Group for more detailed information on THE NUMTEMPS variable.</p> <p>EXAMPLE</p> <p>The List P command is used to view these variables. The variables for each channel are set before the initial factory calibration. To list the values for channel 2, type: LIST P 2<Enter></p> <p>The DTS will return:</p> <pre>SET PT 2 0 0.010000 276468 SET PT 2 1 0.000000 517 SET PT 2 2 0.012000 332795 SET PT 2 3 0.024000 664988 SET PT 2 4 0.036000 997039 SET PT 2 5 0.048000 1329141 SET PT 2 6 0.060000 1661087 SET PT 2 7 0.070000 1937569</pre> <p>The values shown here are values for a standard module. The actual calibration setpoints for a given module may be different.</p> |

PT <TYPE> (PT <TYPE>)

| VARIABLE | PT <type> <chan/board> <temp ndx> <temp> <pt ndx> <act volts> <counts> | | |
|----------------------|---|---|---|
| VALID VALUES | Type | - | T (for T/C) or R (for RTD) |
| | Chan/board | - | A single channel, 1 to 64 for T/C or 1 to 4 for RTD |
| | Temp ndx | - | A range of channels, start chan..end chan |
| | Pt ndx | - | The temperature index from 1 to NUMTEMPS |
| | Act volts | - | The index of this point from 1 to NUMPTS |
| | Counts | - | The actual applied volts |
| | | - | The A/D counts at this point |
| DEFAULT VALUE | Type | - | T |
| | Chan/board | - | 1 |
| | Temp ndx | - | 5 |
| | Pt ndx | - | 5 |
| | Act volts | - | 0 |
| | Counts | - | 0 |
| DATA TYPE | Type | - | char |
| | Chan/board | - | string |
| | Temp ndx | - | integer |
| | Pt ndx | - | integer |
| | Act volts | - | float |
| | Counts | - | integer |
| DESCRIPTION | This is the list of setpoints used to calibrate each channel. | | |
| NOTES | <p>EXAMPLE</p> <p>The List P command is used to view these variables. The variables for each channel are set before the initial factory calibration. To list the values for RTD channel 2at 23 degrees C, type: LIST P R 2 23<Enter></p> <p>The DTS will return:</p> <pre>SET PT R 2 3 23 3 .256 276468</pre> <p>NOTE: The values shown here are values for a typical module. The actual calibration setpoints for a given module may be different.</p> | | |

IDENTIFICATION VARIABLES (LIST I)**AUTO CONNECT (AUTOCON)**

| | |
|----------------------|--|
| VARIABLE | AUTOCON <code> |
| VALID VALUES | 0 or 1 |
| DEFAULT VALUE | 0 |
| DATA TYPE | integer |
| DESCRIPTION | Determines if the DTS will automatically connect to a binary receiver. 0 - the DTS will not automatically convert. 1 - the DTS will automatically convert. |

ECHO (ECHO)

| | |
|----------------------|--|
| VARIABLE | ECHO <code> |
| VALID VALUES | 0 or 1 |
| DEFAULT VALUE | 0 |
| DATA TYPE | integer |
| DESCRIPTION | Determines if characters received from an Ethernet host will be echoed back to the host. 0 - the DTS will not echo characters 1 - the DTS will echo characters back to the host. |

HOST (HOST)

| | |
|----------------------|---|
| VARIABLE | HOST <IP address> <port> <protocol> |
| VALID VALUES | IP Address - Any valid IP address Port - Any valid Port Protocol - T = TCP U = UDP |
| DEFAULT VALUE | IP Address - 0 Port - 0 Protocol - T |
| DATA TYPE | varies |
| DESCRIPTION | Sets the value of the IP address and port number for binary data for the host computer. If IP Address and Port are set to 0, Binary data are sent out over the TelNet Port. If a server address and port number are defined, Binary data are sent out over that port. |

HOST COMMAND (HOSTCMD)

| | |
|----------------------|---|
| VARIABLE | HOSTCMD <ASCII string> |
| VALID VALUES | any valid host command string |
| DEFAULT VALUE | 0 |
| DATA TYPE | ASCII Strings |
| DESCRIPTION | Sends the ASCII command string contained in this variable to the host computer binary receiver. |

PORT (PORT)

| | |
|----------------------|---|
| VARIABLE | PORT <value> |
| VALID VALUES | 0 |
| DEFAULT VALUE | 0 |
| DATA TYPE | integer |
| DESCRIPTION | Sets the Ethernet port. With PORT set to 0, it uses the default value, 23 which is the TelNet port. |

RTD MAXIMUM SLEW LIMIT (RTDMAXSLEW)

| | |
|----------------------|--|
| VARIABLE | RTDMAXSLEW <value> |
| VALID VALUES | 0 to 32000 |
| DEFAULT VALUE | 0 |
| DATA TYPE | integer |
| DESCRIPTION | This is a non-functional variable left in place for legacy compatibility |

THERMOCOUPLE MAXIMUM SLEW LIMIT (TCMAXSLEW)

| | |
|----------------------|--|
| VARIABLE | TCMAXSLEW <value> |
| VALID VALUES | 0 to 3000000 |
| DEFAULT VALUE | 0 |
| DATA TYPE | integer |
| DESCRIPTION | This is a non-functional variable left in place for legacy compatibility |

TITLE 1 (TITLE1)

| | |
|----------------------|---|
| VARIABLE | TITLE1 <title> |
| VALID VALUES | any valid ASCII string up to 255 characters |
| DEFAULT VALUE | Scanivalve DTS4000 |
| DATA TYPE | ASCII String |
| DESCRIPTION | Sets the value of Title number 1. |

TITLE 2 (TITLE2)

| | |
|----------------------|---|
| VARIABLE | TITLE2 <title> |
| VALID VALUES | any valid ASCII string up to 255 characters |
| DEFAULT VALUE | The current software version |
| DATA TYPE | ASCII String |
| DESCRIPTION | Sets the value of Title number 2. |

BOOTLOADER VARIABLES (LIST IP)

NOTE: The SAVE command does not save any variables in the LIST IP group. In order to save any changes to non-volatile memory, the SAVEIP command must be issued. See "Save Bootloader Variables" on page 44 for more information on the SAVEIP command.

DTS4050 IP ADDRESS (IPADD)

| | |
|----------------------|--|
| VARIABLE | IPADD <value> |
| VALID VALUES | any valid IP address |
| DEFAULT VALUE | 191.30.100.XXX – 16 channel units 191.30.105.XXX – 32 channel units 191.30.110.XXX – 64 channel units *where XXX is the serial number of the unit |
| DATA TYPE | integer |
| DESCRIPTION | The IP address of the module. |

DTS4050 SUBNET MASK (SUBNET)

| | |
|----------------------|--|
| VARIABLE | SUBNET <value> |
| VALID VALUES | any valid Subnet Mask |
| DEFAULT VALUE | 255.255.0.0 |
| DATA TYPE | integer |
| DESCRIPTION | The Subnet mask for the module. The subnet mask must be configured for the network where the DTS module will be connected. |

DTS4050 MAC ADDRESS (MAC)

| | |
|----------------------|--|
| VARIABLE | MAC <value> |
| VALID VALUES | 000.096.093.XXX.YYY.ZZZ |
| DEFAULT VALUE | 000.096.093.100.XXX.XXX – 16 channel units 000.096.093.105.XXX.XXX – 32 channel units 000.096.093.110.XXX.XXX – 64 channel units *where XXX is the serial number for the module. |
| DATA TYPE | integer |
| DESCRIPTION | The MAC address of the module. The last three octets may be modified by the user, but it is recommended that they not be modified. The first three octets MUST NOT be modified, they are registered to Scanivalve. |

LOGIN (LOGIN)

| | |
|----------------------|---------------------------------|
| VARIABLE | LOGIN <value> |
| VALID VALUES | any valid character string |
| DEFAULT VALUE | Scanivalve |
| DATA TYPE | string |
| DESCRIPTION | The username for the FTP login. |

PASSWORD (PASSWORD)

| | |
|----------------------|---|
| VARIABLE | PASSWORD <value> |
| VALID VALUES | any valid character string |
| DEFAULT VALUE | Scanner |
| DATA TYPE | string |
| DESCRIPTION | The password associated with the user name for the FTP login. |

LOGIN 1 (LOGIN1)

| | |
|----------------------|---------------------------------|
| VARIABLE | LOGIN1 <value> |
| VALID VALUES | any valid character string |
| DEFAULT VALUE | Scanivalve1 |
| DATA TYPE | string |
| DESCRIPTION | The username for the FTP login. |

PASSWORD 1 (PASSWORD1)

| | |
|----------------------|---|
| VARIABLE | PASSWORD <value> |
| VALID VALUES | any valid character string |
| DEFAULT VALUE | Scanner |
| DATA TYPE | string1 |
| DESCRIPTION | The password associated with the user name for the FTP login. |

ALLOW ANONYMOUS LOGON (ALLOWANON)

| | |
|----------------------|---|
| VARIABLE | ALLOWANON <value> |
| VALID VALUES | 0 or 1 |
| DEFAULT VALUE | 0 |
| DATA TYPE | integer |
| DESCRIPTION | Determines the new line character(s) for all output. 0 – Do not allow anonymous FTP logins 1 – Allow anonymous FTP logins |

APPLICATION FILE (APP)

| | |
|----------------------|---|
| VARIABLE | APP <value> |
| VALID VALUES | any valid application name |
| DEFAULT VALUE | Dts4000.hex |
| DATA TYPE | string |
| DESCRIPTION | The file name of the application to run. This is the file name that is used when automatically running the application from the boot loader. It is also the file name used when using the RUN command. If this file is not found, an error is returned. Note that this entry is case sensitive. |

GATEWAY (GW)

| | |
|----------------------|--|
| VARIABLE | GW <value> |
| VALID VALUES | any valid IP address |
| DEFAULT VALUE | 0.0.0.0 |
| DATA TYPE | integer |
| DESCRIPTION | This IP address will be used to access host with an IP address setting that is outside of the DTS subnet. This is commonly used to access an NTP server that is not in the same subnet as the DTS. |

CALIBRATION VARIABLES (LIST C)**A/D CALIBRATION AVERAGING (CALAVG)**

| | |
|----------------------|---|
| VARIABLE | CALAVG <value> |
| VALID VALUES | 1 to 64 |
| DEFAULT VALUE | 4 |
| DATA TYPE | integer |
| DESCRIPTION | Determines how much averaging to perform during an A/D Calibration. This setting will have an effect on boot up time. |
| NOTES | See "A/D Calibration" on page 27 for more information on the A/D Calibrations. |

NUMBER OF CALIBRATION SETPOINTS (NUMPTS)

| | |
|----------------------|--|
| VARIABLE | NUMPTS <value> |
| VALID VALUES | 1 to 8 |
| DEFAULT VALUE | 8 |
| DATA TYPE | integer |
| DESCRIPTION | Determines the number of setpoints in the channel correction list. |

NUMBER OF CALIBRATION COEFFICIENTS (NUMCOEF)

| | |
|----------------------|---|
| VARIABLE | NUMCOEF <value> |
| VALID VALUES | 1 to 3 |
| DEFAULT VALUE | 3 |
| DATA TYPE | integer |
| DESCRIPTION | Determines the number of calibration coefficients for the channel corrections. <ul style="list-style-type: none"> 1 - Offset only 2 - $y = mx + b$ correction curve 3 - $y = ax^2 + bx + c$ correction curve |

NUMBER OF CALIBRATION TEMPERATURES (NUMTEMPS)

| | |
|----------------------|---|
| VARIABLE | NUMTEMPS <values> |
| VALID VALUES | 0 to 8 |
| DEFAULT VALUE | 0 |
| DATA TYPE | integer |
| DESCRIPTION | <p>When set to 0, module uses calibration coefficients generated during a single temperature calibration.</p> <p>If set to 1 or greater, the module uses calibration coefficients generated during a multi-temperature calibration. The following variables are relevant: PT Option And the following commands: PT Option List P Option</p> |
| NOTES | The value of NUMTEMPS MUST NOT be modified by an end user without detailed and specific training from Scanivalve Corp. If the value of NUMTEMPS is modified after the unit has been calibrated, ALL current calibration coefficients will be LOST . |

PRECISION TIME PROTOCOL VARIABLES (LIST PTP)**PTP ENABLE (PTPEN)**

| | |
|----------------------|--|
| VARIABLE | PTPEN <value> |
| VALID VALUES | 0 or 1 |
| DEFAULT VALUE | 0 |
| DATA TYPE | integer |
| DESCRIPTION | Enables or disables the PTP engine. 0 – disabled 1 – enabled |

TUNE (TUNE)

| | |
|----------------------|---|
| VARIABLE | TUNE <min filter depth> <clock gain> <integral limit> <median filter depth> |
| VALID VALUES | min filter - Not range checked clock gain - Not range checked integral limit - Not range checked median filter - Not range checked |
| DEFAULT VALUE | min filter - 10 clock gain - 0.5 integral limit - 500000 median filter - 5 |
| DATA TYPE | min filter - integer clock gain - float integral limit - integer median filter - integer |
| DESCRIPTION | These variables allow you to tune the PTP synch function. |

SYSLOG SEVERITY LEVEL (SLL)

| | |
|----------------------|---|
| VARIABLE | SLL <value> |
| VALID VALUES | 0 to 9 |
| DEFAULT VALUE | 0 |
| DATA TYPE | integer |
| DESCRIPTION | Sets the system log level: 0-Off 1-Emergency 2-Alert 3-Critical 4-Error 5-Warning 6-Notice 7-Information 8-Debug level 1 9-Debug level 2 Setting this value allows the any messages that occur with the severity level or above to be output to the device that last sent the command. |

STATISTICAL DATA DESTINATION (STAT)

| | |
|----------------------|--|
| VARIABLE | STAT <value> |
| VALID VALUES | 0 to 9 |
| DEFAULT VALUE | 0 |
| DATA TYPE | integer |
| DESCRIPTION | <p>Sets the destination of raw statistical data.</p> <p>0 – off 1 – serial 2 – network 3 – Syslog server</p> <p>The statistical data is output in the following format: <ofm>, <msd>, <smd>, <mpd></p> <p>ofm - Offset From Master. Time that slave and master differ msd - Master to Slave Delay. Filtered packet delivery time from master to slave smd - Slave to Master Delay. Filtered packet delivery time from slave to master mpd - Mean Path Delay. Filtered mean path delay time</p> |

START SCAN TIME (SST)

| | |
|----------------------|--|
| VARIABLE | SST <value> |
| VALID VALUES | Any valid time in the hh:mm:s.fxxxx format |
| DEFAULT VALUE | 12:0:0.0 |
| DATA TYPE | integer |
| DESCRIPTION | Sets the hour, minute and second of the start scan time. This is referenced to the time that the grandmaster serves. |
| NOTES | <p>The DTS4050 will use the current PTP time as the scan start time under two conditions:</p> <ol style="list-style-type: none"> 1) When the PTP system is disabled via the SET PTPEN 0 command. 2) When the current time has not been received from the PTP server since the DTS was powered up. Under this condition the DTS 4050 time will start at Jan 1 1970, 0:00:00.000 hours, or epoch 0 time. This most likely will happen when there is no PTP server on the network. <p>If the DTS was enabled and then disabled after receiving a time set from the PTP time server, the DTS will keep time from the last clock setting from the PTP server.</p> <p>When these two cases are not met, the DTS 4050 uses the start time set via the SET SST <time> and SET SSD <date> setting in the PTP group.</p> |

START SCAN DATE (SSD)

| | |
|----------------------|--|
| VARIABLE | SSD <value> |
| VALID VALUES | Any valid date in the yy/mm/dd format |
| DEFAULT VALUE | 1971/1/1 |
| DATA TYPE | integer |
| DESCRIPTION | Sets the year, month and day of the scan start time. |

UPDATE CLOCK (UC)

| | |
|----------------------|--|
| VARIABLE | UC <value> |
| VALID VALUES | 0 or 1 |
| DEFAULT VALUE | 0 |
| DATA TYPE | integer |
| DESCRIPTION | Sets the switch to update the clock. When set to 0 the PTP servo runs with statistical output available but the clock rate or setting is not adjusted. |

INTERVAL (INTERVAL)

| | |
|----------------------|---|
| VARIABLE | INTERVAL <value> |
| VALID VALUES | 1 to 1,000,000,000 |
| DEFAULT VALUE | 5 |
| DATA TYPE | Long Integer |
| DESCRIPTION | Sets the width of each histogram interval in nanoseconds. |

CLOCK DRIFT ADJUSTMENT (ADJDRIPT)

| | |
|----------------------|---|
| VARIABLE | ADJDRIPT <rate> <rate limit> |
| VALID VALUES | Rate - Not range checked Rate limit - Not range checked |
| DEFAULT VALUE | Rate - 100 Rate limit - 100000 |
| DATA TYPE | Rate - long integer Rate limit - long integer |
| DESCRIPTION | Sets the clock rate and clock rate limit adjustments. When the observed drift of the clock from the master is greater than the clock rate limit, or less than a negative clock rate limit, the clock rate is changed by the value in rate or negative rate, respectively. |

UTC OFFSET (UTCOFFSET)

| | |
|----------------------|---|
| VARIABLE | UTCOFFSET <hours>:<minutes>:<seconds> |
| VALID VALUES | <hours> - 12 and 12 <minutes> - 0 to 59 <seconds> - 0 to 59 |
| DEFAULT VALUE | <hours> 00 <minutes> 00 <seconds> 00 |
| DATA TYPE | integer |
| DESCRIPTION | Sets the offset to be added or subtracted from the network time. |

NETWORK IDENTIFICATION VARIABLES (LIST ID)**MODEL (MODEL)**

| | |
|----------------------|--|
| VARIABLE | MODEL <model number/channels> |
| VALID VALUES | Any valid model number/channel count |
| DEFAULT VALUE | Null |
| DATA TYPE | string |
| DESCRIPTION | Lists the module model number and channel count. |

SERIAL NUMBER (SERNUM)

| | |
|----------------------|---------------------------------|
| VARIABLE | SERNUM <serial number> |
| VALID VALUES | Any valid integer |
| DEFAULT VALUE | Null |
| DATA TYPE | integer |
| DESCRIPTION | The serial number of the module |

VERSION (VER)

| | |
|----------------------|--|
| VARIABLE | VER <version number> |
| VALID VALUES | any valid integer |
| DEFAULT VALUE | null |
| DATA TYPE | integer |
| DESCRIPTION | The firmware version sends the ASCII command string contained in this variable to the host computer binary receiver. This variable is not settable by the user and only displays the current software version set by the current firmware. |

IP ADDRESS (IPADD)

| | |
|----------------------|---|
| VARIABLE | IPADD <value> |
| VALID VALUES | any valid IP address |
| DEFAULT VALUE | 191.30.100.XXX – 16 channel units 191.30.105.XXX – 32 channel units 191.30.110.XXX – 64channel units *where XXX is the serial number of the unit |
| DATA TYPE | integer |
| DESCRIPTION | The IP address of the module. |
| NOTES | This variable is not saved by the SAVE command. The SAVEIP command, followed by the SAVEIPCONFIRM command must be issued in order for any changes to be moved to non-volatile memory. This is a copy of the IPADD variable in the LIST IP group. See “Bootloader Variables (LIST IP)” on page 57 for more information on the bootloader variables. |

CHANNEL IDENTIFICATION VARIABLES (LIST DEF)**CHANNEL DEFINITIONS (DEF)**

| | |
|----------------------|---|
| VARIABLE | DEF <channel> <definition> |
| VALID VALUES | Channel - the channel number Definition - any ASCII string up to 2048 bytes. |
| DEFAULT VALUE | Null |
| DATA TYPE | integer |
| DESCRIPTION | The variable DEF will be available for each channel in the module up to the highest channel number. The variable is intended to be used as a label or definition of the channel assignment. |

LIMIT VARIABLES (LIST LI)**LIMIT (LIMIT)**

| | |
|----------------------|--|
| VARIABLE | LIMIT <channel> <enable> [<high limit> low limit>] |
| VALID VALUES | Channel - 0 to 16, 32, or 64 if 0 is entered all channels will be set. Enable - 0 disables limits 1 enables limits High limit - optional, the high limit value Low limit - optional, the low limit value |
| DEFAULT VALUE | Channel - 0 Enable - 0 High limit - 100 Low limit - 0 |
| DATA TYPE | Channel - integer Enable - integer High limit - float Low limit - float |
| DESCRIPTION | Sets the high and low limits for each channel. When a channel exceeds the low limit, the channel status code will indicate 6000. When the high limit is exceeded, the channel status code will indicate 5000. |

CHANNEL LABELS (LIST LA)**CHANNEL LABEL (LABEL)**

| | |
|----------------------|--|
| VARIABLE | LABEL <channel> <label> |
| VALID VALUES | Channel - 1 to 16, 32, or 64 Label - channel label up to 31 characters. Spaces are allowed. |
| DEFAULT VALUE | Channel - 1 Label - T/C <channel> |
| DATA TYPE | Channel - Integer Label - ASCII string |
| DESCRIPTION | Sets the label for each channel. |

THERMOCOUPLE VARIABLES (LIST T)**THERMOCOUPLE TYPE (TYPE)**

| VARIABLE | TYPE <channel> <type> <shield connect> |
|---------------|--|
| VALID VALUES | channel - the channel number, 0 through 16, 32 or 64 type - thermocouple type shield connect - 0 or 1 |
| DEFAULT VALUE | channel - 0 type - E, J, K, N, R, S, T, B shield connect - 0 |
| DATA TYPE | channel - integer type - char shield connect - integer |
| DESCRIPTION | Determines the thermocouple conversion for each channel. Conversion tables for any thermocouple type can be loaded into the DTS4050's file system. The only limitation is the DTS's -15mV to 70mV calibrated range. If the channel is entered as 0, all 16 channels will be set to the thermocouple type specified. The shield connection switch should be set based on the method used to ground or shield the thermocouple. If shield connect is set to 0, the switch will be open. The default setting is 1 or closed. Refer to "Thermocouple Grounding Scenarios" on page 23 for more information. |

RTD CORRECTION VARIABLES (LIST RPC)**RTD CORRECTION (RPC)**

| | |
|----------------------|---|
| VARIABLE | RPC <board> <index> <volts applied> <counts applied> |
| VALID VALUES | Board - RTD board number; 1, 2, 3 or 4 Index - 0 to 7 Volts Applied - any valid number Counts Applied - any valid number |
| DEFAULT VALUE | Channel - 1 Index - 0 Volts Applied - 0 Counts Applied - 0 |
| DATA TYPE | Channel - Integer Index - Integer Volts Applied - float Counts Applied - Integer |
| DESCRIPTION | This is the list of setpoints used to calibrate the RTD=s. Each RTD pair is corrected by the same setpoints. Each module type has one (1) RTD A/D and consequently one (1) channel for each pair of RTD=s. A 16 channel module has 1 channel, a 32 channel module has 2 channels and a 64 channel module has 4 channels. |
| NOTES | <p>EXAMPLE:</p> <p>The List RP command is used to view these variables. The variables are set to the following before the initial factory calibration:</p> <pre>SET RPC 1 0 0.095000 1287022 SET RPC 1 1 0.115000 1557974 SET RPC 1 2 0.131000 1774736</pre> <p>NOTE: The values shown here are values for an ideal RTD channel. The actual calibration setpoints may be different.</p> |

RTD CONVERSION VOLTS TO OHMS (LIST RTD)**RTD 1 (RTD 1)**

| | |
|----------------------|---|
| VARIABLE | RTD 1 <R0> <A> |
| VALID VALUES | any real number |
| DEFAULT VALUE | R0 - 100.00000 A - 3.908E-03 B - (-)5.775E-07 |
| DATA TYPE | float |
| DESCRIPTION | The conversion factors for RTD 1 to convert ohms to millivolts for temperature conversion. The actual values are provided by the manufacturer. The values for A and B must be entered as exponents. |

RTD 2 (RTD 2)

| | |
|----------------------|---|
| VARIABLE | RTD 2 <R0> <A> |
| VALID VALUES | any real number |
| DEFAULT VALUE | R0 - 100.00000 A - 3.908E-03 B - (-)5.775E-07 |
| DATA TYPE | float |
| DESCRIPTION | The conversion factors for RTD 2 to convert ohms to millivolts for temperature conversion. The actual values are provided by the manufacturer. The values for A and B must be entered as exponents. |

RTD 3 (RTD 3)

| | |
|----------------------|---|
| VARIABLE | RTD 3 <R0> <A> (32 and 64 channel version only) |
| VALID VALUES | any real number |
| DEFAULT VALUE | R0 - 100.00000 A - 3.908E-03 B - (-)5.775E-07 |
| DATA TYPE | float |
| DESCRIPTION | The conversion factors for RTD 3 to convert ohms to millivolts for temperature conversion. The actual values are provided by the manufacturer. The values for A and B must be entered as exponents. |

RTD 4 (RTD 4)

| | |
|----------------------|---|
| VARIABLE | RTD 4 <R0> <A> (32 and 64 channel version only) |
| VALID VALUES | any real number |
| DEFAULT VALUE | R0 - 100.00000 A - 3.908E-03 B - (-)5.775E-07 |
| DATA TYPE | float |
| DESCRIPTION | The conversion factors for RTD 4 to convert ohms to millivolts for temperature conversion. The actual values are provided by the manufacturer. The values for A and B must be entered as exponents. |

RTD 5 (RTD 5)

| | |
|----------------------|---|
| VARIABLE | RTD 5 <R0> <A> (64 channel version only) |
| VALID VALUES | any real number |
| DEFAULT VALUE | R0 - 100.00000 A - 3.908E-03 B - (-)5.775E-07 |
| DATA TYPE | float |
| DESCRIPTION | The conversion factors for RTD 5 to convert ohms to millivolts for temperature conversion. The actual values are provided by the manufacturer. The values for A and B must be entered as exponents. |

RTD 6 (RTD 6)

| | |
|----------------------|---|
| VARIABLE | RTD 6 <R0> <A> (64 channel version only) |
| VALID VALUES | any real number |
| DEFAULT VALUE | R0 - 100.00000 A - 3.908E-03 B - (-)5.775E-07 |
| DATA TYPE | float |
| DESCRIPTION | The conversion factors for RTD 6 to convert ohms to millivolts for temperature conversion. The actual values are provided by the manufacturer. The values for A and B must be entered as exponents. |

RTD 7 (RTD 7)

| | |
|----------------------|---|
| VARIABLE | RTD 7 <R0> <A> (64 channel version only) |
| VALID VALUES | any real number |
| DEFAULT VALUE | R0 - 100.00000 A - 3.908E-03 B - (-)5.775E-07 |
| DATA TYPE | float |
| DESCRIPTION | The conversion factors for RTD 7 to convert ohms to millivolts for temperature conversion. The actual values are provided by the manufacturer. The values for A and B must be entered as exponents. |

RTD 8 (RTD 8)

| | |
|----------------------|---|
| VARIABLE | RTD 8 <R0> <A> (64 channel version only) |
| VALID VALUES | any real number |
| DEFAULT VALUE | R0 - 100.00000 A - 3.908E-03 B - (-)5.775E-07 |
| DATA TYPE | float |
| DESCRIPTION | The conversion factors for RTD 8 to convert ohms to millivolts for temperature conversion. The actual values are provided by the manufacturer. The values for A and B must be entered as exponents. |

CHANNEL GAIN CORRECTION VARIABLES (LIST G)**GAINS (GAIN)**

| | |
|----------------------|--|
| VARIABLE | GAIN <channel> <gain value> |
| VALID VALUES | any real number |
| DEFAULT VALUE | 1 |
| DATA TYPE | float |
| DESCRIPTION | Sets the GAIN correction for a given channel using the formula: Adjusted Counts = (GAIN * counts) + OFFSET. |

CHANNEL OFFSET CORRECTION VARIABLES (LIST O)**OFFSETS (OFFSET)**

| | |
|----------------------|--|
| VARIABLE | OFFSET <channel> <gain value> |
| VALID VALUES | any real number |
| DEFAULT VALUE | 1 |
| DATA TYPE | float |
| DESCRIPTION | Sets the OFFSET correction for a given channel using the formula: Adjusted Counts = (GAIN * counts) + OFFSET. |

RTD CALIBRATION VARIABLES (LIST U)**ARPC (ARPC)**

| | |
|----------------------|---|
| VARIABLE | ARPC <board> <value> |
| VALID VALUES | board - 1, 2, 3 or 4 |
| DEFAULT VALUE | 0.0000 |
| DATA TYPE | floating point |
| DESCRIPTION | This value is the offset value that will be added to the RTD volts value before the Calendar Van-Dusen conversion. This value is calculated from the ARPC command. The software will update the ARPC variable setting after an ARPC command is executed. A LIST U command will only display the number of boards installed. That is: a 16 channel module will only display ARPC 1. A 32 channel module will display ARPC 1 and ARPC 2. A 64 channel module will display ARPC 1, ARPC 2, ARPC 3 and ARPC 4. The software will only allow entry of values for the number of boards installed. |

ARPCON (ARPCON)

| | |
|----------------------|---|
| VARIABLE | ARPCON <value> |
| VALID VALUES | 0 or 1 |
| DEFAULT VALUE | 0 |
| DATA TYPE | integer |
| DESCRIPTION | When set to one, this variable will enable the ARPC correction. |

MAXIMUM RTD DELTA (MAXDELTA)

| | |
|----------------------|--|
| VARIABLE | MAXDELTA <value> |
| VALID VALUES | any real number |
| DEFAULT VALUE | .25 |
| DATA TYPE | Integer |
| DESCRIPTION | This is the maximum allowable difference between the readings of RDT1 and RTD2 in degrees C. If MAXDELTA exceeds this setpoint, bit 12 is set to 1 in the general status element of the data packet (appears immediately after the RTD reading.) |

NUMBER OF RTD SETPOINTS (RNUMPTS)

| | |
|----------------------|--|
| VARIABLE | RNUMPTS <points> |
| VALID VALUES | 1 to 8 |
| DEFAULT VALUE | 8 |
| DATA TYPE | integer |
| DESCRIPTION | Determines the number of setpoints in the RTD correction list. |

NUMBER OF RTD COEFFICIENTS (RNUMCOEF)

| | |
|----------------------|---|
| VARIABLE | RNUMCOEF <coef> |
| VALID VALUES | 1 to 7 |
| DEFAULT VALUE | 5 |
| DATA TYPE | integer |
| DESCRIPTION | <p>Determines the number of calibration coefficients in the RTD correction list.</p> <ul style="list-style-type: none"> 1 - Offset only 2 - $y = mx + b$ 3 - $y = ax^2 + bx + c$ 4 - $y = ax^3 + bx^2 + cx + d$ 5 - $y = ax^4 + bx^3 + cx^2 + dx + e$ 6 - $y = ax^5 + bx^4 + cx^3 + dx^2 + ex + f$ 7 - $y = ax^6 + bx^5 + cx^4 + dx^3 + ex^2 + fx + g$ |

DTS PACKET DEFINITIONS

When requested, the DTS sends an application packet to the client. Each packet sent to the client starts with a Packet Type Word. This word defines the packet type.

PACKET TYPE TABLE

| PACKET NAME | PACKET ID | BYTES | NOTES |
|--------------------------------|-----------|----------|--|
| 16 Channel Data | 0Hex | 168 | |
| Host Control | 1Hex | 168 | Command Packet |
| 32 Channel Data | 2Hex | 304 | |
| 64 Channel Data | 3Hex | 576 | |
| 16 Channel Data w/ PTP Enabled | 4Hex | 168 | |
| 32 Channel Data w/ PTP Enabled | 6Hex | 304 | |
| 64 Channel Data w/ PTP Enabled | 7Hex | 576 | |
| ASCII | 20Hex | Variable | Text Packet may be formatted or un-formatted. The format is determined by the setting of the FORMAT Configuration Variable. NOTE: When the first integer of the packet is 20Hex or greater, the packet is assumed to be in ASCII FORMAT. |

HOST CONTROL PACKETS**COMMAND PACKET**

| FUNCTION DESCRIPTION | BYTES | DESCRIPTION |
|--|-------|---|
| Packet Type | 4 | 1Hex |
| Host ASCII Command Data (Refer to the Command Section of this manual for more information) | 164 | ASCII string received by DTS as the Host command. Each line must be terminated with a CR, LF, CR-LF or LF-CR. |

DTS TO HOST**BINARY DATA PACKETS (DTS4050/16 CHANNEL MODULE)**

| FUNCTION | BYTES | DATA TYPE | DESCRIPTION |
|------------------------|--------------|------------------|---|
| Packet Type | 4 | Integer | 0Hex |
| General Status | 4 | Integer | Refer to Table 1 in this section |
| Frame Number | 4 | Integer | The current frame number if in the scan mode |
| Temperature 1 to 16 | 64 | Float | Channel temperatures in units set by bits 4 - 6 of the General Status Byte. |
| RTD1 Temperature | 4 | Float | Temperature in units defined by the setting of the variable: UNITS. See Table 3 |
| RTD2 Temperature | 4 | Float | Temperature in units defined by the setting of the variable: UNITS. See Table 3 |
| Time Stamp | 4 | Integer | Time Stamp in units set by bit 8 of the General Status Byte. |
| Channel Status 1 to 16 | 64 | Integer | Refer to Table 2 in this section |
| PTP Time (Seconds) | 4 | Integer | Current PTP time stamp in seconds |
| PTP Time (Nanoseconds) | 4 | Integer | Current PTP time stamp in nanoseconds |
| PTP Last Update (ms) | 4 | Integer | Time Elapsed Since Last PTP Update in ms |
| Spares | 4 | Integer | Spares |

BINARY DATA PACKETS (DTS4050/32 CHANNEL MODULE)

| FUNCTION | BYTES | DATA TYPE | DESCRIPTION |
|------------------------|--------------|------------------|--|
| Packet Type | 4 | Integer | 2Hex |
| General Status | 4 | Integer | Refer to Table 1 in this section |
| Frame Number | 4 | Integer | The current frame number if in the scan mode |
| Temperature 1 to 32 | 128 | Float | Channel temperatures in units set by bits 4 - 6 of the General Status Byte. |
| RTD1 Temperature | 4 | Float | Temperature in units defined by the setting of the variable: UNITS. See Table 3 |
| RTD2 Temperature | 4 | Float | Temperature in units defined by the setting of the variable: UNITS. See Table 3 |
| RTD3 Temperature | 4 | Float | Temperature in units defined by the setting of the variable: UNITS. See Table 3. |
| RTD4 Temperature | 4 | Float | Temperature in units defined by the setting of the variable: UNITS. See Table 3 |
| Time Stamp | 4 | Integer | Time Stamp in units set by bit 8 of the General Status Byte. |
| Channel Status 1 to 32 | 128 | Integer | Refer to Table 2 in this section |
| PTP Time (Seconds) | 4 | Integer | Current PTP time stamp in seconds |
| PTP Time (Nanoseconds) | 4 | Integer | Current PTP time stamp in nanoseconds |
| PTP Last Update (ms) | 4 | Integer | Time Elapsed Since Last PTP Update in ms |
| Spares | 4 | Integer | Spares |

BINARY DATA PACKETS (DTS4050/64 CHANNEL MODULE)

| FUNCTION | BYTES | DATA TYPE | DESCRIPTION |
|------------------------|--------------|------------------|---|
| Packet Type | 4 | Integer | 3Hex |
| General Status | 4 | Integer | Refer to Table 1 in this section |
| Frame Number | 4 | Integer | The current frame number if in the scan mode |
| Temperature 1 to 64 | 256 | Float | Channel temperatures in units set by bits 4 - 6 of the General Status Byte. |
| RTD1 Temperature | 4 | Float | Temperature in units defined by the setting of the variable: UNITS. See Table 3 |
| RTD2 Temperature | 4 | Float | Temperature in units defined by the setting of the variable: UNITS. See Table 3 |
| RTD3 Temperature | 4 | Float | Temperature in units defined by the setting of the variable: UNITS. See Table 3 |
| RTD4 Temperature | 4 | Float | Temperature in units defined by the setting of the variable: UNITS. See Table 3 |
| RTD5 Temperature | 4 | Float | Temperature in units defined by the setting of the variable: UNITS. See Table 3 |
| RTD6 Temperature | 4 | Float | Temperature in units defined by the setting of the variable: UNITS. See Table 3 |
| RTD7 Temperature | 4 | Float | Temperature in units defined by the setting of the variable: UNITS. See Table 3 |
| RTD8 Temperature | 4 | Float | Temperature in units defined by the setting of the variable: UNITS. See Table 3 |
| Time Stamp | 4 | Integer | Time Stamp in units set by bit 8 of the General Status Byte. |
| Channel Status 1 to 64 | 256 | Integer | Refer to Table 2 in this section |
| PTP Time (Seconds) | 4 | Integer | Current PTP time stamp in seconds |
| PTP Time (Nanoseconds) | 4 | Integer | Current PTP time stamp in nanoseconds |
| PTP Last Update (ms) | 4 | Integer | Time Elapsed Since Last PTP Update in ms |
| Spares | 4 | Integer | Spares |

GENERAL STATUS BYTE

| | |
|--------------|-------------------|
| Bits 0 - 3 | Not used |
| Bits 4 - 6 | Temperature Units |
| Bit 7 | Not Used |
| Bit 8 | Time Stamp |
| Bits 9 - 11 | Not Used |
| Bits 12 - 15 | RTD Delta Errors |

GENERAL STATUS BYTE

| Bit | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|---|----|----|----|----|----|----|---|---|---|---|---|---|---|---|---|---|
| O - Raw A/D Counts (Uncorrected) | X | X | X | X | X | X | X | X | X | 0 | 0 | 0 | X | X | X | X |
| V - Raw Voltage (Uncorrected) | X | X | X | X | X | X | X | X | X | 0 | 0 | 1 | X | X | X | X |
| A - Corrected Voltage | X | X | X | X | X | X | X | X | X | 0 | 1 | 0 | X | X | X | X |
| C - Degrees C | X | X | X | X | X | X | X | X | X | 0 | 1 | 1 | X | X | X | X |
| F - Degrees F | X | X | X | X | X | X | X | X | X | 1 | 0 | 0 | X | X | X | X |
| K - Degrees K | X | X | X | X | X | X | X | X | X | 1 | 0 | 1 | X | X | X | X |
| R - Degrees R | X | X | X | X | X | X | X | X | X | 1 | 1 | 0 | X | X | X | X |
| Number of Temp Scales (Not Used) | X | X | X | X | X | X | X | X | X | 1 | 1 | 1 | X | X | X | X |
| Time Stamp in microseconds | X | X | X | X | X | X | X | X | 0 | X | X | X | X | X | X | X |
| Time Stamp in milliseconds | X | X | X | X | X | X | X | X | 1 | X | X | X | X | X | X | X |
| No Errors | 0 | 0 | 0 | 0 | X | X | X | X | X | X | X | X | X | X | X | X |
| UTR1 Delta Error (16, 32, 64) | 0 | 0 | 0 | 1 | X | X | X | X | X | X | X | X | X | X | X | X |
| UTR2 Delta Error (32, 64) | 0 | 0 | 1 | 0 | X | X | X | X | X | X | X | X | X | X | X | X |
| UTR3 Delta Error (64) | 0 | 1 | 0 | 0 | X | X | X | X | X | X | X | X | X | X | X | X |
| UTR4 Delta Error (64) | 1 | 0 | 0 | 0 | X | X | X | X | X | X | X | X | X | X | X | X |

CHANNEL STATUS BYTE

Bits 0 - 4 Thermocouple Type
 Bits 5 - 11 Not Used
 Bits 12 - 15 Error Codes

CHANNEL STATUS BYTE

| Bit | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|---------------------|----|----|----|----|----|----|---|---|---|---|---|---|---|---|---|---|
| Type J | X | X | X | X | X | X | X | X | X | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Type E | X | X | X | X | X | X | X | X | X | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| Type K | X | X | X | X | X | X | X | X | X | 0 | 0 | 0 | 0 | 0 | 1 | 0 |
| Type N | X | X | X | X | X | X | X | X | X | 0 | 0 | 0 | 0 | 0 | 1 | 1 |
| Type R | X | X | X | X | X | X | X | X | X | 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| Type S | X | X | X | X | X | X | X | X | X | 0 | 0 | 0 | 0 | 1 | 0 | 1 |
| Type T | X | X | X | X | X | X | X | X | X | 0 | 0 | 0 | 0 | 1 | 1 | 0 |
| Type B | X | X | X | X | X | X | X | X | X | 0 | 0 | 0 | 0 | 1 | 1 | 1 |
| A/D Disabled | 0 | 0 | 0 | 1 | X | X | X | X | X | X | X | X | X | X | X | X |
| Open T/C | 0 | 0 | 1 | 0 | X | X | X | X | X | X | X | X | X | X | X | X |
| High Range Error | 0 | 0 | 1 | 1 | X | X | X | X | X | X | X | X | X | X | X | X |
| Low Range Error | 0 | 1 | 0 | 0 | X | X | X | X | X | X | X | X | X | X | X | X |
| High Limit Exceeded | 0 | 1 | 0 | 1 | X | X | X | X | X | X | X | X | X | X | X | X |
| Low Limit Exceeded | 0 | 1 | 1 | 0 | X | X | X | X | X | X | X | X | X | X | X | X |

RTD UNITS

| UNITS | RTD Units |
|-------|------------|
| A | millivolts |
| C | Degrees C |
| F | Degrees C |
| K | Degrees C |
| M | Degrees C |
| R | Degrees C |
| V | millivolts |
| 0 | A/D counts |

ASCII DATA PACKET

This packet will be transmitted when the host issues one of the following commands:

- 1) SCAN with BIN set to 0
- 2) LIST n
- 3) ERROR
- 4) STATUS

ASCII data can be output in three different basic forms;

- 1) Unformatted
- 2) Unformatted with PTP data
- 3) Formatted

| FUNCTION DESCRIPTION | BYTES | DATA TYPE | VALUE |
|--|--------------------------------|-----------|--|
| ASCII Data (The first two bytes must NOT be 1Hex through 1FHex). Refer to the Command Section of this manual for the proper Command return formats. | 1 to 1492 (Variable length) | String | Unique to Packet. Each line is terminated with a CR, LF, CR-LF, or LF-CR. |

UNFORMATTED WITHOUT PTP DATA

Unformatted data is output in a streaming, multi-column format. Each frame of data has a header with the frame number, RTD readings and temperature units listed. The data columns are: Channel, Reading, Status Code.

Example:

```

Frame # 3
Rtd1  33.71 C
Rtd2  33.72 C 0
Rtd3  25.00 C
Rtd4  25.00 C 1
Units C
01  21.89 0
02 -9999.99 4000
03  9999.99 3000
04 -9999.99 4000
05  9999.99 3000
06  9999.99 3000
07  9999.99 5000
08  9999.99 3000
09  9999.99 3000
10  9999.99 3000
11 -9999.99 4000
12 -9999.99 4000
13  9999.99 3000
14 -9999.99 4000
15  9999.99 3000
16  9999.99 3000
17  28.62 0
18  29.15 0
19  29.09 0
20  29.51 0
21  29.34 0
22  29.63 0
23  29.87 0
24  30.74 0
25  30.63 0
26  31.02 0
27  30.71 0
28  31.57 0
29  31.12 0
30  31.30 0
31  31.59 0
32  32.15 0

```

UNFORMATTED WITH PTP DATA

Unformatted with PTP data is output in a streaming, multi-column format. Each frame of data has a header with the frame number, PTP time, RTD readings and temperature units listed. The data columns are: Channel, Reading, Status Code. This output configuration is exactly the same as unformatted without PTP data with the only difference being the addition of the PTP time in the second line of the header.

Example:

```

Frame # 2
PTP Time 2013/04/24 15:09:26.585355
Rtd1  33.69 C
Rtd2  33.70 C 1
Rtd3  25.00 C
Rtd4  25.00 C 1
Units C
01  22.06 0
02 -9999.99 4000
03  9999.99 3000
04 -9999.99 4000
05  9999.99 3000
06  9999.99 3000
07  9999.99 3000
08  9999.99 3000
09  9999.99 3000
10  9999.99 3000
11 -9999.99 4000
12 -9999.99 4000
13  9999.99 3000
14 -9999.99 4000
15  9999.99 3000
16  9999.99 3000
17  28.62 0
18  29.15 0
19  29.09 0
20  29.51 0
21  29.34 0
22  29.63 0
23  29.87 0
24  30.74 0
25  30.63 0
26  31.02 0
27  30.71 0
28  31.57 0
29  31.12 0
30  31.30 0
31  31.59 0
32  32.15 0

```

FORMATTED

If data formatting is enabled (variable SET FORMAT 1), the data is displayed in a block-style format. This configuration is preferred for manual viewing but is not desirable for data collection. PTP data is not available in formatted data.

Example:

```

Frame=0000000
Rtd1= 19.70 C Rtd2= 19.71 C Rtd3= 19.72 C
Rtd4= 19.71 C Units=C

01= -9999.99 02= -9999.99 03= -9999.99 04=
-9999.99 05= 9999.99 06= -9999.99
07= 9999.99 08= -9999.99 09= -9999.99 10=
-9999.99 11= -9999.99 12= -9999.99
13= -9999.99 14= -9999.99 15= 9999.99 16=
-9999.99 17= -9999.99 18= -9999.99
19= -9999.99 20= -9999.99 21= -9999.99 22=
9999.99 23= -9999.99 24= -9999.99
25= 9999.99 26= -9999.99 27= -9999.99 28=
9999.99 29= -9999.99 30= -9999.99
31= -9999.99 32= 9999.99

```

NETWORK PROTOCOLS SUPPORTED

Physical Layer : 10Base-T IEEE 802.3
Link Layer: INTERNET Protocol (IP)
Transport Layer: Transmission Control Protocol (TCP)
User Datagram Protocol (UDP)

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SECTION 6: MAINTENANCE

CALIBRATION

All DTS4050 modules are calibrated before they are shipped. The calibration performed at Scanivalve is traceable to NIST. Scanivalve recommends subsequent calibrations at 6 month intervals in order to maintain accuracy. Calibrations may be performed at the Scanivalve factory or by a customer in the field. Customers who wish to perform their own calibrations can use Scanivalve's free calibration software, TempCal. TempCal can be downloaded at no cost from the Scanivalve website at www.scanivalve.com.

The TempCal software calibrates the voltage A/Ds in the DTS4050 module. It can be operated in either automatic or manual mode depending on the voltage standard being used. In order to calibrate a DTS using TempCal, a calibration harness is required. The calibration harness can be ordered from Scanivalve using the following part numbers:

- 21079-1 (for 16 channel DTS modules)
- 21079-2 (for 32 channel DTS modules)
- 21079-3 (for 64 channel DTS modules)

In addition to the calibration harness, a host computer running Windows XP or Windows 7 and a DC voltage standard with a range of -10mV to +131mV and an accuracy of $\pm 1.5\mu\text{V}$ or better is required. The procedure for performing a voltage calibration on a DTS using TempCal can be found in the TempCal software manual.

TempCal does not perform a recalibration of the RTDs. Calibration of the RTDs should be completed on a five year interval. Consult Scanivalve directly for a copy of the "full" calibration procedure including calibrating the RTDs. In order to perform a complete calibration, the following additional equipment is required:

- Digital Volt/Ohmmeter - $\pm 10\mu\text{V}$ accuracy from 95 to 105mVdc
- 100 Ω standard resistor - accurate within $\pm 0.001\%$
- Ice point reference
- Thermocouple simulator

A/D CALIBRATION (ADCAL)

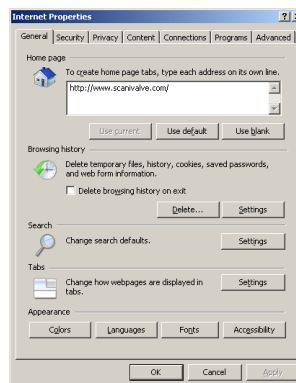
The DTS4050 includes an internal A/D self-calibration function called "ADCAL." This is automatically performed at powerup and whenever the PERIOD variable is changed however it is recommended that the ADCAL be performed periodically in certain situations. Scanivalve recommends that an ADCAL be performed after the module has warmed

up and reached a stable temperature. An ADCAL should also be performed if the DTS is subjected to an ambient temperature change of more than 5°C. Finally, if the DTS has been running continuously for more than a 1 week period, an ADCAL should be performed. For more information on the ADCAL, see "A/D Calibration" on page 27.

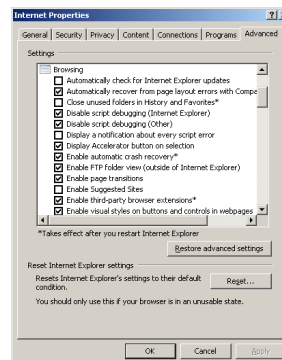
INTERNET EXPLORER SETUP FOR FTP

The firmware and coefficient procedures that follow may not function correctly if Windows Internet Explorer is not set up correctly. A user should verify these settings before attempting these procedures.

1. Open Internet Explorer.
2. Click on Tools
3. Select Internet Options from the drop down menu. The Internet Options window will open.



4. Click on the Advanced Tab.
5. Scroll down to the Heading marked "Browsing"
6. Make sure that the line "Enable FTP Folder View (Outside of Internet Explorer)" is checked. If this is not enabled, Internet Explorer will block FTP file transfers.

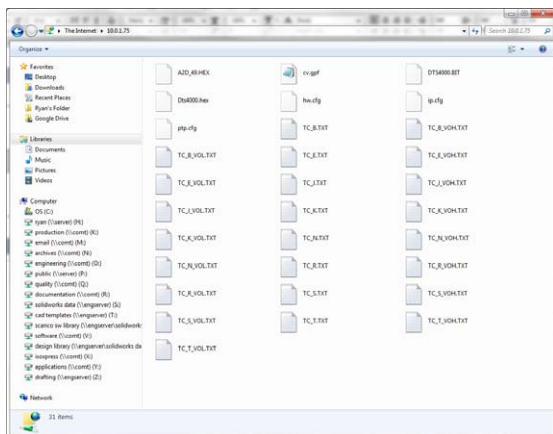


7. Click OK to accept the settings.

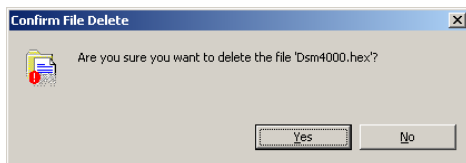
DTS4050 FIRMWARE INSTALLATION **(WINDOWS XP & 7)**

NOTE: Some firewalls may block file transfers. We recommend that firewalls be shut down for the procedures in this section.

1. Connect a host computer to the Ethernet port.
2. Install the disk with the New or updated firmware (Dts4000.Hex) into a drive.
3. Open My Computer
4. In the Address Bar, type:
ftp://<IPAddress><Enter>
Where: <IPAddress> is the IP Address of the DTS4050.
5. The host computer should connect, If the connection is successful, the contents of the DTS4050 Flash chip will be displayed in a folder format.



6. Highlight the existing Dts4000.Hex and .Bit file. Right Click on them and select Delete. A window will open to confirm the delete. Click Yes to delete the file.



7. Open Windows Explorer in another window. Find the directory where the new Dts4000.Hex and .Bit file is stored. Highlight the file and
Click: Edit
Click: Copy
 8. Select the DTS4050 window and,
Click: Edit
Click: Paste
- The file will be copied to the DTS4050. A progress window will provide progress information.

9. When the copy function is complete, the DTS4050 window will show the new files. The time and date will show the Time and Date of the transfer. This is the only time this date will be shown. All files on the DTS4050 will show the same date and time after a reboot or power cycle: August 1, 2008 00:00
10. Cycle the AC power or execute a Reboot command to complete the process.

OPERATING IN BOOTLOADER MODE

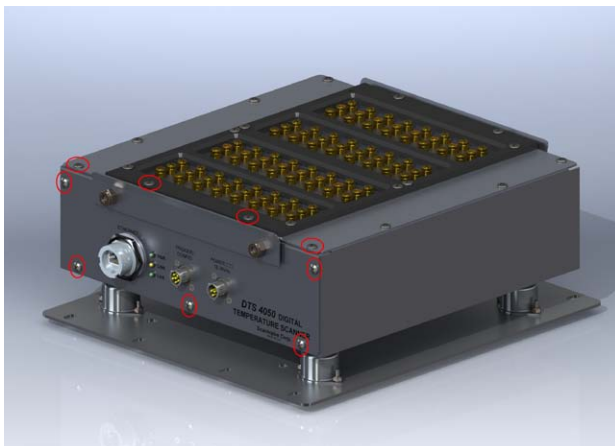
If the DTS4050 will not boot, or appears to have lost communications with a Host, the system may be operated in the Bootloader Mode. In this mode of operation, the application will not start. A list of commands that may be used in the bootloader mode can be found in “DSP Boot Loader” on page 18. All commands may be entered by the Ethernet or Configuration ports.

This mode may be set by switching Dip Switch 1 to the on position.

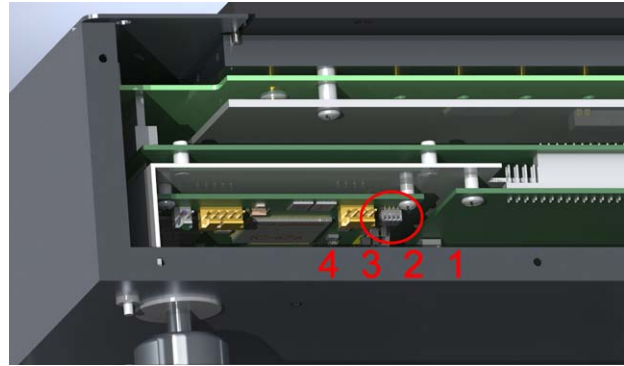


CAUTION! ESD PROTECTION REQUIRED. The proper use of grounded work surfaces and personal wrist straps are required when coming into contact with exposed circuits to prevent static discharge from damaging sensitive electronic components.

1. Switch the input power off, and remove the DTS4050 top insulating cover. In order to access the Dip Switches, the connector end cover must be removed. Removed the nine phillips screws shown and carefully pull the end cover off of the unit.



2. The dip switches are located on the front edge of the processor board. For reference purposes, OFF is towards the bottom of the DTS4050, and on is towards the top of the DTS4050 (towards the circuit board). Slide DIP switch #1 up to turn it on.



3. Re-apply power to the DTS4050. The application will not run, but the bootloader commands can be used to troubleshoot system problems.
4. The most common reason to enter the bootloader is to check or change the IP address of the unit. Once the unit has booted up in the bootloader, send the command “LIST IP” The variable IPADD sets the device IP address. If desired, it can be modified and then saved with the SAVEIP command. Once the save has completed, cycling the power on the unit will implement the new IP address.
5. When troubleshooting is complete, remove power and reset switch #1 to the off position (towards the bottom of the unit). Reinstall the top cover and re-apply power.

REFORMATTING THE DTS4050

Should the file system on the DTS4050 become corrupted, the unit would have to be reformatted. This procedure will delete all data on the DTS4050. Before performing this operation, ensure that all files can be recovered. This can be done by copying the files off of the DTS before reformatting it, or by retrieving the files from the Resource Disk supplied with the unit.

1. Begin by powering the DTS unit down and configuring it to operate in bootloader mode (see "Operating in Bootloader Mode" on page 85).
2. Power the DTS4050 up and establish an Ethernet connection as normal. Because the DIP switches have been reconfigured, you will boot in the bootloader instead of the application. Verify the connection is good by sending the VER command. The DTS4050 should respond with the version of the bootloader (not the application!).
3. To format the SD card, send the command:

```
FDISK
```

Followed by:

```
FDISKCONFIRM
```

It will take about 5-10 seconds for the disk to completely format.

4. When the DTS4050 was formatted, all information including the IP Address was lost. To reset a new IP address, send the command:

```
SET IPADD xxx.xxx.xxx.xxx
```

*(where xxx.xxx.xxx is the new IP address)

Verify the IP address is set properly by sending the LIST S command and checking the setting of the IPADD variable. If it is correct, save the new IP address by sending the command:

```
SAVEIP
```

Followed by:

```
SAVEIPCONFIRM
```

If the IP Address is not set at this point and the DTS4050 is powered down, the default IP address will be used. At this point, the flash memory has been formatted and the DTS4050's IP address has been re-established.

5. Power the DTS4050 down. Remove the processor

board assembly and reconfigured the DIP switches for normal operation.

6. Power the DTS4050 back up. Establish an Ethernet connection to it using the IP address established in step 4 as normal. At this point, the DTS4050 will be operating completely on factory defaults with no calibration coefficients loaded. FTP to the unit using your preferred method and restore the application file (DTS4000.hex), factory coefficients and the CV.GPF (basic configuration file). All of the configuration files and the application file can be found on the DTS4050 Resource Disk supplied with the DTS4050. If there is not an archived copy of this file, each of the configuration variables can be reconfigured manually through the SET commands and then saved with the SAVE command.

APPENDIX

APPENDIX A: THERMOCOUPLE INFORMATION

THERMOCOUPLE BASICS

When two dissimilar metals are joined together to form a closed loop, and if one junction is held at a different temperature from the other, an Electromotive Force (EMF) is generated. The amount of EMF generated is predictable based on the materials used and the temperature of the junction.

The EMF is generated by the wires, not the junction. A temperature gradient must exist before the EMF can be generated.

Three laws have been established that govern thermoelectric circuits.

Law of Homogeneous Materials:

A thermoelectric current cannot be sustained in a circuit of a single homogeneous material, however it varies in cross section, by the application of heat alone. Simply stated, two different materials are required for any thermocouple circuit. If current can be detected in a homogeneous wire when it is heated, this is evidence that the wire is in-homogeneous.

Law of Intermediate Materials:

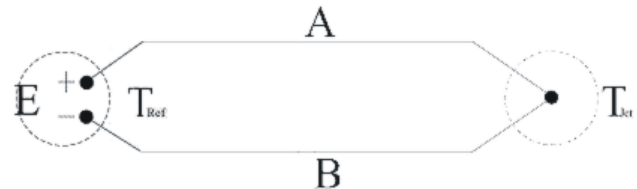
The algebraic sum of the thermoelectromotive forces in a circuit composed of any number of dissimilar materials is zero if all of the circuit is at a uniform temperature. This law states that a third homogeneous material can be added to a circuit with no effect on the net EMF of the circuit as long as temperature of the junctions remain the same.

Law of Successive or Intermediate Temperature:

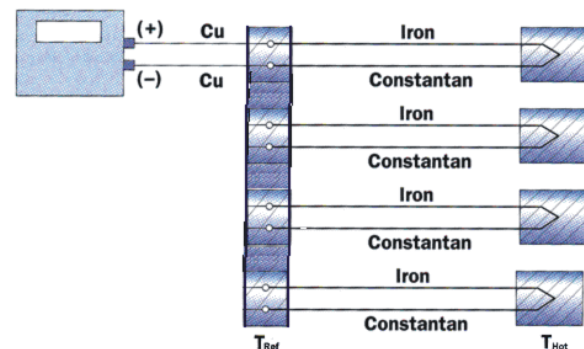
If two dissimilar homogeneous materials produce a thermal EMF of E_1 when the junctions are at temperature T_1 and T_2 , and a thermal EMF of E_2 when the junctions are at T_2 and T_3 , the EMF generated when the junctions are at T_1 and T_3 will be $E_1 + E_2$. This law states that a thermocouple calibrated for one reference temperature can be used with any other reference temperature with a correction. Also, extension wires having the same characteristics as those of the thermocouple wires can be introduced to the circuit without affecting the circuit.

Thermocouple Circuits:

A basic thermocouple circuit consists of two dissimilar homogeneous materials extending from the measuring junction to the reference junction.



When more than one thermocouple is to be measured, each thermocouple should be two continuous wires between the measuring and reference junctions. This is the most common circuit for thermoelectric testing.



Thermocouple Accuracy:

Thermocouple accuracy can be defined as relative and absolute accuracy.

Relative Accuracy

This is the ability of the system to repeat a given measurement. This depends upon the quality of the sensors, the measuring system used and how the system is installed.

Absolute Accuracy

This is the ability of the system to determine a standard accepted value. This can be achieved by calibration relative accepted and recognized standards.

Thermocouple Calibration:

Calibration will not change the characteristics of a thermocouple. It does validate the system and ensure proper readings by allowing corrections to be entered for each thermocouple in the system. Calibrations should conform to ISO 10012-1:1992.

SOURCES OF ERROR IN THERMOCOUPLE MEASUREMENTS**Measuring Junction**

The thermocouple junction at the temperature measuring point is the measuring junction. Errors at this point depend upon the age of the junction, the method of joining and materials used to form the junction. Generally, errors from the measuring junction are small.

Extension Wires

Extension wires are any elements inserted between the measuring junction and the reference junction. Extension wires should have the same characteristics as the thermocouple wire. Extension wires introduce four junctions to each circuit. This can cause errors as large as $\pm 2^{\circ}\text{C}$. The errors can be minimized by calibrating the system with the extension wires in place. If possible, extension wires should not be used.

Reference Junctions

The thermocouple junction maintained at a known temperature is the reference junction. Reference junctions can introduce errors as large as $\pm 0.6^{\circ}\text{C}$.

Copper Connecting Wires

These wires are used to connect the reference junction to the measuring device. The errors caused by these wires are very small.

Thermocouple Switches

When used, these devices can induce errors as large as $\pm 1^{\circ}\text{C}$. Switching should occur in the copper wires between the reference junction and the measuring device.

NOISE IN THERMOCOUPLE CIRCUITS

The external effects that can cause errors in thermocouple circuits include: electrical and magnetic fields, cross-talk, and common mode voltage.

Electric fields radiated from voltage sources are capacitively coupled to thermocouple extension wires. This imposes an AC voltage on the thermoelectric EMF. This can be minimized by shielding the thermocouple extension wire and grounding the shield.

Magnetic fields produce noise current in the thermocouple extension wire. This can be minimized by twisting the thermocouple extension wire pairs.

In a multipair thermocouple extension wire, adjacent pairs can pick up noise from a pulsating signal. This can be minimized by shielding the individual pairs.

Common mode noise will be generated if a grounded

thermocouple is connected to a grounded instrument. This can be minimized by grounding the thermocouple and shield as close as possible to the measuring point.

THERMOCOUPLE DESIGN

The thermocouple used in an application should be selected specifically for the application.

Size: The temperature sensed will be the average temperature across the length of the sensor.

Shape: The shape must conform to the shape of the surface if the thermocouple is measuring surface temperatures.

Response: The response time of a thermocouple is mass dependent. Therefore the size of the thermocouple must be small in relation to the object being measured. The response time should be approximately 5 times shorter than the fastest rate of temperature change to be monitored.

Heat Conduction: Thermocouple extension wires can conduct heat into or out of the thermocouple. The wire must be insulated from the environment if this can occur.

Sensor Position: The thermocouple measures the temperature of the object it is touching or the environment in which it is installed. Therefore the thermocouple must be positioned very carefully to insure that the temperature is being sensed at the correct point.

THERMOCOUPLE TYPES AND DESCRIPTIONS

The DTS family of Temperature Scanners will accept inputs from Type E, J, K, N, R, S, and T Thermocouples. The accuracy of the measurement will depend upon the type of thermocouple and the quality of the extension wire used for the measurement.

Type B

| | |
|--------------|--|
| Positive leg | 70% platinum, 30% rhodium |
| Negative leg | 94% platinum, 6% rhodium |
| Range | 0 to 1800C |
| Usable range | 400 to 1704C |
| Notes | Easily contaminated and damaged by reducing atmospheres. This thermocouple should be protected with a gas tight ceramic tube, a secondary tube of porcelain and a silicon carbide or metal outer tube. |

Type E - Chromel Constantan

| | |
|--------------|--|
| Positive leg | 90% nickel, 10% chromium |
| Negative leg | 43% nickel, 57% copper |
| Range | -270 to 1000° C |
| Usable range | 0 to 900° C |
| Notes | Highest EMF output per degree of all recognized thermocouples. Has similar drift between 316 and 593° C as a Type K thermocouple |

Type J - Iron Constantan

| | |
|--------------|--|
| Positive leg | 100% iron |
| Negative leg | 43% nickel, 57% copper |
| Range | -210 to 1200° C |
| Usable range | 0 to 816° C |
| Notes | Not susceptible to aging from 371 to 538° C. Very stable, should be used with a 96% pure MgO insulation and stainless steel sheath to prevent corrosion of the iron lead. Most commonly used thermocouple. |

Type K - Chromel Alumel

| | |
|--------------|---|
| Positive leg | 90% nickel, 10% chromium |
| Negative leg | 95% nickel, 2% aluminum, 2% manganese, 1% silicon |
| Range | -270 to 1372° C |
| Usable range | -36 to 1260° C |
| Notes | Not recommended from 316 to 593° C because of aging that can cause drift rates of 2° C in a few hours. Best used when corrosion may be a problem. |

Type N

| | |
|--------------|---|
| Positive leg | 14% chromium, 1.4% silicon, 84.6% nickel |
| Negative leg | 95.6% nickel, 4.4% silicon |
| Range | -270 to 1372° C |
| Usable range | 0 to 1260° C |
| Notes | Less aging from 316 to 593° C than a Type K thermocouple. |

Type R

| | |
|--------------|---|
| Positive leg | 87% platinum, 13% rhodium |
| Negative leg | 100% platinum |
| Range | -50 to 1767° C |
| Usable range | 0 to 1482° C |
| Notes | Has a higher output than Type S thermocouples. Easily contaminated. This thermocouple should be protected by compacted mineral insulation and a metal outer sheath. |

Type S

| | |
|--------------|--|
| Positive leg | 90% platinum, 10% rhodium |
| Negative leg | 100% platinum |
| Range | -50 to 1767° C |
| Usable range | 0 to 1482° C |
| Notes | Easily contaminated. This thermocouple should be protected with a gas tight ceramic tube, a secondary tube of porcelain and a silicon carbide or metal outer tube. |

Type T - Copper Constantan

| | |
|--------------|---|
| Positive leg | Pure copper |
| Negative leg | 43% nickel, 57% copper |
| Range | -270 to 400° C |
| Usable range | -262 to 350° C |
| Notes | Good for low temperature and cryogenic applications |

INTERNATIONAL THERMOCOUPLE AND EXTENSION WIRE COLOR CODES

| Country | USA | USA | United Kingdom | United Kingdom | Germany | Japan | Fance |
|--|------------------------|-------------------------|-------------------------|---------------------------|-----------------------|------------------------|----------------------------|
| Standard | ANSIMC96.1 T/C | ANSI MC96.1 Extension | BS 1843 | BS 4937 | DIN 43714 | JIS C1610-1981 | NFE C42-323 |
| B Overall B Positive B Negative | - | Gray Gray Red | - | - | Gray Red Gray | Gray Red Gray | - |
| E Overall E Positive E Negative | Brown Purple Red | Purple Purple Red | Brown Brown Blue | Brown Brown Blue | Black Red Black | Purple Red White | - |
| J Overall J Positive J Negative | Brown White Red | Black White Red | Black Yellow Blue | Black Black White | Blue Red Blue | Yellow Red White | Black Yellow Black |
| K Overall K Positive K Negative | Brown Yellow Red | Yellow Yellow Red | Red Brown Blue | Green Green White | Green Red Green | Blue REd White | Yellow Yellow Purple |
| N Overall N Positive N Negative | Brown Orange Red | Orange Orange Red | - | - | - | - | - |
| R Overall R Positive R Negative | - | Green Black Red | Green White Blue | Orange Orange White | White Red White | Black Red White | Green Yellow Green |
| S Overall S Positive S Negative | - | Breen Black Red | Green White Blue | Orange Orange White | White Red White | Black Red White | Green Yellow Green |
| T Overall T Positive T Negative | Brown Blue Red | Blue Blue Red | Blue White Blue | Brown Brown White | Brown Red Brown | Brown Red White | Blue Yellow Blue |

APPENDIX B - SOFTWARE CHANGE LIST

Version 1.00 - Initial software release. (08/26/2013)

Version 1.01 - Updated to add MINRATE variable (4/21/14)

Version 1.02 - Changed the rate of the RTD A/D to 3x the T/C A/D rate. (6/11/14)

Version 1.03 - Added support for 32Mbit flash chip. Fixed the routing of the serial DIR command. Set SIM default to 0. Error checked for blank file in TYPE command. Remove value checking from QPKTS variable. Change default number of A/D board to 2. Move HW setting to top of LIST A. Added additional outputs to LIST A. Resolved a problem with the save SSN. Added the sequence number to the SAVE command. Remove the write to 4202 on the start up. Added SIM mode to background state function. (8/5/2014)

Version 1.04 - Resolved a bug with the IPO (Ice Point Offset) command that did not use both RTDs for the calculations. Reviewed coding to make channel numbering scheme uniform throughout, all numbering starts at 1. (Not Released)

Version 1.05 - Resolved a timing bug that would cause extremely noisy RTD readings approximately every 500 new scans. (12/9/2014)

Version 1.06 - Resolved a bug that would randomly configure the channel 49 A/D on 64 channel units incorrectly. Removed the initialization of the MODEL and SERNUM variables to ensure proper configuration during manufacture. (12/17/14)

Version 1.07 - Set counter 2 period to 0. Added support for TCP/IP binary data for legacy compatibility. Fixed problems with data destination selection. Added 10ms delay at the end of the FTP transfer to increase transfer reliability. (4/3/15)

Version 1.08 - Added support for binary data to be sent to the telnet port. CALAVG variable made active. (4/16/2015)

Version 1.09 - Resolved a bug in the RTD median filter that rendered it ineffective. (5/4/2015)

Version 1.10 - Resolved bugs that caused the unit to stop scanning prematurely while scanning with an external hardware trigger. Implemented legacy style time stamp. Resolved a bug that caused the unit to scan one extra frame beyond the FPS term in ASCII scan mode. Resolved a bug that caused the RTD readings to jump to 25°C in an over-range condition. (7/24/2015)

Version 1.11 - Removed randomly executed leftover DTS3250 debug code from that, at times, did not perform A/D calibration. (1/6/2016)

Version 1.12 - DTS Processor board flash chip updated. Added support for new flash. (1/10/2017)

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Scanivalve

*1722 N. MADSON ST.
LIBERTY LAKE, WA 99019*

*PHONE: 1-800-935-5151
1-509-891-9970
FAX: 1-509-891-9481*

*SCANCO@SCANIVALVE.COM
WWW.SCANIVALVE.COM*

*DTS4050 HARDWARE & SOFTWARE MANUAL
JANUARY 10, 2017*