DTS4050

THERMOCOUPLE SCANNERS

HARDWARE AND SOFTWARE MANUAL

SOFTWARE VERSION 2.04

Scanivalve

PREFACE

WARNINGS, CAUTIONS AND NOTES

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.

The CAUTION ! symbol indicates 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.

WARRANTY

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Surface transportation charges covering any repaired or replacement product or component part shall be at Seller's expense; however, inspection, testing and return transportation charges covering any product or component part returned and redelivered, which proves not to be defective, shall be at the expense of Buyer or the end user, whichever has returned such product or component part.

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OPERATION OF LAW OR OTHERWISE, INCLUDING THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE, AND IN NO EVENT SHALL SELLER BE LIABLE FOR INCIDENTAL OR CONSEQUENTIAL DAMAGES.

In the event of a failure:

1) Notify Scanivalve Corporation, Customer Service Department. Include model number and serial number. On receipt of this information, service data or shipping instructions will be forwarded. This may be transacted by telephone or e-mail.

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

3) All shipments should be made via "Best Way". The product should be shipped in the original packing container or wrapped in protective material and surrounded by a minimum of four (4) inches of a shock absorbing material.

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Packaging for Shipment

If the product must be shipped, whether being returned to Scanivalve or relocated to another location it must be packaged properly to minimize the risk of damage. The recommended method of packing is to place the instrument in a container, surrounded on all sides with at lease four inches of shock attenuating material such as Styrofoam peanuts.

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:

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SECTION 1: INTRODUCTION

1.1 Overview

The DTS4050 Series is a family of intelligent, high-accuracy thermocouple scanners engineered for precise, reliable temperature measurement in demanding test environments. Designed for flight test, propulsion development, wind tunnel instrumentation, industrial monitoring, and research applications, each module delivers tightly controlled reference-junction performance, robust electrical isolation, and stable temperature data across all channels.

The DTS4050 is optimized for use in electrically noisy environments. High channel-to-channel isolation, input isolation, and excellent common-mode rejection work together with careful grounding and shielding practices to maintain measurement integrity in the presence of EMI and high-energy transients. Housed in a rugged stainless-steel enclosure with integrated vibration isolation, the DTS4050 combines durable construction with advanced electronics to deliver dependable measurements in challenging thermal, mechanical, and electrical environments.

WARNING! This manual may be used for the DTS3250 series, but not all specifications, commands, or features may not be available. Please refer to the DTS3250 Manual.

1.1.1 Core Technology

Each DTS4050 module incorporates a 22-bit analog-to-digital converter on every thermocouple input, supported by dedicated RAM and a digital signal processor for high-resolution measurement, thermocouple linearization, and communication management. NIST thermocouple tables for standard types are stored in non-volatile memory, allowing the DSP to convert millivolt inputs directly to engineering units. Temperature may be reported in °C, °F, °R, K, mV, or raw counts.

A precision Isothermal Block provides the Uniform Temperature Reference (UTR) for cold-junction compensation. Each UTR supports up to 16 thermocouple pairs and is monitored by dual PT100 RTDs, providing a reference-junction accuracy of ±0.1°C. This architecture ensures stable, consistent results across all channels and supports both grounded and ungrounded thermocouples.

To support operation in harsh EMI environments, the DTS4050 input design incorporates:

- High channel-to-channel isolation to minimize interaction between adjacent thermocouple inputs
- Input isolation and common-mode rejection to suppress noise and interference relative to local ground
- Optimized signal routing and shielding within the module to reduce susceptibility to radiated and conducted noise

These measures enable accurate temperature measurement even when installed near power electronics, rotating machinery, or other high-interference sources.

1.1.2 Mechanical Design

The DTS4050 Series is built around a robust isothermal and mechanical framework designed to maintain uniform thermal conditions at the reference junction while protecting the electronics from harsh environments. The stainless-steel housing is corrosion-resistant and incorporates internal shock mounts for vibration isolation. Industrial-grade connectors are used for power, Ethernet, and serial interfaces to provide reliable connectivity in test and industrial settings.

The thermal design focuses on maintaining a uniform temperature at each UTR block to ensure accurate cold-junction compensation. The top cover and insulation help protect the UTR from ambient temperature fluctuations and localized “cold spots,” which could otherwise introduce error.

Copper screw terminal inputs are provided on each UTR for Thermocouple inputs. Each channel provides a positive, negative, and ground lug. Each channel input can be set to any available thermocouple type available in the software. The standard isolating lid will act as strain relief when closed on the thermocouples connected.

Optional features allow adaptation to diverse environments:

- **Internal Heater Option** (16- and 32-channel modules): Extends the operational ambient temperature range down to –20°C by maintaining the internal module temperature at approximately +20°C. This supports accurate measurements in cold-chamber, outdoor, or unconditioned environments.
- **Rack-Mount Chassis Option** (32-channel modules): Enables rack integration in standard 19-inch cabinets for fixed test-cell and laboratory installations.
- **Panel Jack Inputs** (16- and 32-channel modules): 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.

The system is intended for indoor or otherwise protected locations where ambient temperature and thermal gradients can be managed to stay within specified operating limits.

1.1.3 Channel Configurations

The DTS4050 Series is available in multiple input configurations, allowing users to scale measurement density and mechanical layout to specific test requirements.

DTS4050/16Tx - 16-Channel Module

- 16 thermocouple inputs
- Screw Terminal or Panel Jack inputs
- Optional heater

DTS4050/32Tx - 32-Channel Module

- 32 thermocouple inputs
- Screw Terminal or Panel Jack inputs
- Optional heater
- Optional Rack-Mount kit

DTS4050/64Tx - 64-Channel Module

- 64 thermocouple inputs
- Screw Terminal Inputs only
- Optional Rack-Mount kit
- *Note: no longer in production as of April 2026. Manual is reference for existing devices. Contact Scanivalve for more information.*

1.1.4 Manual Scope and Contents

The DTS4050 Series combines precision cold-junction control, advanced signal processing, robust EMI performance, and rugged packaging to deliver accurate and stable temperature measurements across a wide range of applications. Configurations scale from compact 16-channel units to high-density 64-channel systems, with multiple mechanical, connector, and environmental options to match diverse test environments.

This manual includes detailed specifications, wiring and installation guidelines, communication and configuration settings, thermocouple reference operation, EMI and grounding recommendations, calibration information, and environmental usage considerations to support accurate, reliable performance of DTS4050 systems.

SECTION 2: SPECIFICATIONS

	16Tx	32Tx	64Tx
Dimensions	See Dimensions drawings		
Weight	13lbs [5.9kg]	15.5lbs [7.03kg]	25lbs [11.35kg]
Channels	16	32	
Configuration Options	Panel Jack Inputs, Heater	Panel Jack Inputs, Heater, Rack Mount Kit	Rack Mount Kit
Standard Inputs	Screw Terminal (6-32 brass screw)		
Optional Panel Jack Inputs	Omega TPJ (3 prong)		N/A
Thermocouple Types	Screw Terminal Input: E, J, K, S, T, N, B, R Panel Jack Input: E, J, K, S, T		
Accuracy Constant Ambient Temperature*†	E, J, K, N, T: ±0.25°C R and S: ±1.00°C B: ±2.00°C		
Accuracy Dynamic Ambient Temperature†**	E, J, K, N, T: ±0.5°C R and S: ±2.00°C B: ±4.00°C		
UTR Accuracy	±0.1°C		
A/D Resolution	22-bit ADC		
Binary Data Output Rate‡	200Hz		
ASCII Data Output Rate‡	20Hz		
Power Connector	PT06A-8-3S-SR		
Power Supply	18 to 36VDC		
Power Consumption (No Heater)	18W	24W	42W
Power Consumption (w/ Heater)	45W	135W	N/A
Config/Trigger Connector	JT02RE8-6P or MS27473T8F6P		
External Trigger	4.5 to 15 VDC, 6.5mA		
Ethernet Connector	Conec 17-101754		
Ethernet Connection	100BaseT, MDIX Auto-crossing		
Communication Protocols	TCP/IP, UDP, FTP, IEEE1588-2008v2 PTP		
Data Synchronization	IEEE1588-2008v2 PTP Timestamping, External Hardware Triggering		
Input-Output Isolation	600VDC		
Channel-to-Channel Isolation	1000VDC		
Common Mode Rejection (CMRR):	160dB, 0-60Hz		
Operating Temperature (No Heater)	-5° to 60°C		
Operating Temperature (w/ Heater)	-20° to 60°C		N/A
Storage Temperature	0° to 80°C		
Humidity	5 to 95% RH, Non-condensing		
Environment Pressure	Minimum: 1PSIA (6.8kPa abs) Maximum: 100PSIA (690kPa abs)		
Standards	CE, MIL-STD-810G Cat 24, RoHS v3		

** When used in environments where ambient temperature is steady, ±3°C, anywhere in the operating temperature range*

*** When used in environments where temperature is dynamic, but within the operating temperature range*

† Standard Screw Terminal Inputs. Panel Jack option reduces overall accuracy by factor of two

‡ Maximum data rate may vary based on network limitations

DTS4050/16Tx - Screw Terminal Outline Drawing

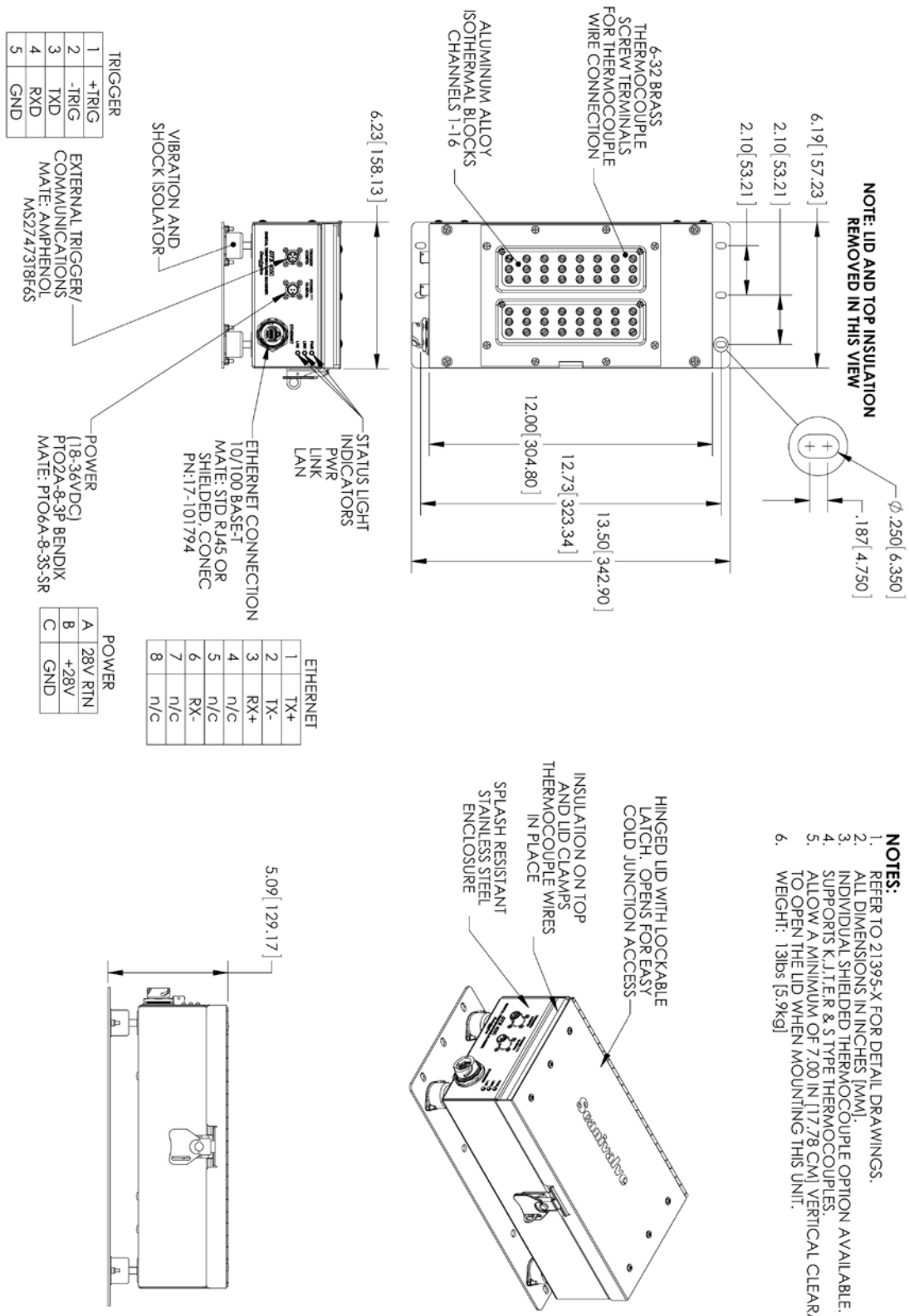


Figure 1.1 - Physical Specification, DTS4050/16Tx, screw terminal inputs

DTS4050/16Tx - Panel Jack Outline Drawing

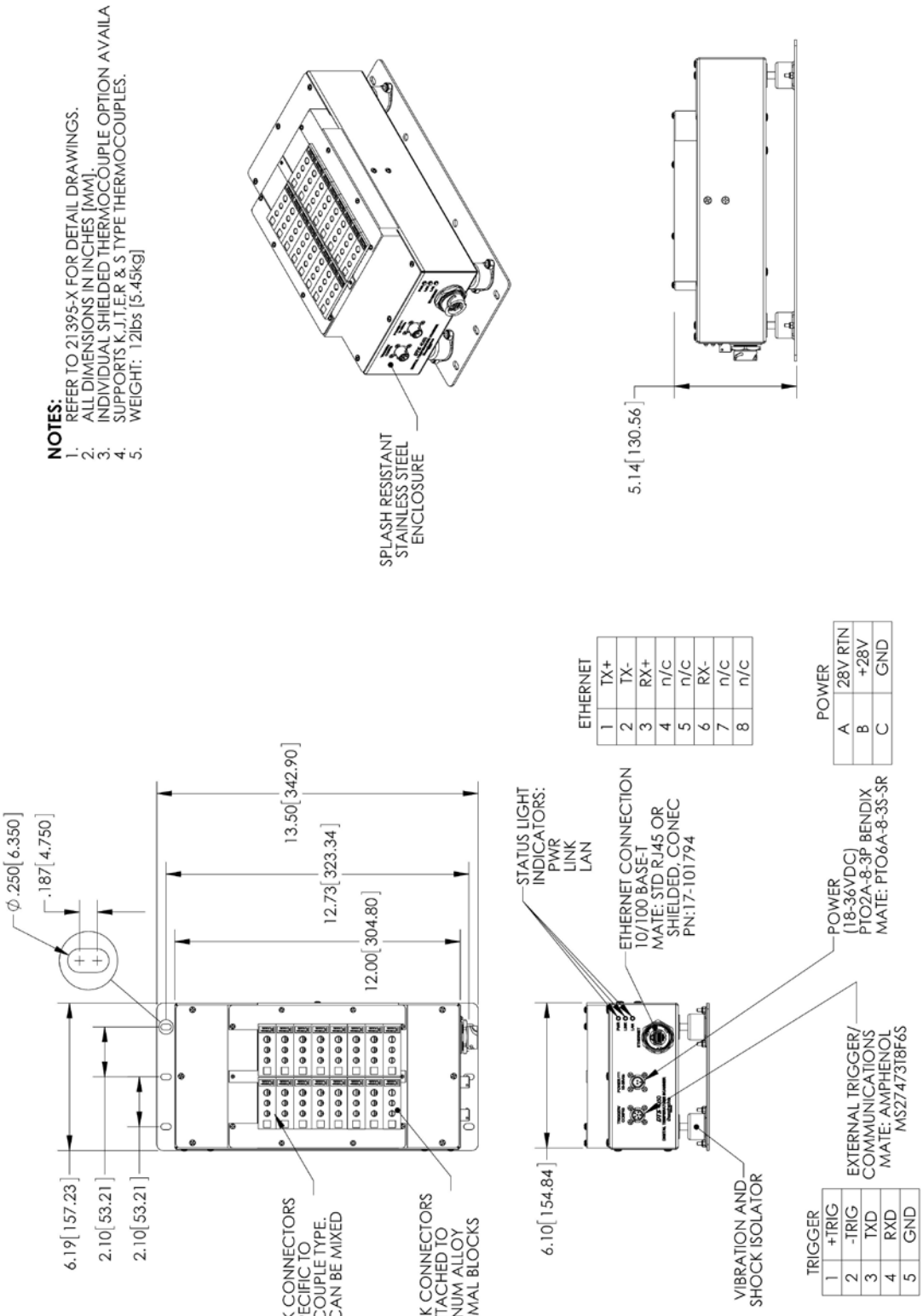


FIGURE 1.2 - PHYSICAL SPECIFICATION, DTS4050/16Tx, PANEL JACK INPUTS

DTS4050/32Tx - Screw Terminal Outline Drawing

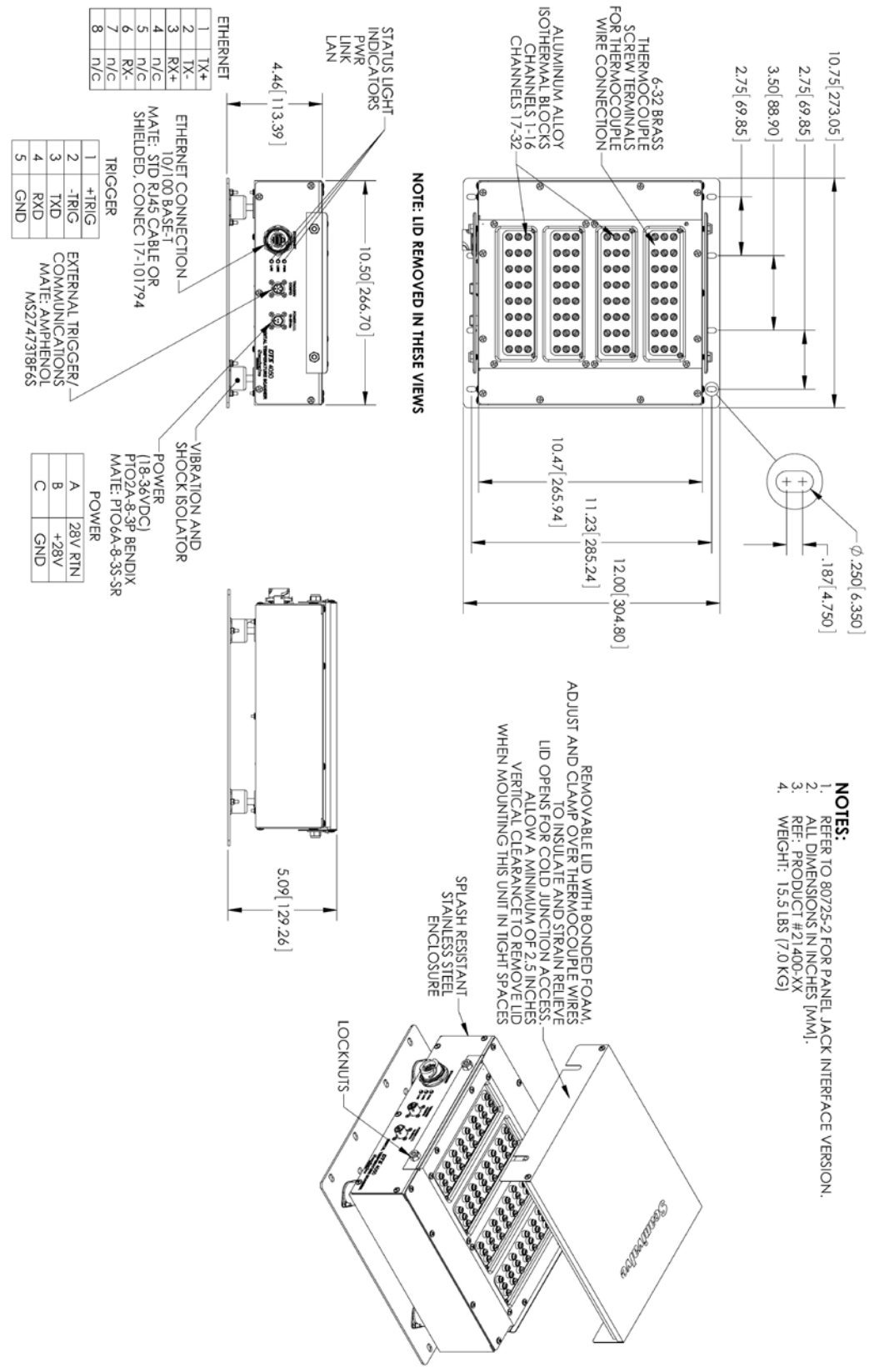


FIGURE 1.3 - PHYSICAL SPECIFICATION, DTS4050/32TX, SCREW TERMINAL INPUTS

DTS4050/32Tx - Panel Jack Outline Drawing

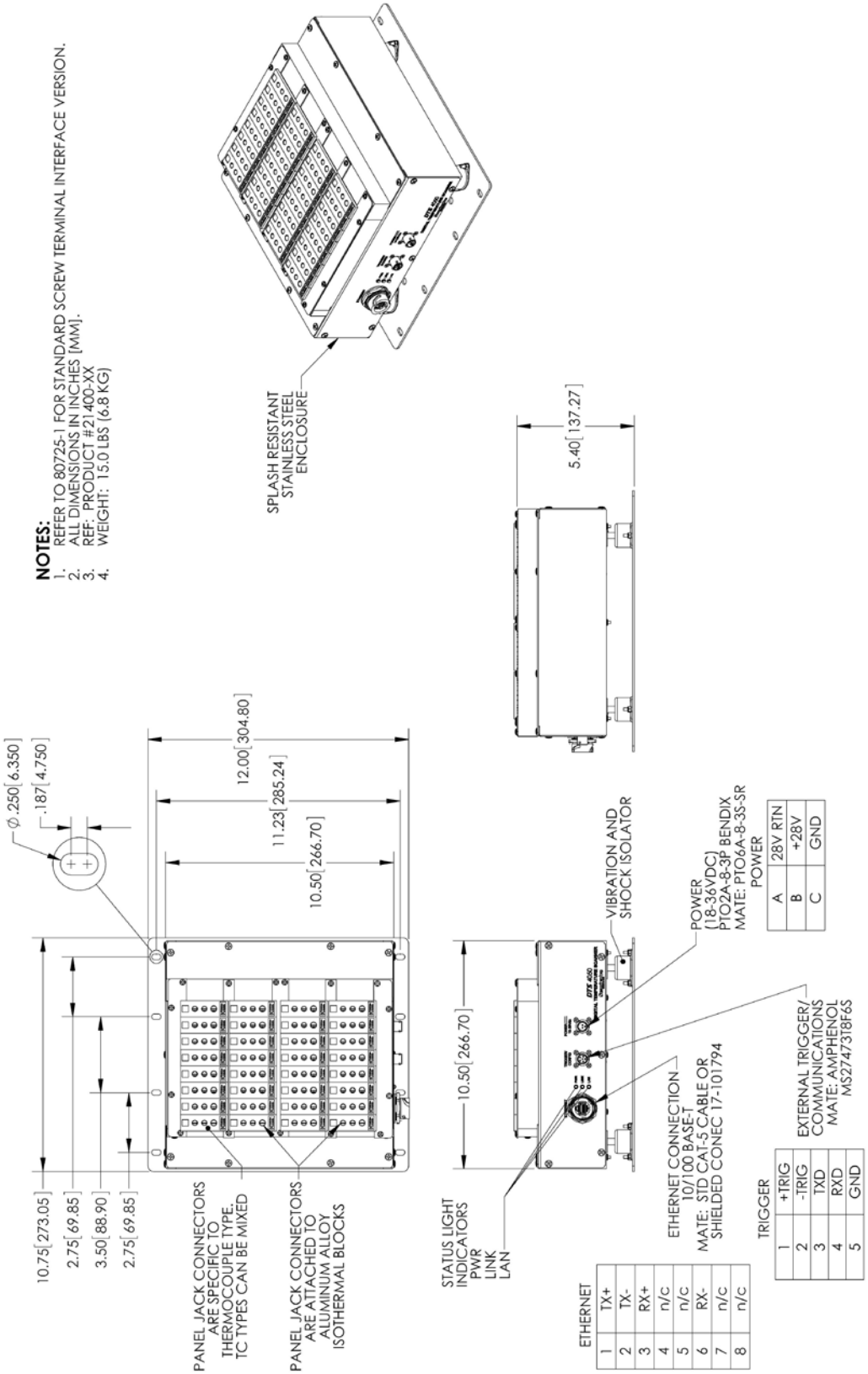


FIGURE 1.4 - PHYSICAL SPECIFICATION, DTS4050/32Tx, PANEL JACK INPUTS

DTS4050/64Tx Outline Drawing

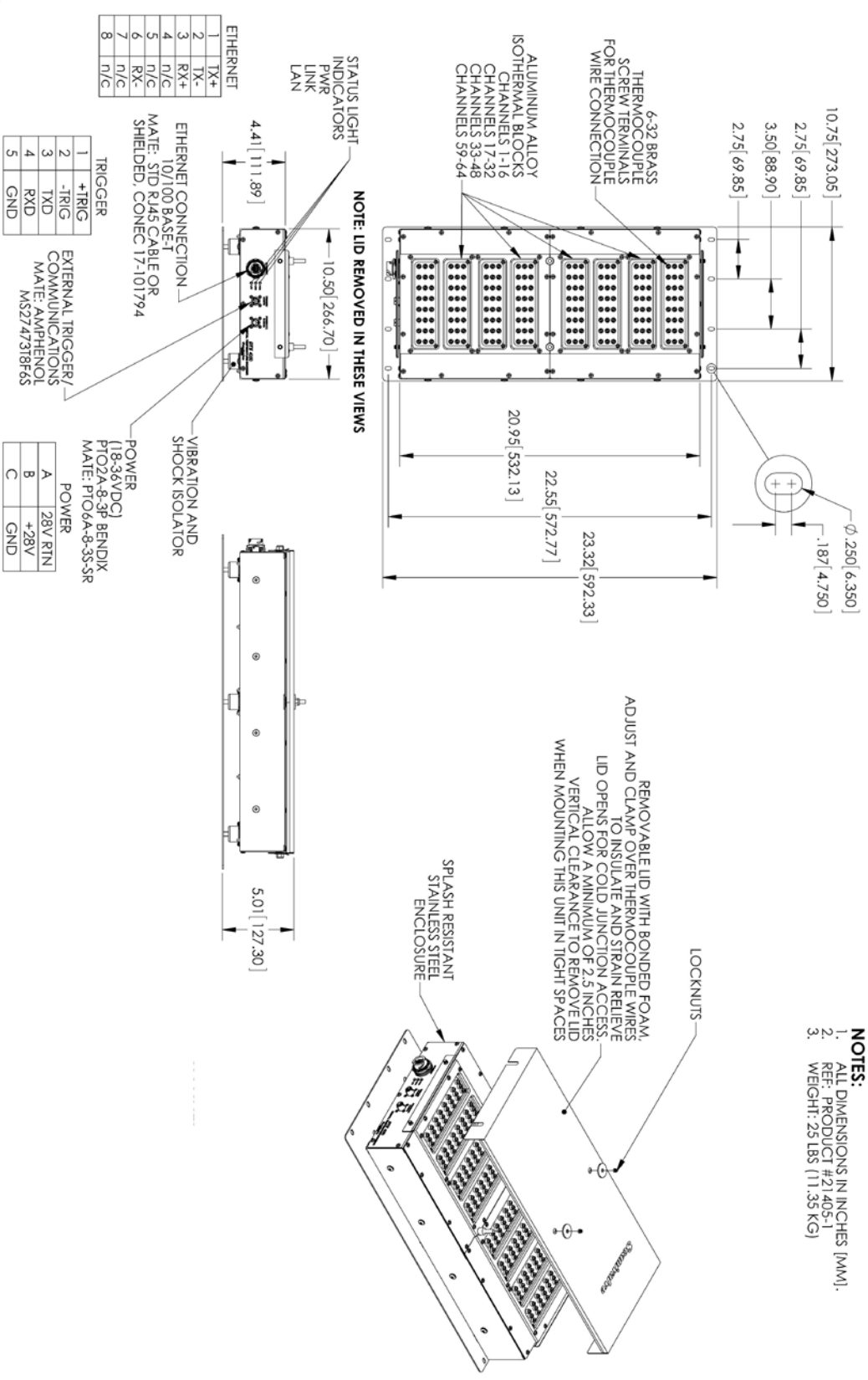


Figure 1.5 - Physical Specification, DTS4050/64Tx, screw terminal inputs

SECTION 3: SAFETY AND SETUP

3.1 Safety Information

WARNING! Failure to follow these instructions may result in injury or damage to the equipment.

- Read this manual and its contents completely before installing or operating the module.
- When required, handle the device in an ESD safe environment using ground work surfaces and wrist straps.
- Do not exceed the specified pressure or electrical ratings as discussed in Section 2.
- Ensure proper grounding before powering the device.
- Do not connect or disconnect power connector when power is active.
- Operate within the environmental conditions specified in ”Section 2: Specifications”.
- Protect the module from splash, spray, or mist. The DTS4050 series is not waterproof.
- Avoid exposing the module to sudden temperature changes that could create gradients across the isothermal block.

3.2 Unpacking and Inventory

When you first unpack the shipment, begin by inspecting and inventorying the contents of the package. If any visible damage is noticed or contents are missing, contact Scanivalve before proceeding. Avoid dropping or exposing the unit to moisture during unpacking.

As a minimum, DTS4050 modules are shipped with the following contents:

1. DTS4050 Module
2. Power mating connector
3. Serial/Trigger mating connector
4. Resource Disk (USB) - Contains full calibration report, firmware files, documentation, and backup coefficients
5. Certificate of Calibration (hard copy)

Note: Optional accessories, power supplies, or cabling may be provided depending on the initial order. Refer to order documentation or contact Scanivalve for details.

3.3 Mounting

All DTS4050 configurations may be mounted in any orientation provided that airflow, cable access, and thermal stability are maintained.

Care should be taken to avoid thermal gradients across the enclosure, especially around the UTR block area. Uniform temperature greatly improves measurement performance.

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

3.3.1 Shock-Mounted Enclosure

The standard DTS4050 configuration provides a mounting plate attached to the bottom using vibration dampers. This mounting plate accepts mounting hardware up to 1/4” (6.4mm) in diameter. For mounting hole location and dimensions, see Section 2 drawings.

For high vibration environments, the shock mounts natural resonant frequency will be somewhere between 15 and 25Hz, depending on the model and configuration.

When the DTS is to be mounted on a wall or vertically on a surface, the DTS must be mounted such that the RTD’s in the UTR are on the same horizontal plane. If the RTD’s are vertical from each other, a gradient can form across the UTR.

For 16-channel units, the electrical connectors (power and Ethernet) should be facing horizontal (left/right). For 32- and 64-channel units, the electrical connectors should be facing vertical (up/down). Figure 3.3.1 shows correct mounting direction for the 16 and 32 channel units.

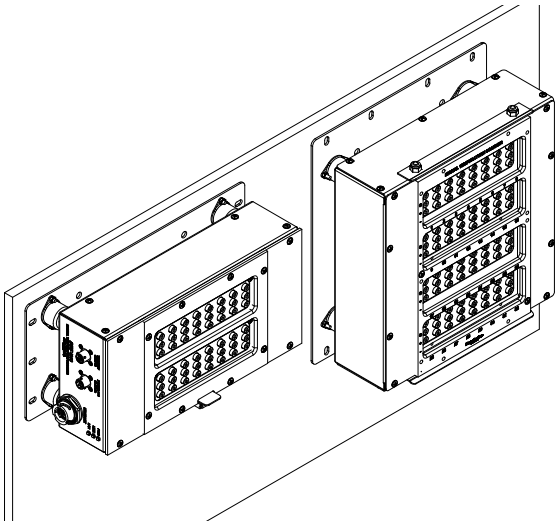


FIGURE 3.3.1: WALL MOUNTING ORIENTATION

3.3.2 RACK-MOUNTED ENCLOSURE

The optional rack-mount DTS4050 configuration (32- and 64-channel units only) provides 19” rack ears to mount to standard 19” rack rails. Rack mount version must be configured at the time of order and cannot be added or changed in the field.

All electrical connectors are provided to be facing out for easy access. 32-channel units require 8U space. 64-channel units require 14U space. Mounting holes and dimensions can be found in Section 2 drawings.

3.4 ENVIRONMENTAL CONSIDERATIONS

The DTS4050 series scanner is designed to withstand normal industrial, educational, wind tunnel or similar applications. The module is not waterproof and it should be protected from any splash, spray, or mist. 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 in a location where it may be subjected to extreme temperature shifts or ambient temperatures outside limits defined in Section 2.

Keep in mind that the internal temperature of the module will run approximately 5°C - 10°C warmer than ambient temperature. This temperature increase is accounted for in the calibration tables. The temperature specification listed is in relation to the ambient temperature.

3.5 ELECTRICAL (EMI) ENVIRONMENT CONSIDERATIONS

The DTS4050 is optimized for operation in electrically noisy environments, but proper installation greatly enhances performance.

- Maintain shield continuity up to the DTS termination point.
- Ground shields at a single, designated location to avoid ground loops.
- Route thermocouple wiring away from high-current power lines, inverters, motors, or ignition systems.
- Use twisted, shielded thermocouple cable for all installations.
- Avoid parallel runs with switching power supplies or high-frequency control lines.
- Ensure the power supply is clean and within specified limits.

Proper grounding and wiring practices significantly improve channel-to-channel isolation and common-mode rejection.

SECTION 4: HARDWARE

This section provide instructions for connecting electrical and pneumatic lines to the DTS series modules. Refer to Section 3 for safety and mounting precautions before proceeding.

4.1 ELECTRICAL CONNECTORS

The DTS4050 includes three electrical connectors located on one end of the module. These provide interfaces for Ethernet communication, external trigger/serial configuration, and DC power input. Each connector is a rugged, polarized industrial interface designed to prevent incorrect mating and ensure reliable operation in demanding test environments.

All connectors include secure locking mechanisms; to disconnect a cable, release the connector latch or coupling ring as specified and pull on the connector body—not on the cable. Pinouts and wiring details for each connector are provided in the following subsections.

CAUTION! Do not make or break the power connector with power applied! Doing so risks damage to the module.

4.1.1 DTS4050 POWER CONNECTION

The Power connector is located on the end of the module and provides inputs for DC power. This connector supplies operating power for the module as well as for the optional internal heater (16Tx and 32Tx models). User-fabricated cables may be made using a compatible mating connector and the pin-out information.

DTS4050 Power Connection			
	16Tx	32Tx	64Tx
Connector	PT02A-8-3P		
Mating Connector	PT02A-8-3S		
Power Supply	18 to 36VDC		
Power Consumption (No Heater)	18W	24W	42W
Power Consumption (w/Heater)	45W	135W	N/A

DTS4050 Power Pin-Out	
Pin A	-RTN
Pin B	+VDC
Pin C	GND

Scanivalve's PDM power supply series may be used to provide suitable DC power. Additional cables are available from Scanivalve. Refer to the Module Accessory Catalog for available part numbers.

4.1.2 DTS4050 TRIGGER/CONFIG CONNECTION

The Trigger/Config connector is located between power and Ethernet connectors on the end of the module. This connector provides connection for an external trigger, used to synchronize data collection with other devices, and a serial configuration connection, used when Ethernet is unavailable or for recovery/troubleshooting.

DTS4050 Trigger/Config Connection			
	16Tx	32Tx	64Tx
Connector	JT02RE8-6P		
Mating Connector	JT06RE8-6S		
External Trigger	4.5 to 15 VDC, 6.5mA		

DTS4050 Trigger/Config Pin-Out	
Pin 1	+TRIG
Pin 2	-TRIG
Pin 3	Serial RX
Pin 4	Serial TX
Pin 5	GND
Pin 6	Unused

Scanivalve provides a mating connector with each modules should a connection need to be created. Often time, a 155829-01 cable is provided with orders as a means to provide an DB9 RS232 connector for serial, and flying leads for triggering. Additional cables can be ordered from Scanivalve.

Additional information for external triggering is described in "5.7 Triggering and Synchronization". Serial communications are described in "5.2 Communications".

4.1.3 DTS4050 Ethernet Connector

The DTS4050 provides one 10/100Base-T Ethernet interface as the primary communication link for configuration, data acquisition, and diagnostics.

A Conec RJ45-IP67 bulkhead connector is used on all Standard DTS modules to support both standard RJ45 cables and optional rugged protective shells for mechanical retention and EMI reduction. Conec cables up to 100 ft are available; consult the Module Accessory Catalog for details.

DTS4050 Ethernet Connection	
Connector	Conec 17-101754
Mating Connector	Conec 17-101794
Ethernet Connection	100BaseT, MDIX Auto-crossing

DTS4050 Ethernet Pin-Out	
Pin 1	+Tx
Pin 2	-Tx
Pin 3	+Rx
Pin 6	-Rx

All other pins unused.

Rack-mounted DTS modules use a standard female RJ45 port and does not utilize the ruggedized Conec connector.

User-manufactured Ethernet cables may be made using the appropriate mating connector and pin out table. These cables, along with generic Ethernet cables, should use sheilded Cat5e or better Ethernet cabling.

Additional information for Ethernet communications can be found in “5.2 Communications”.

4.2 Thermocouple Inputs

The DTS4050 supports multiple thermocouple input configurations depending on the module type. All versions incorporate high-stability isothermal blocks (UTR blocks), individual channel isolation, and flexible grounding/shielding options to ensure accurate operation in demanding temperature-measurement environments.

4.2.1 Screw Terminal Connections

Screw terminal inputs are the standard configuration for all 16Tx, 32Tx, and 64Tx DTS4050 modules. Thermocouples terminate directly into the UTR block using #6-32 brass screws, providing a robust mechanical connection and excellent thermal coupling.

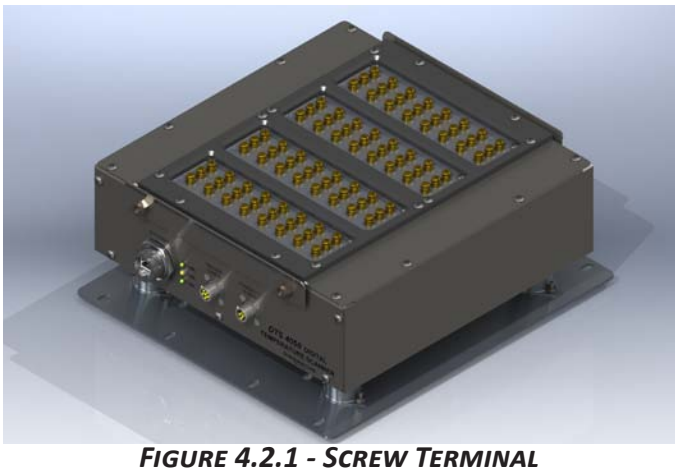


Figure 4.2.1 - Screw Terminal Connections (32Tx shown)

Each channel input provides a +TC (positive TC lead), -TC (negative TC lead), and an isolated ground lug (optional shield or drain reference).

Key characteristics include:

- Direct contact with UTR block for maximum accuracy and thermal compensation.
- Each input ground lug is individually isolated from all others.
- Maximum thermocouple loop is 300Ω
- Supports both grounded and ungrounded thermocouples.
- Software controlled ground switch, per channel, to accommodate various grounding schemes.
- Software controlled thermocouple type, as each input can be used with a different thermocouple.

4.2.2 Panel Jack Connections

Panel jack (PJTx) versions offer a fast, user-friendly interface for environments requiring frequent thermocouple changes or simplified wiring.

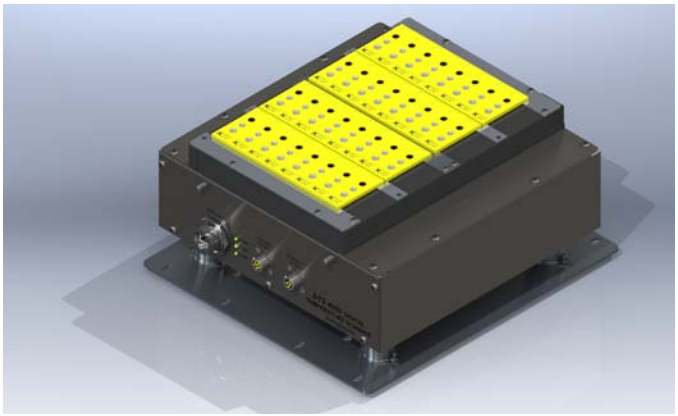


Figure 4.2.2 - Panel Jack Connections (32Tx shown)

The panel jack inputs utilize Omega TPJ-serires connectors. This connectors are compatible with standard OTP-format 3-pring thermocouple plugs, providing a rapid connection points without accessing or using the screw terminals.

Panel jack inputs must be determined at the time of order as they are fixed to the DTS and cannot be changed or used with different thermocouple types. Available types are E, J, K, T and S.

Important considerations:

- Panel jack interfaces introduce additional error and reduces the module accuracy by a factor of 2.
- Users may compensate for this with the use of Gain and Offset term adjustments.
- Unused panel jacks must be plugged or covered to prevent external cooling of the UTR ("cold spots"), which can cause measurement errors.
- Panel jack modules are not available in 64-channel modules.

4.3 Insulation Cover

Screw-terminal DTS4050 modules include an insulating cover designed to:

- Protect the UTR block from ambient temperature changes
- Improve reference-junction stability
- Provide strain relief for thermocouple wiring

16-channel units are fixed to the unit on a piano hinge. An easy twist-lock latch is provided to unlock/latch the lid in position. 32- and 64-channel modules use a removable cover secured with four 1/4-20 lock nuts. Removing the cover requires 2.5 in (64 mm) vertical clearance. Pinch bars on either side help hold the cover in position.

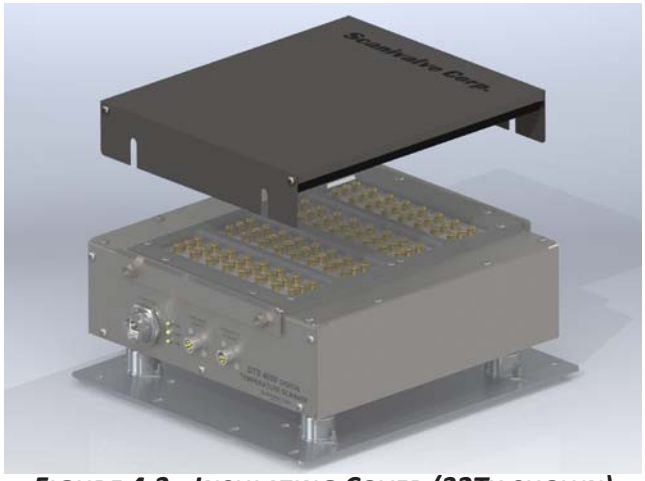


Figure 4.3 - Insulating Cover (32Tx shown)

Use of the insulation cover is strongly recommended during all normal operation. The insulation cover is not available for panel jack units.

4.4 Thermocouple Grounding Scenarios

The DTS4050 supports five thermocouple grounding and shielding configurations. Each input channel includes an independently controlled shield-switch, allowing flexibility in mixed environments and high-EMI installations. The following sections describe common field wiring examples that correspond to each supported mode.

Supported grounding configurations include:

- Floating (ungrounded) thermocouples
- Grounded thermocouples
- Shield grounded at the DTS
- Shield grounded at the sensor end
- Fully isolated mode (shield disconnected at both ends)

Grounding behavior is controlled by the TYPE command ("7.17.1 List Type"). Each example will provide the setting per thermocouple scenario.

4.4.1 Grounded Thermocouples

A grounded (bonded) thermocouple has the junction physically attached to the test article, but the cable contains no shield conductor. The DTS receives only the +TC and –TC leads. This configuration is widely used in engine rigs, turbine blades, and metallic components where the sensor must follow the structure's thermal response and grounding is unavoidable.

For this case, the ground setting must be set to closed (1).

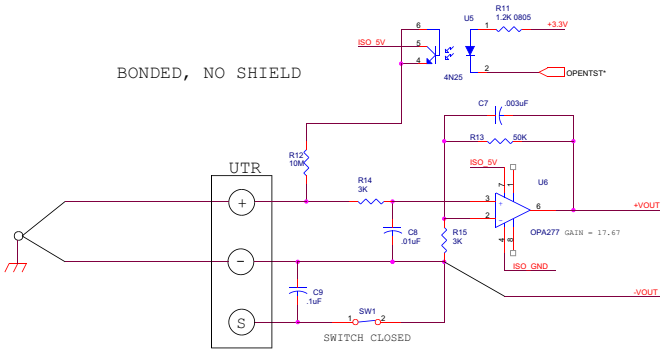


Figure 4.4.1 - Bonded thermocouple, no shield

4.4.2 Floating (Ungrounded) Thermocouples

A floating thermocouple has an ungrounded junction and no shield connection. The sensing tip is electrically isolated from the test article, reducing ground-loop potential and improving noise performance in some installations. This mode is common in laboratory setups or where multiple isolated measurements are required.

For this case, the ground setting must be set to closed (1).

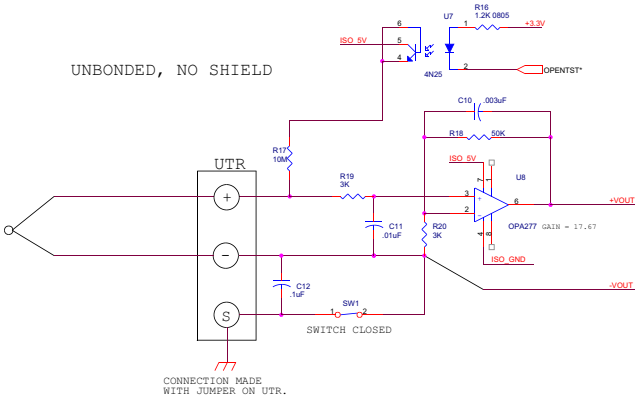


Figure 4.4.2 - Unbonded thermocouple, no shield

4.4.3 Shielded Thermocouple, Connected at DTS

In this configuration, the thermocouple cable includes a shield/drain wire, and the shield is intentionally connected to ground at the DTS only. This approach provides strong EMI rejection while avoiding ground loops by preventing shield contact at the sensor end. It is ideal for installations where the wiring passes near motors, power converters, or switching equipment.

For this case, the ground setting must be set to closed (1).

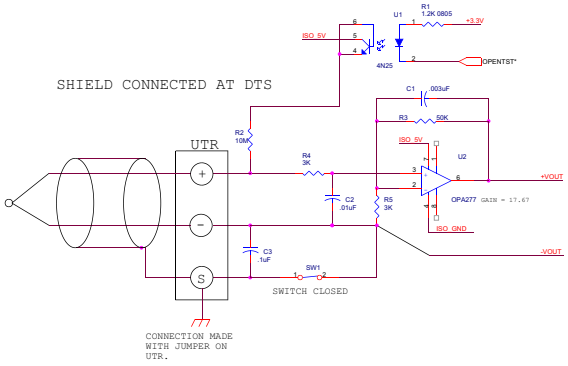


Figure 4.4.3 - Shielded thermocouple, shield connected at DTS

4.4.4 Shielded Thermocouple, Connected at Source

The thermocouple's shield is grounded at the sensor or test-article end, and left floating at the DTS. This configuration helps shunt noise away from the measurement system, particularly when the sensor is mounted on a grounded structure. It is commonly used in aerospace and automotive test environments where the sensor's mounting point provides a stable reference ground.

For this case, the ground setting must be set to open (0).

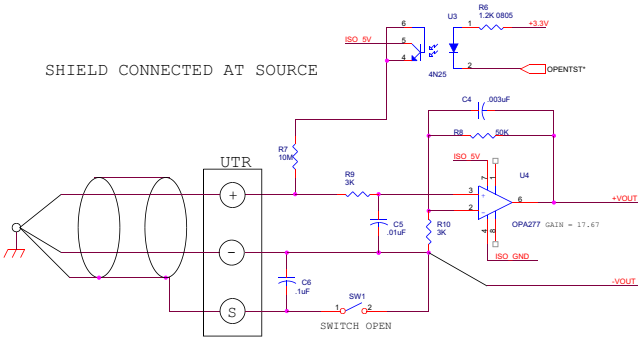


Figure 4.4.4 - Shielded thermocouple, shield connected at source

4.4.5 Full Isolated Mode (Shield Disconnected at Both Ends)

In this scenario, the shield conductor exists but is not connected at either end, leaving the sensor and cable completely floating. This is useful when attempting to minimize coupling paths or when testing in an electrically quiet environment where shielding is not required. It also prevents unintended ground-loop paths in complex or multi-system installations.

For this case, the ground setting must be set to open (0).

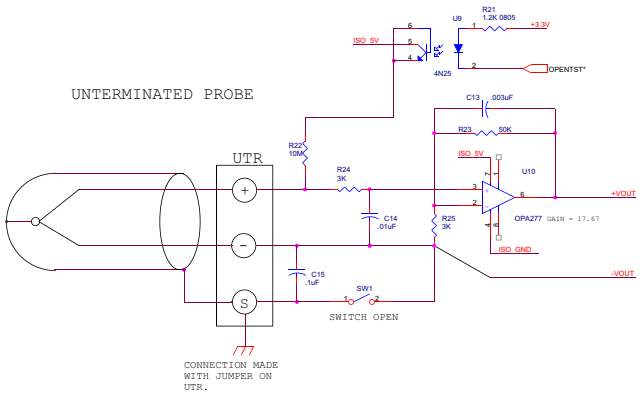


Figure 4.4.5 - Unterminated thermocouple

SECTION 5: OPERATION

This section explains how to connect to the DTS, configure scan behavior, trigger and synchronize acquisitions, and choose data output methods.

5.1 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. This provides a thermal stable environment to provide the most accuracy cold junction compensation. It is recommended that if time allows, the warm-up period should be extended to three hours for most applications.

5.2 COMMUNICATIONS

The DTS communicates primarily over Ethernet, which supports all normal operation including configuration, scanning, data transfer, and firmware updates. Ethernet should be used for all standard workflows.

A secondary RS-232 serial interface is available for maintenance and recovery tasks. Serial communication is not intended for data collection and should only be used when Ethernet is unavailable or when the module requires configuration changes.

Connector pin-outs and mechanical details for both interfaces are provided in Section 4: Hardware.

5.2.1 SERIAL COMMUNICATIONS

Every DTS includes an RS-232 serial interface through the Trigger/Config connector. This interface is intended solely for:

- Viewing or modifying the module's IP address
- Low-level configuration
- Troubleshooting and diagnostics

Serial communication can not be used for scanning or data collection. Default serial settings are:

- 9600 baud
- 8 data bits
- No parity
- 1 stop bit
- No flow control

A serial and Ethernet session may be active simultaneously.

5.2.2 ETHERNET COMMUNICATIONS

Ethernet is the primary interface for the DTS and supports all operational functions. The module includes a 100Base-T Ethernet port with MDIX auto-crossing, allowing the use of standard network cables. For best performance, use shielded Category 5e or better cabling.

The DTS uses static IPv4 addressing. Details on configuring the IP address and verifying communication are provided in Section 5.3 (Ethernet Setup). Once the host and module are on a compatible network, communication can be verified by:

- Pinging the module
- Connecting via Telnet and issuing a basic query

The DTS uses TCP as the primary interface for configuration, command execution, and scan control. All configuration variables, system commands, and operational controls are accessed through a TCP session, either via Telnet. Data output may be sent through TCP, FTP, or UDP, depending on the selected configuration.

A UDP client can be used for configuration, command, and scan control, however is not recommended as the protocol does not guarantee delivery.

5.3 NETWORK CONFIGURATION

The DTS uses static IPv4 addressing for all Ethernet communication. Before establishing a connection, the host computer and the DTS must be configured with compatible IP addresses. This section describes the DTS address format, how to determine compatibility, and the basic steps for updating the IP address if necessary.

5.3.1 FACTORY DEFAULT IP ADDRESS

Each DTS4050 is shipped with a unique static IPv4 address in the following format:

191.30.yy.xxx

Where:

- **191.30** is reserved for Scanivalve products
- **yy** = device family code
  - **100** = DTS4050/16Tx
  - **105** = DTS4050/32Tx
  - **110** = DTS4050/64Tx
- **xxx** = last three digits of the module's serial number

Example:
A DTS4050/32Tx with serial number 2147 would have a default IP address of 191.30.105.147.

5.3.2 SUBNET COMPATIBILITY

To communicate with the DTS, the host computer must

be configured on the same subnet. Compatibility is determined by the subnet mask. A subnet mask defines which parts of the IP address must match between devices.

Examples:

Subnet	Host IP	DTS IP	Compatible?
255.255.255.0	191.30.5.90	191.30.5.1	**Yes**
255.255.0.0	191.30.1.90	191.30.1.1	**Yes**
255.255.255.0	191.30.5.1	191.30.1.9	**No**

If the two devices do not share compatible IPs, you may either change the host computer's IP or change the DTS IP address. Either option is acceptable.

5.3.3 Changing the Host IP Computer's IP Address

The host PC's IP address can be changed using standard operating system network settings. This may require administrative rights. The current IP configuration can be viewed in Windows using Command Prompt and the command:

ipconfig

Computers may have multiple network interfaces, as well as multiple Ethernet interfaces. Ensure you review the correct one per your computer configuration.

The procedure for changing a host computer's IP address varies by operating system. Refer to your OS documentation or search online for instructions appropriate to your system.

5.3.4 Changing the DTS IP Address

If changing the host IP is not possible or practical, the DTS's IP address can be changed by modifying the **IPADD** variable in the IP variable group **LIST IP**.

Changing the IP value requires:

1. An existing Ethernet connection or a serial connection
2. Setting the IP address by following the command syntax and using a compatible IP for the network
3. Issuing the command: **SAVEIP**
   Followed by: **SAVEIPCONFIRM**
4. Power cycling the module for changes to take effect

If Ethernet communication cannot be established due to an unknown IP address, a serial connection provides a reliable fallback for modifying or viewing the IP settings. See "6.5 Changing the IP Address" for exact steps on changing the IP address.

5.3.5 Verifying Communication

Once the host and DTS addresses are compatible, communication can be verified using any of the following:

- Ping the DTS IP address (Windows Command Prompt)
- Connect via Telnet and send a basic **STATUS** command (using ScanTel or similar client software)

Note: anti-virus and firewall programs can block traffic to unknown or new devices. If unable to communicate properly with the device, temporarily disable these and check again.

5.4 Software Operation

Once Ethernet communication has been established, the DTS4050 can be operated through several software interfaces. All configuration, command execution, and scan control are performed using TCP, either through the embedded ScanTel, a Telnet client, or a custom TCP application. These interfaces allow users to configure variables, initiate scans, access diagnostics, and manage module behavior.

Note: Detailed command syntax, variable lists, and data/packet formats are documented in "Section 7: Software".

5.4.1 Choosing the Right Interface

The DTS4050 provides several software interfaces for configuration and data acquisition. The summary below outlines when to use each method.

- **ScanTel**: Fastest non-Web option; ideal for quick operation, basic data collection, and troubleshooting.
- **TCP Client**: Full command and configuration access. Required for automation or programmatic control.
- **UDP Client**: Full command and configuration access. Alternate to TCP, however does not guarantee packet delivery. Not recommended for new installations.
- **LabVIEW Environment**: Common DAQ environment with example VIs and tools available for easy integration.
- **Terminal Emulators**: Useful for simple configuration and diagnostics; best for serial access or troubleshooting.

5.4.2 ScanTel Utility

ScanTel (PN 155406-01) is a free Scanivalve Windows utility for direct communication with a single module. It is the fastest way to operate the DTS when not using the Web Server and not writing a custom client. ScanTel supports

TCP and UDP and provides command-line configuration, real-time monitoring, data capture, and troubleshooting tools. It's ideal for validating connectivity, exploring variables/commands, or basic data collection.

ScanTel is commonly recommended when writing custom software as a validation tool. It is also commonly used as a tool to convert raw binary data from scanners to an ASCII readable format.

5.4.3 TCP/IP Clients

Any software capable of opening a TCP socket can control and operate the DTS4050, including custom applications, LabVIEW programs, Python and MATLAB scripts, and third-party DAQ systems. TCP is the primary protocol for configuration and function control, including scan execution.

For some programming languages, Telnet type libraries or toolboxes can expedite the process of communications with the DTS module, as Scanivalve devices are very basic Telnet servers.

Note: Command sets, variable groups (e.g., LIST categories), and response formats are specified in "Section 7: Software"l.

5.4.4 UDP/IP Clients

Any software capable of opening a UDP socket can control and operate the DTS4050, including custom applications, LabVIEW programs, Python and MATLAB scripts, and third-party DAQ systems.

UDP communications are supported for legacy compatibility. TCP clients are recommended over UDP as UDP packets are not guaranteed. UDP requires the use of the PORT variable for correct operation.

For some programming languages, Telnet type libraries or toolboxes can expedite the process of communications with the DTS module, as Scanivalve devices are very basic Telnet servers.

Note: Command sets, variable groups (e.g., LIST categories), and response formats are specified in "Section 7: Software"l.

Note: A UDP ID server, which is not intended for control, exists for information only.

5.4.5 LabVIEW Tools

Scanivalve provides free LabVIEW utilities and example VIs designed specifically for the DTS series. These tools use TCP to control the module and allow the user to configure modules, scan and collect data, display data in real-time, convert binary data to ASCII format for display or storage, or can help integrate the DTS into an existing LabVIEW environment.

5.4.6 Terminal Emulator Applications

Terminal applications such as PuTTY, HyperTerminal, ScanTel (5.4.2) terminal window can be used to send manual commands for configuration and diagnostics. This is useful for changing network parameters, formatting memory, or performing low-level checks. Terminal use is typically not intended for routine data acquisition.

PuTTY and Hyperterminal are the recommended programs for serial communication.

5.4.6 Third-Party Support

There are many software companies that have integrated the DTS4050 into their environment. Some of these include:

- Kepware's OPC server
- Apex Turbine Testing Technologies
- MDS Areo

For these options, please consult with the software company for information. A full list of partner software and supported devices can be found on the Scanivalve website.

5.5 Measurement Operation

Measurement operation consists of setting the sampling parameters (e.g., rate, frames per scan, units), initiating a scan, and managing the module state until scanning is complete. All scan configuration and scan control is performed through TCP, ScanTel, or a custom TCP client.

Note: For details on ASCII/Binary packet formats, configurations commands, and programming examples, refer to "Section 7: Software".

5.5.1 Scan Rate (RATE)

The scan rate is controlled by the variable RATE, expressed in Hertz (Hz), where 1 Hz corresponds to one sample per channel per second. The scan rate is also controlled by the PERIOD and AVG variables which allow for fine tubing and control of sample averaging and interchannel delay.

Note: changing RATE will adjust the PERIOD (and vice versa) based on the AVG setting. To set rate to faster speeds, AVG must first be adjusted. RATE provides simplicity, PERIOD provides granular control.

The DTS4050 samples all thermocouples with a multiplexer, using one analog-to-digital converter per transducer. Each

complete set of sampled pressure values—along with the associated frame number, timestamp, and other meta-data—is referred to as a frame.

Example:
If RATE = 10, the DTS4050 collects one frame of data every 0.1 seconds (10 frames per second). For the same example, PERIOD may be set to 781.25 and AVG 8 in a 16Tx module to achieve 10Hz. See the PERIOD and AVG variable for more information.

The maximum achievable scan rate depends on the selected data output method and configuration. Refer to Section 2: Specifications, Data Output Rate(s) for details.

Note: Scan Rate and Data Rate are used synonymously. The module samples internally at the RATE setting and outputs data frames at the same rate.

5.5.2 Frames Per Scan (FPS)

The total number of frames produced in a scan is controlled by FPS. FPS is commonly used as a way to scan for a set duration. Once the scan is started, the DTS outputs frames at the configured RATE until one of the following occurs:

- The number of frames reaches the FPS value
- The scan is manually stopped
- The module is powered off

Setting FPS = 0 enables continuous scanning and is common for real-time monitoring or long-duration tests.

Example:
RATE = 10 Hz and FPS = 100: the scan duration lasts 10 seconds. 100 frames of data are output.

RATE = 5 Hz and FPS = 0: the DTS outputs data indefinitely until a STOP command is issued.

Note: using FPS 1 in most cases is not advised. If one frame of data is to be output when requested, see Software Frame Triggering, or TRIG 1.

5.5.3 Scan Data Units (UNITS)

The UNITS variable controls the engineering units for temperature in the output data. The DTS4050 supports a variety of pressure units, such as degrees C, F, K and R, as well as mV (corrected and uncorrected by the cold junction).

Example:
UNITS = C: Thermocouple and UTR data is output in °C.

Notes:

- All calibration tables convert from the raw ADC values to mV first. Then the mV is corrected by the RTD readings in the UTR. Then the mV is converted to an degrees value using ITS-90 tables per each thermocouple type.
- Changing UNITS affects only the formatting of scan output.
- The RAW ADC counts can be output using '0', but this is typically only used for troubleshooting and diagnostics.

5.5.4 Scan Data Format (FORMAT)

The FORMAT variable controls how scan data is presented, transmitted, or logged. FORMAT affects ASCII data only, but does not affect the actual numeric values or sampling behavior. The two options are:

- Unformatted, scrolling column. Best used for data collection and parsing.
- Fixed, updating VT100 terminal. Best used for real-time monitoring.

FORMAT does not determine where data is sent; it determines how the values are encoded. Destination behavior (e.g., TCP, UDP, FTP) is described in Section 5.8.

Note: Binary data formats are mainly controlled with the BIN variable, which is unaffected by the FORMAT variable or data output type.

5.5.5 Initiating a Scan (SCAN/STOP)

Once the measurement parameters have been configured, the scan is started by issuing a SCAN command over TCP. When SCAN is received, the DTS enters scan mode and begins sampling at the configured RATE. When the scan completes (FPS reached or a STOP command is issued), the DTS returns to ready mode and waits for the next instruction.

Typical behaviors are:

- If FPS > 0, scanning stops automatically once the frame count is reached.
- If FPS = 0, scanning continues until a STOP command is sent.

The data destination must be configured prior to a scan to ensure the data is sent to the correct destination. This could include ASCII via TCP for basic collection, or Binary data via UDP/FTP/TCP for high-speed scanning.

Note: Scan behavior may be influenced by triggering or synchronization methods. See "5.7 Triggering and Synchronization" for more information or alternate methods.

5.5.6 Typical Measurement Workflow

Typical (basic) measurement sequence consists of:

- Configure parameters: FPS, FORMAT, UNITS, AVG (if needed) and RATE or PERIOD
- Verify the output destination (Section 5.8)
- Issue the SCAN command
- Receive or monitor data through the configured output channel
- Issue STOP when finished (FPS = 0) or wait for the scan to complete (FPS > 1).
- (Optional, but Recommended) Perform CALZ between tests (Section 5.x)

This workflow is the same regardless of whether the user operates the DTS from ScanTel or a custom TCP client.

Alternative sampling, scanning, and synchronization methods can be found in the next section.

5.6 Module Operating States

The DTS operates in a finite set of internal states that define how it responds to commands, triggers, calibration, and data output operations. Understanding these states helps explain why certain actions succeed, are delayed, or are rejected.

The following table shows an overview on the different states and transitions, which are discussed in the subsequent sections.

State	Purpose	Typical Entry	Typical Exit
READY	Idle or Configuration	Power-up; completion of other states	SCAN; ADCAL; PERIOD; SAVE
SCAN	Data Acquisition	Scan command; trigger event	FPS met; STOP; Error
PERIOD	ADC Sync	Setting RATE or PERIOD	STOP; Process completion; Error
ADCAL	ADC offset Calibration	ADCAL Command; during power-up sequence	STOP; process completion
SAVE	Commit Configuration	SAVE command	Write complete

At any given time, an DTS module is in one primary operating state. Transitions between states occur due to user commands, trigger events, completion of operations, or error conditions. The current state can always be queried with the STATUS command.

Note: Operating states describe functional behavior. They are independent of data output method (TCP, UDP, FTP) and do not change scan rate or data format.

5.6.1 Power-Up and Initialization

When power is first applied, the module enters an Initialization state. During this time, the internal processor, network interface, sensor electronics, and stored configuration are initialized.

- Network services become available near the end of initialization
- No configurations or functions can occur in this state
- Information is always output via serial as the module boots
- An ADCAL is performed to confirm hardware functionality and ADC sync
- The module transitions automatically to the Ready (Idle) state once initialization is complete.

5.6.2 Ready State

READY is the default idle state of the module. The module enters READY on power-up after initialization, and returns to READY when scans or calibration activities are completed.

In the Ready state:

- Configuration variables may be viewed or modified
- Scans may be started (immediately or pending triggers)
- No scan data is being produced.

Most user interaction with the DTS occurs while the module is in the Ready state.

5.6.3 Scan State

The SCAN state indicates that the module is actively performing a scan or is armed for a scan.

In the Scan state:

- All channels are sampled at the configured rate
- Data frames are produced and output via the data output method
- Data output my start immediately or wait for local conditions to be satisfied:
  - Frame trigger (Section 5.7.3)
  - Scan-On-Startup (Section 5.7.5)

- Time trigger (Section 5.7.7)

The module will exit the scan state when:
- The configured number of frames (FPS) is met
- A stop command is received
- An error occurs

Most commands are disabled in this state and will report an error if attempted.

5.6.4 PERIOD STATE

The PERIOD state indicates that the module is actively setting all ADC rates and performing an ADC sync. Upon completion of the process, the module will return to ready.

This state is only triggered if changing the RATE or PERIOD variable.

Note: the time it takes for this to complete will vary based on total channel count and electronics generation. Newer built modules will perform much faster than older units.

5.6.5 ADCAL STATE

ADCAL is a short-duration state used exclusively for ADC Offset Calibration. It is a quick operation intended to correct small zero shifts due to temperature changes or environmental effects in the ADC.

During ADCAL:
- The module performs a brief internal scan, averages the values, and stores the values in an array
- No data frames are produced or output

ADCAL completes and returns the module to READY automatically. Timing will vary based on generation and channel count.

See “6.7 A/D Self Calibration (ADCAL)” for recommended usage.

5.6.6 SAVE STATE

SAVE is a transient state used when the module writes configuration data, calibration coefficients, or system information to non-volatile memory.

While in save, configuration changes are committed to internal memory. These operations are typically short. Once completed, the module will automatically return to ready.

Note: A module should never be powered off while in save mode.

5.7 TRIGGERING AND SYNCHRONIZATION

The DTS4050 supports multiple triggering and timing options to control when scans begin and when individual frames are released. Triggering allows the module to synchronize data acquisition with external equipment, match test events, or coordinate operation across multiple DTS devices. Synchronization using IEEE-1588 Precision Time Protocol (PTPv2) provides a means to align timestamps and initiate scans at a defined future time.

All triggering modes described in this section apply to scanning behavior only.

5.7.1 TRIGGERING OVERVIEW

The DTS4050 can operate using internal or external timing sources to determine:
- When a scan begins or ends
- When an individual frame of data is released
- How the device timestamps
- Internal pacing synchronize with other instruments

The variable TRIG (or XSCANTRIG) selects the trigger mode. Variables such as RATE, FPS, and SSD/SST (for timed starts) also influence system timing.

Because the DTS internally samples at the RATE, even when using external trigger modes, the internal sampling and output rate must be chosen carefully to avoid dropped frames or timing conflicts.

5.7.2 TRIG AND XSCANTRIG RELATIONSHIP

The DTS4050 includes two variables that control the triggering mode: TRIG and XSCANTRIG. Both variables exist in the ASCII command interface and select the same operational behavior. Their relationship reflects historical changes in the triggering implementation.

XSCANTRIG (Legacy)

XSCANTRIG was the original variable used for enabling Frame Triggering.
- XSCANTRIG = 0 — Internal Triggering
- XSCANTRIG = 1 — Enabled Frame Triggering.
- XSCANTRIG > 1 — Enabled Frame Triggering and used the value as a divisor for the trigger rate.

TRIG (Current)

TRIG is the current variable used to select the system trigger mode for modern products (MPS and DSA5000 series). Supported operational values on the DTS4050 include:
- TRIG = 0 — Internal Triggering
- TRIG = 1 — Frame Triggering (no divisor behavior)
- TRIG = 2 — Scan Trigger mode *(not supported on the DTS4050)*
- TRIG = 3 — Scan-on-startup

Variable Interaction

Because TRIG supersedes XSCANTRIG, both variables automatically synchronize with each other when written:

- TRIG = 0 → sets TRIG = 0 and XSCANTRIG = 0
- TRIG = 1 → sets TRIG = 1 and XSCANTRIG = 1
- TRIG > 1 → sets TRIG = value, XSCANTRIG = 0
- XSCANTRIG = 1 → sets TRIG = 1
- XSCANTRIG > 1 → sets XSCANTRIG = value, TRIG = 1

This behavior ensures backward compatibility with legacy systems while allowing newer devices to use TRIG as the primary operational control variable.

5.7.3 Internal Triggering (TRIG XSCANTRIG 0)

In the default mode, all timing is controlled internally.

- The scan begins immediately when the SCAN command is issued.
- Frames are produced at the configured RATE
- Scanning stops once FPS has been met, or a STOP command is issued

Internal triggering is recommended when external synchronization is not required, for slower scanning speeds, or any general use / basic data collection is required.

Note: FPS 1 scans are highly discouraged. Issuing a SCAN command has execution overhead i.e., software entering scan mode and exiting scan mode. If one frame of data is required when commanded or triggered, see "5.7.4 Frame Triggering (TRIG 1 / XSCANTRIG 1)".

5.7.4 Frame Triggering (TRIG 1 / XSCANTRIG 1)

The Frame Trigger mode allows the DTS to release one frame per trigger event. Each hardware trigger pulse or software trigger command results in a single frame of data being output. This mode is useful for synchronizing multiple devices without a PTP infrastructure, coordinating data capture with third-party equipment, or any environment where data is needed on demand.

Frame Trigger Behavior

- The DTS samples internally at RATE (DTS must be in scan mode, executed via command)
- A frame of data is output only when a trigger is received
- Internal timestamps are assigned at the moment the data was sampled
- As long as the DTS is in SCAN mode, it will always be listening for triggers
- DTS will exit scan mode when FPS is met, or STOP command is issued

Setting the Internal Rate

To avoid missed triggers, the internal rate should be set to a value 25% or higher than the expected external trigger rate. For the best timestamp resolution, the internal rate should be 2x the external rate (recommended), or set to the maximum rate.

External Hardware Trigger Requirements

- Input Voltage: 4.5 to 15VDC, 6.5mA
- Input provided through Power/Serial/Trigger connector (see section 4)
- Square wave with ~50% duty cycle, with a low state as close to 0VDC as possible.
- Avoid any slow-rising edges or noisy signals
- Set the internal rate appropriately

Software Trigger Requirements

Alternative to an external voltage / hardware setup, frames can be triggered using a software command. Once in SCAN mode:

- Send the TRIG command
- Send the ASCII TAB character (0x09 or Control I)

5.7.5 Scan Triggering (TRIG 2)

Not currently supported in the DTS series.

5.7.6 Scan-on-Startup (TRIG 3)

When TRIG = 3, the DTS automatically begins scanning after completing its power-up sequence. This mode is typically used for unattended or embedded installations.

Data output and destination must be configured for FTP or UDP, as these methods do not require an open control connection at scan start.

If the configured FTP server is unavailable at startup, the DTS repeatedly attempts to connect until the server responds, a STOP command is received, or power is removed.

Note: using this method in conjunction with PTPv2 may require additional time to data collection as PTP requires synchronization time (generally 5 or more minutes). Timestamps may not be accurate during this time frame. If PTP is enabled but no PTP grandmaster is present, the DTS will stop scanning.

5.7.7 Precision Time Protocol (PTPv2) Synchronization

The DTS4050 is compliant with IEEE-1588v2 Precision Time Protocol and supports the following roles:

PTP Disabled (PTPEN 0)

- The module uses its internal clock
- All timing behavior is local to the device
- Timed scan starts (SST/SSD) still work but are based on internal time

PTP Slave (PTPEN 1)

- The DTS synchronizes its internal time to a network PTP Grandmaster (if available)
- Internal timing (RATE) adjusts to maintain phase alignment with PTP.
- Enables synchronized timestamps across multiple devices
- Scan start can be triggered based on a specific date and time.

Time Retrieval and Manual Adjustment

- GETTIME retrieves the current internal time of a module (any PTP setting)
- SETTIME adjusts time when PTP is disabled

Additional PTP statistics, UTC offset configuration, and diagnostic tools are listed in Section 7: Software.

5.7.8 Time Triggered Scan (SSD/SST)

The DTS can start a scan at a precise time in the future using Scan Start Date (SSD) and Scan Start Time (SST). This is ideally used in systems that are PTP synchronized and allows multiple modules to begin a scan at the same time.

Workflow:

1. Configure SSD and SST
2. Issue SCAN (the device will enter SCAN mode but does not output data)
3. Once the internal time reaches SSD+SST, frames begin to output at the configured rate

If SSD/SST are set to a time in the past, relative to the device time, the SCAN command will begin data output immediately.

Note: The PTP synchronized system can be to a true real-time (PTP Grandmaster) or a naive time (Scanivalve PTP master). Set SSD/SST appropriately based on the synchronized systems time.

5.8 Scan Data Output Methods

After a scan has been started, the DTS4050 will output data using TCP, FTP, or UDP, depending on user configuration. Data output may be formatted in ASCII or Binary format via TCP and FTP, or as Binary via UDP. All data output methods use the same packet structure; only the transport method differs.

TCP can deliver ASCII and Binary data to the Telnet interface. FTP and UDP are output-only transports and do not accept configuration or control commands.

Packet structures, binary formats, buffer information, and parsing details are provided in the "Section 7: Software".

5.8.1 Overview of Output Behavior

The DTS4050 always samples internally at the configured rate, producing one frame of data per sample cycle. Once a scan has begun, frames are delivered to the selected output method(s).

Output method selection does not affect measurement timing or sample rate; it determines only how and where frames are delivered.

The data output method used depends on applicational needs:

- **TCP ASCII** -- Human-readable, easy to verify; ideal for troubleshooting and low-rate monitoring
- **TCP Binary** -- High-throughput, structured, and reliable; best for automation of programmatic acquisition
- **UDP Binary** -- Low-latency; good for real-time displays or broadcasting
- **FTP Output** -- best for long-duration data, archival, or reliable unattended operation

5.8.2 TCP ASCII output

The standard TCP/Telnet interface provides human-readable ASCII data output and also supports full two-way communication for scan control and configuration. ASCII formatting is controlled by the FORMAT variable and supports:

- Unformatted ASCII (A): basic columnar output
- VT100 formatted (F): screen-updating terminal display

TCP ASCII output is useful for:

- Quick functional checks
- Low-rate or simple data collection
- Displaying data in terminal applications
- Debugging or inspecting variable changes in real time

It is the simplest and most transparent way to observe live data frames without parsing binary packets, and can also be used for simple operation and slower-rate data collection.

5.8.3 TCP Binary Output

The TCP Binary interface provides structured binary data output at all available scan rates. Because it uses a consistent binary format, it is the preferred method for high-speed or automated data acquisition. This interface provides reliable, real-time delivery of binary frames and allows the user to achieve the maximum scan rates

supported by the module.

5.8.4 UDP DATA OUTPUT

UDP provides a lightweight, low-latency method of receiving binary scan data. It supports unicast addressing and is useful for real-time visualization or distribution to multiple receiving systems. Important characteristics:

- Binary-only output
- Packet structure is identical to TCP Binary and FTP
- Lower latency, but packet delivery is not guaranteed
- Can be used with Scan-On-Startup (“5.7.6 Scan-on-Startup (TRIG 3)”)

5.8.4 FTP DATA OUTPUT

FTP provides a reliable method for logging long-duration or unattended tests. The DTS4050 writes data directly to a configured FTP server or NAS device in either ASCII or Binary format.

When FTP data output is configured:

1. The DTS attempts a connection to the FTP server when a scan is initiated
2. Attempts to create a new file using the naming format with current time/date (internal time of module)
3. Writes each frame to the file as its sampled
4. Closes the file when the scan stops

During the initial connection attempt, the connection is negotiated, often with user and password requirements, and creating the file. If any of these are to fail, the module will return to ready and report an error.

FTP uses the TCP transport layer, which guarantees packets and data in order. FTP is a good alternative to TCP as FTP servers are often simple to setup and maintain. It is ideal for long duration scans and data collection in environments where a connection to the DTS may not be available (when used in conjunction with Scan triggering or Scan-On-Startup).

SECTION 6: MAINTENANCE

6.1 QUICK TROUBLESHOOTING GUIDE

This section provides practical steps for diagnosing common issues with DTS series modules. Most problems fall into four categories: network communication, scan configuration, data output configuration, or thermocouple connections. This section is designed to help users quickly identify symptoms, understand likely causes, and apply corrective actions.

Symptom	Most Likely Cause(s)	What to Check / Do
Cannot connect to module over Ethernet	No Power or Ethernet connection; IP Mismatch; Subnet Mismatch; Firewall/Antivirus	Very power and Ethernet are connected (Power and Link lights are on). Verify host and DTS IP addresses are in the same subnet. Disable firewall/antivirus temporarily. Attempt to ping the module after any change to validate connection ability.
Telnet connection refused	Wrong IP; blocked port 23; Incorrect PORT setting for UDP Telnet	Check Ethernet Connection. Verify correct IP address (use serial for extra validation) Use serial to confirm boot and PORT setting for UDP connection Ensure port 23 is not blocked (firewall/antivirus).
Scan wont start / no data	Triggering is enabled; PTP is enabled but no valid Grandmaster; Invalid or unexpected data destination settings; Hardware issue	Check TRIG setting under LIST S. Check PTP is enabled, and a PTP Grandmaster is on the network (confirm with Wireshark). Check LIST S, I, NAS and validate settings and destination selection.
No data via UDP	Unresponsive receiver; Bad IGMP settings; Firewall/antivirus blocking unknown UDP data; Confirm scan started	Check that UDP receiver is present or has joined the multicast group (if destination is multicast). Check network switch for IGMP settings. Temporarily disable firmware/antivirus. Check LIST UDP settings are enabled and correct. Check Error log for additional information.
No data via FTP	Credential are incorrect; Path does not exist or lacks permissions; FTP server is unreachable; Firewall issues	Check all settings in LIST FTP are correct per the FTP server configuration. Use Wireshark to monitor port 21 to see connection information for clues. Temporarily disable any firewalls as they may block unknown FTP data. Check Error log for additional information.

External trigger not detected	Wrong voltage level or wiring; Incorrect TRIG setting	Ensure triggering voltage is 4.5-15VDC. Check wiring to trigger input. Ensure that enough power is provided (6.5mA minimum) -- in many cases, current availability is not high enough to drive multiple devices. Check TRIG setting. Check Error log for additional information.
Data looks noisy or offset	Major thermal change; Bad power or cabling; Noisy thermocouple; Bad RTD readings	Perform a ADCAL to see if data is corrected. Allow time for thermal changes, then perform ADCAL. Check RTD readings on the UTR and delta between them. Disconnect TC and short the +/- together. Reading should be close to UTR temperature with little noise. Test with different DC power supply.
Data is 9999	No TC is connected; OTC is not cleared; TC is beyond measuring range (over-range or over-temp); Bad range settings; Temperature is beyond measurement range; Missing or corrupted coefficients; Hardware issue	Check TC and rerun OTC. Remove TC connection and check channel by shorting +/- -- reading should be near UTR RTDs. RANGEV/T settings are too low. Adjust as needed. Remove module from too hot or cold environment and allow time for change. Replace coefficients with last known, good coefficients. Check Error log for additional information.
Scan is short / ends to quickly	FPS is set to low; Unexpected change in trigger; Binary buffer overflow (may come with error); Scanning too fast for configuration (may come with error)	Check FPS setting in LIST S. Validate that external trigger is connected correctly and voltage on/off is expected. Binary buffer overflow is occurring. Generally means network or destination cannot handle amount or speed of data. Check network, receiving host, or receiving software. RATE is too high for data output format or destination. Check rate limitations (Section 2) and adjust accordingly. Check Error log for additional information.
Timestamp drift or inconsistency	PTP has poor sync; External frame trigger inconsistent; Internal rate is not greater than external trigger	Check PTP sync using PTPSTAT, GETTIME, GETUTCO, and check PTP Grandmaster and PTP network. Validate that external frame trigger device is 50% duty cycle, voltage is correct, and “low” voltage is close to 0. Ensure than RATE is set to 1.25x or greater than external rate

6.2 DTS4050 FIRMWARE INSTALLATION

The DTSs firmware can be upload and updated using the FTP file server via Ethernet connection. Please contact Scanivalve for the latest MPS firmware version.

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

NOTE: A new BIN file was added in version 2.01 to handle new and old ADC boards. When upgrading a module to 2.01 or higher, the BIN file needs to be added. This file will not exists on version 2.00 and lower.

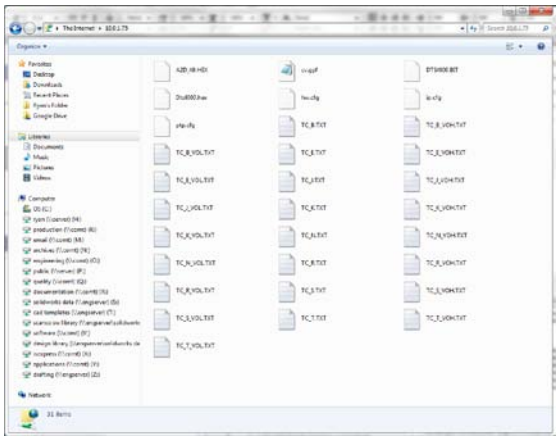
1. Connect a host computer to the Ethernet port of the DTS4050 and ensure the device is powered on.

2. Place the new firmware files (.HEX, .BIT, and .BIN) into a local directory that can be easily accessed.

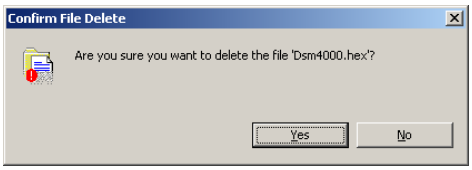
3. Open My Computer or Windows File Explorer.

4. In the Address Bar, type:
FTP://<IPAddress><Enter>
Where: <IPAddress> is the IP Address of the DTS4050.

5. The host computer should connect to the FTP server of the DTS. 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, Dts4000.Bit, and DTS4KAD.BIN files. 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, Dts4000.Bit, and DTS4KAD.BIN files are 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.

If you have errors in the error log that refer to an Incorrect FPGA file or the FPGA cannot be programmed, you may have a mismatched BIT and HEX file. If you have errors relating to missing AD boards, mismatched AD board version, or similar, the module may be missing the BIN file. Please contact Scanivalve for the correct files.

6.3 Operating in Bootloader Mode

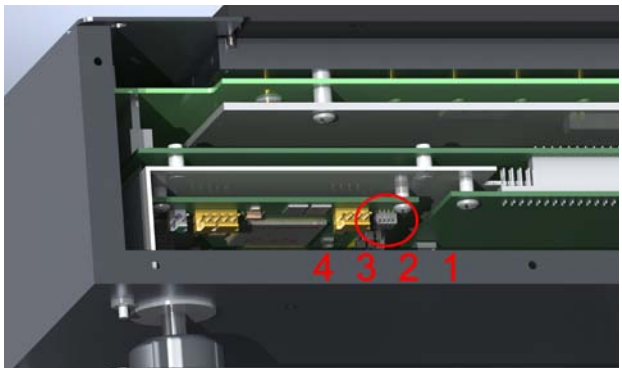
If the DTS4050 will not boot, or appears to have lost communications with a Host, the system may be operated in the Bootloader Mode. In this mode of operation, the application will not start. This mode is not required for standard usage, and should not be used unless instructed by Scanivalve, or reformatting the memory.

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.

To place the DTS into bootloader mode:

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. 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.

6.4 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 ("6.3 Operating in Bootloader Mode").

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 and not the application.

3. To format the memory, 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. Reset the IP address by sending the command:
   SET IPADD xxx.xxx.xxx.xxx
   *(where xxx.xxx.xxx is the IP address to be set)

   Verify the IP address is set properly by sending the LIST IP 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 (191.30.105.100). At this point, the flash memory has been formatted and the DTS4050's IP address has been re-established.

   Open Windows File Explorer or My Computer and type:

   FTP://<ip address><ENTER>

   You will now be connected via FTP to the DTS4050's flast memory. Upload the application files to the DTS4050, which include:
   DTS4000.HEX
   DTS4000.BIT
   TCTAB.TXT
   DTS4KAD.BIN *(required for version 2.01 and up)*

   All of the application file can be found on the DTS4050 Resource Disk supplied with the DTS4050. If there is not an archived copy of these files, please contact Scanivalve. These files are required for proper operation of the DTS4050.

   After these files have been copied to the DTS's memory, close the FTP connection and power down the DTS4050.

   On the processor board, switch the module out of Bootloader mode (reverse of step 1). Switch #1 must be OFF. Reassemble the DTS and power back on the DTS.

5. All of the factory settings and coefficients can now be uploaded to the DTS. Scanivalve provides a LIST A file for each module on the DTS4050 Resource Disk supplied on a USB thumb drive with each DTS module. This file will have the extension of .lsa. If you cannot locate this file, please contact Scanivalve.

   Open this .lsa file in a text editor i.e., Notepad, and delete the lines in the file that read:
   SET PERIOD
   SET RATE
   SET IPADD

   Save this file.

6. Connect via Ethernet to the DTS4050 module using ScanTel. Click "File" > "Upload ASCII File", and then navigate to the .lsa file that was modified. Select and upload this file. The upload will begin.

   Once the upload is completed, issue the SAVE command, followed by the STATUS command. Wait for STATUS: READY. Once STATUS is ready, power cycle the DTS.

7. The DTS should now be restored to factory defaults.

6.5 Changing the IP Address

The following procedure will change the IP address of the DTS4050 using a terminal emulator (ScanTel, HyperTerminal, puTTY, etc).

1. Establish a connection to the DTS54050 using a serial or Ethernet connection and appropriate software. For initial connection information, please see Section 3: Operation.

2. Issue the command:
   LIST IP<ENTER>
   The IP address variable and value will be displayed.

3. Issue the command:
   SET IPADD xxx.xxx.xxx.xxx<ENTER>
   (*where* **xxx.xxx.xxx.xxx** *is the IP address desired)*

4. Issue the command:
   LIST IP<ENTER>
   Confirm that the IP address set is correct.

5. [Optional] If the Subnet or Gateway must be changed, please do so in the same steps as 2 - 4 using the **SUBNET** and **GW** variables.

5. Issue the command:
   SAVEIP<ENTER>
   A prompt will appear to confirm this save. Issue:
   SAVEIPCONFIRM<ENTER>

   The IP address has now been saved. Issue the command: **REBOOT**<ENTER> or cycle the DTS power. The DTS will now boot with the new IP address.

6.6 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 7 and up, and a DC voltage standard with a range of -10mV to +131mV and an accuracy of ±1.5µV or better is required. The procedure for performing a voltage calibration on a DTS using TempCal can be found in the TempCal software manual.

Note: DTS4050s with REV C/D and up AD boards use a RTD jumper cable to calibrate the RTD ADs (from calibration harness kit to both RTD connections). REV C/D boards are identified in the VER command (H/W Ver 0), or during the boot process when monitoring serial output. REV A/B boards do not require this (H/W Ver 9).

TempCal does not perform a recalibration of the RTDs, only the ADCs. The physical RTDs usually do not require recalibration unless there is an issue.

6.7 A/D Self 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. If the DTS has been running continuously for more than a 1 week period, an ADCAL should be performed.

See "7.9.1 A/D Calibration" for the command information.

SECTION 7: SOFTWARE

7.1 Overview

The DTS4050 exposes a single-user network interface for command/control and data access:

- TCP ASCII / Telnet (port 23): Full configuration and control; also supports ASCII and Binary data output. See"5.8.2 TCP ASCII output" and "5.8.3 TCP Binary Output".
- UDP / Telnet (port 23). Data output is Binary only. DTS can be configured to support configuration and control using UDP via port 23. To use the DTS as a UDP server, PORT must be set to a non-zero number. When using the DTS as a UDP server, the UDP ID Server is not usable. It also requires that ENSYSLOG and AUTOOUT are set to 0.
- FTP (ASCII or binary files): Output-only, file-based logging. See "5.8.4 FTP Data Output". Also used for file system access.
- Serial (RS-232): Maintenance/recovery (unknown IP, base config, diagnostics). See "5.2.1 Serial Communications".

Operating states: Command acceptance is constrained by module state (READY, SCAN, ADCAL, PERIOD, SAVE). See "5.6 Module Operating States".

7.2 Network Topology

Choose topology based on throughput, reliability, and accessibility:

- Isolated test network: best throughput/lowest jitter for high-rate TCP Binary/UDP.
- Integrated lab/enterprise network: easiest multi-user access; may require multicast enablement.
- Sub-network with gateway: high-rate capture locally; share data via a multi-homed host (common with FTP archiving).

7.3 DTS4050 Buffer Description

The buffer is the liaison between the scan task and the scan output task. The scan output task has a higher priority than the scan task. Under initial conditions, when the buffer is empty, the scan task places one frame of data in the buffer. It then signals the scan output task to read the buffer until it is empty. However, when multiple frames of data are in the buffer, the output task continues until the buffer is empty. Multiple frames of data will accumulate if the scan output task is blocked by the network while outputting data.

If the data receiver falls behind, the DTS will attempt to buffer frames until the receiver is ready again. If the buffer becomes full and the receiver will no longer receive data, the DTS will empty the buffer, Return to Ready mode, and report an error to the error log.

7.4 DTS Data 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. All packet data will be received as signed.

7.4.1 Host to DTS Command Packet

FUNCTION	BYTES	DATA TYPE	DESCRIPTION
ASCII command data. Refer to the command section of this manual for more information.	1 to 80	String	Unique to packet. Must be terminated. See information below.

TCP/IP does not guarantee that packet boundaries will be maintained between a host and a DTS module. Therefore, all commands from a host must be terminated properly with one of four options. The DTS will detect and adjust to the termination option being used by a host.

The four options are (TCP or UDP Telnet server):

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

The maximum string length for commands sent to the DTS is 79 characters. Any command received that is longer than 79 characters will be discarded and an error will be generated.

When a DTS module is not in "READY" mode, most commands are disabled or not accepted. Non Ready modes can be found in "5.6 Module Operating States".

The exception to this rule include the commands STOP, STATUS, and TRIG. Any command that falls in this category will have a note listed in the following sections if they are accepted when the DTS is not "READY."

7.4.2 DTS to Host ASCII Packet

FUNCTION	BYTES	DATA TYPE	DESCRIPTION
ASCII data*. Refer to the Command Section of this manual for the proper Command return formats.	1 to 1492	String	Unique to packet and varies. See information below.

*This packet will be transmitted when the host issues one of the following commands (excluding a return prompt):

1. SCAN from Telnet connection
2. Any Get command type
3. STATUS
4. LIST <group> or TYPE <group>
5. FDISK

All responses from the DTS will end with a termination configuration. For "multi-list" or "multi-line" responses, such as the response to a LIST command, each line will be terminated with a CR-LF (\r\n).

Single line response: If the DTS is ready, a **STATUS** command would respond as:

STATUS: READY<CR><LF>

Multi-line response: If the DTS is ready, a **LIST IP** command would respond as:

SET IPADD 191.30.95.1<CR><LF>
SET SUBNET 191.30.95.1<CR><LF>
SET GW 0.0.0.0<CR><LF>
SET MAC 0:60:5d:82:0:04<CR><LF>

7.4.3 Scan Data Formats

Scan data from the DTS4050 can be formatted in three different ways: ASCII (A), formatted for VT100 terminals (F), or Binary (B). The format for ASCII data is selected by setting the **FORMAT** configuration variable to 0 (ASCII) or 1 (VT100). Binary data output is enabled using the **BIN** configuration variable.

7.4.4 File Names and Formats

When the DTS4050 is configured to output data via FTP, it must create a file at the destination. The table below shows the common file names and formats for FTP scan data when the different formats are used (ASCII, Binary).

BIN VARIABLE	FORMAT VARIABLE	TYPE OF SCAN	FILE EXTENSION
0	FORMAT 0	ASCII	nnnn.txt
1	X	Binary	nnnn.dat

7.4.5 DTS4050 COMMAND AND DATA MATRIX

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.

Command Source	Command Output	Data Output	Bin	Host	Comment
TCP / Telnet	TCP / Telnet		X	X	Command returned to sender
UDP / Telnet	UDP / Telnet		X	X	Command returned to sender
TCP / Telnet (Scan)		TCP / Telnet	0	X	ASCII Data to TCP 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
UDP / Telnet (Scan)		UDP / Telnet	0	X	ASCII Data to UDP Telnet
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

Note: UDP / Telnet requires PORT be set to a non-zero number.

7.5 ASCII SCAN DATA EXAMPLES

The DTS4050 can be configured to output ASCII scan data in several formats. The format is configured with the **FORMAT** variable. Once a scan has stopped, the output will be followed by the **PROMPT** configuration.

Note: Examples in this section may only show a limited amount of channels for simplicity and space. Channels will vary based on channel configuration.

7.5.1 UNFORMATTED ASCII

When **FORMAT** is set to 0, data is displayed in a column type format and is scrolling at the set rate.

```
Frame # <number>
Time <time>
<RTD 1> <RTD Temp> <Unit>
<RTD 2> <RTD Temp> <Unit> <Delta Error>
<RTD n> <RTD Temp> <Unit>
<RTD n> <RTD Temp> <Unit> <Delta Error>
      ::       ::       ::       ::       ::
Units <TC units>
<channel 1> <Tx Temp> <Status Code>
<channel 2> <Tx Temp> <Status Code>
      ::       ::       ::       ::       ::
<channel n> <Tx Temp> <Status Code>
```

See **UNITS for an explanation of RTD Temp, Tx Temp, and Units.**
The <Delta Error> will only be shown on the 2nd RTD channel (2, 4, 6 and 8 if they exist). See **MAXDELTA**.
See "7.5.3 Channel Status Codes" for information on channel <status code>.
Time is only present is **TIME** is a non-zero number, or **PTPEN** is enabled.

7.5.2 FORMATTED ASCII

When **FORMAT** is set to 1, Data is displayed in a VT100 terminal style and will update at the set rate.

```
Frame=<number> Time = <time> Units = <TC units>
<tRTD 1>= <temperature> <Unit>   <RTD 2>= <temperature> <Unit> ..... <RTD n>= <temperature> <Unit>

<channel 1>= <Tx temp>   <channel 2>=  <Tx temp>    <channel 3>=  <Tx temp>    <channel 4>=  <Tx temp>
      ::      ::      ::      ::       ::      ::       ::
<channel n>= <Tx temp>   <channel n>=  <Tx temp>    <channel n>=  <Tx temp>    <channel n>=  <Tx temp>
```

See **UNITS for an explanation of RTD Temp, Tx Temp, and Units.**
Time is only present is **TIME** is a non-zero number. PTP is not supported in this format.
RTD delta error and channel status codes are not available in this format.

7.5.3 CHANNEL STATUS CODES

When BIN and FORMAT are set to 0, each channel in the ASCII data output will have a status code. This status code can help identify information about the channels health and use. Note: channel status information is also available in the binary packet -- see the binary packet information for details.

The status code will display two different code: error and thermocouple type. It can be displayed in a single or four digit number, depending on the status. The format below is the format:

[<e>]<t>

Where <e> is the error code, which is only generated when an error at the channel is present. Errors are prioritized and the highest priority error will display if multiple exist. The lowest number (i.e., 1) has the highest priority.

<e>	Description
100	Channel A/D is disabled
200	Channel Thermocouple is open
300	Channel is over range (Voltages)
400	Channel is under range (Voltages)
500	Channel is over limit (Temperature / LIST LI)
600	Channel is under limit (Temperature / LIST LI)

Where <t> is the thermocouple type, and is always present.

<t>	Thermocouple Type
0	J
2	E
4	K
6	N
6	R
A	S
C	T
E	B

If no errors exist for the channel, the status code will only display a single character that represents the thermocouple type. If the channel is set to Type K (LIST T) and no errors are present, the channel status code would display: 4. If the same channel was over range, it would display: 4004.

7.6 Binary Scan Data Formats

The DTS4050 can be configured to output binary scan data. The binary data output is enabled using the BIN variable. The main structure of the binary packet is the same across all configurations, however expands in size based on the total channel count (i.e., 16 or 32 channels). The channel count and total size can be identified using the first 4 bytes of the packet (the Packet ID).

7.6.1 Packet Type Table

The following binary packets, identifier and total packet sizes are as follows:

PACKET NAME	PACKET ID	TOTAL PACKET SIZE (BYTES)	NOTES
16Tx Channel Data	0Hex	168	
32Tx Channel Data	2Hex	304	
64Tx Channel Data	3Hex	576	
16Tx Channel Data w/ PTP Enabled	4Hex	168	
32Tx Channel Data w/ PTP Enabled	6Hex	304	
64Tx Channel Data w/ PTP Enabled	7Hex	576	

7.6.2 Binary Packet Structure

FUNCTION	BYTES	DATA TYPE	DESCRIPTION
Packet Type	4	Integer	See “7.6.1 Packet Type Table” for Packet IDs
General Status	4	Integer	Refer to “7.6.3 General Status Bytes”
Frame Number	4	Integer	The current frame number if in the scan mode
Thermocouple Channels	4/Ch	Float	Channel temperatures in units set by bits 4 - 6 of the General Status Byte. Temperatures repeat per number of channels, 4 bytes per channel i.e., 32Tx = 128 Bytes.
RTD Temperatures	4/Ch	Float	Temperature in units defined by the setting of the variable: UNITS. Each RTD channel is 4 bytes. This section repeats based on number of RTDs. 16Tx have 2 RTDs, 32Tx have 4 RTDs, 64Tx have 8 RTDs.
Time Stamp	4	Integer	Time Stamp in units set by bit 7 of the General Status Byte.
Channel Status	4/Ch	Integer	Refer to ”7.6.4 Channel Status Bytes”. Status repeats per number of channels, 4 bytes per channel i.e., 16Tx = 64 Bytes.
PTP Time (Seconds)	4	Integer	Current PTP time stamp in seconds. <seconds>.<nanoseconds> will provide the full timestamp.
PTP Time (Nanoseconds)	4	Integer	Current PTP time stamp in nanoseconds. <seconds>.<nanoseconds> will provide the full timestamp.
PTP Last Update (ms)	4	Integer	Time Elapsed Since Last PTP Update in ms
Spares	4	Integer	Unused

7.6.3 General Status Bytes

The General Status will arrive as 4 bytes. Only the two least significant bytes are used (bits 16 - 31 are not used). Host order is shown below.

Bit Use:

Bits 0 - 3	Not Used
Bits 4 - 6	Temperature Units
Bit 7	Timestamp Units (non-PTP)
Bit 8	Not Used
Bits 9 - 11	Not Used
Bits 12 - 15	RTD Delta Errors

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

7.6.4 CHANNEL STATUS BYTES

The Channel Status will arrive as 4 bytes. Every channel will have its own channel status section. Only the two least significant bytes are used. Bits 16 - 31 are not used.

Bit Use:

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

Bit	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Type J													0	0	0	0
Type E													0	0	1	0
Type K													0	1	0	0
Type N													0	1	1	0
Type R													1	0	0	0
Type S													1	0	1	0
Type T													1	1	0	0
Type B													1	1	1	0
No Channel Errors	0	0	0	0												
A/D Disabled	0	0	0	1												
Open T/C	0	0	1	0												
High Range Error	0	0	1	1												
Low Range Error	0	1	0	0												
High Limit Exceeded	0	1	0	1												
Low Limit Exceeded	0	1	1	0												

7.7 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. See the PORT variable under LIST I for more information.

7.7 Command Format

All of the commands accepted by the DTS are explained with the following sections: command, type, syntax, parameters/ arguments, description, returns, examples, ranges, and default values and notes when applicable. The table below is an example of how commands will be explained and shown in this section of the manual.

7.7.1 Example Command Title

COMMAND	The name of the command
TYPE	Lists the type of command. There are three types of commands in the DTS: Get - a Get type command retrieves information. Set - a Set type command will set configurations. These commands typically require an argument or value. In order to change these variables, these commands must begin with the "SET" command. Function - a Function command will cause the DTS to start a process or function and may not return any data. A command can be one or more types. Any command type labeled as "Disabled" are implemented as a placeholder to create backwards compatibility with DTS3250 software. These commands will be accepted, but will not change any functionality.
DESCRIPTION	Provides a description about the command and what it may be used for.
SYNTAX	Lists the format of the command. The following conventions are used: **BP** - Boldface letters indicate command keywords and operators. Within the discussion of syntax, bold type indicates that the text must be entered exactly as shown. <parameter> - Words in < > indicate place holders for parameters that must be supplied. [<parameter>] - Parameters in [ ] indicate place holders for optional parameters that are not required. *data* - Example data is shown in *italics*. **data** - Example commands are show in **bold**. , - Commas separate options, only one of the options may be used.
RETURNS	Lists the format of the information that the unit returns to the host.
DEFAULT	The default settings from the factory
EXAMPLE(S)	Example commands that do not necessarily apply to all applications. When "//" is used, this indicates a comment to explain the commands that proceed it and are not used in the command sequence. All commands are assumed to be terminated correctly and do not show termination. *data* - Example return data is shown in *italics*. **data** - Example commands are show in **bold**
RANGE	Lists the range of available arguments for the command unless otherwise stated. If range is not provided, the argument(s) are not range checked.
NOTES	Additional comments relevant to the command or variables.

7.8 General Commands

7.8.1 Auto Status

COMMAND	AUTOSTATUS or AS
TYPE	Set
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.
SYNTAX	**AUTOSTATUS <enabled>** **-- or --** **AS <enabled>** **Where <enabled> is 0 or 1 (1 being enabled).**
RETURNS	<nl> - end of line
EXAMPLE	**AUTOSTATUS 1**
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.

7.8.2 Bootloader Version

COMMAND	BLVER
TYPE	Get
DESCRIPTION	Retrieves the current bootloader version.
SYNTAX	**BLVER**
RETURNS	<version string><nl>
EXAMPLE	**BLVER** *Bootloader Version: 2.03*

7.8.3 Clear

COMMAND	CLEAR
TYPE	Function
DESCRIPTION	Commands the DTS to clear any errors that have occurred and empties the error log.
SYNTAX	**CLEAR**
RETURNS	<nl> - end of line
EXAMPLE	**CLEAR**

7.8.4 Connect To Host Binary Server

COMMAND	CONBIN
TYPE	Function
DESCRIPTION	Commands the DTS to connect to a Binary Server configured through the HOST configuration variable. This allows for binary data to be sent TCP to a server listening for data. HOST must be set for the server IP and Port via TCP.
SYNTAX	**CONBIN**
RETURNS	<nl> - end of line

EXAMPLE	// A DTS is not connected to a server, is not in the UDP mode and is in the READY mode and it is desired to connect to a host binary server **CONBIN**
NOTES	If the DTS is in the UDP mode, the TCP server does not exist or cannot be connected to, 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.

7.8.5 Close Host Binary Server Connection

COMMAND	CLOBIN
TYPE	Function
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. See “7.8.5 Connect to Host Binary Server”.
SYNTAX	**CLOBIN**
RETURNS	<nl> - end of line
EXAMPLE	// To close the connection to the Host Binary Server **CLOBIN**

7.8.6 Send Command to Host Binary Server

COMMAND	HOST
TYPE	Function
DESCRIPTION	This command will pass an ASCII string to the Host Binary Server.
SYNTAX	**HOST** <command> Where <command> is an ASCII string that would be recognized by the Host Binary Server.
RETURNS	<nl> - end of line

7.8.7 Error

COMMAND	ERROR
TYPE	Get
DESCRIPTION	Lists all errors that have occurred since the last CLEAR. Only the first 72 errors will be listed. If more than 72 errors have occurred, the message: ERROR: Max Errors exceeded will appear at the end of the list.
SYNTAX	**ERROR**
RETURNS	A list of errors in the following format: ERROR: error ERROR: error
EXAMPLE	**ERROR** *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*
EXAMPLE	// If no errors have been logged **ERROR** *ERROR: No errors*

7.8.9 Flash Directory Contents

COMMAND	DIR
TYPE	Get
DESCRIPTION	Returns the files saved on the flash memory, including the total size (bytes), date, and filename.
SYNTAX	**DIR**
RETURNS	File system contents followed by <nl> - end of line
EXAMPLE	**DIR** -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

7.8.10 Open Thermocouple Test

COMMAND	OTC
TYPE	Function
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 error bits are set accordingly (see ASCII and Binary data formats). This command is NOT performed automatically at power up. If OTC is performed and an open TC is found, correct the TC and perform another OTC or reboot the scanner to clear the error from the channel.
SYNTAX	**OTC**
RETURNS	Information to the error log if there are any errors, and <nl> - end of line
EXAMPLE	**OTC**
NOTES	Use ERROR to see detected OTC channels.

7.8.11 List

COMMAND	LIST
TYPE	Get
DESCRIPTION	Commands the MPS to list settings using a specified group of settings, stored in RAM.
SYNTAX	**LIST** <group> Where <group> can be S, I, ID, IP, DEF, C, PTP, P, G, O, LA, LI, T, NAS, RPC, RTD, RTDX, or U. Using A will output all settings.
RETURNS	<setting> <variable> ::: ::: ::: ::: <setting> <variable>

EXAMPLE	**LIST S** *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* *SET TRIG 0*
NOTES	Detailed responses from each LIST can be found later in the software section.

7.8.12 REBOOT

COMMAND	REBOOT
TYPE	Function
DESCRIPTION	Reboots the DTS (soft reboot). RESTART command can also be used.
SYNTAX	**REBOOT**
RETURNS	Nothing.
EXAMPLE	**REBOOT**
NOTES	**RESTART and REBOOT commands are identical.**

7.8.13 SAVE

COMMAND	SAVE
TYPE	Function
DESCRIPTION	Saves all configurations to memory, or a selected group of configurations.
SYNTAX	**SAVE**[<group>] When no <group> is present, all configurations except IP, PTP, and NAS are saved (these lists must be saved individually). When a configuration is present, only that group will be saved.
RETURNS	Prompt when saving is complete and ready to accept a new command.
EXAMPLE	// To save all of the current settings (excluding IP, PTP, NAS) **SAVE**
EXAMPLE	// To save only the “IP” settings to the file ip.cfg. This will prompt to follow up with SAVEIPCONFIRM to confirm the save **SAVEIP**
WARNING	Do not power cycle a module while the module is in SAVE mode. This can cause undesirable effects. If a SAVE has been issued, wait for the DTS to return a prompt, or use the STATUS command and wait for STATUS: READY before power cycling the unit.

7.8.14 SCAN

COMMAND	SCAN
TYPE	Function

DESCRIPTION	Commands the DTS to being sampling values from the internal sensors and outputs data to the designated target. The DTS will enter SCAN mode. Refer to "5.5 Measurement Operation" for help on scanning.
SYNTAX	**SCAN**
RETURNS	Scan data
EXAMPLE	**SCAN** *::: [Scan Data] :::*
NOTES	Output is based on formatting. Please see "7.5 ASCII Scan Data Examples" or "7.6 Binary Scan Data Formats" for more information.
NOTES	If PTP is enabled, the MPS may used PTP time as a trigger to start scanning if configured to do so. Refer to "5.7.8 Time Triggered Scan (SSD/SST)".
NOTES	If frame triggering is enabled, the MPS will enter SCAN mode but will not output data until a trigger is received. Refer to "5.7.4 Frame Triggering (TRIG 1 / XSCANTRIG 1)".

7.8.15 STATUS

COMMAND	STATUS
TYPE	Get
DESCRIPTION	Displays the current mode of the DTS. Refer to "5.6 Module Operating States" for detailed information on the different states. Some states listed are transient and are only here for documentation.
SYNTAX	**STATUS**
RETURNS	STATUS: <mode> Where <mode> is: ADCAL = The DTS is calibrating the A/D converters CAL = The DTS is executing a PT or RPT command LIST = The DTS is outputting a configuration variable LIST OTC = The DTS is testing for open thermocouples PERIOD = The DTS is changing the ADC period/rate 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. UPLOAD = The DTS is UPLOADING a file.
EXAMPLE	**STATUS** *STATUS: READY* >
EXAMPLE	// If the DTS is scanning **STATUS** *STATUS: SCAN* >
NOTES	This command is accepted at all times.

7.8.16 SET

COMMAND	SET
TYPE	Function
DESCRIPTION	Commands the DTS to set one of the many configuration variables. Configuration variables available are described in subsequent sections.

SYNTAX	**SET** <name> <value> Where: <name> - the name of the configuration variable to be set or modified. <value> - the value or argument for the <name> variable.
RETURNS	Prompt when ready to accept a new command.
EXAMPLE	// Set the PTPEN variable to 1 **SET PTPEN 1** >

7.8.17 STOP

COMMAND	STOP
TYPE	Function
DESCRIPTION	Cancels all commands or routines and returns the DTS to READY mode.
SYNTAX	**STOP** or <ESC>
RETURNS	Prompt when ready to accept a new command.
EXAMPLE	**STOP** >
NOTES	This command is accepted at all times.

7.8.18 FIRMWARE VERSION

COMMAND	VER
TYPE	Get
DESCRIPTION	Retrieves the current software version.
SYNTAX	**VER**
RETURNS	The main firmware version string, followed by the prompt when ready to accept a new command.
EXAMPLE	**VER** *DTS Scanivalve © 2004-2013 Ver 1.00 32 Channels H/W Ver 9* >
NOTES	The end section will identify the current AD boards used in the module. H/W Ver 9 == REV A/B H/W Ver 0 == REV C/D

7.9 ADJUSTMENT FUNCTIONS

7.9.1 A/D CALIBRATION

COMMAND	ADCAL
TYPE	Function
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.
SYNTAX	**ADCAL**
RETURNS	<nl> - end of line
EXAMPLE	**ADCAL**
NOTES	The time the ADCAL takes depends upon the setting of CALAVG and total number of channels. 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 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.

7.9.2 ICE POINT OFFSET ADJUSTMENT

COMMAND	IPO
TYPE	Set/Function
DESCRIPTION	Commands the DTS to calculate and adjust the offset (LIST O) 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.
SYNTAX	**IPO <start channel> [<end channel>]** Where: <start channel> - the first channel to be adjusted. <end channel> - the last channel to be adjusted
RETURNS	Information to the error log if there are any errors, and <nl> - end of line
EXAMPLE	**IPO 1 32**

7.9.3 FILL

COMMAND	FILL
TYPE	Function
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. The command should be used anytime the tables are adjusted (mV calibration or RTD adjustments).
SYNTAX	**STOP** or <ESC>
RETURNS	<nl> - end of line
EXAMPLE	**STOP** >

7.9.4 CORRECT TC VOLTAGES

COMMAND	PT
TYPE	Set/Function

DESCRIPTION	This command is only used to adjust calibration points in the AD to mV table. This command enters the voltage correction to be applied at a given setpoint for one or more channels. The values for the set points do not have specific limitations.
SYNTAX	PT <index> <volts> [<channel>] Where: <Index> - The setpoint number, 0 to 7 <Volts> - The applied voltage in mV <Channel> - If not specified the setpoint voltage will be applied to all channels.
RETURNS	<nl> - end of line
EXAMPLE	// To apply a ADC to mV correction at point 2 for all channels **PT 2 1.256**
NOTES	This command syntax is used only if NUMTEMPS is set to 0. The value of NUMTEMPS MUST NOT be modified. If the value of NUMTEMPS is modified after the unit has been calibrated, all current calibration coefficients will be lost.

7.9.5 Enter RTD Voltage Setpoints

COMMAND	RPC
TYPE	Set/Function
DESCRIPTION	This command enters the voltage correction to be applied at a given setpoint for the RTDs. The values for the setpoints must be between 0.095 Vdc and 0.131 Vdc which represents temperatures from -13 °C to 80 °C.
SYNTAX	RPC <index> <volts> <board> Where: <Index> - The setpoint number, 0 to 7 <Volts> - The applied voltage in mV <Board> - The A/D board: 1, 2, 3 or 4
RETURNS	<nl> - end of line
EXAMPLE	// To enter a value for setpoint 1 for the RTDs on board 2 **RPC 1 0.095 2**
NOTES	For REV A/B (H/D Ver 9): 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. For REV C/D (H/D Ver 0): Voltage for board 1 must be inserted into RTD1 and RTD2 inputs (using the RTD cable adaptor). Voltage for board 2 must be inserted into RTD3 and RTD4 inputs (using the RTD cable adaptor). Repeat for each board in 64Tx units.

7.9.6 Correct RTD Voltages

COMMAND	ARPC
TYPE	Set/Function
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. See ARPCON variable.

SYNTAX	**ADCAL** <Reference Temperature> <RTD number> Where: <Reference Temperature> - The indicated temperature of the standard RTD, in degrees C <RTD number> - The RTD to be corrected (1 to 8)
RETURNS	<nl> - end of line
EXAMPLE	// To calculate a correction for board 1 in a 16 channel module when the reference RTD is 29.95 degrees C: **ARPC 29.95 1**
NOTES	This command will update the ARPC variables, but the data will not be saved until a SAVE command is issued.

7.10 Scan Variables (LIST S)

7.10.1 List Scan Variables

TYPE	Get
DESCRIPTION	Lists the SCAN configuration variables.
SYNTAX	**LIST S**
RETURNS	All of the Scan group variables.
EXAMPLE	LIST S *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* *SET TRIG 0*

7.10.2 PERIOD

COMMAND	PERIOD
TYPE	Set
DESCRIPTION	Sets the interval between channel samples (inter-channel delay). Used in conjunction with AVG to determine RATE (in Hz). Setting RATE or PERIOD will trigger the DTS to enter period mode to synchronize all ADCs.
SYNTAX	**SET PERIOD** <value> Where <value> is 78.125 to 1048576 (expressed in microseconds).
DEFAULT	**7812**
EXAMPLE	**SET FPS 0**
NOTES	**The period variable allows for the rate to be set 2x higher than the max data output rate when frame triggering is being utilized (XSCANTRIG 1 / TRIG 1). These settings will not allow for reliable data output when set at the lowest values and frame triggering is disabled. These settings also do not represent the max data output rate. See "Section 2: Specifications".**

7.10.3 Average (AVG)

COMMAND	AVG
TYPE	Set
DESCRIPTION	This sets the number of raw samples to acquire before producing data output. If set to 1, the DTS performs no internal averaging.
SYNTAX	**SET AVG** <value> Where <value> is a value 1 to 240.
DEFAULT	**4**

EXAMPLE	// set averaging to 4 (DTS averages 4 samples before outputting data) **SET AVG 4**

7.10.4 RATE

COMMAND	RATE
TYPE	Set
DESCRIPTION	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. Rate is calculated by the formula: $\text{Data Rate} = \frac{1}{\text{Period X Number of Channels X Average}}$
SYNTAX	**SET RATE** <Hz> Where <Hz> is 0.01 to 400.
DEFAULT	**2**
EXAMPLE	**SET RATE 10**
NOTES	**The rate variable allows for the rate to be set 2x higher than the max data output rate when frame triggering is being utilized (XSCANTRIG 1 / TRIG 1). These settings will not allow for reliable data output when set at the highest rate and frame triggering is disabled. These settings also do not represent the max data output rate. See "Section 2: Specifications".**

7.10.5 BINARY (BIN)

COMMAND	BIN
TYPE	Set
DESCRIPTION	Enables or disables binary data output. When disabled, all scan data is ASCII.
SYNTAX	**SET BIN** <value> Where <value> is 0 (binary disabled) or 1 (binary enabled).
DEFAULT	**0**
EXAMPLE	**SET BIN 1**

7.10.6 QPKTS

COMMAND	QPKTS
TYPE	Set
DESCRIPTION	This is a non-functioning variable left in place for legacy compatibility.
DEFAULT	**0**

7.10.7 FORMAT

COMMAND	FORMAT
TYPE	Set

DESCRIPTION	Determines the ASCII data output format. Does not effect binary data output (BIN 1).
SYNTAX	**SET FORMAT** <value> Where <value>: 0 - data are scrolled (see "7.5.1 Unformatted ASCII") 1 - data are displayed in place, formatted for a VT100 terminal (see "7.5.2 Formatted ASCII")
DEFAULT	**0**
EXAMPLE	**SET FORMAT 0**

7.10.8 Frames Per Scan (FPS)

COMMAND	FPS
TYPE	Set
DESCRIPTION	Sets the number of frames to send per scan. Can be used to set a scan duration.
SYNTAX	**SET FPS** <value> Where <value> is 0 to 4294967295. When set to 0, the DTS will scan indefinitely until stopped or powered off.
DEFAULT	**0**
EXAMPLE	**SET FPS 0**

7.10.9 Temperature Over Range Values (RANGET)

COMMAND	RANGET
TYPE	Set
DESCRIPTION	Sets the data output error value for an channel when units is set to an EU 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.
SYNTAX	**SET RANGET** <low error value> <high error value> Where low and high error value must be a floating point value with two decimals, and up to 8 total characters (including the decimal and sign).
DEFAULT	**-9999.99 9999.99**
EXAMPLE	**// to set the error values for temperature range limits to provide a specific error code** **SET RANGET -9999.99 9999.99**

7.10.10 Temperature Over Range Values (RANGEV)

COMMAND	RANGEV
TYPE	Set
DESCRIPTION	Sets the data output error value for an channel 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.

SYNTAX	**SET RANGEV** <low error value> <high error value> Where low and high error value must be a floating point value with two decimals, and up to 8 total characters (including the decimal and sign).
DEFAULT	**-9999.99 9999.99**
EXAMPLE	**// to set the error values for temperature range limits to provide a specific error code** **SET RANGET -9999.95 9999.95**

7.10.11 UNITS

COMMAND	UNITS
TYPE	Set
DESCRIPTION	Sets the data output unit of the TC inputs and RTD/UTR values. Unit setting is available in the binary packet in the general status byte.
SYNTAX	**SET UNITS** <value> Where <value> is: C = degrees Celsius F = degrees Fahrenheit K = Kelvin R = Rankin V = Volts (mV), uncorrected A = Volts (mV), corrected by the cold-junction/UTR M = Mixed (T/C data in mV, RTD data in °C) 0 = Raw ADC Counts
DEFAULT	**C**
EXAMPLE	**SET UNITS K**
NOTES	ASCII Output (BIN = 0): When UNITS is set to 0, the RTD temperature is in A/D counts. When UNITS = V or A, the RTD temperature is in mV. When UNITS is set to C, F, K, R, or M, RTD temperature is in °C. 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.

7.10.12 TIME STAMP (TIME)

COMMAND	TIME
TYPE	Set
DESCRIPTION	Enables a time stamp with ASCII data output, and sets the units of the timestamp. All timestamps here are relative to the scan start (0 time). For PTP time, PTP must be enabled and TIME should be disabled.
SYNTAX	**SET TIME** <value> Where <value> is: 0 = No relative time stamp 1 = Enable relative time stamp in microseconds 2 = Enable relative time stamp in milliseconds
DEFAULT	**0**
EXAMPLE	**SET TIME 0**

7.10.13 Frame Trigger (XSCANTRIG)

COMMAND	XSCANTRIG
TYPE	Set
DESCRIPTION	Enables or disables external frame triggering, and can be used to set a frame trigger divisor. See "5.7.4 Frame Triggering (TRIG 1 / XSCANTRIG 1)" for requirements and information on frame triggering.
SYNTAX	**SET XSCANTRIG** <value> Where <value> is: 0 = Frame Triggering disabled. 1 = Frame Triggering enabled. 2 to 254 = Frame triggering is enabled and this number is used as a divisor based on the external trigger. For exmaple, if the external frame trigger rate was 10Hz and XSCANTRIG is set to 2, the DTS will be triggering and output data at 5Hz.
DEFAULT	**0**
EXAMPLE	**SET XSCANTRIG 1**
NOTES	The internal rate of the DTS (PERIOD/AVG or RATE) should be set to a scan rate that is 25% or higher than the external scan rate. For example, if you intend to trigger the DTS at 10Hz with an external frequency generator, the internal rate should be set to 12.5Hz or higher. It is generally recommended that the internal rate be set to 2x the rate or more when external frame triggering unless averaging is needed.
NOTES	**XSCANTRIG and TRIG will configure each other to support both commands. If XSCANTRIG it set to any non-zero value, TRIG will be set to 1 but XSCANTRIG is used as a divisor setting.**

7.10.14 Tirgger Settings (TRIG)

COMMAND	TRIG
TYPE	Set
DESCRIPTION	Enables the triggering method utilized by the DTS.
SYNTAX	**SET TRIG** <value> Where <value> is: 0 = External triggering disabled (internal sampling/triggering only) 1 = Frame trigger is enabled (uses XSCANTRIG setting as a divisor) 2 = Scan triggering is enabled (not currently supported) 3 = Scan-on-startup
DEFAULT	**0**
EXAMPLE	**SET TIME 0**
NOTES	If TRIG is set to 1, it will set XSCANTRIG to 1. If set to any other value, XSCANTRIG will be set to 0. If XSCANTRIG is set, TRIG will follow. If XSCANTRIG is set to > 1, TRIG will be set to 1

7.10.15 QPKTS

COMMAND	QPKTS
TYPE	Set
DESCRIPTION	This is a non-functioning variable left in place for legacy compatibility.
DEFAULT	**0**

7.11 IDENTIFICATION VARIABLES (LIST I)

7.11.1 LIST IDENTIFICATION

TYPE	Get
DESCRIPTION	Lists the identification configuration variables.
SYNTAX	**LIST I**
RETURNS	All of the group I variables.
EXAMPLE	LIST I *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*

7.11.2 ECHO

COMMAND	ECHO
TYPE	Set
DESCRIPTION	Determines if the DTS will automatically connect to a binary receiver.
SYNTAX	**SET AUTOCON** <value> Where <value> is 0 for disabled, 1 for automatic connect.
DEFAULT	**0**
EXAMPLE	**SET AUTOCON 1**

7.11.3 AUTO CONNECT (AUTOCON)

COMMAND	AUTOCON
TYPE	Set
DESCRIPTION	Determines if the DTS will automatically connect to a binary receiver.
SYNTAX	**SET AUTOCON** <value> Where <value> is 0 for disabled, 1 for automatic connect.
DEFAULT	**0**
EXAMPLE	**SET AUTOCON 1**

7.11.4 HOST

COMMAND	HOST
TYPE	Set
DESCRIPTION	Sets the destination (IP address and port number) for binary data to be transferred. Also used to set the data transfer method to TCP or UDP. 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.

SYNTAX	**SET HOST** <ip> <port> <protocol> Where <ip> is 0 or a valid IP address. Where <port> is 0 or a valid port number. Where <protocol> is T for TCP or U for UDP.
DEFAULT	**0 0 T**
EXAMPLE	**SET HOST 192.168.3.23 7001 U**
NOTES	**Only used when Binary data output (BIN) is enabled.**

7.11.5 HOSTCMD

COMMAND	HOSTCMD
TYPE	Set
DESCRIPTION	Sets the ASCII command string that can be sent to the host computer binary receiver.
SYNTAX	**SET HOSTCMD** <value> Where <value> is any valid string.
DEFAULT	**0**
EXAMPLE	**SET HOSTCMD RUNM**

7.11.6 TCMAXSLEW

COMMAND	TCMAXSLEW
TYPE	Set
DESCRIPTION	This is a non-functional variable left in place for legacy compatibility.
DEFAULT	**0**

7.11.7 RTDMAXSLEW

COMMAND	RTDMAXSLEW
TYPE	Set
DESCRIPTION	This is a non-functional variable left in place for legacy compatibility.
DEFAULT	**0**

7.11.8 TITLE 1

COMMAND	TITLE1
TYPE	Set
DESCRIPTION	Sets a value for title number 1 (purely an identifier)
SYNTAX	**SET TITLE1** <value> Where <value> is any valid string up to 255 characters.
DEFAULT	**Scanivalve DTS4050**
EXAMPLE	**SET TITLE1 DTS-RAKE1**

7.11.9 TITLE 2

COMMAND	TITLE2
TYPE	Set
DESCRIPTION	Sets a value for title number 2 (purely an identifier)

SYNTAX	**SET TITLE2** <value> Where <value> is any valid string up to 255 characters.
DEFAULT	**<the current firmware version string>**
EXAMPLE	**SET TITLE1 DTS-RAKE2**

7.11.10 PORT

COMMAND	PORT
TYPE	Set
DESCRIPTION	Sets the Ethernet port used for primary communication, and controls the UDP Server settings. For versions 1.20 and higher: When set to 0 (default), the TCP Telnet server (port 23) is used for the standard Telnet connection and communication. The UDP IP Server will be active under the default settings. If a UDP Telnet Server is required for primary communications, this number must be set to a non-zero number. The DTS will use that port for UDP communications (commands and control). The UDP ID Server will be disabled. If this value is changed, a SAVE and power cycle must be performed
SYNTAX	**SET PORT** <value> Where <value> is 0 to 60000.
DEFAULT	**0**
EXAMPLE	**SET PORT 0**

7.12 NETWORK IDENTIFICATION VARIABLES (LIST ID)

7.12.1 LIST NETWORK IDENTIFICATION

TYPE	Get
DESCRIPTION	Lists the module identification information and configuration variables to support the Network ID command.
SYNTAX	**LIST ID**
RETURNS	All of the group ID variables.
EXAMPLE	LIST I *SET IPADD 191.30.100.100* *SET MODEL DTS4050* *SET SERNUM 1234* *SET VER 2.04*
NOTES	The variable VER are listed to display current setting only. It cannot be changed by the user from the LIST ID group.

7.13 FTP / Network Attached Storage Variables (LIST NAS)

NOTE: The generic SAVE command does not save any variables in the LIST NAS group. In order to save any changes to non-volatile memory, the SAVENAS command must be issued.

7.13.1 List Network Attached Storage

TYPE	Get
DESCRIPTION	Lists the network attached storage configuration variables to support FTP protocol data transfer (temperature data).
SYNTAX	**LIST NAS**
RETURNS	All of the group NAS variables.
EXAMPLE	LIST I *SET USERNAS DTS* *SET PASSNAS scanivalve* *SET ENNAS 0* *SET PATHNAS * *SET IPNAS 0.0.0.0* *SET FILENAS SCAN*

7.13.2 User Name (USERNAS)

COMMAND	USERNAS
TYPE	Set
DESCRIPTION	Sets the user name that can be accepted by the FTP server or NAS to log in.
SYNTAX	**SET USERNAS** <value> Where <value> is a string.
DEFAULT	**admin**
EXAMPLE	**SET USERNAS admin**

7.13.3 User Password (PASSNAS)

COMMAND	PASSNAS
TYPE	Set
DESCRIPTION	Sets the password that can be accepted by the FTP server or NAS to log in.
SYNTAX	**SET PASSNAS** <value> Where <value> is a string.
DEFAULT	**password**
EXAMPLE	**SET PASSNAS password**

7.13.4 Enable FTP (ENNAS)

COMMAND	ENNAS
TYPE	Set
DESCRIPTION	Enables or disables FTP data output to the configured destination.
SYNTAX	**SET ENNAS** <enabled> Where <enabled> is 0 for disabled. 1 will enable FTP data output and append a scan number to the end of the filename (increments by 1). 2 will enabled FTP data output and append the internal date/time of the DTS to the filename.

DEFAULT	**password**
EXAMPLE	**SET ENNAS 1**
NOTE	**If FTP data output is enabled, it will take priority over other configurations.**

7.13.5 FTP File Path (PATHNAS)

COMMAND	PATHNAS
TYPE	Set
DESCRIPTION	Sets the directory path in the server for scan data to be saved.
SYNTAX	**SET ENNAS** <path> Where <path> is a string that starts with /. Cannot start with a drive letter.
DEFAULT	**/disk1/share**
EXAMPLE	**SET PATHNAS /sv/dts1**

7.13.6 FTP Server IP (IPNAS)

COMMAND	IPNAS
TYPE	Set
DESCRIPTION	Sets the FTP server's IP address as the data destination.
SYNTAX	**SET IPNAS** <ip> Where <ip> is any valid IP address.
DEFAULT	**/disk1/share**
EXAMPLE	**SET PATHNAS /sv/dts1**

7.13.7 Filename Prefix (FILENAS)

COMMAND	FILENAS
TYPE	Set
DESCRIPTION	Sets the filename prefix for the scan data file the DTS creates on the FTP server / NAS. The full name of the file will have a scan number, or a time/date appended to the file depending on the ENNAS setting.
SYNTAX	**SET FILENAS** <name> Where <name> is any valid string with no spaces.
DEFAULT	**SCAN**
EXAMPLE	**SET FILENAS DTS1_321_**

7.14 LIST IP VARIABLES (LIST IP)

NOTE: The generic 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. Any changes to these variables require a SAVEIP and power cycle to take effect.

7.14.1 LIST IP VARIABLES

TYPE	Get
DESCRIPTION	Lists the variables in the IP group.
SYNTAX	**LIST IP**
RETURNS	All of the group IP variables.
EXAMPLE	LIST IP *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*

7.14.2 DTS IP ADDRESS (IPADD)

COMMAND	IPADD
TYPE	Set
DESCRIPTION	Sets the ip address of the DTS.
SYNTAX	**SET IPADD** <value> Where <value> is any valid IP address.
DEFAULT	**191.30.100.100 - in the event of total reset.** **IP addresses are set at the factory -- see "5.3.1 Factory Default IP Address" on page 22.**
EXAMPLE	**SET IPADD 192.168.1.100**

7.14.3 SUBNET MASK (SUBNET)

COMMAND	SUBNET
TYPE	Set
DESCRIPTION	Sets the Subnet mask for the module. The subnet mask must be configured properly for the network where the DTS module will be connected.
SYNTAX	**SET SUBNET** <value> Where <value> is any valid subnet.
DEFAULT	255.255.0.0
EXAMPLE	**SET SUBNET 255.255.255.0**

7.14.4 MAC ADDRESS (MAC)

COMMAND	MAC
TYPE	Set

DESCRIPTION	Sets the MAC address of the module. It is recommended that this variable not be modified.
SYNTAX	**SET MAC** <address> Where <address> is the 6 octet address in decimal format. First three octets are registered to Scanivalve, fourth octet is the family id (see IP address) and the last two octets are the serial number.
DEFAULT	000.096.093.YYY.XXX.XXX (varies)
EXAMPLE	**SET MAC 000.096.093.105.001.123**

7.14.5 LOGIN (LOGIN)

COMMAND	LOGIN
TYPE	Set
DESCRIPTION	Sets the login user name for access to the file system via FTP. This is used for file management, firmware uploads, or similar within the DTS's memory.
SYNTAX	**SET LOGIN** <value> Where <value> is any valid string.
DEFAULT	Scanivalve
EXAMPLE	**SET LOGIN Scanivalve**

7.14.6 PASSWORD (PASSWORD)

COMMAND	PASSWORD
TYPE	Set
DESCRIPTION	Sets the login password for access to the file system via FTP. This is used for file management, firmware uploads, or similar within the DTS's memory.
SYNTAX	**SET PASSWORD** <value> Where <value> is any valid string.
DEFAULT	Scanner
EXAMPLE	**SET PASSWORD secretpassword**

7.14.7 LOGIN 1 (LOGIN1)

COMMAND	LOGIN1
TYPE	Set
DESCRIPTION	Sets the secondary login user name for access to the file system via FTP. This is used for file management, firmware uploads, or similar within the DTS's memory.
SYNTAX	**SET LOGIN1** <value> Where <value> is any valid string.
DEFAULT	Scanivalve1
EXAMPLE	**SET LOGIN1 user2**

7.14.8 PASSWORD 1 (PASSWORD1)

COMMAND	PASSWORD1
TYPE	Set
DESCRIPTION	Sets the secondary login password for access to the file system via FTP. This is used for file management, firmware uploads, or similar within the DTS's memory.

SYNTAX	**SET PASSWORD1** <value> Where <value> is any valid string.
DEFAULT	Scanner
EXAMPLE	**SET PASSWORD1 secretpassword2**

7.14.9 Allow Anonymous Login (ALLOWANON)

COMMAND	LOGIN
TYPE	Set
DESCRIPTION	Sets the ability for users to log into DTS's file system via FTP anonymously or with user/password combination.
SYNTAX	**SET ALLOWANON** <value> Where <value> is 0 for do not allow, and 1 for allow anonymous file system access (via FTP).
DEFAULT	1
EXAMPLE	**SET ALLOWANON 0**

7.14.10 Application File (APP)

COMMAND	APP
TYPE	Set
DESCRIPTION	Sets the name of the file the bootloader uses to launch the application firmware. If this file is not found, the DTS will revert to bootloader mode. The variable is case sensitive. It should not be modified in the field.
SYNTAX	**SET APP** <file> Where <file> is any valid application file name.
DEFAULT	Dts4000.hex
EXAMPLE	**SET APP Dts4000.hex**

7.14.11 Gateway (GATEWAY)

COMMAND	GW
TYPE	Set
DESCRIPTION	Sets the network's gateway IP address if needed or used. Allows communication access from another network not in the same subnet if the network is configured correctly.
SYNTAX	**SET GW** <value> Where <value> is any valid IP address.
DEFAULT	0.0.0.0
EXAMPLE	**SET GW 200.200.11.1**

7.15 PRECISION TIME PROTOCOL VARIABLES (LIST PTP)

NOTE: The generic SAVE command does not save any variables in the LIST PTP group. In order to save any changes to non-volatile memory, the SAVEPTP command must be issued.

7.15.1 LIST PTP VARIABLES

TYPE	Get
DESCRIPTION	Lists the variables in the PTP group.
SYNTAX	**LIST IP**
RETURNS	All of the group PTP variables.
EXAMPLE	LIST PTP *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 ADJDRIFT 100 100000* *SET UTCOFFSET 00:00:00*

7.15.2 ENABLE PTP (PTPEN)

COMMAND	PTPEN
TYPE	Set
DESCRIPTION	Enables or disabled the PTP engine.
SYNTAX	**SET PTPEN** <value> Where <value> 0 is disabled, 1 is enabled as a PTP slave device.
DEFAULT	**0**
EXAMPLE	**SET PTPEN 1**
NOTE	**PTPEN 1 will display the internal time in the ASCII data by default, regardless of TIME setting.**

7.15.3 TUNE PTP (TUNE)

COMMAND	TUNE
TYPE	Set
DESCRIPTION	Allows for the DTS's PTP engine to be tuned to maximize sync accuracy.
SYNTAX	**SET TUNE** <min filter depth> <clock gain> <integral limit> <median filter depth> Where: <min filter depth> is any valid integer <clock gain> is any valid float <integral limit> is any valid integer <median filter depth> is any valid integer
DEFAULT	10 0.5 500000 5
EXAMPLE	**SET TUNE 10 0.5 500000 5**

7.15.4 SYSLOG SEVERITY LEVEL (SLL)

COMMAND	SLL
TYPE	Set
DESCRIPTION	Sets the log level of any PTP message in the syslog (when used).
SYNTAX	**SET SLL** <value> Where <value> is: 0 - Off 1 - Emergency 2 - Alert 3 - Critical 4 - Error 5 - Warning 6 - Notice 7 - Information 8 - Debug level 1 9 - Debug level 2
DEFAULT	0
EXAMPLE	**SET SLL 7**

7.15.5 Statistical PTP Output (STAT)

COMMAND	STAT
TYPE	Set
DESCRIPTION	Enables or disabled the PTP statistical data for debug, and sets the output destination.
SYNTAX	**SET STAT** <value> Where <value> 0 is disabled, 1 is output to serial, 2 is output to Telnet, 3 is output to Syslog server.
DEFAULT	**0**
EXAMPLE	**SET STAT 2**
NOTE	**When enabled, stat information will stream as PTP updates are detected, indefinitely. To stop the output, you must SET STAT 0.**
NOTE	The statistical data is output in the following format: <ofm>, <msd>, <smd>, <mpd> ofm - Offset From Master. Time (in microseconds) 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

7.15.6 Scan Start Time (SST)

COMMAND	SST
TYPE	Set

DESCRIPTION	Sets the time that will begin scan data transfer as referenced to the internal time of the module, or retrieves the current setting. Used in combination with SSD. When a SCAN is executed, the DTS will only use the value of SST (scan start time) and SSD (scan start date) to initiate scan data transfer under two conditions: 1) PTPEN is set to a non-zero number. 2) The combination of SST and SSD are set to a future time and date as compared to the DTS's current internal time. When met, the DTS will remain in SCAN mode without transferring scan data to the configured destination until the internal time has met the values of SST and SSD. When these two cases are not met, the DTS will immediately transfer the scan data to the configured destination.
SYNTAX	**SET SST** <hh:mm:ss.fffff> Where: hh = Hours (24 hour format) mm = Minutes ss = Seconds ffff = fractions of a second
DEFAULT	00:00:00.0000
EXAMPLE	**SET SST 13:00:00.000**
NOTES	The internal time and date of the DTS, when PTP is enabled (PTPEN == 1), may be synchronized to a PTP Grandmaster's time as long as PTP Grandmaster packets are discovered on the network by the DTS.

7.15.7 Scan Start Date (SSD)

COMMAND	SSD
TYPE	Set/Get
DESCRIPTION	Sets the time that will begin scan data transfer as referenced to the internal time of the module. Used in combination with SST and see the SST Description for details on how SST/SSD is used.
SYNTAX	**SET SSD** <yyyy/mm/dd > Where: yyyy = Year mm = Month dd = Day
DEFAULT	1971/01/01
EXAMPLE	**SET SSD 2016/08/10**
NOTES	The internal time and date of the DTS, when PTP is enabled (PTPEN == 1), may be synchronized to a PTP Grandmaster's time as long as PTP Grandmaster packets are discovered on the network by the DTS.

7.15.8 Update Clock (UC)

COMMAND	UC
TYPE	Set

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.
SYNTAX	**SET UC** <value> Where <value> 0 disabled internal clock/setting updates, 1 allows the clock rate/setting to be adjusted.
DEFAULT	**0**
EXAMPLE	**SET UC 0**

7.15.9 INTERVAL

COMMAND	INTERVAL
TYPE	Set
DESCRIPTION	Sets the width of each histogram interval in nanoseconds.
SYNTAX	**SET INTERVAL** <value> Where <value> is any integer 1 to 1,000,000,000.
DEFAULT	**5**
EXAMPLE	**SET INTERVAL 10**

7.15.10 CLOCK DRIFT ADJUSTMENT (ADJDRIFT)

COMMAND	ADJDRIFT
TYPE	Set
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.
SYNTAX	**SET ADJDRIFT** <rate> <rate limit> Where <rate> and <rate limit> is any integer 1 to 1,000,000,000.
DEFAULT	**100 1000000**
EXAMPLE	**SET ADJDRIFT 100 100000**

7.15.11 UTC OFFSET (UTCOFFSET)

COMMAND	UTCOFFSET
TYPE	Set
DESCRIPTION	Sets the offset applied to the internal time to allow for adjustments to UTC, time zones, or leap seconds.
SYNTAX	**SET UTCOFFSET** <time> Where <time> is expressed as hh:mm:ss (12 hour time only). A negative sign can be used to make the offset negative.
DEFAULT	**00:00:00**
EXAMPLE	**SET UTCOFFSET -0:0:37**

7.15.12 PTP DOMAIN (DOMAIN)

COMMAND	DOMAIN
TYPE	Set

DESCRIPTION	Sets the PTP domain value to listen on.
SYNTAX	**SET DOMAIN** <value> Where <value> is any number 0 to 127.
DEFAULT	**0**
EXAMPLE	**SET DOMAIN 2**

7.16 PRECISION TIME PROTOCOL COMMANDS

7.16.1 GET TIME

COMMAND	GETTIME
TYPE	Get
DESCRIPTION	Retrieves the current time in the module.
SYNTAX	**GETTIME**
RETURNS	Current Time year/month/day hour:minute:seconds sec xxxxxxxxxx ns xxxxxxxxxx
EXAMPLE	**GETTIME** *Current Time 2026/05/05 13:01:05 sec 1777986065 ns 665702238*
NOTES	The internal time may be naive or may be synchronized to PTP time. When PTP is not used, the internal time will be based on a default time.

7.16.2 SET TIME

COMMAND	SETTIME
TYPE	Set
DESCRIPTION	Sets the current time in the module.
SYNTAX	**SETTIME** year/month/day hour:minute:seconds **Date must be 1970/1/1 or more recent. Time is in 24 hour format.**
RETURNS	Entered year/month/day hour:minute:seconds Time is <seconds since epoch>
EXAMPLE	**SETTIME 2026/03/01 17:00:23**
NOTES	Time can be set when PTP is disabled. If PTP is enabled, the received PTP time will always take priority.

7.16.3 GET UTC OFFSET

COMMAND	GETUTCO
TYPE	Get
DESCRIPTION	Gets the current UTC Offset information from the PTP packets.
SYNTAX	**GETUTCO**
RETURNS	Current UTC Offset <seconds> <update> <valid> Where <seconds> is the current UTC offset in seconds (leap seonds), <update> is the UTC updated flag (1 = true, 0 = false), and <valid> is if UTC offset is valid in the format (1 = true, 0 = false).
EXAMPLE	**GETUTCO** *Current UTC Offset 37 1 1*
NOTES	PTP is always broadcasted in TAI time and must be offset to get to UTC. The value reported here can be used as part of the UTCOFFSET setting to correct the internal time of the module.

7.16.4 Clear Accumulated PTP Data

COMMAND	PTPCLEAR
TYPE	Get
DESCRIPTION	Clears the accumulated data in the PTP histogram buffers and restarts sampling.
SYNTAX	**PTPCLEAR**
RETURNS	<nl>
EXAMPLE	**PTPCLEAR**

7.16.5 Display PTP Statistics

COMMAND	PTPSTAT
TYPE	Get
DESCRIPTION	Displays the accumulated PTP data in histogram form.
SYNTAX	**PTPSTAT**
RETURNS	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	**PTPSTAT** *OFM, INTERVAL, 100000, 114, 13, 10, 23, 21, 15, 36, 6, 12, 9, 23, 10, 129*

7.17 THERMOCOUPLE TYPE CHANNEL SETTINGS (LIST T)

7.17.1 LIST TYPE

TYPE	Get
DESCRIPTION	Lists the variables in the T group.
SYNTAX	**LIST T**
RETURNS	All of the group T variables, one line per channel.
EXAMPLE	LIST T *SET TYPE 1 K 0* *SET TYPE 2 B 1* *SET TYPE 3 J 0* *: : : :* *: : : :* *SET TYPE n K 0*

7.17.2 THERMOCOUPLE TYPE (TYPE)

COMMAND	TYPE
TYPE	Set
DESCRIPTION	Determines the thermocouple conversion for each channel, and the bond/ground wiring for each channel. The thermocouple type set determines the CJC and EU conversions. The shield connection switch should be set based on the method used to ground or shield the thermocouple. Refer to “Thermocouple Grounding Scenarios” on page 68 for more information.
SYNTAX	**SET TYPE** <channel> <tc type> <shield connect> Where: <channel> is the channel number. If 0 is used, it will set all channels to the same settings. <tc type> is the Thermcouple type. E, J, K, N, R, S, T, or B are supported. <sheild connect> is 1 for closed, 0 for open
DEFAULT	**K 0**
EXAMPLE	**SET TYPE 4 J 1**

7.18 CHANNEL LABELS (LIST LA)

7.18.1 LIST CHANNEL LABELS

TYPE	Get
DESCRIPTION	Lists the variables in the LA group.
SYNTAX	**LIST LA**
RETURNS	All of the group LA variables, one line per channel.
EXAMPLE	LIST LA *SET LABEL 1 T/C1* *SET LABEL 2 T/C2* *SET LABEL 3 T/C3* *: : : :* *: : : :* *: : : :* *: : : :* *SET LABEL n T/Cn*

7.18.2 CHANNEL LABEL

COMMAND	LABEL
TYPE	Set
DESCRIPTION	Sets the user definable label for each available channel.
SYNTAX	**SET LABEL** <channel> <label> Where: <channel> is the channel number. If 0 is used, it will set all channels to the same settings. <label> is a sting up to 31 characters. Spaces are allowed.
DEFAULT	**T/C<ch>**
EXAMPLE	**SET LABEL 1 LeftPort1**
NOTES	**These labels are only shown in LIST LA.**

7.19 CHANNEL DEFINITIONS (LIST DEF)

7.19.1 LIST CHANNEL LABELS

TYPE	Get
DESCRIPTION	Lists the channel definitions for a 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.
SYNTAX	**LIST DEF <channel>** Where <channel> is a valid channel number.
RETURNS	SET DEF <channel> < ASCII String up to 2048 bytes>
EXAMPLE	LIST DEF 1 *SET DEF 1 This is a string that defines channel 1*

7.19.2 CHANNEL DEFINITION

COMMAND	DEF
TYPE	Set
DESCRIPTION	Sets the user definable definition for an available channel.
SYNTAX	**SET DEF** <channel> <definition> Where: <channel> is the channel number. <definition> is a sting up to 2048 characters. Spaces are allowed.
DEFAULT	**null**
EXAMPLE	**SET DEF 1 This is a string that defines channel 1**

7.20 CHANNEL LIMITS (LIST LI)

7.20.1 LIST CHANNEL LIMITS

TYPE	Get
DESCRIPTION	Lists the channel limit settings for low and high limits for alarms/flags.
SYNTAX	**LIST LI**
RETURNS	Lists all channel limit settings, one line per channel.

EXAMPLE	LIST LI *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 n 1 500.00 -50.00*

7.20.2 CHANNEL LIMITS

COMMAND	LIMIT
TYPE	Set
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.
SYNTAX	**SET LIMIT** <channel> <enable> [<high limit> <low limit>] Where: <channel> is the channel number. <enable> is 0 for disabled, 1 for enable limit <high limit> and <low limit> are optional, but both are require if set. Sets the high and low limit values as floats.
DEFAULT	**<ch> 0 100 0**
EXAMPLE	**SET LIMIT 1 1 100 -10**

7.21 Calibration Variables (LIST C)

7.21.1 List Calibration Variables

TYPE	Get
DESCRIPTION	Lists the variables in the C group.
SYNTAX	**LIST C**
RETURNS	All of the group C variables.
EXAMPLE	LIST C *SET NUMCOEF 3* *SET NUMPTS 8* *SET CALAVG 4* *SET NUMTEMP 0*

7.21.2 A/D Calibration Averaging (CALAVG)

COMMAND	CALAVG
TYPE	Set
DESCRIPTION	Determines how much averaging is used during an A/D Calibration (ADCAL). This setting will have an effect on boot up time as ADCALs are performed during boot. See “6.7 A/D Self Calibration (ADCAL)” for more information on ADCAL.
SYNTAX	**SET CALAVG** <value> Where <value> is 1 to 64.
DEFAULT	**4**
EXAMPLE	**SET CALAVG 8**

7.21.3 Number of Calibration Coefficients (NUMCOEF)

COMMAND	NUMCOEF
TYPE	Set
DESCRIPTION	Determines the polynomial order for the Engineering Unit conversion (raw ADC counts to voltage).
SYNTAX	**SET NUMCOEF** <value> Where <value> is 1 to 8, which selected the order. For example: 1 - Offset only 2 - y = mx + b correction curve 3 - y = ax2 + bx + c correction curve
DEFAULT	**5**
EXAMPLE	**SET NUMCOEF 5**
NOTES	This variable is set at the factory and should not be adjusted in the field.

7.21.4 Number of Calibration Temperatures (NUMTEMPS)

COMMAND	NUMTEMPS
TYPE	Set
DESCRIPTION	Determines the number of temperature planes required for coefficient conversion. When set, the coefficient tables are reset to default values based on this setting.

SYNTAX	**SET NUMTEMPS** <value> Where <value> is 0 to 8. When set to 0, the DTS uses a single temperature plane.
DEFAULT	**0**
EXAMPLE	**SET NUMTEMPS 5**
NOTES	This variable is set at the factory and should not be adjusted in the field. If changed, all coefficient are lost and reset.

7.21.5 Number of Calibration Setpoints (NUMPTS)

COMMAND	NUMPTS
TYPE	Set
DESCRIPTION	Determines the number of set points (per temperature plane) in the calibration table.
SYNTAX	**SET NUMPTS** <value> Where <value> is 1 to 8.
DEFAULT	**8**
EXAMPLE	**SET NUMPTS 9**
NOTES	This variable is set at the factory and should not be adjusted in the field. If changed, all coefficient are lost and reset.

7.22 RTD Calibration Variables (LIST U)

7.22.1 List UTR Calibration Variables

TYPE	Get
DESCRIPTION	Lists the variables in the UTR group.
SYNTAX	**LIST U**
RETURNS	All of the group U variables.
EXAMPLE	LIST U *SET RNUMCOEF 3* *SET RNUMPTS 8* *SET MAXDELTA 1.000000* *SET ARPCON 0* *SET ARPC 1 0.000* *SET ARPC 2 0.000*

7.22.2 Number of RTD Calibration Coefficients (RNUMCOEF)

COMMAND	RNUMCOEF
TYPE	Set
DESCRIPTION	Determines the polynomial order for the RTD conversion (raw ADC counts to voltage).
SYNTAX	**SET RNUMCOEF** <value> Where <value> is 1 to 7, which selected the order. For example: 1 - Offset only 2 - y = mx + b correction curve 3 - y = ax2 + bx + c correction curve
DEFAULT	**5**
EXAMPLE	**SET NUMCOEF 5**
NOTES	This variable is set at the factory and should not be adjusted in the field.

7.22.3 Number of Calibration Setpoints (RNUMPTS)

COMMAND	RNUMPTS
TYPE	Set
DESCRIPTION	Determines the number of set points for the RTD correction list.
SYNTAX	**SET RNUMPTS** <value> Where <value> is 1 to 8.
DEFAULT	**8**
EXAMPLE	**SET RNUMPTS 8**
NOTES	This variable is set at the factory and should not be adjusted in the field.

7.22.4 Max Delta (MAXDELTA)

COMMAND	MAXDELTA
TYPE	Set
DESCRIPTION	This is the maximum allowable difference between the readings of RTD1 and RTD2 in the same UTR, in degrees C (same value used for each UTR available). 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).

SYNTAX	**SET MAXDELTA** <value> Where <value> is any number 0.01 to 1.00.
DEFAULT	**0.25**
EXAMPLE	**SET MAXDELTA 0.5**
NOTES	The default value should typically be used.

7.22.5 ARPCON

COMMAND	ARPCON
TYPE	Set
DESCRIPTION	If ARPCON is set to 1, the value(s) in the ARPC lines will be used to correct the board set RTD voltages before the Calander Van-Dusen correction is applied to the RTDs, created by the ARPC command.
SYNTAX	**SET ARPCON** <enable> Where <enable> is 0 for disabled, and 1 for enabled.
DEFAULT	**0**
EXAMPLE	**SET ARPCON 1**
NOTES	Not generally changed in the field.

7.22.6 ARPC

COMMAND	ARPC
TYPE	Set
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.
SYNTAX	**ARPC** <board> <value> Where <board> is 1, 2, 3, or 4. Where <value> is any number.
DEFAULT	**0.0000**
EXAMPLE	**ARPC 1 0.001**
NOTES	Not generally changed in the field.

7.23 RTD Correction Values (LIST RTD)

7.23.1 List RTD Correction Variables

TYPE	Get
DESCRIPTION	Lists the RTD correction model 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.
SYNTAX	**LIST RTD**
RETURNS	All of the group RTD variables.
EXAMPLE	**LIST RTD** *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*

7.23.2 RTD

COMMAND	RTD
TYPE	Set
DESCRIPTION	The correction model factors for each RTD. The actual values are provided by the manufacturer.
SYNTAX	**SET RTD** <ch> <R0> <A> <B> Where <ch> is any valid RTD channel. Where <R0> is any number (float). Where <A> is any exponent. Where <B> is any exponent.
DEFAULT	**100.0000 3.908E-03 -5.775E-07**
EXAMPLE	**SET RTD 99.9998 3.131E-03 -5.882E-07**
NOTES	Not generally changed in the field.

7.24 RTD CONVERSION VALUES (LIST RPC)

7.24.1 LIST RTD CONVERSION VALUES

TYPE	Get
DESCRIPTION	Lists the RTD conversion values for all RTD channels (ADC to V). 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.
SYNTAX	**LIST RPC**
RETURNS	All of the group RPC variables.
EXAMPLE	**LIST RPC** *SET RPC 3 0 0.095000 1271278 1271278* *SET RPC 3 1 0.100000 1338897 1338897* *SET RPC 3 2 0.105000 1406643 1406643* *SET RPC 3 3 0.110000 1474311 1474311* *SET RPC 3 4 0.115000 1542011 1542011* *SET RPC 3 5 0.120000 1609718 1609718* *SET RPC 3 6 0.125000 1677418 1677418* *SET RPC 3 7 0.131000 1758718 1758718*

7.24.2 RTD CONVERSION (RPC)

COMMAND	RPC
TYPE	Set
DESCRIPTION	This is the list of set points used to calibrate the RTDs, and provide the conversion table for RTD ADC counts to Volts. A 16Tx DTS module has 1 board, a 32Tx DTS module has 2 boards and a 64Tx DTS module has 4 boards, each board consisting of 2 RTDs.
SYNTAX	**SET RPC** <board> <index> <V> <RTD1> <RTD2> Where <board> is 1, 2, 3, or 4. Where <index> is any number 0 to 7. Where <V> is any valid float (volts value) Where <RTD1> and <RTD2> are raw ADC values (22-bit)
DEFAULT	**1 0 0 0 0**
EXAMPLE	**SET RPC 1 0 0.095000 1287022 1287022**
NOTES	Not generally changed in the field.
NOTES	RTD1 and RTD2 values will match on old ADC boards. New ADC boards will have two different, but similar values.

7.25 RTD Excitation Correction Values (LIST RTDX)

7.25.1 List RTDX Excitation Correction Values

TYPE	Get
DESCRIPTION	Lists the RTD excitation conversion values for all RTD channels (mV to resistance). 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.
SYNTAX	**LIST RTDX**
RETURNS	All of the group RTDX variables.
EXAMPLE	**LIST RPC** *SET RTDX 1 1.0000000* *SET RTDX 2 1.0000000* *SET RTDX 3 1.0000000* *SET RTDX 4 1.0000000* *SET RTDX 5 1.0000000* *SET RTDX 6 1.0000000* *SET RTDX 7 1.0000000* *SET RTDX 8 1.0000000*

7.25.2 RTDX Correction (RDTX)

COMMAND	RDTX
TYPE	Set
DESCRIPTION	Sets the excitation current correcion for the RTD channel.
SYNTAX	**SET RPC** <ch> <value> Where <ch> is the RTD channel 1 through 8 Where <value> is any valid float
DEFAULT	**0 1.0000000**
EXAMPLE	**SET RTDX 1 1.000111**
NOTES	Not generally changed in the field.

7.26 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.

7.26.1 LIST CHANNEL CORRECTION SETPOINTS (SINGLE TEMP)

TYPE	Get
DESCRIPTION	Lists the calibration setpoints for the channel listed. If channel 0 is specified, the setpoints for all channels will be listed. This is only used with NUMTEMPS == 0.
SYNTAX	**LIST P** <channel> Where <channel> is any valid channel from 0 to 64 (depending on module channel count)
RETURNS	All of the group P variables.
EXAMPLE	**LIST P 1** *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*

7.26.2 PT (SINGLE TEMP)

COMMAND	PT
TYPE	Set
DESCRIPTION	This variable sets a conversion setpoint (ADC to V) for any of the TC channel inputs conversion tables.
SYNTAX	**SET PT** <channel> <index> <V> <C> Where <channel> is any valid channel 0 to 64 (depending on the models channel count) Where <index> is any number 0 to 7 Where <V> is any valid float (volts value) Where <C> is a raw ADC integer (22-bit)
DEFAULT	**0 0 0 0 0**
EXAMPLE	**SET PT 1 0.010000 276455**
NOTES	Not generally changed in the field.

7.26.3 List Channel Correction Setpoints (Multi temp)

TYPE	Get
DESCRIPTION	Lists the calibration setpoints for the channel listed: 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 This is only used when NUMTEMPS is 1 or greater.
SYNTAX	**LIST P** <type> <chan/board> [<temp>] Where: <type> is T or R (T for TC channel, R for RTD channel) <channel> is any valid channel from 0 to 64 (depending on module channel count) <temp> is optional, but is a single temperature or a range using the syntax: <starttemp>..<endtem>
RETURNS	All of the group P variables.
EXAMPLE	**LIST P T 1 20** *SET PT T 1 2 20 0 -0.010000 -275283* *SET PT T 1 2 20 1 0.000000 1288* *SET PT T 1 2 20 2 0.012000 333064* *SET PT T 1 2 20 3 0.024000 664759* *SET PT T 1 2 20 4 0.036000 996312* *SET PT T 1 2 20 5 0.048000 1327909* *SET PT T 1 2 20 6 0.060000 1659352* *SET PT T 1 2 20 7 0.070000 1935411*

7.26.4 PT (Multi Temp)

COMMAND	PT
TYPE	Set
DESCRIPTION	This variable sets a conversion setpoint (ADC to V) for any of the TC channel inputs conversion tables, and a specific temperature index point.
SYNTAX	**SET PT <type>** <ch/board> <temp ndx> <temp> <tc ndx> <V> <C> Where: <ch/board> is any valid TC channel 0 to 64 (depending on the models channel count) or RTD board 1 to 4 <temp ndx> is the temperature index between 1 and NUMTEMPS <temp> the tempearture in DegC <tc ndx> is the TC point index from 1 to NUMPTS <V> is any valid float (volts value) <C> is a raw ADC integer (22-bit)
DEFAULT	**0 0 0 0 0**
EXAMPLE	**SET PT T 1 2 20 0 -0.010000 -275283**
NOTES	Should not be altered in the field.

7.27 CHANNEL GAIN CORRECTION VARIABLES (LIST G)

7.27.1 LIST GAIN

TYPE	Get
DESCRIPTION	Lists the thermocouple gain correction assigned to the channel listed.
SYNTAX	**LIST G**
RETURNS	All of the group G variables.
EXAMPLE	**LIST G** *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*

7.27.2 GAIN

COMMAND	GAIN
TYPE	Set
DESCRIPTION	This variable sets a gain correction value for the channel. Gain and Offset terms, per channel, use the formula: Adjusted Counts = (GAIN * ADC counts) + OFFSET.
SYNTAX	**SET GAIN** <channel> <value> Where <channel> is any valid channel 0 to 64 (depending on the models channel count) Where <value> is any number (float)
DEFAULT	**0 1.0000**
EXAMPLE	**SET GAIN 1 1.0001**

7.28 Channel Gain Correction Variables (LIST G)

7.28.1 List Offset

TYPE	Get
DESCRIPTION	Lists the thermocouple offset correction assigned to the channel listed.
SYNTAX	**LIST O**
RETURNS	All of the group O variables.
EXAMPLE	**LIST O** *SET OFFSET 1 120* *SET OFFSET 2 77* *SET OFFSET 3 78* *: : : :* *: : : :* *: : : :* *: : : :* *SET OFFSET 14 124* *SET OFFSET 15 81* *SET OFFSET 16 25*

7.28.2 Offset

COMMAND	GAIN
TYPE	Set
DESCRIPTION	This variable sets a offset correction value for the channel. Gain and Offset terms, per channel, use the formula: Adjusted Counts = (GAIN * ADC counts) + OFFSET.
SYNTAX	**SET OFFSET** <channel> <value> Where <channel> is any valid channel 0 to 64 (depending on the models channel count) Where <value> is any number (integer)
DEFAULT	**0 0**
EXAMPLE	**SET OFFSET 1 1234**

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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.

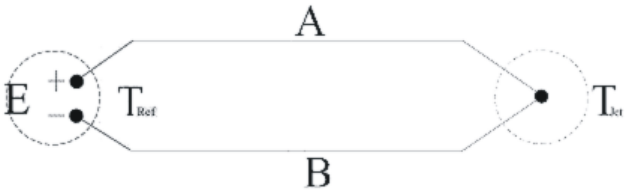
Three laws have been established that govern thermoelectric circuits.

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.

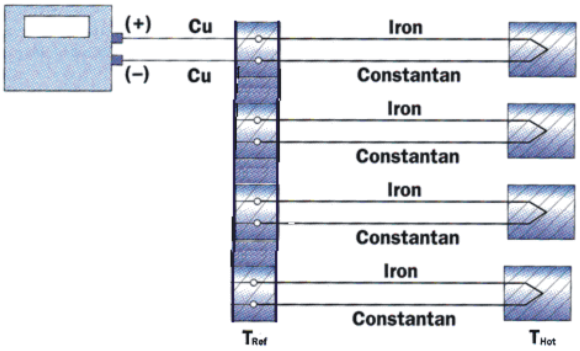
Law of Intermediate Materials:
The algebraic sum of the thermoelectromotive forces in a circuit composed of any number of dissimilar materials is zero if all of the circuit is at a uniform temperature. This law states that a third homogeneous material can be added to a circuit with no effect on the net 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 E1 when the junctions are at temperature T1 and T2 , and a thermal EMF of E2 when the junctions are at T2 and T3, the EMF generated when the junctions are at T1 and T3 will be E1 + E2. 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 homogenous 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 ±2°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 ±0.6°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 ±1°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 1800°C
Usable range	400 to 1704°C
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	France
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 NAS 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)
Version 1.13 - Resolved an issue due to the rounding of the PERIOD variable which caused PTP errors. Resolved premature data output when SST was set to a future time. Resolved a bug for 64 channel units that caused the DTS to run at half speed when scanning at the maximum rate. (11/8/2017)
Version 1.14- Resolved a sign extension error that affected ADCALs. Added clock ID support for PTP grandmasters. Added SETTIME command. Resolved multiple PTP bugs. (4/5/2018)
Version 1.15 - Changed PTPEN to only set time if a change occurred in SET PTPEN. (8/10/18)
Version 1.16 - Adjusted range checking when using SET RATE. (8/28/19)
Version 1.17 - Fix an issued when setting a negative value in UTCOFFSET. (12/20/19)
Version 1.18 - Modified the EU conversion and poly-fit when using a multi-temperature coefficient plane. (6/23/20)
Version 1.19 - Fixed an issue with HOST commands that was created in version 1.18. Changed internal timing methods when frame triggering. (11/10/20)
Version 1.20 - Added UDP Telnet server option. Changed the behavior of the PORT variable. Corrected a reset issue with FPGA. (5/14/21)
Version 2.00 - Support new FPGA chip. This version requires new firmware (.HEX) and FPGA file (.BIT) and is not backward compatible with older firmware versions. It is compatible with all DTS4050 hardware. (4/15/2022)
Version 2.01 - Support for new and old ADC boards. Added RPC argument for RTD2 value. Updated BIT and added a new BIN file for ADC board support (HEX, BIT, and BIN files all required for proper operation). (10/19/2023)
Version 2.02 - Resolve conflict between PTP and FPGA programming. Support update from old firmware to current in regards to RPC values. (5/17/2024)
Version 2.03 - Fixed issue with extra characters being output after a STATUS command in some modes. Fixed an issue where data is sent to the UDP ID server inadvertently. Resolved issue with RTD reading on the first frame. Support PTP Domain setting. (4/18/2025)
Version 2.04 - Resolved initial errant RTD reading when AVG == 1. Added TRIG variable under LIST S. Added TRIG 3 capabilities. Increased scan rate to 200Hz for all configurations. (3/2/2026)

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