



8 Bit PXIbus and PCIbus Digital Storage Oscilloscope

Models ZT450PXI and ZT450PCI

User's Manual: 0004-000033
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Contact

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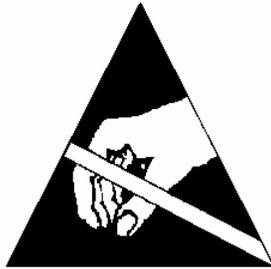
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Handling Precautions for Electronic Devices Subject to Damage by Static Electricity

This instrument is susceptible to Electronic Static Discharge (ESD) damage. When transporting, place the instrument or module in conductive (anti-static) envelopes or carriers. Open only at an ESD-approved work surface. An ESD safe work surface is defined as follows:

- The work surface must be conductive and reliably connected to an earth ground with a safety resistance of approximately 250 kilo Ohms.
- The surface must NOT be metal. A resistance of 30–300 kilo Ohms per square inch is suggested.

Ground the frame of any line-powered equipment, chassis, test instruments, lamps, soldering irons, etc., directly to the earth ground. To avoid shorting out the safety resistance, ensure that the grounded equipment has rubber feet or other means of insulation from the work surface.

Avoid placing tools or electrical parts on insulators. Do NOT use any hand tool that can generate a static charge, such as a non-conductive plunger-type solder sucker. Use a conductive strap or cable with a wrist cuff to reliably ground to the work surface. The cuff must make electrical contact directly with the skin; do NOT wear it over clothing.

Note: Resistance between the skin and the work surface is typically 250 kilo Ohms to 1 mega Ohm using a commercially-available personnel grounding device.

Avoid circumstances that are likely to produce static charges, such as wearing clothes of synthetic material, sitting on a plastic-covered stool (especially when wearing woolen material), combing the hair, or making extensive pencil erasures. These circumstances are most significant when the air is dry.

When testing static sensitive devices, ensure DC power is ON before, during, and after application of test signals. Ensure all pertinent voltages are switched OFF while circuit boards or components are removed or inserted.

Revision History

Rev	Date	Section	Description
1	03-22-05	All	Initial Release
2	05-25-05	Chapter 1 Chapter 2 Chapter 3 Appendix 1	Added notes about PCI connector truth. Added setup of external sample clock. Fixed the external clock source parameter value. Clarified system memory query description. Fixed Pattern Bit description. Added Maximum Voltage de-rating specification. Added Offset Drift specification. Updated Channel Skew specification. Updated External Sample Clock specifications. Added Measurement Accuracy specifications.
2A	07-21-05	TOC Chapter 1 Chapter 2 Chapter 3	Added subsections to Table of Contents. Added product options and part number description. Updated description of PCI Timing Expansion Connector. Updated probe part number. Added product options and descriptions. Added Time Base Reference subsection and description. Updated Invalid Measurements description and figure. Added precision RMS measurements. Updated trigger output sources and description. Updated maximum number of save/recall states. Added PCI Timing Expansion Connector references. Updated description and added restore to Calibrate section. Updated Clock Frequency limits for options. Added Calibrate Restore Factory Defaults command. Removed Calibrate command (query-only). Added External Trigger Output source parameters. Updated Identification Query response string. Updated Input Voltage Range and Offset limits for options. Added high-precision RMS measurement queries. Added high-precision RMS to limit test parameters. Updated Measure Phase parameter. Updated Trigger Pulse Width parameter minimum values. Updated maximum number of save/recall states. Updated Trace Load and Trace Preamble parameters. Added PCI Timing Expansion Connector references.

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Introduction



Description

The Model ZT450PXI (See Figure 1) and Model ZT450PCI (See Figure 2) are 8-bit Digital Storage Oscilloscopes. Each is built around a high speed, deep memory digitizer and embedded TMS320VC5409 Digital Signal Processor (DSP). The ZT450PXI is a single-wide PXIbus module (3U); the ZT450PCI is a single-slot PCIbus card (short). Together with the host processor and software, each provides a simple and powerful way to capture and analyze wide bandwidth analog, IF, and low frequency RF signals.

Initiated by trigger events from both internal and external sources, the ZT450PXI and ZT450PCI digitize signals in user-selectable record sizes. Analog signal processing allows selectable one or two channel operation, AC or DC coupling, input signal range and offset, and bandwidth limiting. Waveform records are transferred from the digitizer into DSP memory, which can then be accessed from the PXIbus or PCIbus. Built-in DSP functions provide a variety of signal analysis and signal manipulation resources. All scope operations are controlled from an intuitive, software-based user interface running on the PXIbus or PCIbus host processor.

Product Options and Part Numbers

Part Number	Maximum Sample Rate	Bandwidth	Memory	Manual Naming
ZT450PXI-00	2 GS/s	500 MHz	2 MSample	ZT450-0X
ZT450PXI-01	2 GS/s	500 MHz	32 MSample	ZT450-0X
ZT450PXI-20	1 GS/s	500 MHz	2 MSample	ZT450-2X
ZT450PXI-21	1 GS/s	500 MHz	32 MSample	ZT450-2X
ZT450PXI-50	2.5 GS/s	750 MHz	2 MSample	ZT450-5X
ZT450PXI-51	2.5 GS/s	750 MHz	32 MSample	ZT450-5X

Table 1: ZT450PXI and ZT450PCI Product Options

Table 1 shows the product options for the ZT450PXI and ZT450PCI that define maximum sample rate, bandwidth and memory size. Note that the PCI products are not shown within Table 1, but simply replace PXI with PCI within the part number. The first digit of the option field defines the sample rate between 1 and 2.5 billion samples-per-second (GS/s) and the analog bandwidth of either 500 MHz or 750 MHz. The second digit of the option field selects the memory size of either 2 or 32 MSamples. Within this manual, the entire ZT450PXI and ZT450PCI product line shall hereafter be designated as ZT450. When referring to specific product options, this manual shall use the naming convention shown in the rightmost column of Table 1.

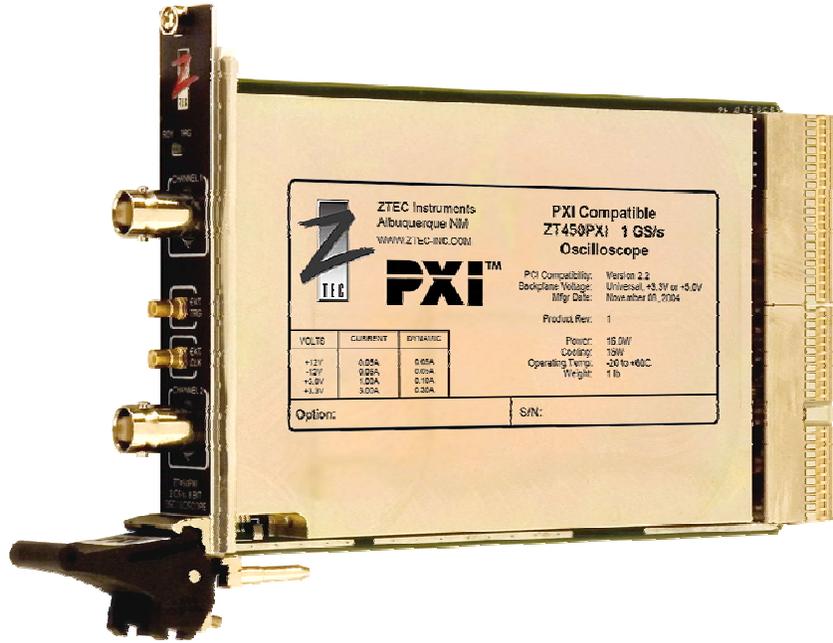


Figure 1: Photo of the ZT450PXI

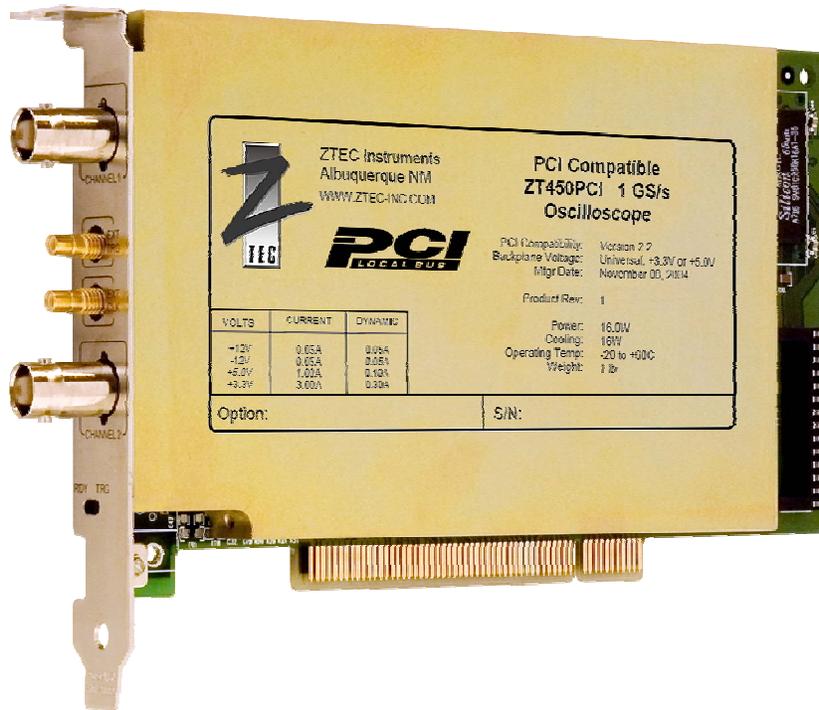


Figure 2: Photo of the ZT450PCI

cPCI/PXI Interoperability for the ZT450PXI

The ZT450PXI module is compliant with the Peripheral Component Interconnect (PCI) Version 2.2 standard. This PCI Bus system features 33 MHz speed, 32-bit addressing, and 16-bit data. The ZT450PXI supports universal voltage requirements of +3.3 volts and +5 volts.

The ZT450PXI may be used in both CompactPCI (cPCI) and PCI eXtensions for Instrumentation (PXI) applications. The PXI standard is a derivative of cPCI and maintains a high level of interoperability; as a result, PXI cards may safely be used in cPCI mainframes for most applications. Compatibility issues arise because the PXI standard reserves several normally undedicated pins on the cPCI P2 connector for a selection of trigger, clock, and inter-card communication functions. Before installing the ZT450PXI into a cPCI mainframe that uses the P2 connector, the user must ensure that pin use conflicts will not occur.

PCI Interoperability for the ZT450PCI

The ZT450PCI module is compliant with the Peripheral Component Interconnect (PCI) Version 2.2 standard. This PCI Bus system features 33 MHz speed, 32-bit addressing, and 16-bit data. The Universal PCI connector is compatible with universal +3.3V and +5V connections.

PCI Timing Expansion Connector

The PCI Timing Expansion Connector enables the synchronization of the trigger, arm and clock timebase for multiple PCI modules from ZTEC Instruments. When using this configuration, one board acts as a timing and arm source; all of the other boards are receivers. The Trigger0-7 inputs for the PCI module mating connector are active low, with internal pull-up resistors. The outputs are open-collector, and consequently can be driven by any module. In most cases, the one source will drive all others in the system, but a wired-or configuration can also be used.

When installing multiple PCI modules, use the ribbon cable (FFSD-10-D-6.00-01-N-D4) to connect to the PCI Timing Expansion Connectors on the top of the modules (See Figure 3). The ribbon cable can be matched in length to achieve a zero clock skew between modules. Table 2 shows the pin out for the mating connectors to the PCI Timing Expansion Connector.

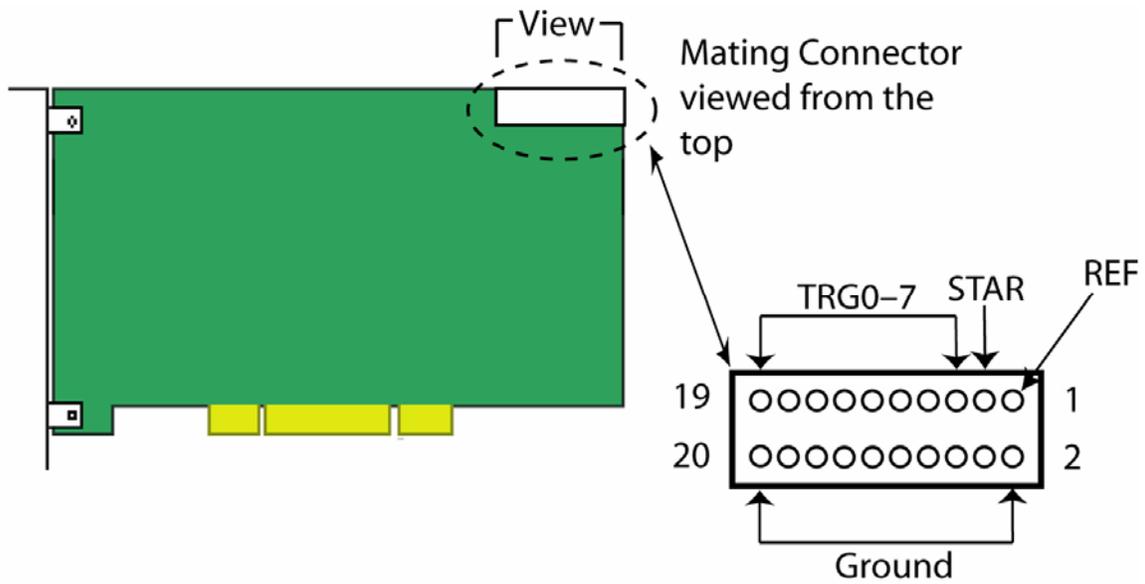


Figure 3: ZT450PCI Timing Expansion Connector

Pin	Function	Pin	Function
1	REF	2	GND
3	STAR	4	GND
5	TRG7	6	GND
7	TRG6	8	GND
9	TRG5	10	GND
11	TRG4	12	GND
13	TRG3	14	GND
15	TRG2	16	GND
17	TRG1	18	GND
19	TRG0	20	GND

Table 2: ZT450PCI Timing Expansion Connector Pin Out

Front Panel

A photo of the ZT450PXI front panel is shown in Figure 4 and a photo of the ZT450PCI front panel is shown in Figure 5. On the front panel, there are two SMB coaxial connectors and two BNC connectors. Table 3 lists the front panel connector functions.

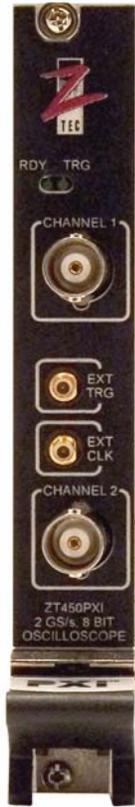


Figure 4: Photo of the ZT450PXI Front Panel



Figure 5: Photo of the ZT450PCI Front Panel

Label	Description
Channel 1	Channel 1 input signal (BNC Connector)
EXT TRG	External Trigger Input (SMB Connector)
EXT CLK	External Clock Input (SMB Connector)
Channel 2	Channel 2 Input Signal (BNC Connector)

Table 3: Front Panel Connectors

Accessory Kits

ZTEC Instruments, Inc. offers the following kit solutions for the ZT450:

ZTPXIKIT-00

This kit consists of four each of the following cables:

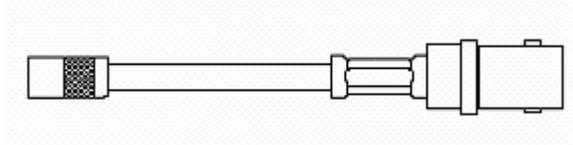


Figure 6: Three-Inch Cable, SMB to Female BNC

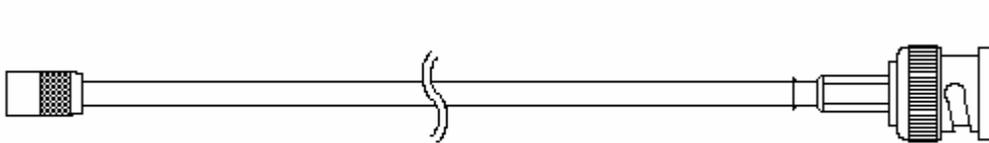


Figure 7: One-Meter Cable, SMB to Male BNC

Optional Cooling Fan Assembly Kit for ZT450PCI

This kit ships unassembled with each ZT450PCI. If a user determines that additional PCI cooling is required within a PC chassis, this optional cooling fan assembly kit can be installed using the included instructions. The cooling fan will draw an additional 120 mA of +5VDC power from the PCI bus connector. The kit consists of the following:

Quantity	ZTEC Part Number	Description
1	0103-000027	Cooling Fan Assembly
1	0103-000026	PCI Cooling Fan Bracket
4	403-256-14-0121	Screw, 2-56 x 1/4, Phillips

Table 4: ZT450PCI Cooling Fan Assembly Kit

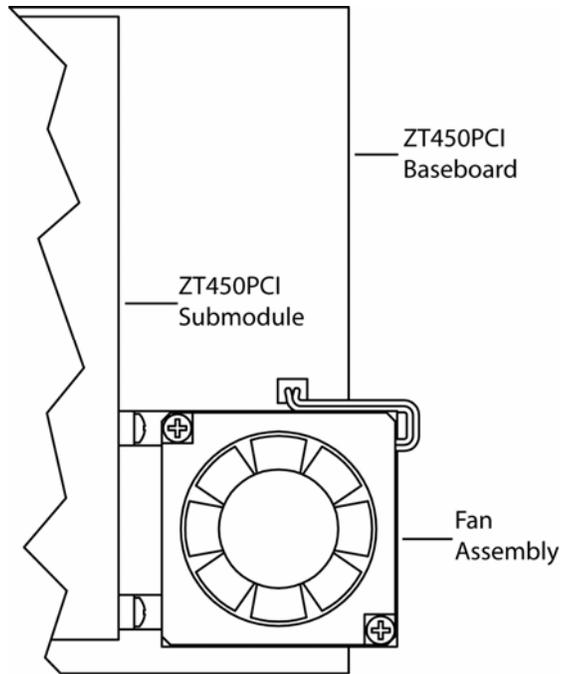


Figure 8: PCI Optional Cooling Fan Assembly

Probe

ZTEC Instruments, Inc. offers the following probe solution for the ZT450.

ZT500PRB-00



Figure 9: ZT500PRB-00 500 MHz Oscilloscope Probe Kit

Attenuation	Length in Feet	Bandwidth (MHz)	Voltage	Loading	
				pF	MOhm
10X	3.5	500	600	8	10

Functionality and Operation



Functional Block Diagram

The functional blocks of the ZT450 are shown in Figure 10. Analog inputs are conditioned and digitized by the Input Channels. The acquisition time base record size and record placement with regard to the trigger event are configured by the Sweep Controls. Triggers are conditioned and selected by the Trigger and Arm Controls. Averager controls enable the instrument to capture the applied signal multiple times to create the resulting waveform record. Once captured, waveforms are manipulated and analyzed by the Calculate Controls. Waveform measurements, returning data from the ZT450, are handled by the Measure Controls. Status reporting and system utilities are handled by Utilities and Status Reporting. And finally, the data is stored for use and retrieval, and referenced by Waveform and Reference.

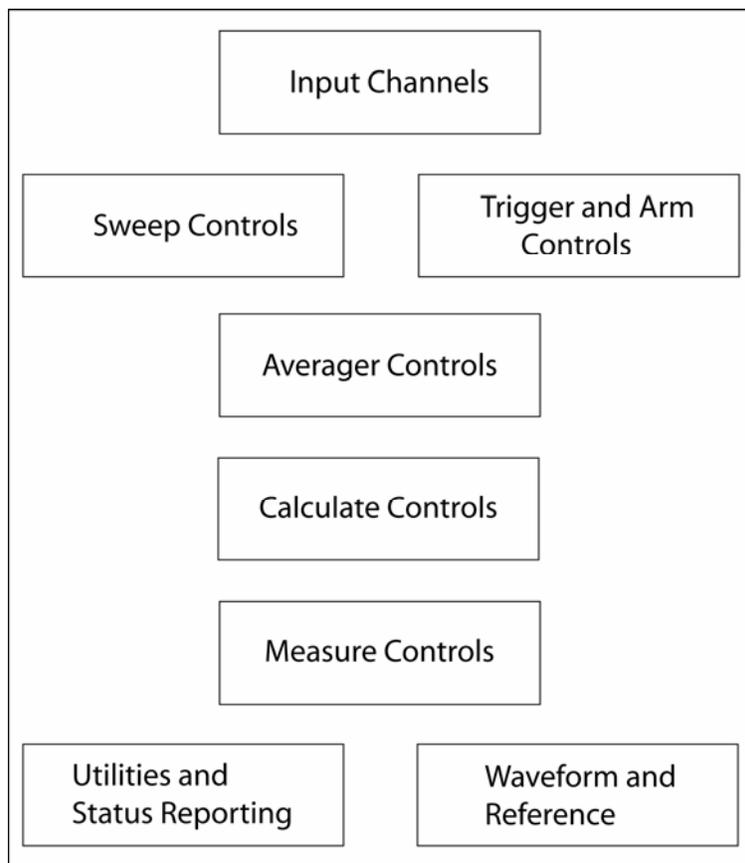


Figure 10: ZT450 Block Diagram

Data Flow

The data flow of the ZT450 is shown in Figure 11. Raw data is input through the two input channels (See *Input Channels* below). Next, the data flows to the Averager, which enables the instrument to acquire multiple waveforms to create the resulting waveform record. The ZT450 has four types of available acquisition: normal, average, envelope, and equivalent-time (See *Averager Controls*). New waveforms can now be mathematically created in the ZT450. The unit has two calculate channels, each capable of a 32K maximum waveform size (See *Calculate Controls*). Scalar measurements are possible using the *Measure Controls*. The ZT450 is capable of providing measurements using the following methods: Entire Waveform, Gated by Time, and Gated by Points. The ZT450 can save and download up to 4 reference waveforms. The reference waveforms, REF1–4, are stored in non-volatile Flash memory and are maintained when the unit is powered off. These waveforms are limited to record sizes of 32 kSamples.

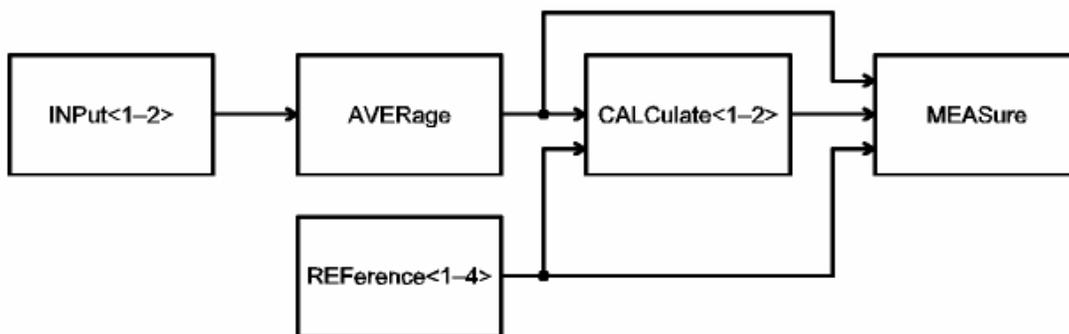


Figure 11: Data Flow

Input Channels

Product Option	1 Channel Maximum Sample Rate	2 Channel Maximum Sample Rate	Bandwidth
ZT450-2X	1 GS/s	500 MS/s	500 MHz
ZT450-0X	2 GS/s	1 GS/s	500 MHz
ZT450-5X	2.5 GS/s	1.25 GS/s	750 MHz

Table 5: Sample Rates and Bandwidths of Product Options

Input Channel Enable

The ZT450 allows capture of two input signals at rates from 2.5 kS/s up to one-half the maximum sample rate. One interleaved channel can be sampled at the maximum sample rate. The maximum sample rate is 1 GS/s for the ZT450-2X, 2 GS/s for the ZT450-0X, and 2.5 GS/s for the ZT450-5X.

Input Signal Conditioning

The ZT450 provides signal conditioning to optimize input signal integrity. The analog bandwidth is DC to the maximum bandwidth. The maximum bandwidth is 500 MHz for the ZT450-2X and ZT450-0X, and 750 MHz for the ZT450-5X. User-configurable analog signal conditioning allows selection of input coupling, impedance, range, offset, and filtering.

Input Coupling

Input coupling can be selected as AC or DC (see the *Input Coupling Command*). Selecting AC causes a high pass filter to be inserted before the input amplifiers to limit the input signal frequency: 200 KHz for low impedance (50 Ω) and 10 Hz for high impedance (1 M Ω). Selecting DC bypasses the AC coupling filter.

Input Impedance

Input impedance can be selected as 50 Ω or as 1 M Ω (see the *Input Impedance Command*). Input load protection automatically switches from 50 Ω to 1 M Ω if voltages exceeding ± 6 VDC are detected.



CAUTION

Do not apply signals having a peak value over ± 210 VDC when using the high impedance (1M Ω) setting as unit damage may result.

Do not apply signals having a peak value over ± 5 VDC when using the low impedance (50 Ω) setting as unit damage may result.

Input Range

A variable gain input amplifier allows selection of voltage ranges up to 10 Volts peak-to-peak (Vpp) for the 50 Ω setting and up to 100 Vpp for the 1 M Ω setting (see the *Input Voltage Range Command*).

Note: The input voltage range and input impedance are interrelated. When changing the input impedance, always resend the input voltage range setting.

Input Offset

The *Input Voltage Offset Command* is used to set the specified input channel voltage offset. The offset range is shown in the following table:

Impedance	ZT450-0X or ZT450-2X		ZT450-5X	
	Range	Offset	Range	Offset
1 M Ω	100 Vpp	$\pm 100V$	100 Vpp	$\pm 50V$
	50 Vpp	$\pm 100V$	50 Vpp	$\pm 25V$
	20 Vpp	$\pm 100V$	20 Vpp	$\pm 10V$
	10 Vpp	$\pm 100V$	10 Vpp	$\pm 5V$
	5 Vpp	$\pm 5V$	5 Vpp	$\pm 2.5V$
	2.5 Vpp	$\pm 5V$	2.5 Vpp	$\pm 1.25V$
	1 Vpp	$\pm 5V$	1 Vpp	$\pm 0.5V$
	0.5 Vpp	$\pm 5V$	0.5 Vpp	$\pm 0.25V$
			0.2 Vpp	$\pm 0.1V$
			0.1 Vpp	$\pm 0.05V$
50 Ω	10 Vpp	$\pm 10V$	10 Vpp	$\pm 5V$
	5 Vpp	$\pm 10V$	5 Vpp	$\pm 2.5V$
	2 Vpp	$\pm 10V$	2 Vpp	$\pm 1V$
	1 Vpp	$\pm 10V$	1 Vpp	$\pm 0.5V$
	0.5 Vpp	$\pm 0.5V$	0.5 Vpp	$\pm 0.25V$
	0.25 Vpp	$\pm 0.5V$	0.25 Vpp	$\pm 0.125V$
	0.1 Vpp	$\pm 0.5V$	0.1 Vpp	$\pm 0.05V$
	0.05 Vpp	$\pm 0.5V$	0.05 Vpp	$\pm 0.025V$

Table 6: Input Voltage Range and Offset

Note: When setting the input voltage offset and range, an incompatible range and offset combination may occur if the commands are sent in the wrong order. In order to preclude setting an incompatible offset, set the offset to 0.0V before changing the range to the new setting.

Input Filtering

The *Input Filter State Command* applies a 20 MHz low pass analog filter to the input signals.

Sweep Controls

The ZT450 provides a set of user-selectable sweep controls that enable the user to adjust the sample rate, timing, record size, and trigger position of the waveform capture process.

Record Size and Sampling Rate

Acquisition record size is specified in sample points. Valid sizes range from 100 points to the full digitizer memory size. Acquisition sample rates can be selected over a range from 2.5 kHz to the maximum sample rate. The available rate selections are based on the traditional 1, 2.5, or 5 steps. Two input signals can be sampled simultaneously at rates from 2.5 kS/s up to one-half the maximum sample rate. One interleaved channel can be sampled at the maximum sample rate. The maximum sample rate is 1 GS/s for the ZT450-2X, 2 GS/s for the ZT450-0X, and 2.5 GS/s for the ZT450-5X. The time duration of the sample record can be calculated by dividing the number of points by the sample rate or by multiplying the number of points by the sample interval.

Time Base Reference Clock

The ZT450 supports flexible time base reference configurations. The 10 MHz time base reference is used to synchronize all internal timing including the sampling clock for the digitizer. The source of the time base reference is selectable between an internal temperature-compensated crystal oscillator (TCXO) and the PXIbus backplane CLK10 or the PCI Timing Expansion Connector reference signal. The time base frequency must be 10 MHz \pm 100 ppm. The internal TCXO reference provides \pm 2.5 ppm frequency accuracy. The reference oscillator source is selected using the *Reference Oscillator Source Command*.

Internal and External Sampling Clock

The ZT450 supports flexible ADC sampling clock configurations. An internal sampling clock is generated by a phase-locked loop that is locked to the 10 MHz time base reference. The external sampling clock may be used to replace the onboard sampling clock for external synchronization or to achieve a sampling rate that cannot be specified by using the onboard clock. The front panel sampling clock input has a clock rate range of 200 MHz to 1 GHz, a maximum input of \pm 5 V (no damage), and an input signal level of 500 mVpp to 1 Vpp (sine or square wave). The input is AC coupled into 50 Ω , with an impedance accuracy of \pm 2%.

When using an external sample clock, the external source must be present before sending the *Clock Source Command*. The external clock frequency must be entered using the *Clock Frequency Command* to properly setup the acquisition timing parameters. If the external clock frequency changes, the new frequency must be entered after the external clock has settled at the new frequency.

Record Length and Sweep

The record length and corresponding record sweep time are controlled using the *Sweep Points Command/Query* and the *Sweep Time Query*. Record lengths can be up to 16 MSamples per channel, or up to 32 MSamples/channel (using 1 channel interleaved). Memory options for the ZT450 are 2 MSamples and 32 MSamples total.

The ZT450 provides two sweep modes: automatic and normal. Automatic mode enables automatic triggering in absence of a trigger event. This mode will wait the sweep time plus 40 ms before it auto triggers. Normal mode will wait indefinitely for a trigger event before capturing data. Sweep mode is configured using the *Sweep Mode Command*.

Sweep Reference Scenarios

The ZT450 provides a flexible trigger to record timing adjustment that enables pre-trigger, post-trigger, or delayed trigger. The following figure depicts five sweep reference scenarios.

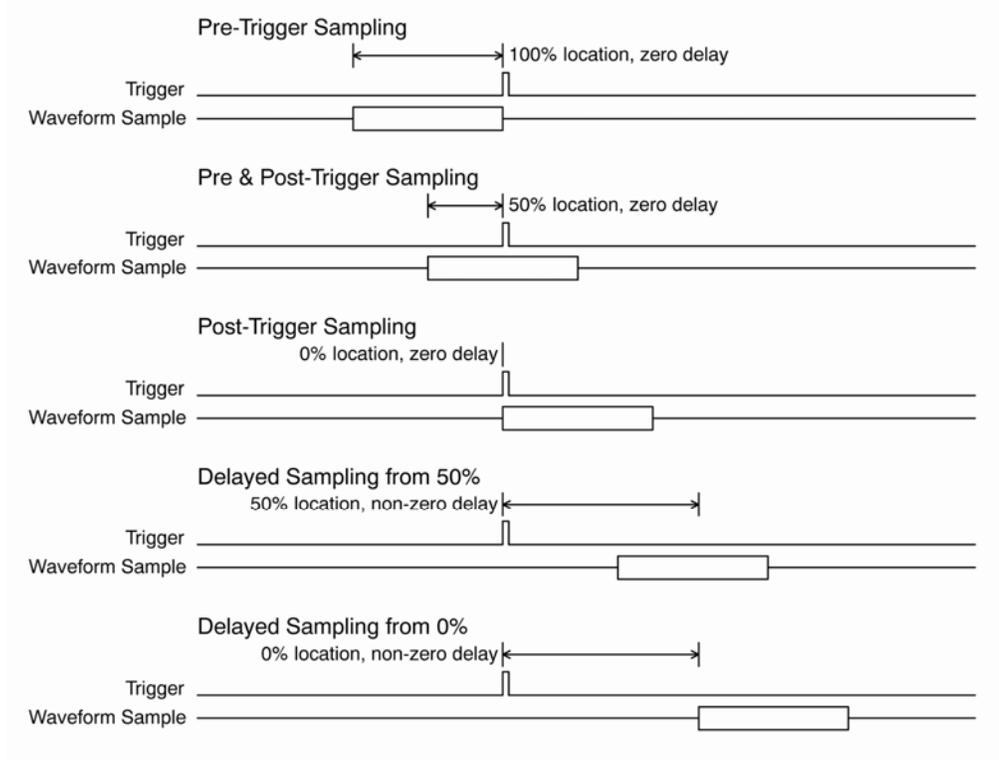


Figure 12: ZT450 Sweep Reference Scenarios

The trigger location within the waveform can be programmed between 0.0 (0%, start of waveform) and 1.0 (100%, end of waveform) using the *Sweep Offset Reference Command*. A timing delay between this reference location and the trigger event is also programmable using the *Sweep Offset Time Command*. This timing delay adjusts the trigger to reference position in the positive time direction. Positive values move the end-of-capture further from the trigger event and consequently move the offset reference to the left. This allows the waveform capture to be delayed long after the trigger event.

The maximum cumulative delay between the trigger event and the end of the waveform record is 655 seconds. The cumulative delay is defined as:

$$\text{Cumulative delay} = (1 - \text{Sweep Offset Location} * \text{Sweep Time}) + \text{Sweep Offset Time}$$

Note: A trigger delay of 0.0 seconds causes the trigger position to be set by the offset reference location only, forcing the trigger to lie within the waveform.

Averager Controls

The ZT450 Averager controls enable the instrument to acquire multiple waveforms to create the resulting waveform record.

Averager Considerations

The following are considerations of using the averager controls:

- When averaging is enabled on the ZT450, only the final output waveform is retained; the raw, un-averaged data is not available.
- When the average is disabled, (NORMAL acquisition mode), waveforms are passed through without modification.
- The number of waveforms averaged and the average operation mode can be selected (See the *Average Count Command* and *Average Type Command* respectively).
- When averaging is enabled, it affects all active input channels.

Acquisition Types

There are four types of acquisition that can take place on the ZT450: Normal, Average, Envelope, and Equivalent-Time.

- In Normal mode, a single waveform is captured.
- In Average mode, waveform points from consecutive acquisitions are averaged together to produce the final displayed waveform.
- In Envelope mode, the minimum and maximum waveform points from multiple acquisitions are combined to form a waveform (an envelope) that shows minimum and maximum changes over time.
- In Equivalent-Time mode, a picture of a repetitive waveform is constructed by capturing a little bit of information from each repetition. This enables waveforms to be reconstructed at equivalent-time sample rates greater than the real-time sample rate (See Figure 13). Because the points appear randomly along the waveform, it is important to note that an entire waveform may not be constructed unless there are sufficient repetitions. Also, the number of points per point (selectable from 2 to 100) can be set to increase the resolution of the waveform. (See the *Average Equivalent Time Points Command*).

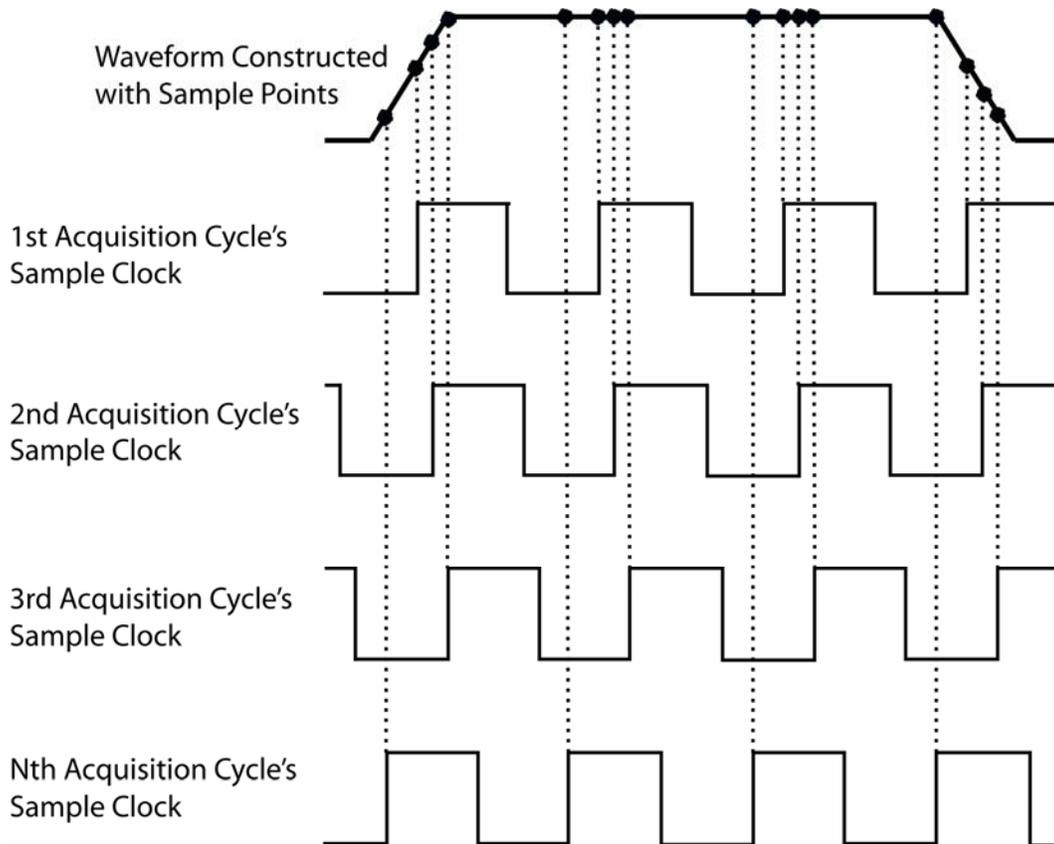


Figure 13: Equivalent Time Acquisition

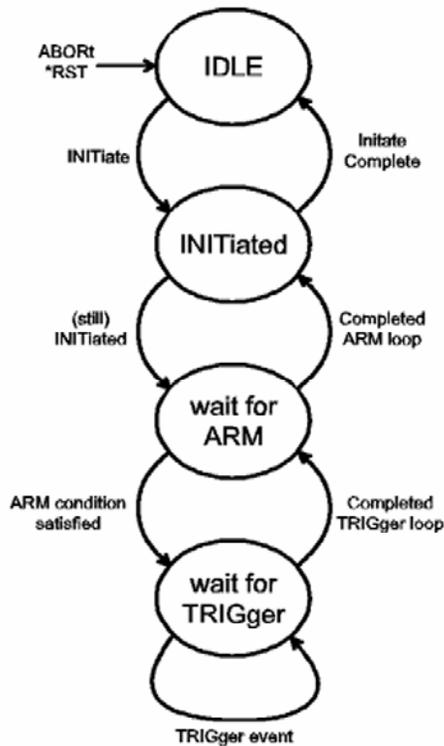
Trigger and Arm Controls

The trigger and arm controls stabilize repeating waveforms and allow capture of single-shot waveforms.

Trigger Initiate Model

The ZT450 uses an arm-trigger model to control data acquisition. All acquisition cycles are started using the *Initiate Command*. Upon receiving an “initiate”, the ZT450 will sequence into the “wait for arm” state. When the arm source goes active or if the arm source is set to immediate, the ZT450 will sequence into the “wait for trigger” state. When a trigger event is detected, the ZT450 will capture a waveform. The trigger loop will cycle for a selected number of times, saving the waveform associated with each pass. When the requested number of trigger loops has completed, the ZT450 will sequence back to the idle state. An *Abort Command* or *Reset Command* will immediately stop the capture sequence and return the instrument to the idle state from any other state.

The following figure shows a diagram of the trigger initiate model based on trigger mode. It shows the arm source, trigger source, and Initiate.



Non-Triggered Mode:
 ARM:SOURce IMMEDIATE
 TRIGger:SOURce IMMEDIATE
 INITiate starts capture

Triggered Mode:
 ARM:SOURce IMMEDIATE
 TRIGger:SOURce <trigger source>
 INITiate enables capture
 trigger event starts capture

Qualified-Triggered Mode:
 ARM:SOURce <arm source>
 TRIGger:SOURce <trigger source>
 INITiate enables capture
 arm qualifies trigger event
 trigger event starts capture

Figure 14: Trigger Initiate Model

Trigger Processing

The ZT450 accepts triggers from the following sources:

- Channels 1 and 2 (BNC)
- External Trigger (SMB)
- Star Trigger (PXI Backplane or PCI Timing Expansion Connector)
- TTL Trigger 0–7 (PXI Backplane or PCI Timing Expansion Connector)
- Pattern
- Software

Figure 15 shows a diagram of the ZT450 trigger processing.

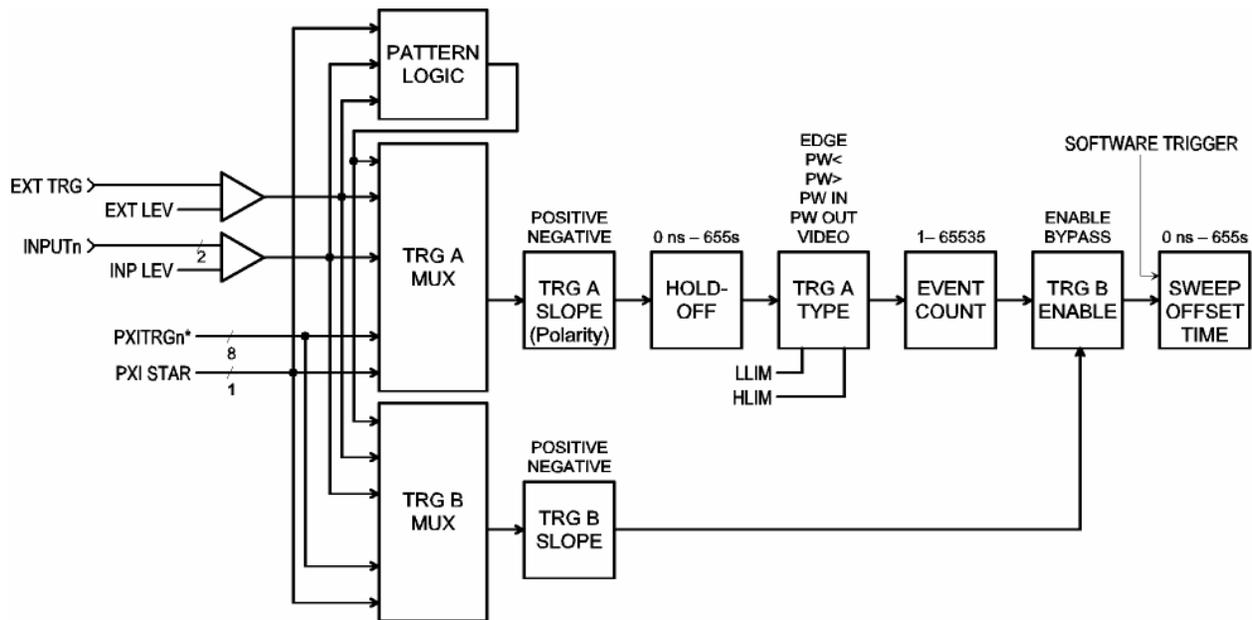


Figure 15: Trigger Processing

Trigger Types

Several types of triggers are used with the ZT450, including software, edge, pulse width, pattern, video, and event. Each type of trigger uses a different configure trigger function.

Software Trigger

Software triggers occur when a software command is used to force a trigger event to continue acquisition irregardless of the selected trigger source, type, or polarity. If manual (software) trigger source is selected, the software trigger must be used to cause a trigger event. An *Operation Complete Query* can not be used in conjunction with software triggering.

Edge Trigger

An edge trigger occurs when a signal crosses a specified trigger threshold. Specify the slope as either positive (on the rising edge) or negative (on the falling edge) to the trigger. Edge triggering is possible on all trigger sources.

Pulse Width Trigger

A pulse width trigger occurs when a signal triggers on a pulse width greater than a set limit, less than a set limit, between two set limits, or outside of two set limits. The pulse width range is 20 ns to 655 seconds with a resolution of 10 ns. Pulse width triggering is possible on all trigger sources.

Pattern Trigger

A pattern trigger occurs when a set pattern is matched true or false. Sources for the pattern are Channels 1 to 2, the External Trigger, and the Star Trigger (PXI Backplane or PCI Timing Expansion Connector). The three states for a pattern match are HIGH, LOW, or DO NOT CARE. Trigger polarity affects pattern match (positive polarity) or pattern not match (negative polarity). For example, a pattern trigger could be set up to trigger only when Channel 1 is LOW, Channel 2 is HIGH, Star is LOW, and the External Trigger is HIGH.

Video Trigger

A video trigger occurs when the ZT450 finds valid video signal synchronization. The ZT450 includes a mode for triggering on NTSC (60 Hz), PAL (50 Hz), and SECAM (50 Hz) format video signals, as well as triggering on a specific video line number and a specific video field.

Event Trigger

An event trigger enables the counting of multiple trigger events before completion of each acquisition cycle. The ZT450 allows a range of 1 to 65535 trigger events. Each trigger event is qualified by the selected source, type, polarity, or slope.

Trigger B

Trigger B enables edge triggering on a second trigger source after all Trigger A conditions are satisfied. Trigger A detection must complete before the Trigger B detector or sweep offset timer are enabled.

Arm

Each trigger must be qualified by an associated arm state condition. The arm polarity can be either positive or negative. The arm is sourced from the following:

- External Trigger (SMB)
- Star Trigger (PXI Backplane or PCI Timing Expansion Connector)
- TTL Trigger 0–7 (PXI Backplane or PCI Timing Expansion Connector)
- Software

Trigger Timestamp

The trigger timestamp captures the time of the trigger event. This timestamp has a one-second period with a 100 ns resolution. With timestamps, it is possible to correlate multiple records or even multiple acquisitions. For example, a timestamp can be used to determine the amount of time between acquisitions.

Outputs

The ZT450 can drive signal outputs on any combination of the front panel External Trigger and the eight TTL trigger outputs (PXI backplane or PCI Timing Expansion Connector). Each output can be independently configured with unique source and enable controls.

The front panel External Trigger output can be selected from the following sources:

- Trigger event
- Arm event
- OPC event that occurs when all ZT450 operations are complete using the *Operation Complete Command*.
- Constant level
- 10 MHz timebase reference clock
- 500 Hz clock
- 10 ns pulse at 1 ms repetition interval

The eight TTL trigger outputs can be selected from the following sources:

- Trigger event
- Arm event
- OPC event that occurs when all ZT450 operations are complete using the *Operation Complete Command*.
- Constant level

Calculate Controls

The ZT450 can create new waveforms mathematically. The unit has two calculate channels, each capable of a 32K maximum waveform size. Sources include the following:

- 2 Input Channels
- 4 Reference Channels
- 2 Calculation Channels

Calculations are processed in channel order (i.e. Calculation Channel 1 can act on Calculation Channel 1, Calculation Channel 2 can act on Calculation Channel 2, or Calculation Channel 2 can act upon Calculation Channel 1). Examples of calculations include:

- Filter Measurements (Time Domain Transform)
- Two Channel Measurements
- Math Measurements
- FFT Measurements (Frequency Domain Transform)
- Limit and Mask Testing

Calculate Functions

The following are the calculate functions:

Add

Use the *Calculate Add Command* to add the waveforms from the two sources.

Subtract

Use the *Calculate Subtract Command* to subtract the waveform from one channel from the other channel.

Multiply

Use the *Calculate Multiply Command* to multiply the waveforms from two sources.

Copy

Use the *Calculate Copy Command* to copy the waveform from a source channel to the calculation channel.

Invert

Use the *Calculate Invert Command* to invert the waveform.

Integral

Use the *Calculate Integral Command* to calculate the integral of a source waveform and place the result into its output.

Derivative

Use the *Calculate Derivative Command* to create a waveform that shows the rate of change from any given function. The derivative equation is:

$$y(i) = \frac{x(i) - x(i - 1)}{\Delta t}$$

Absolute Value

Absolute value establishes an absolute value of the calculation source. All negative values are converted to positive (See the *Calculate Absolute Value Command*).

Limit Test

This conducts a limit test on a waveform (See Chapter 3 for all of the limit test commands). Limit testing is the ability to compare an active signal with user-defined vertical and horizontal tolerances (test conditions) applied to measurements. Test conditions are established and an *Initiate Continuous Command* is given to initiate the waveform continuously. If the active waveform exceeds the test conditions, it is a failure and the following actions occur:

- The waveform is stored into memory
- Measurement statistics are recorded including the Minimum, Maximum, Average, Failure Count, Total Count, and Most Recent Measurement Performed.

- The test may be stopped or run continuously.

Note: Do not perform a limit test where the calculation source and destination use the same calculation channel.

Mask Test

This conducts a mask test on a waveform (See Chapter 3 for all of the mask test commands).

A mask test is a type of limit test performed point-by-point on a waveform, determining whether an acquired signal meets a given set of criteria. It consists of an upper boundary (Ref_Max) and lower boundary (Ref_Min) where the captured waveform must not cross. These masks are typically defined by industry standards or user-defined limits, but both references and the waveform must be the same length. The signal is first captured by the unit and then compared to the limit mask to verify whether it falls between the given limits. If any part of the waveform falls outside the mask, the software counts a failure.

Note: Do not perform a mask test where the calculation source and destination use the same calculation channel.

Frequency Transform

This conducts a Fast Fourier Transform (FFT) on a waveform (Use the *Calculate Transform Frequency Command* and the *Calculate Transform Frequency Window Command*).

The Fast Fourier Transform process mathematically converts the standard time-domain signal into its frequency components, providing spectrum analysis capabilities. Being able to quickly look at the signal frequency components and spectrum shape is a powerful research and analysis tool. FFT is an excellent troubleshooting aid for:

- Testing impulse response of filters and systems
- Measuring harmonic content and distortion in systems
- Identifying and locating noise and interference sources
- Analyzing vibration
- Analyzing harmonics in 50 and 60 Hz power lines

FFT results in power spectrum data in units of RMS voltage (V_{RMS}) represented as signed 16-bit values. The sample size is always a power of 2 (2^N). The following table shows the sample range, FFT size, and approximate computation time:

Sample Range	FFT Size	Approximate Computation Time in seconds
100–128	64	0.01s
129–256	128	0.02s
257–512	256	0.03s
513–1024	512	0.06s
1025–2048	1024	0.12s
2049–4096	2048	0.25s
4097–8192	4096	0.53s
8193–16384	8192	1.13s
16385–32768	16384	2.35s

Table 7: FFT Sample Range and Size

Four FFT windows (Rectangular, Hamming, Hanning, and Blackman-Harris) are available to match an analyzed signal. The Rectangular window is best for non-periodic events such as transients, pulses, and one-shot acquisitions. The Hamming, Hanning, and Blackman-Harris windows are better for periodic signals. See the following comparison table:

FFT Window	Characteristics	Used For
Rectangular	Best frequency, worst magnitude resolution. This is essentially the same as no window.	<ul style="list-style-type: none"> • Transients or bursts where the signal levels before and after the event are nearly equal • Equal-amplitude sine waves with frequencies that are very close • Broadband random noise with a relatively slow varying spectrum
Blackman-Harris	Best magnitude, worst at resolving frequencies	<ul style="list-style-type: none"> • Single frequency waveforms to look for higher order harmonics
Hamming	Better frequency, poorer magnitude resolution than Rectangular. Slightly better frequency resolution than Hanning.	<ul style="list-style-type: none"> • Sine, periodic, and narrowband random noise. • Transients or bursts where the signal levels before and after the event are significantly different
Hanning	Better frequency, poorer magnitude resolution than Rectangular.	<ul style="list-style-type: none"> • Sine, periodic, and narrowband random noise. • Transients or bursts where the signal levels before and after the event are significantly different

Table 8: FFT Window Comparison

Time Domain Transform

This conducts a low-pass filter Time Transform on a waveform (Use the *Calculate Transform Time Command*). The number of filter length data points (Range of 2 to 40) used to calculate the Time Transform is set in the second-order Infinite Impulse Response (IIR) filter (Use the *Calculate Transform Time Points Command*). A higher filter length point number causes a lower cutoff frequency for the filter.

Measure Controls

Waveform measurements offer a method for returning data from the ZT450. Instead of time-domain waveforms, the results are scalar measurements. Figure 16 shows an example detailing measurement terminology.

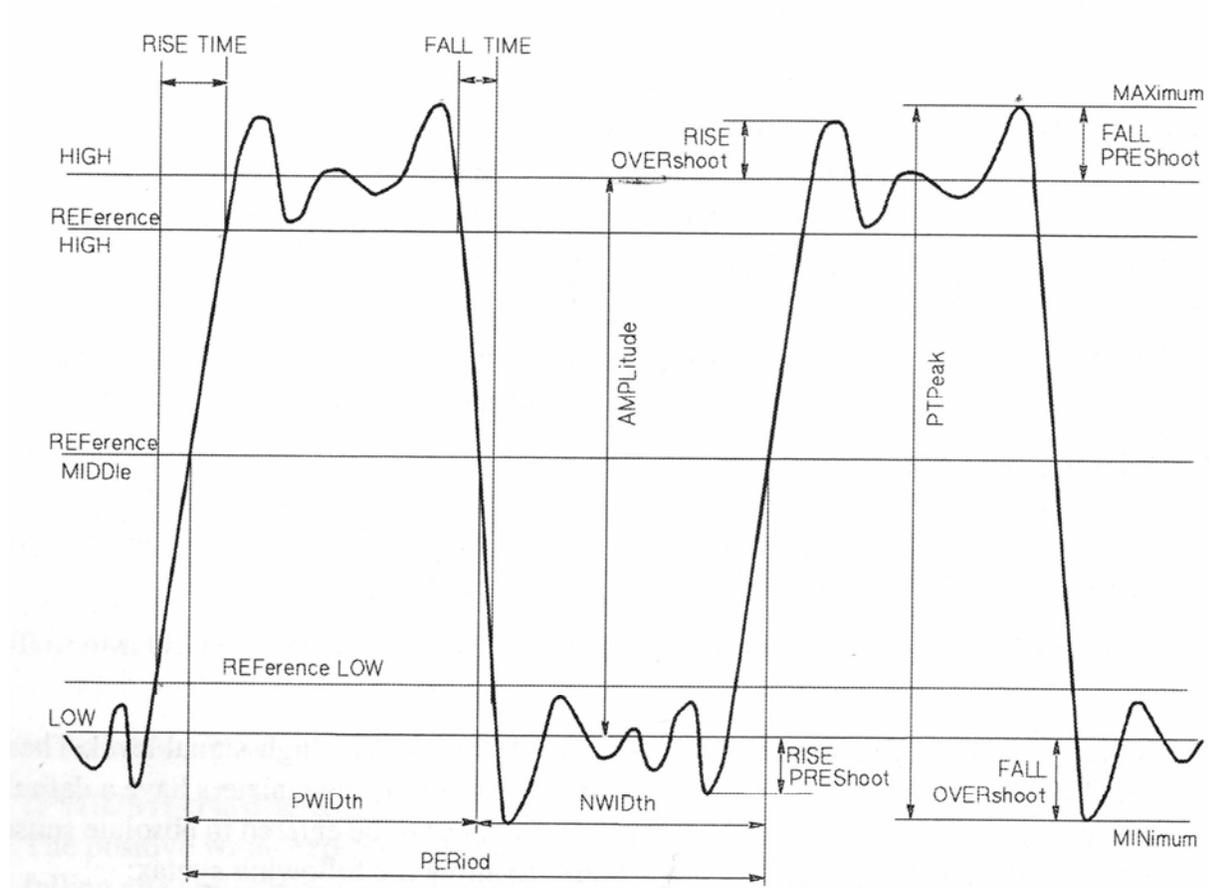


Figure 16: Example with Measurements Terminology

Measurements

The following describes the waveform measurements:

Average	Average value of the entire captured waveform.
Alternating Current (AC)	The AC RMS characteristic of the signal subtracts the DC Average before computing the RMS.
AC High-Precision	The AC RMS level of the signal with more precision for use with waveform records having more than 8-bit resolution, such as averaged waveforms. The added precision requires approximately 10X processing time. The added precision is most noticeable when there is a non-zero input offset setting.
Amplitude	The low-to-high voltage amplitude of the applied signal.
Cycle Average	The average level of the first cycle of the selected waveform source.
Cycle Frequency	The frequency of the first cycle of the waveform.
Cycle Period	The period of the first cycle of the waveform.
Cycle RMS	The AC voltage RMS for one cycle of the waveform, measured from mid-point to mid-point.
Direct Current (DC)	The DC RMS level of the signal.
DC High-Precision	The DC RMS level of the signal with more precision for use with waveform records having more than 8-bit resolution, such as averaged waveforms. The added precision requires approximately 10X processing time. The added precision is most noticeable when there is a non-zero input offset setting.
Fall Crossing Time	The time of the selected falling edge of a waveform crossing the middle threshold measured from the start of the waveform. The edge number is selectable.
Fall Overshoot	The difference between the low level and the negative peak level of a signal as it transitions from its high state to its low state, expressed as a ratio of waveform amplitude.
Fall Preshoot	The difference between the high level and the maximum level of a signal as it transitions from its high state to its low state, expressed as a ratio of the waveform amplitude.

Fall Time	The time it takes the falling edge of a pulse to go from the upper threshold of peak voltage to the lower threshold of peak voltage.
Frequency	The frequency of the signal. All cycles in the entire capture window are used.
High	The high signal level.
Low	The low signal level.
Maximum	The maximum value of the waveform.
Minimum	The minimum value of the waveform.
Negative Duty Cycle	The ratio of negative width to period.
Negative Width	The negative width is expressed in seconds from the first falling edge reference to the next rising edge reference. The same reference is used for the rising and falling edges. The threshold is defined as midway between high and low levels.
Peak-To-Peak	The peak-to-peak voltage or maximum to minimum voltage of the signal.
Period	Measures the period of the signal (1/frequency) using all cycles in the entire capture window.
Phase	Measures the phase of a periodic signal at the start of the Waveform in radians.
Positive Duty Cycle	The ratio of positive width to period.
Positive Width	The positive width expressed in seconds from the first rising edge reference to the next falling edge reference. The same reference is used for the rising and falling edges. The threshold is defined as midway between high and low levels.
Rise Crossing Time	The time of the rising edge of a waveform as it crosses the middle reference measured from the start of the waveform. The edge number is selectable.
Rise Overshoot	The difference between the high level and the positive peak level of a signal as it transitions from its low state to its high state, expressed as a ratio of waveform amplitude.

Rise Preshoot	The difference between the low level and the negative peak level of a signal as it transitions from its low state to its high state, expressed as a ratio of the waveform amplitude.
Rise Time	Measures the time for the leading edge of a pulse to rise from its lower threshold of peak voltage to its upper threshold of peak voltage. The edge number is selectable.
Time of Minimum	The time at which the first occurrence of the minimum voltage occurs.
Time of Maximum	The time at which the first occurrence of the maximum voltage occurs.

Invalid Measurements

The ZT450 returns an invalid measurement code (9.99999E+37) whenever it encounters an invalid measurement condition. The following describes types of invalid measurement conditions.

Voltage Measurements

Voltage measurements (such as *Measure High Voltage Query*) where there is an over-voltage condition with the applied voltage exceeding the input range of the ADC will return the invalid measurement code (See Figure 17).

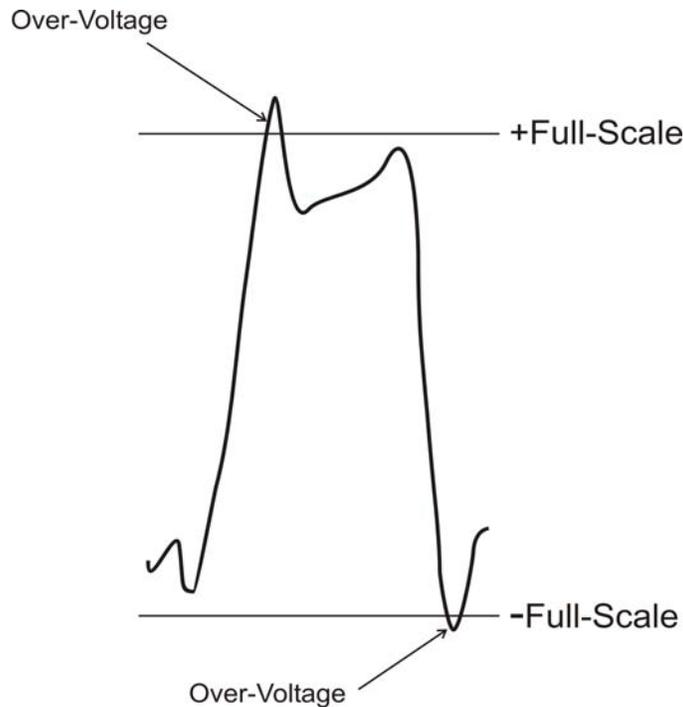


Figure 17: Invalid Voltage Measurement

RMS Measurements

The ZT450 will always return the measured value for an RMS measurement, even if a signal is clipped (over-voltage).

Cycle and Width Measurements

Cycle measurements (such as *Measure Period Query* or *Measure Frequency Query*) require at least three mid-point crossings in the capture window. Width measurements (such as *Measure Positive Width Query* or *Measure Positive Duty Cycle Query*) use at least two mid-point crossings in the capture window. If the required number of mid-point crossings is not found, the ZT450 will return the invalid measurement code.

Edge Measurements

Edge measurements (such as *Measure Rise Time Query*) require at least as many edges present in the capture window as the user-requested edge number. If the requested edge is greater than the number of edges in the capture window (3 or greater for a rise time measurement on the waveform in Figure 18), the ZT450 will return the invalid measurement code. However, other time measurements such as *Measure Positive Width Query* or *Measure Period Query* may be possible, depending on the number of edges found.

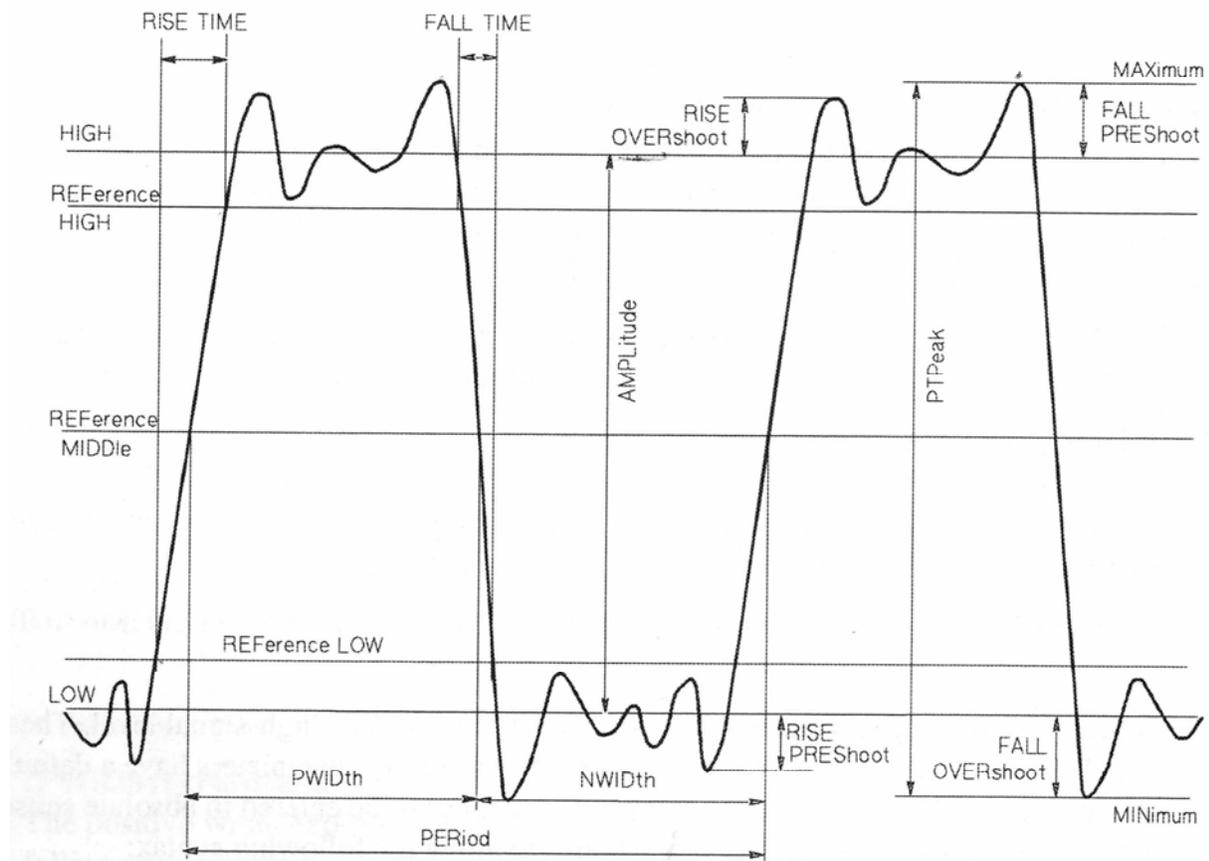


Figure 18: Invalid Edge Measurements

Measurement Method

The following are the measurement methods available on the ZT450: Entire Waveform, Gated by Time, and Gated by Points.

Entire Waveform

Entire Waveform measurement is used to perform measurements upon the entire captured waveform.

Gated by Time

Gated by Time measurement is used to perform measurements upon a waveform, where the user defines a start time and stop time. "0" represents the start of the waveform.

Gated by Points

Gated by Points measurement is used to perform measurements on a waveform, where the user defines a start point and stop point. "0" represents the start of the waveform.

Measurement Reference Levels

Measurement reference levels are high, low, and mid range values that are set to take rise time, fall time, fall crossing time, and rise crossing time measurements. Reference levels are configured in relative terms of the percentage of the waveform acquired, or in absolute voltage levels. By default, the low value is 10 percent of the waveform, the mid level is 50 percent, and the high value is 90 percent.

Reference levels are user-defined using the *Measure Reference Command* and *Measure Reference Method Command*. Levels can be set either by percentage or voltage as follows:

- Low reference selects the threshold for detection of the input signal low state.
- Middle reference selects the threshold for detection of the input signal middle level.
- High reference selects the threshold for detection of the input signal high state.
- The allowed relative reference values range from 0.0 (0 percent) to 1.0 (100 percent).
- Absolute reference values are expressed in voltages.

Measurement Edge

The measurement edge is the waveform edge used in edge-related measurements (See *Measure Edge Command*). A falling or rising edge is selected using a 16-bit unsigned integer value and is used in the following measurement types: rise time, rise crossing time, rise overshoot, rise preshoot, fall time, fall crossing time, fall preshoot, and fall overshoot.

Waveform and Reference

Read Waveform

The ZT450 uses a shared PXI memory to report acquisition results to the PXI host processor. Because the shared PXI memory is smaller than most waveform records, a typical waveform download will require that the waveform be read in blocks multiple times and the data be appended together to form the final output.

A waveform consists of signed 16-bit values: Typically, bits 15–8 contain the 8-bit data. Averaging and calculating extend beyond 8-bit resolution using bits 7–0.

Read Waveform Preamble

The preamble provides information necessary to convert the 16-bit integer waveform samples to and from time and voltage values. Preamble information is divided into three blocks, header information, time axis information, and voltage information as described below:

Header Information

- Waveform Type:
 - 0 = Invalid waveform
 - 1 = Normal voltage-time waveform
 - 2 = Averaged voltage-time waveform
 - 3 = Envelope waveform
 - 4 = Equivalent Time waveform
 - 16 = Frequency Domain Waveform (FFT)
- Count: The number of waveforms processed to produce an output, N average count for averaged or enveloped waveforms, or equivalent time waveforms.
- Size: The number of samples in the sample record.

Time Axis Information

- Increment: The time interval between samples
- Offset: Time between the trigger event and the first sample in the sample record

Note: For FFT waveforms, the X-axis displays the frequency in Hertz.

Voltage Axis Information

- Increment: The voltage interval of 1 Least Significant Bit (LSB).
- Offset: The voltage offset represented by the sample “0” code

To recreate a waveform from the preamble and sample record use the following relationships:

- Sample Time = time offset + (sample number * time increment)
- Sample Voltage = voltage offset + (sample code value * voltage increment)

Reference Waveform

The ZT450 can save and download up to 4 reference waveforms. The reference waveforms, REF1–4, are stored in non-volatile Flash memory and are maintained when the unit is powered off. These waveforms are limited to 32 kSamples record sizes.

- Store: copied from input, calculate and reference sources.
- Load: loaded as codes from PXI host (load preamble when loading waveform).

Utilities and Status Reporting

Auto Scale

The ZT450 can automatically adjust settings to the input signal. The following are the adjustable parameters for all enabled input channels:

- Input Range
- Offset
- Points (Automatically sets the number of points to 1,000)
- Sample Rate (Selected for the signal with the largest amplitude)
- Trigger Source (Selected for the signal with the largest amplitude)
- Trigger Level (Available if signals are present on both enabled input channels)

Reset and Device Clear

Use the *Reset Command* to perform a hard reset of the ZT450. This stops all acquisition and configures the unit to its default state. See *Appendix 2, Default Reset Conditions*, for a listing of all ZT450 default conditions.

Save and Recall States

The ZT450 can save and recall up to 31 instrument configuration states. These states record the input settings, horizontal sweep settings, trigger settings, and capture settings. The current instrument state can be saved and recalled later. All states are stored in non-volatile Flash memory and are maintained when the unit is powered off. The *Reset Command*, *Save Instrument State Command*, and *Recall Instrument State Command* control the instrument state configuration.

Error

There is a capability to see any and all system errors. The *System Error All Query* returns all 32 entries in the error log and clears the error log. Multiple errors are stored sequentially in the error log with the oldest error first. A zero (0) value is returned for all non-error entries when there are less than 32 errors stored in the error log. The *System Error Count Query* returns the number of errors in the error log. The *System Error Query* returns and clears the first entry in the error log. See *Appendix 3, System Error Codes*, for a list of error codes.

Status

The status register provides a common way to perform status reporting. Each status data structure has a single output, a summary message that summarizes the structure states. A FALSE summary status means that there is no status to report and a TRUE summary status indicates that there is status to report. The structure states are as follows:

Condition

This is a device state that is either TRUE or FALSE. A condition register reflects these states in its condition bits.

A condition register may range in length from 1 to a maximum of 16 bits, and may contain unused bits. Unused bits shall return a zero (0) value when read.

The ZT450 uses the condition register to state or overlay summary messages so that they may be read together. It provides device-specific commands to read any or all of the device's condition registers.

Note: Reading a condition register does not change its contents.

Event

This is a device state that captures changes in conditions. Each event bit in an event register corresponds to a condition bit in a condition register. Event registers range in length from 1 to a maximum of 16 bits and may contain unused bits. Unused bits shall return a zero (0) when the register is read.

An event becomes TRUE when the associated device condition makes certain device-defined transactions. The event register guarantees that the application cannot miss an event that occurs between the reading and clearing of an event register. An event register bit shall be set TRUE when an associated event occurs. These bits, once set, cannot be cleared even if they do not reflect the current status of a related condition, until they are read by the application. There is only one transition criterion for setting event bits TRUE on the ZT450:

- Positive Transition: The event becomes TRUE when its associated condition makes a FALSE to TRUE transition only.

Also, the device:

- Provides queries to ready any or all of the event registers.
- Provides commands to clear the entire register.

Note: Event bits are cleared when read.

Enable

This is a device state that selects which event bits in the corresponding event register will cause a TRUE summary message when set. Each event bit shall have a corresponding enable bit in the event enable register. The ZT450 requests service for any single event, inclusive event, or on any group of events.

The event enable register is the same length as the corresponding event register. Any unused bits in the event enable register correspond with unused bits in the event register. The value of unused bits is zero (0) when the event enable register is read and is ignored when written to by commands.

The ZT450 provides device-defined queries to read any or the entire event enable registers. It also provides commands to write to any of the event enable registers.

Status Register

The following events are shown on the status register:

- Voltage
- Frequency
- Questionable
- Calibration
- Test
- Operation
- Standard Event

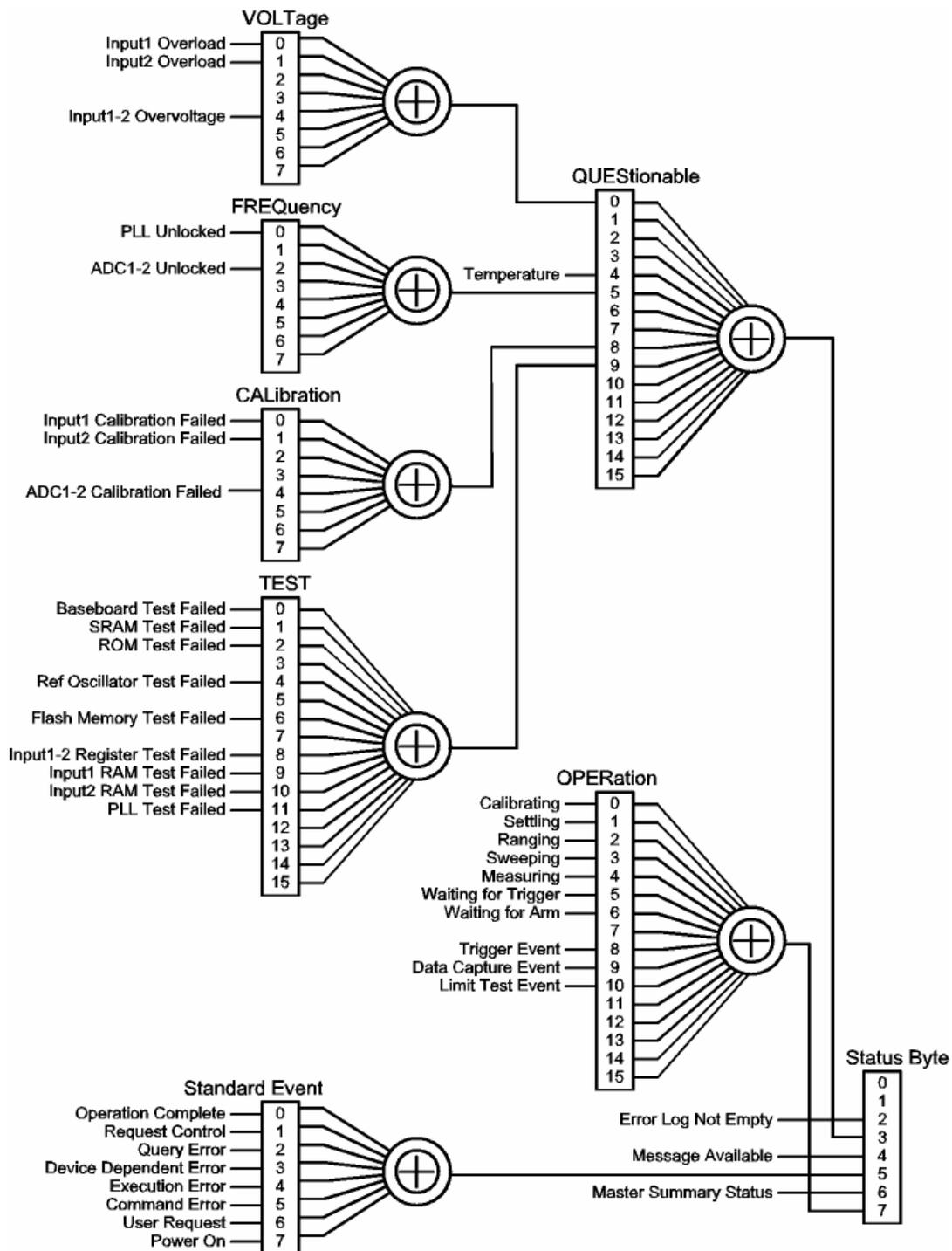


Figure 19: Status Registers

Current Status

The current status of the ZT450 can be viewed at any time using any of the following commands and queries:

Note: See the appropriate command or query syntax in Chapter 3.

Command or Query	Response
Clear Status Command	Clears all event status registers and the error log.
Event Status Enable Command	Sets the state of the event status enable register. The event status enable register allows the enabled standard events to affect the event summary status bit within the status byte.
Event Status Enable Query	Returns the state of the event status enable register. The event status enable register allows the enabled standard events to affect the event summary status bit within the status byte.
Event Status Query	Returns the status bits for the standard event status register.
Service Request Enable Command	Sets the state of the service request enable register. The service request enable register allows the enabled status byte events to affect the service request summary bits with the status byte.
Service Request Enable Query	Returns the state of the service request enable register. The service request enable register allows the enabled status byte events to affect the service request summary bits with the status byte.
Status Byte Query	Returns the Status Byte code.
Status Calibration Condition Query	Returns the current condition of the questionable calibration status register.
Status Calibration Enable Command	Allows the user to enable or disable the bits in the questionable calibration status register. The parameter is a bit mask which enables the corresponding questionable calibration status register bits.
Status Calibration Enable Query	Returns the bit mask of the questionable calibration status enable register.
Status Calibration Event Query	Returns the latched event state for the questionable calibration status register.
Status Frequency Condition Query	Returns the current condition of the questionable frequency status register.

Command or Query	Response
Status Frequency Enable Command	Allows the user to enable or disable the bits in the questionable frequency status register. The parameter is a bit mask which enables the corresponding questionable frequency status register bits.
Status Frequency Enable Query	Returns the bit mask of the questionable frequency status enable register.
Status Frequency Event Query	Returns the latched event state for the questionable frequency status register.
Status Operation Condition Query	Returns the present condition of the operation status register.
Status Operation Enable Command	Sets the contents of the operation status enable register. The parameter is a bit mask which enables the corresponding operation status register bits.
Status Operation Enable Query	Returns the bit mask of the operation status enable register.
Status Operation Event Query	Returns the latched event state for the operation status register.
Status Preset Command	Sets the enable register to all 1's. For the mandatory status data structures, it sets the enable register to 0's. Also, it sets the error/event queue enabling to report only errors.
Status Questionable Condition Query	Returns the present condition for the questionable status register.
Status Questionable Enable Command	Allows the user to enable or disable the bits in the questionable status register. The parameter is a bit mask which enables the corresponding questionable status register bits.
Status Questionable Enable Query	Returns the bit mask of the questionable status register. That is, it returns a bit mask that indicates which questionable status register bits are enabled.
Status Questionable Event Query	Returns the latched event state for the Questionable Status Register.
Status Test Condition Query	Returns the present condition of the questionable test status register.
Status Test Enable Command	Allows users to Enable or Disable bits in the questionable test status register. The parameter is a bit mask which enables the corresponding questionable test status register bits.

Command or Query	Response
Status Test Enable Query	Returns the bit mask of the Questionable Test Status Enable Register. That is, it returns a bit mask that indicates which Questionable Test Status Register bits are enabled.
Status Test Event Query	Returns the latched event state for the questionable test status register.
Status Voltage Condition Query	Returns the current condition of the questionable voltage status register.
Status Voltage Enable Command	Sets the contents of the voltage status enable register. The parameter is a bit mask which enables the corresponding questionable voltage status register bits.
Status Voltage Enable Query	Returns the bit mask of the questionable voltage enable register.
Status Voltage Event Query	Returns the latched event state for the questionable voltage status register.

Table 9: System Status

Self Test

The ZT450 can initiate an instrument self test and return any test error results as a 16-bit code (See *Test Query*). The self test is initiated on instrument power up and returns:

Hex Number Code	Error Type
0001 ₁₆	Baseboard Test Failed Bit
0002 ₁₆	SRAM Test Failed Bit
0004 ₁₆	ROM Test Failed Bit
0008 ₁₆	Unused Bits
0010 ₁₆	Reference Oscillator Test Failed Bit
0020 ₁₆	Unused Bits
0040 ₁₆	Flash Memory Test Failed Bit
0080 ₁₆	Unused Bits
0100 ₁₆	Input 1–2 Register Test Failed Bit
0200 ₁₆	Input 1 RAM Test Failed Bit
0400 ₁₆	Input 2 RAM Test Failed Bit
0800 ₁₆	PLL Test Failed
F000 ₁₆	Unused Bits

Table 10: Self-Test Errors

Calibrate

The ZT450 can perform an automatic, internal self-calibration upon command. The internal calibration nulls the zero DC offset for all combinations of input range and filter settings for both input channels. Note that the external cables should be removed or 0.0 VDC should be applied to both input channels before commanding a self-calibration. Upon completion of the self-calibration process, the ZT450 will respond indicating the status of the calibration. A zero (0) value is returned if the calibration is completed successfully; a one (1) value is returned if the calibration failed; otherwise, a two (2) value is returned to indicate corruption of the calibration. Calibration errors are also reported through the status-reporting system. All self-calibration data is stored in non-volatile memory and shall be used as the default, power-on calibration data. If desired, the original factory default calibration data can be restored upon command.

Identification and Version

Use the *ID Query* to return the ZT450 instrument identification including manufacturer, model number, serial number, and firmware version. The results are returned as a block of ASCII string data up to 44 characters in length.

Example: ZTEC,ZT450PXI-00,S/N 100,Version 1.00

Temperature Monitoring

Use the *System Temperature Query* to return the temperature value of the instrument in degrees Celsius. Temperature has a high threshold of 60 degrees Celsius. If the instrument temperature exceeds the high threshold, the instrument will immediately power down and must be reset to return to a normal operating state.

Command Interface



Introduction

The ZTEC Instruments, Inc. ZT450 uses a non-queued, one command packet in / one response packet out, control technique that is encapsulated in the device driver software. Burst data transfers may proceed in parallel with command/response activity.

Both models use the Texas Instruments PCI2040 PCI-to-DSP Bridge to handle PCIbus traffic. The PCI2040 responds to configuration space queries by the PCI bus and presents a simple four register interface for commands and data transfers. PCI Base Address Register 1 points to this four register interface. Table 11 shows the command and data transfer interface.

Address		Description
AD31-AD15	AD14-AD00	
Set by config	0000 ₁₆	Control Register
Set by config	0800 ₁₆	Data Register (auto-increment)
Set by config	1000 ₁₆	Address Register
Set by config	1800 ₁₆	Data Register (no increment)

Table 11: Low Level PCI Interface

The control register is set by the initialization function to a value of 0101₁₆ and should be left unchanged. Host access to shared memory is accomplished by writing to the Address Register to set the target address and then reading/writing one of the data registers. Any access to address 0800₁₆ causes the contents of the Address Register to be incremented. This facility is useful for transferring command parameters or data blocks.

Commands to and responses from the ZT450 are exchanged using shared memory located within the DSP. Table 12 describes the memory map.

Address Register	Name	Description
4000 ₁₆	HOST_SIGNAL	Host computer command activity signal
4001 ₁₆	HOST_COMMAND	Host computer command code
4002 ₁₆ –4041 ₁₆	HOST_PARAMETER	Parameters required by host computer command
4042 ₁₆	UNIT_STATUS	Status flags
4043 ₁₆	UNIT_SIGNAL	Response activity signal
4044 ₁₆	UNIT_RESPONSE	Response code
4045 ₁₆ –4084 ₁₆	UNIT_PARAMETER	Parameters reported with response

Table 12: Command/Response Memory Map

In order to exchange commands and responses, the host computer and ZT450 must execute the following steps:

1. The host computer must write a 0 to the UNIT_SIGNAL register.
2. The host computer must set up the HOST_COMMAND and HOST_PARAMETERS.
3. The host computer must write a 0002₁₆ to the HOST_SIGNAL register and begin monitoring the UNIT_SIGNAL register for a non-zero value.
4. The ZT450 monitors the HOST_SIGNAL register and execute the HOST_COMMAND when a non-zero HOST_SIGNAL is detected.
5. Upon completion of command processing the ZT450 copies the command code into the UNIT_RESPONSE register, set up the UNIT_PARAMETER registers, and write a 0 to the HOST_SIGNAL register.
6. Finally, the ZT450 updates the UNIT_SIGNAL register. This code, as shown in Table 13, defines the command processing result.

Response Code	Meaning
0001 ₁₆	CMD_DONE, command successfully completed
0002 ₁₆	CMD_UNK_CMD, unknown command
0004 ₁₆	CMD_INV_DATA, command parameter error
0008 ₁₆	CMD_REJECT, command rejected, incompatible with current state
0010 ₁₆	CMD_FAIL, requested operation failed

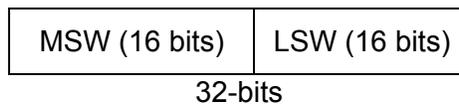
Table 13: ZT450 Response Signals Codes

Data Interface

Waveform records are sent to the host computer using the shared memory located on the baseboard DSP chip. This memory always begins at 4085₁₆ and has a maximum length of 800₁₆ (2048₁₀).

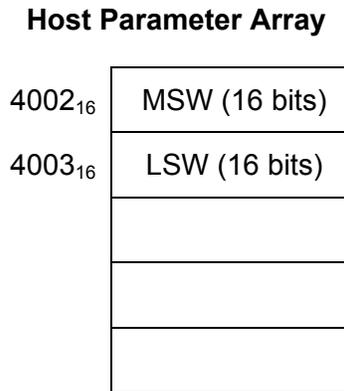
Parameters

Command and response parameters are sent and returned as 16-bit integers. 32-bit integers and 32-bit floating point numbers must be broken into 16-bit integers to be loaded as parameters. The ZT450 processes these 32-bit integers as two 16-bit words as follows:



Note: MSW equals the Most Significant Word and LSW equals the Least Significant Word

Example:



MSW, LSW, and Long Value are determined using the following C-language equations:

```
LSW = LONG_VALUE && 0xFFFF;  
MSW = LONG_VALUE >> 16;  
LONG VALUE = (MSW << 16) + LSW;
```

For a 32-bit floating integer, use the following C-language equations to determine Long_value, and Float_value:

```
LONG_VALUE = *(LONG*) &FLOAT_VALUE;  
MSW = (LONG_VALUE) && 0xFFFF;  
LSW = (LONG_VALUE) >> 16;  
LONG VALUE = (MSW << 16) + LSW;  
FLOAT_VALUE = *(FLOAT*) &LONG_VALUE;
```

Commands and Queries

Name	Description
<p>Abort Command 0305₁₆</p>	<p>Terminates waveform capture. When an abort is received the unit will end any on-going capture activity and return to its idle state. The waveform being captured will be dropped but any previous captured waveforms will be available. The unit start state can be queried from the status register.</p> <p>Command Syntax 0305₁₆</p> <p>Query Syntax None</p> <p>Parameters None</p>
<p>Arm Command 0306₁₆</p> <p>Arm Query 8306₁₆</p>	<p>The <i>Arm Command</i> arms or disarms the unit through software when manual arm source selected. The unit will begin trigger detection when armed. When disarmed, the unit ignores triggers. The <i>Arm Query</i> returns the arm condition.</p> <p>Command Syntax 0306₁₆ <state></p> <p>Query Syntax 8306₁₆ → <state></p> <p>Parameters <state> Type: 16-bit unsigned integer</p> <p>0000₁₆ Disarmed state 0001₁₆ Armed state</p>

Name	Description
<p>Arm Polarity Command 0308₁₆</p> <p>Arm Polarity Query 8308₁₆</p>	<p>Sets or queries the active state of the selected source. If an arm source is selected and the state of the selected source matches the arm polarity state, the unit will arm. The following considerations apply when setting the arm polarity:</p> <ul style="list-style-type: none"> • <i>POSITIVE</i> state defines the active state as the selected source in its high state • <i>NEGATIVE</i> state defines the active state as the selected source in its low state <p>Command Syntax 0308₁₆ <polarity></p> <p>Query Syntax 8308₁₆ → <polarity></p> <p>Parameters <polarity> Type: 16-bit unsigned integer</p> <p>0000₁₆ Negative Polarity 0001₁₆ Positive Polarity</p>

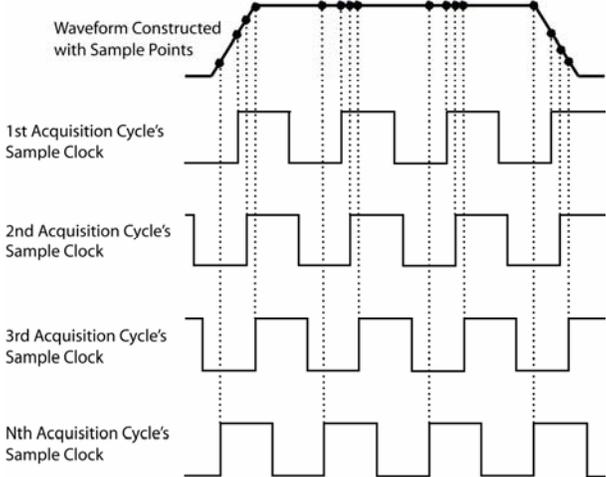
Name	Description
<p>Arm Source Command 0307₁₆</p> <p>Arm Source Query 8307₁₆</p>	<p>Sets or queries the arm source setting that will be used to arm the unit. For example, if the <i>Arm Source Command</i> is set to 0009₁₆, the Star Trigger will be used to arm the unit. If an immediate output is desired regardless of trigger, <i>Arm Source Command</i> can be set to 000E₁₆.</p> <p>Command Syntax 0307₁₆ <source></p> <p>Query Syntax 8307₁₆ → <source></p> <p>Parameters</p> <p><source> Type: 16-bit unsigned integer</p> <ul style="list-style-type: none"> 0000₁₆ Software 0001₁₆ TTL Trigger0 0002₁₆ TTL Trigger1 0003₁₆ TTL Trigger2 0004₁₆ TTL Trigger3 0005₁₆ TTL Trigger4 0006₁₆ TTL Trigger5 0007₁₆ TTL Trigger6 0008₁₆ TTL Trigger7 0009₁₆ Star Trigger 000A₁₆ Channel 1 000B₁₆ Channel 2 000C₁₆ External Trigger 000D₁₆ Pattern Trigger 000E₁₆ Arm Immediate
<p>Auto Scale Command 0400₁₆</p>	<p>Commands the instrument to auto scale on enabled channels only. Auto scale changes the range, offset, impedance, sample rate, trigger source, and trigger level based on the input signal. It also sets the number of points to 1000.</p> <p>Command Syntax 0400₁₆</p> <p>Query Syntax None</p> <p>Parameters None</p>

Name	Description
<p>Average Count Command 0422₁₆</p> <p>Average Count Query 8422₁₆</p>	<p>Sets or queries the acquisition count for repetitive acquisition modes:</p> <ul style="list-style-type: none"> In Normal mode, this parameter is ignored. In Average mode, this specifies the number of waveforms to be averaged before the acquisition is complete. In Envelope mode, this specifies the number of waveforms for which to capture minimum and maximum values before the acquisition is complete. In Equivalent Time mode, a picture of a repetitive waveform is constructed by capturing a little bit of information from each repetition. Because the points appear randomly along the waveform, it is important to note that an entire waveform may <u>not</u> be constructed unless there are sufficient repetitions. Unfilled points will be constructed using a zero-order hold and are flagged with a "1" in the LSB of the 16-bit waveform code. Also, the number of points per point can be set to increase the resolution of the waveform. (See the <i>Average Equivalent Time Points Command</i>). <div data-bbox="727 940 1347 1470" style="text-align: center;"> </div> <p>Command Syntax 0422₁₆ <count></p> <p>Query Syntax 8422₁₆ → <count></p> <p>Parameters: <count> Type: 16-bit unsigned integer</p> <p>Range: 2 to 2048</p>

Name	Description
<p>Average Envelope View Command 0423₁₆</p> <p>Average Envelope View Query 8423₁₆</p>	<p>Sets or queries the active envelope view; that is, which envelope view to set active. The default view is Minimum.</p> <p>Command Syntax 0423₁₆ <view></p> <p>Query Syntax 8423₁₆ → <view></p> <p>Parameters: <view> Type: 16-bit unsigned integer</p> <p>0000₁₆ Minimum 0001₁₆ Maximum</p>

Name	Description
<p>Average Equivalent Time Points Command 0424₁₆</p> <p>Average Equivalent Time Points Query 8424₁₆</p>	<p>Sets or queries the number of user-defined points-per-point for equivalent time sampling of a waveform. When a DSO uses equivalent time sampling, it can acquire any signal up to the analog bandwidth of the scope regardless of the sample rate. In this mode, the scope gathers the necessary number of samples across several triggers. The following considerations apply when using the <i>Average Equivalent Time Points Command</i> and <i>Average Equivalent Time Points Query</i>.</p> <ul style="list-style-type: none"> • The waveform is constantly sampled and digitized. • The sampling rate is determined by the instrument clock and not the trigger repetition rate. • The input signal must be repetitive to generate the multiple triggers needed for equivalent-time sampling • The points-per-point value is user-defined at 2 to 100 points per waveform point. • Since each calculation channel is limited to a maximum waveform size of 32K, the waveform size <u>must</u> be less than 32k / points-per-point value. • Very precise time interval measurements can be made on very high bandwidth waveforms. • The trigger source must be set to an enabled input channel (Input Channel 1 or Input Channel 2). <p>Command Syntax 0424₁₆ <points></p> <p>Query Syntax 8424₁₆ → <points></p> <p>Parameters: <points> Type: 16-bit unsigned integer Range: 2 to 100</p>

Name	Description
<p>Average State Command 0420₁₆</p> <p>Average State Query 8420₁₆</p>	<p>Sets or queries the waveform averaging state. The following considerations apply:</p> <ul style="list-style-type: none"> • When the average is enabled, only the final output waveform is retained, the raw, un-averaged data is not available. • When the average is disabled, (Normal acquisition mode), waveforms from the digitizers are passed through without modification. • The number of waveforms averaged and the average operation mode can be selected using the <i>Average Count Command</i> and <i>Average Type Command</i> respectively. • The average enable setting affects all active input channels. <p>Command Syntax 0420₁₆ <state></p> <p>Query Syntax 8420₁₆ → <state></p> <p>Parameters: <state> Type: 16-bit unsigned integer</p> <p>0000₁₆ Disable averaging 0001₁₆ Enable averaging</p>

Name	Description
<p>Average Type Command 0421₁₆</p> <p>Average Type Query 8421₁₆</p>	<p>Sets or queries the type of acquisition that is to take place.</p> <ul style="list-style-type: none"> In Normal mode, a single waveform is captured. In Average mode, multiple captured waveforms are averaged. In Envelope mode, the minimum and maximum waveform points from multiple acquisitions are combined to form a waveform (an envelope) that shows min/max changes over time. In Equivalent Time mode, a picture of a repetitive waveform is constructed by capturing a little bit of information from each repetition. Because the points appear randomly along the waveform, it is important to note that an entire waveform may <u>not</u> be constructed unless there are sufficient repetitions. Unfilled points will be constructed using a zero-order hold and are flagged with a "1" in the LSB of the 16-bit waveform code. Also, the number of points per point can be set using the <i>Average Equivalent Time Points Command</i> to increase the resolution of the waveform.  <p>Non-captured points have an initial start value of XX01₁₆. Captured points have an initial value of XX00₁₆.</p> <p>Command Syntax 0421₁₆ <type></p> <p>Query Syntax 8421₁₆ → <type></p> <p>Parameters: <type> Type: 16-bit unsigned integer</p> <p>0000₁₆ Normal 0001₁₆ Average 0002₁₆ Envelope 0003₁₆ Equivalent Time</p>

Name	Description
<p>Calculate Absolute Value Command 0811₁₆</p>	<p>Sets the calculate channel <calc_channel> to determine the absolute value of a waveform and place the result in its output, point by point.</p> <p>Command Syntax 0811₁₆ <calc_channel> <source></p> <p>Query Syntax None</p> <p>Parameters: <calc_channel> Type: 16-bit unsigned integer</p> <ul style="list-style-type: none"> 0002₁₆ Calculation Channel 1 0003₁₆ Calculation Channel 2 <p><source> Type: 16-bit unsigned integer</p> <ul style="list-style-type: none"> 0000₁₆ Input Channel 1 0001₁₆ Input Channel 2 0002₁₆ Calculation Channel 1 0003₁₆ Calculation Channel 2 0004₁₆ Reference Channel 1 0005₁₆ Reference Channel 2 0006₁₆ Reference Channel 3 0007₁₆ Reference Channel 4

Name	Description
<p>Calculate Add Command 0810₁₆</p>	<p>Sets the calculate channel <calc_channel> to add two waveforms and place the result in its output.</p> <p>Command Syntax 0810₁₆ <calc_channel> <source1> <source2></p> <p>Query Syntax None</p> <p>Parameters: <calc_channel> Type: 16-bit unsigned integer</p> <p>0002₁₆ Calculation Channel 1 0003₁₆ Calculation Channel 2</p> <p><source1> Type: 16-bit unsigned integer</p> <p>0000₁₆ Input Channel 1 0001₁₆ Input Channel 2 0002₁₆ Calculation Channel 1 0003₁₆ Calculation Channel 2 0004₁₆ Reference Channel 1 0005₁₆ Reference Channel 2 0006₁₆ Reference Channel 3 0007₁₆ Reference Channel 4</p> <p><source2> Type: 16-bit unsigned integer</p> <p>0000₁₆ Input Channel 1 0001₁₆ Input Channel 2 0002₁₆ Calculation Channel 1 0003₁₆ Calculation Channel 2 0004₁₆ Reference Channel 1 0005₁₆ Reference Channel 2 0006₁₆ Reference Channel 3 0007₁₆ Reference Channel 4</p>

Name	Description
Calculate Copy Command 0812 ₁₆	<p>Sets the calculate channel <calc_channel> to copy a source waveform into its output.</p> <p>Command Syntax 0812₁₆ <calc_channel> <source></p> <p>Query Syntax None</p> <p>Parameters: <calc_channel> Type: 16-bit unsigned integer</p> <ul style="list-style-type: none"> 0002₁₆ Calculation Channel 1 0003₁₆ Calculation Channel 2 <p><source> Type: 16-bit unsigned integer</p> <ul style="list-style-type: none"> 0000₁₆ Input Channel 1 0001₁₆ Input Channel 2 0002₁₆ Calculation Channel 1 0003₁₆ Calculation Channel 2 0004₁₆ Reference Channel 1 0005₁₆ Reference Channel 2 0006₁₆ Reference Channel 3 0007₁₆ Reference Channel 4

Name	Description
<p>Calculate Derivative Command 0813₁₆</p>	<p>Sets the calculate channel <calc_channel> to calculate the derivative of a source waveform and place the result into its output.</p> <p>Command Syntax 0813₁₆ <calc_channel> <source></p> <p>Query Syntax None</p> <p>Parameters: <calc_channel> Type: 16-bit unsigned integer</p> <p>0002₁₆ Calculation Channel 1 0003₁₆ Calculation Channel 2</p> <p><source> Type: 16-bit unsigned integer</p> <p>0000₁₆ Input Channel 1 0001₁₆ Input Channel 2 0002₁₆ Calculation Channel 1 0003₁₆ Calculation Channel 2 0004₁₆ Reference Channel 1 0005₁₆ Reference Channel 2 0006₁₆ Reference Channel 3 0007₁₆ Reference Channel 4</p>

Name	Description
Calculate Function Query 8803 ₁₆	<p>Queries the current calculate channel <calc_channel> function.</p> <p>Command Syntax None</p> <p>Query Syntax 8803₁₆ <calc_channel> → <function> <source1> <source2></p> <p>Parameters:</p> <p><calc_channel> Type: 16-bit unsigned integer 0002₁₆ Calculation Channel 1 0003₁₆ Calculation Channel 2</p> <p><function> Type: 16-bit unsigned integer 0000₁₆ Add 0001₁₆ Absolute Value 0002₁₆ Copy 0003₁₆ Derivative 0004₁₆ Integral 0005₁₆ Invert 0006₁₆ Multiply 0007₁₆ Subtract 0008₁₆ Limit 0009₁₆ FFT 000A₁₆ Time Transform</p> <p><source1> Type: 16-bit unsigned integer 0000₁₆ Input Channel 1 0001₁₆ Input Channel 2 0002₁₆ Calculation Channel 1 0003₁₆ Calculation Channel 2 0004₁₆ Reference Channel 1 0005₁₆ Reference Channel 2 0006₁₆ Reference Channel 3 0007₁₆ Reference Channel 4</p> <p><source2></p> <p>Note: Queries the source2. This is always returned by a query, but has no meaning when using only one source.</p> <p>Type: 16-bit unsigned integer 0000₁₆ Input Channel 1 0001₁₆ Input Channel 2 0002₁₆ Calculation Channel 1 0003₁₆ Calculation Channel 2 0004₁₆ Reference Channel 1 0005₁₆ Reference Channel 2 0006₁₆ Reference Channel 3 0007₁₆ Reference Channel 4</p>

Name	Description
<p>Calculate Immediate Command 0804₁₆</p>	<p>Forces the instrument to immediately perform calculations on the calculation channel.</p> <p>Command Syntax 0804₁₆ <calc_channel></p> <p>Query Syntax None</p> <p>Parameters: <calc_channel> Type: 16-bit unsigned integer</p> <p>0002₁₆ Calculation Channel 1 0003₁₆ Calculation Channel 2</p>
<p>Calculate Integral Command 0814₁₆</p>	<p>Sets the calculate channel <calc_channel> to calculate the integral of a source waveform and place the result into its output.</p> <p>Command Syntax 0814₁₆ <calc_channel> <source></p> <p>Query Syntax None</p> <p>Parameters: <calc_channel> Type: 16-bit unsigned integer</p> <p>0002₁₆ Calculation Channel 1 0003₁₆ Calculation Channel 2</p> <p><source> Type: 16-bit unsigned integer</p> <p>0000₁₆ Input Channel 1 0001₁₆ Input Channel 2 0002₁₆ Calculation Channel 1 0003₁₆ Calculation Channel 2 0004₁₆ Reference Channel 1 0005₁₆ Reference Channel 2 0006₁₆ Reference Channel 3 0007₁₆ Reference Channel 4</p>

Name	Description
Calculate Invert Command 0815 ₁₆	<p>Sets the calculate channel <calc_channel> to invert the sign of a source waveform and place the result into its output.</p> <p>Command Syntax 0815₁₆ <calc_channel> <source></p> <p>Query Syntax None</p> <p>Parameters: <calc_channel> Type: 16-bit unsigned integer</p> <ul style="list-style-type: none"> 0002₁₆ Calculation Channel 1 0003₁₆ Calculation Channel 2 <p><source> Type: 16-bit unsigned integer</p> <ul style="list-style-type: none"> 0000₁₆ Input Channel 1 0001₁₆ Input Channel 2 0002₁₆ Calculation Channel 1 0003₁₆ Calculation Channel 2 0004₁₆ Reference Channel 1 0005₁₆ Reference Channel 2 0006₁₆ Reference Channel 3 0007₁₆ Reference Channel 4
Calculate Limit Test Clear Command 0824 ₁₆	<p>Clears the statistics from a limit or mask test for the specified channel.</p> <p>Command Syntax 0824₁₆ <calc_channel></p> <p>Query Syntax None</p> <p>Parameters: <calc_channel> Type: 16-bit unsigned integer</p> <ul style="list-style-type: none"> 0002₁₆ Calculation Channel 1 0003₁₆ Calculation Channel 2

Name	Description
<p>Calculate Limit Test Command 0820₁₆</p>	<p>Configures the instrument to perform a limit test.</p> <p>Command Syntax 0820₁₆ <calc_channel> <source></p> <p>Query Syntax None</p> <p>Parameters: <calc_channel> Type: 16-bit unsigned integer</p> <p>0002₁₆ Calculation Channel 1 0003₁₆ Calculation Channel 2</p> <p><source> Type: 16-bit unsigned integer</p> <p>0000₁₆ Input Channel 1 0001₁₆ Input Channel 2 0002₁₆ Calculation Channel 1 0003₁₆ Calculation Channel 2 0004₁₆ Reference Channel 1 0005₁₆ Reference Channel 2 0006₁₆ Reference Channel 3 0007₁₆ Reference Channel 4</p>
<p>Calculate Limit Test Continuous Command 0825₁₆</p> <p>Calculate Limit Test Continuous Query 8825₁₆</p>	<p>Sets or returns if the calculation channel is doing a continuous limit test. Continuous ON runs the limit test until aborted. Continuous OFF stops the limit test upon the first failure.</p> <p>Command Syntax 0825₁₆ <calc_channel> <state></p> <p>Query Syntax 8825₁₆ <calc_channel> → <state></p> <p>Parameters: <calc_channel> Type: 16-bit unsigned integer</p> <p>0002₁₆ Calculation Channel 1 0003₁₆ Calculation Channel 2</p> <p><state> Type: 16-bit unsigned integer</p> <p>0000₁₆ Off 0001₁₆ On</p>

Name	Description
<p>Calculate Limit Test Fail Query 8822₁₆</p>	<p>Returns whether the limit test has failed. A “0” indicates no failures and a “1” indicates a failed limit test.</p> <p>Command Syntax None</p> <p>Query Syntax 8822₁₆ <calc_channel> → <fail_num></p> <p>Parameters: <calc_channel> Type: 16-bit unsigned integer</p> <p>0002₁₆ Calculation Channel 1 0003₁₆ Calculation Channel 2</p> <p><fail_num> Type: 16-bit unsigned integer Range: 0 or 1</p>
<p>Calculate Limit Test Lower Command 0827₁₆</p> <p>Calculate Limit Test Lower Query 8827₁₆</p>	<p>Sets or returns the lower limit for a limit test.</p> <p>Command Syntax 0827₁₆ <calc_channel> <lower_limit></p> <p>Query Syntax 8827₁₆ <calc_channel> → <lower_limit></p> <p>Parameters: <calc_channel> Type: 16-bit unsigned integer</p> <p>0002₁₆ Calculation Channel 1 0003₁₆ Calculation Channel 2</p> <p><lower_limit> Type: 32-bit floating point Range: Variable</p>

Name	Description
<p>Calculate Limit Test Measurement Command 0821₁₆</p> <p>Calculate Limit Test Measurement Query 8821₁₆</p>	<p>Set or queries the measurement to use for the limit test.</p> <p>Command Syntax 0821₁₆ <calc_channel> <measurement></p> <p>Query Syntax 8821₁₆ <calc_channel> → <measurement></p> <p>Parameters:</p> <p><calc_channel> Type: 16-bit unsigned integer</p> <p>0002₁₆ Calculation Channel 1 0003₁₆ Calculation Channel 2</p> <p><measurement> Type: 16-bit unsigned integer</p> <p>0000₁₆ AC RMS 0001₁₆ Amplitude 0002₁₆ Average 0003₁₆ DC RMS 0004₁₆ Fall Overshoot 0005₁₆ Fall Preshoot 0006₁₆ Fall Crossing Time 0007₁₆ Fall Time 0008₁₆ Frequency 0009₁₆ High 000A₁₆ Low 000B₁₆ MAX 000C₁₆ MIN 000D₁₆ MID 000E₁₆ Negative Duty 000F₁₆ Negative Width 0010₁₆ Positive Duty 0011₁₆ Positive Width 0012₁₆ Period 0013₁₆ Phase 0014₁₆ Peak-To-Peak 0015₁₆ Rise Overshoot 0016₁₆ Rise Preshoot 0017₁₆ Rise Crossing Time 0018₁₆ Rise Time 0019₁₆ Time of Maximum 001A₁₆ Time of Minimum 001B₁₆ Cycle Average 001C₁₆ Cycle Frequency 001D₁₆ Cycle Period 001E₁₆ Cycle RMS 001F₁₆ AC High-Precision 0020₁₆ DC High-Precision 00FF₁₆ Mask</p>

Name	Description
<p>Calculate Limit Test Report Query 8823₁₆</p>	<p>Returns all of the limit test reports for a calculation channel. The values returned include the number of tests performed, the number of test failures encountered, the minimum measurement result, the maximum measurement result, the average measurement result, and the most recent measurement performed.</p> <p>Command Syntax None</p> <p>Query Syntax 8823₁₆ <calc_channel> → <count> <fail_num> <min> <max> <average> <last_val></p> <p>Parameters: <calc_channel> Type: 16-bit unsigned integer</p> <p>0002₁₆ Calculation Channel 1 0003₁₆ Calculation Channel 2</p> <p><count> Type: 16-bit unsigned integer Range: 0 to 65535</p> <p><fail> Type: 16-bit unsigned integer Range: 0 to 65535</p> <p><min> Type: 32-bit Floating Point</p> <p><max> Type: 32-bit Floating Point</p> <p><average> Type: 32-bit Floating Point</p> <p><last_val> Type: 32-bit Floating Point</p>

Name	Description
<p>Calculate Limit Test Upper Command 0826₁₆</p> <p>Calculate Limit Test Upper Query 8826₁₆</p>	<p>Sets or returns the upper limit for a limit test.</p> <p>Command Syntax 0826₁₆ <calc_channel> <upper_limit></p> <p>Query Syntax 8826₁₆ <calc_channel> → <upper_limit></p> <p>Parameters: <calc_channel> Type: 16-bit unsigned integer</p> <p>0002₁₆ Calculation Channel 1 0003₁₆ Calculation Channel 2</p> <p><upper_limit> Type: 32-bit floating point Range: Variable</p>
<p>Calculate Mask Test Lower Command 0829₁₆</p> <p>Calculate Mask Test Lower Query 8829₁₆</p>	<p>Sets or returns the source to use for the lower reference for a mask test.</p> <p>Note: Do <u>not</u> perform a mask test where the calculation source and destination use the same calculation channel.</p> <p>Command Syntax 0829₁₆ <calc_channel> <lower_reference></p> <p>Query Syntax 8829₁₆ <calc_channel> → <lower_reference></p> <p>Parameters: <calc_channel> Type: 16-bit unsigned integer</p> <p>0002₁₆ Calculation Channel 1 0003₁₆ Calculation Channel 2</p> <p><lower_reference> Type: 16-bit unsigned integer</p> <p>0000₁₆ Input Channel 1 0001₁₆ Input Channel 2 0002₁₆ Calculation Channel 1 0003₁₆ Calculation Channel 2 0004₁₆ Reference Channel 1 0005₁₆ Reference Channel 2 0006₁₆ Reference Channel 3 0007₁₆ Reference Channel 4</p>

Name	Description
<p>Calculate Mask Test Upper Command 0828₁₆</p> <p>Calculate Mask Test Upper Query 8828₁₆</p>	<p>Sets or returns the source to use for the upper reference for a mask test.</p> <p>Note: Do <u>not</u> perform a mask test where the calculation source and destination use the same calculation channel.</p> <p>Command Syntax 0828₁₆ <calc_channel> <upper_reference></p> <p>Query Syntax 8828₁₆ <calc_channel> → <upper_reference></p> <p>Parameters:</p> <p><calc_channel> Type: 16-bit unsigned integer</p> <p>0002₁₆ Calculation Channel 1 0003₁₆ Calculation Channel 2</p> <p><upper_reference> Type: 16-bit unsigned integer</p> <p>0000₁₆ Input Channel 1 0001₁₆ Input Channel 2 0002₁₆ Calculation Channel 1 0003₁₆ Calculation Channel 2 0004₁₆ Reference Channel 1 0005₁₆ Reference Channel 2 0006₁₆ Reference Channel 3 0007₁₆ Reference Channel 4</p>

Name	Description
<p>Calculate Multiply Command 0816₁₆</p>	<p>Sets the Calculation Channel to multiply two waveforms and place the result in its output.</p> <p>Command Syntax 0816₁₆ <calc_channel> <source1> <source2></p> <p>Query Syntax None</p> <p>Parameters: <calc_channel> Type: 16-bit unsigned integer</p> <p>0002₁₆ Calculation Channel 1 0003₁₆ Calculation Channel 2</p> <p><source1> Type: 16-bit unsigned integer</p> <p>0000₁₆ Input Channel 1 0001₁₆ Input Channel 2 0002₁₆ Calculation Channel 1 0003₁₆ Calculation Channel 2 0004₁₆ Reference Channel 1 0005₁₆ Reference Channel 2 0006₁₆ Reference Channel 3 0007₁₆ Reference Channel 4</p> <p><source2> Type: 16-bit unsigned integer</p> <p>0000₁₆ Input Channel 1 0001₁₆ Input Channel 2 0002₁₆ Calculation Channel 1 0003₁₆ Calculation Channel 2 0004₁₆ Reference Channel 1 0005₁₆ Reference Channel 2 0006₁₆ Reference Channel 3 0007₁₆ Reference Channel 4</p>

Name	Description
<p>Calculate State Command 0800₁₆</p> <p>Calculate State Query 8800₁₆</p>	<p>Sets or queries the Calculate Channel <calc_channel> processing enable. Enabled channels are processed upon every capture cycle. Disabled channels may be processed after a waveform capture using the <i>Calculate Immediate Command</i>.</p> <p>Command Syntax 0800₁₆ <calc_channel> <state></p> <p>Query Syntax 8800₁₆ <calc_channel> → <state></p> <p>Parameters:</p> <p><calc_channel></p> <p>This is where the result of the calculation is stored.</p> <p>Type: 16-bit unsigned integer</p> <p>0002₁₆ Calculation Channel 1 0003₁₆ Calculation Channel 2</p> <p><state></p> <p>Type: 16-bit unsigned integer</p> <p>0000₁₆ Inactive 0001₁₆ Active</p>

Name	Description
<p>Calculate Subtract Command 0817₁₆</p>	<p>Sets the Calculation Channel to subtract two waveforms and place the result in its output. The result is generated by source1 – source2.</p> <p>Command Syntax 0817₁₆ <calc_channel> <source1> <source2></p> <p>Query Syntax None</p> <p>Parameters: <calc_channel> Type: 16-bit unsigned integer</p> <ul style="list-style-type: none"> 0002₁₆ Calculation Channel 1 0003₁₆ Calculation Channel 2 <p><source1> Type: 16-bit unsigned integer</p> <ul style="list-style-type: none"> 0000₁₆ Input Channel 1 0001₁₆ Input Channel 2 0002₁₆ Calculation Channel 1 0003₁₆ Calculation Channel 2 0004₁₆ Reference Channel 1 0005₁₆ Reference Channel 2 0006₁₆ Reference Channel 3 0007₁₆ Reference Channel 4 <p><source2> Type: 16-bit unsigned integer</p> <ul style="list-style-type: none"> 0000₁₆ Input Channel 1 0001₁₆ Input Channel 2 0002₁₆ Calculation Channel 1 0003₁₆ Calculation Channel 2 0004₁₆ Reference Channel 1 0005₁₆ Reference Channel 2 0006₁₆ Reference Channel 3 0007₁₆ Reference Channel 4

Name	Description
<p>Calculate Transform Frequency Command 0830₁₆</p>	<p>Sets the instrument to calculate an FFT.</p> <p>Command Syntax 0830₁₆ <calc_channel> <source></p> <p>Query Syntax None</p> <p>Parameters: <calc_channel> Type: 16-bit unsigned integer</p> <p>0002₁₆ Calculation Channel 1 0003₁₆ Calculation Channel 2</p> <p><source> Type: 16-bit unsigned integer</p> <p>0000₁₆ Input Channel 1 0001₁₆ Input Channel 2 0002₁₆ Calculation Channel 1 0003₁₆ Calculation Channel 2 0004₁₆ Reference Channel 1 0005₁₆ Reference Channel 2 0006₁₆ Reference Channel 3 0007₁₆ Reference Channel 4</p>
<p>Calculate Transform Frequency Window Command 0831₁₆</p> <p>Calculate Transform Frequency Window Query 8831₁₆</p>	<p>Sets or queries the type of Transform Frequency window to use when calculating an FFT.</p> <p>Command Syntax 0831₁₆ <calc_channel> <window></p> <p>Query Syntax 8831₁₆ <calc_channel> → <window></p> <p>Parameters: <calc_channel> Type: 16-bit unsigned integer</p> <p>0002₁₆ Calculation Channel 1 0003₁₆ Calculation Channel 2</p> <p><window> Type: 16-bit unsigned integer</p> <p>0000₁₆ Rectangular 0001₁₆ Hamming 0002₁₆ Hanning 0003₁₆ Blackman-Harris</p>

Name	Description
<p>Calculate Transform Time Command 0840₁₆</p>	<p>Sets the instrument to perform a time transform on a waveform. A time transform performs a second order IIR low pass filter operation on the data.</p> <p>Command Syntax 0840₁₆ <calc_channel> <source> <state></p> <p>Query Syntax None</p> <p>Parameters: <calc_channel> Type: 16-bit unsigned integer</p> <p>0002₁₆ Calculation Channel 1 0003₁₆ Calculation Channel 2</p> <p><source> Type: 16-bit unsigned integer</p> <p>0000₁₆ Input Channel 1 0001₁₆ Input Channel 2 0002₁₆ Calculation Channel 1 0003₁₆ Calculation Channel 2 0004₁₆ Reference Channel 1 0005₁₆ Reference Channel 2 0006₁₆ Reference Channel 3 0007₁₆ Reference Channel 4</p> <p><state> Type: 16-bit unsigned integer</p> <p>0000₁₆ Off 0001₁₆ On</p>

Name	Description
<p>Calculate Transform Time Points Command 0841₁₆</p> <p>Calculate Transform Time Points Query 8841₁₆</p>	<p>Sets or queries the number of filter length points used to calculate a Time Transform.</p> <p>Command Syntax 0841₁₆ <calc_channel> <points></p> <p>Query Syntax 8841₁₆ <calc_channel> → <points></p> <p>Parameters: <calc_channel> Type: 16-bit unsigned integer</p> <p>0002₁₆ Calculation Channel 1 0003₁₆ Calculation Channel 2</p> <p><points> Type: 16-bit unsigned integer</p> <p>Range: 2 to 40 points</p>
<p>Calculate Voltage Offset Command 0802₁₆</p> <p>Calculate Voltage Offset Query 8802₁₆</p>	<p>Sets or queries the DC voltage offset for the calculate channel (calc_channel). When a calculate channel is configured, the unit derives a DC offset voltage that is represented at the vertical center for the selected channel.</p> <p>Command Syntax 0802₁₆ <calc_channel> <offset_volts></p> <p>Query Syntax 8802₁₆ <calc_channel> → <offset_volts></p> <p>Parameters: <calc_channel> Type: 16-bit unsigned integer</p> <p>0002₁₆ Calculation Channel 1 0003₁₆ Calculation Channel 2</p> <p><offset_volts> Type: 32-bit floating point</p>

Name	Description
<p>Calculate Voltage Range Command 0801₁₆</p> <p>Calculate Voltage Range Query 8801₁₆</p>	<p>Sets or queries the expected voltage range for the calculate channel (calc_channel).</p> <p>Command Syntax 0801₁₆ <calc_channel> <range></p> <p>Query Syntax 8801₁₆ <calc_channel> → <range></p> <p>Parameters: <calc_channel> Type: 16-bit unsigned integer</p> <p>0002₁₆ Calculation Channel 1 0003₁₆ Calculation Channel 2</p> <p><range> Type: 32-bit floating point</p>
<p>Calibrate Query 8600₁₆</p>	<p>Initiates and returns the results of the unit self-calibration process. The self-calibration performs automatic zero DC offset null calibration for all combinations of input range and filter settings for both channels. The instrument is reset upon completion of the calibration process.</p> <p>Note: The two input channels <u>must</u> be disconnected or be driven with 0.0 VDC before starting the calibration.</p> <p>The timeout value should be set to infinite before starting the calibration, and reset to the default value when completed.</p> <p>Note: Do <u>not</u> interrupt the instrument during calibration or the calibration tables could be corrupted.</p> <p>Command Syntax None</p> <p>Query Syntax 8600₁₆ → <result></p> <p>Parameters: <result> Type: 16-bit signed integer</p> <p>0 = Pass 1 = Fail (Did not converge) 2 = Corrupt</p>

Name	Description
Calibrate Restore Factory Defaults Command 0610 ₁₆	<p>Restores the factory default calibration data. This will clear all self-calibration data resulting from the <i>Calibrate Query</i> that is used to automatically null the zero DC offset.</p> <p>Command Syntax 0610₁₆</p> <p>Query Syntax None</p> <p>Parameters: None</p>
Clear Status Command 0A00 ₁₆	<p>The clear status command clears all event registers, the request for OPC flag, and all status queues (except the response queue).</p> <p>Command Syntax 0A00₁₆</p> <p>Query Syntax None</p> <p>Parameters None</p>

Name	Description												
<p>Clock Frequency Command 0405₁₆</p> <p>Clock Frequency Query 8405₁₆</p>	<p>Sets or queries the sample clock frequency in Hertz.</p> <p>The following considerations apply when setting the clock frequency:</p> <ul style="list-style-type: none"> • A frequency <u>must</u> be entered when using an external sample clock in order to setup timing parameters. • Whenever a frequency changes for an external sample clock, the new frequency must be entered after the external clock has settled at the new frequency. <p>Command Syntax 0405₁₆ <frequency></p> <p>Query Syntax 8405₁₆ → <frequency></p> <p>Parameters <frequency> Type: 32-bit floating point</p> <p>Range: Internal Clock Source</p> <table border="1" data-bbox="602 905 1417 1129"> <thead> <tr> <th data-bbox="602 905 842 1003">Product Option</th> <th data-bbox="842 905 1130 1003">1 Channel Maximum Sample Rate</th> <th data-bbox="1130 905 1417 1003">2 Channel Maximum Sample Rate</th> </tr> </thead> <tbody> <tr> <td data-bbox="602 1003 842 1045">ZT450-0X</td> <td data-bbox="842 1003 1130 1045">2 GS/s</td> <td data-bbox="1130 1003 1417 1045">1 GS/s</td> </tr> <tr> <td data-bbox="602 1045 842 1087">ZT450-2X</td> <td data-bbox="842 1045 1130 1087">1 GS/s</td> <td data-bbox="1130 1045 1417 1087">500 MS/s</td> </tr> <tr> <td data-bbox="602 1087 842 1129">ZT450-5X</td> <td data-bbox="842 1087 1130 1129">2.5 GS/s</td> <td data-bbox="1130 1087 1417 1129">1.25 GS/s</td> </tr> </tbody> </table> <p>2.5 kS/s to 2-Channel Maximum Sample Rate in 1, 2.5, or 5 steps 1 GS/s, 1 channel interleaved (ZT450-2X) 2 GS/s, 1 channel interleaved (ZT450-0X or ZT450-5X) 2.5 GS/s, 1 channel interleaved (ZT450-5X)</p> <p>Range: External Clock Source 200 MS/s to 1 GS/s</p>	Product Option	1 Channel Maximum Sample Rate	2 Channel Maximum Sample Rate	ZT450-0X	2 GS/s	1 GS/s	ZT450-2X	1 GS/s	500 MS/s	ZT450-5X	2.5 GS/s	1.25 GS/s
Product Option	1 Channel Maximum Sample Rate	2 Channel Maximum Sample Rate											
ZT450-0X	2 GS/s	1 GS/s											
ZT450-2X	1 GS/s	500 MS/s											
ZT450-5X	2.5 GS/s	1.25 GS/s											

Name	Description
<p>Clock Source Command 0404₁₆</p> <p>Clock Source Query 8404₁₆</p>	<p>Sets or queries the selected sample clock source. Internal generator or external input sample clock sources are supported.</p> <p>Note: An external clock source <u>must</u> be present before setting to external clock.</p> <p>Command Syntax 0404₁₆ <source></p> <p>Query Syntax 8404₁₆ → <source></p> <p>Parameters <source> Type: 16-bit unsigned integer</p> <p>0000₁₆ Internal sample clock 0001₁₆ External sample clock</p>
<p>Event Status Enable Command 0A03₁₆</p> <p>Event Status Enable Query 8A03₁₆</p>	<p>The command allows users to Enable or Disable bits in the Standard Event Status Register. The query returns the bit mask of the standard event status register. That is, it returns a bit mask which indicates those standard event status register bits that are enabled. The command parameter is a bit mask which enables the corresponding standard event status register bits.</p> <p>Command Syntax 0A03₁₆ <enable></p> <p>Query Syntax 8A03₁₆ → <enable></p> <p>Parameters: <enable> Type: 16-bit unsigned integer</p> <p>Range: 0 to 255</p> <p>0001₁₆ Operation Complete Bit 0002₁₆ Request Control Bit 0004₁₆ Query Error Bit 0008₁₆ Device Dependent Error Bit 0010₁₆ Execution Error Bit 0020₁₆ Command Error Bit 0040₁₆ User Request Bit 0080₁₆ Power On Bit</p>

Name	Description
<p>Event Status Query 8A02₁₆</p>	<p>Returns the status bits for the Standard Event Status Register.</p> <p>Command Syntax None</p> <p>Query Syntax 8A02₁₆ → <status></p> <p>Parameters <status> Type: 16-bit unsigned integer</p> <p>Range: 0 to 255</p> <ul style="list-style-type: none"> 0001₁₆ Operation Complete Bit 0002₁₆ Request Control Bit 0004₁₆ Query Error Bit 0008₁₆ Device Dependent Error Bit 0010₁₆ Execution Error Bit 0020₁₆ Command Error Bit 0040₁₆ User Request Bit 0080₁₆ Power On Bit
<p>External Trigger Polarity Command 020F₁₆</p> <p>External Trigger Polarity Query 820F₁₆</p>	<p>Sets the polarity of the external trigger output when the output is enabled. When positive output polarity is selected, the output driver forces a low logic “0” onto the TTL output when the signal source is active, i.e. for a positive polarity setting and an Arm source signal, the external trigger output will be a low TTL logic level when the unit is armed.</p> <p>Command Syntax 020F₁₆ <polarity></p> <p>Query Syntax 820F₁₆ → <polarity></p> <p>Parameters <polarity> Type: 16-bit unsigned integer</p> <ul style="list-style-type: none"> 0000₁₆ Negative polarity 0001₁₆ Positive polarity

Name	Description
<p>External Trigger Source Command 020E₁₆</p> <p>External Trigger Source Query 820E₁₆</p>	<p>Selects the source for the external trigger output when enabled.</p> <p>Command Syntax 020E₁₆ <source></p> <p>Query Syntax 820E₁₆ → <source></p> <p>Parameters <source> Type: 16-bit unsigned integer</p> <p>0000₁₆ Arm Event 0001₁₆ Trigger Event 0002₁₆ Constant State 0003₁₆ Operation Complete 0004₁₆ 10 MHz Timebase Reference Clock 0005₁₆ 500 Hz Clock 0006₁₆ 10 ns Pulse at 1 ms Repetition Interval</p>
<p>External Trigger State Command 020D₁₆</p> <p>External Trigger State Query 820D₁₆</p>	<p>Allows the user to enable or disable the external trigger output.</p> <p>Command Syntax 020D₁₆ <state></p> <p>Query Syntax 820D₁₆ → <state></p> <p>Parameters <state> Type: 16-bit unsigned integer</p> <p>0000₁₆ Inactive state 0001₁₆ Active state</p>
<p>Format Byte Command 0010₁₆</p> <p>Format Byte Query 8010₁₆</p>	<p>Sets and returns the current byte order setting. Normal byte order is MSB first, Swapped is LSB first.</p> <p>Command Syntax 0010₁₆ <order></p> <p>Query Syntax 8010₁₆ → <order></p> <p>Parameters: <order> Type: 16-bit unsigned integer</p> <p>0000₁₆ Normal byte order (MSB first) 0001₁₆ Swapped byte order (LSB first)</p>

Name	Description
<p>ID Query 8103₁₆</p>	<p>Returns the instrument identification including manufacturer, model number, serial number and firmware version as a block of ASCII string data up to 44 characters in length. The string will be of this form: "ZTEC,ZT450PXI-nn,S/N nnn,Version n.nn".</p> <p>Command Syntax None</p> <p>Query Syntax 8103₁₆ → <char_n></p> <p>Parameters <char_n> Type: character string</p> <p>Example: Returns a string of characters in the form: "ZTEC,ZT450PXI-00,S/N 100,Version 1.00"</p>
<p>Initiate Command 0304₁₆</p> <p>Initiate Query 8304₁₆</p>	<p>Initiates the instrument. While initiated, the instrument is enabled to acquire waveforms and perform calculations and measurements.</p> <p>Command Syntax 0304₁₆ <state></p> <p>Query Syntax 8304₁₆ → <state></p> <p>Parameters: <state> Type: 16-bit unsigned integer</p> <p>0000₁₆ Inactive 0001₁₆ Active</p>
<p>Initiate Continuous Command 0309₁₆</p> <p>Initiate Continuous Query 8309₁₆</p>	<p>Sets or returns the instrument initiate continuous state. This is usually only used for limit and mask tests.</p> <p>Command Syntax 0309₁₆ <state></p> <p>Query Syntax 8309₁₆ → <state></p> <p>Parameters: <state> Type: 16-bit unsigned integer</p> <p>0000₁₆ Initiate Continuous OFF 0001₁₆ Initiate Continuous ON</p>

Name	Description
<p>Input Attenuation Command 0411₁₆</p> <p>Input Attenuation Query 8411₁₆</p>	<p>Sets or queries the external attenuation for an input signal. The attenuation feature allows the user to set voltage levels using non-attenuated values.</p> <p>Command Syntax 0411₁₆ <source> <attenuation></p> <p>Query Syntax 8411₁₆ <source> → <attenuation></p> <p>Parameters: <source> Type: 16-bit unsigned integer</p> <p>0000₁₆ Input Channel 1 0001₁₆ Input Channel 2</p> <p><attenuation> Type: 32-bit floating point</p> <p>Range: 0.9 to 1000.0</p>

Name	Description
<p>Input Coupling Command 0412₁₆</p> <p>Input Coupling Query 8412₁₆</p>	<p>Sets or queries the input signal coupling. The signal coupling feature allows the user to selectively pass or block the DC component of an input signal. The following considerations apply when using the input coupling command:</p> <ul style="list-style-type: none"> • DC coupling passes all frequencies equally • AC coupling blocks low frequencies. • AC coupling and input impedance setting interact to set the low frequency cutoff frequency. AC and high input impedance attenuates frequencies below 10 Hz. AC coupling and low input impedance attenuates frequencies below 200 kHz. <p>Command Syntax 0412₁₆ <input> <coupling></p> <p>Query Syntax 8412₁₆ <input> → <coupling></p> <p>Parameters: <input> Type: 16-bit unsigned integer</p> <p style="padding-left: 40px;">0000₁₆ Input Channel 1 0001₁₆ Input Channel 2</p> <p><coupling> Type: 16-bit unsigned integer</p> <p style="padding-left: 40px;">0000₁₆ AC 0001₁₆ DC</p>

Name	Description
<p>Input Filter State Command 0416₁₆</p> <p>Input Filter State Query 8416₁₆</p>	<p>Sets or queries the input analog filter state.</p> <p>Command Syntax 0416₁₆ <input> <filter_state></p> <p>Query Syntax 8416₁₆ <input> → <filter_state></p> <p>Parameters: <input> Type: 16-bit unsigned integer</p> <p>0000₁₆ Input Channel 1 0001₁₆ Input Channel 2</p> <p><filter_state> Type: 16-bit unsigned integer</p> <p>0000₁₆ Bypass 0001₁₆ 20 MHz</p>
<p>Input Impedance Command 0413₁₆</p> <p>Input Impedance Query 8413₁₆</p>	<p>Sets or queries the input impedance in ohms.</p> <p>Note: When setting the input impedance, set a temporary level to preclude setting an incompatible impedance range. Set the range to 10.0V (which is valid for both low and high impedances) before changing the value to the new setting.</p> <p>Command Syntax 0413₁₆ <input> <ohms></p> <p>Query Syntax 8413₁₆ <input> → <ohms></p> <p>Parameters: <input> Type: 16-bit unsigned integer</p> <p>0000₁₆ Input Channel 1 0001₁₆ Input Channel 2</p> <p><ohms> Type: 32-bit floating point</p> <p>50 Low Impedance 1e6 High Impedance</p>

Name	Description
<p>Input State Command 0410₁₆</p> <p>Input State Query 8410₁₆</p>	<p>Enables or disables an input channel capture.</p> <p>Command Syntax 0410₁₆ <input> <input_state></p> <p>Query Syntax 8410₁₆ <input> → <input_state></p> <p>Parameters: <input> Type: 16-bit unsigned integer</p> <p>0000₁₆ Input Channel 1 0001₁₆ Input Channel 2</p> <p><input_state> Type: 16-bit unsigned integer</p> <p>0000₁₆ Off 0001₁₆ On</p>

Name	Description																																																																												
<p>Input Voltage Offset Command 040C₁₆</p> <p>Input Voltage Offset Query 840C₁₆</p>	<p>Sets or queries the specified input channel voltage offset.</p> <p>Note: The limits upon the input voltage offset setting are dependent upon the input voltage range.</p> <p>Command Syntax 040C₁₆ <input> <volts></p> <p>Query Syntax 840C₁₆ <input> → <volts></p> <p>Parameters: <input> Type: 16-bit unsigned integer</p> <p>0000₁₆ Input Channel 1 0001₁₆ Input Channel 2</p> <p><volts> Type: 32-bit floating point</p> <table border="1" data-bbox="597 905 1419 1822"> <thead> <tr> <th data-bbox="604 913 756 995">Impedance</th> <th colspan="2" data-bbox="763 913 1084 953">ZT450-0X or ZT450-2X</th> <th colspan="2" data-bbox="1091 913 1412 953">ZT450-5X</th> </tr> <tr> <td></td> <th data-bbox="763 961 915 995">Range</th> <th data-bbox="922 961 1084 995">Offset</th> <th data-bbox="1091 961 1243 995">Range</th> <th data-bbox="1250 961 1412 995">Offset</th> </tr> </thead> <tbody> <tr> <td data-bbox="604 1003 756 1457" rowspan="8">1 MΩ</td> <td data-bbox="763 1003 915 1037">100 Vpp</td> <td data-bbox="922 1003 1084 1037">±100V</td> <td data-bbox="1091 1003 1243 1037">100 Vpp</td> <td data-bbox="1250 1003 1412 1037">±50V</td> </tr> <tr> <td data-bbox="763 1045 915 1079">50 Vpp</td> <td data-bbox="922 1045 1084 1079">±100V</td> <td data-bbox="1091 1045 1243 1079">50 Vpp</td> <td data-bbox="1250 1045 1412 1079">±25V</td> </tr> <tr> <td data-bbox="763 1087 915 1121">20 Vpp</td> <td data-bbox="922 1087 1084 1121">±100V</td> <td data-bbox="1091 1087 1243 1121">20 Vpp</td> <td data-bbox="1250 1087 1412 1121">±10V</td> </tr> <tr> <td data-bbox="763 1129 915 1163">10 Vpp</td> <td data-bbox="922 1129 1084 1163">±100V</td> <td data-bbox="1091 1129 1243 1163">10 Vpp</td> <td data-bbox="1250 1129 1412 1163">±5V</td> </tr> <tr> <td data-bbox="763 1171 915 1205">5 Vpp</td> <td data-bbox="922 1171 1084 1205">±5V</td> <td data-bbox="1091 1171 1243 1205">5 Vpp</td> <td data-bbox="1250 1171 1412 1205">±2.5V</td> </tr> <tr> <td data-bbox="763 1213 915 1247">2.5 Vpp</td> <td data-bbox="922 1213 1084 1247">±5V</td> <td data-bbox="1091 1213 1243 1247">2.5 Vpp</td> <td data-bbox="1250 1213 1412 1247">±1.25V</td> </tr> <tr> <td data-bbox="763 1255 915 1289">1 Vpp</td> <td data-bbox="922 1255 1084 1289">±5V</td> <td data-bbox="1091 1255 1243 1289">1 Vpp</td> <td data-bbox="1250 1255 1412 1289">±0.5V</td> </tr> <tr> <td data-bbox="763 1297 915 1457">0.5 Vpp</td> <td data-bbox="922 1297 1084 1331">±5V</td> <td data-bbox="1091 1297 1243 1457">0.5 Vpp 0.2 Vpp 0.1 Vpp</td> <td data-bbox="1250 1297 1412 1457">±0.25V ±0.1V ±0.05V</td> </tr> <tr> <td data-bbox="604 1465 756 1822" rowspan="8">50Ω</td> <td data-bbox="763 1465 915 1499">10 Vpp</td> <td data-bbox="922 1465 1084 1499">±10V</td> <td data-bbox="1091 1465 1243 1499">10 Vpp</td> <td data-bbox="1250 1465 1412 1499">±5V</td> </tr> <tr> <td data-bbox="763 1507 915 1541">5 Vpp</td> <td data-bbox="922 1507 1084 1541">±10V</td> <td data-bbox="1091 1507 1243 1541">5 Vpp</td> <td data-bbox="1250 1507 1412 1541">±2.5V</td> </tr> <tr> <td data-bbox="763 1549 915 1583">2 Vpp</td> <td data-bbox="922 1549 1084 1583">±10V</td> <td data-bbox="1091 1549 1243 1583">2 Vpp</td> <td data-bbox="1250 1549 1412 1583">±1V</td> </tr> <tr> <td data-bbox="763 1591 915 1625">1 Vpp</td> <td data-bbox="922 1591 1084 1625">±10V</td> <td data-bbox="1091 1591 1243 1625">1 Vpp</td> <td data-bbox="1250 1591 1412 1625">±0.5V</td> </tr> <tr> <td data-bbox="763 1633 915 1667">0.5 Vpp</td> <td data-bbox="922 1633 1084 1667">±0.5V</td> <td data-bbox="1091 1633 1243 1667">0.5 Vpp</td> <td data-bbox="1250 1633 1412 1667">±0.25V</td> </tr> <tr> <td data-bbox="763 1675 915 1709">0.25 Vpp</td> <td data-bbox="922 1675 1084 1709">±0.5V</td> <td data-bbox="1091 1675 1243 1709">0.25 Vpp</td> <td data-bbox="1250 1675 1412 1709">±0.125V</td> </tr> <tr> <td data-bbox="763 1717 915 1751">0.1 Vpp</td> <td data-bbox="922 1717 1084 1751">±0.5V</td> <td data-bbox="1091 1717 1243 1751">0.1 Vpp</td> <td data-bbox="1250 1717 1412 1751">±0.05V</td> </tr> <tr> <td data-bbox="763 1759 915 1822">0.05 Vpp</td> <td data-bbox="922 1759 1084 1793">±0.5V</td> <td data-bbox="1091 1759 1243 1793">0.05 Vpp</td> <td data-bbox="1250 1759 1412 1793">±0.025V</td> </tr> </tbody> </table>	Impedance	ZT450-0X or ZT450-2X		ZT450-5X			Range	Offset	Range	Offset	1 MΩ	100 Vpp	±100V	100 Vpp	±50V	50 Vpp	±100V	50 Vpp	±25V	20 Vpp	±100V	20 Vpp	±10V	10 Vpp	±100V	10 Vpp	±5V	5 Vpp	±5V	5 Vpp	±2.5V	2.5 Vpp	±5V	2.5 Vpp	±1.25V	1 Vpp	±5V	1 Vpp	±0.5V	0.5 Vpp	±5V	0.5 Vpp 0.2 Vpp 0.1 Vpp	±0.25V ±0.1V ±0.05V	50Ω	10 Vpp	±10V	10 Vpp	±5V	5 Vpp	±10V	5 Vpp	±2.5V	2 Vpp	±10V	2 Vpp	±1V	1 Vpp	±10V	1 Vpp	±0.5V	0.5 Vpp	±0.5V	0.5 Vpp	±0.25V	0.25 Vpp	±0.5V	0.25 Vpp	±0.125V	0.1 Vpp	±0.5V	0.1 Vpp	±0.05V	0.05 Vpp	±0.5V	0.05 Vpp	±0.025V
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Name	Description
Input Voltage Protection State Command 040B ₁₆	Sets or queries the specified input channel voltage protection state. Command Syntax 040B ₁₆ <input> <state>
Input Voltage Protection State Query 840B ₁₆	Query Syntax 840B ₁₆ <input> → <state> Parameters: <input> Type: 16-bit unsigned integer 0000 ₁₆ Input Channel 1 0001 ₁₆ Input Channel 2 <state> Type: 16-bit unsigned integer 0000 ₁₆ Off 0001 ₁₆ On

Name	Description																																																																																				
<p>Input Voltage Range Command 0407₁₆</p> <p>Input Voltage Range Query 8407₁₆</p>	<p>Sets or queries the specified input channel voltage range.</p> <p>Note: The limits upon the input voltage offset setting are dependent upon the input voltage range. When setting the input voltage range, set a temporary offset level of 0.0V to preclude setting an incompatible range and offset.</p> <p>Command Syntax 0407₁₆ <input> <volts></p> <p>Query Syntax 8407₁₆ <input> → <volts></p> <p>Parameters: <input> Type: 16-bit unsigned integer</p> <p>0000₁₆ Input Channel 1 0001₁₆ Input Channel 2</p> <p><volts> Type: 32-bit floating point</p> <table border="1" data-bbox="597 961 1419 1890"> <thead> <tr> <th data-bbox="604 970 753 1012">Impedance</th> <th colspan="2" data-bbox="760 970 1084 1012">ZT450-0X or ZT450-2X</th> <th colspan="2" data-bbox="1091 970 1412 1012">ZT450-5X</th> </tr> <tr> <th data-bbox="604 1020 753 1062"></th> <th data-bbox="760 1020 922 1062">Range</th> <th data-bbox="928 1020 1084 1062">Offset</th> <th data-bbox="1091 1020 1253 1062">Range</th> <th data-bbox="1260 1020 1412 1062">Offset</th> </tr> </thead> <tbody> <tr> <td data-bbox="604 1071 753 1516" rowspan="10">1 MΩ</td> <td data-bbox="760 1071 922 1102">100 Vpp</td> <td data-bbox="928 1071 1084 1102">±100V</td> <td data-bbox="1091 1071 1253 1102">100 Vpp</td> <td data-bbox="1260 1071 1412 1102">±50V</td> </tr> <tr> <td data-bbox="760 1110 922 1142">50 Vpp</td> <td data-bbox="928 1110 1084 1142">±100V</td> <td data-bbox="1091 1110 1253 1142">50 Vpp</td> <td data-bbox="1260 1110 1412 1142">±25V</td> </tr> <tr> <td data-bbox="760 1150 922 1182">20 Vpp</td> <td data-bbox="928 1150 1084 1182">±100V</td> <td data-bbox="1091 1150 1253 1182">20 Vpp</td> <td data-bbox="1260 1150 1412 1182">±10V</td> </tr> <tr> <td data-bbox="760 1190 922 1222">10 Vpp</td> <td data-bbox="928 1190 1084 1222">±100V</td> <td data-bbox="1091 1190 1253 1222">10 Vpp</td> <td data-bbox="1260 1190 1412 1222">±5V</td> </tr> <tr> <td data-bbox="760 1230 922 1262">5 Vpp</td> <td data-bbox="928 1230 1084 1262">±5V</td> <td data-bbox="1091 1230 1253 1262">5 Vpp</td> <td data-bbox="1260 1230 1412 1262">±2.5V</td> </tr> <tr> <td data-bbox="760 1270 922 1302">2.5 Vpp</td> <td data-bbox="928 1270 1084 1302">±5V</td> <td data-bbox="1091 1270 1253 1302">2.5 Vpp</td> <td data-bbox="1260 1270 1412 1302">±1.25V</td> </tr> <tr> <td data-bbox="760 1310 922 1341">1 Vpp</td> <td data-bbox="928 1310 1084 1341">±5V</td> <td data-bbox="1091 1310 1253 1341">1 Vpp</td> <td data-bbox="1260 1310 1412 1341">±0.5V</td> </tr> <tr> <td data-bbox="760 1350 922 1381">0.5 Vpp</td> <td data-bbox="928 1350 1084 1381">±5V</td> <td data-bbox="1091 1350 1253 1381">0.5 Vpp</td> <td data-bbox="1260 1350 1412 1381">±0.25V</td> </tr> <tr> <td data-bbox="760 1390 922 1421"></td> <td data-bbox="928 1390 1084 1421"></td> <td data-bbox="1091 1390 1253 1421">0.2 Vpp</td> <td data-bbox="1260 1390 1412 1421">±0.1V</td> </tr> <tr> <td data-bbox="760 1430 922 1461"></td> <td data-bbox="928 1430 1084 1461"></td> <td data-bbox="1091 1430 1253 1461">0.1 Vpp</td> <td data-bbox="1260 1430 1412 1461">±0.05V</td> </tr> <tr> <td data-bbox="604 1524 753 1890" rowspan="8">50Ω</td> <td data-bbox="760 1524 922 1556">10 Vpp</td> <td data-bbox="928 1524 1084 1556">±10V</td> <td data-bbox="1091 1524 1253 1556">10 Vpp</td> <td data-bbox="1260 1524 1412 1556">±5V</td> </tr> <tr> <td data-bbox="760 1564 922 1596">5 Vpp</td> <td data-bbox="928 1564 1084 1596">±10V</td> <td data-bbox="1091 1564 1253 1596">5 Vpp</td> <td data-bbox="1260 1564 1412 1596">±2.5V</td> </tr> <tr> <td data-bbox="760 1604 922 1635">2 Vpp</td> <td data-bbox="928 1604 1084 1635">±10V</td> <td data-bbox="1091 1604 1253 1635">2 Vpp</td> <td data-bbox="1260 1604 1412 1635">±1V</td> </tr> <tr> <td data-bbox="760 1644 922 1675">1 Vpp</td> <td data-bbox="928 1644 1084 1675">±10V</td> <td data-bbox="1091 1644 1253 1675">1 Vpp</td> <td data-bbox="1260 1644 1412 1675">±0.5V</td> </tr> <tr> <td data-bbox="760 1684 922 1715">0.5 Vpp</td> <td data-bbox="928 1684 1084 1715">±0.5V</td> <td data-bbox="1091 1684 1253 1715">0.5 Vpp</td> <td data-bbox="1260 1684 1412 1715">±0.25V</td> </tr> <tr> <td data-bbox="760 1724 922 1755">0.25 Vpp</td> <td data-bbox="928 1724 1084 1755">±0.5V</td> <td data-bbox="1091 1724 1253 1755">0.25 Vpp</td> <td data-bbox="1260 1724 1412 1755">±0.125V</td> </tr> <tr> <td data-bbox="760 1764 922 1795">0.1 Vpp</td> <td data-bbox="928 1764 1084 1795">±0.5V</td> <td data-bbox="1091 1764 1253 1795">0.1 Vpp</td> <td data-bbox="1260 1764 1412 1795">±0.05V</td> </tr> <tr> <td data-bbox="760 1803 922 1835">0.05 Vpp</td> <td data-bbox="928 1803 1084 1835">±0.5V</td> <td data-bbox="1091 1803 1253 1835">0.05 Vpp</td> <td data-bbox="1260 1803 1412 1835">±0.025V</td> </tr> </tbody> </table>	Impedance	ZT450-0X or ZT450-2X		ZT450-5X			Range	Offset	Range	Offset	1 MΩ	100 Vpp	±100V	100 Vpp	±50V	50 Vpp	±100V	50 Vpp	±25V	20 Vpp	±100V	20 Vpp	±10V	10 Vpp	±100V	10 Vpp	±5V	5 Vpp	±5V	5 Vpp	±2.5V	2.5 Vpp	±5V	2.5 Vpp	±1.25V	1 Vpp	±5V	1 Vpp	±0.5V	0.5 Vpp	±5V	0.5 Vpp	±0.25V			0.2 Vpp	±0.1V			0.1 Vpp	±0.05V	50Ω	10 Vpp	±10V	10 Vpp	±5V	5 Vpp	±10V	5 Vpp	±2.5V	2 Vpp	±10V	2 Vpp	±1V	1 Vpp	±10V	1 Vpp	±0.5V	0.5 Vpp	±0.5V	0.5 Vpp	±0.25V	0.25 Vpp	±0.5V	0.25 Vpp	±0.125V	0.1 Vpp	±0.5V	0.1 Vpp	±0.05V	0.05 Vpp	±0.5V	0.05 Vpp	±0.025V
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Name	Description
<p>Measure AC High-Precision Query 872F₁₆</p>	<p>Queries the high-precision AC RMS level of the selected waveform source. This measurement increases the measurement accuracy of waveform records having more than 8-bit resolution, such as averaged waveforms. The added precision requires approximately 10X processing time. The added precision is most noticeable when there is a non-zero input offset adjustment.</p> <p><i>Root-mean-square (RMS)</i> refers to the most common mathematical method of defining the effective voltage or current of an AC wave. This method subtracts the AC voltage average before computing the RMS value.</p> <p>For a sine wave, the rms value is 0.707 times the peak value, or 0.354 times the peak-to-peak value.</p> <p>Command Syntax None</p> <p>Query Syntax 872F₁₆ <source> → <ac_volts></p> <p>Parameters <source> Type: 16-bit unsigned integer</p> <ul style="list-style-type: none"> 0000₁₆ Input Channel 1 0001₁₆ Input Channel 2 0002₁₆ Calculation Channel 1 0003₁₆ Calculation Channel 2 0004₁₆ Reference Channel 1 0005₁₆ Reference Channel 2 0006₁₆ Reference Channel 3 0007₁₆ Reference Channel 4 <p><ac_volts> Type: 32-bit floating point</p>

Name	Description
<p>Measure AC RMS Query 8710₁₆</p>	<p>Queries the AC RMS level of the selected waveform source.</p> <p><i>Root-mean-square (RMS)</i> refers to the most common mathematical method of defining the effective voltage or current of an AC wave. This method subtracts the AC voltage average before computing the RMS value.</p> <p>For a sine wave, the rms value is 0.707 times the peak value, or 0.354 times the peak-to-peak value.</p> <p>Command Syntax None</p> <p>Query Syntax 8710₁₆ <source> → <ac_volts></p> <p>Parameters <source> Type: 16-bit unsigned integer</p> <ul style="list-style-type: none"> 0000₁₆ Input Channel 1 0001₁₆ Input Channel 2 0002₁₆ Calculation Channel 1 0003₁₆ Calculation Channel 2 0004₁₆ Reference Channel 1 0005₁₆ Reference Channel 2 0006₁₆ Reference Channel 3 0007₁₆ Reference Channel 4 <p><ac_volts> Type: 32-bit floating point</p>

Name	Description
Measure Amplitude Query 8711 ₁₆	<p>Queries the amplitude of the selected waveform source. The amplitude measurement assumes a bi-level signal with distinct high and low levels and is defined as (waveform high level – waveform low level). Use the <i>Measure Peak-to-Peak Voltage Query</i> to detect signal amplitude without assuming a bi-level signal.</p> <p>Command Syntax None</p> <p>Query Syntax 8711₁₆ <source> → <amplitude_volts></p> <p>Parameters <source> Type: 16-bit unsigned integer</p> <ul style="list-style-type: none"> 0000₁₆ Input Channel 1 0001₁₆ Input Channel 2 0002₁₆ Calculation Channel 1 0003₁₆ Calculation Channel 2 0004₁₆ Reference Channel 1 0005₁₆ Reference Channel 2 0006₁₆ Reference Channel 3 0007₁₆ Reference Channel 4 <p><amplitude_volts> Type: 32-bit floating point</p>

Name	Description
Measure Average Voltage Query 8712 ₁₆	<p>Queries the average voltage level of the selected waveform source. The average voltage is defined as the sum of all the sample voltage values in the waveform record divided by the number of samples.</p> <p>Command Syntax None</p> <p>Query Syntax 8712₁₆ <source> → <average_volts></p> <p>Parameters <source> Type: 16-bit unsigned integer</p> <ul style="list-style-type: none"> 0000₁₆ Input Channel 1 0001₁₆ Input Channel 2 0002₁₆ Calculation Channel 1 0003₁₆ Calculation Channel 2 0004₁₆ Reference Channel 1 0005₁₆ Reference Channel 2 0006₁₆ Reference Channel 3 0007₁₆ Reference Channel 4 <p><average_volts> Type: 32-bit floating point</p>
Measure Cycle Average Query 872C ₁₆	<p>Queries the average level of one cycle of the selected waveform source. This is always the first cycle seen.</p> <p>Command Syntax None</p> <p>Query Syntax 872C₁₆ <source> → <average></p> <p>Parameters: <source> Type: 16-bit unsigned integer</p> <ul style="list-style-type: none"> 0000₁₆ Input Channel 1 0001₁₆ Input Channel 2 0002₁₆ Calculation Channel 1 0003₁₆ Calculation Channel 2 0004₁₆ Reference Channel 1 0005₁₆ Reference Channel 2 0006₁₆ Reference Channel 3 0007₁₆ Reference Channel 4 <p><average> Type: 32-bit floating point</p>

Name	Description
<p>Measure Cycle Frequency Query 872D₁₆</p>	<p>Queries the frequency for one cycle of the waveform. This is always the first cycle seen.</p> <p>Command Syntax None</p> <p>Query Syntax 872D₁₆ <source> → <frequency></p> <p>Parameters: <source> Type: 16-bit unsigned integer</p> <p>0000₁₆ Input Channel 1 0001₁₆ Input Channel 2 0002₁₆ Calculation Channel 1 0003₁₆ Calculation Channel 2 0004₁₆ Reference Channel 1 0005₁₆ Reference Channel 2 0006₁₆ Reference Channel 3 0007₁₆ Reference Channel 4</p> <p><frequency> Type: 32-bit floating point</p>
<p>Measure Cycle Period Query 872E₁₆</p>	<p>Queries the period for one cycle of the waveform. This is always the first cycle seen.</p> <p>Command Syntax None</p> <p>Query Syntax 872E₁₆ <source> → <period></p> <p>Parameters: <source> Type: 16-bit unsigned integer</p> <p>0000₁₆ Input Channel 1 0001₁₆ Input Channel 2 0002₁₆ Calculation Channel 1 0003₁₆ Calculation Channel 2 0004₁₆ Reference Channel 1 0005₁₆ Reference Channel 2 0006₁₆ Reference Channel 3 0007₁₆ Reference Channel 4</p> <p><period> Type: 32-bit floating point</p>

Name	Description
Measure Cycle RMS Query 872B ₁₆	<p>Queries the voltage RMS for one cycle of the waveform, measured from mid-point to mid-point. This is always the first cycle seen.</p> <p>Command Syntax None</p> <p>Query Syntax 872B₁₆ <source> → <volts_rms></p> <p>Parameters: <source> Type: 16-bit unsigned integer</p> <ul style="list-style-type: none"> 0000₁₆ Input Channel 1 0001₁₆ Input Channel 2 0002₁₆ Calculation Channel 1 0003₁₆ Calculation Channel 2 0004₁₆ Reference Channel 1 0005₁₆ Reference Channel 2 0006₁₆ Reference Channel 3 0007₁₆ Reference Channel 4 <p><volts_rms> Type: 32-bit floating point</p>

Name	Description
Measure DC High-Precision Query 8730 ₁₆	<p>Queries the high-precision DC RMS level of the selected waveform source. This measurement increases the measurement accuracy of waveform records having more than 8-bit resolution, such as averaged waveforms. The added precision requires approximately 10X processing time. The added precision is most noticeable when there is a non-zero input offset adjustment.</p> <p>Command Syntax None</p> <p>Query Syntax 8730₁₆ <source> → <dc_volts></p> <p>Parameters <source> Type: 16-bit unsigned integer</p> <ul style="list-style-type: none"> 0000₁₆ Input Channel 1 0001₁₆ Input Channel 2 0002₁₆ Calculation Channel 1 0003₁₆ Calculation Channel 2 0004₁₆ Reference Channel 1 0005₁₆ Reference Channel 2 0006₁₆ Reference Channel 3 0007₁₆ Reference Channel 4 <p><dc_volts> Type: 32-bit floating point</p>
Measure DC RMS Query 8713 ₁₆	<p>Queries the DC RMS level of the selected waveform source.</p> <p>Command Syntax None</p> <p>Query Syntax 8713₁₆ <source> → <dc_volts></p> <p>Parameters <source> Type: 16-bit unsigned integer</p> <ul style="list-style-type: none"> 0000₁₆ Input Channel 1 0001₁₆ Input Channel 2 0002₁₆ Calculation Channel 1 0003₁₆ Calculation Channel 2 0004₁₆ Reference Channel 1 0005₁₆ Reference Channel 2 0006₁₆ Reference Channel 3 0007₁₆ Reference Channel 4 <p><dc_volts> Type: 32-bit floating point</p>

Name	Description
<p>Measure Edge Command 0700₁₆</p> <p>Measure Edge Query 8700₁₆</p>	<p>Sets or queries the waveform edge used in edge-related measurements. A falling or rising edge is selected using a 16-bit unsigned integer value and is used in the following measurement types: rise time, rise crossing time, rise overshoot, rise preshoot, fall time, fall crossing time, fall preshoot, and fall overshoot.</p> <p>Command Syntax 0700₁₆ <edge></p> <p>Query Syntax 8700₁₆ → <edge></p> <p>Parameters: <edge> Type: 16-bit unsigned integer</p> <p>Range: 1 to 65535</p>
<p>Measure Fall Crossing Time Query 8716₁₆</p>	<p>Queries the fall crossing time of the selected waveform edge relative to the start of the waveform.</p> <p>Command Syntax None</p> <p>Query Syntax 8716₁₆ <source> → <fall_crossing_time></p> <p>Parameters: <source> Type: 16-bit unsigned integer</p> <ul style="list-style-type: none"> 0000₁₆ Input Channel 1 0001₁₆ Input Channel 2 0002₁₆ Calculation Channel 1 0003₁₆ Calculation Channel 2 0004₁₆ Reference Channel 1 0005₁₆ Reference Channel 2 0006₁₆ Reference Channel 3 0007₁₆ Reference Channel 4 <p><fall_crossing_time> Type: 32-bit floating point</p>

Name	Description
<p>Measure Fall Overshoot Time Query 8714₁₆</p>	<p>Queries the voltage overshoot of the selected waveform. The following considerations apply when using the <i>Measure Fall Overshoot Query</i>:</p> <ul style="list-style-type: none"> • Fall overshoot is defined as the amount of voltage past the low level of a bi-level signal that a signal travels as it transitions from its high state to its low state. • Fall overshoot is calculated as the (signal minimum voltage – low level voltage)/signal amplitude. • The value returns as a percent in a decimal format. For example, a 10 percent fall overshoot will be returned as 0.1. <p>Command Syntax None</p> <p>Query Syntax 8714₁₆ <source> → <overshoot></p> <p>Parameters: <source> Type: 16-bit unsigned integer</p> <p>0000₁₆ Input Channel 1 0001₁₆ Input Channel 2 0002₁₆ Calculation Channel 1 0003₁₆ Calculation Channel 2 0004₁₆ Reference Channel 1 0005₁₆ Reference Channel 2 0006₁₆ Reference Channel 3 0007₁₆ Reference Channel 4</p> <p><overshoot> Type: 32-bit floating point</p> <p>Range: 0.0 (0 percent) to 1.0 (100 percent)</p>

Name	Description
<p>Measure Fall Preshoot Time Query 8715₁₆</p>	<p>Queries the voltage preshoot of the selected waveform. The following considerations apply when using the <i>Measure Fall Preshoot Query</i>:</p> <ul style="list-style-type: none"> • Fall preshoot is defined as the amount of voltage past the high level of a bi-level signal that a signal travels as it transitions from its high state to its low state. • Fall preshoot is calculated as the (signal maximum voltage – high level voltage)/signal amplitude. • The value returns as a percent in a decimal format. For example, a 10 percent fall preshoot will be returned as 0.1. <p>Command Syntax None</p> <p>Query Syntax 8715₁₆ <source> → <preshoot></p> <p>Parameters: <source> Type: 16-bit unsigned integer</p> <p>0000₁₆ Input Channel 1 0001₁₆ Input Channel 2 0002₁₆ Calculation Channel 1 0003₁₆ Calculation Channel 2 0004₁₆ Reference Channel 1 0005₁₆ Reference Channel 2 0006₁₆ Reference Channel 3 0007₁₆ Reference Channel 4</p> <p><preshoot> Type: 32-bit floating point</p> <p>Range: 0.0 (0 percent) to 1.0 (100 percent)</p>

Name	Description
<p>Measure Fall Time Query 8717₁₆</p>	<p>Queries the fall time of the selected waveform. Fall time is the time it takes the falling edge of a pulse to go from the upper threshold of peak voltage (high reference) to the lower threshold of peak voltage (low reference).</p> <p style="text-align: center;">fall time = low reference – high reference</p> <p>Returned Format: The measurement is returned as a numeric value representing the measured fall time in seconds.</p> <p>Command Syntax None</p> <p>Query Syntax 8717₁₆ <source> → <fall_time></p> <p>Parameters: <source> Type: 16-bit unsigned integer</p> <ul style="list-style-type: none"> 0000₁₆ Input Channel 1 0001₁₆ Input Channel 2 0002₁₆ Calculation Channel 1 0003₁₆ Calculation Channel 2 0004₁₆ Reference Channel 1 0005₁₆ Reference Channel 2 0006₁₆ Reference Channel 3 0007₁₆ Reference Channel 4 <p><fall_time> Type: 32-bit floating point</p>

Name	Description
Measure Frequency Query 8718 ₁₆	<p>Queries the frequency of the selected waveform source. All cycles in the entire capture window are used.</p> <p>Command Syntax None</p> <p>Query Syntax 8718₁₆ <source> → <frequency></p> <p>Parameters: <source> Type: 16-bit unsigned integer</p> <ul style="list-style-type: none"> 0000₁₆ Input Channel 1 0001₁₆ Input Channel 2 0002₁₆ Calculation Channel 1 0003₁₆ Calculation Channel 2 0004₁₆ Reference Channel 1 0005₁₆ Reference Channel 2 0006₁₆ Reference Channel 3 0007₁₆ Reference Channel 4 <p><frequency> Type: 32-bit floating point</p>

Name	Description
<p>Measure Gate Points Command 0704₁₆</p> <p>Measure Gate Points Query 8704₁₆</p>	<p>Sets or queries the measurement of the selected waveform source using gate start and stop points.</p> <p>Command Syntax 0704₁₆ <source> <gate_start> <gate_stop></p> <p>Query Syntax 8704₁₆ <source> → <gate_start> <gate_stop></p> <p>Parameters: <source> Type: 16-bit unsigned integer</p> <ul style="list-style-type: none"> 0000₁₆ Input Channel 1 0001₁₆ Input Channel 2 0002₁₆ Calculation Channel 1 0003₁₆ Calculation Channel 2 0004₁₆ Reference Channel 1 0005₁₆ Reference Channel 2 0006₁₆ Reference Channel 3 0007₁₆ Reference Channel 4 <p><gate_start> Type: 32-bit unsigned integer</p> <p>Range: 0 to maximum waveform size</p> <p><gate_stop> Type: 32-bit unsigned integer</p> <p>Range: 0 to maximum waveform size</p>

Name	Description
<p>Measure Gate Time Command 0703₁₆</p> <p>Measure Gate Time Query 8703₁₆</p>	<p>Sets or queries the measurement of the selected waveform source using gate start and stop times relative to the trigger time.</p> <p>Command Syntax 0703₁₆ <source> <start> <stop></p> <p>Query Syntax 8703₁₆ <source> → <start> <stop></p> <p>Parameters: <source> Type: 16-bit unsigned integer</p> <ul style="list-style-type: none"> 0000₁₆ Input Channel 1 0001₁₆ Input Channel 2 0002₁₆ Calculation Channel 1 0003₁₆ Calculation Channel 2 0004₁₆ Reference Channel 1 0005₁₆ Reference Channel 2 0006₁₆ Reference Channel 3 0007₁₆ Reference Channel 4 <p><start> Type: 32-bit Floating Point</p> <p><stop> Type: 32-bit Floating Point</p>

Name	Description
<p>Measure High Voltage Query 8719₁₆</p>	<p>Queries the high level of the selected waveform source. The high level measurement assumes a bi-level signal with distinct high and low levels and is defined as the waveform upper level. Use the <i>Measure Maximum Voltage Query</i> to detect the most positive waveform voltage level without assuming a bi-level signal.</p> <p>Command Syntax None</p> <p>Query Syntax 8719₁₆ <source> → <voltage_high></p> <p>Parameters: <source> Type: 16-bit unsigned integer</p> <ul style="list-style-type: none"> 0000₁₆ Input Channel 1 0001₁₆ Input Channel 2 0002₁₆ Calculation Channel 1 0003₁₆ Calculation Channel 2 0004₁₆ Reference Channel 1 0005₁₆ Reference Channel 2 0006₁₆ Reference Channel 3 0007₁₆ Reference Channel 4 <p><voltage_high> Type: 32-bit floating point</p>

Name	Description
<p>Measure Low Voltage Query 871A₁₆</p>	<p>Queries the low level of the selected waveform source. The low level measurement assumes a bi-level signal with distinct high and low levels and is defined as the waveform lower level. Use the <i>Measure Minimum Voltage Query</i> to detect the most negative waveform voltage level without assuming a bi-level signal.</p> <p>Command Syntax None</p> <p>Query Syntax 871A₁₆ <source> → <voltage_low></p> <p>Parameters: <source> Type: 16-bit unsigned integer</p> <ul style="list-style-type: none"> 0000₁₆ Input Channel 1 0001₁₆ Input Channel 2 0002₁₆ Calculation Channel 1 0003₁₆ Calculation Channel 2 0004₁₆ Reference Channel 1 0005₁₆ Reference Channel 2 0006₁₆ Reference Channel 3 0007₁₆ Reference Channel 4 <p><voltage_low> Type: 32-bit floating point</p>

Name	Description
<p>Measure Maximum Voltage Query 871B₁₆</p>	<p>Queries the most positive voltage of the selected waveform source. The maximum level measurement is defined as the waveform most positive voltage level. Use the <i>Measure High Voltage Query</i> to detect the upper level in a bi-level signal such as a square wave.</p> <p>Command Syntax None</p> <p>Query Syntax 871B₁₆ <source> → <voltage_max></p> <p>Parameters: <source> Type: 16-bit unsigned integer</p> <ul style="list-style-type: none"> 0000₁₆ Input Channel 1 0001₁₆ Input Channel 2 0002₁₆ Calculation Channel 1 0003₁₆ Calculation Channel 2 0004₁₆ Reference Channel 1 0005₁₆ Reference Channel 2 0006₁₆ Reference Channel 3 0007₁₆ Reference Channel 4 <p><voltage_max> Type: 32-bit floating point</p>

Name	Description
Measure Method Command 0701 ₁₆	Sets or queries the method to use for measurements. The following method types are available on the ZT450:
Measure Method Query 8701 ₁₆	<p><u>Entire Waveform</u></p> <p>Entire Waveform measurement is used to perform measurements upon the entire captured waveform.</p> <p><u>Gated by Time</u></p> <p>Gated by Time measurement is used to perform measurements upon a waveform, where the user defines a start time and stop time. "0" represents the start of the waveform.</p> <p><u>Gated by Points</u></p> <p>Gated by Points measurement is used to perform measurements on a waveform, where the user defines a start point and stop point. "0" represents the start of the waveform.</p> <p>Command Syntax 0701₁₆ <method></p> <p>Query Syntax 8701₁₆ → <method></p> <p>Parameters: <method> Type: 16-bit unsigned integer</p> <p>0000₁₆ Entire Waveform 0001₁₆ Gated</p>

Name	Description
Measure Mid Voltage Query 871D ₁₆	<p>Queries the mid level voltage of the selected waveform source. The mid level voltage measurement assumes a bi-level signal with distinct high and low voltage levels and is defined as the waveform mid level.</p> $\text{Mid Level} = \frac{\text{High Level} + \text{Low Level}}{2}$ <p>Use the <i>Measure Maximum Voltage Query</i> to detect the most positive waveform voltage level, and the <i>Measure Minimum Voltage Query</i> to detect the most negative voltage, without assuming a bi-level signal.</p> <p>Command Syntax None</p> <p>Query Syntax 871D₁₆ <source> → <voltage_mid></p> <p>Parameters: <source> Type: 16-bit unsigned integer</p> <ul style="list-style-type: none"> 0000₁₆ Input Channel 1 0001₁₆ Input Channel 2 0002₁₆ Calculation Channel 1 0003₁₆ Calculation Channel 2 0004₁₆ Reference Channel 1 0005₁₆ Reference Channel 2 0006₁₆ Reference Channel 3 0007₁₆ Reference Channel 4 <p><voltage_mid> Type: 32-bit floating point</p>

Name	Description
Measure Minimum Voltage Query 871C ₁₆	<p>Queries the most negative voltage of the selected waveform source. The minimum level measurement is defined as the most negative voltage level of the waveform. Use the <i>Measure Low Voltage Query</i> to detect the low level in a bi-level signal such as a square wave.</p> <p>Command Syntax None</p> <p>Query Syntax 871C₁₆ <source> → <voltage_min></p> <p>Parameters: <source> Type: 16-bit unsigned integer</p> <ul style="list-style-type: none"> 0000₁₆ Input Channel 1 0001₁₆ Input Channel 2 0002₁₆ Calculation Channel 1 0003₁₆ Calculation Channel 2 0004₁₆ Reference Channel 1 0005₁₆ Reference Channel 2 0006₁₆ Reference Channel 3 0007₁₆ Reference Channel 4 <p><voltage_min> Type: 32-bit floating point</p>
Measure Negative Duty Cycle Query 871E ₁₆	<p>Queries the percent of a cycle the selected waveform is below the middle voltage value.</p> <p>Command Syntax None</p> <p>Query Syntax 871E₁₆ <source> → <negative_duty></p> <p>Parameters: <source> Type: 16-bit unsigned integer</p> <ul style="list-style-type: none"> 0000₁₆ Input Channel 1 0001₁₆ Input Channel 2 0002₁₆ Calculation Channel 1 0003₁₆ Calculation Channel 2 0004₁₆ Reference Channel 1 0005₁₆ Reference Channel 2 0006₁₆ Reference Channel 3 0007₁₆ Reference Channel 4 <p><negative_duty> Type: 32-bit floating point</p>

Name	Description
<p>Measure Negative Width Query 871F₁₆</p>	<p>Queries the time that the selected waveform is below the middle voltage value.</p> <p>Command Syntax None</p> <p>Query Syntax 871F₁₆ <source> → <negative_width></p> <p>Parameters: <source> Type: 16-bit unsigned integer</p> <ul style="list-style-type: none"> 0000₁₆ Input Channel 1 0001₁₆ Input Channel 2 0002₁₆ Calculation Channel 1 0003₁₆ Calculation Channel 2 0004₁₆ Reference Channel 1 0005₁₆ Reference Channel 2 0006₁₆ Reference Channel 3 0007₁₆ Reference Channel 4 <p><negative_width> Type: 32-bit floating point</p>

Name	Description
<p>Measure Peak-To-Peak Voltage Query 8724₁₆</p>	<p>Performs a peak-to-peak voltage measurement on the specified source, and then returns the measurement results to the output buffer. The method the instrument uses to determine peak-to-peak voltage is to measure Voltage High (Vhigh) and Voltage Low (Vlow), and then calculate peak-to-peak voltage as follows:</p> $\text{peak-to-peak voltage} = \text{Vhigh} - \text{Vlow}$ <p>Command Syntax None</p> <p>Query Syntax 8724₁₆ <source> → <voltage_ptp></p> <p>Parameters: <source> Type: 16-bit unsigned integer</p> <ul style="list-style-type: none"> 0000₁₆ Input Channel 1 0001₁₆ Input Channel 2 0002₁₆ Calculation Channel 1 0003₁₆ Calculation Channel 2 0004₁₆ Reference Channel 1 0005₁₆ Reference Channel 2 0006₁₆ Reference Channel 3 0007₁₆ Reference Channel 4 <p><voltage_ptp> Type: 32-bit floating point</p>

Name	Description
Measure Period Query 8722 ₁₆	<p>Performs a period measurement on the specified source, and then returns the measurement results to the output buffer. The period of the signal (1/frequency) is measured using all cycles in the entire capture window.</p> <p>Command Syntax None</p> <p>Query Syntax 8722₁₆ <source> → <period></p> <p>Parameters: <source> Type: 16-bit unsigned integer</p> <ul style="list-style-type: none"> 0000₁₆ Input Channel 1 0001₁₆ Input Channel 2 0002₁₆ Calculation Channel 1 0003₁₆ Calculation Channel 2 0004₁₆ Reference Channel 1 0005₁₆ Reference Channel 2 0006₁₆ Reference Channel 3 0007₁₆ Reference Channel 4 <p><period> Type: 32-bit floating point</p>

Name	Description
Measure Phase Query 8723 ₁₆	<p>Performs a phase measurement on the specified source. This is a measurement of the phase of a periodic signal at the start of the waveform in radians.</p> <p>Command Syntax None</p> <p>Query Syntax 8723₁₆ <source> → <phase></p> <p>Parameters: <source> Type: 16-bit unsigned integer</p> <p>0000₁₆ Input Channel 1 0001₁₆ Input Channel 2 0002₁₆ Calculation Channel 1 0003₁₆ Calculation Channel 2 0004₁₆ Reference Channel 1 0005₁₆ Reference Channel 2 0006₁₆ Reference Channel 3 0007₁₆ Reference Channel 4</p> <p><phase> Type: 32-bit floating point</p> <p>Range: 0 to 2 PI (6.283185307)</p>
Measure Positive Duty Cycle Query 8720 ₁₆	<p>Queries the percent of a cycle of the selected waveform that is above the signal middle voltage value.</p> <p>Command Syntax None</p> <p>Query Syntax 871E₁₆ <source> → <positive_duty></p> <p>Parameters: <source> Type: 16-bit unsigned integer</p> <p>0000₁₆ Input Channel 1 0001₁₆ Input Channel 2 0002₁₆ Calculation Channel 1 0003₁₆ Calculation Channel 2 0004₁₆ Reference Channel 1 0005₁₆ Reference Channel 2 0006₁₆ Reference Channel 3 0007₁₆ Reference Channel 4</p> <p><positive_duty> Type: 32-bit floating point</p>

Name	Description
<p>Measure Positive Width Query 8721₁₆</p>	<p>Queries the time that the selected waveform is above the middle voltage value.</p> <p>Command Syntax None</p> <p>Query Syntax 8721₁₆ <source> → <positive_width></p> <p>Parameters: <source> Type: 16-bit unsigned integer</p> <ul style="list-style-type: none"> 0000₁₆ Input Channel 1 0001₁₆ Input Channel 2 0002₁₆ Calculation Channel 1 0003₁₆ Calculation Channel 2 0004₁₆ Reference Channel 1 0005₁₆ Reference Channel 2 0006₁₆ Reference Channel 3 0007₁₆ Reference Channel 4 <p><positive_width> Type: 32-bit floating point</p>

Name	Description
<p>Measure Reference Command 0708₁₆</p> <p>Measure Reference Query 8708₁₆</p>	<p>Sets or queries the high, low, and middle reference levels that are used to take rise time, fall time, fall crossing time, and rise crossing time measurements. Reference levels are configured in relative terms of the percentage of the waveform acquired, or in absolute voltage levels. By default, the low value is 10% of the waveform, the mid level is 50%, and the high value is 90%.</p> <p>Reference levels can be set either by percentage or voltage as follows:</p> <ul style="list-style-type: none"> • Low reference selects the threshold for detection of the input signal low state. • Middle reference selects the threshold for detection of the input signal middle level. • High reference selects the threshold for detection of the input signal high state. • The allowed relative reference values range from 0.0 (0 percent) to 1.0 (100 percent). • Absolute reference values are expressed in voltages. <p>Command Syntax 0708₁₆ <low_reference> <mid_reference> <high_reference></p> <p>Query Syntax 8708₁₆ → <low_reference> <mid_reference> <high_reference></p> <p>Parameters: <low_reference> Type: 32-bit floating point</p> <p><mid_reference> Type: 32-bit floating point</p> <p><high_reference> Type: 32-bit floating point</p>

Name	Description
<p>Measure Reference Method Command 0709₁₆</p> <p>Measure Reference Method Query 8709₁₆</p>	<p>Sets or queries the reference method used in waveform voltage analysis. Reference methods are in absolute voltages or relative percentages.</p> <p>Command Syntax 0709₁₆ <reference_method></p> <p>Query Syntax 8709₁₆ → <reference_method></p> <p>Parameters: <reference_method> Type: 16-bit unsigned integer</p> <p>0000₁₆ Voltages 0001₁₆ Percentages</p>
<p>Measure Rise Crossing Time Query 8727₁₆</p>	<p>Queries the rise crossing time of the selected waveform edge. "0" is the start of the waveform.</p> <p>Command Syntax None</p> <p>Query Syntax 8727₁₆ <source> → <rise_crossing_time></p> <p>Parameters: <source> Type: 16-bit unsigned integer</p> <p>0000₁₆ Input Channel 1 0001₁₆ Input Channel 2 0002₁₆ Calculation Channel 1 0003₁₆ Calculation Channel 2 0004₁₆ Reference Channel 1 0005₁₆ Reference Channel 2 0006₁₆ Reference Channel 3 0007₁₆ Reference Channel 4</p> <p><rise_crossing_time> Type: 32-bit floating point</p>

Name	Description
<p>Measure Rise Overshoot Query 8725₁₆</p>	<p>Queries the voltage overshoot of the selected waveform. The following considerations apply when using the <i>Measure Rise Overshoot Query</i>:</p> <ul style="list-style-type: none"> • Rise overshoot is defined as the amount of voltage past the high level of a bi-level signal that a signal travels as it transitions from its low state to its high state. • Rise overshoot is calculated as the signal (maximum voltage – high level voltage)/signal amplitude. • The value returns as a percent in a decimal format. For example, a 10 percent overshoot will be returned as 0.1. <p>Command Syntax None</p> <p>Query Syntax 8725₁₆ <source> → <overshoot></p> <p>Parameters: <source> Type: 16-bit unsigned integer</p> <p>0000₁₆ Input Channel 1 0001₁₆ Input Channel 2 0002₁₆ Calculation Channel 1 0003₁₆ Calculation Channel 2 0004₁₆ Reference Channel 1 0005₁₆ Reference Channel 2 0006₁₆ Reference Channel 3 0007₁₆ Reference Channel 4</p> <p><overshoot> Type: 32-bit floating point Range: 0.0 (0 percent) to 1.0 (100 percent)</p>

Name	Description
<p>Measure Rise Preshoot Query 8726₁₆</p>	<p>Queries the voltage preshoot of the selected waveform. The following considerations apply when using the <i>Measure Rise Preshoot Query</i>.</p> <ul style="list-style-type: none"> • Rise preshoot is defined as the amount of voltage past the low level of a bi-level signal that a signal travels as it transitions from its low state to its high state. • Rise preshoot is calculated as the signal (minimum voltage – low level voltage)/signal amplitude. • The value returns as a percent in a decimal format. For example, a 10 percent overshoot will be returned as 0.1. <p>Command Syntax None</p> <p>Query Syntax 8726₁₆ <source> → <preshoot></p> <p>Parameters: <source> Type: 16-bit unsigned integer</p> <p>0000₁₆ Input Channel 1 0001₁₆ Input Channel 2 0002₁₆ Calculation Channel 1 0003₁₆ Calculation Channel 2 0004₁₆ Reference Channel 1 0005₁₆ Reference Channel 2 0006₁₆ Reference Channel 3 0007₁₆ Reference Channel 4</p> <p><preshoot> Type: 32-bit floating point Range: 0.0 (0 percent) to 1.0 (100 percent)</p>

Name	Description
Measure Rise Time Query 8728 ₁₆	<p>Performs a rise time measurement one time on the signal present, and then sends the measurement results to the output buffer. I</p> <p>Rise time is the time it takes the rising edge of a pulse to go from the lower threshold of peak voltage (low reference) to the upper threshold of peak voltage (high reference).</p> <p style="text-align: center;">Rise time = high reference – low reference</p> <p>Returned Format: The measurement is returned as a numeric value representing the measured rise time in seconds.</p> <p>Command Syntax None</p> <p>Query Syntax 8728₁₆ <source> → <rise_time></p> <p>Parameters: <source> Type: 16-bit unsigned integer</p> <ul style="list-style-type: none"> 0000₁₆ Input Channel 1 0001₁₆ Input Channel 2 0002₁₆ Calculation Channel 1 0003₁₆ Calculation Channel 2 0004₁₆ Reference Channel 1 0005₁₆ Reference Channel 2 0006₁₆ Reference Channel 3 0007₁₆ Reference Channel 4 <p><rise_time> Type: 32-bit floating point</p>

Name	Description
<p>Measure Time of Maximum Voltage Query 8729₁₆</p>	<p>Returns the time at which the first maximum voltage occurred on the acquired waveform. The value is sent to the output buffer.</p> <p>Command Syntax None</p> <p>Query Syntax 8729₁₆ <source> → <max_voltage_time></p> <p>Parameters: <source> Type: 16-bit unsigned integer</p> <ul style="list-style-type: none"> 0000₁₆ Input Channel 1 0001₁₆ Input Channel 2 0002₁₆ Calculation Channel 1 0003₁₆ Calculation Channel 2 0004₁₆ Reference Channel 1 0005₁₆ Reference Channel 2 0006₁₆ Reference Channel 3 0007₁₆ Reference Channel 4 <p><max_voltage_time> Type: 32-bit floating point</p>
<p>Measure Time of Minimum Voltage Query 872A₁₆</p>	<p>Returns the time at which the first minimum voltage occurred on the acquired waveform. The value is sent to the output buffer.</p> <p>Command Syntax None</p> <p>Query Syntax 872A₁₆ <source> → <min_voltage_time></p> <p>Parameters: <source> Type: 16-bit unsigned integer</p> <ul style="list-style-type: none"> 0000₁₆ Input Channel 1 0001₁₆ Input Channel 2 0002₁₆ Calculation Channel 1 0003₁₆ Calculation Channel 2 0004₁₆ Reference Channel 1 0005₁₆ Reference Channel 2 0006₁₆ Reference Channel 3 0007₁₆ Reference Channel 4 <p><min_voltage_time> Type: 32-bit floating point</p>

Name	Description
Operation Complete Command 0004 ₁₆	The command sets the request for the operation complete flag when all pending operations have completed. When all operations have completed, the operation complete bit in the event status register will be set.
Operation Complete Query 8004 ₁₆	<p>The query returns a 0 to indicate that all pending operations have <u>not</u> completed and a 1 to indicate that all pending operations have completed.</p> <p>Command Syntax 0004₁₆</p> <p>Query Syntax 8004₁₆ → <state></p> <p>Parameters: <state> Type: 16-bit unsigned integer</p> <p>0000₁₆ All operations are <u>not</u> complete 0001₁₆ All operations complete</p>

Name	Description
<p>Output Trigger Polarity Command 020A₁₆</p> <p>Output Trigger Polarity Query 820A₁₆</p>	<p>Sets or queries the output driver polarity for any of the eight TTL trigger outputs (PXI Backplane or PCI Timing Expansion Connector). The following considerations apply when using the <i>Output Trigger Polarity Command</i> and <i>Output Trigger Polarity Query</i>:</p> <ul style="list-style-type: none"> • When positive output polarity is selected, the output driver forces a logic “0” onto the TTL output when the signal source is active, i.e. for a positive polarity setting and an Arm source signal, the TTL trigger line will be a logic 0 when the unit is armed. • Output driver polarity does not affect TTL trigger line sensing used by other unit functions. • Each output line polarity is selected individually • TTL trigger lines can be sourced and sensed simultaneously. <p>Command Syntax 020A₁₆ <output_trigger> <polarity></p> <p>Query Syntax 820A₁₆ <output_trigger> → <polarity></p> <p>Parameters <output_trigger> Type: 16-bit unsigned integer</p> <p>0000₁₆ TTL trigger 0 0001₁₆ TTL trigger 1 0002₁₆ TTL trigger 2 0003₁₆ TTL trigger 3 0004₁₆ TTL trigger 4 0005₁₆ TTL trigger 5 0006₁₆ TTL trigger 6 0007₁₆ TTL trigger 7</p> <p><polarity> Type: 16-bit unsigned integer</p> <p>0000₁₆ Negative polarity 0001₁₆ Positive polarity</p>

Name	Description
<p>Output Trigger Source Command 0209₁₆</p> <p>Output Trigger Source Query 8209₁₆</p>	<p>Sets or queries the output driver source for any of the eight TTL trigger outputs (PXI Backplane or PCI Timing Expansion Connector). The following considerations apply when using the <i>Output Trigger Source Command</i> and <i>Output Trigger Source Query</i>:</p> <ul style="list-style-type: none"> • The output driver may be enabled or disabled and the polarity selected. • Each output line source is selected individually • TTL trigger lines can be sourced and sensed simultaneously. <p>Command Syntax 0209₁₆ <output_trigger> <source></p> <p>Query Syntax 8209₁₆ <output_trigger> → <source></p> <p>Parameters <output_trigger> Type: 16-bit unsigned integer</p> <p>0000₁₆ TTL trigger 0 0001₁₆ TTL trigger 1 0002₁₆ TTL trigger 2 0003₁₆ TTL trigger 3 0004₁₆ TTL trigger 4 0005₁₆ TTL trigger 5 0006₁₆ TTL trigger 6 0007₁₆ TTL trigger 7</p> <p><source> Type: 16-bit unsigned integer</p> <p>0000₁₆ Arm Event 0001₁₆ Trigger Event 0002₁₆ Constant State 0003₁₆ Operation Complete</p>

Name	Description
<p>Output Trigger State Command 0208₁₆</p> <p>Output Trigger State Query 8208₁₆</p>	<p>Sets or queries the output driver state for any of the eight TTL trigger outputs (PXI Backplane or PCI Timing Expansion Connector). The following considerations apply when using the <i>Output Trigger State Command</i> and <i>Output Trigger State Query</i>.</p> <ul style="list-style-type: none"> • The output source and polarity are selectable. • Each output line driver state is selected individually • TTL trigger lines can be sourced and sensed simultaneously. <p>Command Syntax 0208₁₆ <output_trigger> <state></p> <p>Query Syntax 8208₁₆ <output_trigger> → <state></p> <p>Parameters <output_trigger> Type: 16-bit unsigned integer</p> <p>0000₁₆ TTL trigger 0 0001₁₆ TTL trigger 1 0002₁₆ TTL trigger 2 0003₁₆ TTL trigger 3 0004₁₆ TTL trigger 4 0005₁₆ TTL trigger 5 0006₁₆ TTL trigger 6 0007₁₆ TTL trigger 7</p> <p><state> Type: 16-bit unsigned integer</p> <p>0000₁₆ Inactive state 0001₁₆ Active state</p>
<p>Recall Instrument State Command 0007₁₆</p>	<p>Recalls the selected saved instrument state from non-volatile memory.</p> <p>Command Syntax 0007₁₆ <number></p> <p>Query Syntax None</p> <p>Parameters: <number> Type: 16-bit unsigned integer</p> <p>Range: 1 to 31</p>

Name	Description
<p>Reference Oscillator Source Command 0200₁₆</p> <p>Reference Oscillator Source Query 8200₁₆</p>	<p>Sets and queries the source for the 10 MHz reference clock that provides the instrument time base. External reference source is the PXI CLK10 reference or the reference Input on the PCI Timing Expansion connector.</p> <p>Command Syntax 0200₁₆ <source></p> <p>Query Syntax 8200₁₆ → <source></p> <p>Parameters: <source> Type: 16-bit unsigned integer</p> <p>0000₁₆ Local reference selected 0004₁₆ External reference selected</p>
<p>Reset Command 0000₁₆</p>	<p>Performs a hardware reset function that returns the instrument to the initial default condition. Status registers are <u>not</u> cleared.</p> <p>Command Syntax 0000₁₆</p> <p>Query Syntax None</p> <p>Parameters: None</p>
<p>Save Instrument State Command 0006₁₆</p>	<p>Stores the current state of the instrument to the selected storage index in non-volatile memory.</p> <p>Command Syntax 0006₁₆ <number></p> <p>Query Syntax None</p> <p>Parameters: <number> Type: 16-bit unsigned integer</p> <p>Range: 1 to 31</p>

Name	Description
<p>Service Request Enable Command 0A04₁₆</p> <p>Service Request Enable Query 8A04₁₆</p>	<p>Selects and returns the enabled bits for the Status Byte. The parameter is a bit mask which enables the corresponding status byte bits.</p> <p>Command Syntax 0A04₁₆ <mask></p> <p>Query Syntax 8A04₁₆ → <mask></p> <p>Parameters:</p> <p><mask> Type: 16-bit unsigned integer Range: 0 to 255</p> <ul style="list-style-type: none"> 0001₁₆ Unused Bit 0002₁₆ Unused Bit 0004₁₆ Error Log Not Empty Bit 0008₁₆ Questionable Summary Bit 0010₁₆ Message Available Bit 0020₁₆ Standard Event Summary Bit 0040₁₆ Master Summary Bit 0080₁₆ Operation Summary Bit
<p>Status Byte Query 8002₁₆</p>	<p>Returns the Status Byte.</p> <p>Command Syntax None</p> <p>Query Syntax 8002₁₆ → <mask></p> <p>Parameters:</p> <p><mask> Type: 16-bit unsigned integer Range: 0 to 255</p> <ul style="list-style-type: none"> 0001₁₆ Unused Bit 0002₁₆ Unused Bit 0004₁₆ Error Log Not Empty Bit 0008₁₆ Questionable Summary Bit 0010₁₆ Message Available Bit 0020₁₆ Standard Event Summary Bit 0040₁₆ Master Summary Bit 0080₁₆ Operation Summary Bit

Name	Description
<p>Status Calibration Condition Query 8A16₁₆</p>	<p>Queries the contents of the Questionable Calibration Condition Register, represented by <condition> in the parameters below. The Questionable Calibration Condition Register identifies current questionable results from all internally-generated calibration conditions. The following considerations apply when using the <i>Status Calibration Condition Query</i>:</p> <ul style="list-style-type: none"> • The Questionable Calibration Condition Register identifies current conditions. Use the Status Questionable Calibration Event Query to identify a history of which calibration conditions have failed since the last event status check. • The Status Questionable Calibration Condition Query does <u>not</u> clear the Questionable Calibration Condition Register. <p>Command Syntax None</p> <p>Query Syntax 8A16₁₆ → <condition></p> <p>Parameters: <condition> Type: 16-bit unsigned integer Range: 0 to 65535</p> <p>0001₁₆ Input 1 Calibration Failed 0002₁₆ Input 2 Calibration Failed 000C₁₆ Unused Bits 0010₁₆ ADC 1–2 Calibration Failed FFE0₁₆ Unused Bits</p>

Name	Description
<p>Status Calibration Enable Command 0A17₁₆</p> <p>Status Calibration Enable Query 8A17₁₆</p>	<p>Sets or queries the contents of the Questionable Calibration Enable Register. The Questionable Calibration Enable Register enables the reporting of questionable calibration events to the Questionable Summary Register. The following considerations apply when using the <i>Status Calibration Enable Command</i> and <i>Status Calibration Enable Query</i>.</p> <ul style="list-style-type: none"> • The Questionable Calibration Enable Register is a bit mask that allows selected questionable calibration events to be reported to the Questionable Summary Register. • Only low to high (inactive to active) Questionable Calibration Enable Register bit transitions are reported. • Questionable calibration events are reported in bit 8 of the Questionable Summary Register. • The Status Preset Command sets all 15 LSBs to one (1), which enables all event reporting. <p>Command Syntax 0A17₁₆</p> <p>Query Syntax 8A17₁₆ → <enable></p> <p>Parameters: <enable> Type: 16-bit unsigned integer Range: 0 to 65535</p> <p>0001₁₆ Input 1 Calibration Failed 0002₁₆ Input 2 Calibration Failed 000C₁₆ Unused Bits 0010₁₆ ADC 1–2 Calibration Failed FFE0₁₆ Unused Bits</p>

Name	Description
<p>Status Calibration Event Query 8A18₁₆</p>	<p>Queries the Questionable Calibration Event Register. The Questionable calibration Event Register identifies calibration processes that have completed with questionable results. The following considerations apply when using the <i>Status Calibration Event Query</i>:</p> <ul style="list-style-type: none"> • The Questionable Calibration Event Register records the history of the questionable calibration process results generated since the previous <i>Questionable Calibration Event Query</i>. • The <i>Status Questionable Event Query</i> clears the Questionable Frequency Event Register after returning the current register contents. • Questionable calibration events are reported in bit 8 of the Questionable Summary Register. • In order to identify questionable results from a particular process, the Questionable Calibration Event Register <u>must</u> be cleared by reading it before the processes are run. <p>Command Syntax None</p> <p>Query Syntax 8A18₁₆ → <event></p> <p>Parameters: <event> Type: 16-bit unsigned integer Range: 0 to 65535</p> <p>0001₁₆ Input 1 Calibration Failed 0002₁₆ Input 2 Calibration Failed 000C₁₆ Unused Bits 0010₁₆ ADC 1–2 Calibration Failed FFE0₁₆ Unused Bits</p>

Name	Description
<p>Status Frequency Condition Query 8A13₁₆</p>	<p>Queries the contents of the Questionable Frequency Condition Register, represented by <condition> in the parameters below. The Questionable Frequency Condition Register identifies current questionable results from all internally-generated clock frequency conditions. The following considerations apply when using the <i>Status Frequency Condition Query</i>:</p> <ul style="list-style-type: none"> • The Questionable Frequency Condition Register identifies current conditions. Use the <i>Status Questionable Frequency Event Query</i> to identify a history of which frequency conditions have failed since the last event status check. • The <i>Status Frequency Condition Query</i> does <u>not</u> clear the Questionable Frequency Condition Register. <p>Command Syntax None</p> <p>Query Syntax 8A13₁₆ → <condition></p> <p>Parameters <condition> Type: 16-bit unsigned integer Range: 0 to 65535</p> <p>0001₁₆ PLL Unlocked Bit 0002₁₆ Unused Bits 0004₁₆ ADC1–2 Unlocked Bit FFF8₁₆ Unused Bits</p>

Name	Description
<p>Status Frequency Enable Command 0A14₁₆</p> <p>Status Frequency Enable Query 8A14₁₆</p>	<p>Sets or queries the contents of the Questionable Frequency Enable Register. The Questionable Frequency Enable Register enables the reporting of questionable frequency events to the Questionable Summary Register. The following considerations apply when using the <i>Status Frequency Enable Command</i> and <i>Status Frequency Enable Query</i>.</p> <ul style="list-style-type: none"> • The Questionable Frequency Enable Register is a bit mask that allows selected questionable frequency events to be reported to the Questionable Summary Register. • Only low to high (inactive to active) Questionable Frequency Enable Register bit transitions are reported. • Questionable frequency events are reported in bit 5 of the Questionable Summary Register. • The <i>Status Preset Command</i> sets all 15 LSBs to one (1), which enables all event reporting. <p>Command Syntax 0A14₁₆</p> <p>Query Syntax 8A14₁₆ → <enable></p> <p>Parameters: <enable> Type: 16-bit unsigned integer Range: 0 to 65535</p> <p>0001₁₆ PLL Unlocked Bit 0002₁₆ Unused Bits 0010₁₆ ADC1–2 Unlocked Bit FFF8₁₆ Unused Bits</p>

Name	Description
<p>Status Frequency Event Query 8A15₁₆</p>	<p>Queries the Questionable Frequency Event Register. The Questionable Frequency Event Register identifies frequency processes that have completed with questionable results. The following considerations apply when using the <i>Status Frequency Event Query</i>:</p> <ul style="list-style-type: none"> • The Questionable Frequency Event Register records the history of the questionable frequency process results generated since the previous <i>Status Questionable Frequency Event Query</i>. • The <i>Status Questionable Event Query</i> clears the Questionable Frequency Event Register after returning the current register contents. • Questionable frequency events are reported in bit 5 of the Questionable Summary Register. • In order to identify questionable results from a particular process, the Questionable Frequency Event Register <u>must</u> be cleared by reading it before the processes are run. <p>Command Syntax None</p> <p>Query Syntax 8A15₁₆ → <event></p> <p>Parameters: <event> Type: 16-bit unsigned integer Range: 0 to 65535</p> <p>0001₁₆ PLL Unlocked Bit 0002₁₆ Unused Bits 0004₁₆ ADC1–2 Unlocked Bit FFF8₁₆ Unused Bits</p>

Name	Description
<p>Status Operation Condition Query 8A05₁₆</p>	<p>Queries the contents of the Operation Status Condition Register. The Operation Status Condition Register identifies currently running processes, such as waveform acquisition. The following considerations apply when using the <i>Status Operation Condition Query</i>.</p> <ul style="list-style-type: none"> • The Operation Status Condition Register identifies current running processes, use the <i>Status Operation Event Query</i> to identify a history of which processes have run since the last operation event status check. • The <i>Status Operation Condition Query</i> does <u>not</u> clear the Operation Status Condition Register <p>Command Syntax None</p> <p>Query Syntax 8A05₁₆ → <condition></p> <p>Parameters: <condition> Type: 16-bit unsigned integer Range: 0 to 65535</p> <p>0001₁₆ Calibrating Bit 0002₁₆ Settling Bit 0004₁₆ Ranging Bit 0008₁₆ Sweeping Bit 0010₁₆ Measuring Bit 0020₁₆ Waiting for Trigger Bit 0040₁₆ Waiting for Arm Bit 0080₁₆ Unused Bit 0100₁₆ Trigger Event Bit 0200₁₆ Data Capture Event Bit 0400₁₆ Limit Test Event Bit F800₁₆ Unused Bits</p>

Name	Description
<p>Status Operation Enable Command 0A06₁₆</p> <p>Status Operation Enable Query 8A06₁₆</p>	<p>Sets or queries the contents of the Operation Status Enable Register. The Operation Status Enable Register enables the reporting of operation events to the Status Byte. The following considerations apply when using the <i>Status Operation Enable Command</i> and <i>Status Operation Enable Query</i>:</p> <ul style="list-style-type: none"> • The Operation Status Enable Register is a bit mask that allows selected operation status events to be reported to the Status Byte. • Only low to high (inactive to active) Operation Status Event Register bit transitions are reported. • Operation status events report in bit 7 of the Status Byte. • The <i>Status Preset Command</i> sets all register bits to zero (0), which disables all operation event reporting. <p>Command Syntax 0A06₁₆</p> <p>Query Syntax 8A06₁₆ → <enable></p> <p>Parameters: <enable> Type: 16-bit unsigned integer Range: 0 to 65535</p> <p>0001₁₆ Calibrating Bit 0002₁₆ Settling Bit 0004₁₆ Ranging Bit 0008₁₆ Sweeping Bit 0010₁₆ Measuring Bit 0020₁₆ Waiting for Trigger Bit 0040₁₆ Waiting for Arm Bit 0080₁₆ Unused Bit 0100₁₆ Trigger Event Bit 0200₁₆ Data Capture Event Bit 0400₁₆ Limit Test Event Bit F800₁₆ Unused Bits</p>

Name	Description
<p>Status Operation Event Query 8A07₁₆</p>	<p>Queries the contents of the Operation Event Status Register. The Operation Event Status Register identifies unit processes that have been run, such as waveform acquisition. The following considerations apply when using the <i>Status Operation Event Query</i>:</p> <ul style="list-style-type: none"> • The Operation Event Status Register records the history of the processes that have been run since the previous operation event status query, use the <i>Status Operation Condition Query</i> to identify currently running processes • The <i>Status Operation Event Query</i> clears the Operation Status Event Register after returning the current register contents • Operation Status Event Register bits may be summarized in the Status Byte. • In order to identify which processes have run between two times, ex. acquisition start and later status check, the Operation Event Status Register <u>must</u> be cleared by reading it before the processes are run. <p>Command Syntax None</p> <p>Query Syntax 8A07₁₆ → <event></p> <p>Parameters: <event> Type: 16-bit unsigned integer Range: 0 to 65535</p> <p>0001₁₆ Calibrating Bit 0002₁₆ Settling Bit 0004₁₆ Ranging Bit 0008₁₆ Sweeping Bit 0010₁₆ Measuring Bit 0020₁₆ Waiting for Trigger Bit 0040₁₆ Waiting for Arm Bit 0080₁₆ Unused Bit 0100₁₆ Trigger Event Bit 0200₁₆ Data Capture Event Bit 0400₁₆ Limit Test Event Bit F800₁₆ Unused Bits</p>

Name	Description
Status Preset Command 0A01 ₁₆	<p>Disables event reporting from the Standard Event Status, Operation Status Event, and Questionable Status Event Registers, i.e. the reporting enable registers are set to 0. Enables event reporting from the Questionable Frequency Event Register and the Questionable Test Event Register, i.e. the reporting event registers are set to 7FFF₁₆ (the 15 LSBs set). Current condition and event register contents are not affected.</p> <p>Command Syntax 0A01₁₆</p> <p>Query Syntax None</p> <p>Parameters: None</p>
Status Questionable Condition Query 8A08 ₁₆	<p>Queries the contents of the Questionable Status Condition Register. The Questionable Status Condition Register identifies current questionable results from running processes, such as self-test. The following considerations apply when using the <i>Status Questionable Condition Query</i>:</p> <ul style="list-style-type: none"> • The Questionable Status Condition Register identifies current questionable results from running processes. Use the <i>Status Questionable Event Query</i> to identify which questionable results generated since the last questionable event status check. • The <i>Status Questionable Condition Query</i> does <u>not</u> clear the Questionable Status Condition Register <p>Command Syntax None</p> <p>Query Syntax 8A08₁₆ → <condition></p> <p>Parameters: <condition> Type: 16-bit unsigned integer Range: 0 to 65535</p> <p>0001₁₆ Voltage Bit 000E₁₆ Unused Bits 0010₁₆ Temperature Bit 0020₁₆ Frequency Bit 00C0₁₆ Unused Bits 0100₁₆ Calibration Bit 0200₁₆ Test Bit FC00₁₆ Unused Bits</p>

Name	Description
<p>Status Questionable Enable Command 0A09₁₆</p> <p>Status Questionable Enable Query 8A09₁₆</p>	<p>Sets or queries the contents of the Questionable Status Enable Register. The Questionable Status Enable Register enables the reporting of questionable events to the Status Byte. The following considerations apply when using the <i>Status Questionable Enable Command</i> and <i>Status Questionable Enable Query</i>:</p> <ul style="list-style-type: none"> • The Questionable Status Enable Register is a bit mask that allows selected questionable status events to be reported to the Status Byte. • Only low to high (inactive to active) Questionable Status Event Register bit transitions are reported. • Questionable status events are reported in bit 3 of the Status Byte. Refer to the <i>Status Byte Query</i>. • <i>Status Preset Command</i> sets all register bits to zero (0) which disables all questionable event reporting. <p>Command Syntax 0A09₁₆</p> <p>Query Syntax 8A09₁₆ → <enable></p> <p>Parameters: <enable> Type: 16-bit unsigned integer Range: 0 to 65535</p> <p>0001₁₆ Voltage Bit 000E₁₆ Unused Bits 0010₁₆ Temperature Bit 0020₁₆ Frequency Bit 00C0₁₆ Unused Bits 0100₁₆ Calibration Bit 0200₁₆ Test Bit FC00₁₆ Unused Bits</p>

Name	Description
<p>Status Questionable Event Query 8A0A₁₆</p>	<p>Queries the Questionable Status Event Register. The Questionable Event Status Register identifies unit processes that have completed with questionable results, such as self test errors. The following considerations apply when using the <i>Status Questionable Event Query</i>.</p> <ul style="list-style-type: none"> • The Questionable Status Event Register records the history of the questionable process results generated since the previous questionable event status query. • The <i>Status Questionable Event Query</i> clears the Questionable Status Event Register after returning the current register contents. • Questionable Status Event Register bits may be summarized in the Status Byte. • In order to identify questionable results from a particular process, the Questionable Status Event Register <u>must</u> be cleared by reading it before the processes are run. <p>Command Syntax None</p> <p>Query Syntax 8A0A₁₆ → <event></p> <p>Parameters: <event> Type: 16-bit unsigned integer Range: 0 to 65535</p> <p>0001₁₆ Voltage Bit 000E₁₆ Unused Bits 0010₁₆ Temperature Bit 0020₁₆ Frequency Bit 00C0₁₆ Unused Bits 0100₁₆ Calibration Bit 0200₁₆ Test Bit FC00₁₆ Unused Bits</p>

Name	Description
<p>Status Test Condition Query 8A10₁₆</p>	<p>Queries the contents of the Questionable Test Condition Register. The Questionable Test Condition Register identifies the test results of memory (RAM, and Flash) tests, along with register and PLL tests. The following considerations apply when using the <i>Status Test Condition Query</i>:</p> <ul style="list-style-type: none"> • The Questionable Test Condition Register identifies current tests. Use the <i>Status Questionable Test Condition Query</i> to identify a history of which tests have failed since the last test status check. • Questionable test events report in bit 9 of the Questionable Summary Register. • The <i>Status Questionable Test Condition Query</i> does <u>not</u> clear the Questionable Test Condition Register. <p>Command Syntax None</p> <p>Query Syntax 8A10₁₆ → <condition></p> <p>Parameters: <condition> Type: 16-bit unsigned integer Range: 0 to 65535</p> <p>0001₁₆ Baseboard Test Failed Bit 0002₁₆ SRAM Test Failed Bit 0004₁₆ ROM Test Failed Bit 0008₁₆ Unused Bits 0010₁₆ Ref Oscillator Test Failed Bit 0020₁₆ Unused Bits 0040₁₆ Flash Memory Test Failed Bit 0080₁₆ Unused Bits 0100₁₆ Input1–2 Register Test Failed Bit 0200₁₆ Input1 RAM Test Failed Bit 0400₁₆ Input2 RAM Test Failed Bit 0800₁₆ PLL Test Failed Bit F000₁₆ Unused Bits</p>

Name	Description
<p>Status Test Enable Command 0A11₁₆</p> <p>Status Test Enable Query 8A11₁₆</p>	<p>Sets or queries the contents of the Questionable Test Status Register. The Questionable Test Status Register enables the reporting of questionable events to the Status Byte. The following considerations apply when using the <i>Status Test Enable Command</i> and <i>Status Test Enable Query</i>:</p> <ul style="list-style-type: none"> • The Questionable Test Status Register is a bit mask that allows selected questionable self-test events to be reported to the Status Byte. • Only low to high (inactive to active) Questionable Test Status Register bit transitions are reported. • Questionable test status events report in bit 9 of the Questionable Summary Register. • The <i>Status Preset Command</i> sets the 15 LSB enable register bits to “1”, which enables all test event reporting. <p>Command Syntax 0A11₁₆</p> <p>Query Syntax 8A11₁₆ → <enable></p> <p>Parameters: <enable> Type: 16-bit unsigned integer Range: 0 to 65535</p> <p>0001₁₆ Baseboard Test Failed Bit 0002₁₆ SRAM Test Failed Bit 0004₁₆ ROM Test Failed Bit 0008₁₆ Unused Bits 0010₁₆ Ref Oscillator Test Failed Bit 0020₁₆ Unused Bits 0040₁₆ Flash Memory Test Failed Bit 0080₁₆ Unused Bits 0100₁₆ Input1–2 Register Test Failed Bit 0200₁₆ Input1 RAM Test Failed Bit 0400₁₆ Input2 RAM Test Failed Bit 0800₁₆ PLL Test Failed Bit F000₁₆ Unused Bits</p>

Name	Description
<p>Status Test Event Query 8A12₁₆</p>	<p>Queries the Questionable Test Status Register. The Questionable Test Status Register identifies unit self tests that have completed with questionable results, such as self test errors. The following considerations apply when using the <i>Status Test Event Query</i>.</p> <ul style="list-style-type: none"> • The Questionable Test Status Register records the history of the questionable process results generated since the previous questionable event status query. • The <i>Status Questionable Event Query</i> clears the Questionable Status Event Register after returning the current register contents. • Questionable Test Status Event Register reports in bit 9 of the Questionable Summary Register. • In order to identify questionable results from a particular process, the Questionable Status Event Register <u>must</u> be cleared by reading it before the processes are run. <p>Command Syntax None</p> <p>Query Syntax 8A12₁₆ → <event></p> <p>Parameters: <event> Type: 16-bit unsigned integer Range: 0 to 65535</p> <p>0001₁₆ Baseboard Test Failed Bit 0002₁₆ SRAM Test Failed Bit 0004₁₆ ROM Test Failed Bit 0008₁₆ Unused Bits 0010₁₆ Ref Oscillator Test Failed Bit 0020₁₆ Unused Bits 0040₁₆ Flash Memory Test Failed Bit 0080₁₆ Unused Bit 0100₁₆ Input1–2 Register Test Failed Bit 0200₁₆ Input1 RAM Test Failed Bit 0400₁₆ Input2 RAM Test Failed Bit 0800₁₆ PLL Test Failed Bit F000₁₆ Unused Bits</p>

Name	Description
<p>Status Voltage Condition Query 8A19₁₆</p>	<p>Queries the contents of the Questionable Voltage Condition Register. The Questionable Voltage Condition Register identifies the voltage overages for the input channels. The following considerations apply when using the <i>Status Voltage Condition Query</i>:</p> <ul style="list-style-type: none"> • The Questionable Voltage Condition Register identifies voltage overloads. Use the <i>Status Questionable Voltage Condition Query</i> to identify a history of which voltages have had overloads since the last voltage status check. • Questionable voltage events report in bit 0 of the Questionable Summary Register. • The <i>Status Questionable Voltage Condition Query</i> does <u>not</u> clear the Questionable Voltage Condition Register. <p>Command Syntax None</p> <p>Query Syntax 8A19₁₆ → <condition></p> <p>Parameters: <condition> Type: 16-bit unsigned integer Range: 0 to 65535</p> <p>0001₁₆ Input 1 Overload 0002₁₆ Input 2 Overload 000C₁₆ Unused Bits 0010₁₆ Input 1–2 Over voltage FFE0₁₆ Unused Bits</p>

Name	Description
<p>Status Voltage Enable Command 0A1A₁₆</p> <p>Status Voltage Enable Query 8A1A₁₆</p>	<p>Sets or queries the contents of the Questionable Voltage Status Register. The Questionable Voltage Status Register enables the reporting of questionable events to the Status Byte. The following considerations apply when using the <i>Status Voltage Enable Command</i> and <i>Status Voltage Enable Query</i>.</p> <ul style="list-style-type: none"> • The Questionable Voltage Status Register is a bit mask that allows selected questionable voltage overload and over voltage events to be reported to the Status Byte. • Only low to high (inactive to active) Questionable Voltage Status Register bit transitions are reported. • Questionable voltage status events report in bit 0 of the Questionable Summary Register. • The <i>Status Preset Command</i> sets the 15 LSB enable register bits to “1”, which enables all voltage overload and over voltage reporting. <p>Command Syntax 0A1A₁₆</p> <p>Query Syntax 8A1A₁₆ → <enable></p> <p>Parameters: <enable> Type: 16-bit unsigned integer Range: 0 to 65535</p> <p>0001₁₆ Input 1 Overload 0002₁₆ Input 2 Overload 000C₁₆ Unused Bits 0010₁₆ Input 1–2 Over voltage FFE0₁₆ Unused Bits</p>

Name	Description
Status Voltage Event Query 8A1B ₁₆	<p>Queries the Questionable Voltage Status Register. The Questionable Voltage Status Register identifies unit voltage overloads and over voltages that have completed with questionable results. The following considerations apply when using the <i>Status Voltage Event Query</i>:</p> <ul style="list-style-type: none"> • The Questionable Voltage Status Register records the history of the questionable process results generated since the previous <i>Status Questionable Event Query</i>. • The <i>Status Questionable Event Query</i> clears the Questionable Status Event Register after returning the current register contents. • Questionable Voltage Status Event Register reports in bit 0 of the Questionable Summary Register. • In order to identify questionable results from a particular process, the Questionable Status Event Register <u>must</u> be cleared by reading it before the processes are run. <p>Command Syntax None</p> <p>Query Syntax 8A1B₁₆ → <event></p> <p>Parameters: <event> Type: 16-bit unsigned integer Range: 0 to 65535</p> <p>0001₁₆ Input 1 Overload 0002₁₆ Input 2 Overload 000C₁₆ Unused Bits 0010₁₆ Input 1–2 Over voltage FFE0₁₆ Unused Bits</p>

Name	Description
<p>Sweep Mode Command 0510₁₆</p> <p>Sweep Mode Query 8510₁₆</p>	<p>Sets or queries the trigger mode to enable automatic triggering in absence of a trigger event.</p> <p>Command Syntax 0510₁₆ <trigger_mode></p> <p>Query Syntax 8510₁₆ → <trigger_mode></p> <p>Parameters: <trigger_mode> Type: 16-bit unsigned integer</p> <p>0000₁₆ Auto 0001₁₆ Normal</p>
<p>Sweep Offset Reference Command 0514₁₆</p> <p>Sweep Offset Reference Query 8514₁₆</p>	<p>Sets or queries the waveform record offset reference location. The following considerations apply when using the <i>Sweep Offset Reference Command</i> and <i>Sweep Offset Reference Query</i>.</p> <ul style="list-style-type: none"> • The waveform offset reference can be considered a “handle” on the record. The waveform offset reference location is the location of the handle relative to the start of the waveform record. • The offset reference is used by the <i>Sweep Offset Time Command</i> to move the record relative to the trigger event. • An offset reference value of 0.0 places the handle at the first point of the record; a value of 0.5 selects the mid point; and a value of 1.0 selects the last point. • When the offset time is set to 0.0, a reference location of 0.0 will place the trigger event at the waveform record start, a reference location of 1.0 will place the trigger event at the waveform record end. • All captured waveforms use the same offset reference. <p>Command Syntax 0514₁₆ <location></p> <p>Query Syntax 8514₁₆ → <location></p> <p>Parameters: <location> Type: 32-bit floating point Range: 0.0 to 1.0</p>

Name	Description																
<p>Sweep Offset Time Command 0515₁₆</p> <p>Sweep Offset Time Query 8515₁₆</p>	<p>Sets or queries the time between the sweep offset reference and the trigger event. The following considerations apply when using the <i>Sweep Offset Time Command</i> and <i>Sweep Offset Time Query</i>:</p> <ul style="list-style-type: none"> The offset time is the time between the trigger event and the offset reference, refer to the <i>Sweep Offset Reference Command</i> for more information on the offset reference. Offset times move the offset reference after the trigger event. The time of the last sample taken may be calculated as: Last Sample Time = offset time + sweep time * (1 – offset reference location) All channels use the same sweep offset time <p>Command Syntax 0515₁₆ <sweep_offset_time></p> <p>Query Syntax 8515₁₆ → <sweep_offset_time></p> <p>Parameters: <sweep_offset_time> Type: 32-bit floating</p> <p>Range: 0 to 655 seconds Resolution:</p> <table border="1" data-bbox="699 1184 1318 1562"> <thead> <tr> <th>Resolution</th> <th>Sweep Offset Time</th> </tr> </thead> <tbody> <tr> <td>10 ns</td> <td>0 to 655.36 μs</td> </tr> <tr> <td>100 ns</td> <td>655.36 μs to 6.5536 ms</td> </tr> <tr> <td>1 μs</td> <td>6.5536 ms to 65.536 ms</td> </tr> <tr> <td>10 μs</td> <td>65.536 ms to 655.36 ms</td> </tr> <tr> <td>100 μs</td> <td>655.36 ms to 6.5536 s</td> </tr> <tr> <td>1 ms</td> <td>6.5536 s to 65.536 s</td> </tr> <tr> <td>10 ms</td> <td>65.536 s to 655 s</td> </tr> </tbody> </table>	Resolution	Sweep Offset Time	10 ns	0 to 655.36 μs	100 ns	655.36 μs to 6.5536 ms	1 μs	6.5536 ms to 65.536 ms	10 μs	65.536 ms to 655.36 ms	100 μs	655.36 ms to 6.5536 s	1 ms	6.5536 s to 65.536 s	10 ms	65.536 s to 655 s
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Name	Description
<p>Sweep Points Command 0511₁₆</p> <p>Sweep Points Query 8511₁₆</p>	<p>Sets or queries the number of samples in a waveform record. The range of points varies with the size of the installed digitizer memory. The following considerations apply when using the <i>Sweep Points Command</i> and <i>Sweep Points Query</i>.</p> <ul style="list-style-type: none"> • The minimum record length is 100 data points. • The maximum record length is the size of the digitizer memory. The maximum record size is further limited by the number of active channels. • When in 2 channel modes, each channel may use up to the full digitizer memory size. <p>Note: The capture circuitry requires a small number of samples in the digitizer memory for housekeeping, thus at the maximum waveform sizes, bad samples may be returned at the beginning of the waveform record</p> <ul style="list-style-type: none"> • Use the <i>Sweep Time Query</i> to read the current sample rate in samples per second. • All active channels share the same record length setting. <p>Command Syntax 0511₁₆ <points></p> <p>Query Syntax 8511₁₆ → <points></p> <p>Parameters: <points> Type: 32-bit unsigned integer</p> <p>Range: 100 to N, where N is the maximum memory size.</p>

Name	Description
Sweep Time Query 8512 ₁₆	<p>Queries the time span or duration of the waveform acquisition gate. The following considerations apply when using the <i>Sweep Time Query</i>.</p> <ul style="list-style-type: none"> The minimum sweep time is 40 ns; the maximum sweep time is N/2.5 KS/s, where N is the maximum memory. All channels share the same sweep time span. <p>Command Syntax None</p> <p>Query Syntax 8512₁₆ → <seconds></p> <p>Parameters: <seconds> Type: 32-bit floating point Range: 40 ns to N/2.5 KS/s, where N is the maximum memory</p>
System Error All Query 8003 ₁₆	<p>Returns all 32 entries in the error log and clears the error log. Multiple errors are stored sequentially in the error log with the oldest error first. A zero value is returned for all non-error entries when there are less than 32 errors stored in the error log.</p> <p>Command Syntax None</p> <p>Query Syntax 8003₁₆ → <error_number></p> <p>Parameters: <error_number> Type: 16-bit signed integer Range: 0 to -32768</p> <p>0: No error</p> <p>Note: See <i>Appendix 3, Error Table</i>, for a description of errors.</p>
System Error Count Query F002 ₁₆	<p>Returns the number of errors in the error log.</p> <p>Command Syntax None</p> <p>Query Syntax F002₁₆ → <error_count></p> <p>Parameters: <error_count> Type: 16-bit unsigned integer Range: 0 to 32</p>

Name	Description
<p>System Error Query F000₁₆</p>	<p>Returns and clears the first entry in the error log. Multiple errors are stored sequentially in the error log with the oldest error first. A zero value is returned if there are no errors in the log.</p> <p>Note: This command is not recommended for new applications. Use <i>System Error All Query</i> instead.</p> <p>Command Syntax None</p> <p>Query Syntax F000₁₆ → <error></p> <p>Parameters: <error> Type: 16-bit signed integer Range: 0 to -32768</p> <p>0: no error</p> <p>Note: See <i>Appendix 3, Error Table</i>, for a description of errors.</p>
<p>System Memory Query 8500₁₆</p>	<p>Returns the total available waveform memory for use by the two digitizer channels.</p> <p>Command Syntax None</p> <p>Query Syntax 8500₁₆ → <size></p> <p>Parameters: <size> Type: 32-bit unsigned integer</p> <p>Memory Options 2 MSamples Total 32 MSamples Total</p> <p>Note: Total samples <u>must</u> be equal to the installed memory option.</p>

Name	Description
System Temperature Query 8008 ₁₆	<p>Returns the instrument temperature in degrees Celsius. The temperature has a high threshold of 60 degrees Celsius. If the instrument temperature exceeds the high threshold, it will immediately power down.</p> <p>Command Syntax None</p> <p>Query Syntax 8008₁₆ → <temperature></p> <p>Parameters: <temperature> Type: 32-bit floating point</p>
Test Query 8001 ₁₆	<p>Initiates an instrument self test and returns the test results as a 16-bit code. The self test is initiated on instrument power up.</p> <p>Command Syntax None</p> <p>Query Syntax 8001₁₆ → <code></p> <p>Parameters: <code> Type: 16-bit unsigned integer Range: 0 to 65535</p> <ul style="list-style-type: none"> 0001₁₆ Baseboard Test Failed Bit 0002₁₆ SRAM Test Failed Bit 0004₁₆ ROM Test Failed Bit 0008₁₆ Unused Bits 0010₁₆ Ref Oscillator Test Failed Bit 0020₁₆ Unused Bits 0040₁₆ Flash Memory Test Failed Bit 0080₁₆ Unused Bits 0100₁₆ Input1–2 Register Test Failed Bit 0200₁₆ Input1 RAM Test Failed Bit 0400₁₆ Input2 RAM Test Failed Bit 0800₁₆ PLL Test Failed Bit F000₁₆ Unused Bits

Name	Description
<p>Trace Copy Reference Command 0528₁₆</p>	<p>Stores the reference waveform in nonvolatile memory.</p> <p>Command Syntax 0528₁₆ <reference_channel> <source></p> <p>Query Syntax None</p> <p>Parameters: <reference_channel> Type: 16-bit unsigned integer</p> <p>0004₁₆ Reference Channel 1 0005₁₆ Reference Channel 2 0006₁₆ Reference Channel 3 0007₁₆ Reference Channel 4</p> <p><source> Type: 16-bit unsigned integer</p> <p>0000₁₆ Input Channel 1 0001₁₆ Input Channel 2 0002₁₆ Calculation Channel 1 0003₁₆ Calculation Channel 2 0004₁₆ Reference Channel 1 0005₁₆ Reference Channel 2 0006₁₆ Reference Channel 3 0007₁₆ Reference Channel 4</p>

Name	Description
<p>Trace Load Calculate Query 8522₁₆</p>	<p>Returns the calculate channel waveform data. The instrument returns a "1" response to the query when it has moved all of the data into the memory.</p> <p>Command Syntax None</p> <p>Query Syntax 8522₁₆ <calc_channel> <waveform_index> <buffer_address> <points> → "1"</p> <p>Parameters: <calc_channel> Type: 16-bit unsigned integer</p> <p>0002₁₆ Calculation Channel 1 0003₁₆ Calculation Channel 2</p> <p><waveform_index> Type: 32-bit unsigned integer Range: 0 to 32768</p> <p><buffer_address> Type: 32-bit unsigned integer Range: 16517 (4085₁₆)</p> <p><points> Type: 32-bit unsigned integer Range: 0 to 2048 (800₁₆)</p>

Name	Description
Trace Load Input Query 8520 ₁₆	<p>Returns the waveform data for the input channel. The instrument returns a "1" response to the query when it has moved all of the data into the memory.</p> <p>Command Syntax None</p> <p>Query Syntax 8520₁₆ <input_channel> <waveform_index> <buffer_address> <points> → "1"</p> <p>Parameters: <input_channel> Type: 16-bit unsigned integer</p> <p style="padding-left: 40px;">0000₁₆ Input Channel 1 0001₁₆ Input Channel 2</p> <p><waveform_index> Type: 32-bit unsigned integer Range: 0 to N, where N = Maximum Memory</p> <p><buffer_address> Type: 32-bit unsigned integer Range: 16517 (4085₁₆)</p> <p><points> Type: 32-bit unsigned integer Range: 0 to 2048 (800₁₆)</p>

Name	Description
<p>Trace Load Reference Command 0521₁₆</p> <p>Trace Load Reference Query 8521₁₆</p>	<p>Read or write the reference channel waveform data. The instrument returns a “1” response to the query when it has moved all of the data into the memory.</p> <p>Note: Use <i>Trace Preamble Command/Query</i> to read/write the appropriate time and voltage conversion factors.</p> <p>Command Syntax 0521₁₆ <reference_channel> <waveform_index> <buffer_address> <points></p> <p>Query Syntax 8521₁₆ <reference_channel> <waveform_index> <buffer_address> <points> → “1”</p> <p>Parameters: <reference_channel> Type: 16-bit unsigned integer</p> <p>0004₁₆ Reference Channel 1 0005₁₆ Reference Channel 2 0006₁₆ Reference Channel 3 0007₁₆ Reference Channel 4</p> <p><waveform_index> Type: 32-bit unsigned integer Range: 0 to 32768</p> <p><buffer_address> Type: 32-bit unsigned integer Range: 16517 (4085₁₆)</p> <p><points> Type: 32-bit unsigned integer Range: 0 to 2048 (800₁₆)</p>
<p>Trace Preamble Command 0529₁₆</p> <p>Trace Preamble Query 8529₁₆</p>	<p>Reads or writes the waveform trace preamble to the unit. The Trace Preamble is an ordered syntax of values. The values are shown below.</p> <p>Note: Preambles may only be loaded for reference waveforms.</p> <ul style="list-style-type: none"> • Source: Selects the source to read the waveform preamble from. • Type: Returns the type of acquisition used. • Points: Returns the number of points in a waveform. • Count: Returns the acquired waveform count used to create the selected average, envelope or equivalent-time waveform. In Normal acquisition the Acquisition Count is always 1. • Time Interval: Returns the time interval between points. • Time Offset: Returns the time in seconds of the first data point relative to the trigger. • Voltage Interval: Returns the voltage resolution. • Voltage Offset: Returns the zero-voltage reference or DC offset

Name	Description
	<p>voltage for the specified waveform.</p> <p>Command Syntax 0529₁₆ <source> <type> <points> <count> <time_interval> <time_offset> <voltage_interval> <voltage_offset></p> <p>Query Syntax 8529₁₆ <source> → <type> <points> <count> <time_interval> <time_offset> <voltage_interval> <voltage_offset></p> <p>Parameters: <source> Type: 16-bit unsigned integer 0000₁₆ Input Channel 1 0001₁₆ Input Channel 2 0002₁₆ Calculation Channel 1 0003₁₆ Calculation Channel 2 0004₁₆ Reference Channel 1 0005₁₆ Reference Channel 2 0006₁₆ Reference Channel 3 0007₁₆ Reference Channel 4</p> <p><type> Type: 16-bit unsigned integer 0000₁₆ Invalid Waveform 0001₁₆ Normal Waveform 0002₁₆ Averaged Waveform 0003₁₆ Envelope Waveform 0004₁₆ Equivalent Time Waveform 0010₁₆ Frequency Domain Waveform (FFT)</p> <p><points> Type: 32-bit unsigned integer Range: 100 to Maximum memory</p> <p><count> Type: 16-bit unsigned integer Range: 1 to 65535</p> <p><time_interval> Type: 32-bit floating point</p> <p><time_offset> Type: 32-bit floating point</p> <p><voltage_interval> Type: 32-bit floating point</p> <p><voltage_offset> Type: 32-bit floating point</p>

Name	Description
<p>Trigger A Event Count Command 0211₁₆</p> <p>Trigger A Event Count Query 8211₁₆</p>	<p>Sets or queries the number of events that Trigger A must count before it enables other waveform capture functions. The following considerations apply when using the <i>Trigger A Event Count Command</i>:</p> <ul style="list-style-type: none"> • The event count affects the capture cycle as follows: <ul style="list-style-type: none"> ○ Arm ○ Count trigger events ○ When the event count is reached, Trigger A will: <ul style="list-style-type: none"> ▪ Enable Trigger B detection ▪ Enable the sweep timer ○ End the capture cycle and begin post-capture processing • The event counter uses the output of the trigger qualifier as an event source (Refer to the <i>Trigger A Pattern Command</i>, <i>Trigger A Pulse High Limit Command</i>, <i>Trigger A Pulse Low Limit Command</i>, <i>Trigger A Slope Command</i>, <i>Trigger A Source Command</i>, and <i>Trigger A Type Command</i> for information on configuring trigger qualifier parameters). <p>Command Syntax 0211₁₆ <count></p> <p>Query Syntax 8211₁₆ → <count></p> <p>Parameters: <count> Type: 16-bit unsigned integer Range: 1 to 65535</p>

Name	Description																
<p>Trigger A Pulse High Limit Command 0214₁₆</p> <p>Trigger A Pulse High Limit Query 8214₁₆</p>	<p>Sets or queries the upper pulse width limit. The instrument triggers when the pulse width is greater than or less than the upper limit value. For example, to trigger when the pulse width is greater than 50 ns, set the upper limit to 50 ns. The instrument triggers when the pulse width is greater than 50 ns.</p> <p>Note: Pulse high limit and pulse low limit use the same resolution for <i>pulse width in</i> and <i>pulse width out</i> when both limits are used.</p> <p>Command Syntax 0214₁₆ <high_limit></p> <p>Query Syntax 8214₁₆ → <high_limit></p> <p>Parameters: <upper_limit> Type: 32-bit floating point</p> <p>Range: 0 to 655 seconds Resolution:</p> <table border="1" data-bbox="760 898 1260 1276"> <thead> <tr> <th>Resolution</th> <th>Pulse Width Range</th> </tr> </thead> <tbody> <tr> <td>10 ns</td> <td>20 ns to 655.36 us</td> </tr> <tr> <td>100 ns</td> <td>655.36 us to 6.5536 ms</td> </tr> <tr> <td>1 us</td> <td>6.5536 ms to 65.536 ms</td> </tr> <tr> <td>10 us</td> <td>65.536 ms to 655.36 ms</td> </tr> <tr> <td>100 us</td> <td>655.36 ms to 6.5536 s</td> </tr> <tr> <td>1 ms</td> <td>6.5536 s to 65.536 s</td> </tr> <tr> <td>10 ms</td> <td>65.536 s to 655 s</td> </tr> </tbody> </table>	Resolution	Pulse Width Range	10 ns	20 ns to 655.36 us	100 ns	655.36 us to 6.5536 ms	1 us	6.5536 ms to 65.536 ms	10 us	65.536 ms to 655.36 ms	100 us	655.36 ms to 6.5536 s	1 ms	6.5536 s to 65.536 s	10 ms	65.536 s to 655 s
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Name	Description																
<p>Trigger A Pulse Low Limit Command 0215₁₆</p> <p>Trigger A Pulse Low Limit Query 8215₁₆</p>	<p>Sets or queries the lower pulse width limit. The instrument triggers when the pulse width is less than the lower limit value.</p> <p>Note: Pulse high limit and pulse low limit use the same resolution for <i>pulse width in</i> and <i>pulse width out</i> when both limits are used.</p> <p>Command Syntax 0215₁₆ <low_limit></p> <p>Query Syntax 8215₁₆ → <low_limit></p> <p>Parameters: <lower_limit> Type: 32-bit floating point</p> <p>Range: 0 to 655 seconds Resolution:</p> <table border="1" data-bbox="751 810 1268 1188"> <thead> <tr> <th>Resolution</th> <th>Pulse Width Range</th> </tr> </thead> <tbody> <tr> <td>10 ns</td> <td>10 ns to 655.36 us</td> </tr> <tr> <td>100 ns</td> <td>655.36 us to 6.5536 ms</td> </tr> <tr> <td>1 us</td> <td>6.5536 ms to 65.536 ms</td> </tr> <tr> <td>10 us</td> <td>65.536 ms to 655.36 ms</td> </tr> <tr> <td>100 us</td> <td>655.36 ms to 6.5536 s</td> </tr> <tr> <td>1 ms</td> <td>6.5536 s to 65.536 s</td> </tr> <tr> <td>10 ms</td> <td>65.536 s to 655 s</td> </tr> </tbody> </table>	Resolution	Pulse Width Range	10 ns	10 ns to 655.36 us	100 ns	655.36 us to 6.5536 ms	1 us	6.5536 ms to 65.536 ms	10 us	65.536 ms to 655.36 ms	100 us	655.36 ms to 6.5536 s	1 ms	6.5536 s to 65.536 s	10 ms	65.536 s to 655 s
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1 us	6.5536 ms to 65.536 ms																
10 us	65.536 ms to 655.36 ms																
100 us	655.36 ms to 6.5536 s																
1 ms	6.5536 s to 65.536 s																
10 ms	65.536 s to 655 s																
<p>Trigger A Slope Command 0203₁₆</p> <p>Trigger A Slope Query 8203₁₆</p>	<p>Sets or queries the active edge of the selected trigger.</p> <p>Command Syntax 0203₁₆ <slope></p> <p>Query Syntax 8203₁₆ → <slope></p> <p>Parameters: <slope> Type: 16-bit unsigned integer</p> <p>0000₁₆ Falling Edge 0001₁₆ Rising Edge</p>																

Name	Description
<p>Trigger A Source Command 0201₁₆</p> <p>Trigger A Source Query 8201₁₆</p>	<p>Sets or queries the Trigger A signal source. The following considerations apply when using the <i>Trigger A Source Command</i> and <i>Trigger A Source Query</i>:</p> <ul style="list-style-type: none"> • All sources are assumed to be low-to-high transitioning signals when active. If a source becomes active on a high-to-low transition, use the <i>Trigger A Slope Command</i> to select negative slope. • Trigger A detection must complete before the Trigger B detector or sweep offset timer are enabled. <p>Command Syntax 0201₁₆ <source></p> <p>Query Syntax 8201₁₆ → <source></p> <p>Parameters: <source> Type: 16-bit unsigned integer</p> <p>0000₁₆ Software 0001₁₆ TTL Trigger0 0002₁₆ TTL Trigger1 0003₁₆ TTL Trigger2 0004₁₆ TTL Trigger3 0005₁₆ TTL Trigger4 0006₁₆ TTL Trigger5 0007₁₆ TTL Trigger6 0008₁₆ TTL Trigger7 0009₁₆ Star Trigger 000A₁₆ Channel 1 Trigger 000B₁₆ Channel 2 Trigger 000C₁₆ External Trigger 000D₁₆ Pattern Trigger</p>

Name	Description
<p>Trigger A Type Command 0210₁₆</p> <p>Trigger A Type Query 8210₁₆</p>	<p>Sets or queries the Trigger A detection type. The following considerations apply when using the <i>Trigger A Type Command</i> and <i>Trigger A Type Query</i>:</p> <ul style="list-style-type: none"> • Six trigger types are accepted: edge, pulse inside limits, pulse outside limits, pulse less than limit, pulse greater than limit, and video. • Edge triggering looks for a rising or falling edge from the selected signal source. • Pulse inside limits looks for a pulse width greater than a low-time limit and less than or equal to a high-time limit. • Pulse outside limits looks for a pulse width less than a low time limit or greater than a high time limit. • Pulse less than looks for a pulse width less than a low time limit. • Pulse greater than looks for a pulse width greater than a high time limit. • Video triggering looks for a specific field or line from the selected source. • Trigger A detection must complete before the Trigger B detector or sweep offset timer are enabled <p>Command Syntax 0210₁₆ <trigger_type></p> <p>Query Syntax 8210₁₆ → <trigger_type></p> <p>Parameters: <trigger_type> Type: 16-bit unsigned integer</p> <p>0000₁₆ Edge 0001₁₆ Pulse Inside Limits 0002₁₆ Pulse Outside Limits 0003₁₆ Pulse Less Than 0004₁₆ Pulse Greater Than 0005₁₆ Video</p>

Name	Description
<p>Trigger A Video Field Command 0217₁₆</p> <p>Trigger A Video Field Query 8217₁₆</p>	<p>Sets or queries which video field to select a line to trigger on.</p> <p>Command Syntax 0217₁₆ <video_field></p> <p>Query Syntax 8217₁₆ → <video_field></p> <p>Parameters: <video_field> Type: 16-bit unsigned integer Range: 1 or 2</p>
<p>Trigger A Video Line Command 0218₁₆</p> <p>Trigger A Video Line Query 8218₁₆</p>	<p>Sets or queries which video line to trigger on.</p> <p>Note: The line depends on the video standard and video field.</p> <p>Command Syntax 0218₁₆ <video_line></p> <p>Query Syntax 8218₁₆ → <video_line></p> <p>Parameters: <video_line> Type: 16-bit unsigned integer Range:</p> <p><u>NTSC</u> Field 1: 1 to 263 Field 2: 1 to 262</p> <p><u>PAL/SECAM</u> Field 1: 1 to 313 Field 2: 314 to 625</p>
<p>Trigger A Video Standard Command 0216₁₆</p> <p>Trigger A Video Standard Query 8216₁₆</p>	<p>Sets or queries the video standard.</p> <p>Command Syntax 0216₁₆ <video_standard></p> <p>Query Syntax 8216₁₆ → <video_standard></p> <p>Parameters: <video_standard> Type: 16-bit unsigned integer</p> <p>0000₁₆ PAL 0001₁₆ NTSC 0002₁₆ SECAM</p>

Name	Description
<p>Trigger B Slope Command 0223₁₆</p> <p>Trigger B Slope Query 8223₁₆</p>	<p>Sets or queries the active edge of the selected trigger.</p> <p>Command Syntax 0223₁₆ <slope></p> <p>Query Syntax 8223₁₆ → <slope></p> <p>Parameters: <slope> Type: 16-bit unsigned integer</p> <p>0000₁₆ Falling Edge 0001₁₆ Rising Edge</p>
<p>Trigger B Source Command 0221₁₆</p> <p>Trigger B Source Query 8221₁₆</p>	<p>Sets or queries the Trigger B signal source. The following considerations apply:</p> <ul style="list-style-type: none"> • Trigger B slope is selectable using edge triggering. • If a source becomes active on a high-to-low transition, use the <i>Trigger B Slope Command</i> to change the slope. • Trigger A detection must complete before the Trigger B detector or sweep offset timer are enabled. <p>Command Syntax 0221₁₆ <source></p> <p>Query Syntax 8221₁₆ → <source></p> <p>Parameters: <source> Type: 16-bit unsigned integer</p> <p>0000₁₆ Software 0001₁₆ TTL Trigger0 0002₁₆ TTL Trigger1 0003₁₆ TTL Trigger2 0004₁₆ TTL Trigger3 0005₁₆ TTL Trigger4 0006₁₆ TTL Trigger5 0007₁₆ TTL Trigger6 0008₁₆ TTL Trigger7 0009₁₆ Star Trigger 000A₁₆ Channel 1 Trigger 000B₁₆ Channel 2 Trigger 000C₁₆ External Trigger 000D₁₆ Pattern Trigger</p>

Name	Description																
<p>Trigger B State Command 0220₁₆</p> <p>Trigger B State Query 8220₁₆</p>	<p>Sets or queries the Trigger B status state.</p> <p>Command Syntax 0220₁₆ <state></p> <p>Query Syntax 8220₁₆ → <state></p> <p>Parameters: <state> Type: 16-bit unsigned integer</p> <p>0000₁₆ Disable 0001₁₆ Enable</p>																
<p>Trigger Hold Off Command 020B₁₆</p> <p>Trigger Hold Off Query 820B₁₆</p>	<p>Sets or queries the duration (in seconds) to hold off or ignore all other triggers before recognizing the next trigger event.</p> <p>Command Syntax 020B₁₆ <seconds></p> <p>Query Syntax 820B₁₆ → <seconds></p> <p>Parameters: <seconds> Type: 32-bit floating point</p> <p>Range: 0 to 655 seconds Resolution:</p> <table border="1" data-bbox="750 1224 1268 1604"> <thead> <tr> <th>Resolution</th> <th>Hold Off Range</th> </tr> </thead> <tbody> <tr> <td>10 ns</td> <td>0 to 655.36 μs</td> </tr> <tr> <td>100 ns</td> <td>655.36 μs to 6.5536 ms</td> </tr> <tr> <td>1 μs</td> <td>6.5536 ms to 65.536 ms</td> </tr> <tr> <td>10 μs</td> <td>65.536 ms to 655.36 ms</td> </tr> <tr> <td>100 μs</td> <td>655.36 ms to 6.5536s</td> </tr> <tr> <td>1 ms</td> <td>6.5536s to 65.536s</td> </tr> <tr> <td>10 ms</td> <td>65.536s to 655s</td> </tr> </tbody> </table>	Resolution	Hold Off Range	10 ns	0 to 655.36 μs	100 ns	655.36 μs to 6.5536 ms	1 μs	6.5536 ms to 65.536 ms	10 μs	65.536 ms to 655.36 ms	100 μs	655.36 ms to 6.5536s	1 ms	6.5536s to 65.536s	10 ms	65.536s to 655s
Resolution	Hold Off Range																
10 ns	0 to 655.36 μs																
100 ns	655.36 μs to 6.5536 ms																
1 μs	6.5536 ms to 65.536 ms																
10 μs	65.536 ms to 655.36 ms																
100 μs	655.36 ms to 6.5536s																
1 ms	6.5536s to 65.536s																
10 ms	65.536s to 655s																

Name	Description
<p>Trigger Immediate Command 0202₁₆</p>	<p>Causes an immediate trigger event for any selected trigger source. If enabled, the trigger outputs on the PXI backplane of PCI Timing Expansion Connector will also toggle when this command is issued.</p> <p>Command Syntax 0202₁₆</p> <p>Query Syntax None</p> <p>Parameters: None</p>
<p>Trigger Input Level Command 0207₁₆</p> <p>Trigger Input Level Query 8207₁₆</p>	<p>Sets or queries an analog input channel trigger level. The following considerations apply when setting the input trigger level:</p> <ul style="list-style-type: none"> • The trigger level has the same range as the input range. • Each input channel has an independent trigger level. • The logic level out of the threshold detector is reported to the Trigger A and B multiplexers for selection as the input trigger sources. <p>Command Syntax 0207₁₆ <input_channel> <volts></p> <p>Query Syntax 8207₁₆ <input_channel> → <volts></p> <p>Parameters: <input_channel> Type: 16-bit unsigned integer</p> <p>0000₁₆ Input Channel 1 0001₁₆ Input Channel 2</p> <p><volts> Type: 32-bit floating point Range: Input Offset ± $\frac{\text{Input Range}}{2}$</p>

Name	Description
<p>Trigger Pattern Mask Command 0212₁₆</p> <p>Trigger Pattern Mask Query 8212₁₆</p>	<p>Sets or queries which sources to use in the pattern.</p> <p>Command Syntax 0212₁₆ <pattern_mask></p> <p>Query Syntax 8212₁₆ → <pattern_mask></p> <p>Parameters: <pattern_mask> Type: 16-bit unsigned integer</p> <p>0 Do <u>not</u> use in pattern trigger 1 Use in pattern trigger</p> <p>Source Order (MSB–LSB):</p> <ul style="list-style-type: none"> • Bits 15–4 are ignored • Bit 3—Star Trigger • Bit 2—External Trigger • Bit 1—Channel 2 • Bit 0—Channel 1
<p>Trigger Pattern Truth Command 0213₁₆</p> <p>Trigger Pattern Truth Query 8213₁₆</p>	<p>Sets or queries the state of each source for the pattern trigger to occur.</p> <p>Command Syntax 0213₁₆ <pattern_truth></p> <p>Query Syntax 8213₁₆ → <pattern_truth></p> <p>Parameters: <pattern_truth> Type: 16-bit unsigned integer</p> <p>0 Low 1 High</p> <p>Source Order (MSB–LSB):</p> <ul style="list-style-type: none"> • Bits 15–4 are ignored • Bit 3—Star Trigger • Bit 2—External Trigger • Bit 1—Channel 2 • Bit 0—Channel 1

Name	Description
Trigger Timestamp Query 820C ₁₆	<p>Returns the trigger timestamp of the most recent trigger event in fractional seconds with a 1 second period.</p> <p>Command Syntax None</p> <p>Query Syntax 820C₁₆ → <seconds></p> <p>Parameters: <seconds> Type: 32-bit floating point</p> <p>Range: 0 to 1 second Resolution: 100 ns</p>
Wait to Continue Command 0005 ₁₆	<p>Allows the user to force the interface to wait unit operations are complete before resuming.</p> <p>Command Syntax 0005₁₆</p> <p>Query Syntax None</p> <p>Parameters: None</p>

Specifications



Analog Input

Channels

Quantity 2

Bandwidth (50 Ω)

Product Option	50 Ω Typical Bandwidth	50 Ω Minimum Bandwidth
ZT450-0X	500 MHz	400 MHz
ZT450-2X	500 MHz	400 MHz
ZT450-5X	750 MHz	650 MHz

Bandwidth (1 M Ω)

Product Option	1 M Ω Typical Small Signal Bandwidth	1 M Ω Minimum Small Signal Bandwidth
ZT450-0X	300 MHz	250 MHz
ZT450-2X	300 MHz	250 MHz
ZT450-5X	350 MHz	300 MHz

Slew Rate = 500 V/ μ s*

* - limits the large signal BW

Maximum Input (50 Ω)

\pm 5V (DC + peak AC)
Input load protection @ \pm 6 VDC

Maximum Input (1 M Ω)

\pm 210V [DC + peak AC (<10 kHz)]
Peak AC, de-rated 20 dB/decade above 10 kHz

Product Option	1 M Ω Maximum Working Voltage	1 M Ω Maximum Range + Offset
ZT450-0X	\pm 210 V	\pm 150 V
ZT450-2X	\pm 210 V	\pm 150 V
ZT450-5X	\pm 210 V	\pm 100 V

Input VSWR (50 Ω)

\leq 1.4:1, DC to 50 Ω Bandwidth

Input Bias (50 Ω)

\leq \pm 40 μ A

Input Bias (1 M Ω)

\leq \pm 1 nA

Full Scale Input Range
& Offset Adjust

Impedance	ZT450-0X or ZT450-2X		ZT450-5X	
	Range	Offset	Range	Offset
1 MΩ	100 Vpp	±100V	100 Vpp	±50V
	50 Vpp	±100V	50 Vpp	±25V
	20 Vpp	±100V	20 Vpp	±10V
	10 Vpp	±100V	10 Vpp	±5V
	5 Vpp	±5V	5 Vpp	±2.5V
	2.5 Vpp	±5V	2.5 Vpp	±1.25V
	1 Vpp	±5V	1 Vpp	±0.5V
	0.5 Vpp	±5V	0.5 Vpp	±0.25V
			0.2 Vpp	±0.1V
		0.1 Vpp	±0.05V	
50Ω	10 Vpp	±10V	10 Vpp	±5V
	5 Vpp	±10V	5 Vpp	±2.5V
	2 Vpp	±10V	2 Vpp	±1V
	1 Vpp	±10V	1 Vpp	±0.5V
	0.5 Vpp	±0.5V	0.5 Vpp	±0.25V
	0.25 Vpp	±0.5V	0.25 Vpp	±0.125V
	0.1 Vpp	±0.5V	0.1 Vpp	±0.05V
	0.05 Vpp	±0.5V	0.05 Vpp	±0.025V

DC Gain Accuracy

Product Option	DC Gain Accuracy
ZT450-0X	≤ ± 1.5% of full scale
ZT450-2X	≤ ± 1.5% of full scale
ZT450-5X	≤ ± 1.0% of full scale

DC Offset Accuracy

Product Option	DC Offset Accuracy
ZT450-0X	≤ ± (1% offset + 2% full scale)
ZT450-2X	≤ ± (1% offset + 2% full scale)
ZT450-5X	≤ ± (1% offset + 1% full scale)

DC Offset Drift

Product Option	DC Offset Drift
ZT450-0X	≤ ± (0.3% full scale) per °C
ZT450-2X	≤ ± (0.3% full scale) per °C
ZT450-5X	≤ ± (0.1% full scale) per °C

Impedance	1 M Ω 12 pF or 50 Ω
Impedance Accuracy	\pm 1%
Coupling	DC or AC
AC Coupling	200 kHz high pass (50 Ω) 10 Hz high pass (1 M Ω)
Probe Attenuation	0.9 to 1000:1
Analog Filter	20 MHz or Bypass Filter Stopband Rejection: approximately 3dB @ 20 MHz

RMS Noise (50 Ω)

Product Option	RMS Noise (50 Ω)
ZT450-0X	\leq (350 μ V + 0.5% range), 0.05 Vpp to 0.5 Vpp \leq (3.5 mV + 0.5% range), 1 Vpp to 10 Vpp
ZT450-2X	\leq (350 μ V + 0.5% range), 0.05 Vpp to 0.5 Vpp \leq (3.5 mV + 0.5% range), 1 Vpp to 10 Vpp
ZT450-5X	\leq (100 μ V + 0.5% range) range

RMS Noise (1M Ω)

Product Option	RMS Noise (1 M Ω)
ZT450-0X	\leq (3.5 mV + 0.5% range), 0.5 Vpp to 5 Vpp \leq (35 mV + 0.5% range), 10 Vpp to 100 Vpp
ZT450-2X	\leq (3.5 mV + 0.5% range), 0.5 Vpp to 5 Vpp \leq (35 mV + 0.5% range), 10 Vpp to 100 Vpp
ZT450-5X	\leq (1 mV + 0.5% range)

RMS Noise (20 MHz Filter) \leq (0.25% range)

Connectors BNC

Analog-to-Digital Converter

Resolution 8 bit

Sample Rate

Product Option	1 Channel Maximum Sample Rate	2 Channel Maximum Sample Rate
ZT450-0X	2 GS/s	1 GS/s
ZT450-2X	1 GS/s	500 MS/s
ZT450-5X	2.5 GS/s	1.25 GS/s

2.5 kS/s to 2-Channel Maximum Sample Rate in 1, 2.5, or 5 steps
 1 GS/s, 1 channel interleaved (ZT450-2X)
 2 GS/s, 1 channel interleaved (ZT450-0X or ZT450-5X)
 2.5 GS/s, 1 channel interleaved (ZT450-5X)

Trigger Hold Off	Programmable delay after trigger before recognizing next trigger event
Hold Off Range	0 to 655 seconds
Trigger B	Second edge trigger event qualifier
Pattern Trigger	Pattern match true or false
Pattern Sources	Channels 1 to 2, External Trigger, Star Trigger (PXI Backplane or PCI Timing Expansion Connector)
Event Trigger	Event Counter: 1 to 65535 trigger events
Trigger Modes	Edge, Pulse Width, Video
Edge Trigger Mode	Rising or Falling Edge
Pulse Width Trigger Mode	Triggers on pulse width greater than, less than, or between limits
Pulse Width Type	< limit1, > limit1, < limit1 & > limit2
Pulse Width Range	20 ns to 655 seconds
Pulse Width Resolution	10 ns
Video Trigger Mode	PAL (50 Hz), NTSC (60 Hz), SECAM (50 Hz) Standard, Field, Line selectable
Ch 1–2 Trigger Level	(offset – full scale/2) to (offset + full scale/2)
Ch 1–2 Trigger Sensitivity	5% of full scale (DC to 100 MHz) 10% of full scale (100 MHz to 500 MHz) 25% of full scale (> 500 MHz)
Ch 1–2 Trigger Bandwidth	≥ 400 MHz
Ch 1–2 Trigger Hysteresis	5% (overdrive required)
Ch 1–2 Level Resolution	0.025% of full scale
Ch 1–2 Level Accuracy	±(2% setting + 2% full scale + offset accuracy)
Trigger Timestamp	100 ns resolution, 1 second rollover

TTL Trigger Outputs

Functionality	Event Output Signals
Outputs	TTL Trigger0–7 (PXI Backplane or PCI Timing Expansion Connector)
Source	Trigger Event, Arm Event, OPC, Constant State

External Trigger

Functionality	Trigger Input or Output
Maximum Input	0V to 5V, no damage
Trigger Input	TTL Compatible, 10 k Ω Input Impedance
Trigger Output	TTL Compatible into 50 Ω
Trigger Output Source	Trigger Event, Arm Event, OPC, Constant State, 10MHz Reference Clock, 500 Hz Clock, 10 ns Pulse at 1 ms Repetition Interval
Connector	SMB

Arm

Functionality	Arm to qualify trigger event
Source	External Trigger, Software, Star Trigger, TTL Trigger0–7 (PXI Backplane or PCI Timing Expansion Connector)
Polarity	Positive or Negative

External Arm Input

Maximum Input	0V to 5V, no damage
Nominal Level	TTL Compatible
Input Impedance	10 k Ω \pm 2%
Connector	SMB (Shared with Trigger I/O)

External Sampling Clock

Functionality	External Sampling Clock bypasses Phase Locked Loop
Synchronization	Both channels synchronized to external clock
Clock Rates	200 MHz to 1 GHz
Maximum Input	\pm 5VDC, no damage
Input Signal Level	500 mVpp to 1 Vpp, sine or square wave
Input Impedance	AC coupled, 50 Ω \pm 2%
Connector	SMB

10 MHz Time Base Reference

Clock Source	Internal TCXO, PXI Backplane or PCI Timing Expansion Connector
Internal TCXO	± 2.5 ppm accuracy

Data Processing

Auto Scale	Automatic adjust to input signals: Input Range, Offset, Sample Rate, Trigger Source, and Trigger Level
Self-Calibration	Automatic internal calibration: Input DC Offset

Measurements

Measurements	Min, Max, Low, High, Mid, Average, Amplitude, Peak-to-Peak, DC RMS, AC RMS, +Width, -Width, Period, Frequency, +Duty, -Duty, Phase, Rise Time, Rise Overshoot, Rise Preshoot, Rise Crossing Time, Fall Time, Fall Overshoot, Fall Preshoot, Fall Crossing Time, Time of Maximum, Time of Minimum, Cycle Average, Cycle RMS, Cycle Frequency, Cycle Period, AC High-Precision, DC High-Precision
Measurement Methods	Entire Waveform, Gated by Time, Gated by Points
Measurement Levels	Low, Mid, High reference levels for edge measurements set in absolute voltages or relative percentages
Measurement Accuracy	
Delta DC Voltage	± (DC gain accuracy)
Absolute DC Voltage	± [(DC gain accuracy)+(offset accuracy)]
Time	± (time resolution)
Frequency	± [1/(time resolution)]

Note: time resolution = one sample interval or one ETS sample interval (for ETS acquisition)

Reference Waveforms

Reference Channels	Quantity 4
Reference Storage	Non-volatile memory storage
Reference Size	32k maximum waveform size

Calculations

Calculate Channels	Quantity 2
Calculate Size	32k maximum waveform size
Calculate Functions	Add, Subtract, Multiply, Copy, Invert, Integral, Derivative, Absolute Value, Limit Test, Mask Test, Frequency Transform, Time

	Transform
Limit Test	Measurement Limit Range Testing or Waveform Mask Testing
Limit Test Reports	Measurement maximum, minimum, average, current value, and pass/fail counts
Frequency Transform	FFT Magnitude
FFT Windowing	Rectangular, Hamming, Hanning, Blackman
Time Transform	Infinite Impulse Response (IIR) filtering
IIR Filter Count	2 to 40 data points

Instrument Setup Storage

Reset	Non-volatile storage of default instrument setup configuration
Save & Recall	Non-volatile storage of 31 instrument setup configurations

Data Interface

PCI Bus	33 MHz, 32 bit address, 16 bit data
PCI Voltage	Universal, +3.3V or +5V
PCI Compatibility	Version 2.2
PXI Signals	PXI_TRGn input/output selectable PXI_STAR input 10 MHz reference input Left and right side buses not used
Manufacturer ID	4172 (104C ₁₆)
Model Code	44128 (AC60 ₁₆)

PXI J2 Trigger & Clock Pin Usage

Pin A16	PXI Trigger 1	(TTL level bidirectional)
Pin A17	PXI Trigger 2	(TTL level bidirectional)
Pin A18	PXI Trigger 3	(TTL level bidirectional)
Pin B16	PXI Trigger 0	(TTL level bidirectional)
Pin B18	PXI Trigger 4	(TTL level bidirectional)
Pin C18	PXI Trigger 5	(TTL level bidirectional)
Pin D17	PXI Star Trigger	(TTL level input)
Pin E16	PXI Trigger 7	(TTL level bidirectional)
Pin E17	PXI CLK10 In	(TTL level input)
Pin E18	PXI Trigger 6	(TTL level bidirectional)

LED Indicators

RDY	Unit has passed power-up self-diagnostics. Toggles when unit has an error pending in error queue.
TRG	Flashes when trigger event occurs

Physical

Physical size	Single-Wide 3U CompactPCI/PXI Instrument (PXI) Single-Slot Short PCI Card (PCI)
Weight	1 lb.

DC Power

Cooling & Power Consumption

Product Option	Typical Cooling & Power	Maximum Cooling & Power
ZT450-00	15.5 W	20.0 W
ZT450-01	18.8 W	23.3 W
ZT450-20	14.8 W	19.1 W
ZT450-21	18.1 W	22.4 W
ZT450-50	19.6 W	27.2 W
ZT450-51	22.9 W	30.5 W

Note: Optional PCI Cooling Fan adds 0.12A to +5VDC current requirements and 0.6W to total power consumption.

Power Supplies

Product Option	Voltage	Typical Current	Maximum Current
ZT450-00	+3.3V	2.5A	2.8A
	+5V	0.8A	1.2A
	+12V	0.02A	0.05A
	-12V	0.25A	0.35A
ZT450-01	+3.3V	3.5A	3.8A
	+5V	0.8A	1.2A
	+12V	0.02A	0.05A
	-12V	0.25A	0.35A
ZT450-20	+3.3V	2.3A	2.5A
	+5V	0.8A	1.2A
	+12V	0.02A	0.05A
	-12V	0.25A	0.35A
ZT450-21	+3.3V	3.3A	3.5A
	+5V	0.8A	1.2A
	+12V	0.02A	0.05A
	-12V	0.25A	0.35A
ZT450-50	+3.3V	3.0A	3.3A
	+5V	1.3A	2.3A
	+12V	0.02A	0.05A
	-12V	0.25A	0.35A
ZT450-51	+3.3V	4.0A	4.3A
	+5V	1.3A	2.3A
	+12V	0.02A	0.05A
	-12V	0.25A	0.35A

Temperature Range

Operating	0 °C to +40 °C Ambient
Storage	-40 °C to +75 °C
Over-Temp Protection	Automatic shutdown if internal temperature is greater than +60 °C
Calibration Range	+20 °C to +30 °C Ambient, after a 20 minute warm-up period, to meet all calibration specification accuracies.

Relative Humidity

Operating or Storage	10 to 90%, non-condensing, up to +40 °C
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Altitude

Operating	Up to 2,000 m
Storage	Up to 15,000 m

Safety

This product is designed to meet the requirements of the following standard of safety for electrical equipment for measurement, control and laboratory use:

EN 61010-1

Electromagnetic Compatibility

CE Marking EN 61326-1:1997 with A1:1998 and A2:2001 Compliant
FCC Part 15 (Class A) Compliant

Emissions

EN 55011	Radiated Emissions, ISM Group 1, Class A, distance 10 m, emissions < 1 GHz
EN 55011	Conducted Emissions, Class A, emissions < 30 MHz

Immunity

EN 61000-4-2	Electrostatic Discharge (ESD), 4 kV by Contact, 8 kV by Air
EN 61000-4-3	RF Radiated Susceptibility, 10 V/m
EN 61000-4-4	Electrical Fast Transient Burst (EFTB), 2 kV AC Power Lines
EN 61000-4-5	Surge
EN 61000-4-6	Conducted Immunity
EN 61000-4-8	Power Frequency Magnetic Field, 30 A/m
EN 61000-4-11	Voltage Dips and Interrupts

CE Compliance

This product meets the necessary requirements of applicable European Directives for CE Marking as follows:

73/23/EEC	Low Voltage Directive (Safety)
89/336/EEC	Electromagnetic Compatibility Directive (EMC)

See Declaration of Conformity for this product for additional regulatory compliance information.

Default Reset Conditions



Parameter	Default
Acquisition Mode	Normal
Arm Polarity	Positive
Arm Source	Immediate
Averaging Waveform Count	8
Averaging Type	Average
Calculation Channel Enable	False
Calculation Operation	Add Input1 and Input 2
Envelope View	Minimum
Equivalent-Time Points	10
External Trigger Output	Disabled, Positive Polarity, Trigger Event Source
Initiate Continuous	OFF
Input Bandwidth	Full (Bypass)
Input Channel Enable	True
Input Coupling	DC
Input Impedance	1 M Ω
Input Probe Attenuation	1.0
Input Voltage Offset	0.0V
Input Voltage Range	10.0Vpp
Limit Test Continuous	On
Limit Test Lower Limit	0.0

Parameter	Default
Limit Test Measurement	AC RMS
Limit Test Upper Limit	0.0
Mask Test Lower Source	Reference 1
Mask Test Upper Source	Reference 1
Measurement Edge	1
Measurement Gate Start Points	0
Measurement Gate Start Time	0 seconds
Measurement Gate Stop Points	1000
Measurement Gate Stop Time	1 μ s
Measurement High Reference Level	0.9 (90 percent)
Measurement Low Reference Level	0.1 (10 percent)
Measurement Method	All
Measurement Mid Reference Level	0.5 (50 percent)
Measurement Reference Method	Relative Percentages
Pulse Width Trigger High	2 μ s
Pulse Width Trigger Low	1 μ s
Sample Clock Source	Internal
Sample Rate	500 MHz
Sweep Mode (Auto trigger)	Normal
Sweep Offset Reference	0.5 (50 percent)
Sweep Offset Time	0.0 seconds
Sweep Points	1000
Time Base Reference	Internal
Transform Frequency Window	Rectangular
Transform Time Points	40
Trigger B Polarity	Positive

Parameter	Default
Trigger B Source	Channel 2
Trigger B State	Bypass
Trigger Event Count	1
Trigger Hold Off	0.0 seconds
Trigger Level Channel 1	0.0V
Trigger Level Channel 2	0.0V
Trigger Pattern Mask	0
Trigger Pattern Truth	0
Trigger Polarity	Positive
Trigger Source	Channel 1
Trigger Type	Edge
TTL Trigger Output	Disabled, Positive Polarity, Trigger Event Source
Video Trigger Field	1
Video Trigger Line	1
Video Trigger Standard	NTSC
Waveform Byte Order	Normal (MSB First)

Error Codes



The ZT450 maintains an error queue containing codes for faults conditions encountered during unit operation. These codes are listed in the table below along with a brief description of the code meaning. The error log may be read by using the *System Error Query*.

Code	Error Summary	Description
-100	Command error	A generic syntax error (only used when a more specific error does not apply)
-101	Invalid character	A syntactic element contains a character which is invalid for that type
-102	Syntax error	An unrecognized command or data type was encountered
-103	Invalid separator	The parser was expecting a separator and encountered an illegal character
-104	Data type error	The parser recognized a data element different than the one allowed
-105	Get not allowed	
-108	Parameter not allowed	More parameters were received than expected
-109	Missing parameter	Fewer parameters were received than expected
-110	Command header error	A generic error was detected in the command
-111	Header separator error	A character which was not a legal separator was encountered while parsing the command
-112	Mnemonic too long	The command contains too many characters
-113	Undefined header	The command is correct, but undefined for the specific instrument
-114	Header suffix out-of-range	The suffix number makes the command invalid
-118	Query not allowed	

Code	Error Summary	Description
-120	Numeric data error	A generic numeric syntax error (only used when a more specific error does not apply)
-121	Invalid char in number	An invalid character for the data type was encountered
-123	Exponent too large	The magnitude of the exponent was larger than 32000
-124	Too many digits	The mantissa of a decimal numeric data element contained more than 255 digits excluding zero
-128	Numeric data not allowed	A legal numeric data element was received, but the instrument does not accept one in this position in the command
-130	Suffix error	General command suffix error (only used when a more specific error does not apply)
-131	Invalid suffix	The command suffix is invalid for this instrument
-134	Suffix too long	The command suffix is too long
-138	Suffix not allowed	A suffix was encountered after a numeric element which does not allow suffixes
-140	Character data error	General character data element error (only used when a more specific error does not apply)
-141	Invalid character data	Either a invalid character in the parameter or the character data is not valid for this command
-144	Character data too long	The character parameter contains too many characters
-148	Character data not allowed	The character data is legal but not supported by this instrument
-150	String data error	General data string error (only used when a more specific error does not apply)
-151	Invalid string data	An invalid string command parameter
-158	String data not allowed	A string element was in the wrong place for this instrument command
-160	Block data error	General block data error (only used when a more specific error does not apply)

Code	Error Summary	Description
-161	Invalid block data	An invalid block data element was received for this instrument command
-168	Block data not allowed	Block data element not allowed by this instrument command at this parameter
-170	Expression error	General expression error (only used when a more specific error does not apply)
-171	Invalid expression	Invalid expression data element like unmatched parentheses or illegal character
-178	Expression data not allowed	A legal expression was encountered but is not allowed by this instrument in this command
-180	Macro error	General macro error (only used when a more specific error does not apply)
-181	Invalid outside macro	Indicates that a macro parameter placeholder was encountered outside a macro definition
-183	Invalid inside macro	Syntactically invalid message unit sequence
-184	Macro parameter error	The command inside the macro definition had the wrong number or type of parameters
-200	Execution error	General execution error (only used when a more specific error does not apply)
-201	Invalid while in local	Indicates that the command is not executable while the device is in local control
-202	Settings lost due to RTL	The settings were lost when the instrument was returned to local control
-203	Command protected	Indicates that a legal password protected program command or query could not be executed because the command was disabled
-210	Trigger Error	General trigger error
-211	Not ready for trigger	Indicates that a trigger was received by the instrument but was ignored because of timing considerations
-212	Not ready for arm	Indicates that a ARM was received by the instrument but was ignored
-213	Already initiated	Indicates that a measurement request was ignored because another measurement was already in progress

Code	Error Summary	Description
-214	Not ready for trigger	The trigger is deadlocked because a measurement result was requested before the instrument measurement was triggered
-220	Parameter error	General program parameter error (only used when a more specific error does not apply)
-221	Settings conflict	Indicates that a legal command was received by the instrument but could not be executed because of the current state of the instrument
-222	Data out of range	Indicates that a valid parameter was received but could not be executed because the parameter is out of range for the instrument
-223	Too much data	The command contained more data than the instrument memory could support
-224	Illegal parameter value	A value outside the list of possible values was received
-225	Out of memory	The instrument contains insufficient memory to perform the requested operation
-226	Lists not the same length	The lists do not have equal lengths
-230	Data corrupt or stale	New reading started but not completed resulting in invalid data
-231	Questionable data	Indicates that there is a problem with the instrument measurement accuracy
-232	Data has invalid format	The command tried to execute using an inappropriate data format or structure
-233	Incompatible version	Indicates that a file version or instrument version is not appropriate for this command
-240	Hardware error	Indicates that a general error occurred because there was a hardware problem in the instrument (only used when a more specific error does not apply)
-241	Hardware missing	Indicates that a command could not be executed because a hardware option is not present
-250	Mass storage error	General mass storage error (only used when a more specific error does not apply)

Code	Error Summary	Description
-251	Missing mass storage	The command could not be executed because an optional mass storage device was not present
-252	Missing media	The command could not be executed because of a missing media (disk) from a storage device
-253	Corrupt media	Indicates that the requested media is corrupt (bad or unformatted disk)
-254	Media full	Indicates that the requested media is full
-255	Directory full	Indicates that the requested media directory is full
-256	File name not found	Indicates that the command or query could not be executed because the requested file could not be found
-257	File name error	Indicates that the command or query could not be executed because the requested file was in error
-258	Media protected	Indicates that the requested media is protected
-260	Expression execution failed	General command expression error (only used when a more specific error does not apply)
-261	Math expression execution failed	Indicates that a command tried to perform an illegal math operation
-270	Macro execution error	General macro error (only used when a more specific error does not apply)
-271	Macro syntax error	The command could not be executed because there is an error within the syntax of the macro
-272	Macro execution error	The command could not be executed because there is an error within the macro definition
-273	Illegal macro label	The macro label is not valid for this instrument
-274	Macro parameter error	The macro definition improperly uses a macro parameter placeholder
-275	Macro definition too long	The string or block content of a macro was too long for the instrument
-276	Macro recursion error	The macro program data sequence could not be executed because the instrument found it to be recursive

Code	Error Summary	Description
-277	Macro redefinition not allowed	The command could not be executed because the macro label was already defined
-278	Macro header not found	Could not execute the macro because the macro was not previously defined
-280	Program error	General downloaded program error (only used when a more specific error does not apply)
-281	Can not create program	Indicates that the attempt to create a downloaded program was unsuccessful generally due to lack of memory
-282	Illegal program name	The command referenced a nonexistent program or attempted to redefine an existing program
-283	Illegal variable name	An attempt was made to reference a nonexistent program variable
-284	Program currently running	An attempt was made to redefine or delete an existing program while it is running
-285	Program syntax error	Indicates that a syntax error appears in a downloaded program
-286	Program runtime error	A runtime error exists in a downloaded program
-290	Memory usage error	Indicates that the user request has directly or indirectly caused an error related to memory
-291	Out of memory	The instrument memory is full
-292	Reference name does not exist	The reference name does not exist
-293	Reference name already exists	The reference name already exists
-294	Incompatible Type	Indicates that the type or structure of a memory item is inadequate
-300	Device specific error	General instrument error (only used when a more specific error does not apply)
-310	System error	Indicates that an instrument system error has occurred
-311	Memory error	Indicates a physical fault in the instruments memory, such as a parity fault
-312	PUD memory lost	Indicates that the protected user data in the instrument has been lost

Code	Error Summary	Description
-313	Calibration memory corrupted	Indicates that the instruments nonvolatile calibration memory has been lost or corrupted
-314	Configuration memory corrupted	Indicates that the instruments nonvolatile memory that was saved has been lost or corrupted
-315	Manufacturing info corrupted	Indicates that the instruments nonvolatile configuration memory has been lost or corrupted
-320	Storage Fault	Indicates that the firmware detected a fault when using data storage. Generally this error does not indicate a hardware error
-321	Out of memory for an internal operation	An internal operation needed more memory than was available
-330	Self test failed	The internal self test failed. This self test is either run on power up or by command
-340	Calibration failed	The instrument internal calibration failed
-350	Queue overflow	This code indicates that there is no room in the queue and an error occurred but was not recorded
-360	Communications error	General instrument communications error (only used when a more specific error does not apply)
-361	Parity error in program message	The serial port parity bit was not correct when data was received
-362	Framing error in program message	A serial port stop bit was not detected when data was received
-363	Input buffer overrun	The input buffer on a serial port overflowed with data caused by improper or nonexistent spacing
-400	Query error	General query error (only used when a more specific error does not apply)
-410	Query interrupt error	Indicates that a command was received before the query was fully executed
-420	Query un-terminated error	An incomplete query command was received
-430	Query deadlock error	The instrument is locked due to a incomplete query command

Code	Error Summary	Description
-440	Query un-terminated after indefinite response	Indicates that a query was received in the same command after a query requesting an indefinite response was executed
-500	Power on	The instrument has detected an off to on transition in its power system
-600	User request	The instrument has detected the activation of a user request for local control
-700	Request control	The instrument requested to become the active controller-in-charge
-800	Operation complete	The instrument has completed all selected pending operations
-1001	PLL unlocked	The instrument clock is not locked to the PLL
-1002	Boot Failed	Firmware boot failure detected
-1003	Wave Invalid	Unable to create a desired waveform due to invalid parameter set
-1004	Overtemp	The instrument temperature has exceeded the 60 degree Celsius high threshold.

Commands Index



The following is an alphabetic list of the commands and queries for the ZT450.

Command Code	Query Code	Command Name
0305 ₁₆		Abort Command
0306 ₁₆	8306 ₁₆	Arm Command/Query
0308 ₁₆	8308 ₁₆	Arm Polarity Command/Query
0307 ₁₆	8307 ₁₆	Arm Source Command/Query
0400 ₁₆		Auto Scale Command
0422 ₁₆	8422 ₁₆	Average Count Command/Query
0423 ₁₆	8423 ₁₆	Average Envelope View Command/Query
0420 ₁₆	8420 ₁₆	Average State Command/Query
0421 ₁₆	8421 ₁₆	Average Type Command/Query
0811 ₁₆		Calculate Absolute Value Command
0810 ₁₆		Calculate Add Command
0812 ₁₆		Calculate Copy Command
0813 ₁₆		Calculate Derivative Command
	8803 ₁₆	Calculate Function Query
0804 ₁₆		Calculate Immediate Command
0814 ₁₆		Calculate Integral Command
0815 ₁₆		Calculate Invert Command
0824 ₁₆		Calculate Limit Test Clear Command
0820 ₁₆		Calculate Limit Test Command
0825 ₁₆	8825 ₁₆	Calculate Limit Test Continuous Command/Query
	8822 ₁₆	Calculate Limit Test Fail Query
0827 ₁₆	8827 ₁₆	Calculate Limit Test Lower Command/Query
0821 ₁₆	8821 ₁₆	Calculate Limit Test Measurement Command/Query
	8823 ₁₆	Calculate Limit Test Report Query
0826 ₁₆	8826 ₁₆	Calculate Limit Test Upper Command/Query
0829 ₁₆	8829 ₁₆	Calculate Mask Test Lower Command/Query

Command Code	Query Code	Command Name
0828 ₁₆	8828 ₁₆	Calculate Mask Test Upper Command/Query
0816 ₁₆		Calculate Multiply Command
0800 ₁₆	8800 ₁₆	Calculate State Command/Query
0817 ₁₆		Calculate Subtract Command
0831 ₁₆	8831 ₁₆	Calculate Transform Freq Window Command/Query
0830 ₁₆		Calculate Transform Frequency Command
0802 ₁₆	8802 ₁₆	Calculate Voltage Offset Command/Query
0801 ₁₆	8801 ₁₆	Calculate Voltage Range Command/Query
	8600 ₁₆	Calibrate Command/Query
0610 ₁₆		Calibrate Restore Factory Defaults Command
0A00 ₁₆		Clear Status Command
0405 ₁₆	8405 ₁₆	Clock Frequency Command/Query
0404 ₁₆	8404 ₁₆	Clock Source Command/Query
	F001 ₁₆	Configuration Query
0A03 ₁₆	8A03 ₁₆	Event Status Enable Command/Query
	8A02 ₁₆	Event Status Query
0010 ₁₆	8010 ₁₆	Format Byte Order Command/Query
	8103 ₁₆	ID Query
0304 ₁₆	8304 ₁₆	Initiate Command/Query
0309 ₁₆	8309 ₁₆	Initiate Continuous Command/Query
0411 ₁₆	8411 ₁₆	Input Attenuation Command/Query
0412 ₁₆	8412 ₁₆	Input Coupling Command/Query
0416 ₁₆	8416 ₁₆	Input Filter State Command/Query
0413 ₁₆	8413 ₁₆	Input Impedance Command/Query
0415 ₁₆	8415 ₁₆	Input Smoothing Points Command/Query
0414 ₁₆	8414 ₁₆	Input Smoothing State Command/Query
0410 ₁₆	8410 ₁₆	Input State Command/Query
040C ₁₆	840C ₁₆	Input Voltage Offset Command/Query
040B ₁₆	840B ₁₆	Input Voltage Protection State Command/Query
0407 ₁₆	8407 ₁₆	Input Voltage Range Command/Query
	872F ₁₆	Measure AC High-Precision Query
	8710 ₁₆	Measure AC RMS Query
	8711 ₁₆	Measure Amplitude Query
	8712 ₁₆	Measure Average Voltage Query

Command Code	Query Code	Command Name
	872C ₁₆	Measure Cycle Average Query
	872D ₁₆	Measure Cycle Frequency Query
	872E ₁₆	Measure Cycle Period Query
	872B ₁₆	Measure Cycle RMS Query
	8730 ₁₆	Measure DC High-Precision Query
	8713 ₁₆	Measure DC RMS Query
0700 ₁₆	8700 ₁₆	Measure Edge Command/Query
	8716 ₁₆	Measure Fall Crossing Time Query
	8714 ₁₆	Measure Fall Overshoot Query
	8715 ₁₆	Measure Fall Pre-shoot Query
	8717 ₁₆	Measure Fall Time Query
	8718 ₁₆	Measure Frequency Query
0704 ₁₆	8704 ₁₆	Measure Gate Points Command/Query
0703 ₁₆	8703 ₁₆	Measure Gate Time Command/Query
	8719 ₁₆	Measure High Voltage Query
	871A ₁₆	Measure Low Voltage Query
	871B ₁₆	Measure Maximum Voltage Query
0701 ₁₆	8701 ₁₆	Measure Method Command/Query
	871D ₁₆	Measure Mid Voltage Query
	871C ₁₆	Measure Minimum Voltage Query
	871E ₁₆	Measure Negative Duty Cycle Query
	871F ₁₆	Measure Negative Width Query
	8724 ₁₆	Measure Peak-to-Peak Voltage Query
	8722 ₁₆	Measure Period Query
	8723 ₁₆	Measure Phase Query
	8720 ₁₆	Measure Positive Duty Cycle Query
	8721 ₁₆	Measure Positive Width Query
0708 ₁₆	8708 ₁₆	Measure Reference Command/Query
0709 ₁₆	8709 ₁₆	Measure Reference Method Command/Query
	8727 ₁₆	Measure Rise Crossing Time Query
	8725 ₁₆	Measure Rise Overshoot Query
	8726 ₁₆	Measure Rise Pre-shoot Query
	8728 ₁₆	Measure Rise Time Query
	8729 ₁₆	Measure Time of Maximum Voltage Query

Command Code	Query Code	Command Name
	872A ₁₆	Measure Time of Minimum Voltage Query
0004 ₁₆	8004 ₁₆	Operation Complete Command/Query
020F ₁₆	820F ₁₆	Output External Trigger Polarity Command/Query
020E ₁₆	820E ₁₆	Output External Trigger Source Command/Query
020D ₁₆	820D ₁₆	Output External Trigger State Command/Query
020A ₁₆	820A ₁₆	Output Trigger Polarity Command/Query
0209 ₁₆	8209 ₁₆	Output Trigger Source Command/Query
0208 ₁₆	8208 ₁₆	Output Trigger State Command/Query
0007 ₁₆		Recall Instrument State Command
0200 ₁₆	8200 ₁₆	Reference Oscillator Source Command/Query
0000 ₁₆		Reset Command
0006 ₁₆		Save Instrument State Command
0A04 ₁₆	8A04 ₁₆	Service Request Enable Command/Query
	8002 ₁₆	Status Byte Query
	8A16 ₁₆	Status Calibration Condition Query
0A17 ₁₆	8A17 ₁₆	Status Calibration Enable Command/Query
	8A18 ₁₆	Status Calibration Event Query
	8A13 ₁₆	Status Frequency Condition Query
0A14 ₁₆	8A14 ₁₆	Status Frequency Enable Command/Query
	8A15 ₁₆	Status Frequency Event Query
	8A05 ₁₆	Status Operation Condition Query
0A06 ₁₆	8A06 ₁₆	Status Operation Enable Command/Query
	8A07 ₁₆	Status Operation Event Query
0A01 ₁₆		Status Preset Command
	8A08 ₁₆	Status Questionable Condition Query
0A09 ₁₆	8A09 ₁₆	Status Questionable Enable Command/Query
	8A0A ₁₆	Status Questionable Event Query
	8A10 ₁₆	Status Test Condition Query
0A11 ₁₆	8A11 ₁₆	Status Test Enable Command/Query
	8A12 ₁₆	Status Test Event Command/Query
	8A19 ₁₆	Status Voltage Condition Query
0A1A ₁₆	8A1A ₁₆	Status Voltage Enable Command/Query
	8A1B ₁₆	Status Voltage Event Query
0510 ₁₆	8510 ₁₆	Sweep Mode Command/Query

Command Code	Query Code	Command Name
0514 ₁₆	8514 ₁₆	Sweep Offset Reference Command/Query
0515 ₁₆	8515 ₁₆	Sweep Offset Time Command/Query
0511 ₁₆	8511 ₁₆	Sweep Points Command/Query
	8512 ₁₆	Sweep Time Query
	8003 ₁₆	System Error All Query
	F002 ₁₆	System Error Count Query
	F000 ₁₆	System Error Query
	8500 ₁₆	System Memory Query
	8008 ₁₆	System Temperature Query
	8001 ₁₆	Test Query
0528 ₁₆		Trace Copy Reference Command/Query
	8522 ₁₆	Trace Load Calculate Query
	8520 ₁₆	Trace Load Input Query
0521 ₁₆	8521 ₁₆	Trace Load Reference Command/Query
0529 ₁₆	8529 ₁₆	Trace Preamble Command/Query
0211 ₁₆	8211 ₁₆	Trigger A Event Count Command/Query
0214 ₁₆	8214 ₁₆	Trigger A Pulse High Limit Command/Query
0215 ₁₆	8215 ₁₆	Trigger A Pulse Low Limit Command/Query
0203 ₁₆	8203 ₁₆	Trigger A Slope Command/Query
0201 ₁₆	8201 ₁₆	Trigger A Source Command/Query
0210 ₁₆	8210 ₁₆	Trigger A Type Command/Query
0217 ₁₆	8217 ₁₆	Trigger A Video Field Command/Query
0218 ₁₆	8218 ₁₆	Trigger A Video Line Command/Query
0216 ₁₆	8216 ₁₆	Trigger A Video Standard Command/Query
0223 ₁₆	8223 ₁₆	Trigger B Slope Command/Query
0221 ₁₆	8221 ₁₆	Trigger B Source Command/Query
0220 ₁₆	8220 ₁₆	Trigger B State Command/Query
020B ₁₆	820B ₁₆	Trigger Hold off Command/Query
0202 ₁₆		Trigger Immediate Command
0207 ₁₆	8207 ₁₆	Trigger Input Level Command/Query
0212 ₁₆	8212 ₁₆	Trigger Pattern Mask Command/Query
0213 ₁₆	8213 ₁₆	Trigger Pattern Truth Command/Query
	820C ₁₆	Trigger Timestamp Query
0005 ₁₆		Wait to Continue Command



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