Serial API Guide

SLICE-QTC Four-channel Temperature Controller

Revision 01

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1. Purpose

This document describes the Application Programming Interface (API) for controlling and communicating with the Vescent SLICE-QTC USB interface. This document provides command formats, parameter types, and functional descriptions of API commands.

2. Scope

This document applies to USB communication with SLICE-QTC. This API is compatible with the software configuration listed below.

SC Firmware: SC 2.29

QTC Firmware: QT 2.63

3. Serial Configuration

Communication with the SLICE-QTC via the rear panel USB interface is performed by using ASCII-based serial commands issued from an external computer via PC terminal programs such as Putty or Tera Term. Serial port settings should be as follows:

Data Bits	8
Parity	None
Stop Bits	1
Flow Control	None

A Baud Rate between 9600 and 115200 is recommended for initial setup and troubleshooting.

4. Command Structure

The USB API uses ASCII-based commands with the following format:

[command name] [parameter] [parameter] [parameter]

The command name string is followed by 0 to 3 space-delimited parameter strings. Command names are case-insensitive. Commands must be terminated with a Carriage Return character.

5. SLICE-QTC Command List

Commands are categorized by the functional groups listed below.

Functional Groups

Global SLICE Commands

#SCBKLT?	Returns the touch screen backlight setting
Parameters: None	*Example:* #SCBKLT? #SCBKLT? 5
#SCBKLT	Sets the touch screen backlight setting to the level given as a parameter
Parameters: [INT] level (0 – 20)	*Example:* #SCBKLT 3 #SCBKLT 3
#SCVOL?	Returns the touch screen and rotary knob audio feedback volume level
Parameters: None	*Example:* #SCVOL? #SCVOL? 5
#SCVOL	Sets the touch screen and rotary knob audio feedback volume to the level given as a parameter
Parameters: [INT] level (0 – 20)	*Example:* #SCVOL 8 #SCVOL 8
***RST**	SCPI Compatible Device Reset Command Restarts the device in an OFF state
Parameters: [none]	*Example:* *RST Resetting System
***IDN?**	SCPI Compatible Device Information Query Returns: Manufacturer Model Serial Number System Controller Firmware version ICE2 Board Firmware Versions
Parameters: [none]	*Example:* *IDN? Vescent Photonics,SLICE-QTC,006543,S-V1.226,QTC-V2.67
_FACTORY	Tells an ICE2 board to restore and save factory default settings. Causes the device to restart with new settings. **NOTE**: All saved PID parameters will be erased requiring re-tuning of temperature control for all channels.
Parameters: [Int] Any number	*Example:* _FACTORY 1 Success

SAVE	Saves the board's current settings into EEPROM. Unsaved changes will be lost when the board is powered off. Returns SUCCESS or FAIL. **NOTE:** The SAVE command is only necessary when changing parameters via the API. Parameters changed through the Touch Screen are saved automatically.
Parameters: None	*Example:* SAVE Success

General Commands

TEMPSET?	Returns the temperature setpoint for a Temperature Control Channel. Value is in °C
Parameters: [Int] CHANNEL	*Example:* TempSet? 3 26.280000
TEMPSET	Sets the temperature setpoint °C for a temperature control channel to TEMP. Returns output from TempSet?. *Note: temperature setpoint cannot be set outside of the bounds of the minium and maximum temperature. If TEMP is outside that range, temperature setpoint will be set to the range limit it was attempting to exceed. The temperature returned will be displayed to 6 decimal digits and may be slightly different from the TEMP parameter due to hardware limitations on what can be represented by the temperature control DAC.*
Parameters: [Int] CHANNEL [Float] TEMP	*Example:* Tempset 3 26.28 26.280001
BIPOLAR?	Returns whether the temperature loop for CHANNEL is bipolar.
Parameters: [Int] CHANNEL	*Example:* Bipolar? 3 On
BIPOLAR	Sets the temperature loop for CHANNEL bipolar (heating only) on or off. Turn Bipolar off when driving resistive heaters. Returns output from TBipolar? STATE parameter 1 = ON 0 = OFF
Parameters: [Int] CHANNEL [INT] STATE	*Example:* Bipolar 3 1 On

CONTROL?	Returns the status () and Mode (Manual, Servo, Auto Tune) of the temperature servo loop for CHANNEL. NOTE CONTROL CODES: OFF Manual Mode = 0 OFF Servo Mode = 1 OFF Auto Tune Mode = 2 ON Manual Mode = 3 ON Servo Mode = 4 ON Auto Tune Mode = 5
Parameters: [Int] CHANNEL	*Example:* CONTROL? 3 1
CONTROL	Turns the temperature servo loop for CHANNEL on or off. Returns the output of CONTROL? NOTE CONTROL CODES: OFF Manual Mode = 0 OFF Servo Mode = 1 OFF Auto Tune Mode = 2 ON Manual Mode = 3 ON Servo Mode = 4 ON Auto Tune Mode = 5
Parameters: [Int] CHANNEL [Int] CODE	*Example:* CONTROL 3 4 4
TEMP?	Returns the current measured temperature for CHANNEL in degrees Celsius.
Parameters: [Int] CHANNEL	*Example:* Temp? 3 26.999193
TERROR?	Returns the temperature error ($T_{setpoint} - T_{actual}$) in degrees Celsius.
Parameters: [Int] CHANNEL	*Example:* Error? 3 0.919101
CURRENT?	Returns the current flowing through TEC (or resistive heater) in Amps.
Parameters: [Int] CHANNEL	*Example:* Current? 3 0.117762

TEMPMIN?	Returns the minimum temperature for CHANNEL. If the temperature is ever less than MINTEMP while temperature control is in the Servo On mode, the board will disable the temperature loop and freeze the offending temperature on the GUI with a red background. Note: Value returned is the closest value that can be represented with a 32 bit floating point.
Parameters: [Int] CHANNEL	*Example:* TEMPMIN? 3 -5.000793
TEMPMIN	Sets the minimum temperature CHANNEL to MINTEMP. Returns TempMin? Note: You cannot set MINTEMP greater than the temperature setpoint. Attempting to do so will not change the minimum temperature.
Parameters: [Int] CHANNEL [Float] MINTEMP	*Example:* TEMPMIN 3 -5 -5.000793
TEMPMAX?	Returns the maximum temperature for CHANNEL. If the temperature is ever greater than MAXTEMP while temperature control is in the Servo On mode, the board will disable the temperature loop and freeze the offending temperature on the GUI with a red background. Note: Value returned is the closest value that can be represented with a 32 bit floating point.
Parameters: [Int] CHANNEL	*Example:* TEMPMAX? 3 49.999847
TEMPMAX	Sets the maximum temperature CHANNEL to MAXTEMP. Returns TempMax?. Note: You cannot set MAXTEMP less than the temperature setpoint. Attempting to do so will not change the maximum temperature.
Parameters: [Int] CHANNEL [Float] MAXTEMP	*Example:* TEMPMAX 3 50 49.999847
TWARN?	Reads the Temperature Control Warning (locked) range [mK] for CHANNEL's temperature error value.
Parameters: [INT] CHANNEL	*Example:* TWARN? 4 1.000000

TWARN	Sets the Temperature Control Warning (locked) range [mK] for CHANNEL's temperature error value.
Parameters: [INT] CHANNEL [FLOAT]mK	*Example:* TWARN 4 0.9 0.900000
MAXCURR?	Returns the current limit for CHANNEL in Amps
Parameters: [INT] CHANNEL	*Example:* MAXCURR? 2 2.000000
MAXCURR	Sets the current limit for CHANNEL in Amps. Returns the result of MAXCURR? in Amps
Parameters: [INT] CHANNEL [FLOAT] current	*Example:* MAXCURR 2 3.5 3.500000
POWER?	Returns the power output for CHANNEL in watts
Parameters: [INT] CHANNEL	*Example:* POWER? 3 0.035269
MAXPWR?	Returns the power limit in Watts for CHANNEL
Parameters: [INT] CHANNEL	*Example:* MAXPWR? 1 7.500000
MAXPWR	Sets the power limit in Watts for CHANNEL Returns MAXPWR? NOTE: Maximum Power for a channel is limited by the available power for the system – the maximum power allocated for other channels.
Parameters: [INT] CHANNEL [FLOAT] value	*Example:* MAXPWR 2 7.0 7.000000
CVOLT?	Returns the absolute voltage [V] across the temperature control load for CHANNEL
Parameters: [INT] CHANNEL	*Example:* Cvolt? 2 0.204979

CURRSET?	Reads the Temperature Control Manual Mode Current Setpoint [A] for CHANNEL
Parameters: [Int] CHANNEL	*Example:* CURRSET? 2 0.400000
CURRSET	Sets the Temperature Control Manual Mode Current Setpoint [A] for CHANNEL Returns CURRSET?
Parameters: [Int] CHANNEL [Float] SETPOINT	*Example:* CURRSET 2 0.3 0.300000
AVLPWR?	Reads the available power [W] for driving all 4 temperature control channels
Parameters: NONE	*Example:* AVLPWR 37.046055
TTLPWR?	Reads the total power limits [W] set for driving all 4 temperature control channels
Parameters: NONE	*Example:* TTLPWR 30.000000
ATPCNCT?	Reads the percentage completion of an Auto Tune Returns 0 when an Auto Tune is complete
Parameters: NONE	*Example:* ATPCNCT? 85
SFTYTMT?	Reads the shutdown timeout [s] to wait before disabling temperature CHANNEL if temperature exceeds the maximum or minimum temperature limits. Return value is a floating point number with 0.10000s being the lowest value due to timer limitations.
Parameters: [Int] CHANNEL	*Example:* SFTYTMT? 3 0.100000
SFTYTMT	Sets the shutdown timeout [s] to wait before disabling temperature CHANNEL if temperature exceeds the maximum or minimum temperature limits. Returns SFTYTMT?
Parameters: [Int] CHANNEL [Float] SECONDS	*Example:* SFTYTMT 2 5 5.000000

Loop Filter Commands

PGAIN?	Returns the proportional gain for CHANNEL
Parameters: [INT] CHANNEL	*Example:* PGAIN? 2 6.456254
PGAIN	Sets the proportional gain for CHANNEL. Returns the result of PGAIN?
Parameters: [INT] CHANNEL [FLOAT] gain	*Example:* TPGAIN 2 1.8 1.800000
INTEG?	Returns the integral time constant for CHANNEL
Parameters: [INT] CHANNEL	*Example:* INTEG? 2 1.223750
INTEG	Sets the integral time constant for CHANNEL. Returns the result of INTEG?
Parameters: [INT] CHANNEL [FLOAT] integral time constant	*Example:* INTEG 2 0.8 0.800000
DERIV?	Returns the derivative time constant for CHANNEL
Parameters: [INT] CHANNEL	*Example:* DERIV? 2 0.305937
DERIV	Sets the derivative time constant for CHANNEL. Returns the result of DERIV?
Parameters: [INT] CHANNEL [FLOAT] derivative time constant	*Example:* DERIV 2 0.2 0.200000
SLEW?	Returns the slew rate for CHANNEL in degrees C per minute
Parameters: [INT] CHANNEL	*Example:* SLEW? 2 1.500000

SLEW	Sets the slew rate for CHANNEL in degrees C per minute. Returns the result of SLEW?
Parameters: [INT] CHANNEL [FLOAT] slew rate	*Example:* SLEW 2 1.5 1.500000
PGAINEN?	Returns the enabled/disabled status of the proportional gain factor for CHANNEL
Parameters: [INT] CHANNEL	*Example:* PGAINEN? 2 On
PGAINEN	Sets the enabled/disabled status of the proportional gain factor for CHANNEL. Returns the result of PGAINEN?
Parameters: [INT] CHANNEL [INT] state	*Example:* PGAINEN 2 0 Off
INTEGEN?	Returns the enabled/disabled status of the integral time constant factor for CHANNEL
Parameters: [INT] CHANNEL	*Example:* INTEGEN? 2 On
INTEGEN	Sets the enabled/disabled status of the integral time constant factor for CHANNEL. Returns the result of INTEGEN?
Parameters: [INT] CHANNEL [INT] state	*Example:* INTEGEN 2 0 Off
DERIVEN?	Returns the enabled/disabled status of the derivative time constant factor for CHANNEL
Parameters: [INT] CHANNEL	*Example:* DERIVEN? 2 On
DERIVEN	Sets the enabled/disabled status of the derivative time constant factor for CHANNEL. Returns the result of DERIVEN?
Parameters: [INT] CHANNEL [INT] state	*Example:* DERIVEN 2 1 On

SLEWEN?	Returns the enabled/disabled status of the slew rate limiter for CHANNEL
Parameters: [INT] CHANNEL	*Example:* SLEWEN? 2 On
SLEWEN	Sets the enabled/disabled status of the slew rate limiter for CHANNEL. Returns the result of SLEWEN?
Parameters: [INT] CHANNEL [INT] state	*Example:* SLEWEN 2 1 On

Thermistor Parameters

TEMPLUT	Re-calculates the temperature measurement lookup table. Should be run after changing thermistor coefficients. No Return Value
Parameters: [INT] CHANNEL	*Example:* TEMPLUT 1
POL?	Returns the output polarity for CHANNEL. On indicates factory default Negative polarity, Off indicates alternative Positive polarity
Parameters: [INT] CHANNEL	*Example:* POL? 1 On
POLARITY	Sets the output polarity for CHANNEL. State = 1 sets factory default Negative polarity, state = 0 indicates alternative Positive polarity
Parameters: [INT] CHANNEL [INT] state	*Example:* POLARITY 1 1 On
BETA?	Returns the Betatherm Beta thermistor coefficient for CHANNEL
Parameters: [INT] CHANNEL	*Example:* BETA? 1 3450.000000
BETA	Sets the Betatherm Beta thermistor coefficient for CHANNEL. Returns BETA? NOTE: This command triggers a recalculation of Steinhart-Hart A, B, and C coefficients.
Parameters: [INT] CHANNEL [FLOAT] value	*Example:* BETA 1 3450 3450.000000
REFTEMP?	Returns the Betatherm Reference temperature C for CHANNEL
Parameters: [INT] CHANNEL	*Example:* REFTEMP? 1 25.000000
REFTEMP	Sets the Betatherm Reference temperature C for CHANNEL. Returns REFTEMP? NOTE: This command triggers a recalculation of Steinhart-Hart A, B, and C coefficients.
Parameters: [INT] CHANNEL [FLOAT] value	*Example:* REFTEMP 1 25.0 25.000000
REFRES?	Returns the Betatherm Resistance at the reference temperature C for CHANNEL
Parameters: [INT] CHANNEL	*Example:* REFRES? 1 10000.000000

REFRES	Sets the Betatherm Resistance at the reference temperature C for CHANNEL. Returns REFRES? NOTE: This command triggers a recalculation of Steinhart-Hart A, B, and C coefficients.
Parameters: [INT] CHANNEL [FLOAT] value	*Example:* REFRES? 1 10000.0 10000.000000
TCOEFA?	Returns the Steinhart Hart A coefficient for CHANNEL
Parameters: [INT] CHANNEL	*Example:* TCOEFA? 1 0.000684
TCOEFA	Sets the Steinhart Hart A coefficient for CHANNEL Returns TCOEFA?
Parameters: [INT] CHANNEL [FLOAT] value	*Example:* TCOEFA 1 0.000684 0.000684
TCOEFB?	Returns the Steinhart Hart B coefficient for CHANNEL
Parameters: [INT] CHANNEL	*Example:* TCOEFB? 1 0.000290
TCOEFB	Sets the Steinhart Hart B coefficient for CHANNEL Returns TCOEFB? NOTE: This command will recalculate the Betatherm Beta value.
Parameters: [INT] CHANNEL [FLOAT] value	*Example:* TCOEFB 1 0.000290 0.000290
TCOEFC?	Returns the Steinhart Hart C coefficient for CHANNEL
Parameters: [INT] CHANNEL	*Example:* TCOEFC? 1 0.000001
TCOEFC	Sets the Steinhart Hart C coefficient for CHANNEL Returns TCOEFC?
Parameters: [INT] CHANNEL [FLOAT] value	*Example:* TCOEFC 1 0.00001 0.000010

Analog Input Commands

GAINA?	Returns the gain value for Analog Input A Note: Each A Input choice maintains a Gain Value specific to the Input mode and channel chosen. The return value reflects the Gain value for the Channel and Mode chosen for the CHANNEL
Parameters: [INT] CHANNEL	*Example:* Gaina? 1 1.000000
GAINA	Sets the gain value for Analog Input A Returns GAINA? Note: Select the Input A mode for the channel before adjusting the Gain.
Parameters: [INT] CHANNEL [FLOAT] GAIN	*Example:* Gaina 2 2.5 2.500000
GAINB?	Returns the gain value for Analog Input B Note: Each B Input choice maintains a Gain Value specific to the Input mode and channel chosen. The return value reflects the Gain for the Channel and Mode chosen for the CHANNEL
Parameters: [INT] CHANNEL	*Example:* Gainb? 3 1.000000
GAINB	Sets the gain value for Analog Input B Returns GAINB? Note: Select the Input B mode for the channel before adjusting the Gain.
Parameters: [INT] CHANNEL [FLOAT] GAIN	*Example:* Gainb 3 2.5 2.500000
OFFSETA?	Returns the offset value for Analog Input A Note: Each A Input choice maintains an Offset Value specific to the Input mode and channel chosen. The return value reflects the Offset value for the Channel and Mode chosen for the CHANNEL
Parameters: [INT] CHANNEL	*Example:* OFFSETA? 1 10.000000
OFFSETA	Sets the offset value for Analog Input A Returns OFFSETA? Note: Select the Input A mode for the channel before adjusting the offset.
Parameters: [INT] CHANNEL [FLOAT] OFFSET	*Example:* OFFSETA 3 2.5 2.500000

OFFSETB?	Returns the offset value for Analog Input B Note: Each B Input choice maintains an Offset Value specific to the Input mode and channel chosen. The return value reflects the Offset value for the Channel and Mode chosen for the CHANNEL
Parameters: [INT] CHANNEL	*Example:* OFFSETB? 1 10.000000
OFFSETB	Sets the offset value for Analog Input B Returns OFFSETB? Note: Select the Input B mode for the channel before adjusting the offset.
Parameters: [INT] CHANNEL [FLOAT] OFFSET	*Example:* OFFSETB 3 2.5 2.500000
MODEA?	Returns the Analog Input A channel and input mode Note: Both the Channel and Mode are contained in the returned value. Return_Value / 256 = channel_number Return_Value - (channel_number * 256) = mode Mode values: NO_INPUT = 0 EXTERNALSETPOINT_INPUT_ABS = 1 EXTERNALSETPOINT_INPUT_REL = 2 EXTERNAL_TEMPERATURE = 3 EXTERNALERROR_INPUT = 4 FEEDFORWARD_INPUT = 5 SLOWSERVO_INPUT = 6
Parameters: NONE	*Example:* MODEA? 513 (Channel 2 External Setpoint Absolute)
MODEA	Sets the Analog Input A channel and input mode Returns MODEA?
Parameters: [INT] CHANNEL&MODE	*Example:* MODEA 514 514 (Channel 2 External Setpoint Relative)

MODEB?	Returns the Analog Input B channel and input mode Note: Both the Channel and Mode are contained in the returned value. Return_Value / 256 = channel_number Return_Value - (channel_number * 256) = mode Mode values: NO_INPUT = 0 EXTERNALSETPOINT_INPUT_ABS = 1 EXTERNALSETPOINT_INPUT_REL = 2 EXTERNAL_TEMPERATURE = 3 EXTERNALERROR_INPUT = 4 FEEDFORWARD_INPUT = 5 SLOWSERVO_INPUT = 6
Parameters: NONE	*Example:* MODEB? 513 (Channel 2 External Setpoint Absolute)
MODEB	Sets the Analog Input B channel and input mode Returns MODEB?
Parameters: [INT] CHANNEL&MODE	*Example:* MODEB 514 514 (Channel 2 External Setpoint Relative)
APOL?	Returns the Front Panel Input A Slow Servo Input Mode polarity setting for CHANNEL 0 = Positive (Off) 1 = Negative (On)
Parameters: [Int] CHANNEL	*Example:* APOL? 1 Off
APOL	Sets the Front Panel Input A Slow Servo Input Mode polarity setting for CHANNEL 0 = Positive (Off) 1 = Negative (On) Returns APOL?
Parameters: [Int] CHANNEL [Int] STATE	*Example:* APOL 1 0 Off
BPOL?	Returns the Front Panel Input B Slow Servo Input Mode polarity setting for CHANNEL 0 = Positive (Off) 1 = Negative (On)
Parameters: [Int] CHANNEL	*Example:* BPOL? 1 Off

BPOL	Sets the Front Panel Input B Slow Servo Input Mode polarity setting for CHANNEL 0 = Positive (Off) 1 = Negative (On) Returns TBPOL?
Parameters: [Int] CHANNEL [Int] STATE	*Example:* BPOL 1 1 On

Analog Output Commands

GAIN1?	Returns the gain value for Analog Output 1 Note: Each Output 1 choice maintains a Gain Value specific to the Output mode and channel chosen. The return value reflects the Gain for the Channel and Mode chosen for the CHANNEL
Parameters: [INT] CHANNEL	*Example:* GAIN1? 3 1.000000
GAIN1	Sets the gain value for Analog Output 1 Returns GAIN1? Note: Select the Output 1 mode for the channel before adjusting the Gain.
Parameters: [INT] CHANNEL [FLOAT] GAIN	*Example:* GAIN1 3 2.5 2.500000
GAIN2?	Returns the gain value for Analog Output 2 Note: Each Output 2 choice maintains a Gain Value specific to the Output mode and channel chosen. The return value reflects the Gain for the Channel and Mode chosen for the CHANNEL
Parameters: [INT] CHANNEL	*Example:* GAIN2? 3 1.000000
GAIN2	Sets the gain value for Analog Output 2 Returns GAIN2? Note: Select the Output 2 mode for the channel before adjusting the Gain.
Parameters: [INT] CHANNEL [FLOAT] GAIN	*Example:* GAIN1 3 2.5 2.500000
OFFSET1?	Returns the offset value for Analog Output 1 Note: Each Output 1 choice maintains an Offset Value specific to the Input mode and channel chosen. The return value reflects the Offset value for the Channel and Mode chosen for the CHANNEL
Parameters: [INT] CHANNEL	*Example:* OFFSET1? 1 10.000000
OFFSET1	Sets the offset value for Analog Output 1 Returns OFFSET1? Note: Select the Output 1 mode for the channel before adjusting the offset.
Parameters: [INT] CHANNEL [FLOAT] OFFSET	*Example:* OFFSET1 3 2.5 2.500000

OFFSET2?	Returns the offset value for Analog Output 2 Note: Each Output 2 choice maintains an Offset Value specific to the Input mode and channel chosen. The return value reflects the Offset value for the Channel and Mode chosen for the CHANNEL
Parameters: [INT] CHANNEL	*Example:* OFFSET2? 1 10.000000
OFFSET2	Sets the offset value for Analog Output 1 Returns OFFSET2? Note: Select the Output 2 mode for the channel before adjusting the offset.
Parameters: [INT] CHANNEL [FLOAT] OFFSET	*Example:* OFFSET2 3 2.5 2.500000
MODE1?	Returns the Analog Output 1 channel and input mode Note: Both the Channel and Mode are contained in the returned value. Return_Value / 256 = channel_number Return_Value - (channel_number * 256) = mode Mode values: NO_OUTPUT = 0 TEMPERATURE_OUTPUT = 1 TEMPERATURE_ERROR_OUTPUT= 2 CURRENT_OUTPUT = 3
Parameters: NONE	*Example:* MODE1? 513 (Channel 2 Temperature Output)
MODE1	Sets the Analog Output 1 channel and input mode Returns MODE1?
Parameters: [INT] CHANNEL&MODE	*Example:* MODE1 514 514 (Channel 2 Temperature Error Output)

MODE2?	Returns the Analog Output 2 channel and input mode Note: Both the Channel and Mode are contained in the returned value. Return_Value / 256 = channel_number Return_Value - (channel_number * 256) = mode Mode values: NO_OUTPUT = 0 TEMPERATURE_OUTPUT = 1 TEMPERATURE_ERROR_OUTPUT= 2 CURRENT_OUTPUT = 3
Parameters: NONE	*Example:* MODE2? 513 (Channel 2 Temperature Output)
MODE2	Sets the Analog Output 2 channel and input mode Returns MODE2?
Parameters: [INT] CHANNEL&MODE	*Example:* MODE2 514 514 (Channel 2 Temperature Error Output)

Trigger Commands

TRIGOUT?	Reads the Trigger Out flags for temperature CHANNEL Each channel has its own Trigger Out bitset. Values are as follows: Minimum Temperature Exceeded = 0x01 hex = 1 decimal Maximum Temperature Exceeded = 0x02 hex = 2 decimal Minimum or Maximum Temperature Exceeded = 0x03 hex = 3 decimal Slew Rate Limit Exceeded = 0x04 hex = 4 decimal Temperature Setpoint Reached = 0x08 = 8 decimal NOTE: There is no Invert option for output triggers due to hardware limitations.

Parameters:
`[Int] CHANNEL`
	Example:
	`TRIGOUT? 2`
	`3`
	`(Minimum or Maximum Temperature Exceeded)`

TRIGOUT	Sets the Trigger Out flags for temperature CHANNEL Each channel has its own Trigger Out bitset. FLAG values are as follows: Minimum Temperature Exceeded = 0x01 hex = 1 decimal Maximum Temperature Exceeded = 0x02 hex = 2 decimal Minimum or Maximum Temperature Exceeded = 0x03 hex = 3 decimal Slew Rate Limit Exceeded = 0x04 hex = 4 decimal Temperature Setpoint Reached = 0x08 = 8 decimal **NOTE:** It is possible to set more than one trigger with the same command. I.e. To set Minimum Temperature Exceeded and Maximum Temperature Exceeded add the individual values together. 0x01 + 0x02 = 0x03 **CAUTION: The Minimum and Maximum Temperature triggers are the only ones that should be chosen together. Other Combinations will yield unpredictable results.** NOTE: There is no Invert option for output triggers due to hardware limitations. Returns TRIGOUT?

Parameters:
`[Int] CHANNEL`
`[Int] FLAGS`
	Example:
	`TRIGOUT 2 4`
	`4`
	`(Slew Rate Limit Exceeded)`

TRIGIN?	Reads the Trigger In flags for temperature CHANNEL Each channel has its own Trigger In bitset. Values are as follows: Enable / Disable Temperature Control = 0x01 hex = 1 decimal Disable Temperature Control = 0x02 hex = 2 decimal Invert Triggers = 0x80 = 32768 decimal NOTE: Invert Triggers applies to both channels and is added to the trigger selection value. I.e. Disable Temperature Control on transition to active low requires the flags to be 32768 + 2 = 32770
Parameters: [Int] CHANNEL	*Example:* TRIGIN? 2 1
TRIGIN	Sets the Trigger In flags for temperature CHANNEL Each channel has its own Trigger In bitset. Values are as follows: Enable / Disable Temperature Control = 0x01 hex = 1 decimal Disable Temperature Control = 0x02 hex = 2 decimal Choosing one of the above clears the other. Invert Triggers = 0x80 = 32768 decimal NOTE: Invert Triggers applies to both channels and is added to the trigger selection value. I.e. Disable Temperature Control on transition to active low requires the flags to be 32768 + 2 = 32770 Returns TRIGIN?
Parameters: [Int] CHANNEL [Int] FLAG	*Example:* TRIGIN 2 32770 32770 (Inverted Disable Temperature Control – Transition from High to Low disables temperature channel 2)

Error Commands

ERROR?	Returns the 16 bit error register for CHANNEL All Return Values have two validation bits included (0xC000 hex = 49152 decimal) Subtract the validation value from the return value to leave the error bits. NOTE Error Bit Definitions (multiple errors can be contained in the return value so that Error_1 + Error_2 + Error_n = Return Value): Temperature Control Open Circuit = 0x0001 hex = 1 decimal Temperature Hard Limit Exceeded = 0x0002 hex = 2 decimal Temperature Bounds Exceeded = 0x0004 hex = 4 decimal Slew Rate Exceeded = 0x0008 hex = 8 decimal Current Limit Exceeded = 0x0010 hex = 16 decimal Power Limit Exceeded = 0x0100 hex = 256 decimal Incompatablel Thermistor Coefficients = 0x0200 hex = 512 decimal Refresh All Channel Settings (signal) = 0x2001 hex = 8193 decimal Auto Tune No Limit Cycles Detected = 0x2002 hex = 8194 decimal Auto Tune Timed Out = 0x2004 hex = 8196 decimal Auto Tune Temperature Bounds Exceeded = 0x2008 hex = 8200 decimal Auto Tune Current Lower Bound Exceeded = 0x2010 hex = 8208 decimal Auto Tune Current Upper Bound Exceeded = 0x2020 hex = 8224 decimal Auto Tune Heater Setpoint Too Low = 0x2040 hex = 8256 decimal Auto Tune Unstable Plant = 0x2080 hex = 8320 decimal

Parameters:
`[INT] CHANNEL`
	Example:
	`Error? 2`
	`49153`
	`49153 – 49152 = 1 (Open Circuit Error)`

ERROR	Clears the error bit (s) in the CHANNEL 16bit error register. Returns ERROR? NOTE: The parameter is the value that was returned by TERROR? From the table above.

Parameters:
`[INT] CHANNEL`
`[INT] Error to be cleared`
	Example:
	`Error 2 49153`
	`49152`