

- **IEEE-488 BUS COMPATIBLE**
 GPIB Remote Control
 Any number of TIME-TEMP Segments
- **RS232 PORT**
 Use with microcomputer or terminal
- **LOCAL CONTROL**
 16 Key Keyboard
- **PROGRAMMABLE SCAN MODE**
 Automatic Execution of:
 10 Temperatures
 10 Times
- **PROGRAMMABLE CYCLE MODE**
 Automatic Cycle Execution
- **COMPRESSOR CONTROL**
 Plus Additional Auxillary Output
- **BIDIRECTIONAL INTERFACE**
 IEEE-488 to RS-232
- **PID CONTROL ALGORITHM**
- **RETROFITS DELTA TENNEY JR**
 Other Chambers, Custom Chambers



The TC01 temperature controller is a microprocessor based replacement for analog temperature controllers currently being used to control temperature chambers. The TC-series is electrically and mechanically designed to be incorporated into temperature chambers manufactured by Delta Design, Inc. and Tenney Engineering Inc. The TC01 is also easily installed into other temperature chambers and custom systems.

The TC01 offers features and flexibility unmatched with analog controllers and was designed to be incorporated into modern computer systems or to stand alone as an intelligent local controller.

In the local mode the 16 key keyboard allows the operator to:

- set and read any of 10 SCAN temperatures
- set and read any of 10 SCAN times
- set number of cycles for SCAN mode
- read remaining time-at-temperature
- read chamber temperature
- start SCAN mode
- start single temperature/time mode
- reset controller

In addition, the temperature controller gives an audio and visual indication when time-at-temperature expires.

The remote mode of the TC-series allows all functions mentioned above to be executable via the IEEE-488 (GPIB) or RS232 bus. Audio and visual indications of time-at-temperature expiration is accompanied by an "interrupt" on the IEEE-488 bus and RS232 port. Local control can be enabled or disabled via IEEE-488 and/or RS232 commands. Two auxiliary outputs (TTL) are controlled by IEEE-488/RS232 to provide on/off control of external events (e.g.compressor). Local control can be enabled or disabled via IEEE-488/RS232.

An extra feature of the TC01 is its ability to act as a bidirectional IEEE-488 to RS232 interface. As such, commands are supported which allow ASCII characters to be input via the TC01 and IEEE-488 bus and sent out via the RS232 port, and vice-versa. This feature allows control and status of an RS232 compatible device or RS232 compatible user-installed hardware.

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COMMAND SUMMARY

FUNCTION	KEYBD/DISPLAY	RS232	IEEE-488
SINGLE TEMP MODE			
SET Chamber Temp	nn TEMP	nn.nC	nn.nC
SET Time-at-Temp	n TIME	nM	nM
SET Deviation Limit	(n/a)	EDInn	EDInn
OUTPUT Chamber Temp	automatic	T	T
OUTPUT Current Set Temp	TEMP	C	C
OUTPUT remaining Time-at-Temp	TIME	M	M
SCAN MODE			
SET Scan Temp m	nn SCANTEMP m	nn.nAm	nn.nAm
SET Scan Time m	nSCANTIME m	nBm	nBm
SET # Cycles	nSCANTIME-	nB-	nB-
SET Deviation Limit	(n/a)	EDInn	EDInn
OUTPUT Scan Temp m	SCANTEMP m	Am	Am
OUTPUT Scan Time m	SCANTIME m	Bm	Bm
OUTPUT Current Cycle #	SCANTIME -	B-	B-
OUTPUT Chamber Temp	automatic	T	T
OUTPUT Current Set Scan Temp	TEMP	C	C
OUTPUT Current remaining Scan Time	TIME	M	M
DELETE Scan Temp m	-SCANTEMP m	-Am	-Am
DELETE Scan Time m	-SCANTIME m	-Bm	-Bm
START Scan Mode	SCANTEMP SCANTIME	AB	AB
STOP Scan Mode	SCANTIME SCANTEMP	BA	BA
CONTROL GROUP			
Reset (Clear)	C	R	R
ENABLE Local Control	(n/a)	PressKey	lcl 7**
ENABLE Remote Control	(n/a)	automatic	rem703**
ENABLE RS232 Echo	(n/a)	H	H
ENABLE Heat/Cool Out	H/C switches ON	ON	ON
ENABLE Auxiliary #1 Out	(n/a)	OUT1ON	OUT1ON
ENABLE Auxiliary #2 Out	(n/a)	OUT2ON	OUT2ON
ENABLE Scan Interrupts	(n/a)	ESI	ESI
ENABLE Deviation Interrupts	(n/a)	EDInn	EDInn
DISABLE Local Control	(n/a)	(n/a)	llo7**
DISABLE RS232 Echo	(n/a)	R	R
DISABLE Heat/Cool Out	H/C switches OFF	OFF	OFF
DISABLE Auxiliary #1 Out	(n/a)	OUT1OFF	OUT1OFF
DISABLE Auxiliary #2 Out	(n/a)	OUT2OFF	OUT2OFF
DISABLE Scan Interrupts	(n/a)	DSI	DSI
DISABLE Deviation Interrupts	(n/a)	DDI	DDI
SPECIAL			
TRANSFER GPIB to RS232	(n/a)	(n/a)	!sss
TRANSFER RS232 to GPIB	(n/a)	(n/a)	S
PID COEFFICIENTS CHANGE	(n/a)	PID=n,n,n	PID=n,n,n
OUTPUT Probe Option	(n/a)	OPT	OPT
OUTPUT Aux Input State	(n/a)	INI	INI
SET UTL	(n/a)	nnUTL	nn UTL
OUTPUT UTL	(n/a)	UTL	UTL
INIT	(n/a)	INITn,...	INITn,...

nn.n- Refers to a temperature or time setting.
 m- Refers to temperature segment definition in SCAN mode, 0-9

INTERRUPT CHARACTERS

Condition	RS232(ASCII)	IEEE-488(HEX)
No Interrupt	(n/a)	00
Single Temp Mode time-out	I	41
Command Error	CMD ERROR!!	42
SCAN Temp Point time-out	P	43
SCAN Temp Cycle time-out	L	44
SCAN Temp End of Run	E	45
DEVIATION Alarm	D	46
Chamber Temp - UTL	0	47
GPIB Lock-up time-out	(n/a)	4F

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TC01 Temperature Controller Command Summary

KEYBOARD CONVENTIONS

1. "n" or "m" refers to any numeric key (a single keystroke).
2. "-" refers to the minus key.
3. Items enclosed in parentheses are optional. Thus n(n(n)) means that at least one numeric key has to be depressed. Two additional numeric keystrokes are optional.
4. "A = > B" is read as "A equal to or greater than B."
5. All temperatures referred to are in the units of "degrees centigrade."
6. Keystrokes are noted as a sequence of numbers and words that define each entry. "n(n(n)) TEMP" means "press 1, 2, or 3 numeric keys, then press the TEMP key." "SCAN TEMP m" means "press the key marked 'SCAN TEMP' followed by a numeric entry."

RS232 CONVENTIONS

1. "n" or "m" refers to any numeric character 0 through 9.
2. Items enclosed in parentheses "("") are optional. Thus n(n(n.(n))) means that at least one numeric character has to be sent. Optionally, one or two additional numeric characters to the left of a decimal and one character after a decimal is allowed.
3. All times referred to are in the units of "minutes."
4. All temperatures referred to are in the units of "degrees centigrade."
5. Commands sent to the controller, and data sent from the controller are in the form of "ASCII character strings." Commands sent to the controller are masked to 7 bits and may contain space characters (blanks). The controller ignores all received ASCII characters with a value of less than HEX 10. Therefore, carriage return, line feed, and null characters can be used at will. Data sent from the controller are 8 bits long with the most significant bit a 0 and the rest defining an ASCII character.
6. Data sent from controller are followed by carriage return and line feed characters.
7. RS232-C CONTACT ASSIGNMENTS are shown in TABLE 3-1 in the User Manual.
8. The command processor software ignores leading zero's and trailing digits on all numeric data received. For example: -000025.32 C will set the single mode temperature to -25.3 deg.
9. **BOLD** type in the Terminal Examples indicates keystrokes required from the terminal keyboard.
10. When a 'dumb terminal' is used for the RS232 interface, any TC01 output will automatically be displayed on the terminal. When using a computer, any TC01 output must be read through some form of 'INPUT' or 'READ' statement - usually a part of an application program written in a language such as BASIC.
11. Computer Examples are written in BASIC. In these BASIC statements, the variables X, Y and A\$ are assumed to be defined somewhere else in the BASIC program and contain the proper values for desired results. The BASIC program statements: PRINT#1 and INPUT #1 are assumed to output RS232 data to the TC01 and input RS232 data from the TC01, respectively.
12. The RS232 encoding format used is: 7 bits data, even parity, 2 stop bits.

IEEE-488 CONVENTIONS

1. "n" or "m" refers to any numeric character 0 through 9.
2. Items enclosed in parenthesis "("") are optional. Thus n(n(n.(n))) means that at least one numeric character has to be sent. Optionally, one or two additional characters to the left of a decimal are allowed and one character after the decimal is allowed.
3. The sample 9825 commands assume that the calculator's IEEE-488 interface card is set to select code 7; and that the temperature controller's address has been set to binary 3.
4. Blanks are ignored. The controller ignores all received ASCII characters with a value less than HEX 10. Therefore, carriage return, line feed and null characters can be used at will.
5. "X" and "Y" are variables assumed to be defined elsewhere in the 9825 controlling program.
6. IEEE-488 CONTACT ASSIGNMENTS are shown in TABLE 3-2 in the User Manual.
7. IEEE-488 BUS ADDRESS SWITCH SETTINGS are shown in TABLE 3-3 in the User Manual.
8. The command processor software ignores leading zero's and trailing digits on all numeric data received. For example: -000025.321000C will set the single mode temperature to -25.3 deg.

EXAMPLE: To set/delete a SCAN TEMPERATURE.
RS232

TERMINAL

-30A3 sets SCAN TEMP #3 to -30°C

50.2A0 sets SCAN TEMP #0 to +50.2°C

100.5A8 sets SCAN TEMP #8 to +100.5°C

The above sequence will be executed, +50.2° first, -30° second and +100.5° third.

-A3 deletes SCAN TEMP #3. With SCAN TEMP#3 deleted, execution will start with +50.2° & end with 100.5°.

150.5A8 sets SCAN TEMP #8 to 150.5°C.

Note that the new SCAN TEMP of 150.5 writes over the old one of 100.5°.

COMPUTER

PRINT #1, "-30A3"

or PRINT #1, X, "A", Y

IEEE-488

wrt703, "50.2A3" or fxd0;wrt703, X, "A", Y sets SCAN TEMP #3 to +50.2°C.

EXAMPLE: To set the DEVIATION LIMIT and ENABLE
DEVIATION INTERRUPTS.

RS232

TERMINAL

EDI5.3 Enables interrupts and sets limit to +/- 5.3°C.

COMPUTER

PRINT #1, "EDI5.3"

or PRINT #1, "EDI", X

IEEE-488

wrt703, "EDI10.2" or fxd0;wrt703, "EDI", X enables deviation interrupts & sets deviation limit to +/- 10.2°C.

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(specifications subject to change without notice)

TEMPERATURE

Set Temperature Range	-100°C to +300°C
Number of Scan Stet Temperatures	10
Absolute Error Over Temperature Range	± .4°C
Chamber Temperature Measurement Resolution	.1°C
Long Term Stability	± .2°C
Repeatability	± .2°C
Temperature Control Technique	Pulse Width Modulation PID Algorithm

TIME

Set Time-at Temperature Range	1-1800 minutes and continuous
Number of Scan Set Times	10
Time-at-Temperature Resolution	.1 minute
Time-at-Temperature expiration	
Audio	Audible Tone
Visual	Red LED
IEEE-488 Bus	Interrupt SRQ
RS232 Bus	Interrupt ASCII "I"
Maximum Time-at-Temperature capability	225 days

CONTROL

Local	Via 16 key keyboard
Remote	*RS232-C 2400 Baud IEEE-488 Bus
Automatic Cycling of Programmed SCAN Time/Temp Sequence	1-1800 cycles and continuous

MISC

Size	23cm H x 12cm W x 11.5cm D (9" H x 4.75" W x 4.5" D)
Power	110 volts 50/60HZ, 35 watts
Cooling Selenoid Control	1 amp @ 240 volts
Heater Control	25 amp @ 240 volts
Probe Short/Open Detection	Disable Heat/Cool in 30 sec. displays "199.9"
Auxiliary Outputs	Quan 2, TTL open collector w/pullup

standard models includes temperature probe, and step-by-step instruction manual for installation and use
*jumper selectable: 300, 600, 1200, 24000, 4800 baud

TC01 11/02

CUSTOM INSTALLATON

Installation of the TC01 into custom systems is easily accomplished via an 8 position terminal strip. Heat and cool outputs are switched by triacs which in turn are controlled by the TC01 logic. SUN SYSTEMS can provide custom changes to TC01 for specific customer requirements.

OTHER CHAMBERS

The TC01 is capable of controlling most commercially available chambers. Call or write for details on how to retrofit your particular chamber.

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