TCON 2000

High Precision Dry Bath System

User's Manual

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WARRANTY INFORMATION AND NOTICES

DURATECH warrants all products of its manufacture to be free from defects in material and workmanship. This warranty is effective for one year from the date of delivery to the original Purchaser.

DURATECH warrants all other products not of its manufacture but sold as part of this DURATECH system to be free from defects in material and workmanship. This warranty is effective for ninety days from the date of delivery to the original Purchaser.

Upon prompt notification by the Purchaser, DURATECH will, at its option, repair or replace equipment that proves to be defective during the warranty period. The equipment must be returned to DURATECH at the expense of the Purchaser, if required by DURATECH Parts, labor and return shipment to the Purchaser shall be at the expense of DURATECH. Parts used and labor performed during on-site warranty service requested by the Purchaser shall be at the expense of DURATECH. Travel costs, meals, and lodging shall be at the expense of the Purchaser.

<u>This warranty shall not apply to defects originating from:</u>

1. Improper maintenance or operation by the Purchaser.
2. Purchaser-supplied accessories or consumables.
3. Modification or misuse by the Purchaser.
4. Operation outside the environmental and electrical specifications for the product.
5. Improper or inadequate site preparation.
6. Purchaser induced contamination or leaks.

DURATECH reserves the right to make changes in design or construction at any time without incurring any obligation to make any changes whatsoever on units previously purchased. DURATECH assumes no obligation of any kind with respect to design or construction of products not of DURATECH manufacture.

This warranty is expressly made by DURATECH and accepted by Purchaser in lieu of all other warranties, including warranties of merchantability and fitness for a particular purpose, whether written, oral, expressed, implied, or statutory. Purchaser agrees that DURATECH shall not be liable for normal wear and tear, nor for any contingent, incidental or consequential damage or expense due to partial or complete inoperability of its products for any reason whatsoever.

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1.0 TECHNICAL SPECIFICATIONS

1.1 Physical

Dimensions:	10” high x 15” deep x 5” wide
Weight:	25 pounds unpacked
Control:	(4) operator pushbuttons; RS-232
Display:	20 character x 4 line backlit LCD

1.2 Power Requirements

115VAC 60 Hz, single phase	3 amps
230VAC 50 Hz, single phase	1.5 amps

1.3 Environmental

Operating Temperature:	30ºC maximum
Storage Temperature:	-20ºC to 50ºC
Humidity:	10% to 60%, non-condensing

1.4 Temperature

Range	0°C to 70°C guaranteed (can be set from -5°C to 70°C)
Accuracy	Better than ±0.3°C
Repeatability	Better than ±0.1°C
Stability	Better than ±0.02°C (Measured at the temperature sensor within the blocks. Insertion of tubes to be heated or cooled will momentarily, and slightly, disturb the temperature.)
Uniformity	±0.1°C

1.5 Control

Multiple Peltier devices are controlled by the firmware on the circuit board. Temperature sensors are monitored by a 24 bit Analog to Digital (A/D) converter. Custom Proportional Integral (PI) algorithms are used for controlling temperature.

1.6 Purge Gas

Purge gas must be used at temperatures below ambient. Without purge gas condensation may damage the insulation and affect the temperature of the sample. You may use nitrogen gas or dehumidified or desiccated air (dew point of -10°C or below). Gas must be filtered to 10µm or better.

1.7 Blocks

Up to four independently controllable blocks, each holding a maximum of ten 10mm tubes is possible. Other custom tube diameters and number of independently controlled blocks are available on request and may be at an additional cost. Typical TCON 2000 test tube sizes are 18mm, 10mm and 7.5mm. Typical TCON 2000 independently controlled blocks are 1, 2 and 4.

1.8 RS-232 Interface

The TCON 2000 uses a standard RS-232 serial interface with the following protocol:

9600, 8, N, 1 (9600 baud, 8 bits, no parity, 1 stop bit)

1.9 RS-232 Commands

‘n:<bath>:<temperature><LF>’: Set the slope calibration value. Each bath has two calibration points. The TCON2000 product expects the bath for slope calibration to be at 50 degrees C while the TCON1000 product expects the bath for slope calibration to be at 90 degrees C.

If you leave off ':<temperature>' the command will fail; however, the return value will be the current slope calibration value for the specified bath.

<bath>:	ASCII character ‘1’, ‘2’, ‘3’, ‘4’	(TCON 2000)
	ASCII character ‘1’,’2’	(TCON 1000 2-bath)
	ASCII character ‘1’	(TCON 1000 1-bath)

<temperature>: ASCII characters ‘0’ – ‘9’ only.

Format:	<digit><digit>’.’<digit><digit>	
Range:	45.00 - 55.00	(TCON 2000)
	85.00 - 95.00	(TCON 1000)

Return Value: ‘n<success><bath>:+<digit><digit>.<digit><digit><LF>’

<success>: ASCII character ‘:’ for success.
ASCII character ’!’ for failure.
<bath>: ASCII character '1' thru '4'.
<digit>: ASCII characters ‘0’ thru ’9’.
<LF>: ASCII character LF (0x10).

‘o:<bath>[:|-]<temperature><LF>’: Set the y-intercept calibration value. Each bath has two calibration points. The TCON2000 product expects the bath for y-intercept calibration to be at 0 degrees C while the TCON1000 product expects the bath for slope calibration to be at 40 degrees C. If a negative temperature is desired, the ':' must be replaced by a '-'.

If you leave off ':<temperature>' the command will fail; however, the return value will be the current y-intercept calibration value for the specified bath.

<bath>: ASCII character ‘1’, ‘2’, ‘3’, ‘4’ (TCON 2000)
ASCII character ‘1’,’2’ (TCON 1000 2-bath)
ASCII character ‘1’ (TCON 1000 1-bath)

<temperature>: ASCII characters ‘0’ – ‘9’ only.

Format: <digit><digit>’.’<digit><digit>
Range: -5.00 - 5.00 (TCON 2000)
35.00 - 45.00 (TCON 1000)

Return Value: ‘o<success><bath>:[+|-]<digit><digit>.<digit><digit><LF>’

<success>: ASCII character ‘:’ for success.
ASCII character ’!’ for failure.
<bath>: ASCII character '1' thru '4'.
<digit>: ASCII characters ‘0’ thru ’9’.
<LF>: ASCII character LF (0x10).

‘t:<bath><LF>’: Request the current temperature value for a given bath.

<bath>: ASCII character ‘1’, ‘2’, ‘3’, ‘4’ (TCON 2000)
ASCII character ‘1’,’2’ (TCON 1000 2-bath)
ASCII character ‘1’ (TCON 1000 1-bath)

Return Value: ‘t<success><bath>:[-][<digit>]<digit><digit>.<digit><digit><LF>’

<success>: ASCII character ‘:’ for success.
ASCII character ’!’ for failure.
<bath>: ASCII character '1' thru '4'.

<digit>: ASCII characters ‘0’ thru ’9’. The optional <digit> may appear when using the TCON1000 product and the setpoint is equal to 100 degrees C or greater.

<LF>: ASCII character LF (0x10).

‘s:<bath>[:|-]<temperature><LF>’: Set a new set point for the 'bath' location to 'temperature'. If a negative temperature is desired, the ':' must be replaced by a '-'.

If you leave off ':<temperature>' the command will fail; however, the return value will be the current set point value for the specified bath.

<bath>: ASCII character ‘1’, ‘2’, ‘3’, ‘4’ (TCON 2000)
ASCII character ‘1’,’2’ (TCON 1000 2-bath)
ASCII character ‘1’ (TCON 1000 1-bath)

<temperature>: ASCII characters ‘0’ – ‘9’ only.

Format: <digit><digit>’.’<digit><digit>
Range: -5.00 – 70.00 (TCON 2000)
30.00 - 110.00 (TCON 1000)

Return Value: ‘s<success><bath>:[+|-]<digit><digit>.<digit><digit><LF>’

<success>: ASCII character ‘:’ for success.
ASCII character ’!’ for failure.
<bath>: ASCII character '1' thru '4'.
<digit>: ASCII characters ‘0’ thru ’9’.
<LF>: ASCII character LF (0x10).

‘v:<LF>’: Get the date and version number for the TCON.

Return Value: ‘d:<month> <day> <year><LF>v:<major>.<minor><LF>’

<month>: ASCII characters ‘0’’0’ thru ‘1’’2’.
<day>: ASCII characters ‘0’’0’ thru ‘3’’1’.
<year>: ASCII characters ‘0’’5’ thru ‘9’’9’.
<LF>: ASCII character LF (0x10).
<major>: ASCII character ‘3’ thru ‘9’.
<minor>: ASCII character ‘0’ thru ‘9’.

‘p:<LF>’: Get the TCON product string.

Return Value: ‘p:TCON2000<LF>’ (TCON2000)
‘p:TCON1000<LF>’ (TCON1000)

OVERVIEW

The TCON 2000 was designed to replace costly water bath systems. The standard model has four deep well blocks. Each block can be programmed to any set point in the temperature range of the instrument.

2.1 Temperature Control

Each block is monitored by a precision RTD temperature sensor, which is read by a 24 bit Analog to Digital (A/D) converter on the circuit board.

The microprocessor constantly calculates and updates the output to the blocks using a custom Proportional Integral (PI) algorithm. The control is two-way, meaning that the temperature is driven up and down when necessary to maintain the set point.

2.2 Temperature Range

The guaranteed temperature range is from 0°C to 70°C. Higher temperature settings are not permitted due to insulation ratings. The set point may be adjusted from -5°C to 70°C, to compensate for possible offsets between the embedded sensor and actual temperatures inside the wells.

2.3 Condensation Reduction System

Each block in the TCON 2000 has a precision air flow restrictor that supplies it with a known flow rate of dry purging air, as controlled by supply air pressure. The relationship between supply air pressure and flow rate is detailed in the chart below (under setup).

The purging system was designed to keep the tubes dry as they cool down from ambient (or higher) to below ambient temperatures. The purging system also *helps* to eliminate any slight condensation on test tubes that may be present.

If your protocols involve placing pre-cooled tubes into the block, you may have to increase the flow rate of purge gas. For example, if one block is at 10°C, and you want to remove the tubes from this block and place them into another block at 5°C, condensation will form on the tube immediately upon removal. If moved quickly from the 10°C block to the 5°C block, the slight amount of condensation may be removed by dried air. If the condensation is not completely removed, you can try increasing the flow rate of the dried air.

NOTE: If excessive amounts of condensation are present from insertion of pre-cooled tubes, you will have to change the set point for that block to 70°C for a short period of time to evaporate the condensation.

3.0 SETUP

3.1 Purge Gas Connection

Place the TCON on the bench top (or in the Duratech ASP960 Autosampler if used), making sure that the area behind it is clear of obstructions. Connect the 1/8" tubing to the barb connector on the front of the unit. Connect the other end to your supply of dry gas. Each block in the TCON 2000 has a precision flow restrictor, which delivers a known flow for a given pressure.

NOTE: Use a 0psi - 50psi (or 0KPa - 340KPa) regulator, so you have precise control over the range. DO NOT EXCEED 30psi (200KPa).

FLOW PER BLOCK

		SCFH	LPH	Cc/min
PSI	KPa	FLOW	FLOW	FLOW
0.0	0.0	0.0	0.0	0
5.0	34.5	0.5	14.4	240
10.0	69.0	0.7	19.8	330
15.0	103.4	0.8	22.8	380
20.0	137.9	1.0	28.2	470
25.0	172.4	1.2	34.2	570
30.0	206.9	1.4	39.6	660

Our experience is that condensation begins to form with gas flows under 80cc/min, or about 1psi. It is recommended that you use the lowest flow rate that eliminates condensation. A flow of 240cc/min (5psi) generally is sufficient.

To check the flow requirements for yourself, first remove all the tubes. Next, set the temperature to the lowest temperature that you intend to use, and set the desired pressure. Let the unit sit overnight, and check for frost or condensation at the mouths of the aluminum wells, just below the white insulation.

3.2 Electrical Connection

Use the supplied power cable to connect the TCON 2000 to the power source. Be sure to look at the label for correct voltage operation.

WARNING: Plugging a 115VAC unit into a 220VAC receptacle may destroy the power supply.

Be sure that the purge air is connected and flowing before turning on power. Turn on power.

4.0 OPERATION

4.1 Basic Operator Interface

The main screen layout looks like this:

BATH					SETPOINT									ACTUAL					
B	4				4	0	.	0	0	°				4	0	.	0	0	°
B	3				3	0	.	0	0	°				3	0	.	0	0	°
B	2				1	0	.	0	0	°				1	0	.	0	0	°
B	1				0	0	.	0	0	°				0	0	.	0	0	°

B1 to B4 are baths 1 to 4, respectively. Bath 1 is at the front of the unit, bath 4 is at the rear of the unit. The baths are listed this way so they match the actual layout of the blocks.

The operator interface consists of (4) pushbuttons labeled: MENU, CURSOR, UP, and DOWN. All pertinent data is displayed on the 20 character x 4 line LCD display.

All numeric data is entered the same way: MENU selects the next menu item, the CURSOR key moves the cursor, and the UP & DOWN arrows adjust the digit (or sign) above the cursor. A typical screen could show:

BATH					SETPOINT									ACTUAL					
B	4			+	4	0	.	0	0	°									
B	3			+	3	0	.	0	0	°									
B	2			+	1	0	.	0	0	°									
B	1			±	0	0	.	0	0	°		←		e	n	t	e	r	

Note there is a cursor under the "+" sign for block 1. Pressing CURSOR advances the cursor to the right. (The cursor will wrap around to the sign character.) Using the UP and DOWN buttons changes the value above the cursor. To change the sign, simply press UP or DOWN. When the value is set, press MENU for the next selection. You can press MENU at any time to bypass any desired screen.

NOTE: Be sure that the main screen (with set points and actual temperatures) is showing when you are done setting temperatures.

4.2 Notes

When changing set points, the temperature of the adjacent block(s) may be affected due to the common heat sink. The adjacent block(s) temperature may increase or decrease about 0.05°C while other blocks are moving towards their set points.

5.0 CALIBRATION

Use a precision thermometer and a test tube to calibrate. Your thermometer should be calibrated to be correct when it is inserted in the sample to the depth that you are using. Put the test tube, with the thermometer in it, near the middle of the block that you are first going to calibrate. The test tube should be filled with anti-freeze (ethylene glycol) to a level so that WHEN THE PRECISION THERMOMETER IN INSERTED, THE LEVEL WILL BE AT THE NORMAL SAMPLE LEVEL, TYPICALLY 3 to 5 CM. Calibration is done at 0°C and 50°C. First, you must do the calibration at 0°C. Proceed as follows:

1. Set all the temperatures to 0°C, and let the temperatures stabilize, for about 1 hour. Be advised that condensation may affect the calibration at 0°C. You must use dry purge air at temperatures below ambient.

2. Press the “MENU” button, once. This takes you to the screen to enter the set point for block 1. Press it repeatedly to select the desired block. Then press and hold the “MENU” button. The display will then go to the calibration screen for that block.

3. Now enter the temperature read from the thermometer. Then press the “MENU” button to return to the operate screen. Repeat the above for the remaining blocks.

4. Proceed in a similar manner with calibration at 50°C.

5. Record the results. The Duratech website has a convenient form to store the calibration values. (http://www.duratech.biz/brochures/calibration_record.pdf) The current values can be viewed by holding down the ⇧⇩ buttons when turning power on. Should calibration be lost for any reason it can be restored without repeating the calibration steps above, by re-entering these values. See “RESTORING A LOST CALIBRATION” (section 5.1).

You may re-calibrate at any time. The TCON automatically takes into account all previous calibrations, and calculates the required offset and slope from your inputs. The sum of all calibrations is stored, and can be read out. To do this, turn off power, and turn it on, while holding down both the up and down arrows. The 0°C calibrations are listed under the set point column, and the 50°C calibrations are listed under the actual column. Turn power off and on to return to normal operation.

The TCON 2000 has been calibrated at the factory. However, there are many factors that affect the temperature of the sample. The temperature that is actually controlled is a point within the aluminum block. The sample is slightly separated from this. It can be influenced by the temperature of neighboring blocks, by the thermal characteristics of the test tube, and by the thermal conductivity of the precision thermometer itself.

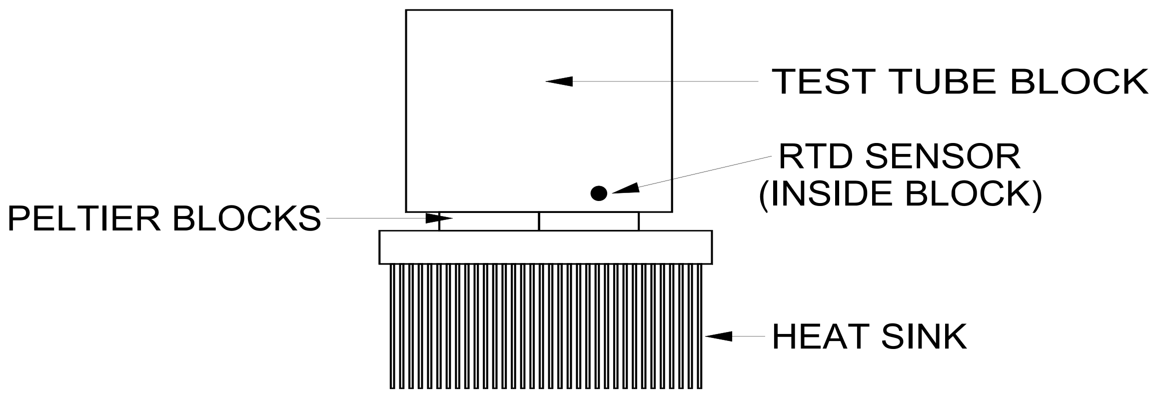
5.1 RESTORING A LOST CALIBRATION

The last set point and calibration values for each block are stored in non-volatile memory (memory that is maintained when power to the unit is off). Should the calibration be lost for any reason, such as a fault, or operator error, it can be restored without repeating the calibration steps above, providing that the calibration values have been recorded. The values entered at the factory are recorded and can be requested by phone or e-mail. Recorded values may be re-entered as follows:

1) View current calibration by turning power on while pressing the ⇧⇩keys.
2) If in error, select a calibration value to change using the menu key.
3) Correct a calibration value with the cursor and ⇧⇩keys.
4) Save corrected calibration values by pressing and holding the menu key.
5) Repeat step 1 to confirm corrections.
6) Exit without re-saving changes by turning power off.

6.0 OPERATIONAL THEORY

The basic construction of one dry bath is shown below:



When current is passed through a Peltier block, heat is pumped from one side of the device to the other. Changing the direction of the current changes the direction that heat is pumped. One side of the device is in contact with the test tube block while the other is in contact with the heat sink. (The heat sink either provides heat to transfer to the test tube block, or a place for the heat in the test tube block to be dumped.) The Peltier blocks can be switched from heating to cooling as fast ten times per second. This fast switching provides the superior temperature stability of the TCON 2000.

The test tube block temperature is measured using a Resistance Temperature Detector (RTD) that is placed close to the Peltier blocks. (This allows the unit to rapidly detect changes in temperature.) The temperature displayed on the TCON 2000 is from this sensor. We state a temperature stability of better than ±0.02°C. This is the temperature read at the RTD's location in the aluminum mass.