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Fast Temperature
Programmer
Operator's Manual

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Table of Contents

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Introduction

Please read the manual completely before using the Fast Temperature Controller.

⚠ **The column controlled by the FTC will be heated very rapidly to a very high temperature (450°C).** *Do not touch* **the column at any time the FTC is on.** *Do not handle* **the column unless the FTC has been turned off for at least 15 minutes, and then use caution.**

General Description

The VICI Fast Temperature Controller (FTC) is designed for precision temperature programming of a low mass nickel-clad or nickel-wire column. The nickel serves as both the heating element and the temperature sensor. This reduces the mass of the column and enables the use of a safe, low voltage to heat the column. Eight programmable states can be set for Temperature, Ramp Rate, and Duration. A small fan is used to cool the column to the starting temperature. (Fan ordered separately.)

Serial communication is accomplished via a terminal emulation or communication software (such as HyperTerminal®, included with Windows®) running on a PC-compatible computer.

Parts Included

The Fast Temperature Controller system includes the following:

Description	Product number
• FTC	I-25223-1
• Power supply, 48VDC	I-25264
• Power cord, 110VAC	I-W-17600
• Column harness	I-25251-2
• Fan harness	I-25345
• USB cable	30-001-06B

Columns and fans sold separately.

Figure 1: Rear panel of Fast Temperature Controller

FTC REAR PANEL

REMOTE START/
READY SIGNAL CABLE
(for custom applications)
P/N I-25344

COLUMN HARNESS
P/N I-25251-2

FAN HARNESS
P/N I-25345

**SUPPLIED
SEPARATELY**

FAN

COLUMN

POWER SUPPLY
P/N I-25264

SUPPLIED SEPARATELY

TO 110 OR 220 VAC

FTC FRONT PANEL
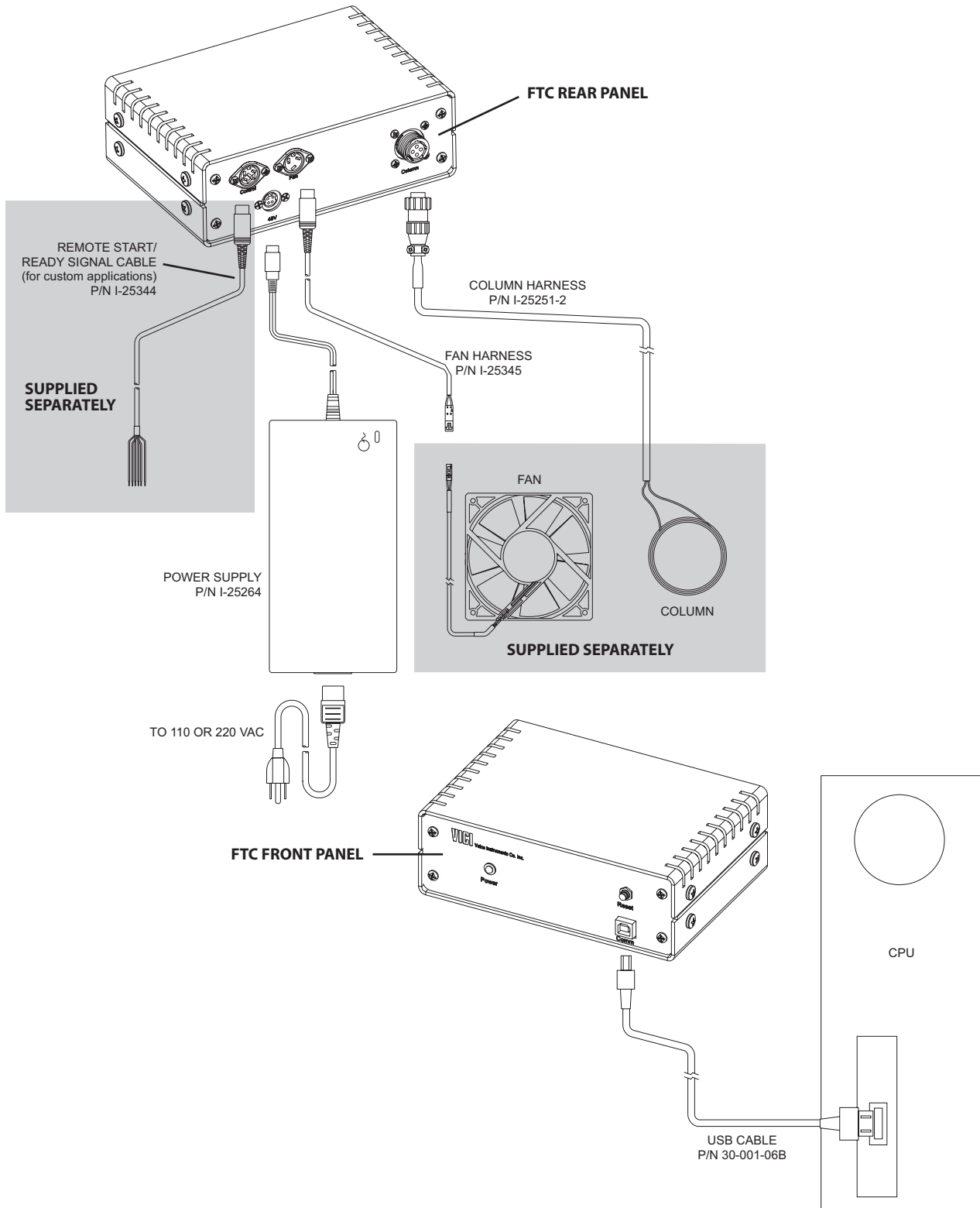
CPU

USB CABLE
P/N 30-001-06B

Figure 2: Connecting the components to the rear panel *(top)* and front panel *(bottom)* of the Fast Temperature Controller. Components in gray boxes are supplied separately.

Getting Started

Cable Connections

Refer to **Figures 1** and **2** as necessary.

1. Connect the USB cable to the front of the FTC and to the computer.

2. Connect the column harness to the FTC and to the column.

3. A 12 VDC fan with a 1.0 amp maximum average may be used to cool the column, under the control of the FTC. Connect the red wire of the fan harness to the red (positive) wire on the fan.

4. Connect the black wire of the fan harness to the black (negative) wire of the fan.

5. Connect the fan harness to the FTC.

6. Connect the 48 VDC power supply to the FTC.

7. Connect the AC power cord to the power supply.

Establishing Serial Communication

Operation of the FTC is primarily through a serial port connection on a personal computer (PC) in conjunction with a terminal emulator such as HyperTerminal®, available on Windows® XP. Since the fast temperature controller employs the FTDI USB serial port chip, the corresponding driver code must be installed on the PC. The latest revision of the driver can be obtained from http://www.ftdichip.com/FTDrivers.htm or from Valco. The driver will recognize the controller and define the virtual "COM" port to which the terminal emulator can connect.

1. Turn on the computer and select the following on the desktop:
    Start > All Programs > Accessories > Communications > HyperTerminal

2. If the Default Telnet Program prompt appears, select **Yes**. Otherwise go to the next step.

3. When prompted, type **FTC** as the name for the connection, then click **OK**.

4. When asked to select a COM port, select the highest port available, **COM3**, then **OK**.

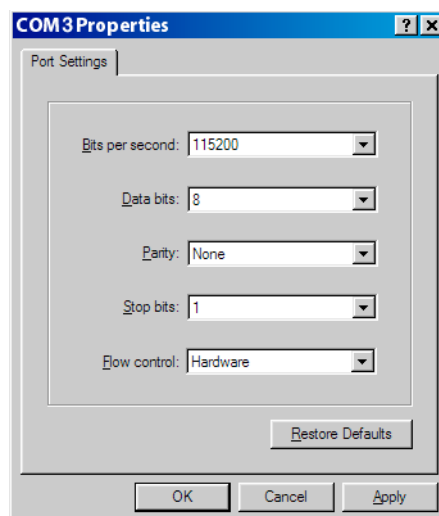5. In the Properties screen for the COM port, set up the following:

Figure 3: Setting the COM port properties

6. Click **Apply**, then **OK**.

7. On the next screen, select **File > Properties > Settings**, and click on **ASCII Setup**.

8. In the ASCII setup window, click the check boxes or enter the values as required to match the screen in **Figure 3**.

9. Click **OK**, then **OK** again to close the FTC Properties window.

10. HyperTerminal:
    Click on the phone icon just below "View" to connect. If the connection is not available, repeat the procedure, selecting a different COM port in step 4.

11. When HyperTerminal is connected, press the reset button of the FTC. The FTC will read as follows:
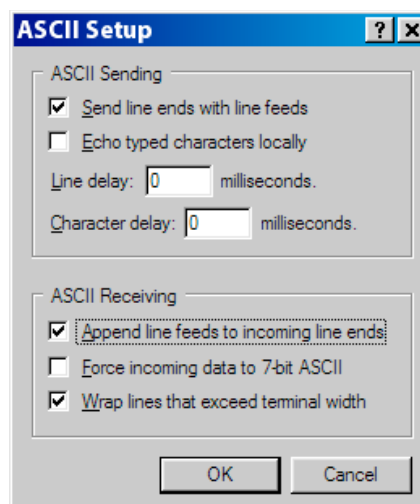

Figure 4: ASCII setup

FTC Response	Explanation
Resetting PWM … ok	*Pulse Width Modulator working*
A/D started	*Analog to Digital converter working*
EEPROM parameters recovered	*Operational parameters loaded*
DS24B33 present	*Memory chip recognized*
1-wire checksum ok	*Verify chip is OK*
ID = 00000142F5DA	*Chip ID number*
Reading embedded parameters …	*Reading column data*
Column id : 12345	*Column serial number*
Length m : 10	*Column length in meters*
Phase id : VB-1 250um	*Column phase, film thickness (µm) & inside diameter (µm)*
Element equation :	*Column temperature vs. resistance equation*

$$R(T) = 1.31039E1 + 6.44364E\text{-}2 * T + 1.74357E - 4 * T^\wedge 2$$

M = 1.550	*Heat capacity of the column*
Alpha = 2.10000E-2	*Time constant in seconds, how fast does the temp. rise*
Lambda = 1.00000E-4	*PWM dampener*
Max. temp = 340	*Column maximum temperature*
Calibration data :	*Column resistance and temperature calibration data*
1 40.000 5.600	*pair #1 (*C) (ohms)*
2 183.000 10.692	*pair #2 (*C) (ohms)*
3 300.000 17.785	*pair #3 (*C) (ohms)*
OK	*Data accepted*
Weighting vector generated.	*Algorithm calculation complete*
Checking input connections … ok	*If not "ok", check column connections*
0.4.8.095 July 5 2012 12:30:55, Unit #321	*FTC firmware and serial number*
DSP Column Control online	*FTC ready for use*

Viewing the Command Set

To view the list of commands for the FTC, type **??**<enter>. All HyperTerminal commands must be followed by <enter> on the keyboard. Characters may be in either upper or lower case. You may wish to print the list for for reference.

A+	Enable autocorrection
A-	Disable autocorrection
CC	Connect column
CD	Disconnect column
CI	Calibrate current scale
CR	Calibrate column resistance
CV	Calibrate voltage scale
D+	Debug on
D-	Debug off
DD	Dump data
DR	Dump ram
DX	Dump parameters to Xml
E+	Terminal echo on
E-	Terminal echo off
EC	Enter R(t) calibration data
EM	Enter MPC parameters: [offset [skip]]
ES	Enter state data
ET[=n]	Show/set equilibration time (seconds)
F+	Fan on
F-	Fan off
FM[=n]	Show/set fan mode: [0]off, [1]on, [2]temp, [3]time
FT[=n]	Show/set fan temp (°C) / time (seconds)
GO	Start ramp/cooling cycle
L+	Start data logging
L-	Stop data logging
LA[=n]	Show/set matrix lambda
RR	Read column resistance
RS	Reset state machine
RT	Read column temperature
RX	Read parameters from Xml. Use flow control!
SR	Run step response test
SS[n]	Show/set state (n=1-8) parameters
VR	Show firmware version
WP	Write eprom parameters
Z-	Turn off column heating
Z+	Turn on column heating
??	Show this list

Verifying Column Parameters

Remember that commands can be upper or lower case, and that they must always be followed by <enter>.

To verify that the column parameters have been correctly loaded into the FTC, type **SC**<enter> (for "show column"). The column parameters should match those on the data sheet supplied with the column.

: sc

Column id/sn:
   12345   *Column serial number*

Max. temperature:
   325   *Maximum column temperature in ℃*

Calibration data:

Temp.	Res.	
40.00	6.30000	*The three resistance vs. temperature*
183.00	11.74200	*calibration points in ℃ and ohms*
325.00	19.65400	

Element equation:
   $R = 1.31039\text{E}1 + 6.44364\text{E-}2 * T + 1.74357\text{E-}4 * T\text{^}2$ *Resistance equation*

Input scaling:
   $V = -2.82099\text{E-}3 + 6.00694\text{E-}6 * C - 3.83986\text{E-}16 * C\text{^}2$ *Voltage equation*
   $I = 2.59489\text{E-}4 + 6.02032\text{E-}7 * C - 6.12730\text{E-}16 * C\text{^}2$ *Current equation*

Verifying Control

1. Read the column temperature by typing **RT**<enter> (for "read temperature"). The column temperature should be appropriate for its environment. If the temperature response is not reasonable, recheck the column parameters for errors.

2. Check the column resistance by typing **RR**<enter> (for "read resistance").

Programming and Running a Sequence

Entering Data for the States

Heating and cooling sequences are controlled by states. State 1 is the idle-mode (starting) temperature, with no ramp. States 2 to 8 are programmable by ramp rate, end temperature, and hold time, for as long as the state is active. States are observed in order, while any state indicated as inactive is skipped. States may be turned on and off by electing the states active (Yes) or inactive (No). When the last active state hold time is completed, the fan will cool the column to the state 1 temperature and hold idle until the next "start" command.

Viewing the Current States

Enter the column heating state interface by typing **SS**<enter> (for "show states"). A new unit may show these values:

State	Active	Rate	Temp	Time
1	Yes	0	0	0
2	Yes	0	0	0
3	No	0	0	0
4	No	0	0	0
5	No	0	0	0
6	No	0	0	0
7	No	0	0	0
8	No	0	0	0

Editing States to Create a Program

To make a change to a state, enter the command **SS**[n], where n is the number of the state to be changed. Settings are changed by typing the new value after the colon, followed by <enter>.

For an example, set up a program that starts with the column at 25°C, hold for 5 seconds (no ramp). The temperature will ramp to 100°C at 100°C/min and hold for 10 seconds, followed by a ramp to 200°C at 200°C/min, holding for 30 seconds. In a final step, the column will ramp to 300°C at 200°C/min and hold for 25 seconds.

To set up the example:

1. Type **SS1**<enter> to bring up the following:

>   : ss1
>   Setpoint (0):
>   Hold time, seconds (0):

2. Enter the values for state 1 as below, then <enter>.

>   : ss1
>   Setpoint (0):25
>   Hold time, seconds (0):5

NOTE: The state 1 temperature setpoint must be at least 5°C above the column ambient environment.

3. Type **SS2**<enter> and type the values below for example state 2, followed by <enter>.

> : ss2
> Active (Y)? *(no change)*
> Ramp rate, degC/min (0):100
> Setpoint (0):100
> Hold time, seconds (0):10

3. Type **SS3**<enter> and type the values below for example state 3, followed by <enter>.

> : ss3
> Active (N)? Y
> Ramp rate, degC/min (0):200
> Setpoint (0):200
> Hold time, seconds (0):30

4. Type **SS4**<enter> and type the values below for example state 4, followed by <enter>.

> : ss4
> Active (N)? Y
> Ramp rate, degC/min (0):200
> Setpoint (0):300
> Hold time, seconds (0):25

⚠️ **Always verify that changes were made by repeating the command to view the current state, or SS<enter> to show all states.**

5. Type **SS**<enter>. If the data were entered correctly, the screen will reflect the following information (except for the italicized explanatory text).

State	Active	Rate	Temp	Time	
1	Yes	0	25	5	*Start at 25°C, hold for 5 seconds (no ramp in state 1)*
2	Yes	100	100	10	*Ramp @ 100°C/min to 100°C, hold 10 seconds*
3	Yes	200	200	30	*Ramp @ 200°C/min to 200°C, hold 30 seconds*
4	Yes	200	300	25	*Ramp @ 200°C/min to 300°C, hold 25 seconds*
5	No	0	0	0	If no other state is active, the fan will automati-
6	No	0	0	0	cally come on to cool the column down to the
7	No	0	0	0	State 1 temperature. The FTC will hold "Ready" for the next run. *(Refer to the section entitled "Fan*
8	No	0	0	0	*Modes" on page 9.)*

NOTE: State parameters are saved when the FTC is powered down. Pushing the RESET button on the front of the FTC may erase the state parameters.

Setting Equilibration Time

Equilibration Time delays the "Ready" flag for state 1, allowing time for the column temperature to equalize once the temperature has been reached. A "Go" command will not execute until this time has elapsed. The equilibration time is preset to 5 seconds. To change it:

1. Type **ET=n**<enter>, where n is the desired equilibration time, in seconds.

2. Type **ET**<enter> to verify that the change has been executed.

Logging Column Data

Data logging allows the user to view column information collected by the FTC. Turn *on* data logging, type **L+**<enter>. To *stop* logging data, type **L-**<enter>.

The data is presented as follows:

Total Time (sec)	Target Temp	Measured Temp	Tt-Tm	Voltage	Current	PWM	State Flag
00000001.0	40.00	40.000	0.000	0.6110	0.1038	983	1R
00000002.0	40.00	40.000	0.000	0.6110	0.1038	983	1R
00000003.0	40.00	40.000	0.000	0.6110	0.1038	983	1R
00000004.0	40.00	40.000	0.000	0.6110	0.1038	983	1R
00000005.0	40.00	40.000	0.000	0.6110	0.1038	983	1R
00000006.0	40.00	40.000	0.000	0.6110	0.1038	983	1R

The first digit of the last value denotes the number of the active state. The second digit conveys the following meaning:

Flag	Meaning
A	Ramp auto correction on
D	PWM duty cycle limit reached
F	Fan is on
I	Column current limit reached
H	Holding in state
P	Column power limit reached
R	Ready
V	Column voltage limit reached
X	External start command received

Turning the Column On

Power to the column must be turned on before the programmed states will execute. To do this:

1. Type **Z+**<enter>. The following message will appear:

   WARNING: Operating with incorrect parameters may damage column!
   Column temperature reading: 19.7.

   Is this correct (N)?

2. If the temperature is appropriate for its environment, type **Y**<enter> and the FTC will power up the column. If the column temperature reading is inaccurate, the column may be damaged. Type N<enter> and the column will not receive power.

⚠ **Incorrect column data can contribute to permanent damage to the column. If you get a suspicious reading, please contact Valco for further assistance.**

Typing **Z-**<enter> will turn the column off.

Starting the Sequence

Before the column ramp sequence will start, the column must be turned on and there must be a "ready" flag viewable in the data log, indicating that the equilibration time has elapsed. As soon as the "ready" signal is received, the ramp sequence may be restarted by typing GO<enter>.

Once the heating cycle is complete, the fan will be turned on to cool the column to the stage 1 starting temperature. Once the state 1 temperature has been reached and the ready flag appears in the data log, the sequence may be restarted by typing GO<enter>.

Autocorrection Feature

During ramping, the difference between the target and measured temperatures may be observed to drift in an almost linear manner. The tracking error may start low and gradually increase during the ramp. The autocorrection feature compensates for this by internally adding a small offset and slope correction to the target temperature value.

To turn *on* the autocorrection feature, type **A+**<enter>. To turn *off* the autocorrection feature, type **A-**<enter>.

Shut Down Procedure

VICI recommends that the FTC be shutdown when not in use. To shut down the FTC:

1. Type **Z-**<enter> to turn off power to the column.
2. Unplug the power cord from the 110 VAC outlet to power down the FTC.
3. Exit HyperTerminal

Fan Installation and Modes

Installation

1. Before turning on the fan, verify that the power to the column is off (**Z-**<enter>), to prevent column damage.

2. To test the connections, turn on the fan by typing **F+**<enter>. If it does not come on, check the connections and/or replace the fan.

3. Turn off the fan by typing **F-**<enter>.

Mode Descriptions

The cooling fan has four modes:

	0	Off
	1	The fan is always on. (This will generally never be used.)
(default)	2	The fan cuts off when it has reached a preset temperature above the state 1 temperature. (Refer to the section on page 10 entitled *To View or Change the Drop Out Temperature*.)
	3	The fan is on for a length of time set by the user.
	4	The fan remains on in state 1.

The fan turns on automatically after the last state hold time is completed as long as the fan is in mode 2 or 3. In mode 2, the fan cools the column until it reaches 1-2° above the state 1 idle temperature (drop out). The column temperature will continue to fall and the controller will automatically power up the column as necessary to "idle" at the state 1 temperature. Fan mode 2 is the default mode, and is recommended for most applications.

In fan mode 3, the fan will come on for the designated amount of time—30 seconds, for example—after which it cuts off.

⚠ **In mode 3, if the fan is on too long and the state 1 temperature is too high, current will be applied to maintain the state 1 temperature at the same time the fan is attempting to cool the column. This may potentially damage the column. For this reason, we recommend fan mode 2 for most applications.**

In mode 4, the fan remains on in state 1 to allow a lower starting temperature.

NOTE: Since we are unable to electrically reverse the heating process, controlled ramping from a higher to a lower temperature is not possible.

To View or Change the Fan Mode

To view the current fan mode setting:

1. Type **FM**<enter>. The response will be
        :fm
        2 *(or 0, 1, or 3)*
    2 indicates that the fan is in the default mode 2.

To change the fan mode setting to 0, for example:

1. Type **FM=0**<enter>

2. Verify that the change was made by typing **FM**<enter>. The response should be
        :fm
        0

To View or Change the Drop Out Temperature

The drop out temperature applies only in mode 2. It is defined as the number of degrees ***above*** *the state 1 temperature set point* at which the fan will be cut off.

To view the current drop out temperature setting:

1. Type **FT**<enter>. The response will be
        :ft
        1.000
    1.000 indicates a drop out temperature setting of 1°C.

To change the drop out temperature setting to 2 seconds, for example:

1. Type **FT=2**<enter>

2. Verify that the change was made by typing **FT**<enter>. The response should be
        :ft
        2.000

Optional Electronic Control

External electronic control of the FTC is provided by a 5 volt, low-true, (1 ma drive) logic level interface. An external input/output (I/O) cable is used for this purpose.

To start the programmed heating sequence remotely, momentarily connect the orange and black wires. Additional signals, listed in the table below, are available for custom applications. Please contact Valco for further assistance.

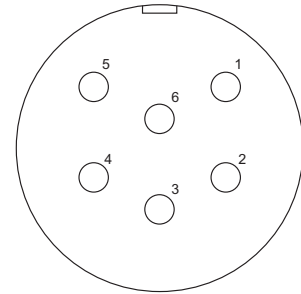| Pin	Wire color	Function
1	Brown	End (output)
2	Red	Ready (output)
3	Orange	Start (input)
4	Green	Reset (input)
5	Yellow	Column power (input)
6	Black	Signal common

Figure 5: I/O receptacle view

Warranty

This Limited Warranty gives the Buyer specific legal rights, and a Buyer may also have other rights that vary from state to state. For a period of 365 calendar days from the date of shipment, Valco Instruments Company, Inc. (hereinafter Seller) warrants the goods to be free from defect in material and workmanship to the original purchaser. During the warranty period, Seller agrees to repair or replace defective and/or noncon- forming goods or parts without charge for material or labor, or, at the Seller's option, demand return of the goods and tender repayment of the price. Buyer's exclusive remedy is repair or replacement of defective and nonconforming goods, or, at Seller's option, the repayment of the price.

Seller excludes and disclaims any liability for lost profits, personal injury, interruption of service, or for consequential incidental or special damages arising out of, resuiting from, or relating in any manner to these goods

This Limited Warranty does not cover defects, damage, or nonconformity resulting from abuse, misuse, neglect, lack of reasonable care, modification, or the attachment of im- proper devices to the goods. This Limited Warranty does not cover expendable items. This warranty is VOID when repairs are performed by a nonauthorized service center or representative. For information about authorized service centers or representatives, write Customer Repairs, Valco Instruments Company, Inc, P.O. Box 55603, Houston, Texas 77255, or phone (713) 688-9345. At Seller's option, repairs or replacements will be made on site or at the factory. If repairs or replacements are to be made at the factory, Buyer shall re- turn the goods prepaid and bear all the risks of loss until delivered to the factory. If Seller returns the goods, they will be delivered prepaid and Seller will bear all risks of loss until delivery to Buyer. Buyer and Seller agree that this Limited Warranty shall be governed by and construed in accordance with the laws of the State of Texas.

The warranties contained in this agreement are in lieu of all other warranties expressed or implied, including the warranties of merchantability and fitness for a particular purpose.

This Limited Warranty supercedes all prior proposals or representations oral or written and constitutes the entire understanding regarding the warranties made by Seller to Buyer. This Limited Warranty may not be expanded or modified except in writing signed by the parties hereto.