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TCIC User's Manual

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1. Main Features

- Very High Speed & High Resolution.
- Supports up to 8 channels (differential inputs).
- Each channel can be set for a thermocouple reading or for a voltage (millivolt) reading.
- Internal A/D resolution: 24 bit (not all are used).
- Sampling rate: 400 Hz (50 Hz for each channel).
- Single opto-isolated output per channel which can be used as a set-point (alarm etc.) or as a general purpose output.
- Conversion tables are on board to enable stand-alone operation.
- Reading is in °F, °C or mV.
- CJC (Cold Junction Compensation) built on board.
- Each channel supports the most popular families of thermocouples (E, J, K, R, S, T) or any indefinite voltage source in the range -500mV -> +500mV.
- USB as a standard method of communication.
- USB + RS485 and RS232 (option).
- Multiple boards may be connected via USB or the optional RS485.
- On board high accuracy reference voltage for easy calibration.
- No need for external power supply when used with USB.
- Includes Windows software for initial setup and also a Smart data logger package for monitoring & collecting readings in high speed – with graphic mode display.

Communication

Two types of drivers are available:

- The **direct** driver provides access via a DLL supplying functions to directly control the device.
- The **VCP** (Virtual COM Port) driver would make the TCIC appear as a spare COM port on the PC, e.g. COM3.

Setpoints

Each channel may be defined as a ***setpoint***, which means that the corresponding output will turn on upon crossing some level. The setpoint user-defined selection also controls the *direction* of the 'setpoint indication'; that is, turn the output on upon crossing the limit either ***upwards*** or ***downwards***. In other words, the *direction* of the trigger is user-defined. Likewise, the user may define a *hysteresis* behavior, e.g., the output turns **on** when the temperature goes above some limit and only goes **off** again when the temperature falls below another (lower) limit, thus eliminating undesirable fluctuations in the status of the output.

2. Installation

(The following description refers to Windows XP. Obviously, on another operating system it might be different.)

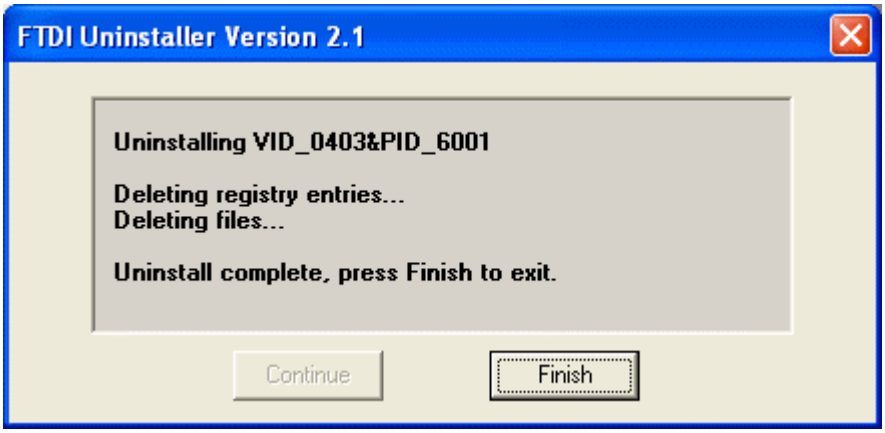
1. Make sure that all package files have been copied – and unzipped if necessary – to your hard disk.

2. Two types of drivers are available. Install the one that meets best your requirements. Note that **only one driver may be installed at the same time**. That is, if for some reason you want to switch to the other driver, first uninstall the retired one.
   - The **direct** driver provides access via a DLL supplying functions to directly control the device.
   - The **VCP** (Virtual COM Port) driver would make the TCIC appear as a spare COM port on the PC, e.g. COM3.

   Consider which driver is best for you and proceed accordingly to step 3 or 4.

3. Installing the Direct DLL Driver:
   3.1 If the VCP (Virtual COM Port) Driver is installed, uninstall it as follows:
   Click: Start – Control Panel – Add or Remove Programs – FTDI USB Serial Converter Drivers – Change/Remove

   Disconnect all TCIC boards from the USB port and click Continue…



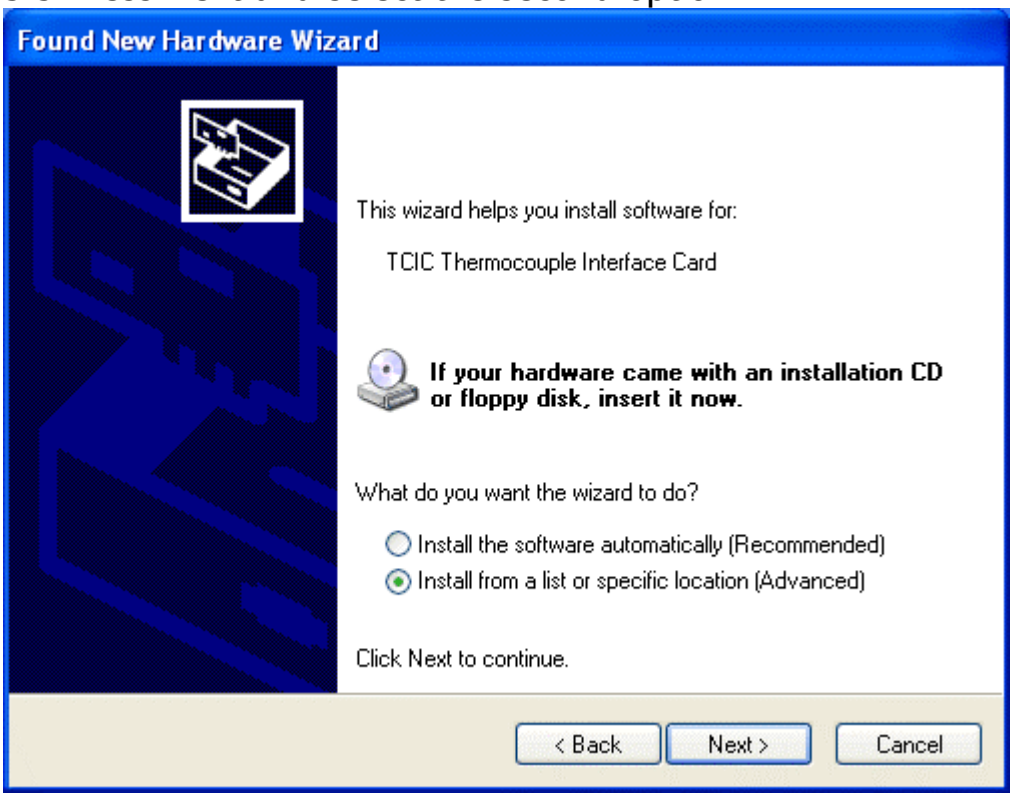
Click Finish.

3.2 Disconnect or disable the internet communication if such exists. The reason for that is that there are cases where the installation procedure automatically communicates with manufacturer's site, which might lead to wrong operation.

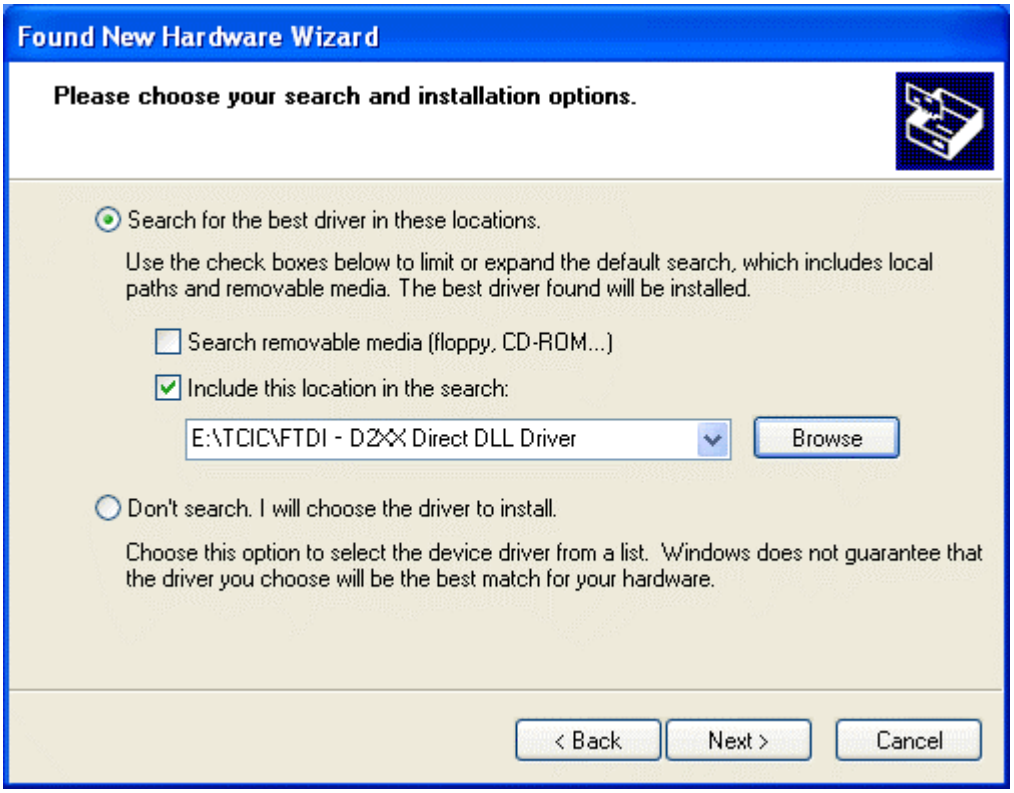
3.3 Connect the TCIC card to your PC.

3.4 The 'Found New Hardware Wizard' appears.
Select the last option like this:

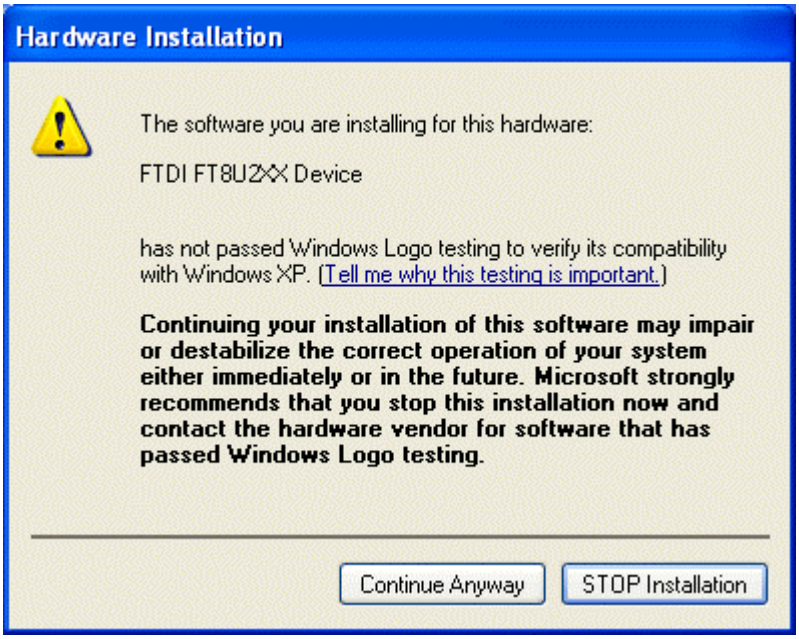
3.5 Press Next and select the second option:



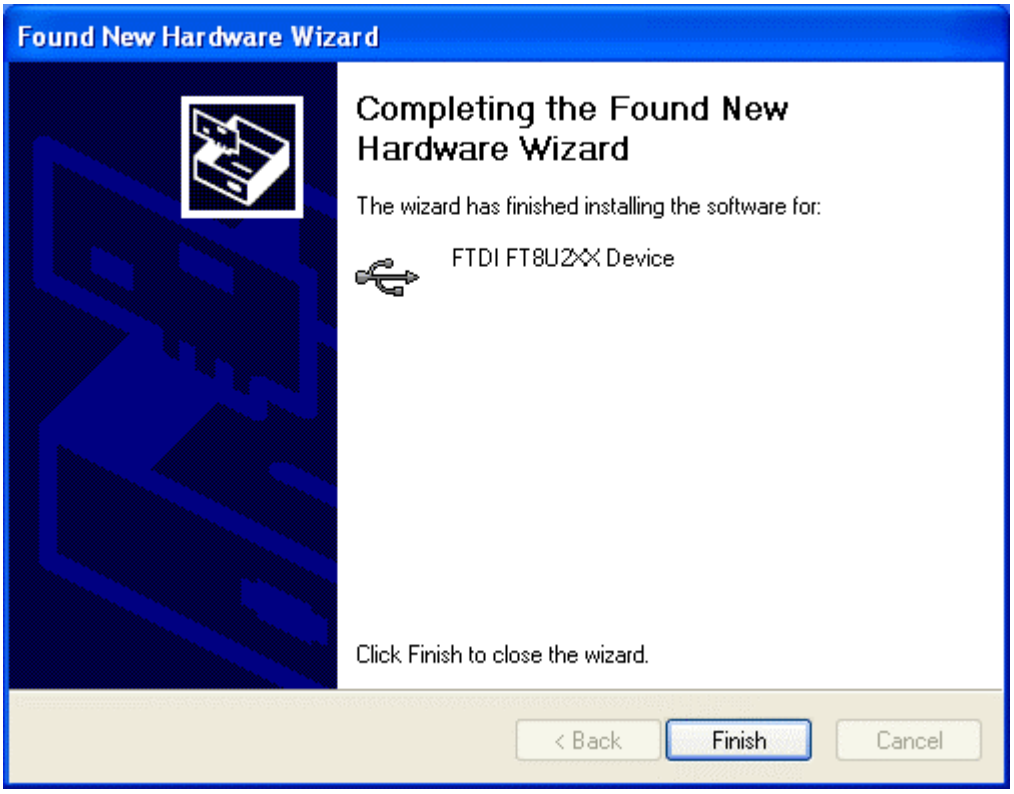
3.6 Press Next and browse to the Direct DLL driver folder:



3.7 Click Next…

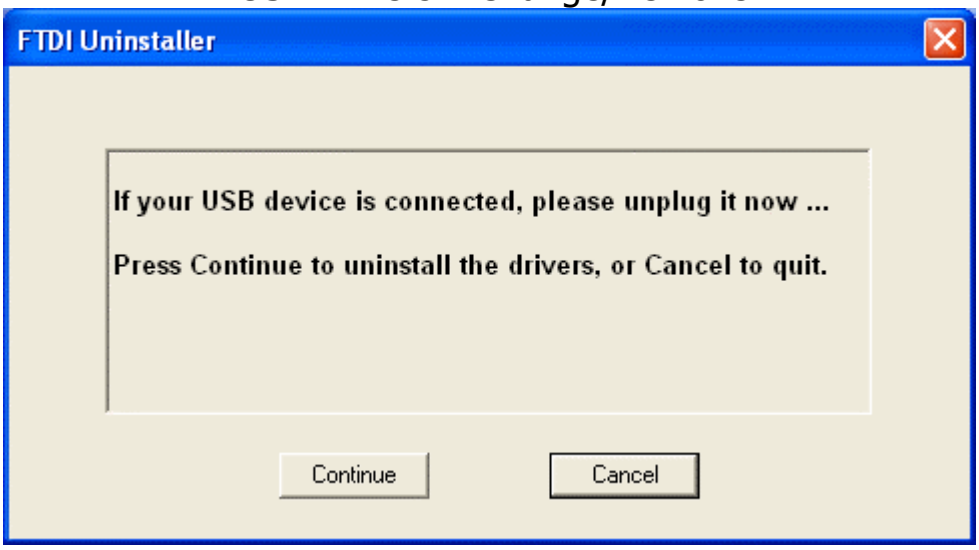


3.8 Press Continue Anyway…

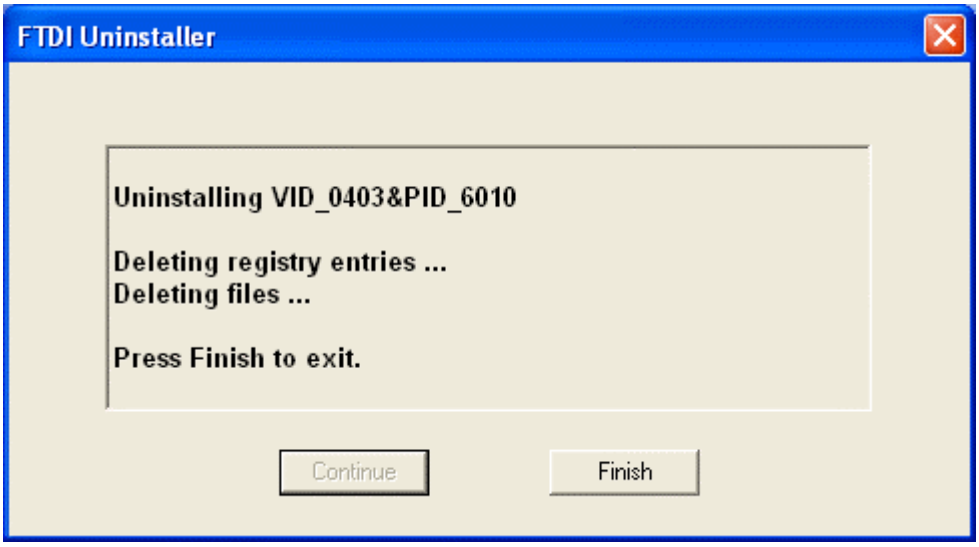


Click Finish – that's it!

4. Installing the VCP (Virtual COM Port) Driver:
   4.1 If the Direct DLL Driver is installed, uninstall it as follows:
   Click: Start – Control Panel – Add or Remove Programs – FTDI FTD2XX USB Drivers – Change/Remove



Disconnect all TCIC boards from the USB port and click Continue…

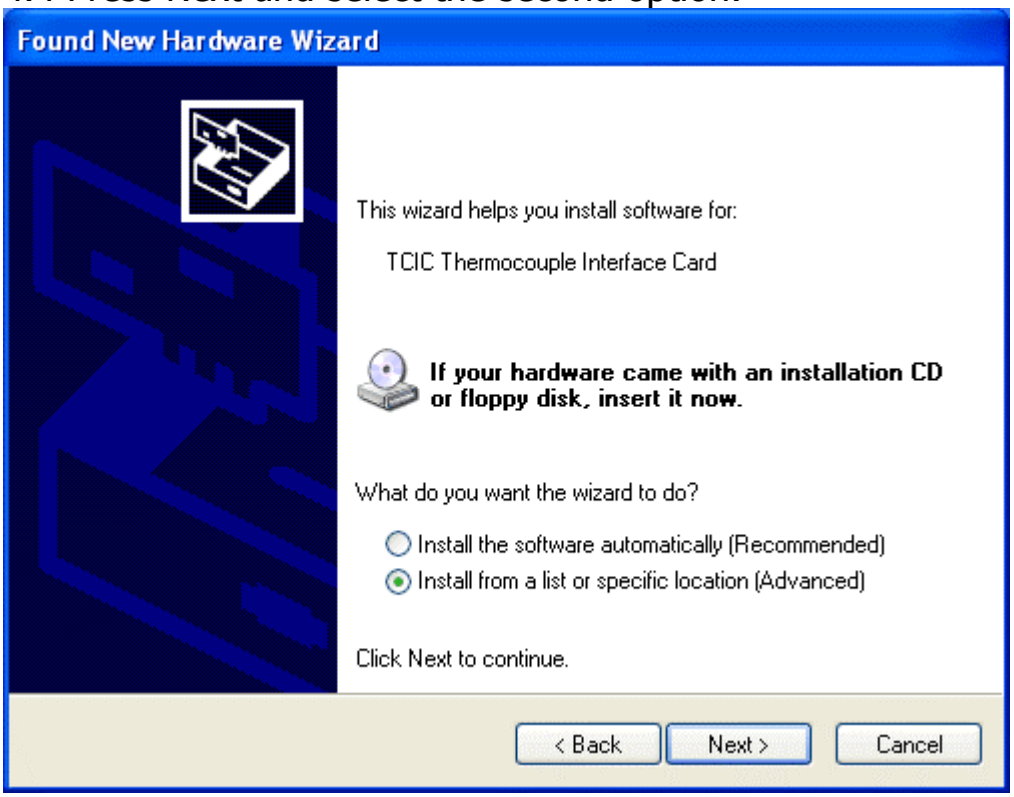


Click Finish.

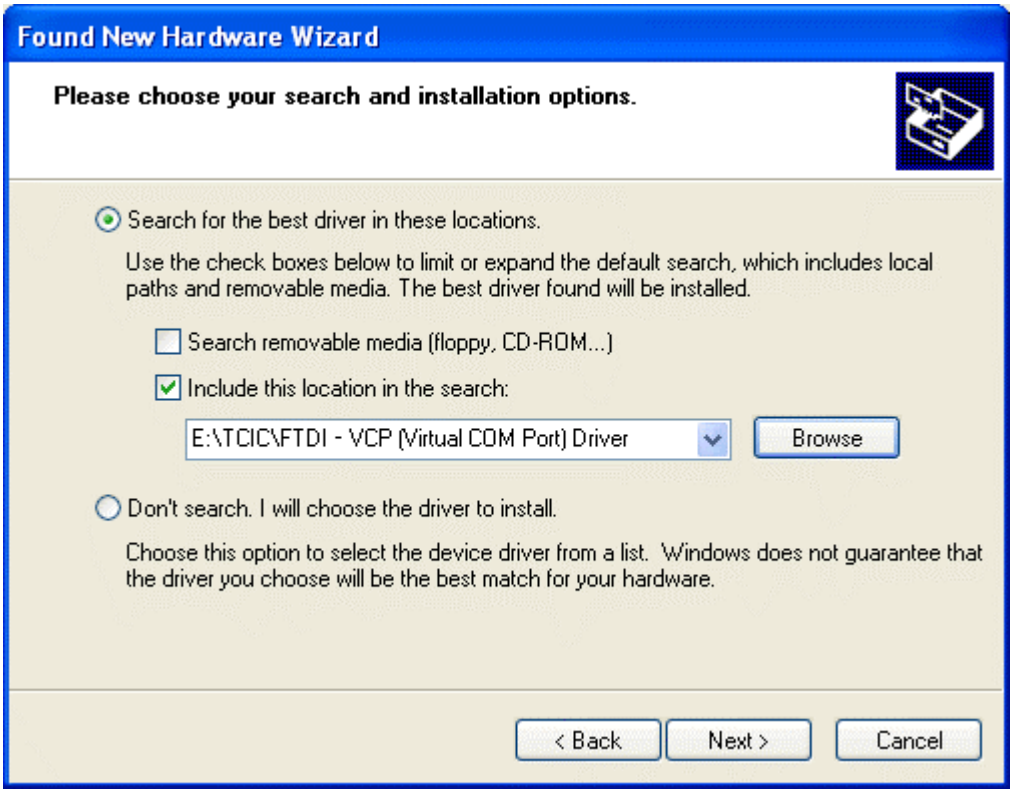
4.2 Connect the TCIC card to your PC.

4.3 The 'Found New Hardware Wizard' appears.
Select the last option like this:

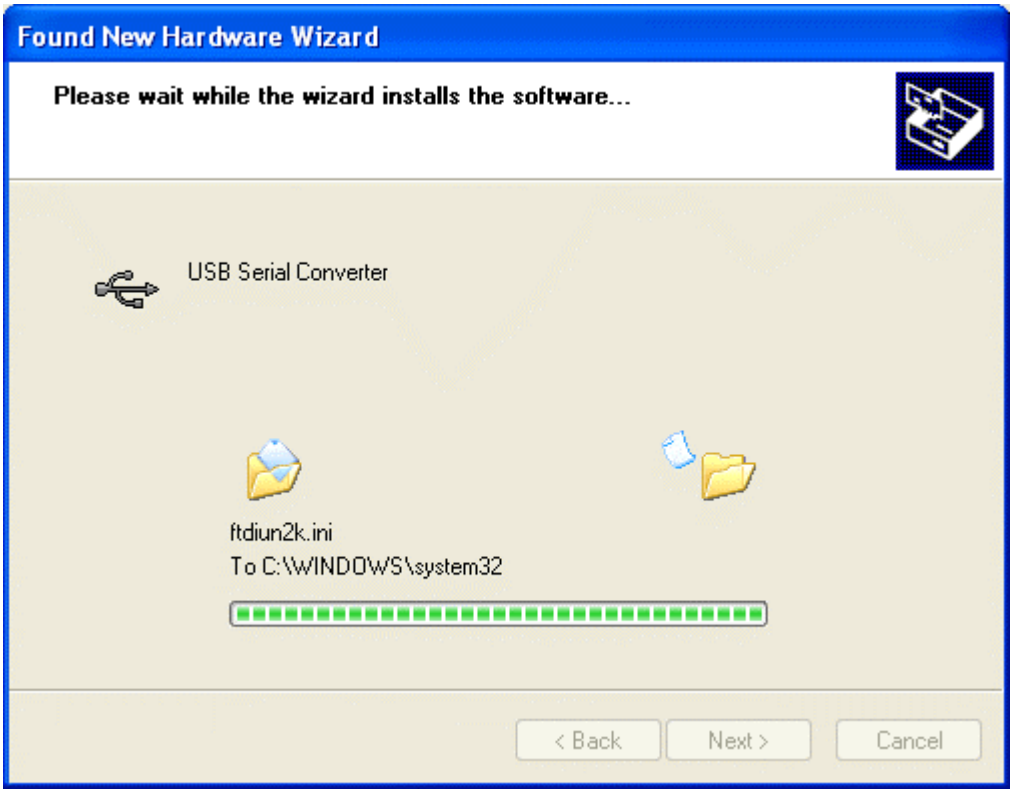
4.4 Press Next and select the second option:

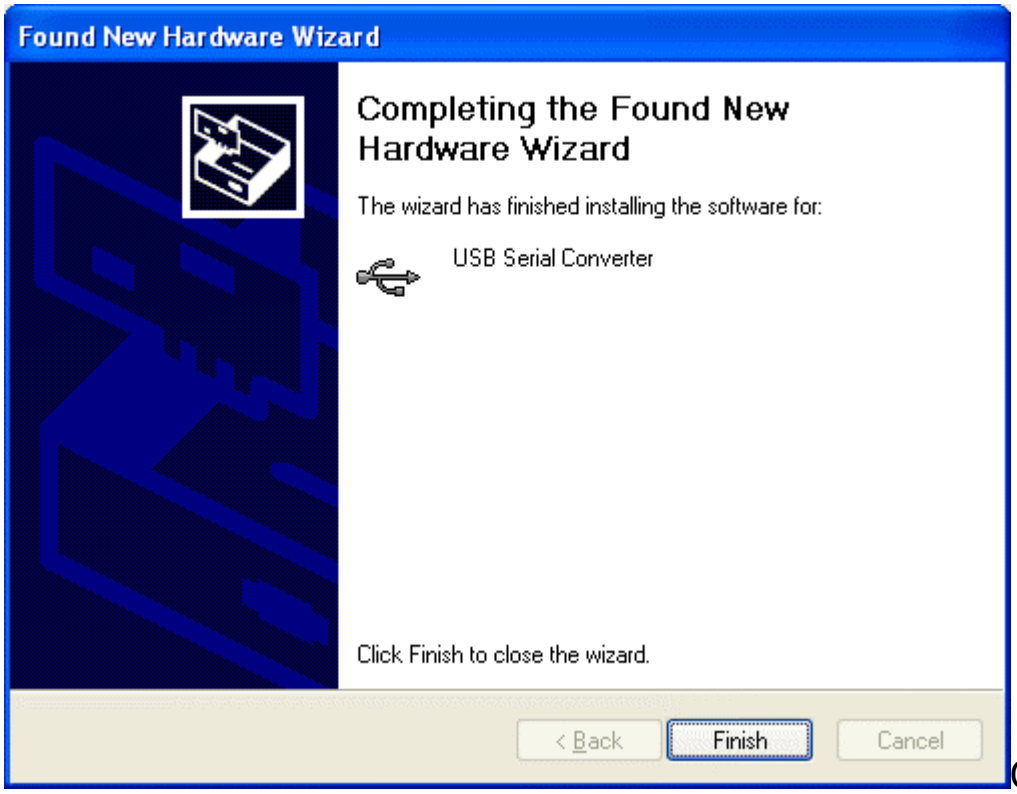


4.5 Press Next and browse to the VCP driver folder:



4.6 Click Next…





Click 'Finish' – that's it!

Notes

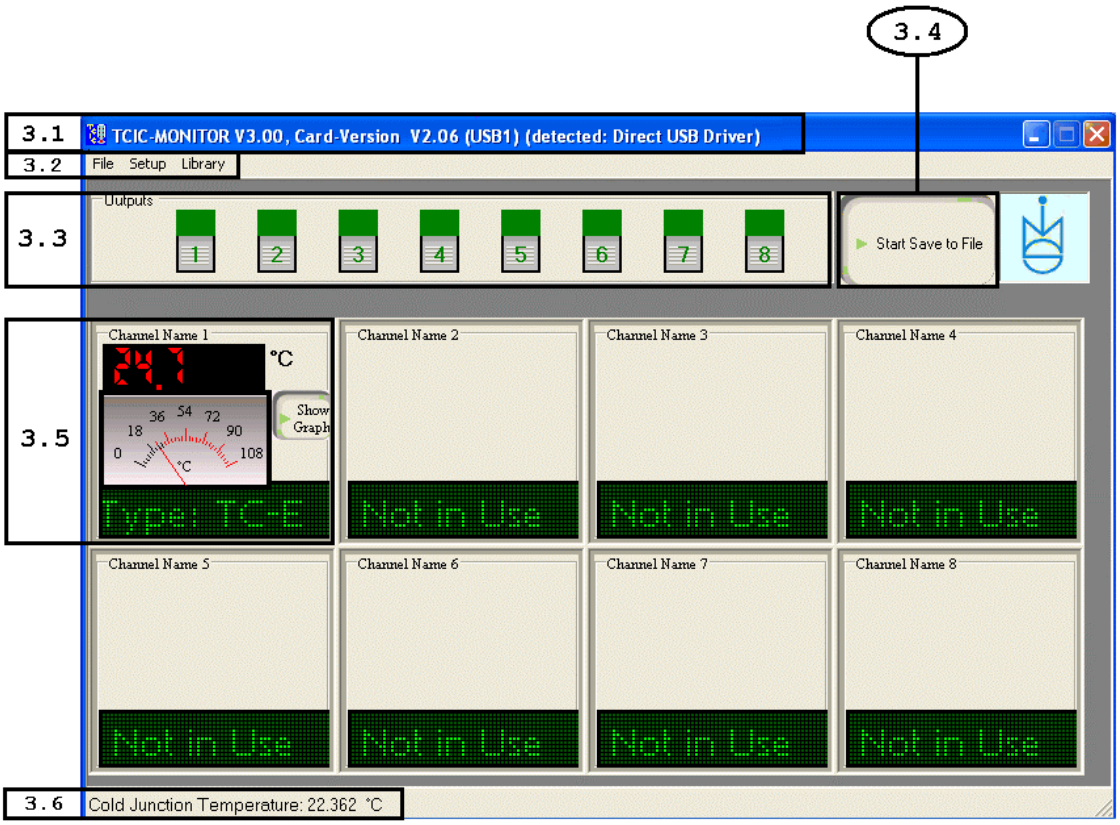
1. It might occur that the wizard will return to step 4.3, requiring to repeat the process. This is normal, just repeat steps 4.3-4.6.
2. The package includes also an **RS232 terminal** found on the Web, called Termite, through which the TCIC may be communicated when the VCP driver is installed.
Termite (http://www.compuphase.com/software_termite.htm) is freeware, yet it is easy to use and easy to configure.
TCIC communication parameters are:
Baud Rate: 115,200; Data: 8 bits; Parity: None; Stop Bits: 1.

3. TCIC-Monitor

The TCIC-Monitor utility is an initial setup tool and a smart data logger package for monitoring & collecting readings in high speed, including graphic mode display. The TCIC-Monitor works with both driver types (refer to section 1 - Main Features / Communication). It detects which driver type (direct or VCP) is installed and communicates with the card(s) using that driver (the type of the driver detected is reported in the title). More than one TCIC board may be connected to the PC while using the TCIC-Monitor; the user should select the required board. It is legitimate to run the TCIC-Monitor twice (or more) selecting each time another free board. Likewise, when no free board is detected, the TCIC-Monitor lets the user to work in 'Demo' mode.

Note: The TCIC-Monitor was developed under *'.NET' (dot NET)*, so it requires the 'dotnet framework' V1.1.4322 in order to run. The setup for this 'dotnet framework' is available free via Microsoft site; however, to facilitate the process, it is included in the attached CD-ROM (named dotnetfxV1.1.4322.exe).

The markings in the screenshot below show the section where each part of the display is described.



3.1 Title

This main title shows the versions of the TCIC-Monitor and of the card. For example, the title in the above screenshot indicates that the version of the TCIC-Monitor is 1.03, while card's version is 2.01.

3.2 Menus

The menus enable various operations, as described below.

3.2.1 File

3.2.1.1 Exit

Leaves the TCIC-Monitor program.

3.2.2 Setup

3.2.2.1 Card Settings

Adjusts the settings that reside in the card (on its non-volatile memory).

The settings at a glance:

- Common Setting
  - Temperature Unit: °C / °F
- Channel Settings
  - Channel Name: ... (view only)
  - Input Type: None / TC-E / TC-J / TC-K / TC-R / TC-S / TC-T / mV
  - Output Mode: SP-Auto / SP-Latch / Manual
  - Set Points Switch
    - On: ...
    - Off: ...

The settings in detail:

Common Setting

The following is a <u>common</u> setting for all the channels:

<u>Temperature Unit</u>: °C / °F

Selects the temperature unit for all channels whose 'Input Type' is defined as a thermocouple, i.e., TC-E, TC-J, TC-K, TC-R, TC-S, or TC-T. In other words, this setting has no effect on channels whose 'Input Type' is mV (or None).

Channel Settings

The following are <u>individual</u> settings for each channel:

<u>Channel Name</u>: ... (view only)

The user may assign a name to each channel.
This 'Channel Name' is actually a part of the 'TCIC-Monitor Settings' (section 3.2.2.2); it does <u>not</u> reside in the card. Though, for convenience's sake, the 'Channel Name' is shown in the 'Card Settings' display, but restricted to 'view only'.

<u>Input Type</u>: None / TC-E / TC-J / TC-K / TC-R / TC-S / TC-T / mV

Each channel may be referred to as one of three main types:

* Channel not in use ('None').
  In this case channel's description (section 3.5.4) will show 'Not in Use' regardless of the input coming in that channel.
* Channel represents a thermocouple whose type is one of the six supported ones (E, J, K, R, S, or T). The card converts the sampled voltage to degrees (°C or °F), taking into account the cold junction temperature. So, the readings passed by the card are in ***degrees*** (°C or °F); the TCIC-Monitor shows these readings (in the displays and in the graph) in degrees either. In case the card detects that no thermocouple is connected, it reports it to the PC, so the TCIC-Monitor displays 'OPEN' in that case.
* Channel represents an indefinite source of voltage, to be reported in ***millivolts*** (mV), <u>not</u> in degrees. In this case, there is *no* 'OPEN' indication when a channel is disconnected.

Output Mode: **SP-Auto / SP-Latch / Manual**

This is actually '**output** x' setting rather than '**channel** x' setting. This setting defines the nature of output x (x=1,2,...,8):

Roughly speaking, output x may be either a **'setpoint indicator'** of channel x, or a **manual output** with no relation to channel x (nor any other channel).

'Manual output' simply means that the output can be turned on or off directly by the host PC by simple software commands.

The **'setpoint indicator'** definition, however, is more complicated:

The main idea is that when output x is defined as a 'setpoint indicator' (SP-Auto or SP-Latch), it will go high (on) when input x crosses the 'Set Points Switch / On' limit. Now, there are still some points to clarify:

The user may define two characteristics of the setpoint indication:

* How will the indication stop (i.e., output goes 'off')? Automatically or manually?
  - Selecting **'SP-Auto'** means automatic stop of the indication. The 'turn off' operation will occur when input x crosses the 'Set Points Switch/Off' limit. That mechanism enables the user to define a *hysteresis* eliminating undesirable fluctuations in the status of the output.
  - Selecting **'SP-Latch'** means that once there is 'setpoint indication' (output is on), the output will **stay on** until manually turned off by the TCIC-Monitor.
* The **direction** of temperature change that will trigger the indication: Will the indication be supplied upon crossing the 'On' limit **upwards** or **downwards**? This characteristic is controlled by the 'Set Points Switch/Off' limit, as described below.

Set Points Switch

On: **…**

Defines the limit that upon its crossing output x will go high (on) signaling a 'setpoint indication'.

Off: **…**

1. Defines the **direction** of temperature change that will trigger the indication:
   Off < On means indication upon crossing the On limit **upwards**.
   Off > On means indication upon crossing the On limit **downwards**.
2. When Output Mode = 'SP-Auto', the Off limit plays one more role:
   It defines the hysteresis, i.e., the limit where the output will go low (off) again.

To make the above description more comprehensible, some examples follow:

Example 1:
Output Mode = 'SP-Auto', 'On' = 100°, 'Off' = 90°.
The output will go high (on) when the temperature **rises** from 99° to 100°, and back low (off) upon falling from 91° to 90°.

Example 2:
Output Mode = 'SP-Auto', 'On' = 100°, 'Off' = 110°.
The output will go high (on) when the temperature **falls** from 101° to 100°, and back low (off) upon rising from 109° to 110°.

Example 3:
Output Mode = 'SP-Latch', 'On' = 100°, 'Off' = 90°.
The output will go high (on) when the temperature **rises** from 99° to 100°, and stay high (regardless of any temperature change) until manually turned off. Note that – as Output Mode = 'SP-Latch' – the only meaning of 'Off' = 90° is to set the direction, as 90° < 100°. Specifying 'Off' = 80° will give the same effect!

Example 4:
Output Mode = 'SP-Latch', 'On' = 100°, 'Off' = 110°.
The output will go high (on) when the temperature **falls** from 101° to 100°, and stay high (regardless of any temperature change) until manually turned off. Note that – as Output Mode = 'SP-Latch' – the only meaning of 'Off' = 110° is to set the direction, as 110° > 100°. Specifying 'Off' = 120° will give the same effect!

3.2.2.2 TCIC-Monitor Settings

Adjusts the settings that reside in the PC (i.e., in a file).

The settings at a glance:

- Common Settings
  - Temperature Unit: °C / °F (view only)
  - Filter: Off/2/4/8/16/32/64/128/256
  - Sampling Rate: Max. / 0.5 Sec. / ... seconds
- Channel Settings
  - Channel Name: ...
  - Input Limits
    - Min.: ...
    - Max.: ...

The settings in detail:

Common Settings

The following are common settings for all the channels:

Temperature Unit: °C / °F (view only)

The user may define system's Temperature Unit.
This 'Temperature Unit' is actually a part of the 'Card Settings' (section 3.2.2.1); it does not reside in the PC. Though, for convenience's sake, the 'Temperature Unit' is shown in the 'TCIC-Monitor Settings' display, but restricted to 'view only'.

Filter: Off/2/4/8/16/32/64/128/256

The Filter defines the filtering degree of the readings. A *higher* filter leads to more stable readings display, but slower response to changes; a *lower* filter will give the opposite: faster response to changes, but less stable readings display.

Sampling Rate: **Max. / 0.5 Sec. / ... seconds**

The Sampling Rate defines the frequency in which readings are refreshed on the display.

There are three options:

- Max. – Maximal rate that the card can support.
- 0.5 Sec. – One refresh each 0.5 sec.
- ... seconds – One refresh each x seconds, where x is user-defined. x should be at least 0.5 and at most 1000.

Channel Settings

The following are individual settings for each channel:

Channel Name: **...**

The user may assign a name to each channel.
This name is displayed as 'Channel Title' (refer to section 3.5.1), giving the user more control on his system.

Input Limits

The Input Limits (Min. & Max.) define the expected temperature (or mV) range. The low & high limits on the analog display and on graph's vertical axis (temp.) will be based on Min. & Max. (usually, the range of the analog display will be somewhat wider).

Min.: **...**

Minimal expected temperature.

Max.: **...**

Maximal expected temperature.

3.2.2.3 Calibration and Defaults

Change Calibration

The TCIC is factory programmed with the value of the on board reference voltage (1.25V). However, this default 1.25V value may be re-defined in the range 1.2375V to 1.2625V, that is 1.25V ±1%. In order to find out the voltage, use a high resolution DVM (at least 5.5 digits), and measure between 'GND' and 'COM' in the screw terminal (CONN1 or CONN2). Click 'Change Calibration' and enter your measured new value.

Reset to Factory Default Values

You may return the card to its initial factory settings:

- All channels set to **voltage** reading (Input Type = mV).
- Temperature Unit: ºC.
- All Output Modes: Manual.
- All Setpoints (both 'switch on' and 'switch off'): 0.
- Reference Voltage: 1.25V.
- Card Filter Level: Standard.

3.2.2.4 Card Address

This display is meaningful only in case of a multi-card system (see section 5). The current card address is displayed. Likewise, the card can be re-configured to another address. For more details refer to the "Configuring a Card Address" paragraph in section 5.

3.2.2.5 View All Settings (Read Only)

The 'View All Settings' display shows – in 'view only' mode – the following values:

- Card Settings (section 3.2.2.1)
- TCIC-Monitor Settings (section 3.2.2.2)
- Calibration reference voltage (section 3.2.2.3)

3.2.3 Library

There is a 'settings library' on the PC disk in which all settings may be stored - both Card Settings (section 3.2.2.1) and TCIC-Monitor Settings (section 3.2.2.2). The library files reside in the subfolder TCIC_Lib under the installation folder, for example:
C:\Program Files\IMS\TCIC-MONITOR\TCIC_Lib

3.2.3.1 Load

Loads a setting set from the library.
Once you want the loaded set to take effect, click the 'Save Settings & Exit' button. As long as you don't click that button, the *previous* set remains in effect.

3.2.3.2 Save

Saves the current setting set into the library.

3.2.3.3 Delete

Deletes a setting set from the library.

3.3 "Outputs" Box

This box both describes the status of the 8 outputs, and enables to manually change their status. Just click to invert output status. Note that an output is sometimes accessible for manual change and sometimes not, depending on the selection of Output Mode and the actual value of the output:

* Output Mode = 'Manual': Output is accessible for manual change.
* Output Mode = 'SP-Auto': Output is not accessible for manual change.
* Output Mode = 'SP-Latch': Output is accessible only in order to turn it **off**. In other words: The output can be turned **on** only by the card, and turned **off** only manually.

3.4 "Save to File" Command ('Start' or 'Stop')

The "Save to File" function enables recording card's readings in a text file.
Upon clicking "Start Save to File" the program suggests an automatic file name, based on the current time & date. Either accept this suggested name, or change it; then click 'Save'. The recording operation goes on until you press the same button again ("**Stop** Save to File"), or exit the TCIC-Monitor.
The readings files reside in the subfolder TCIC_Readings under the installation folder, for example:
C:\Program Files\IMS\TCIC-MONITOR\TCIC_Readings

3.5 Channel Boxes

3.5.1 Channel Title
Displays the Channel Name (refer to section 3.2.2.2).

3.5.2 Digital Display
Displays current channel's reading.
Reading's unit is ºC, ºF or mV, according to user's setting of Temperature Unit and the specific channel's Input Type (see section 3.2.2.1).

3.5.3 Analog Display
Displays the same reading as in the Digital Display, in an analog form. The limits of the meter are based on the Input Limits (refer to section 3.2.2.2).

3.5.4 Channel Description
Displays card's Channel Settings (section 3.2.2.1).

3.5.5 "Show Graph" Command
Displays current channel in a graph. Graph's display may be resized dragging its edge or corner, as customary in Windows, or magnified using the Maximize button.

3.6 Cold Junction Temperature

Displays the temperature of the cold junction, which is essential for the CJC (Cold Junction Compensation). The value of the cold junction temperature is meaningful only when the Input Type is some thermocouple; i.e., it's irrelevant in case the Input Type is mV (or, of course, None).

4. Command Set

The communication with the TCIC is via USB (standard), or RS232 or RS485 (optional).

Notes

1. After the TCIC has been powered-on, user application software should send a single null (0x00) character to the TCIC, prior to commencing regular communications.
2. There is one more command (card selection in a multi-card system), described in the next section (section 5).

4.1 Requesting Data

'>' The TCIC returns a string containing the 8 actual channel values, each followed by a tab (0x09). The end of the string is followed by CR/LF. Each value is padded to have a fixed length of 8 characters, so the string has a fixed length of 72 characters (excluding the CR/LF).
That is, the contents of the string is:
Channel 1 reading + tab character
Channel 2 reading + tab character
Channel 3 reading + tab character
Channel 4 reading + tab character
Channel 5 reading + tab character
Channel 6 reading + tab character
Channel 7 reading + tab character
Channel 8 reading + tab character
CR/LF

► The channel values may represent ºC, ºF or millivolts, depending on the Card Settings selection.

► In case a channel has been defined in the Card Settings as a 'thermocouple' source (Input Type is *not* mV) *and* the card recognises that the channel is disconnected, that channel value will be '9999.000', indicating an 'open' condition.

'T' Returns the board (Cold Junction) in ºC or ºF, whatever was selected in Card settings, plus CR/LF. The value is padded to have a fixed length of 8 characters, so the string has a fixed length of 8 characters (excluding the CR/LF).

'O' (upper case letter O) The TCIC returns a string of the form 11110000 plus CR/LF, indicating the actual status of the output switches 1-8. '0' = off, '1' = on.

'<' The TCIC returns a string that includes the following items:
1. The response on the '>' command (excluding the CR/LF).
2. The response on the 'T' command (excluding the CR/LF).
3. The response on the 'O' command (excluding the CR/LF).
4. Card Filter level.
5. CR/LF.

That is, the contents of the string is:
Channel 1 reading + tab character
Channel 2 reading + tab character
Channel 3 reading + tab character
Channel 4 reading + tab character
Channel 5 reading + tab character
Channel 6 reading + tab character
Channel 7 reading + tab character
Channel 8 reading + tab character
Cold Junction reading + tab character
Output status – eight characters either '0' (off) or '1' (on)
Card Filter level – one character either '0' (standard) or '1' (high)
CR/LF

As each reading (both channel and cold junction) is padded to have a fixed length of 8 characters, the whole string has a fixed length of 90 characters (excluding the CR/LF).

'V' TCIC returns version number information, plus CR/LF.

4.2 Change Output Status

The one-character 'a' command turns output #1 **off**.
The one-character 'A' command turns output #1 **on**.
Similarly, the one-character 'b' through 'h' and 'B' through 'H' commands turn the other channels (2-8) off or on, respectively.

4.3 Setpoint Configuration

The 'switch on' & 'switch off' limits define the points where the output will go **on** and, possibly, back **off**. The relation between the 'switch on' limit and the 'switch off' limit defines the ***direction*** of the mechanism:

'Switch on' limit > 'Switch off' limit: trigger on **upwards** change
When current reading is **larger** than 'switch on' limit, output goes **on**.

- If the channel is defined as '**Latch**', the output *remains on* until turned off manually.
- If the channel is defined as '**Auto**', the output goes back off when reading is **smaller** then 'switch off' limit.

'Switch on' limit < 'Switch off' limit: trigger on **downwards** change
When current reading is **smaller** than 'switch on' limit, output goes **on**.

- If the channel is defined as '**Latch**', the output *remains on* until turned off manually.
- If the channel is defined as '**Auto**', the output goes back off when reading is **larger** then 'switch off' limit.

"Switch On" Limit

'$A' or '$B' through '$H'

Sets 'switch on' limit for the specified channel (1-8).
PC must send channel's letter and a string representing a floating point value in the range -2000.0 to +2000.0 followed by CR.

E.g., to set 'switch on' limit for channel 3 to 145.2 the PC would send "$C145.2" with CR. Note, the 'C' is the channel selection.

If the string is accepted as valid the TCIC returns "OK" with CR/LF and stores the value in its non-volatile memory.

Else the TCIC returns "ERR" with CR/LF and does not store the value.

'S' The TCIC returns a string containing actual 8 'switch on' limits, each followed by a tab (0x09). The end of the string is followed by CR/LF. Each value is padded to have a fixed length of 8 characters, so the string has a fixed length of 72 characters (excluding the CR/LF).

"Switch Off" Limit

'$a' or '$b' through '$h'

Sets the 'switch off' limit for the specified channel (1-8). PC must send channel's letter and a string representing a floating point value in the range -2000.0 to +2000.0 followed by CR.

E.g., to set 'switch off' limit for channel 3 to 145.2 the PC would send "$c145.2" with CR. Note, the 'c' is the channel selection.

If the string is accepted as valid the TCIC returns "OK" with CR/LF and stores the value in its non-volatile memory.

Else the TCIC returns "ERR" with CR/LF and does not store the value.

's' The TCIC returns a string containing actual 8 'switch off' limits, each followed by a tab (0x09). The end of the string is followed by CR/LF. Each value is padded to have a fixed length of 8 characters, so the string has a fixed length of 72 characters (excluding the CR/LF).

► For more details and examples refer to section 3.2.2.1 (Card Settings), parameters **Output Mode** and **Set Points Switch**.

4.4 Sample Program

The sample program is an improved version of Microsoft's example "Using the Comm Port". This is a basic VB-Net program that clearly shows how to communicate with the card. The sample program works with both driver types (refer to section 1 - Main Features / Communication). It detects which driver type (direct or VCP) is installed and communicates with the card using that driver (the type of the driver detected is reported in the title). More than one TCIC board may be connected to the PC while using the sample program; however, the sample program communicates only with **one** board – the **last** one detected. Upon running the program, press the 'Check for Ports' button and then the 'Check for TCIC' button. The box below this button should show something like 'Using TCIC on COM7' or 'Using TCIC on USB1'.
Now, to send a command to the TCIC:

1. Type the required command in the 'User Command' Box.
2. Select the proper C/R mode:
   * One or two character commands do not require C/R, so 'C/R' should be unchecked.
   * Three or more character commands do require C/R, so 'C/R' should be checked.
3. Click the 'Send User Command' button, or press <Enter>. Card's response is shown in the frame on the right side.

Note

The sample program supports also a card that is configured to a non-default (i.e., non-'a') address (refer to section 5). Its policy is the same as with the TCIC-Monitor, that is:

* Upon initialization, card 'a' is selected (':a'), so, no matter what is the current card's address, it will be selected for communication. Note that this implies that while using the sample program only one board may be connected to the same port even though RS485 is used.
* Upon termination, if card's address is other than 'a', it will be deselected. This ensures that a card will not remain in 'selected' mode and then connected to RS485, causing a situation of more than one card selected in the same time. In other words, user's application should be the only source that selects a card.

4.5 Troubleshooting

Q. I can communicate with the TCIC when it is located in COM1 through COM9, but when it is in COM10 or more, my application does not work. The TCIC-Monitor, however, works fine.

A. Opening COM port 10 or above is done differently:
Prefix "\\.\" to its name.

For example:
In C:
CreateFile("\\\\.\\COM10",...)

In VB.Net:

```
' Creates a COM Port stream handle
Dim COM_Name As String = "COM" & miPort.ToString
If miPort > 9 Then
   COM_Name = "\\.\COM" & miPort.ToString
End If
mhRS = CreateFile(COM_Name, _
GENERIC_READ Or GENERIC_WRITE, 0, 0, _
OPEN_EXISTING, iMode, 0)
```

5. Multi-Card System

This section is relevant only for the TCIC with the RS485 communication option.

Introduction

The TCIC's RS485 communication option supports multi-card systems. In order to utilize this feature, two TCIC operations are required:

- Card configuration
- Card selection

Card **configuration** – carried out by the TCIC-Monitor utility (see section 3.2.2.4) – sets a card's address to one of 26 options. This address is saved in the card's non-volatile memory ensuring that once a card has been configured, the address is retained even if the card is powered off.

Card **selection** – carried out by user's application – activates the communication with a card that has a specific address, and de-activates ('de-selects') the communication with all other cards in the system. Once a card is selected, regular communication can take place, i.e. the card will respond to instructions from the main command set. A selection lasts until an alternative address selection is applied, or power is off. The Status LED (LED2) reflects whether a card is selected or not: LED2 off means 'card not selected', LED2 on means 'card selected'.

Addresses

There are 26 potential card addresses, denoted by the letters a,…,z (lower case). Address 'a', the factory default, is unique in the sense that its selection activates the card connected regardless of its address configuration. Obviously, address 'a' should be used only when a **single** card is connected. Otherwise all connected cards will respond causing an RS485 bus conflict.

One Card System

When a system includes only one card, neither configuration nor selection is required, as the card is factory defaulted to address 'a'. Indeed, if a card has been configured to some non-'a' address and later it is required as a single card, you may re-configure it to address 'a', eliminating the need for the selection function in your application. This is the only case that a card is configured to address 'a'.

Configuring a Card Address

Configuring a card address is carried out by the TCIC-Monitor utility:

- Connect the card to be configured to the USB port.
- In the TCIC-Monitor utility click Setup/Card Address and choose the required address. Be sure to choose a free and non-'a' address; that is, an address that no other card is configured to, but **not** 'a'.
- Exit the TCIC-Monitor utility.

The card is now ready to be wired into an RS485 network. When it is powered on, it will **not** be selected until a selection command with the correct address is sent by the application.

It is the *user's responsibility* to make sure that each card is configured to a unique, non-'a', address.

Communication Protocol

There are 26 allowable addresses, referenced by the lower case letters a-z.

The address 'a' is a special address: every board will respond to this address. In single board RS485, RS232 and USB applications, the board will always be given the address 'a', which is also the factory set default.

Selecting the board

To SELECT a TCIC board, the ':' command is used, followed by the address character. (A CR character is **not** required).

E.g., sending ":e" will SELECT the board that has the address 'e'. Note, the TCIC does not send any answer on a ':' command.

Once selected, a TCIC board will respond to the main command set and the STATUS LED (LED2) will be illuminated.

De-Selecting the board

To DE-SELECT a TCIC board, simply transmit the ':' command with an alternative address.

For example, suppose there are 3 TCIC boards on the RS485 bus, with addresses b, c & d:

To access board 'b' transmit ":b"
(this will SELECT board 'b' and DE-SELECT boards 'c' & 'd')

To access board 'c' transmit ":c"
(this will SELECT board 'c' and DE-SELECT boards 'b' & 'd')

To access board 'd' transmit ":d"
(this will SELECT board 'd' and DE-SELECT boards 'b' & 'c')

6. USB, RS232 & RS485

In addition to USB, The TCIC has an option for both full-duplex RS232 and half-duplex RS485 interfaces. These are brought out on CONN6, a 9 way 'D' type connector. The pin-out is as follows:

CONN6 PIN	FUNCTION
1	RS485-
2	RS232 TX (out of TCIC)
3	RS232 RX (into TCIC)
4	NC
5	SIGNAL GROUND
6	RS485+
7	NC
8	NC
9	NC

I.e., for RS232 use pins 2,3 & 5 and for RS485 use pins 1,5 & 6
For RS232 connection, a standard direct (straight through) wired 9D M-F cable can be used for direct connection to a standard 9 way 'D' type PC COM port.

RS485 line termination – placing a jumper across the two leftmost pins of LK2 puts a 120 Ohm (ac coupled) impedance across the RS485 data lines. This should be used in single TCIC RS485 applications. In applications where multiple TCIC boards reside on one RS485 bus, the termination impedance should only be added on the last board on the bus.

COMMUNICATION PARAMETERS

For both the full-duplex RS232 and half-duplex RS485 interfaces the communications parameters are fixed as follows:

Baud Rate 115,200 baud
Data 8 bits
Parity None
Stop Bits 1
► This is generally referred to as "8,N,1".

POWER SUPPLY

Using an external power supply is optional on USB* applications but essential for RS232 and RS485 applications.

- When used, the external power supply should be connected to the 5V connector (CONN3).
- Near this 5V connector there is the 'LK1' jumper, and rightwards there is the LK5 jumper:
  * **Option 1**: 5V from the USB port
    Put the 'LK1' & 'LK5' jumpers in the 'USB' side.
  * **Option 2**: External 5V supply
    Put the 'LK1' jumper in the 'DC JACK' side.
    Put the 'LK5' jumper in the 'NOT USB' side.

The external supply should be 5V DC (±5%) only.

* **Using USB hubs**

The TCIC may be connected to a USB hub provided that:

Either

1. The USB hub is externally powered such that the USB ports of the hub meet the standard USB power specification. In this case use option 1.

Or

2. A bus powered USB hub (with no external supply to the hub) is used but the TCIC takes its power from the TCIC DC jack. In this case use option 2.

7. Specifications

7.1 Power Supply

5.0 VDC ±5% from either external supply via DC jack or from USB Bus,
jumper selectable.

7.2 Communication Ports

7.2.1 USB Either USB bus powered or locally powered.
Compatible with USB 2.0 and USB 1.1.
Up to 921,600 baud using either direct or VCP (Virtual COM Port) driver.

7.2.2 RS232/RS485 (option)
Available on a 9 way D connector.
RS232 allows connection to PC with "straight through" 9D-9D lead cable
RS485: Half duplex (2 wire)
Jumper option to terminate line with 120 Ohms
Up to 25 TCIC boards may be connected to one RS485 bus
Factory set baud rate of 115,200 baud

7.3 Analog Inputs

8 fully differential inputs for connection to floating thermocouples or floating millivolt sources. Full scale differential input is ±500millivolts. Open thermocouple detection on each channel.

Connection is via 2 off, 10 way screw terminal connectors. 3.81 mm pitch

Bias current:	120 nA
Maximum allowable input voltage:	±10 Volts relative to the GND terminal
Common mode input range:	+0.25V to +4.0V relative to the TCIC GND terminal.
ADC Internal Resolution:	24 bits.
ADC Noise free resolution:	Noise of 1 microvolt rms, giving ENOB = 20 bits on ±500 mV or ENOB = 15.9 bits for a type K thermocouple
ADC Sampling rate:	400 Hz (50 Hz for each channel)
Millivolt accuracy:	Uncalibrated ±0.05% Gain drift 5ppm/˚C typical, 10ppm/˚C maximum

7.4 Thermocouple Types

The following thermocouple types and temperature ranges are supported by onboard ITS-90 polynomial conversion functions:

Thermocouple Type	Range ˚C	Accuracy ˚C *	Resolution ˚C based on 1uVrms noise
J	-210 to 1200	± 1.5	0.019
K	-200 to 1372	± 1.5	0.024
E	-200 to 1000	± 1.5	0.015
R	-50 to 1768	± 2.0	0.125
S	-50 to 1768	± 2.0	0.143
T	-200 to 400	± 1.5	0.022

*Total accuracy, allowing for the effects of millivolt measurement accuracy, cold junction compensation and conversion to temperature using the onboard conversion functions.

7.5 Switch Outputs

Connection is via a 10 way screw terminal connector. 3.81 mm pitch
8 optically isolated MOSFET switches, each with an indicator LED.
External I/O supply required in range 10-30V
Output rating max 0.25A per output.

WARNING

The TCIC inputs are not electrically isolated from the TCIC USB, RS232, RS485 or Ethernet ports and hence any attached PC, PLC etc.
Sensor inputs must never be attached to hazardous voltages. The channel input voltages, relative to TCIC GND, must never exceed ±10 Volts.

8. LabVIEW Sample

The LabVIEW sample was created with LabVIEW 6.1 using the VCP (Virtual COM Port) driver.

Figure #1 shows the screen that the LabVIEW sample produces, that is, virtual thermometers of all the eight channels, and a graph of one of these channels (user selectable).

Here is an explanation of the LabVIEW sample & how it might be used:

The included sample LabVIEW 'vi' file enables users of LabVIEW to quickly start acquiring data from the TCIC.

If a LabVIEW application is to be used simply to acquire data from the TCIC, then it is recommended that the TCIC-Monitor is used to configure the TCIC prior to communication with LabVIEW. For the LabVIEW sample, the TCIC-Monitor should be used to setup the TCIC for 8 *thermocouple* (i.e., not mV) inputs.

The LabVIEW sample is setup for serial communication with the TCIC. This can be either via USB (using Virtual COM Port drivers supplied with the TCIC) or through direct RS232 or RS485 COM ports.

If USB communication is being used, then the TCIC USB drivers must be installed prior to using LabVIEW; also the TCIC must be attached and powered before LabVIEW is started, otherwise LabVIEW will not see the USB virtual COM port.

The sample 'vi' requires that the correct COM port is selected prior to running the application: use NI's Measurement and Automation Explorer (often abbreviated to "MAX") to search for attached devices. This utility is available when the LabVIEW system is present. Figure #2 is a screenshot of MAX, where the TCIC appears as COM7, as it does on the LabVIEW sample screen also (refer to the top of figure #1).

The LabVIEW sample is provided 'as is' and is only intended as a starting point to developing TCIC LabVIEW applications. The other parts of the User's Manual (particularly section 4) provide a more comprehensive guide to the features and command set of the TCIC that may be accessed by a user's application.

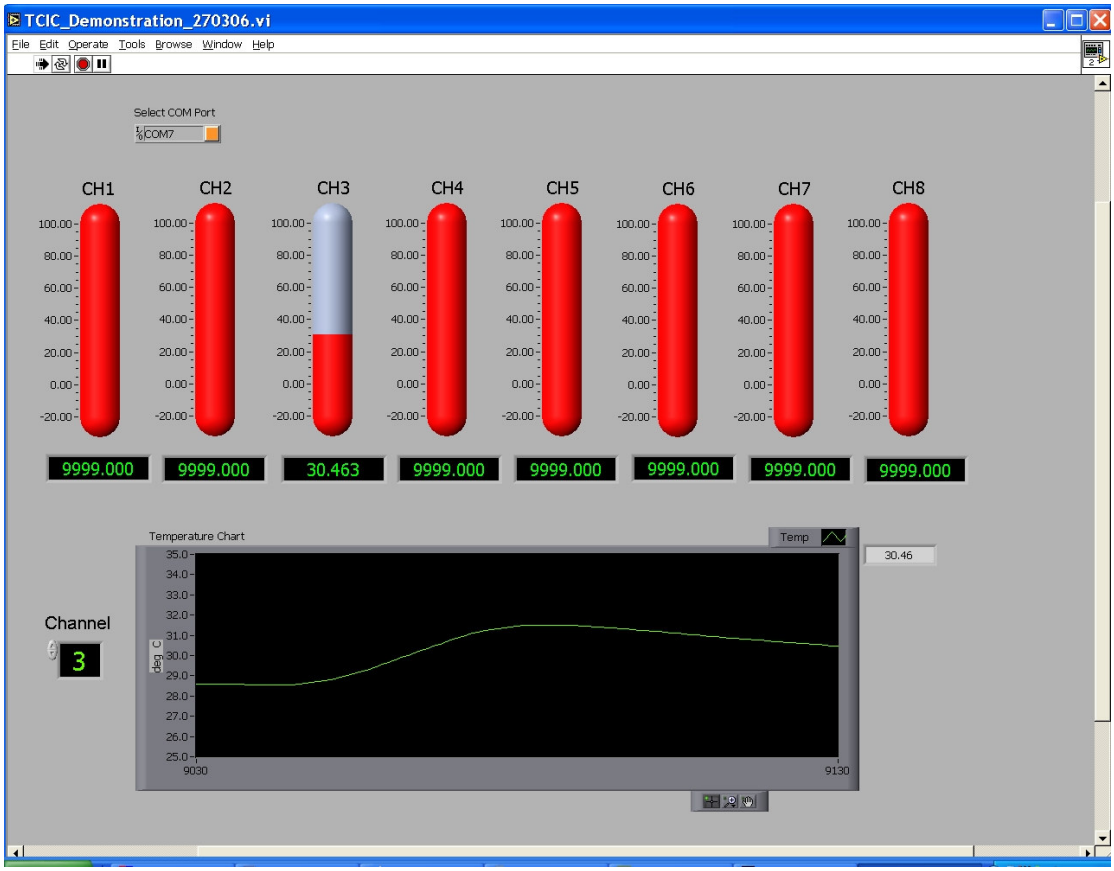


Figure #1 – output screen of the LabVIEW sample

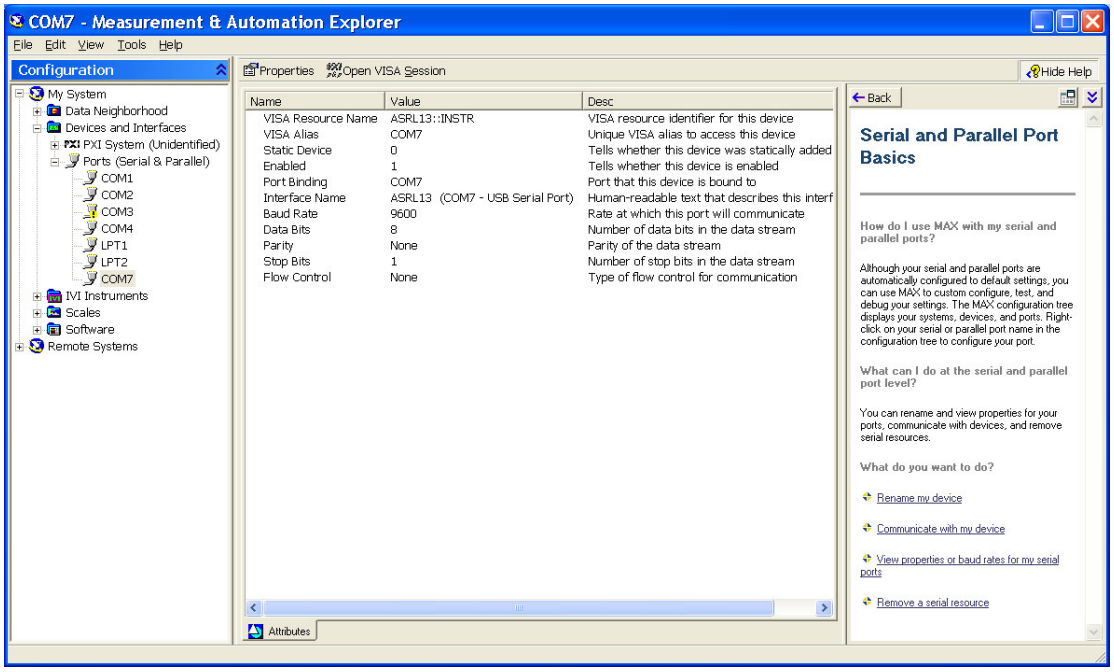


Figure #2 – LabVIEW's MAX (Measurement and Automation Explorer)

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