TMx00 Control Software & EVB Kit Guide

RFA-04-040 Rev 1.1

05/2023

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TABLE OF CONTENTS

FIGURES

TABLES

REVISION HISTORY

Revision	Date	Description
1.0	01/2023	Initial Release
1.1	05/2023	Updated for Control Software version 1.1 &1.2

INTRODUCTION

DESCRIPTION

This document defines the operation of the TMx00 Control Software in conjunction with the EB_TMx00 Evaluation Board.

INCLUDED HARDWARE & SOFTWARE

- EB_TMx00 Evaluation Board
- EB_TMx00 Evaluation Board & Schematic PDF
- Power Harness
- FTDI C232HM MPSSE (C232HM-DDHSL-0) Serial USB to I^2C Interface Cable and software drivers
- TMx00 Control Software (TMx00Control-Install Application)

FTDI Cable Installation

The FTDI C232HM MPSSE cable (C232HM-DDHSL-0) converts serial commands from the computer into the I^2C interface format for communications with the characterization board. It needs a software driver installed for proper operation.

The cable documentation and needed software is contained in the <FTDI\CDM v2.12.28 WHQL Certified> subdirectory of the provided package. DS_232HM_MPSSE_CABLE.pdf is the data sheet for the cable assembly.

Plug the FTDI Cable into the Computer

First, plug the cable into a USB port on the computer. USB 2 ports are preferred over USB 3 because the FTDI interface cable will sometimes not respond properly to a USB 3 port.

Versions of Windows 10 & 11 may automatically detect and install the needed FTDI drivers. If the drivers are automatically installed, skip the section "Install the Software Drivers"

Install the Software Drivers

This section is extracted from FTDI application notes AN-396 and AN-119. They are available in the FTDI subdirectory of the software package. Refer to the application notes as needed.

Navigate to the Device Manager of the computer. It will be an item located on the control panel under Windows 10/11 or Windows 7.

For Windows 10/11, click on the Settings icon under Start in the lower left-hand corner. Then type “Device Manager” in the Find a setting box. For Windows 7, the process is similar.

In the Device Manager window there should be a device under Other Devices with a yellow warning symbol to indicate a problem i.e. no driver installed, as shown in Figure 3. The text next to this device will show “USB Serial Cable”.

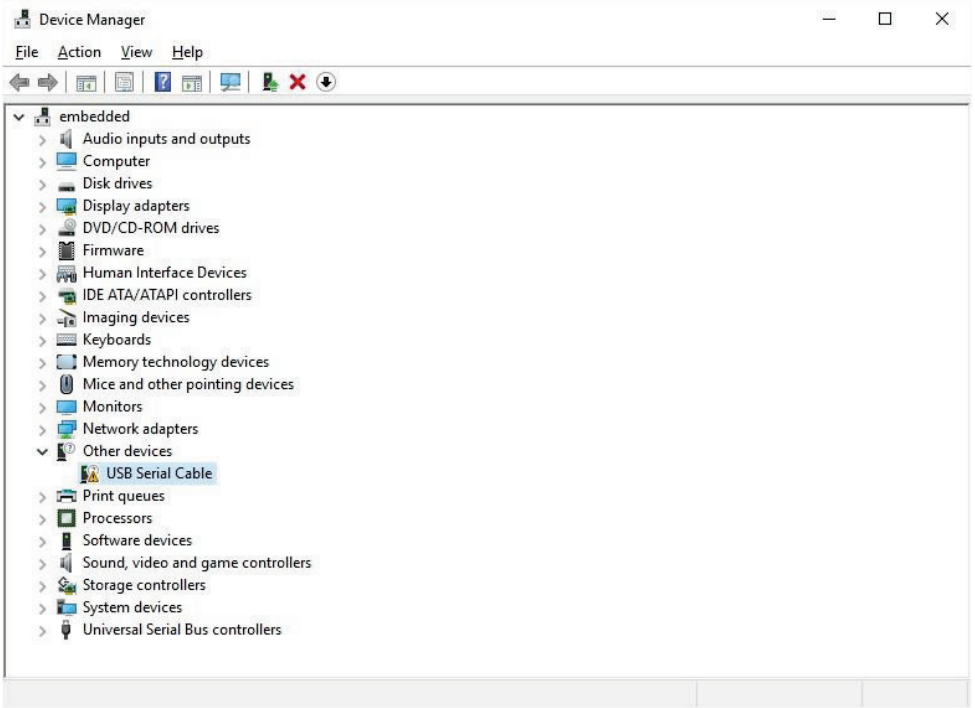


Figure 1 - Device Manager

Right click the device to bring up a menu as shown. From the displayed menu select “Update Driver Software…”

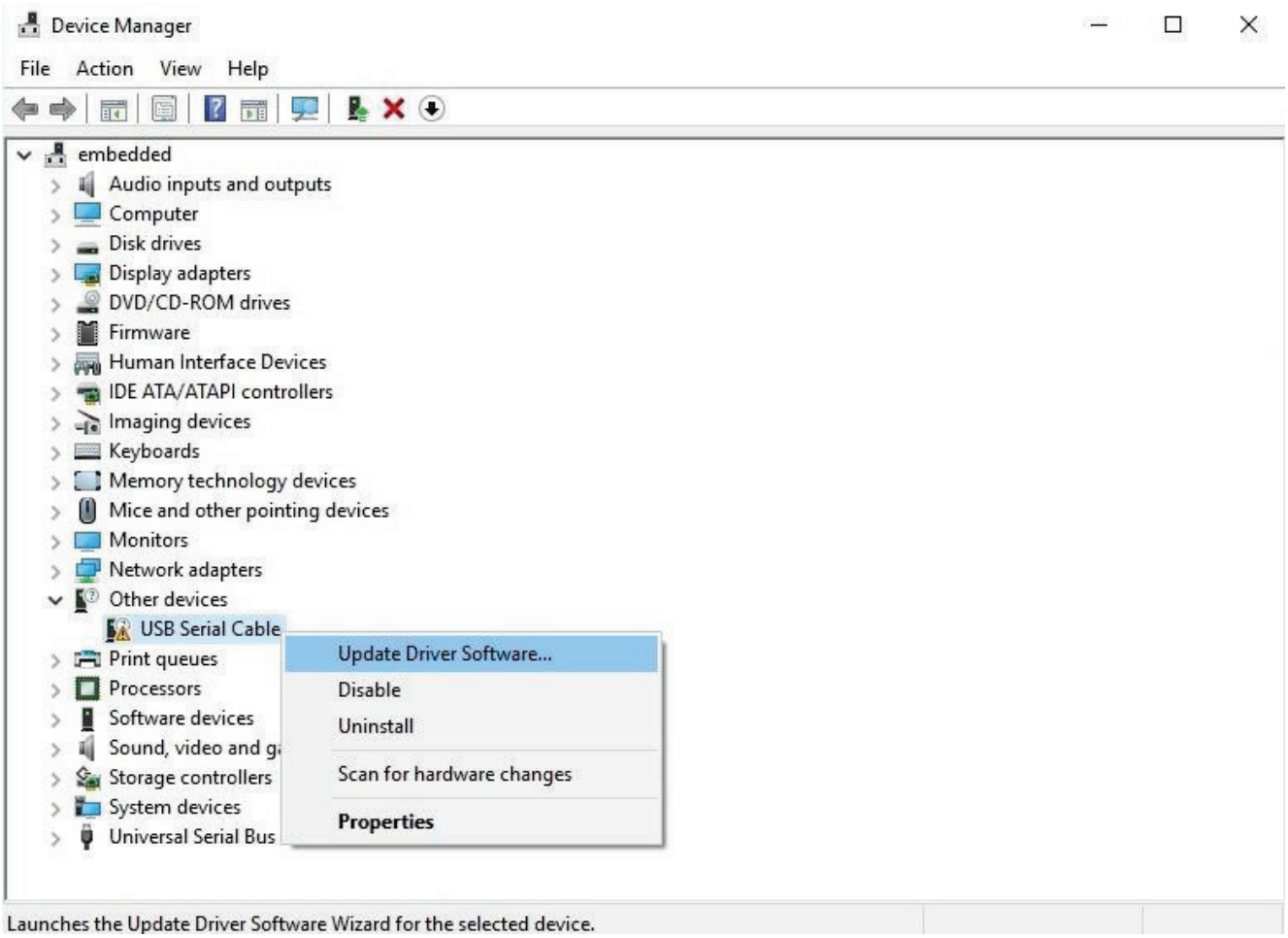


Figure 2 - Update Driver Software

This then displays the option for an automatic search or a manual search. Select the second option to browse manually.

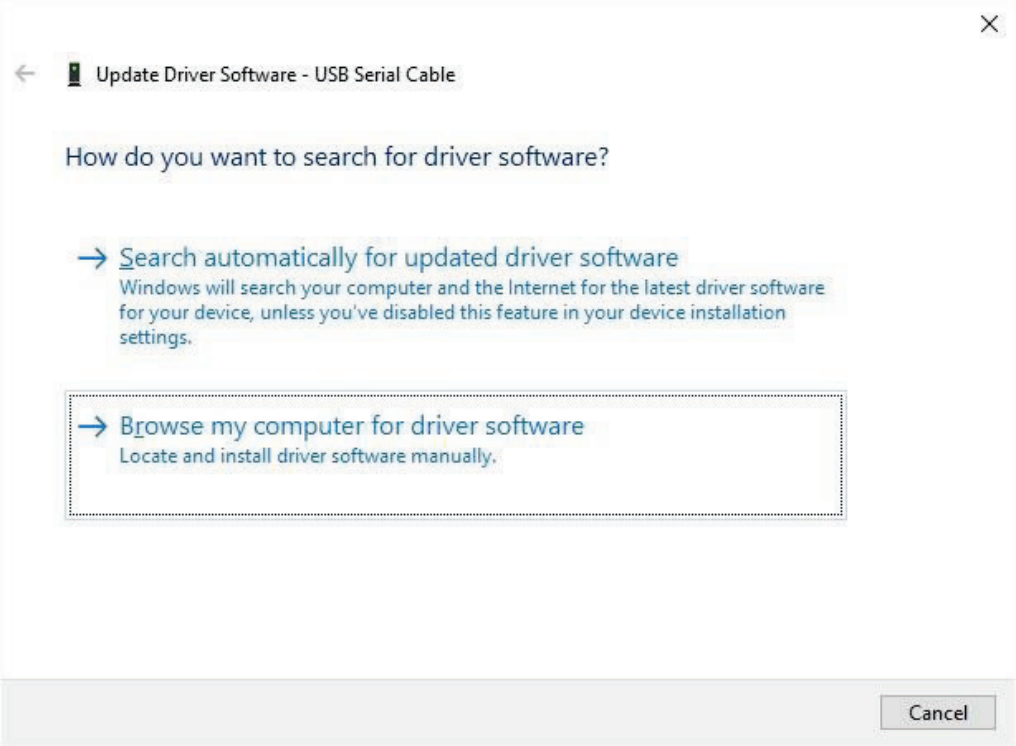


Figure 3 - Browse my computer for driver software

In the address box ("Search for driver software in this location") put the location where the drivers have been saved. The directory name will be "<local_copy_address>\FTDI\CDM v2.12.28 WHQL Certified."

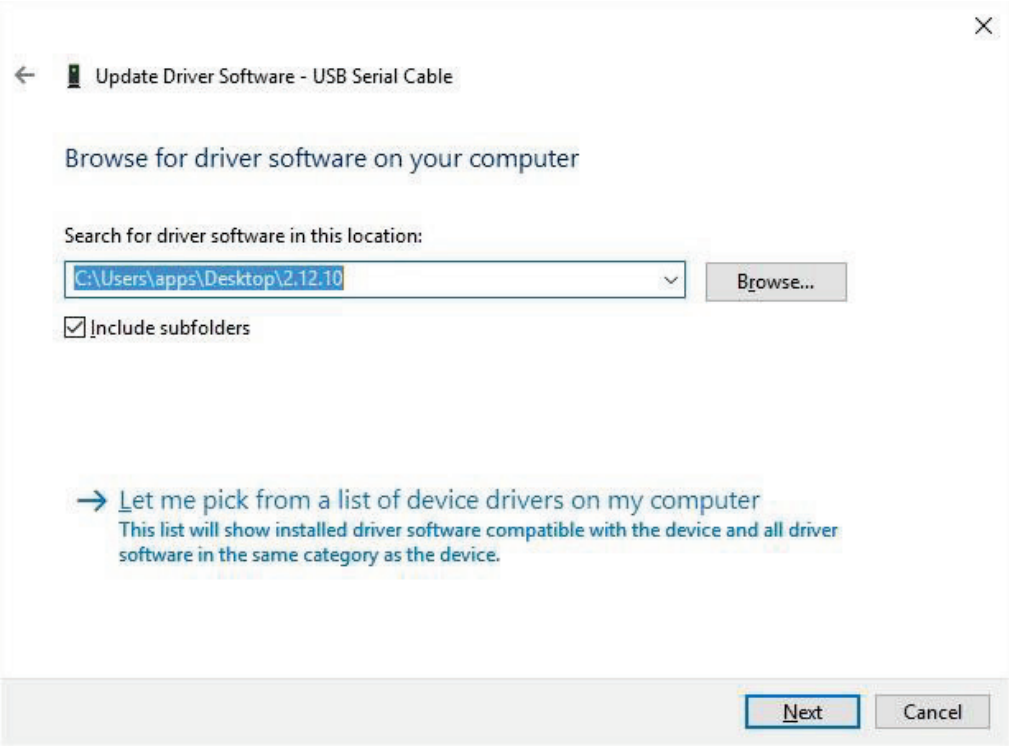


Figure 4 - Search Location

After entering the address, select “Next” to start the installation as shown.

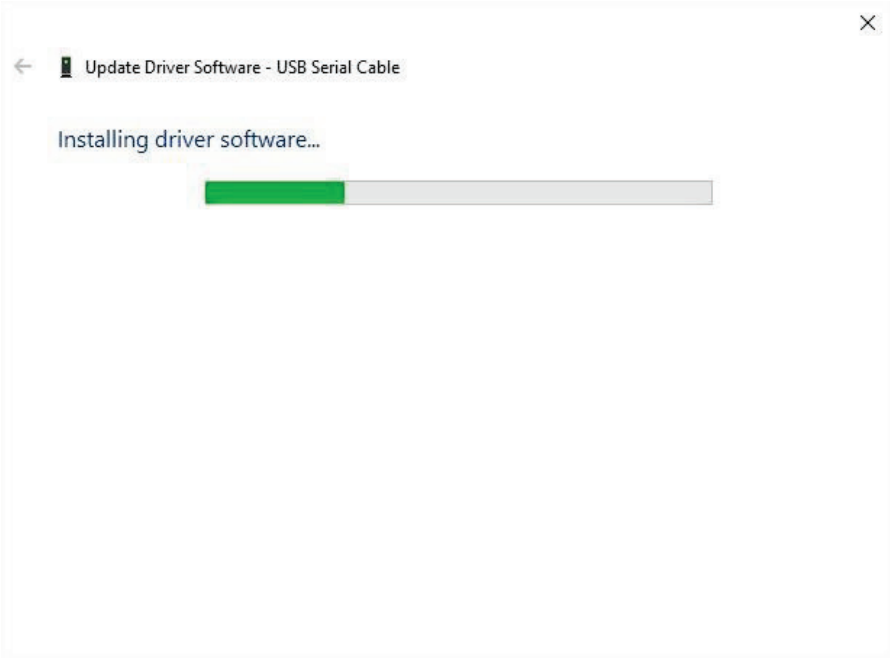


Figure 5 - Installing Driver Software

When the installation has finished, a completion screen is displayed.

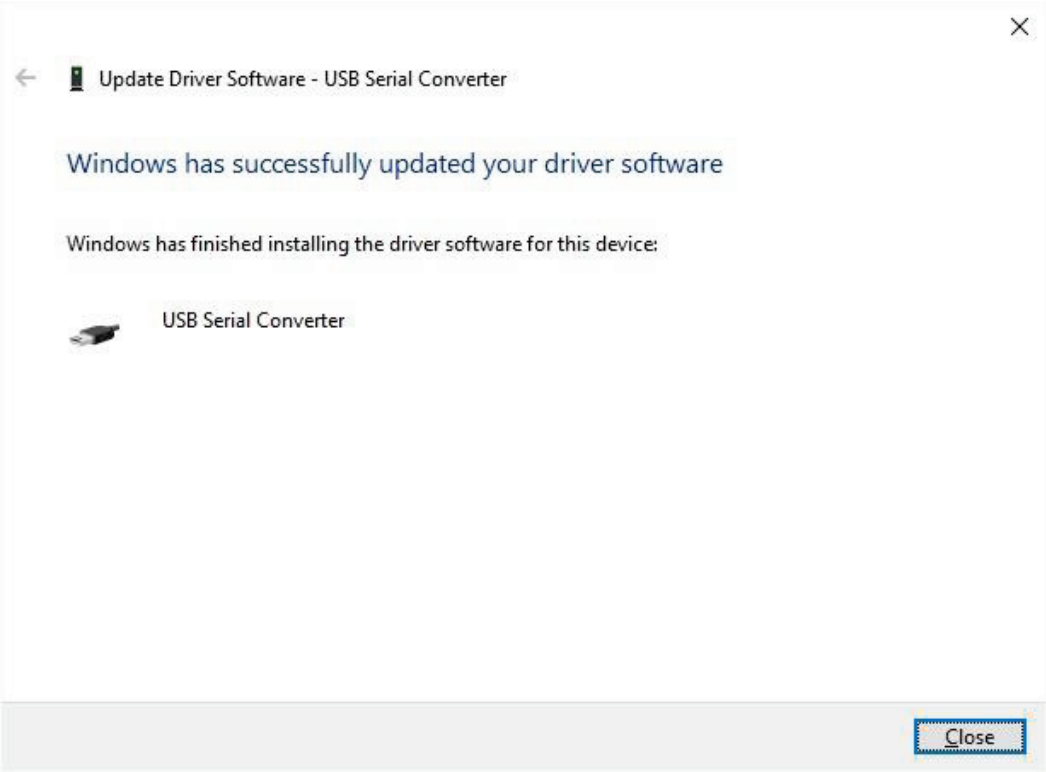


Figure 6 - Successful Driver Software Update

Press Close to close this window and go back to the Device Manager Window. Make sure the yellow warning symbol is not present for the USB Serial Cable.

Restart the computer to ensure the driver is fully activated.

TMx00 Control Software Installation

The TMx00 Control Software is installed with the TMx00Control-Installer.exe file. This will install the TMx00Control.exe file, icon name TMx00 Control, and an optional Documentation folder into the directory location of choice.

The installer has a documentation option which places TMx00 documentation into the installation folder.

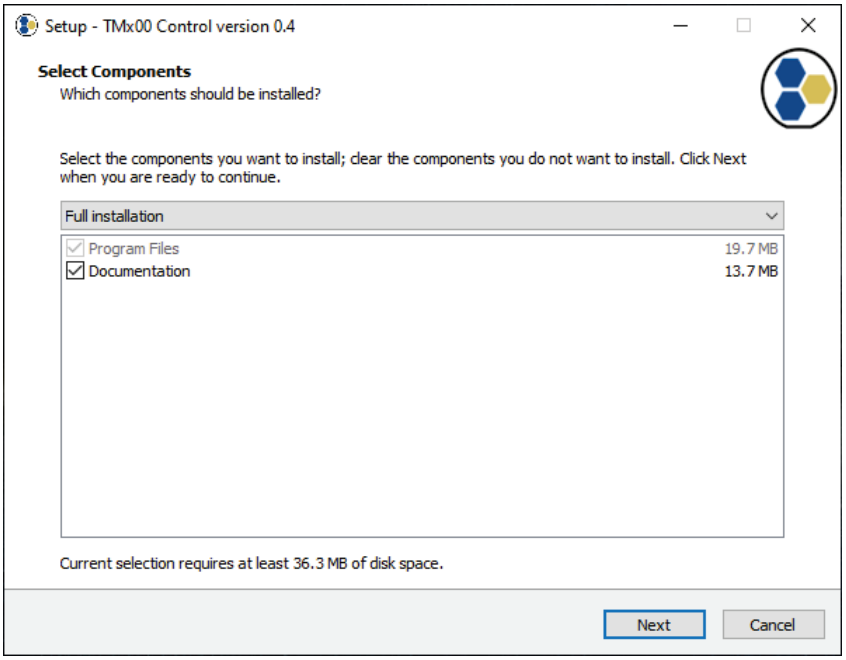


Figure 7 – Installation Options

Select if a desktop icon is desired.

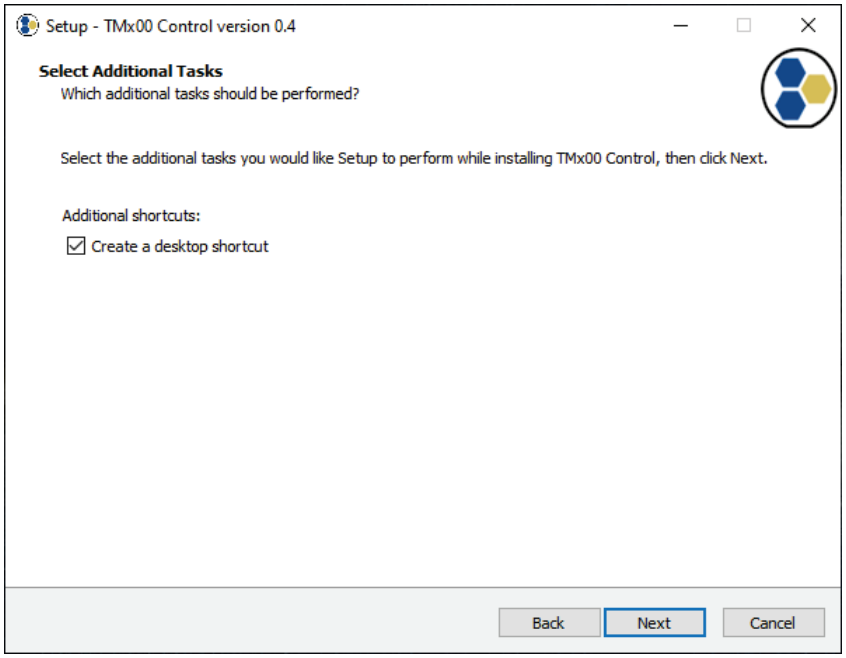


Figure 8 – Desktop Icon Option

The installer is ready to install the TMx00 Control software.

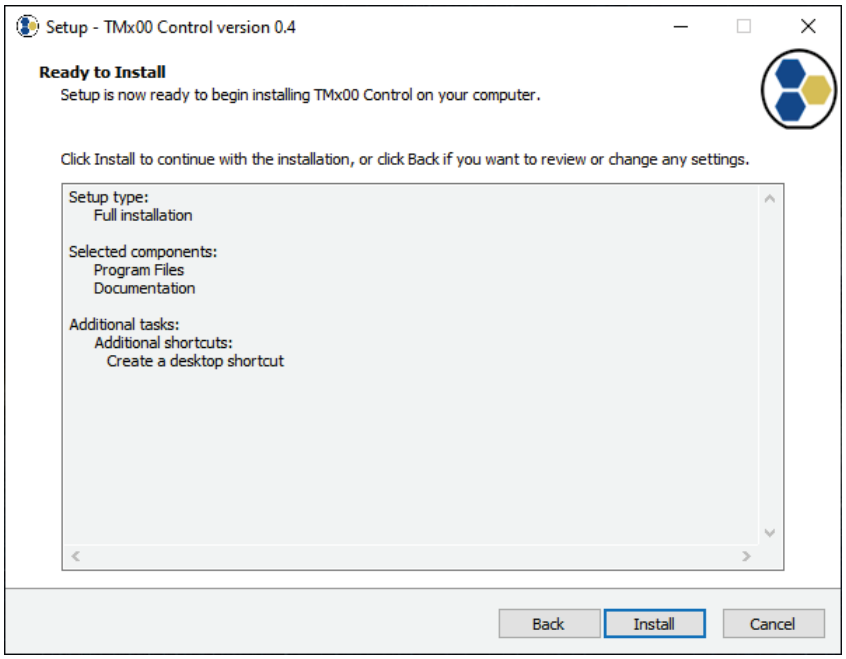


Figure 9 – Ready To Install

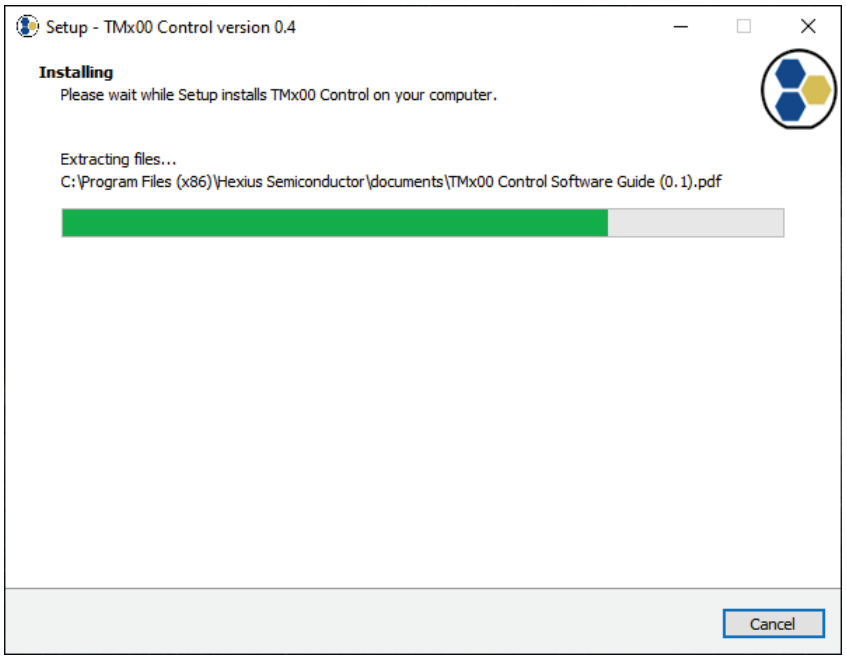


Figure 10 - Installing

Installation complete

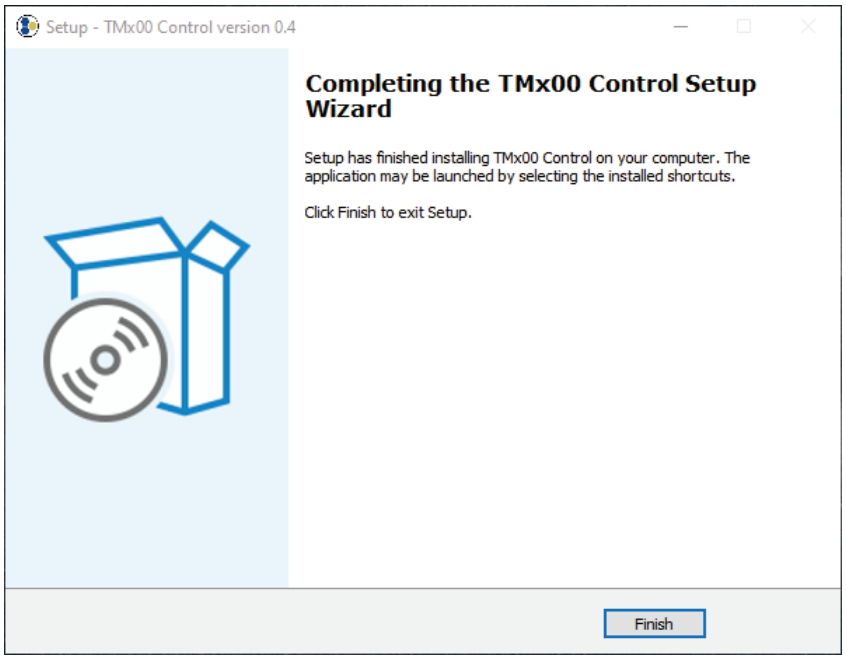


Figure 11 - Installation Complete

Cable Connections To The Evaluation Board

The FTDI MPSSE cable connects to the EB_TMx00 Evaluation Board as shown.

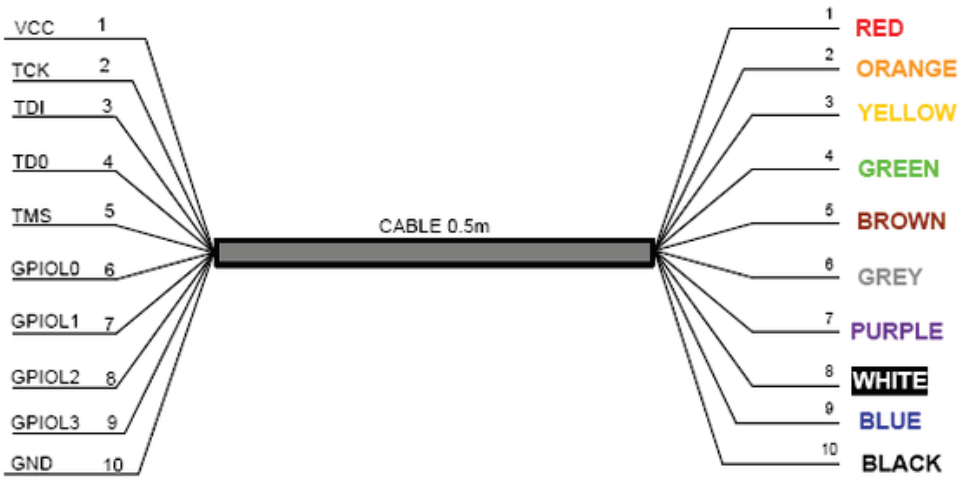


Figure 12 - C232HM MPSSE (C232HM-DDHSL-0) Cable Connections

Table 1 - FTDI Cable Connections to EB_TMx00 Evaluation Board

Name	Color	Function
TCK	Orange (O)	**SCL**
TDO	Green (G)	**SDA**
DI	Yellow (Y)	**SDA**
GND	Black (B)	**GND**

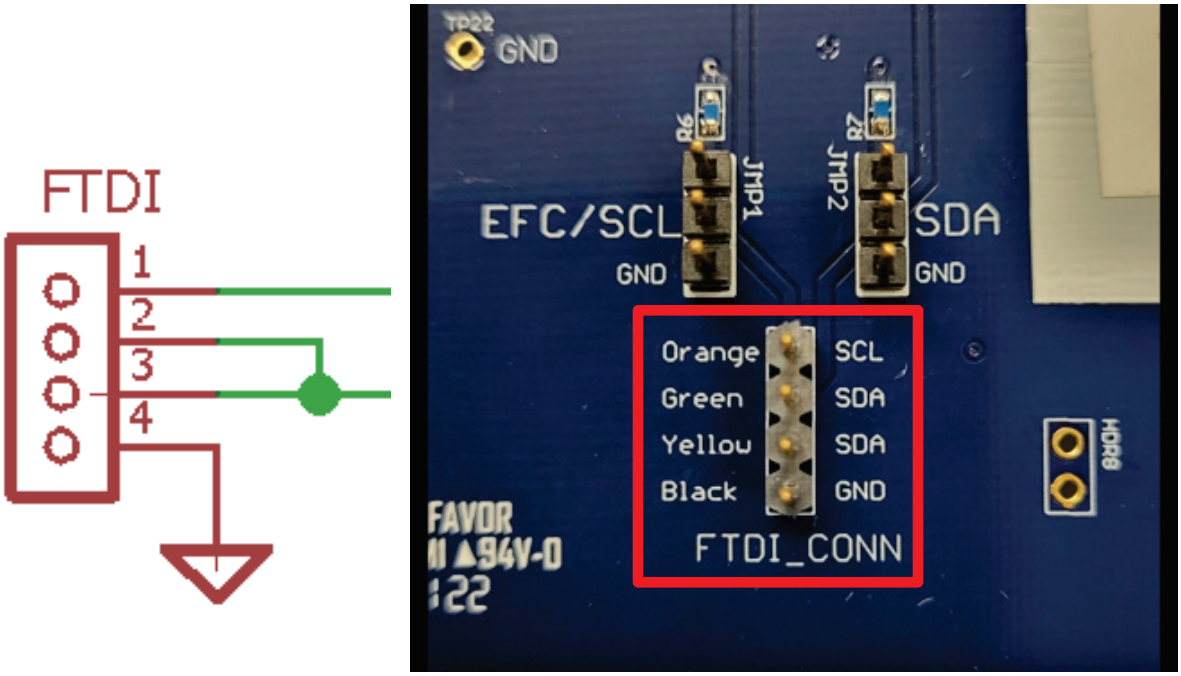


Figure 13 - FTDI to EB_TMx00 Evaluation Board Connection

Power Harness Connection

The EB_TMx00 Evaluation Kit comes with the power harness required to provide power to the evaluation board. Connect the terminal block side of the included power harness to the connector seen below. The other side of the power harness is a standard banana plug compatible with power supply outputs.

Figure 14 – Power Harness Connection for EB_TMx00 Evaluation Board

Control Software Operation

Overview

After starting, the control program displays the windows shown in the figure below.

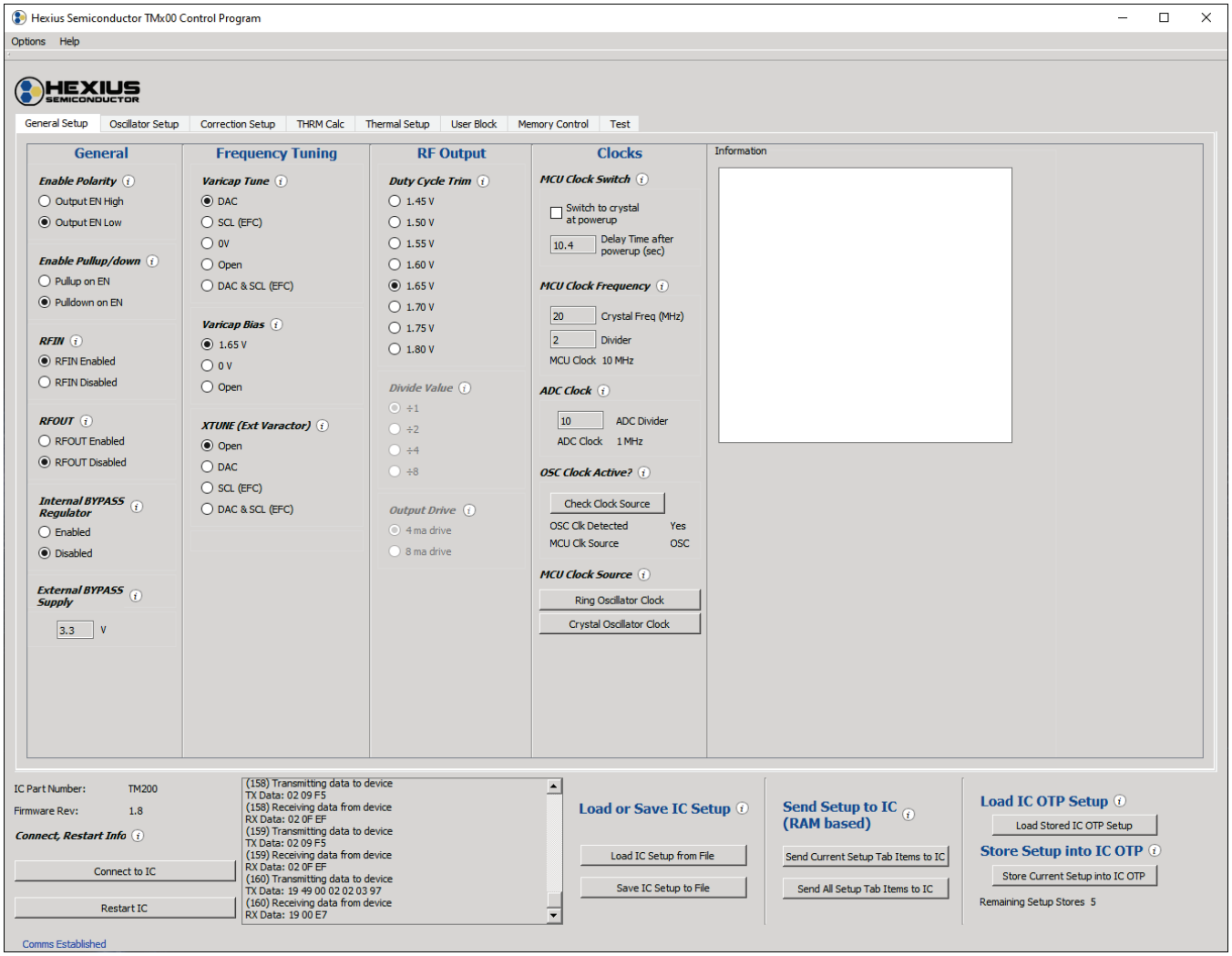


Figure 15 - Initial Startup Screen

The control software is organized into four sections. The lower left section relates to the communication and status of the connected IC. The lower right section loads, programs, and saves the programmable configuration of the IC (parameter management). The upper left section is the configuration parameter selections that can be changed within the IC and are organized by separate Setup tabs related to the function. The upper right section is an Information window to help detail the programmable options.

COMMUNICATION STATUS

The lower left section of the window details the connection status to the IC and Part Number and Firmware revision of the IC that is connected the FTDI cable. It also contains buttons to reset the PC connection to the IC and restart the IC. When the I^2C interface is active, the message displayed will be "I2C Connected."

The scroll box shows the communications and command status between the computer and the TMx00.

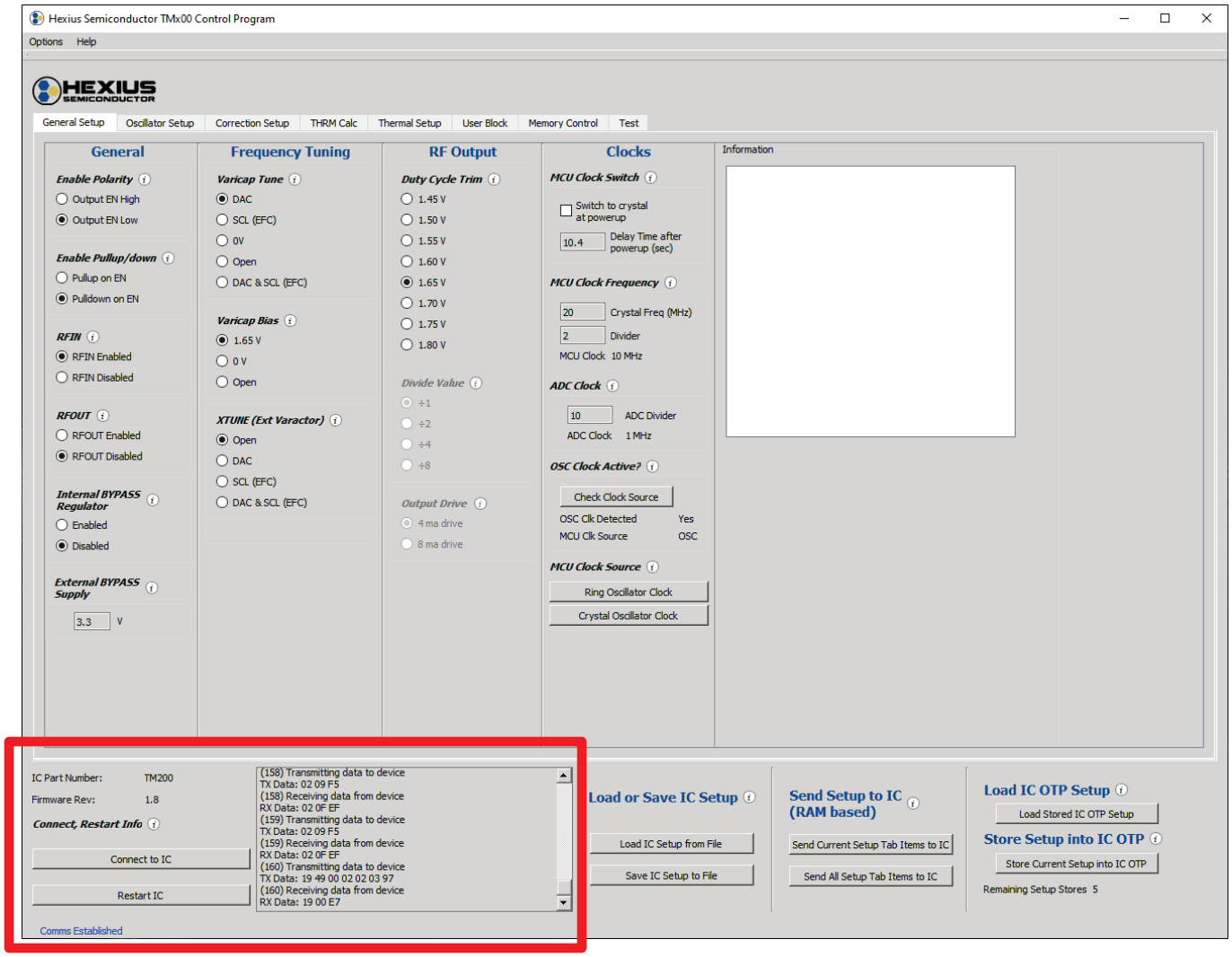


Figure 16 - Communication Status Section

IC Parameter Management

Initial Powerup

At power up, the IC loads the initial configuration with the parameters stored in its OTP. This allows the TMx00 to be programmed by the oscillator manufacturer permanently so the end customer will not need to perform any module setup during operation. When the control software is initially loaded, the stored values of the connected TMx00 are not reflected by the selections in the Setup tabs. To load the stored OTP values in the Setup tabs, press the '*Load Stored IC OTP Setup*' button.

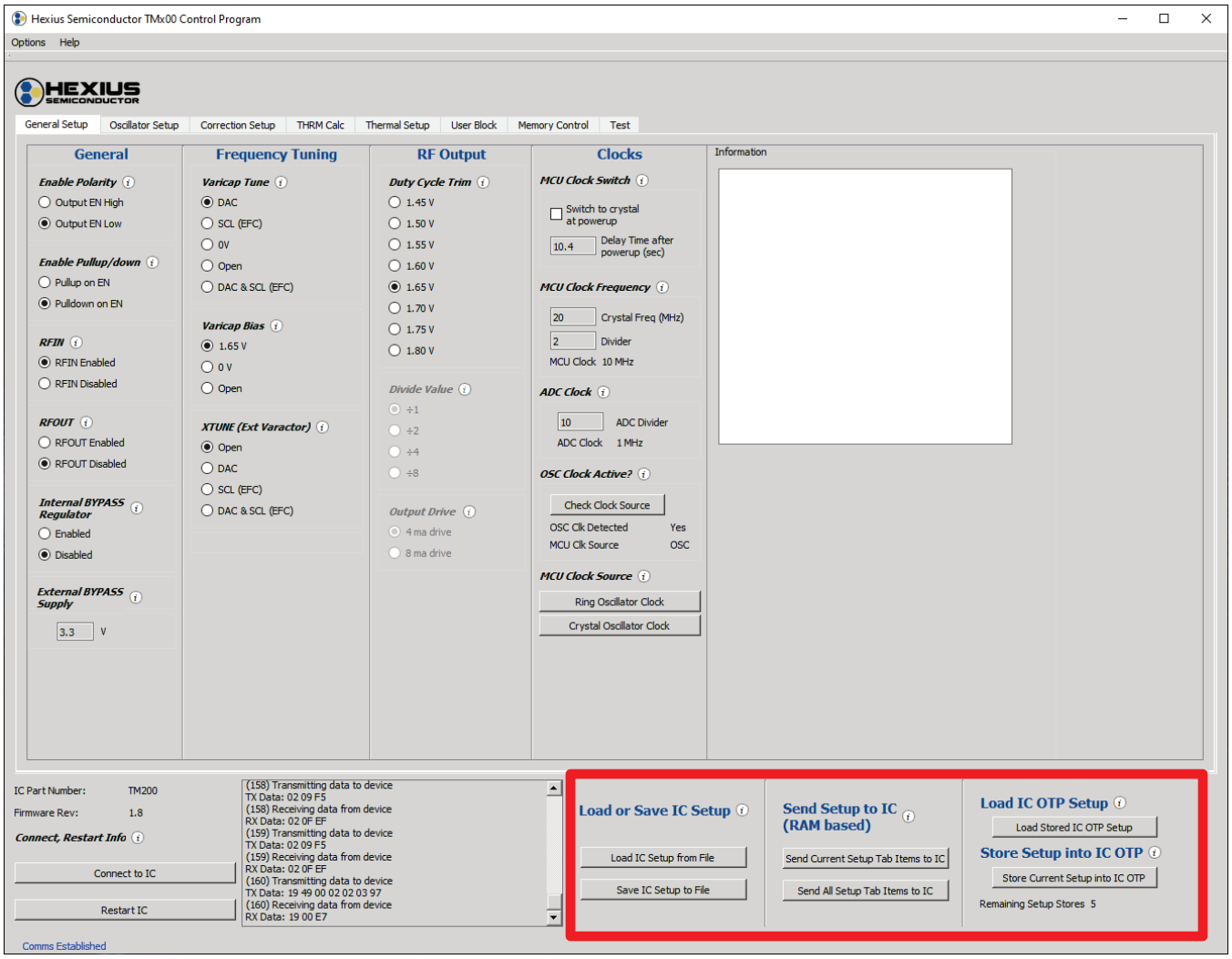


Figure 17 – Parameter Management Section

Load/Save IC Setup to File

Any specific configuration within the Setup tabs can loaded or saved as a file in a .xml format. This is particularly useful in loading and saving known configurations in a dynamic environment without having to move the configuration into OTP.

'*Load IC Setup from File*' allows loading a specific configuration into the setup parameters stored in the .xml file. The setup items loaded are not automatically moved into the IC. Press '*Send All Setup Tabs Items to IC*' to load the setup values into the IC.

'*Save IC Setup* to File' allows storing the current setup parameters as a .xml file.

Send Setup to IC (RAM based)

All operations with the control software are volatile unless the software is specifically commanded to write those items into the OTP memory. This allows the user to test various configurations using the software prior to final programming. Those configurations are volatile so when power is cycled on the IC, the parameters stored in the IC's OTP is re-loaded.

There are two buttons under the Send Setup to IC:

'*Send Current Setup Tab Items to IC*' will update the IC configuration with only the currently visible Setup tab selections.

'*Send All Setup Tab Items to IC*' will update the IC configuration with all the Setup tab selections.

Load IC OTP Setup

'*Load Stored IC OTP Setup*' reads the contents of the most recent IC setup configuration in OTP storage and moves them into the control software, allowing testing and modification.

Store Current Setup Into IC OTP

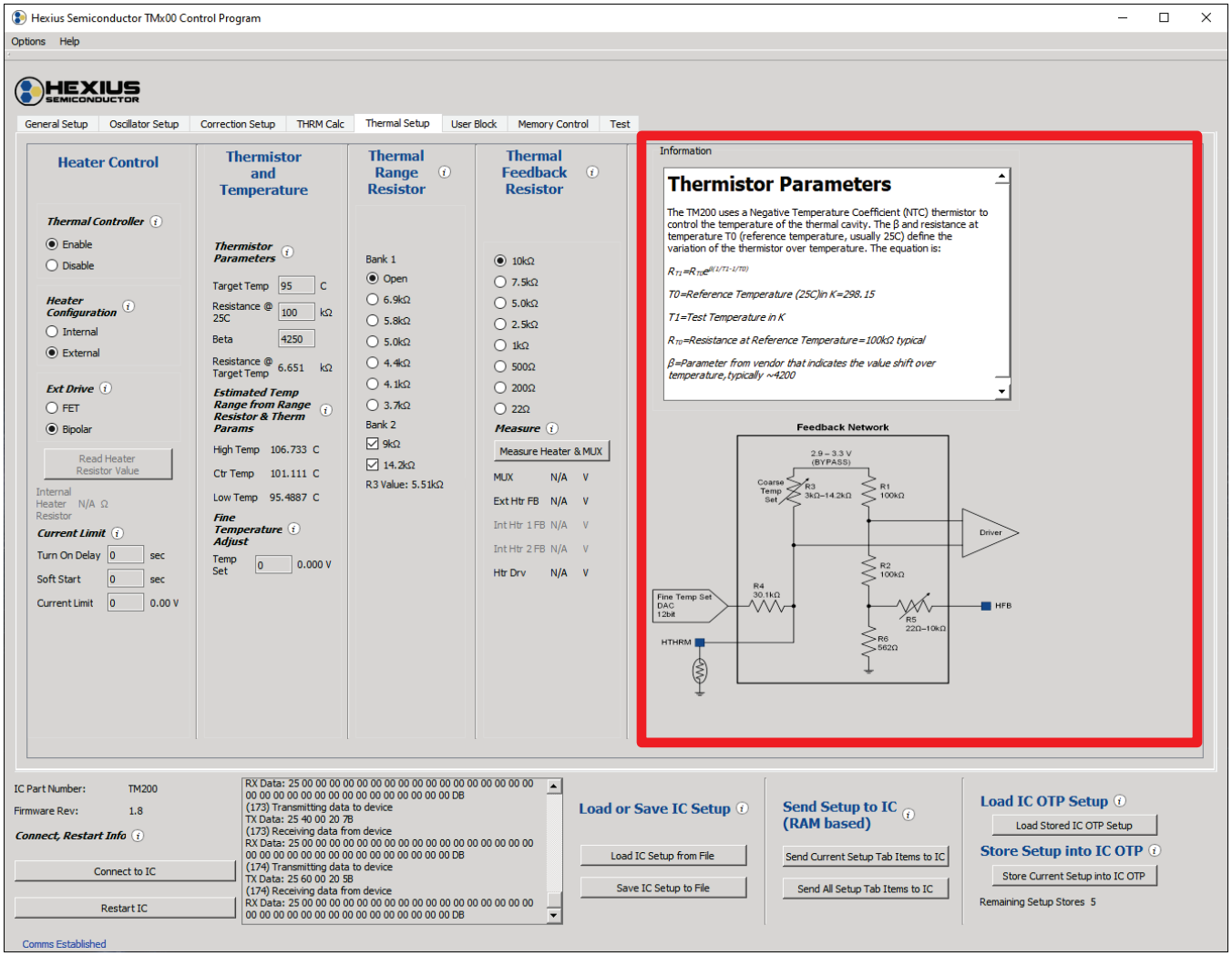
'*Store Current Setup into IC OTP*' writes the current IC setup parameters into the IC OTP storage area and replaces any previously written setup. Storing the setup values into the OTP storage moves the desired IC/crystal/Correction parameters into non-volatile memory and load when power is applied to the IC.

The setup data can be stored up to 6 times.

INFORMATION WINDOW

The Information section of the software provides the user with detailed information regarding each functional option. It provides definitions, functional descriptions, guidance, and diagrams to assist in configuring the TMx00. The information in this section is also located in even more detail in the datasheet.

Pressing the ⓘ button will bring up the information regarding the option/



Heater Control

Thermal Controller
● Enable
○ Disable

Heater Configuration
○ Internal
● External

Ext Drive
○ FET
● Bipolar

Internal Heater Resistor N/A Ω

Current Limit
Turn On Delay 0 sec
Soft Start 0 sec
Current Limit 0 0.00 V

Thermistor and Temperature

Thermistor Parameters
Target Temp 95 C
Resistance @ 25C 100 kΩ
Beta 4250
Resistance @ Target Temp 6.651 kΩ

Estimated Temp Range from Range Resistor & Therm Params
High Temp 106.733 C
Ctr Temp 101.111 C
Low Temp 95.4887 C

Fine Temperature Adjust
Temp Set 0 0.000 V

Thermal Range Resistor

Bank 1
● Open
○ 6.9kΩ
○ 5.8kΩ
○ 5.0kΩ
○ 4.4kΩ
○ 4.1kΩ
○ 3.7kΩ
Bank 2
☑ 9kΩ
☑ 14.2kΩ
R3 Value: 5.51kΩ

Thermal Feedback Resistor

● 10kΩ
○ 7.5kΩ
○ 5.0kΩ
○ 2.5kΩ
○ 1kΩ
○ 500Ω
○ 200Ω
○ 22Ω

Measure
MUX N/A V
Ext Htr FB N/A V
Int Htr 1 FB N/A V
Int Htr 2 FB N/A V
Htr Drv N/A V

Thermistor Parameters

The TM200 uses a Negative Temperature Coefficient (NTC) thermistor to control the temperature of the thermal cavity. The β and resistance at temperature T0 (reference temperature, usually 25C) define the variation of the thermistor over temperature. The equation is:

$R_{T1}=R_{T0}e^{\beta(1/T1-1/T0)}$

T0=Reference Temperature (25C)in K=298.15

T1=Test Temperature in K

R_{T0}*=Resistance at Reference Temperature=100kΩ typical*

β=Parameter from vendor that indicates the value shift over temperature,typically ~4200

IC Part Number: TM200
Firmware Rev: 1.8

Connect, Restart Info

```
RX Data: 25 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 DB
(173) Transmitting data to device
TX Data: 25 40 00 20 7B
(173) Receiving data from device
RX Data: 25 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 DB
(174) Transmitting data to device
TX Data: 25 60 00 20 5B
(174) Receiving data from device
RX Data: 25 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 DB
```

Load or Save IC Setup

Send Setup to IC (RAM based)

Load IC OTP Setup

Store Setup into IC OTP

Remaining Setup Stores 5

Comms Established

Figure 18 – Information Window

Configuration Parameter Selections

Methods of Configuring the IC

The control software contains check boxes, radio buttons, edit boxes, and other user interface items within organized Setup tabs to allow setting the IC configuration. Selections are not sent to the IC until either of the 'Send Setup to IC' buttons are pressed to the send the Setup tab selections.

General Setup Tab

This setup tab contains selections for general operational configurations related to the application of the TMx00 IC. This includes enabling/disabling IC blocks, configuring signal pathways, and setting timing parameters.

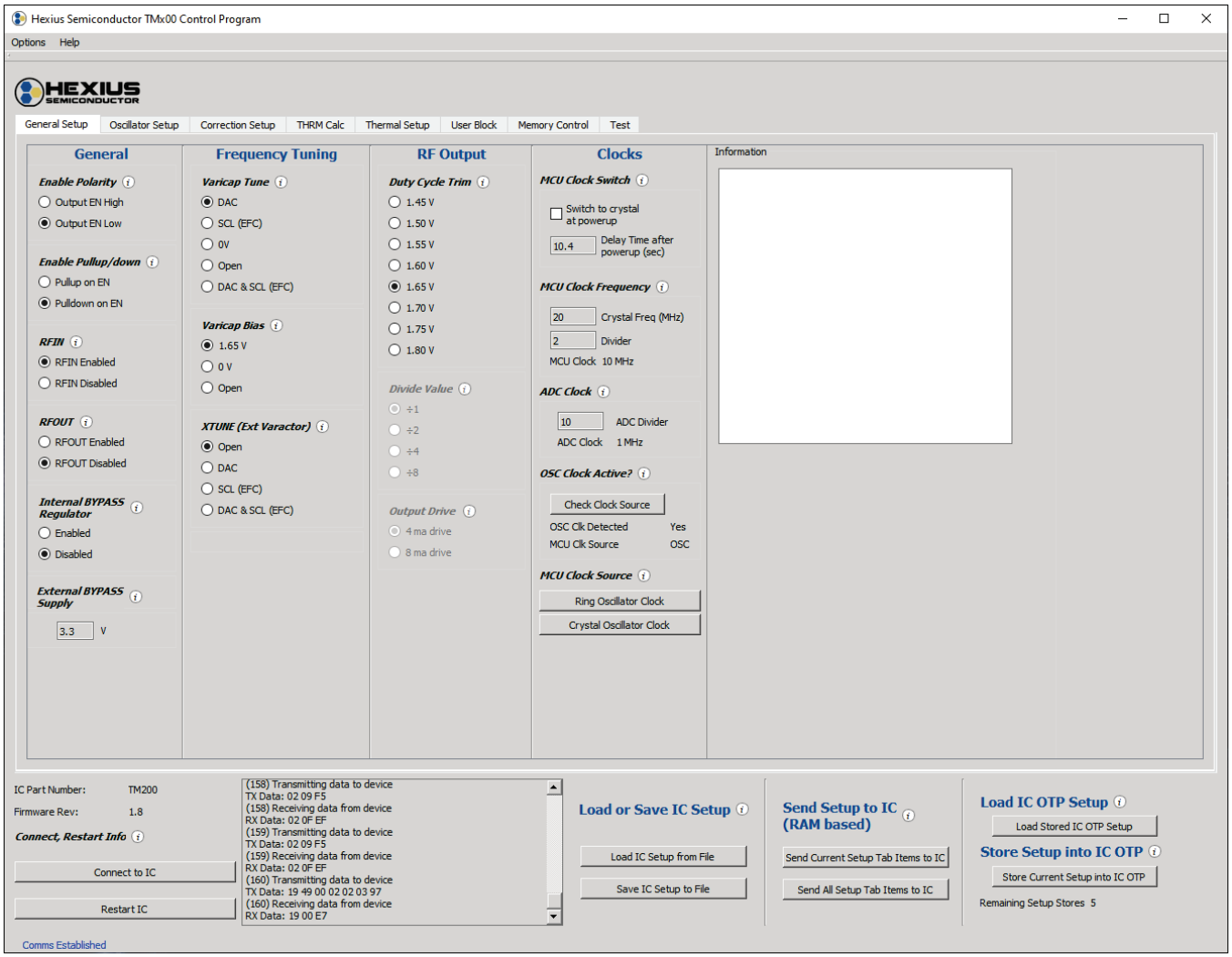


Figure 19 - General Setup Tab

Oscillator Setup Tab

The Oscillator Setup tab controls the operation of the Pierce oscillator stage that are internal to the IC. Much of the configurations for the Pierce oscillator can also be implemented externally with other components.

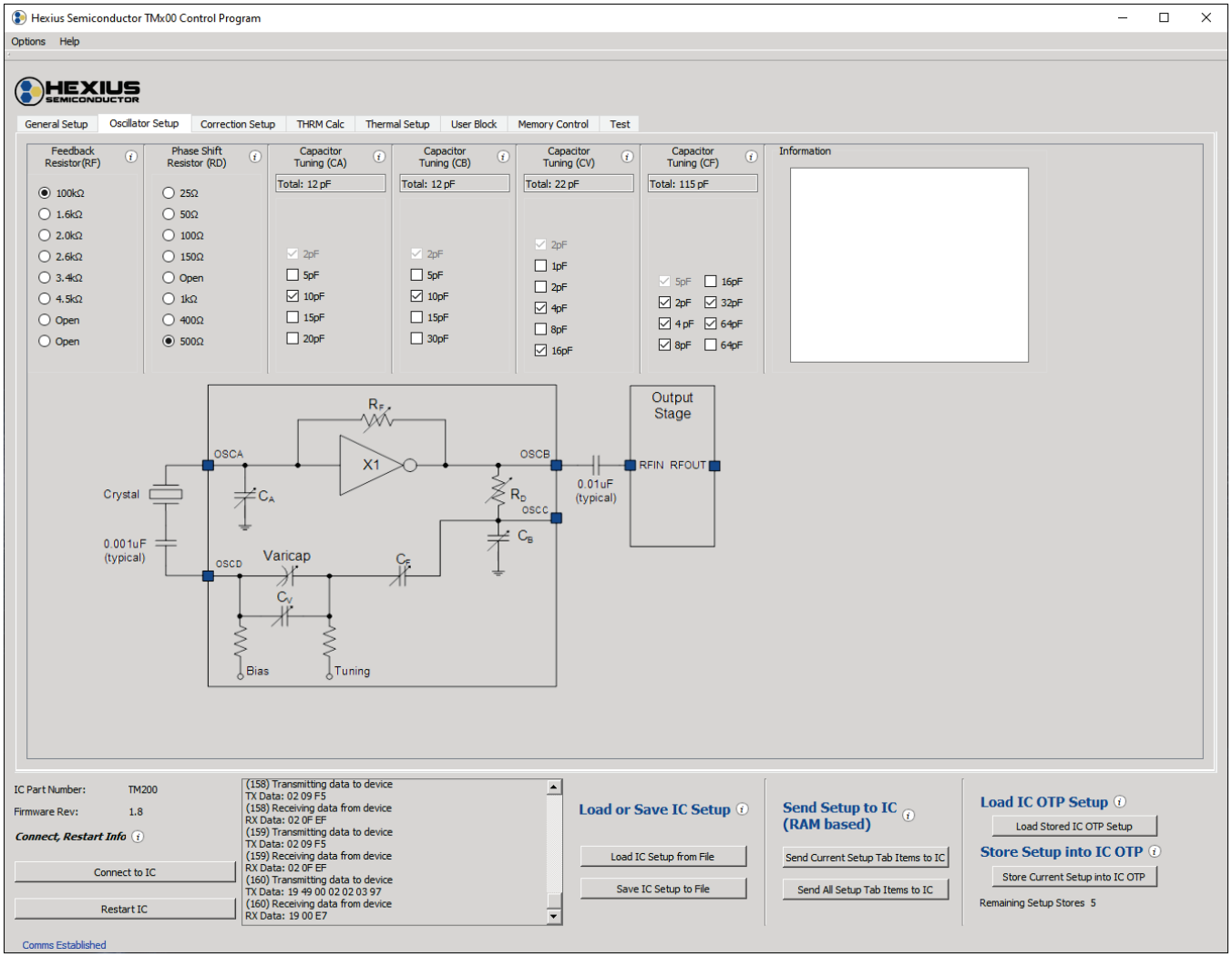


Figure 20 - Oscillator Setup Tab

Correction Setup Tab

The Correction Setup tab configures the correction technique for the TMx00, if desired. Many of the entries on this setup tab is part of the manufacturing process and characterization and are detailed in the Application Note *TMx00 Correction Algorithm Development for Characterization and Manufacturing*.

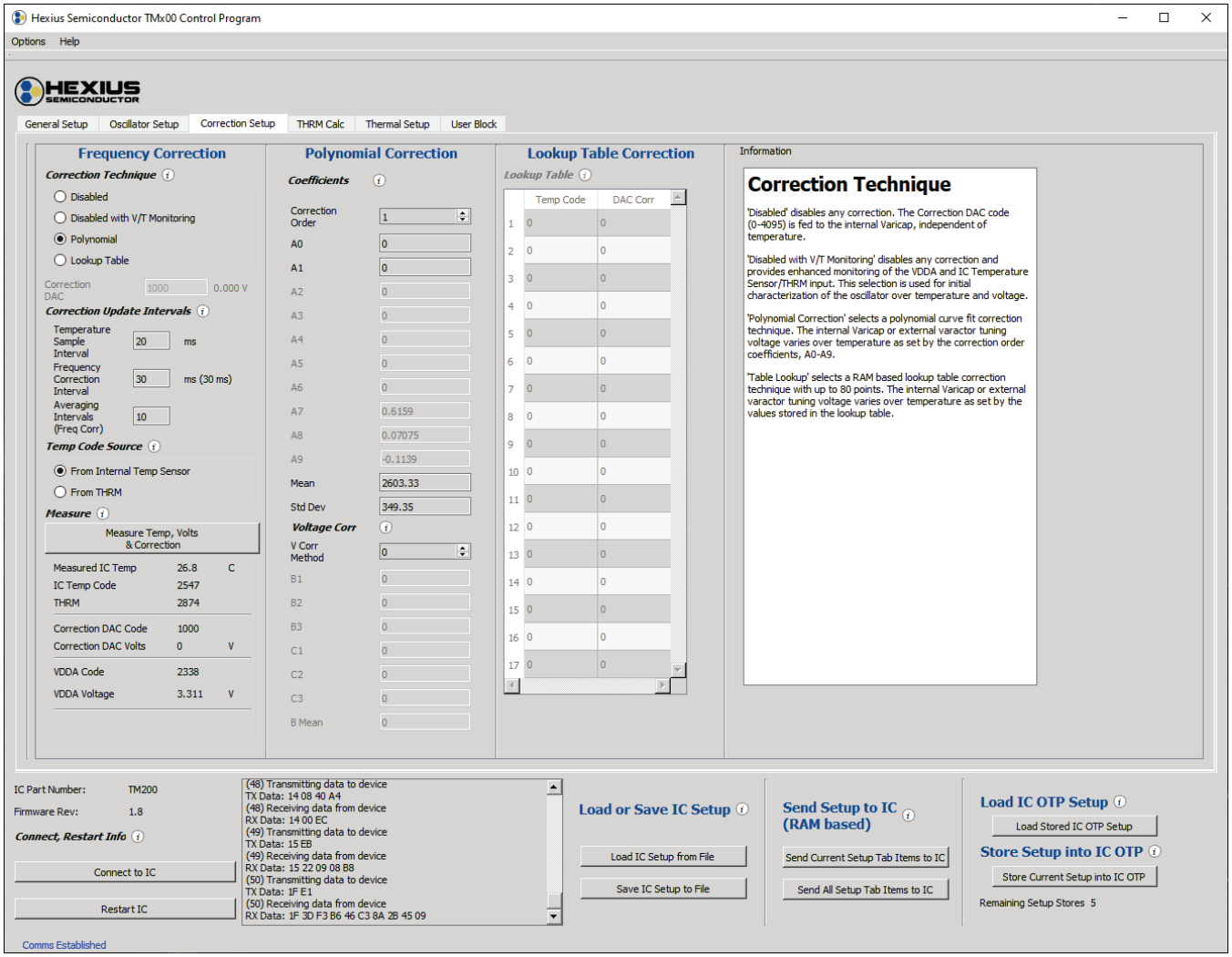
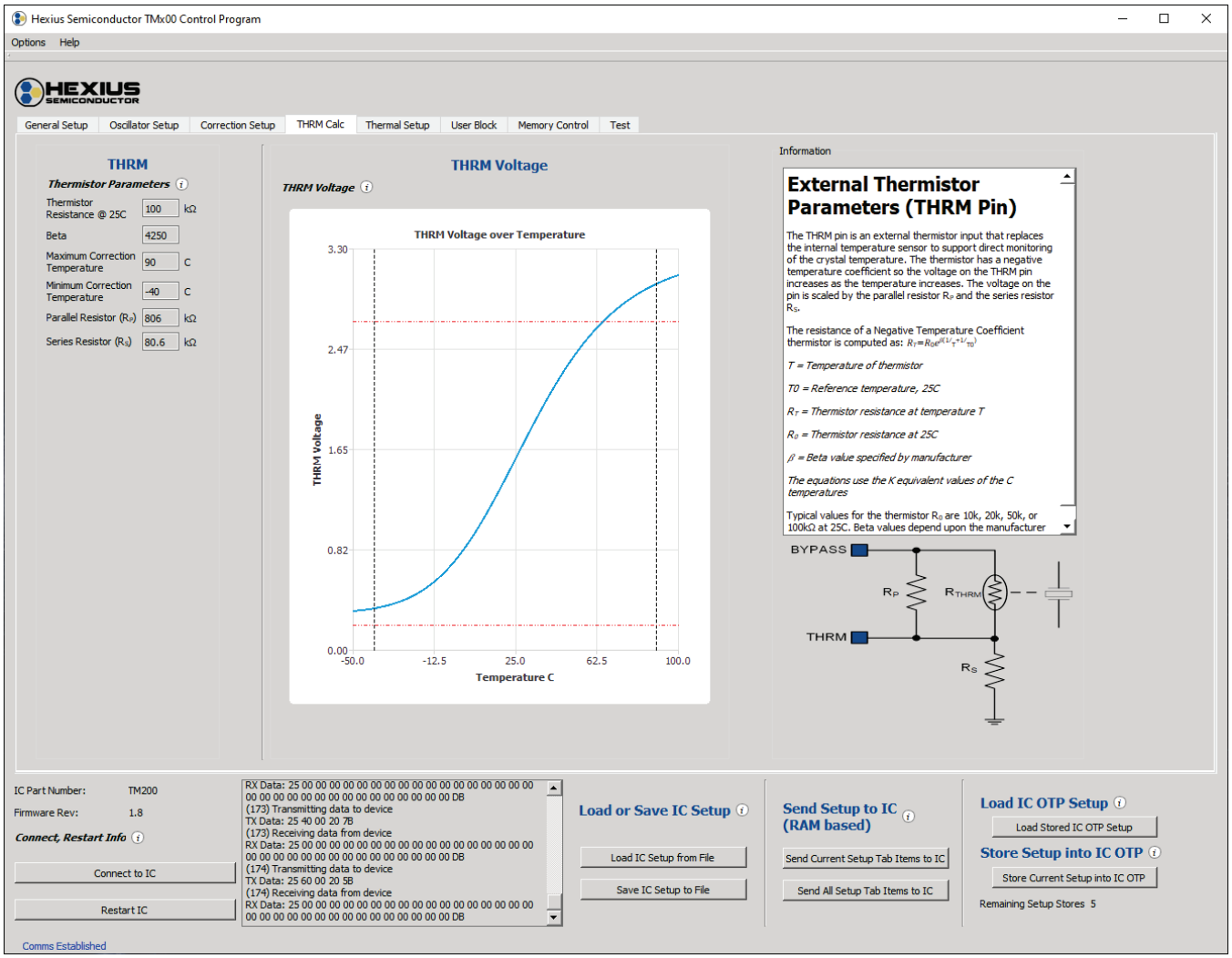


Figure 21 - Correction Setup Tab

THRM Calculation

The THRM Calc tab is a calculator tool that is useful when using an external thermistor component connected to the THRM pin. Inputting thermistor parameters and resistor network values will provide an approximation of the THRM voltage over the desired temperature range.



Thermistor Resistance @ 25C: 100 kΩ

Beta: 4250

Maximum Correction Temperature: 90 C

Minimum Correction Temperature: -40 C

Parallel Resistor (R_P): 806 kΩ

Series Resistor (R_S): 80.6 kΩ

External Thermistor Parameters (THRM Pin)

The THRM pin is an external thermistor input that replaces the internal temperature sensor to support direct monitoring of the crystal temperature. The thermistor has a negative temperature coefficient so the voltage on the THRM pin increases as the temperature increases. The voltage on the pin is scaled by the parallel resistor R_P and the series resistor R_S.

The resistance of a Negative Temperature Coefficient thermistor is computed as: $R_T = R_0 e^{\beta(1/T + 1/T0)}$

T = Temperature of thermistor

T0 = Reference temperature, 25C

R_T = Thermistor resistance at temperature T

R_0 = Thermistor resistance at 25C

β = Beta value specified by manufacturer

The equations use the K equivalent values of the C temperatures

Typical values for the thermistor R_0 are 10k, 20k, 50k, or 100kΩ at 25C. Beta values depend upon the manufacturer

IC Part Number: TM200

Firmware Rev: 1.8

```
RX Data: 25 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 DB
(173) Transmitting data to device
TX Data: 25 40 00 20 7B
(173) Receiving data from device
RX Data: 25 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 DB
(174) Transmitting data to device
TX Data: 25 60 00 20 5B
(174) Receiving data from device
RX Data: 25 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 DB
```

Remaining Setup Stores 5

Comms Established

Figure 22 – THRM Calculation Setup Tab

Thermal Setup

The Thermal Setup tab is for the TM200 only and configures the Thermal Controller and Heater settings. This tab configures the parameters of the thermal loop and aids in setting the cavity temperature of an OCXO module.

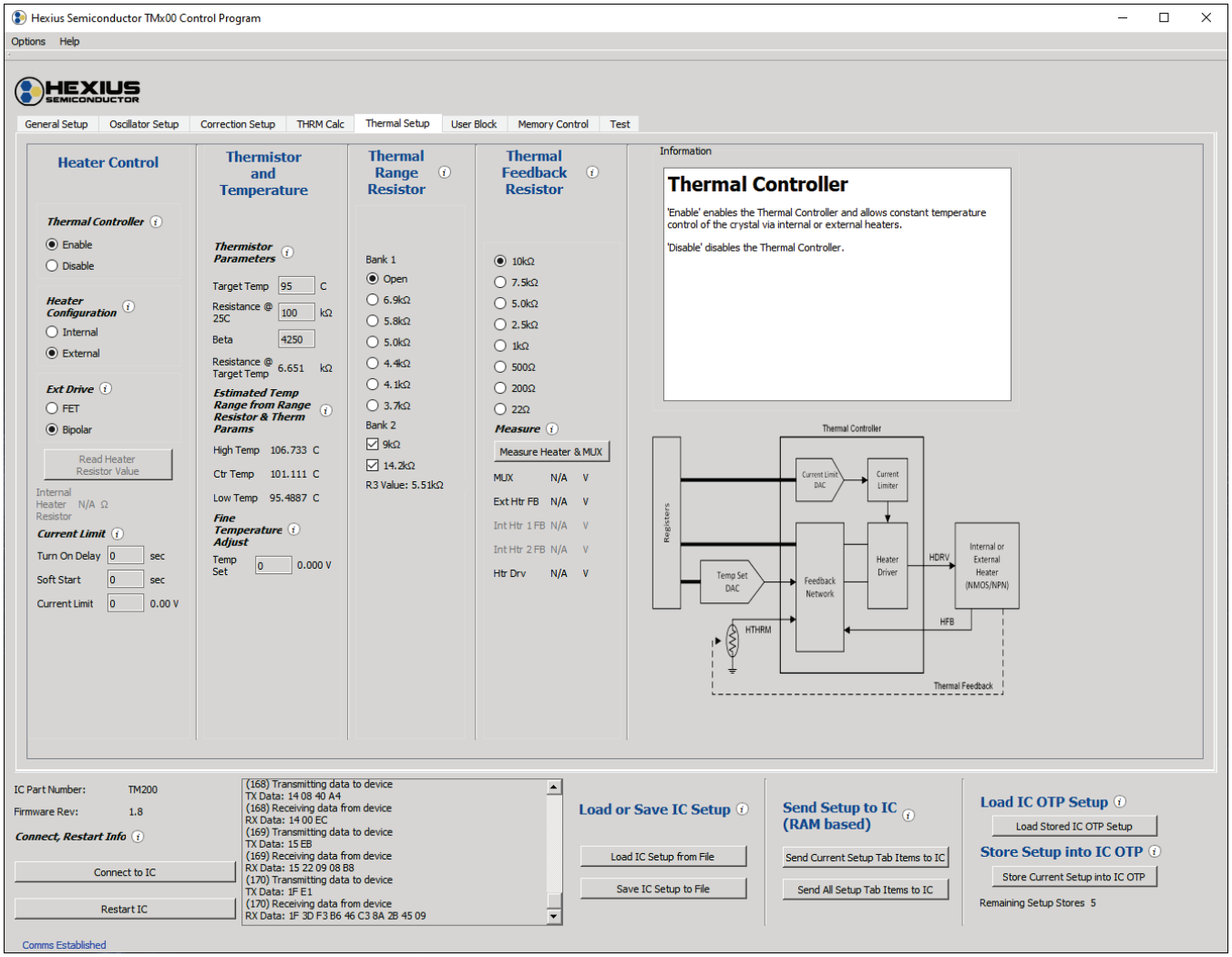
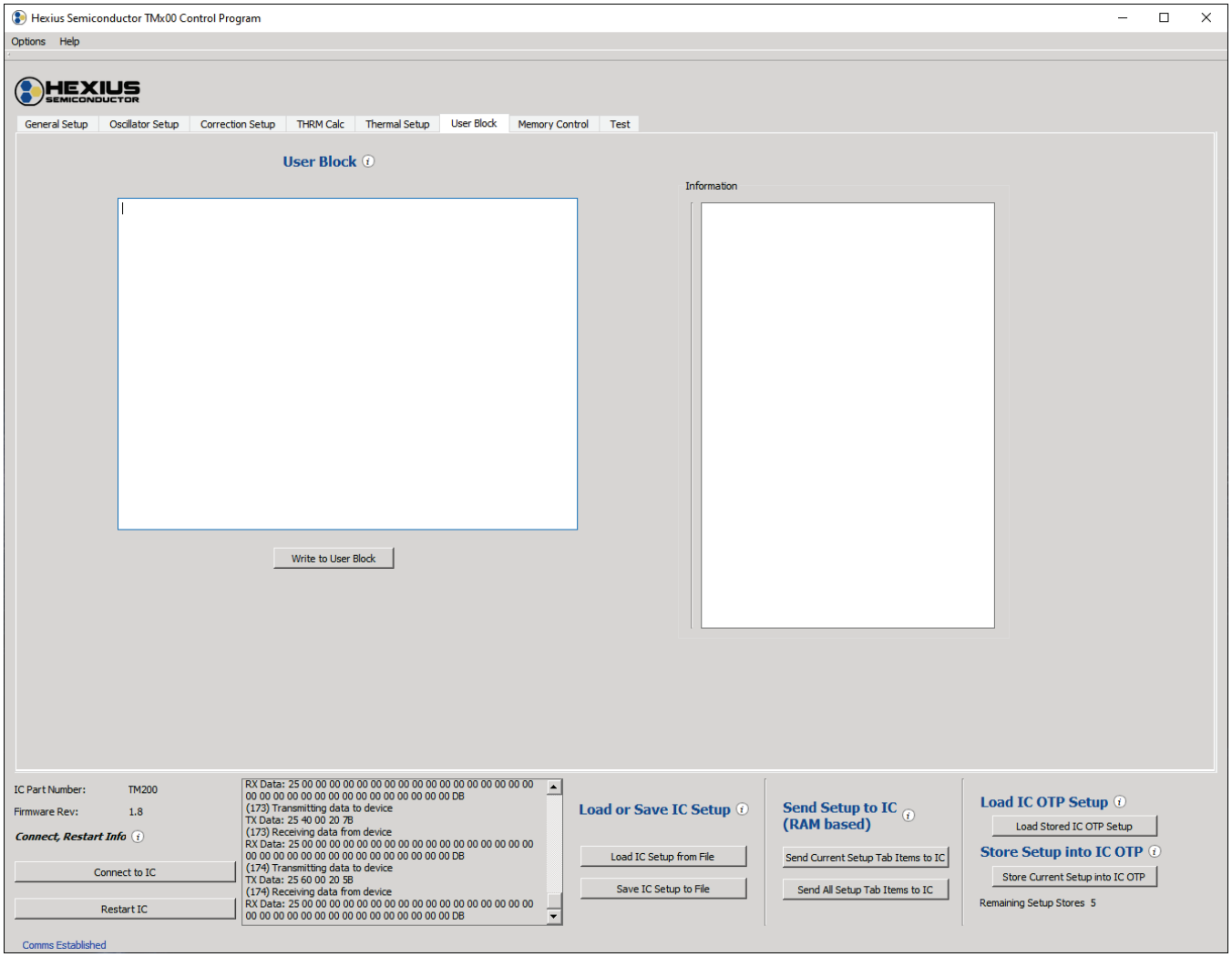


Figure 23 - Thermal Setup Tab (TM200 only)

User Block

The User Block tab allows the user to enter information they wish to have stored in the OTP. This may be a note, part number, serial number, etc. The space is limited to 128bytes and is an ASCII format.



IC Part Number: TM200
Firmware Rev: 1.8

```
RX Data: 25 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 DB
(173) Transmitting data to device
TX Data: 25 40 00 20 7B
(173) Receiving data from device
RX Data: 25 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 DB
(174) Transmitting data to device
TX Data: 25 60 00 20 5B
(174) Receiving data from device
RX Data: 25 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 DB
```

Remaining Setup Stores 5

Comms Established

Figure 24 – User Block Setup Tab