# EVB-LAN9252-HBI+
# Quick Start Guide

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Manufacturer: Microchip Technology Inc.
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USA

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This development/evaluation tool complies with EU RoHS2 Directive 2011/65/EU.

This development/evaluation tool, when incorporating wireless and radio-telecom functionality, is in compliance with the essential requirement and other relevant provisions of the R&TTE Directive 1999/5/EC and the FCC rules as stated in the declaration of conformity provided in the module datasheet and the module product page available at www.microchip.com.

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Signed for and on behalf of Microchip Technology Inc. at Chandler, Arizona, USA

Derek Carlson
VP Development Tools

12-Sep-14
Date

**NOTES:**

# Table of Contents

# Preface

**NOTICE TO CUSTOMERS**

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**Documents are identified with a "DS" number. This number is located on the bottom of each page, in front of the page number. The numbering convention for the DS number is "DSXXXXXA", where "XXXXX" is the document number and "A" is the revision level of the document.**

**For the most up-to-date information on development tools, see the MPLAB® IDE online help. Select the Help menu, and then Topics to open a list of available online help files.**

## INTRODUCTION

This chapter contains general information that will be useful to know before using and configuring the EVB-LAN9252-HBI+. Items discussed in this chapter include:

- Document Layout
- Conventions Used in this Guide
- The Microchip Web Site
- Development Systems Customer Change Notification Service
- Customer Support
- Document Revision History

## DOCUMENT LAYOUT

This document describes how to configure the EVB-LAN9252-HBI+, such as the DIGIO and SPI, as well as various setup options, scanning, and programming. The manual layout is as follows:

- **Chapter 1. "Overview"** – Shows a brief description of the EVB-LAN9252-HBI+ board quick setup.
- **Chapter 2. "EVB-LAN9252-HBI+"** – Provides instructions in configuring HBI and SPI.
- **Appendix A. "Setting Up Master in Windows®"** – This appendix shows how to set up Master in Windows.
- **Appendix B. "EEPROM Programming"** – This appendix shows how to program EEPROM.
- **Appendix C. "Scanning EtherCAT Slaves"** – This appendix shows how to scan EtherCAT Slaves.
- **Appendix D. "Generating SSC Files"** – This appendix shows how to generate SSC files.
- **Appendix E. "Compiling and Programming SoC Firmware"** – This appendix

shows how to compile and program SoC firmware.

- **Appendix F. "Programming PIC32 Firmware Using Pre-Built Binaries"** – This appendix shows how to program the PIC32 firmware using pre-built binaries.
- **Appendix G. "Troubleshooting"** - This appendix shows some basic trouble-shooting tips for common problems.

## CONVENTIONS USED IN THIS GUIDE

This manual uses the following documentation conventions:

**DOCUMENTATION CONVENTIONS**

| Description | Represents | Examples |
|---|---|---|
| **Arial font:** | | |
| Italic characters | Referenced books | *MPLAB® IDE User's Guide* |
| | Emphasized text | ...is the *only* compiler... |
| Initial caps | A window | the Output window |
| | A dialog | the Settings dialog |
| | A menu selection | select Enable Programmer |
| Quotes | A field name in a window or dialog | "Save project before build" |
| Underlined, italic text with right angle bracket | A menu path | *File>Save* |
| Bold characters | A dialog button | Click **OK** |
| | A tab | Click the **Power** tab |
| N'Rnnnn | A number in verilog format, where N is the total number of digits, R is the radix and n is a digit. | 4'b0010, 2'hF1 |
| Text in angle brackets < > | A key on the keyboard | Press <Enter>, <F1> |
| **Courier New font:** | | |
| Plain Courier New | Sample source code | `#define START` |
| | Filenames | `autoexec.bat` |
| | File paths | `c:\mcc18\h` |
| | Keywords | `_asm, _endasm, static` |
| | Command-line options | `-Opa+, -Opa-` |
| | Bit values | `0, 1` |
| | Constants | `0xFF, 'A'` |
| Italic Courier New | A variable argument | *`file`*`.o`, where *`file`* can be any valid filename |
| Square brackets [ ] | Optional arguments | `mcc18 [options]` *`file`* `[options]` |
| Curly brackets and pipe character: { \| } | Choice of mutually exclusive arguments; an OR selection | `errorlevel {0\|1}` |
| Ellipses... | Replaces repeated text | `var_name [, var_name...]` |
| | Represents code supplied by user | `void main (void) { ... }` |

## THE MICROCHIP WEB SITE

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- **Product Support** – Data sheets and errata, application notes and sample programs, design resources, user's guides and hardware support documents, latest software releases and archived software
- **General Technical Support** – Frequently Asked Questions (FAQs), technical support requests, online discussion groups, Microchip consultant program member listing
- **Business of Microchip** – Product selector and ordering guides, latest Microchip press releases, listing of seminars and events, listings of Microchip sales offices, distributors and factory representatives

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The Development Systems product group categories are:

- **Compilers** – The latest information on Microchip C compilers, assemblers, linkers and other language tools. These include all MPLAB C compilers; all MPLAB assemblers (including MPASM assembler); all MPLAB linkers (including MPLINK object linker); and all MPLAB librarians (including MPLIB object librarian).
- **Emulators** – The latest information on Microchip in-circuit emulators.This includes the MPLAB REAL ICE and MPLAB ICE 2000 in-circuit emulators.
- **In-Circuit Debuggers** – The latest information on the Microchip in-circuit debuggers. This includes MPLAB ICD 3 in-circuit debuggers and PICkit 3 debug express.
- **MPLAB IDE** – The latest information on Microchip MPLAB IDE, the Windows Integrated Development Environment for development systems tools. This list is focused on the MPLAB IDE, MPLAB IDE Project Manager, MPLAB Editor and MPLAB SIM simulator, as well as general editing and debugging features.
- **Programmers** – The latest information on Microchip programmers. These include production programmers such as MPLAB REAL ICE in-circuit emulator, MPLAB ICD 3 in-circuit debugger and MPLAB PM3 device programmers. Also included are nonproduction development programmers such as PICSTART Plus and PIC-kit 2 and 3.

## CUSTOMER SUPPORT

Users of Microchip products can receive assistance through several channels:

- Distributor or Representative
- Local Sales Office
- Field Application Engineer (FAE)
- Technical Support

Customers should contact their distributor, representative or field application engineer (FAE) for support. Local sales offices are also available to help customers. A listing of sales offices and locations is included in the back of this document.

Technical support is available through the web site at:
http://www.microchip.com/support

## DOCUMENT REVISION HISTORY

| Revisions | Section/Figure/Entry | Correction |
|---|---|---|
| DS50002425C (06-22-16) | Entire Document | Updated to EVB_LAN9252-HBI+. |
| | **Appendix G. "Troubleshooting"** | Added new appendix. |
| | **Chapter 1. "Overview"** | Updated terms in abbreviations. |
| | **Chapter 2. "EVB-LAN9252-HBI+"** | Updated entire chapter. |
| | **Section 2.3 "EVB-LAN9252-HBI+ Calculations"** | Added new section to chapter with calculations. |
| | **Appendix B. "EEPROM Programming"** | Updated pictures in appendix. |
| | **Appendix C. "Scanning EtherCAT Slaves"** | Updated entire appendix. |
| | Figure D-9 | Updated figure. |
| DS50002425B (02-24-16) | **Appendix F. "Programming PIC32 Firmware Using Pre-Built Binaries"** | Added new appendix. |
| | **Appendix E. "Compiling and Programming SoC Firmware"** | Added new appendix. |
| | **Appendix D. "Generating SSC Files"** | Added new appendix. |
| | Appendix D. Changing Vendor ID and Object Configuration | Removed entire appendix. |
| | **Appendix C. "Scanning EtherCAT Slaves"** | Updated entire appendix. |
| | **Appendix B. "EEPROM Programming"** | Updated entire appendix. |
| | **Appendix A. "Setting Up Master in Windows®"** | Updated entire appendix. |
| | **Chapter 2. "EVB-LAN9252-HBI+"** | Moved from Chapter 3. LAN9252-HBI |
| | Chapter 2. DIGIO Configuration | Removed entire chapter. |
| | **Section 1.1 "Introduction"** | Updated first paragraph. Added note. |
| | Trademarks (Page 2) | Updated trademarks page. |
| DS50002425A (10-20-15) | Initial release of document | |

# Chapter 1. Overview

## 1.1 INTRODUCTION

This document describes how to use the EVB-LAN9252-HBI+ Software Development Kit (SDK) as a development tool for the Microchip EVB-LAN9252 EtherCAT® Slave Controller.

**Note:** All the figures in the document are captured from TwinCAT 3.1.

### 1.1.1 Abbreviations

ADC - Analog to Digital Converter

DAC - Digital to Analog Converter

ESC - EtherCAT Slave Controller

EVB - Evaluation Board

GPIO - General Purpose Input/Output

HAL - Hardware Abstraction Layer

HBI - Host Bus Interface

IDE - Integrated Development Environment

SPI - Serial Protocol Interface

SSC - Slave Stack Code

SoC - System on a Chip

UART - Universal Asynchronous Receiver/Transmitter

# Chapter 2. EVB-LAN9252-HBI+

## 2.1 EVB-LAN9252-HBI+ IN HBI MODE

### 2.1.1 EtherCAT Master and Slave Configuration

The following steps describe how to configure the LAN9252-HBI:

1. Configure the Master with the TwinCAT driver.

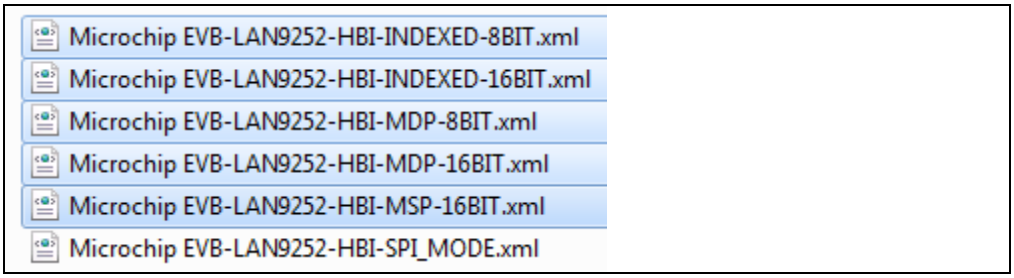
   Refer to **Appendix A. "Setting Up Master in Windows®"** to configure the TwinCAT in Windows.

2. Download and extract `EVB-LAN9252-HBI_SPI_PIC32_SDK_Vx.x.zip` from the Microchip website (http://www.microchip.com/LAN9252-041715a).

**Note:** Vx.x denotes the version number of the SDK.

3. In the SDK, the `\ESI Files` directory contains the ESI files which can be loaded to EVB-LAN9252-HBI+ EEPROM using TwinCAT, as displayed in Figure 2-1.

**FIGURE 2-1: ESI FILES DIRECTORY**




HBI ESI files:

| ESI File name | Description |
|---|---|
| `Microchip EVB-LAN9252-HBI-INDEXED-8BIT.xml` | Configures LAN9252 in HBI - Indexed 8-bit mode. |
| `Microchip EVB-LAN9252-HBI-INDEXED-16BIT.xml` | Configures LAN9252 in HBI - Indexed 16-bit mode. |
| `Microchip EVB-LAN9252-HBI-MDP-8BIT.xml` | Configures LAN9252 in HBI - Multiplexed dual phase 8-bit mode. |
| `Microchip EVB-LAN9252-HBI-MDP-16BIT.xml` | Configures LAN9252 in HBI - Multiplexed dual phase 16-bit mode |
| `Microchip EVB-LAN9252-HBI-MSP-16BIT.xml` | Configures LAN9252 in HBI - Multiplexed single phase 16-bit mode. |

**Note:** Refer to **Appendix D. "Generating SSC Files"** to change the Vendor ID and slave information in the ESI files.

4. Copy `Microchip EVB-LAN9252-HBI-MSP-16BIT.xml` for this example to the directory path `C:\TwinCAT\3.1\Config\Io\EtherCAT` for TwinCAT 3.1.

> **Note:** There can only be one microchip `.xml` file present in the directory path at a time. Please remove any `.xml` not being used.

5. Configure the evaluation board in HBI mode and change the switches to 16-bit Multiplexed single-phase mode, as mentioned in "Section 2.4 Configuration" of *EVB-LAN9252-HBI-SPI-SQI-GPIO EtherCAT User's Guide*, which can be downloaded from the Microchip website (http://www.microchip.com/Development-Tools/ProductDetails.aspx?PartNO=evb-lan9252-hbi).
6. By default, the corresponding ESI file of PIC32 firmware is flashed to the delivered EVB-LAN9252-HBI+. Refer to **Appendix F. "Programming PIC32 Firmware Using Pre-Built Binaries"**

   To change the firmware in the PIC32 SoC, refer to **Appendix D. "Generating SSC Files"** and **Appendix E. "Compiling and Programming SoC Firmware"**.

> **Note:** The pre-built binaries are available from the `Binaries` directory found in the SDK.

7. Launch TwinCAT and scan EtherCAT slaves from TwinCAT.

   Refer to **Appendix C. "Scanning EtherCAT Slaves"** for steps on scanning EtherCAT slaves.

> **Note:** Please reset the board using SW2 or go to TWINCAT -> EtherCAT Devices ->Reload Device Descriptions

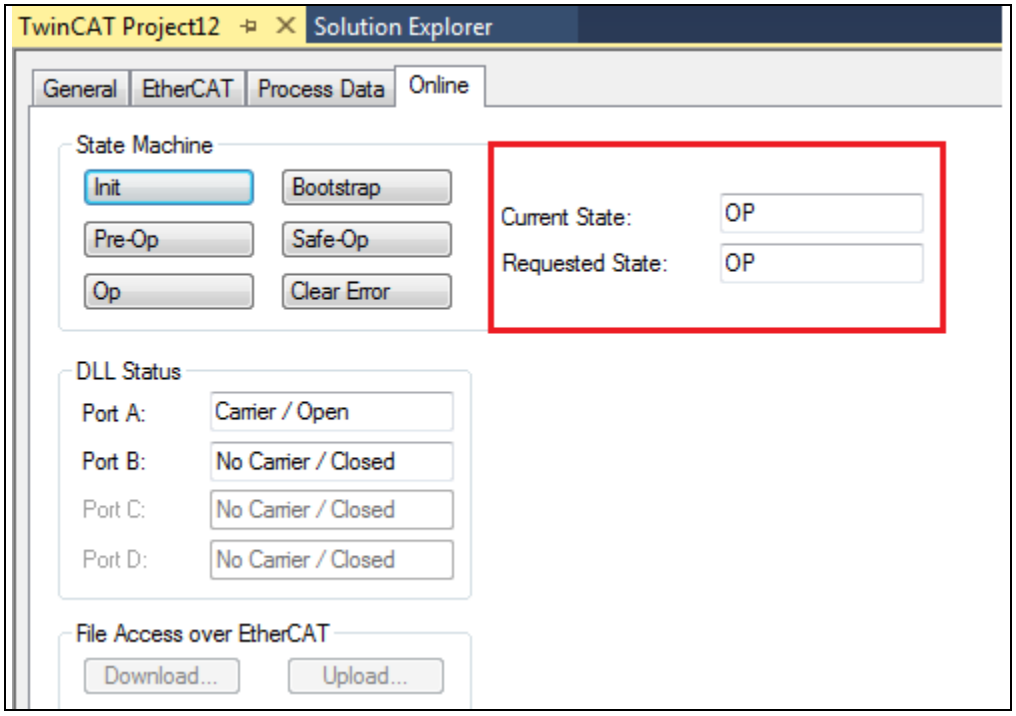
8. Program EEPROM using `Microchip EVB-LAN9252-HBI-MSP-16BIT.xml`.

   Refer to **Appendix B. "EEPROM Programming"** for steps on EEPROM programming.

   Once the EEPROM has been programmed, power cycle the board without closing the TwinCAT project.

   If the EEPROM programming is successful, the state will change to 'OP' mode as displayed in Figure 2-2.

**FIGURE 2-2: OP MODE**



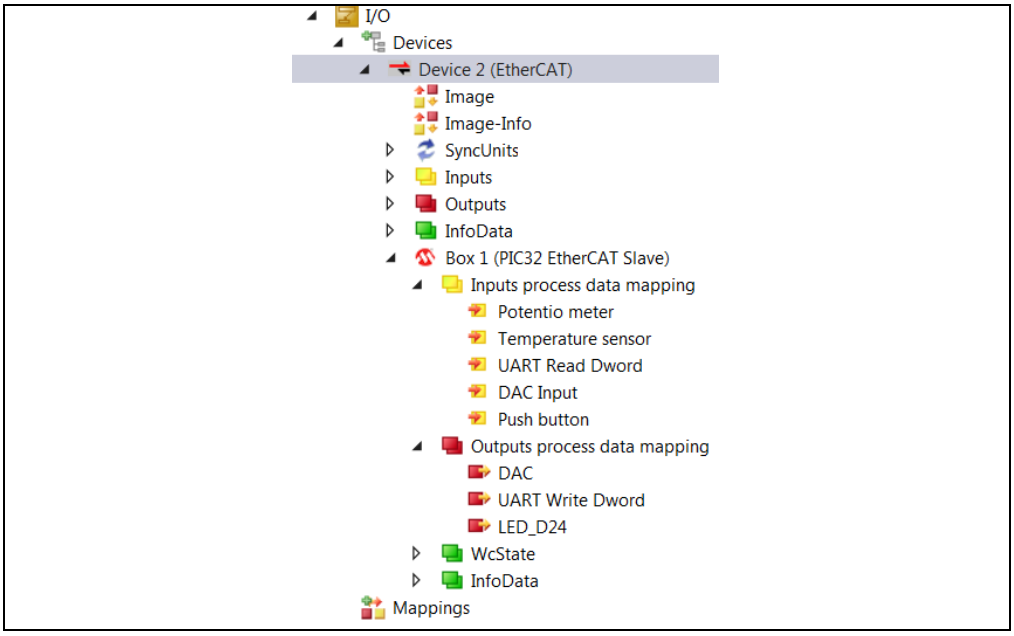

**Note:** If it changes to OP mode as highlighted above, then the device is in operational state. Otherwise there is an issue with the setup.

### 2.1.2 HBI Demo

The following describes a demo of EVB-LAN9252-HBI+ in HBI mode:

1. Follow the steps as provided in **Section 2.1.1 "EtherCAT Master and Slave Configuration"**. Eight demo objects exist, 3 Outputs and 5 inputs, that can be seen on the Solution Explorer of the TwinCAT tool, as displayed in Figure 2-3.

**FIGURE 2-3: HBI DEMO**




As part of this demo, eight object variables are mapped to PIC32 pins as detailed in Table 2-1.

**TABLE 2-1: OBJECT VARIABLE MAPPING**

| Variable | PIC32 GPIO |
|---|---|
| Potentiometer (Input) | PIC32 RB1 |
| Temperature Sensor (Input) | PIC32 RB0 |
| UART Read Dword (Input) | PIC32 RF2 |
| DAC Input (Input) | PIC32 AETXEN and PIC32 AETXCLK |
| Push Button (Input) | PIC32 RD3 |
| DAC (Output) | PIC32 RB2 |
| UART Write Dword (Output) | PIC32 RF8 |
| LED_D24 (Output) | PIC32 RD2 |

2. To change GPIO inputs, click the Inputs process data mapping option under Box 1 in the Solution Explorer, as displayed in Figure 2-3.

   The TwinCAT project window displays.

3. There are 5 different inputs that can be observed in Figure 2-4:
   - Potentiometer can be adjusted on the board (ADC Pot1: See Figure 2-7).
   - Temperature Senor output can be used to calculate ambient temperature. Refer to **Section 2.3.1 “Calculating Temperature”** for more information.
   - UART Read Dword will display the information seen on RX from J24 RS232 connector. It will be a decimal number reflecting 4 characters. Refer to **Section 2.3.2 “UART Decimal to ASCII Conversion”** for information on converting this decimal number into hex and eventually ASCII.
   - DAC Input will display the input data going into the PIC. Refer to **Section 2.3.3 “DAC Calculations”** for how this number is obtained.
   - Push Button (SW50: See Figure 2-7) will be 1 when not pressed and 0 when pressed.

**FIGURE 2-4: INPUT VALUES**

| Name | Online | Type | Size | >Ad... | In/O... | User... | Linked to |
|---|---|---|---|---|---|---|---|
| Potentiometer | 511 | UDINT | 4.0 | 39.0 | Input | 0 | |
| Temperature... | 236 | UDINT | 4.0 | 43.0 | Input | 0 | |
| UART Read ... | 1482185281 | UDINT | 4.0 | 47.0 | Input | 0 | |
| DAC Input | 251 | UDINT | 4.0 | 51.0 | Input | 0 | |
| Push button | 1 | BIT | 0.1 | 55.0 | Input | 0 | |

4. To view GPIO outputs, click Outputs process data mapping under Box 1 in the Solution Explorer, as displayed in Figure 2-3.
5. There are 3 different outputs that can be observed in Figure 2-5:
   - DAC is a value that can be set and will adjust the DAC output voltage as well as the ADC output. Refer to **Section 2.3.3 "DAC Calculations"** for more information.
   - UART Write Dword will output the value entered through TX on J24 RS232 connector in a repeated fashion.
   - LED_D24 can be set as high or low as can be seen in Figure 2-6 and on the board in Figure 2-7.

**FIGURE 2-5: OUTPUT VALUES**

| Name | Online | Type | Size | >Ad... | In/O... | User... | Linked to |
|---|---|---|---|---|---|---|---|
| DAC | 1004 | UDINT | 4.0 | 39.0 | Out... | 0 | |
| UART Write ... | 0 | UDINT | 4.0 | 43.0 | Out... | 0 | |
| LED_D24 | 1 | BIT | 0.1 | 47.0 | Out... | 0 | |

**FIGURE 2-6: GPIO_INPUTS VARIABLE**

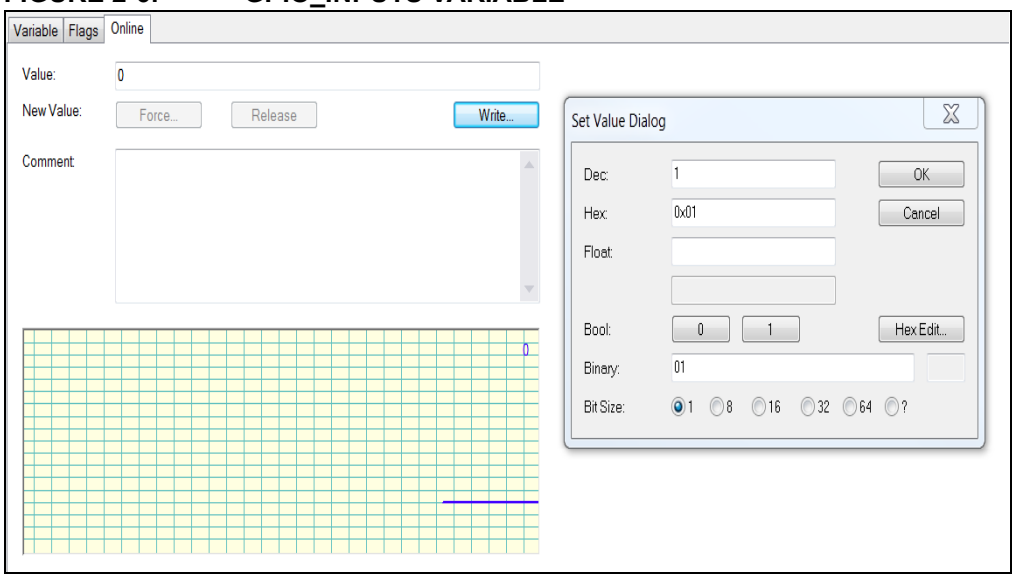
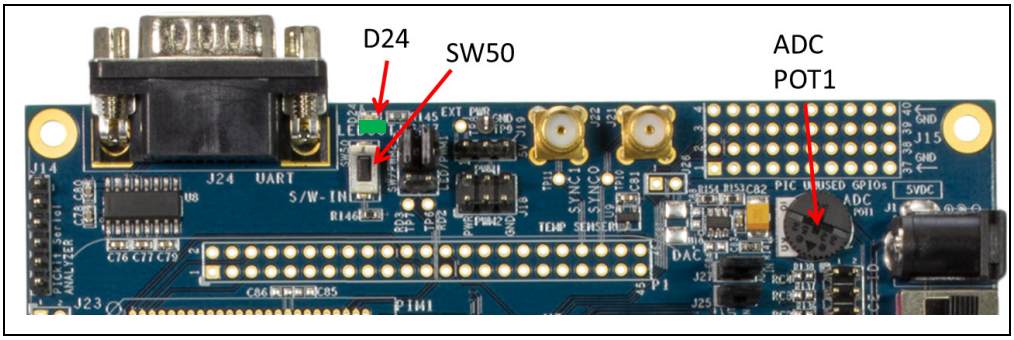


**FIGURE 2-7: FEATURES ON HBI+ BOARD**




## 2.2 EVB-LAN9252-HBI+ IN SPI MODE

### 2.2.1 EtherCAT Master and Slave Configuration

1. Configure the Master with the TwinCAT driver.

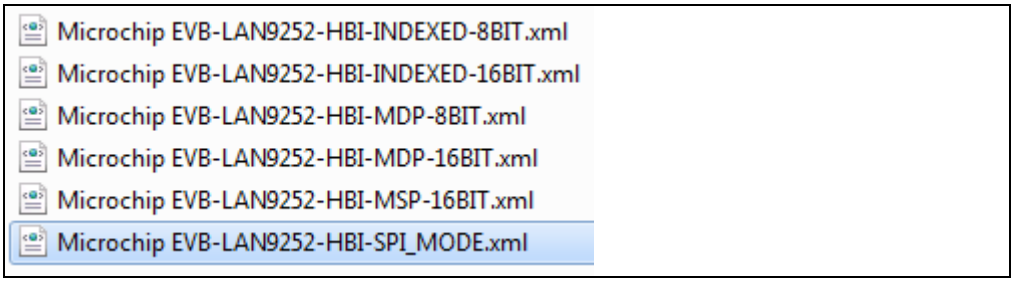
   Refer to **Appendix A. "Setting Up Master in Windows®"** to configure the TwinCAT in Windows.

2. Download and extract `EVB-LAN9252-HBI_PIC32_SDK_Vx.x.zip` from the Microchip website (http://www.microchip.com/LAN9252-041715a).

| **Note:** | Vx.x denotes the version number of the SDK. |
|---|---|

3. In SDK, the `\ESI Files` directory contains the ESI files which can be loaded to EVB-LAN9252-HBI+ EEPROM using TwinCAT, as displayed in Figure 2-8.

**FIGURE 2-8: ESI FILES DIRECTORY**




SPI ESI files:

| ESI File name | Description |
|---|---|
| `Microchip EVB-LAN9252-HBI-SPI_MODE.xml` | Configures LAN9252 in SPI with GPIO - 2-port mode. |

| **Note:** | Refer to **Appendix D. "Generating SSC Files"** to change the Vendor ID and slave information in the ESI files. |
|---|---|

4. Copy `Microchip EVB-LAN9252-HBI-SPI_MODE.xml` to the directory path `C:\TwinCAT\3.1\Config\Io\EtherCAT` for TwinCAT 3.1.

| **Note:** | There can only be one microchip `.xml` file present in the directory path at a time. Please remove any `.xml` not being used. |
|---|---|

5. Configure the evaluation board in SPI mode as mentioned in “Section 2.4 Configuration” of *EVB-LAN9252-HBI-SPI-SQI-GPIO EtherCAT User's Guide*, which can be downloaded from the Microchip website (http://www.microchip.com/DevelopmentTools/ProductDetails.aspx?PartNO=evb-lan9252-hbi).
6. By default, the corresponding ESI file of PIC32 firmware is flashed to the delivered EVB-LAN9252-HBI+. Refer to **Appendix F. “Programming PIC32 Firmware Using Pre-Built Binaries”**

   To change the firmware in PIC32 SoC, refer to **Appendix D. “Generating SSC Files”** and **Appendix E. “Compiling and Programming SoC Firmware”**..

**Note:** The pre-built binaries are available from the `Binaries` directory. This step can be skipped if pre-built binary is used for programming.

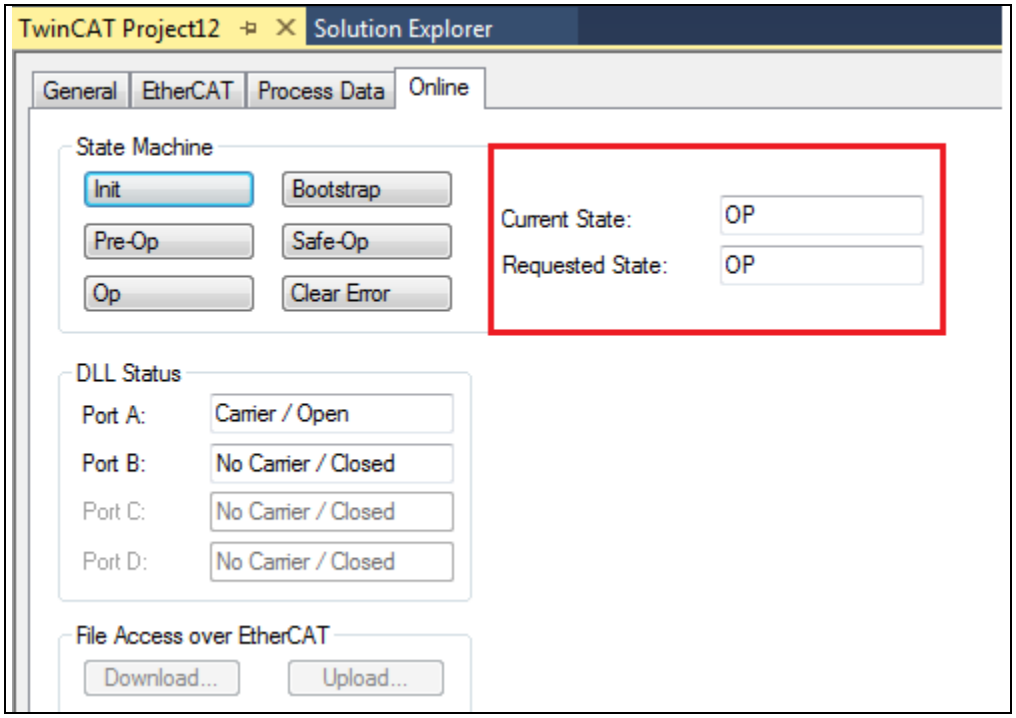
7. Launch TwinCAT and scan EtherCAT slaves from TwinCAT.

   Refer to **Appendix C. “Scanning EtherCAT Slaves”** for steps on scanning EtherCAT slaves.
8. Program `Microchip EVB-LAN9252-HBI-SPI_MODE.xml` ESI file to EEPROM using TwinCAT.

   Once the EEPROM has been programmed, power cycle the board without closing the TwinCAT project.

   If the EEPROM programming is successful, state will change to ‘OP’ mode as displayed in Figure 2-9.

**FIGURE 2-9: OP MODE**



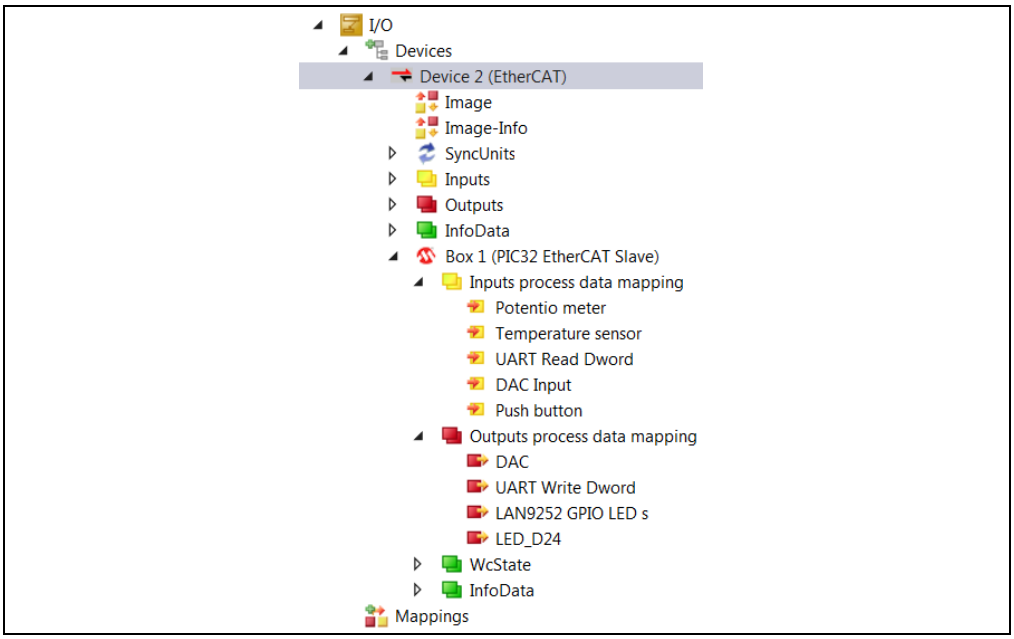

**Note:** If it changes to OP mode as highlighted above, then the device is in operational state. Otherwise there is an issue with the setup.

### 2.2.2 SPI Demo

The following describes a demo of EVB-LAN9252-HBI+ in SPI mode:

1. Follow the steps as provided in **Section 2.2.1 "EtherCAT Master and Slave Configuration"**. Nine demo objects, 4 outputs and 5 inputs, can be seen on the Solution Explorer of the TwinCAT tool, as displayed in Figure 2-10.

**FIGURE 2-10: SPI DEMO**




2. As part of this demo, nine object variables are mapped to LAN9252 GPIOs as in Table 2-2.

**TABLE 2-2: OBJECT VARIABLE MAPPING**

| Variable | LAN/PIC32 GPIOs |
|---|---|
| Potentiometer (Input) | PIC32 RB1 |
| Temperature Sensor (Input) | PIC32 RB0 |
| UART Read Dword (Input) | PIC32 RF2 |
| DAC Input (Input) | PIC32 AETXEN and PIC32 AETXCLK |
| Push Button (Input) | PIC32 RD3 |
| DAC (Output) | PIC32 RB2 |
| UART Write Dword (Output) | PIC32 RF8 |
| LAN9252 GPIO LEDs (Output) | LAN9252 GPO0-15 |
| LED_D24 (Output) | PIC32 RD2 |

3. To change GPIO inputs, click the Inputs process data mapping option under Box 1 in the Solution Explorer, as displayed in Figure 2-10.

   The TwinCAT project window displays.

4. There are 5 different inputs that can be observed in Figure 2-11:
   - Potentiometer can be adjusted on the board (ADC Pot1: See Figure 2-7).
   - Temperature Senor output can be used to calculate ambient temperature. Refer to **Section 2.3.1 "Calculating Temperature"** for more information.
   - UART Read Dword will display information seen on RX from J24 RS232 connector. It will be a decimal number reflecting 4 characters. Refer to **Section 2.3.2 "UART Decimal to ASCII Conversion"** for information on

converting this decimal number into hex and eventually ASCII.

- DAC Input will display the input data going into the PIC. Refer to **Section 2.3.3 "DAC Calculations"** for how this number is obtained.
- Push Button (SW50: See Figure 2-7) will be 1 when not pressed and 0 when pressed.

**FIGURE 2-11: INPUTS IN SPI MODE**

| Name | Online | Type | Size | >Ad... | In/O... | User... | Linked to |
|---|---|---|---|---|---|---|---|
| Potentiometer | 511 | UDINT | 4.0 | 39.0 | Input | 0 | |
| Temperature... | 236 | UDINT | 4.0 | 43.0 | Input | 0 | |
| UART Read ... | 1482185281 | UDINT | 4.0 | 47.0 | Input | 0 | |
| DAC Input | 251 | UDINT | 4.0 | 51.0 | Input | 0 | |
| Push button | 1 | BIT | 0.1 | 55.0 | Input | 0 | |

5. To view GPIO outputs, click Outputs process data mapping under Box 1 in the Solution Explorer, as displayed in Figure 2-10.
6. There are 4 different outputs that can be observed in Figure 2-12:
   - DAC is a value that can be set and will adjust the DAC output voltage as well as the ADC output. Refer to **Section 2.3.2 "UART Decimal to ASCII Conversion"** for information on how to calculate this.
   - UART Write Dword will output the value entered through TX on J24 RS232 connector in a repeated fashion.
   - LAN9252 GPIO LEDs can be turned on and off by clicking on LAN9252 GPIO LEDs under the Outputs process data mapping. An example on how to do this and what it looks like on the board can be seen in Figure 2-13 and Figure 2-14 respectively.
   - LED_D24 (See Figure 2-7) can be set as high or low for on or off respectively.

**FIGURE 2-12: OUTPUTS IN SPI MODE**

| Name | Online | Type | Size | >Ad... | In/O... | User... | Linked to |
|---|---|---|---|---|---|---|---|
| DAC | 0 | UDINT | 4.0 | 39.0 | Out... | 0 | |
| UART Write ... | 0 | UDINT | 4.0 | 43.0 | Out... | 0 | |
| LAN9252 GPI... | 33825 | UDINT | 4.0 | 47.0 | Out... | 0 | |
| LED_D24 | 0 | BIT | 0.1 | 51.0 | Out... | 0 | |

**FIGURE 2-13: SETTING LAN9252 GPIO OUTPUTS**

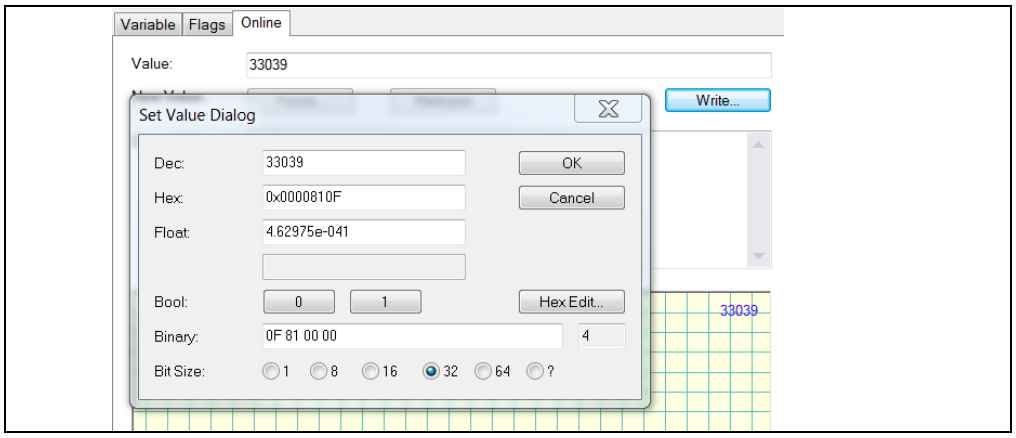
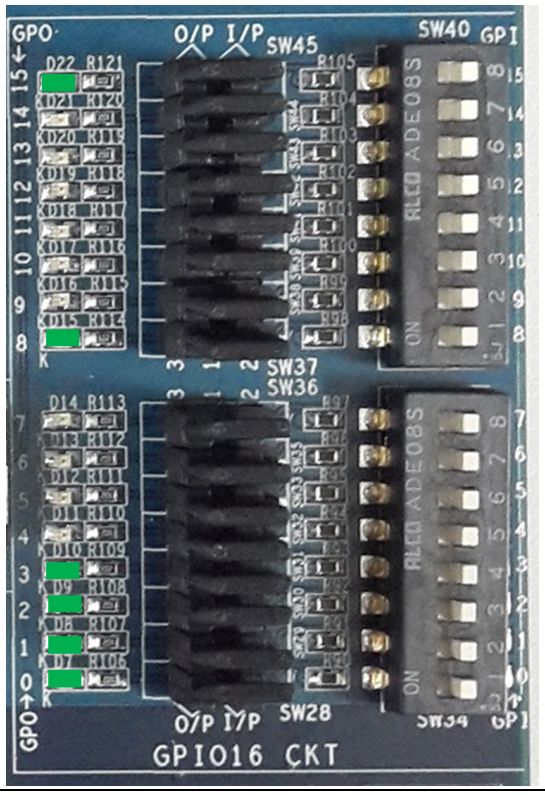


**FIGURE 2-14: MODIFIED GPIOS ON THE BOARD**




## 2.3 EVB-LAN9252-HBI+ CALCULATIONS

### 2.3.1 Calculating Temperature

The Vout of the temperature sensor is connected to the ADC. The output of the ADC (ADCout) will be the value displayed in the EtherCAT application and be named Temperature Sensor. To get the output voltage (Vout) see Equation 2-1

**EQUATION 2-1: TEMP SENSOR VOUT**

$$Vout = \left(\frac{ADCout \times 3300mV}{1023mV}\right)$$

Now use Vout and calculate the temperature in degrees Celsius (Equation 2-2):

**EQUATION 2-2: TEMPERATURE**

$$Temp(°C) = \left(\frac{Vout - 500mV}{10\frac{mV}{°C}}\right)$$

**EXAMPLE 2-1: ETHERCAT APPLICATION OUTPUTS 235 (ADCOUT=235).**

$$Vout = \frac{(235 \times 3300mV)}{1023mV} = 758.06mV$$

$$Temp(°C) = \frac{(758.06mV - 500mV)}{10\frac{mV}{°C}} = 25.8°C$$

### 2.3.2 UART Decimal to ASCII Conversion

The EtherCAT application will display the UART input as decimal. This decimal number represents 4 different characters. Example 2-2 details how to convert from a decimal number to hex and then ASCII. The characters entered in order were a, A, 1, !.

**EXAMPLE 2-2: DECIMAL TO HEX TO ASCII**

Decimal = 556876129
Hex = 0x21314161
ASCII = 21 = !
ASCII = 31 = 1
ASCII = 41 = A
ASCII = 61 = a

### 2.3.3 DAC Calculations

Depending on the value entered into the DAC Output, a calculated voltage will be present on the DAC output. This voltage is then sent to the ADC on the PIC and this number is displayed on the DAC input. An example can be found in Example 2-3 below. The first equation needed is the calculation of the output voltage of the DAC (Equation 2-3).

**EQUATION 2-3: DAC OUT**

$$\text{DACout} = \frac{(3300\text{mV} \times \text{DAC})}{\text{\# of Resistors in Ladder}}$$

# of Resistors in Ladder will always be 4096 for this board

After calculating the DAC output voltage, it is possible to determine the value produced from the ADC (Equation 2-4).

**EQUATION 2-4: ADC OUT**

$$\text{ADCout} = \frac{(\text{DACout} \times 1023)}{3300}$$

1023 is the MAX ADC according to the ADC Transfer Function

**EXAMPLE 2-3: A VALUE OF 1250 IS ENTERED INTO THE DAC OUTPUT.**

$$\text{DACout} = \frac{(3300\text{mV} \times 1250\text{mV})}{4096} = 1007\text{mV}$$

$$\text{ADCout} = \frac{(1007\text{mV} \times 1023)}{3300\text{mV}} = 312$$

# Appendix A. Setting Up Master in Windows®

## A.1 INTRODUCTION

This appendix details how to setup a Master in Windows®.

Download and install TwinCAT on Windows from http://beckhoff.com.

### A.1.1 TwinCAT Ethernet Driver - Installation

To install the TwinCAT Ethernet Driver:

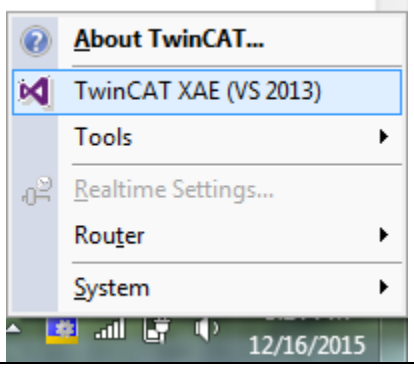
1. If TwinCAT installed successfully, a TwinCAT icon will display in the bottom-right corner of the desktop. Click the TwinCAT icon.

   A pop-up menu displays.

2. Select TwinCAT XAE (VS XXXX), as displayed in Figure A-1.

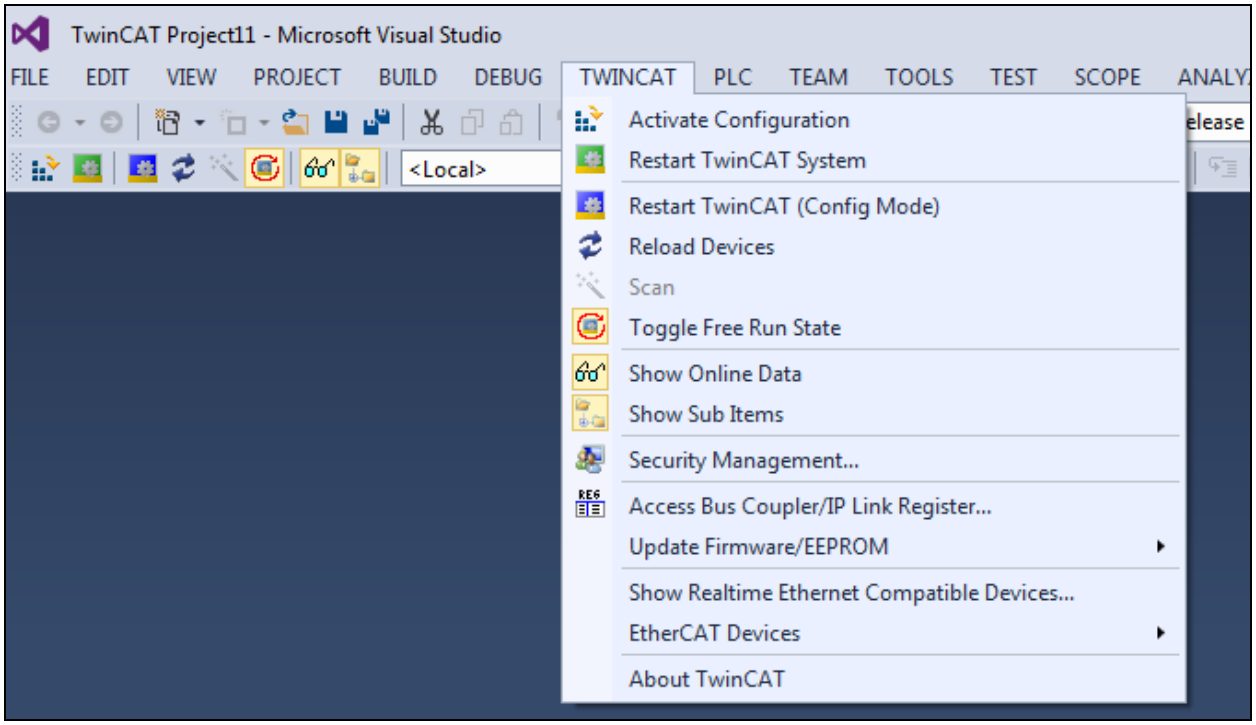
**Note:** VS XXXX refers to the version of Visual Studio installed on the computer.

**FIGURE A-1: SYSTEM MANAGER**



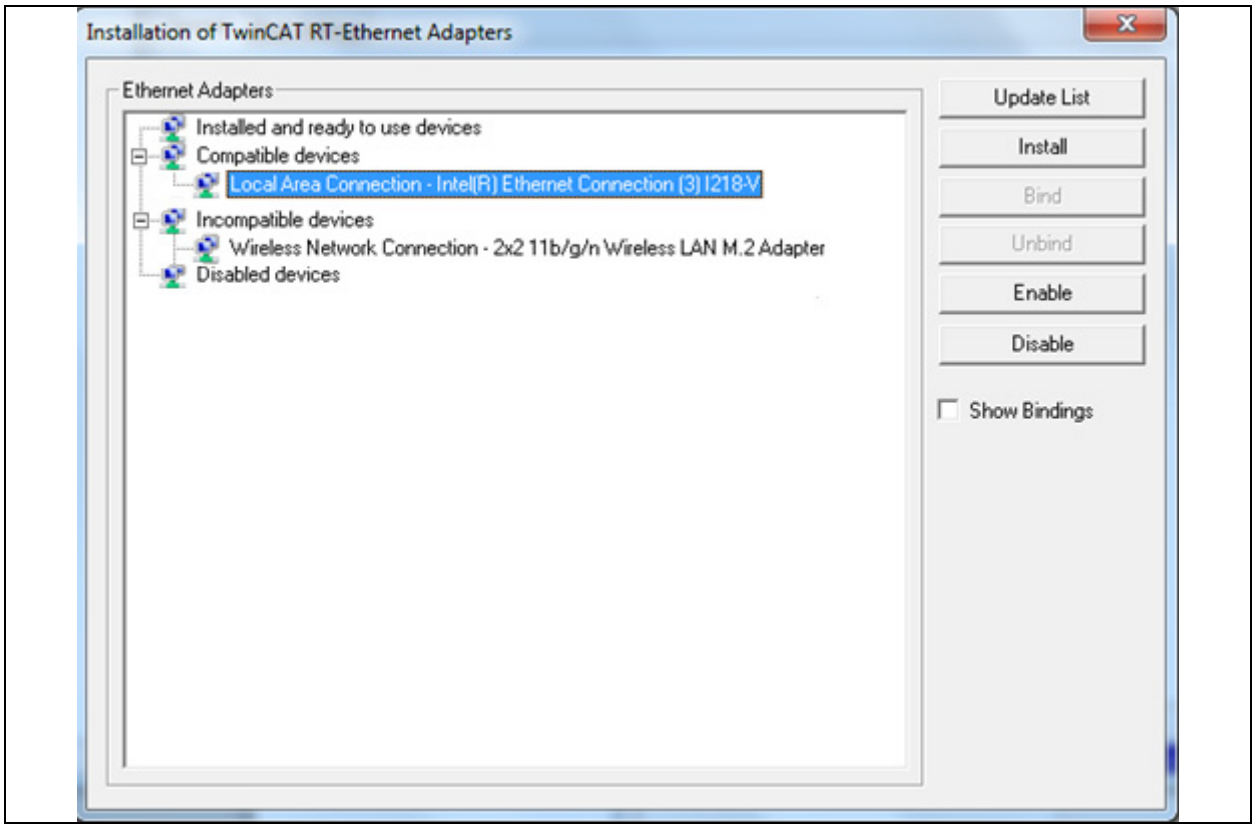

3. Go to *TWINCAT>Show Real Time Ethernet Compatible Devices…* as in Figure A-2.

**FIGURE A-2: SHOW REAL TIME ETHERNET COMPATIBLE DEVICES**



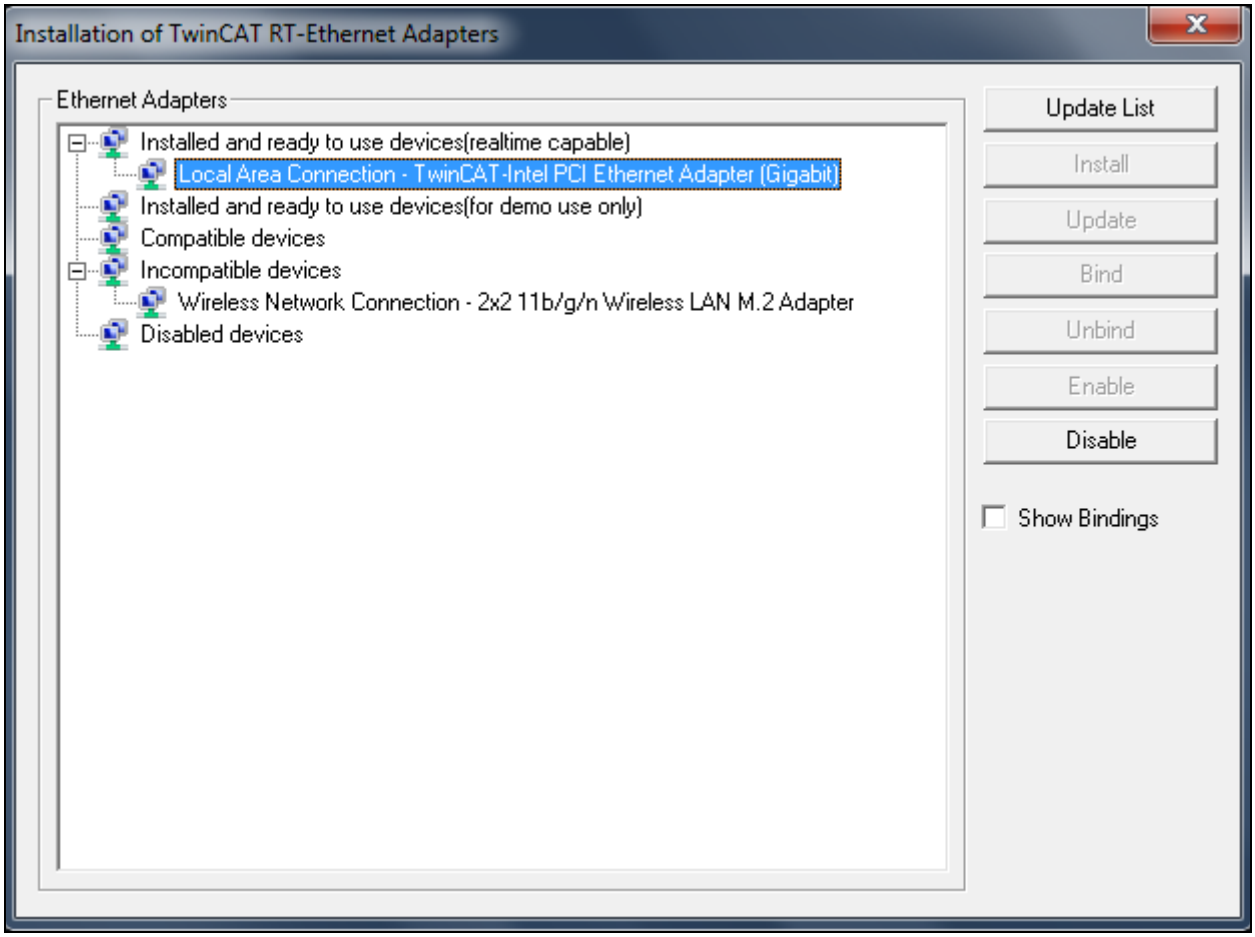

4. Select the network adapter and install the TwinCAT driver as in Figure A-3.

**FIGURE A-3: ETHERNET ADAPTERS DIALOG**



Once the TwinCAT driver is installed successfully, the driver is compatible with the TwinCAT master. The network adapter will then be moved to “Installed and ready to use devices” as displayed in Figure A-4.

**FIGURE A-4: INSTALLED AND READY TO USE DEVICES**




5. Go to the corresponding network adapter properties and then select TwinCAT drivers as displayed in Figure A-5 and Figure A-6. To access network adapter properties as seen in the figures below go to Control Panel\Network and Internet\Network Connections.

**FIGURE A-5: NETWORK ADAPTER PROPERTIES MENU**

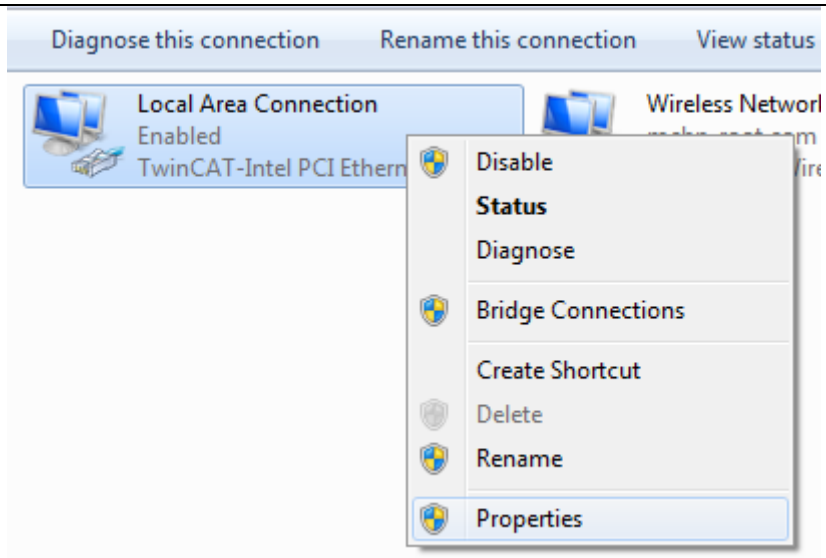
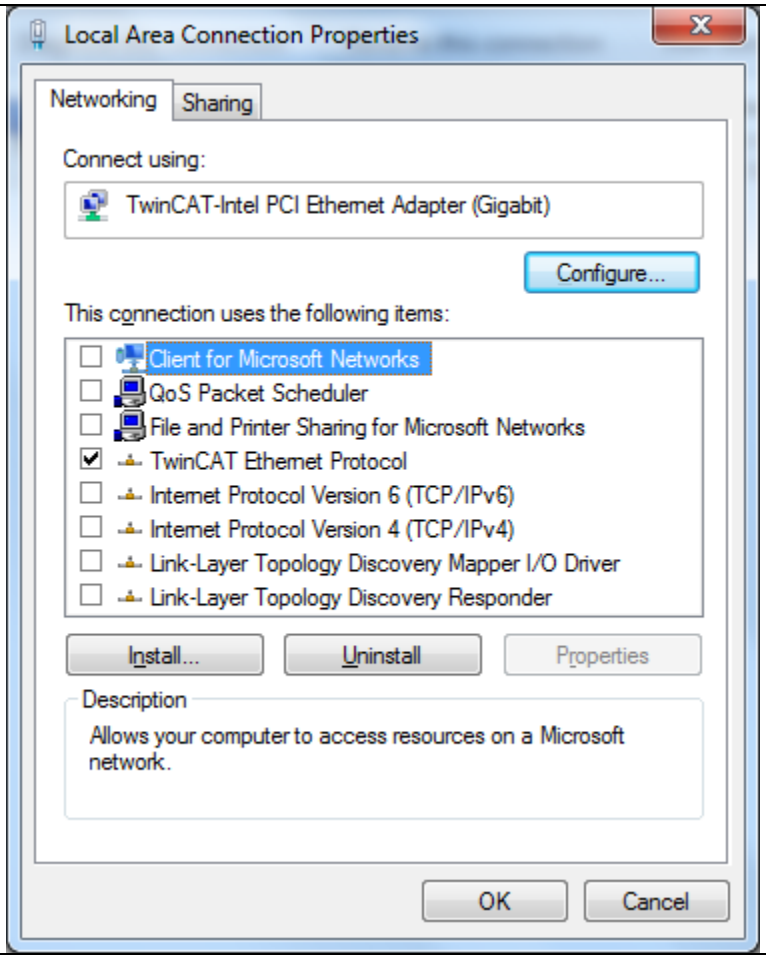



**FIGURE A-6: LOCAL AREA CONNECTION PROPERTIES**




**Note 1:** Only select TwinCAT drivers.

**2:** If TwinCAT cannot find the EtherCAT slaves after following the steps in **Appendix C. "Scanning EtherCAT Slaves"**, restart the computer and attempt to scan again.

# Appendix B. EEPROM Programming

## B.1 INTRODUCTION

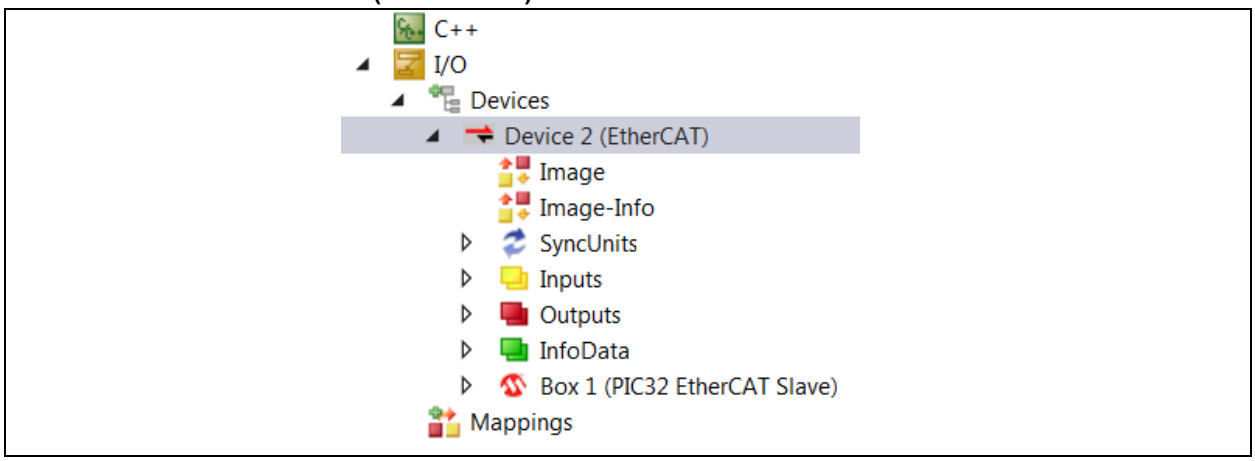
This appendix shows how to program EEPROM.

### B.1.1 EEPROM Programming

To program EEPROM:

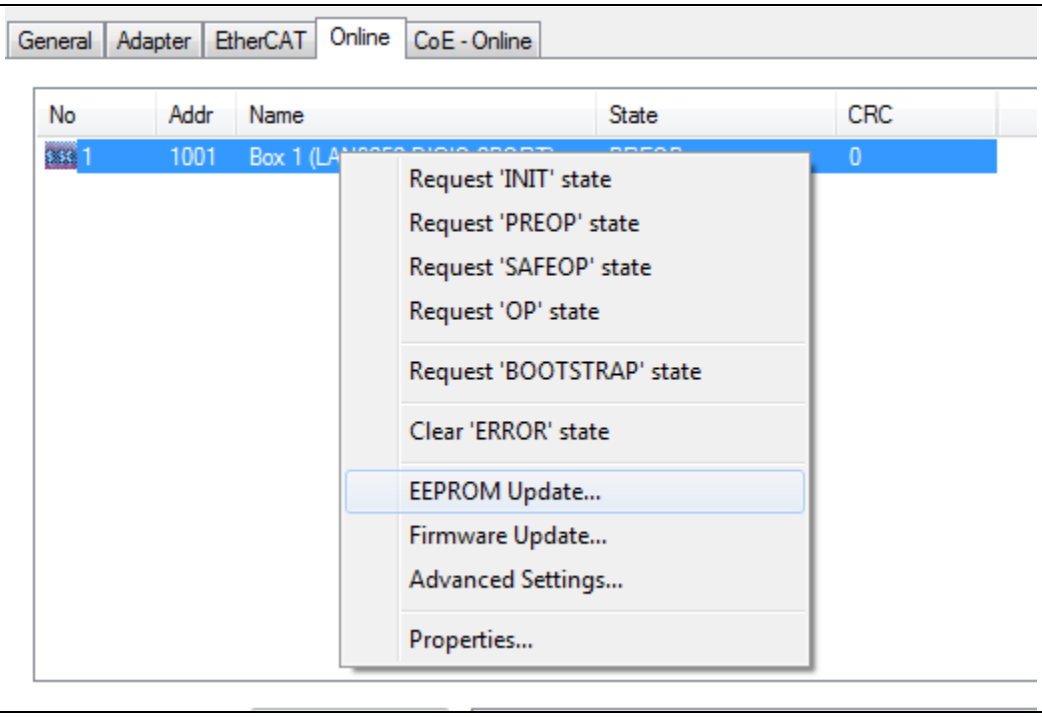
1. After a successful scan, click the arrow next to “Device 2 (EtherCAT)” on the Solution Explorer in the TwinCAT tool, as displayed in Figure B-1.

**FIGURE B-1: DEVICE 2 (ETHERCAT)**




2. Click the **Online** tab in the TwinCAT project window.
3. Right-click the LAN9252 listing and select EEPROM Update from the contextual menu, as displayed in Figure B-2.

**FIGURE B-2: EEPROM UPDATE**



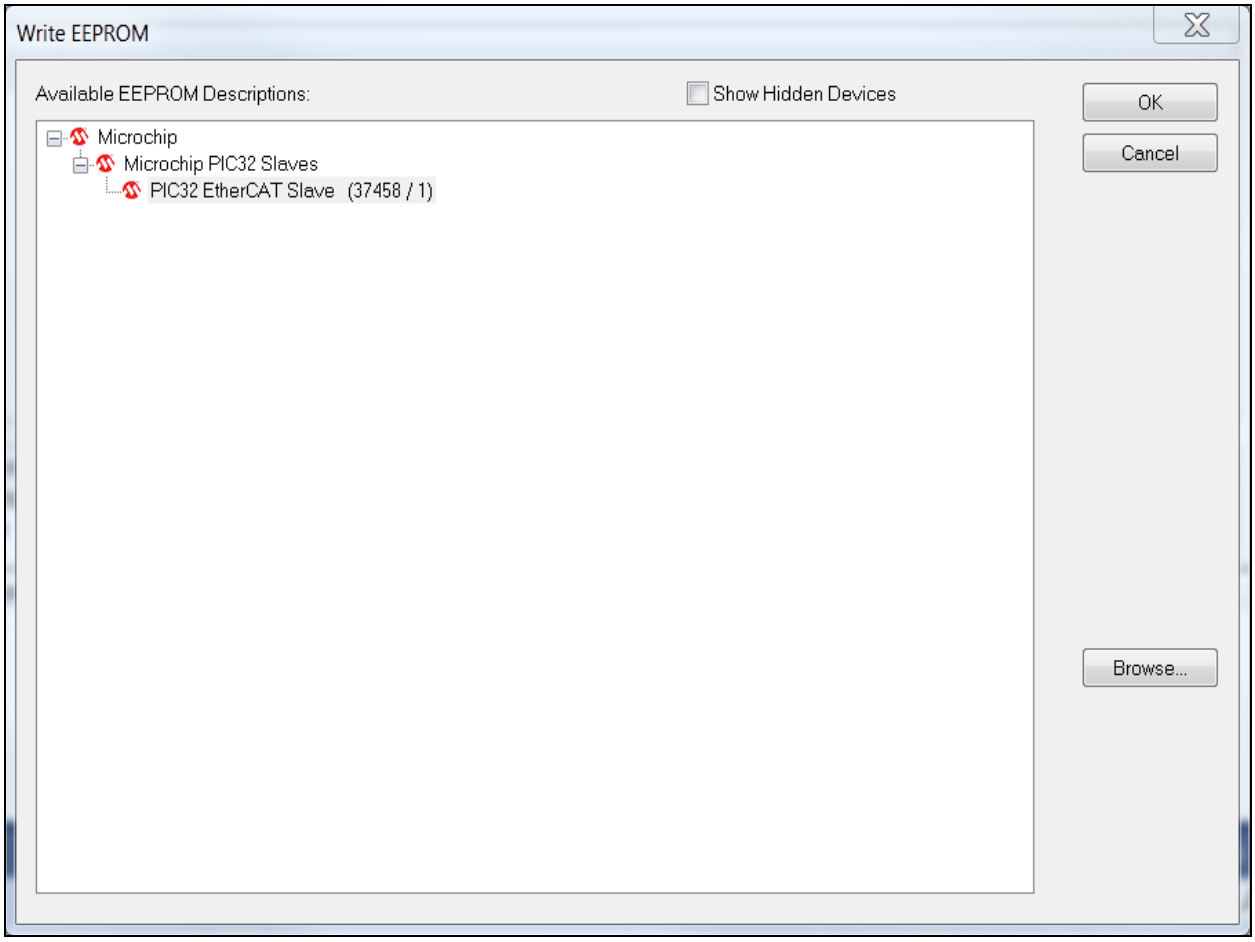

The Write EEPROM window displays.

4. Select the corresponding EEPROM configuration and then click **OK** to initiate EEPROM programming.

   For example, Figure B-3 shows LAN9252 one of DIGIO configuration is selected for EEPROM programming in TwinCAT.

**Note:** The xml file that is to be programmed MUST be copied into “C:\TwinCAT\3.1\Config\Io\EtherCAT

**FIGURE B-3: WRITE EEPROM DIALOG**



# Appendix C. Scanning EtherCAT Slaves

## C.1 INTRODUCTION

This appendix shows how to scan EtherCAT Slaves.

### C.1.1 Scanning EtherCAT Slaves

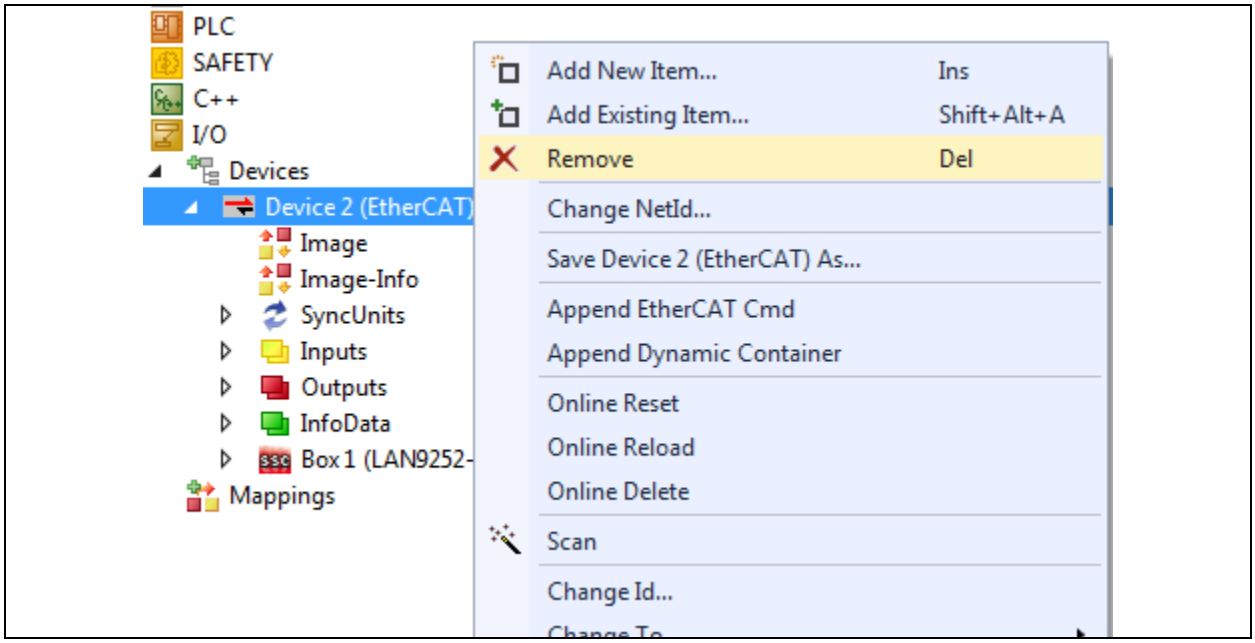
To scan EtherCAT slaves:

1. Connect Port 0 of the device to the master using RJ45 Ethernet cable, and then power up the board.

   The Link/Act LED should be ON at Port 0 when the cable is present. If the Link/Act LED is not ON, it indicates there is an issue with the connection or cable.

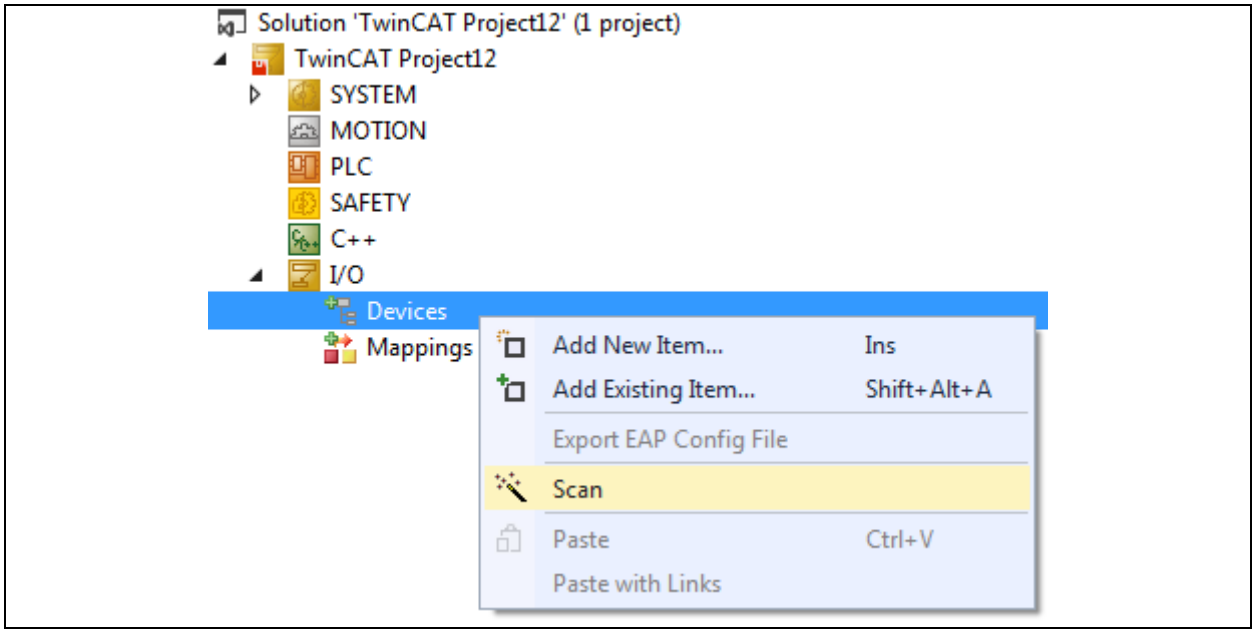
2. If any devices are present, delete them accordingly by right-clicking the device and selecting Remove, as displayed in Figure C-1.

**FIGURE C-1: REMOVE DEVICE**



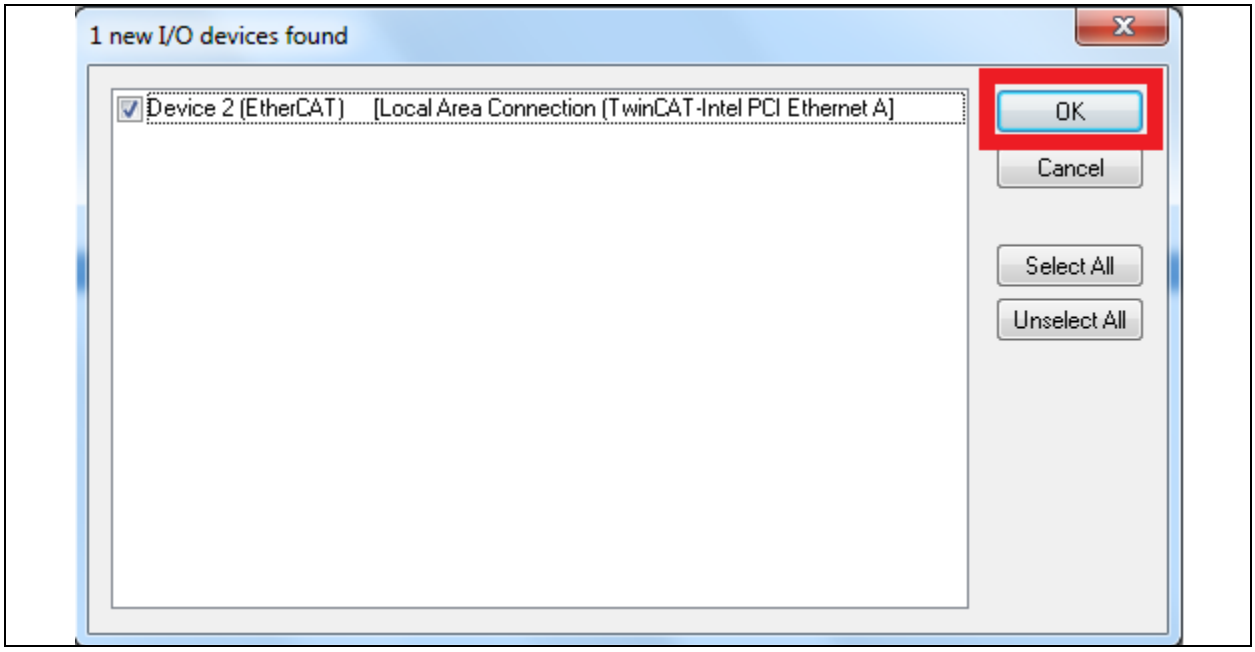

3. Scan for EtherCAT slave devices by right-clicking Devices under I/O and then selecting Scan, as displayed in Figure C-2.

**FIGURE C-2: SCAN DEVICES MENU**



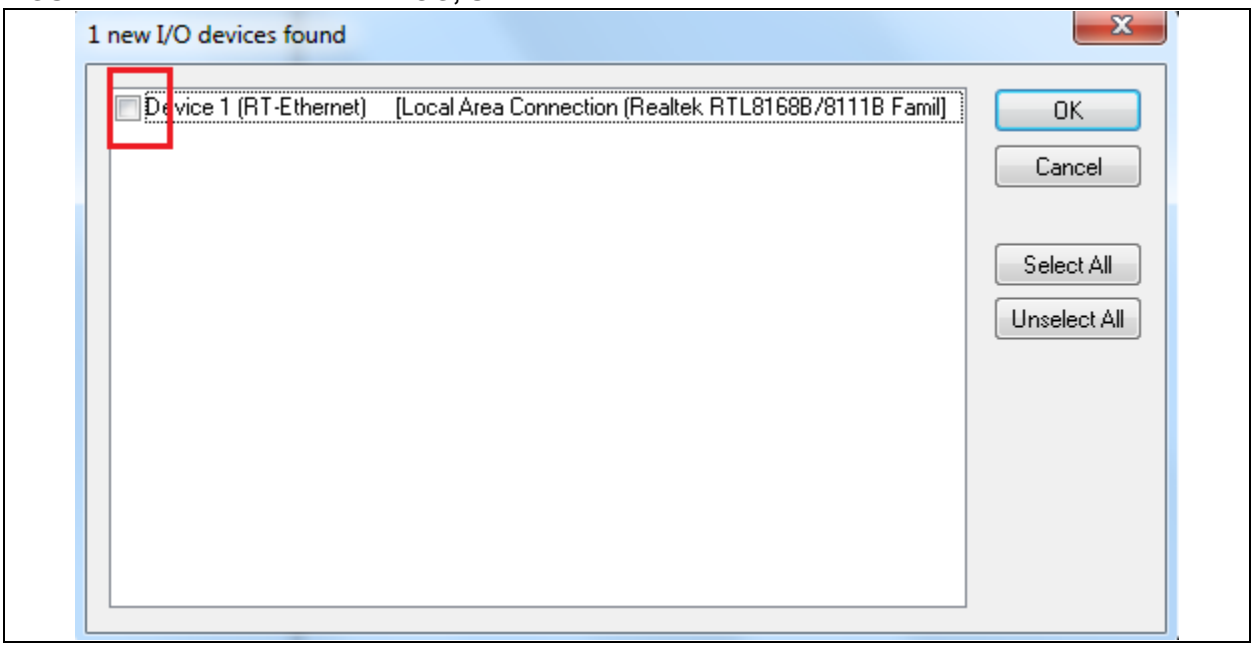

4. Click **OK** to continue scanning as in Figure C-3.

**FIGURE C-3: DEVICE DIALOG**



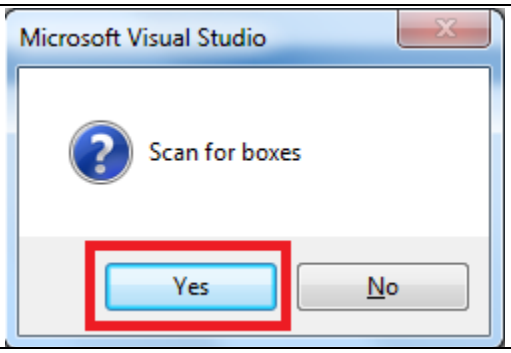

If the check box is not checked as displayed in Figure C-4, then either the device is not functional or the driver is not installed properly.

**FIGURE C-4: DEVICE DIALOG, UNCHECKED**



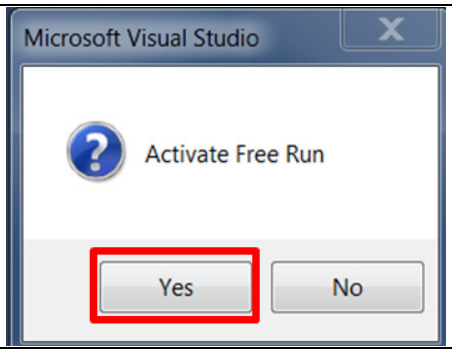

5. Click **Yes** as displayed in Figure C-5 to scan for boxes.

**FIGURE C-5: CONFIRMATION DIALOG**



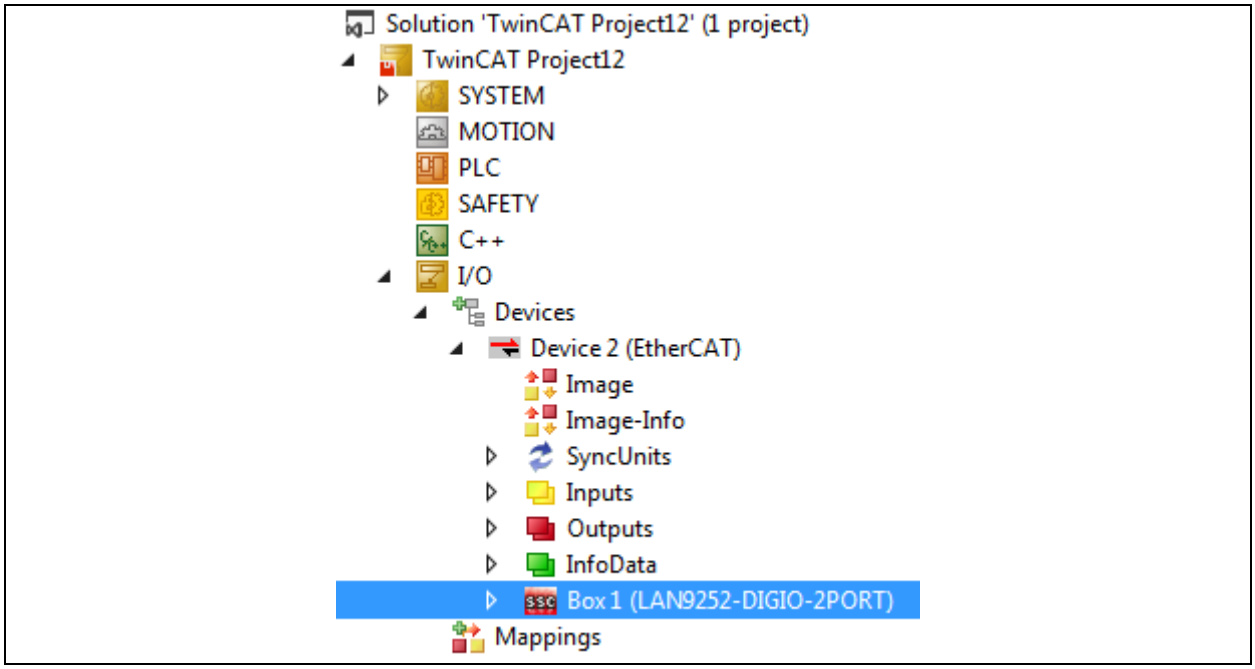

6. Click **Yes** as displayed in Figure C-6 to allow free run.

**FIGURE C-6: CONFIRMATION DIALOG 2**



7. The device list is displayed as seen in Figure C-7.

**FIGURE C-7: DEVICE LIST**




8. After a successful scan, there will be activity on Link/Act LED at Port 0 (It will blink rapidly).

# Appendix D. Generating SSC Files

## D.1 INTRODUCTION

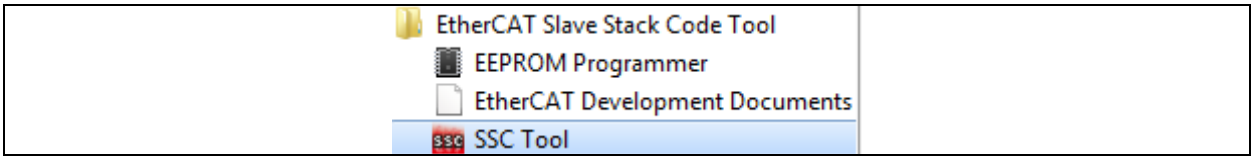
This appendix details how to generate SSC files. These files can be found here:
http://www.microchip.com/SWLibraryWeb/producttc.aspx?product=LAN9252%20EtherCAT%20SDK

### D.1.1 Generating SSC Files

To generate SSC files:

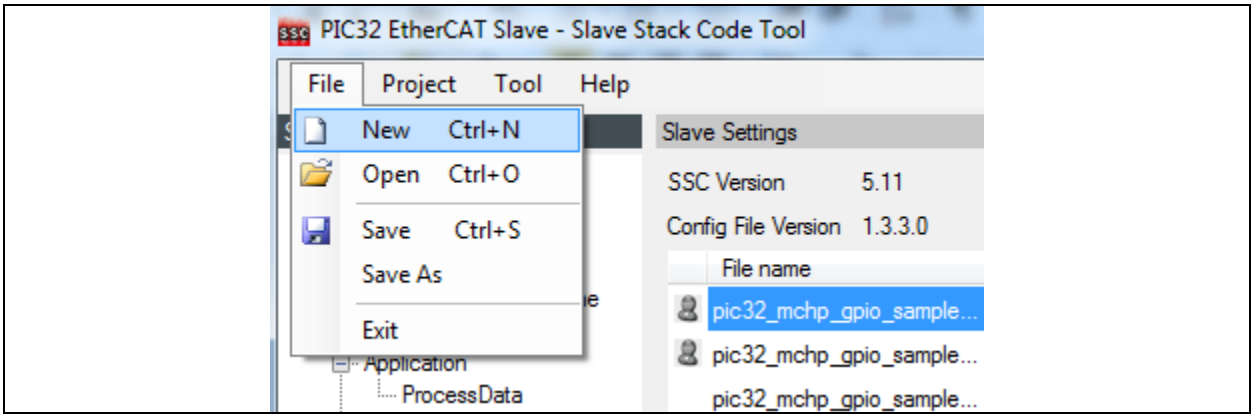
1. Start the SSC Tool from the Windows Start menu, as displayed in Figure D-1.

**FIGURE D-1: SSC TOOL**



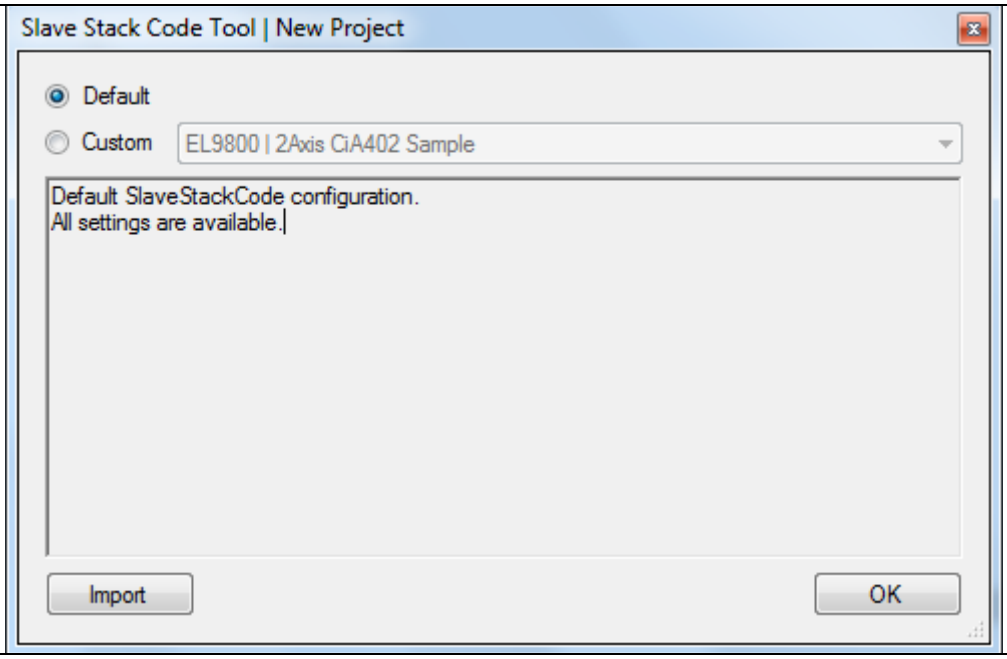

2. From the menu bar, click *File>New* as displayed in Figure D-2.

**FIGURE D-2: NEW ETHERCAT SLAVE**




3. Click **Import** to import the SSC Tool configuration file `Microchip EVB-LAN9252-HBI-SPI-SSC-CONFIG.xml` from the directory `{SDK_INSTALL_PATH}/EVB-LAN9252_SDK_VX.X/SSC/` as displayed in Figure D-3.

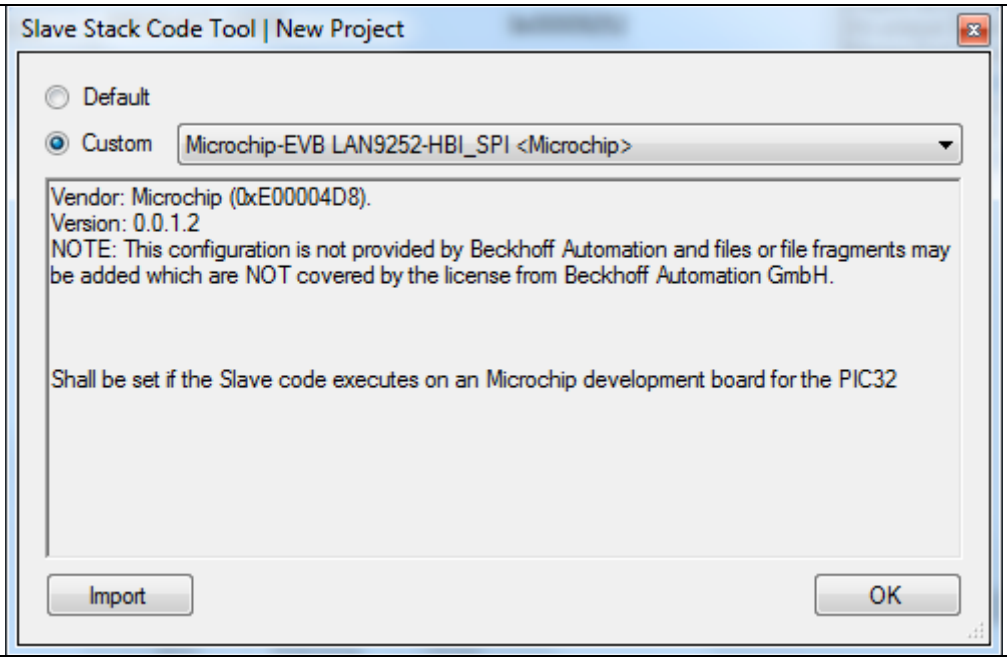
**FIGURE D-3: IMPORT PROJECT**




After selecting the file, click **Open** to import the SSC Tool configuration file.

4. Once imported, check the “Custom” drop-down box, select the “Microchip-EVB-LAN9252-HBI” configuration, and then click **OK**, as displayed in Figure D-4.

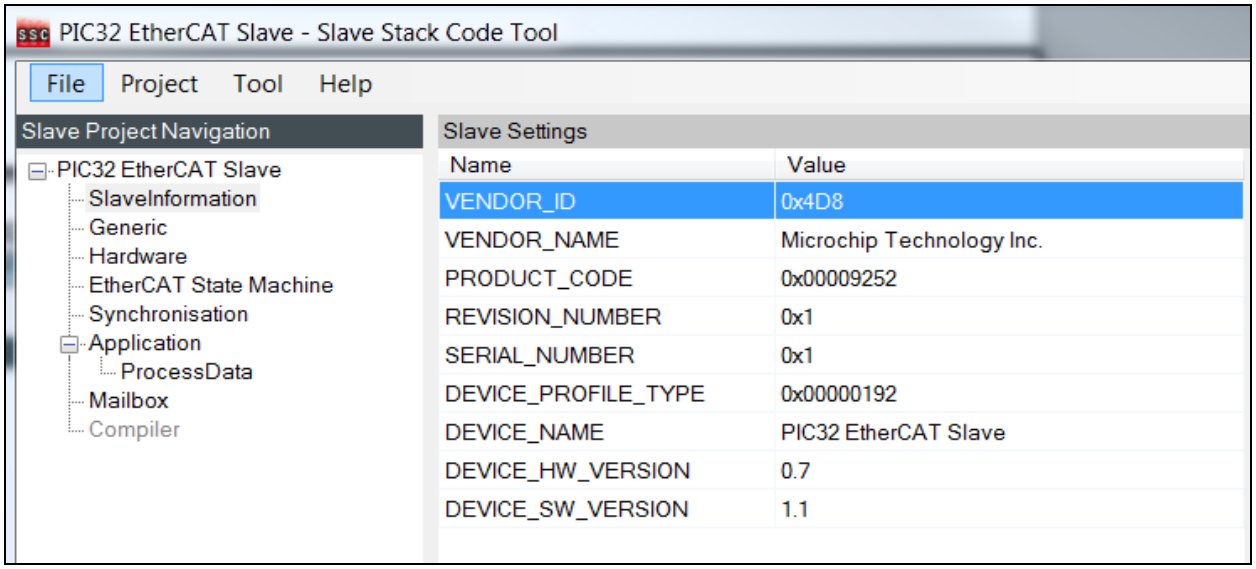
**FIGURE D-4: CUSTOM SSC FILE SELECTED**




5. All listed parameters under the **Slave Information** tab can be changed, as displayed in Figure D-5.

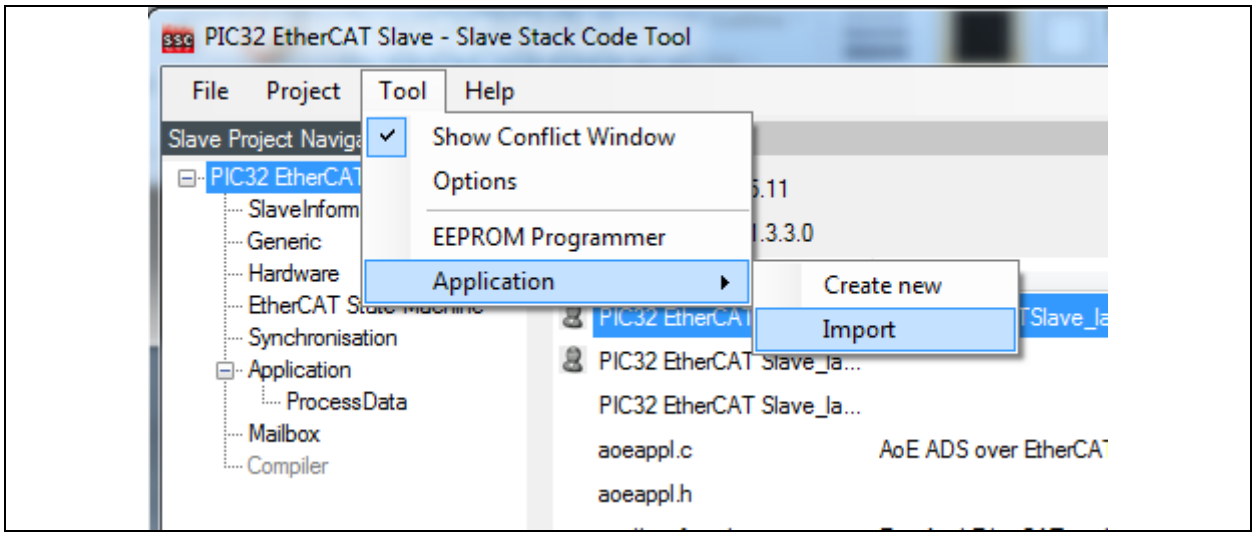
**Note:** By default, SDK ESI files have an object configuration with Microchip Vendor ID.

**FIGURE D-5: SLAVE SETTINGS**




6. Click *Tool>Application>Import* from the menu bar, as displayed in Figure D-6.

**FIGURE D-6: IMPORT MENU**

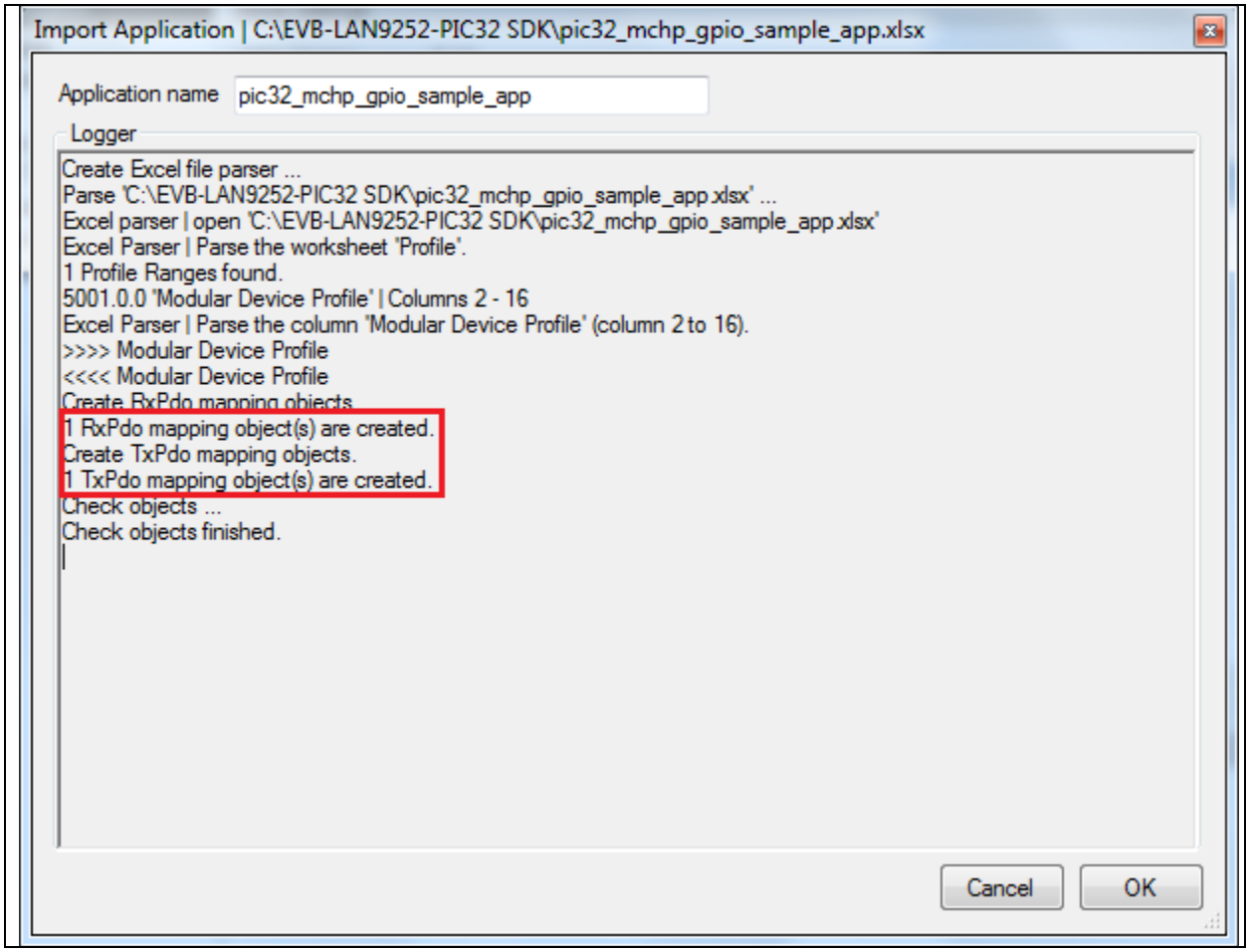



7. Select the file `pic32_mchp_gpio_sample_app.xlsx` which can be found in the directory `{SDK_INSTALL_PATH}/EVB-LAN9252_SDK_VX.X/HBI Application/` or `{SDK_INSTALL_PATH}/EVB-LAN9252_SDK_VX.X/SPI Application/` depending on the mode the board is configured for.

   `pic32_mchp_gpio_sample_app.xlsx` is an object file which contains the information about application objects.

   A status message displays as in Figure D-7.

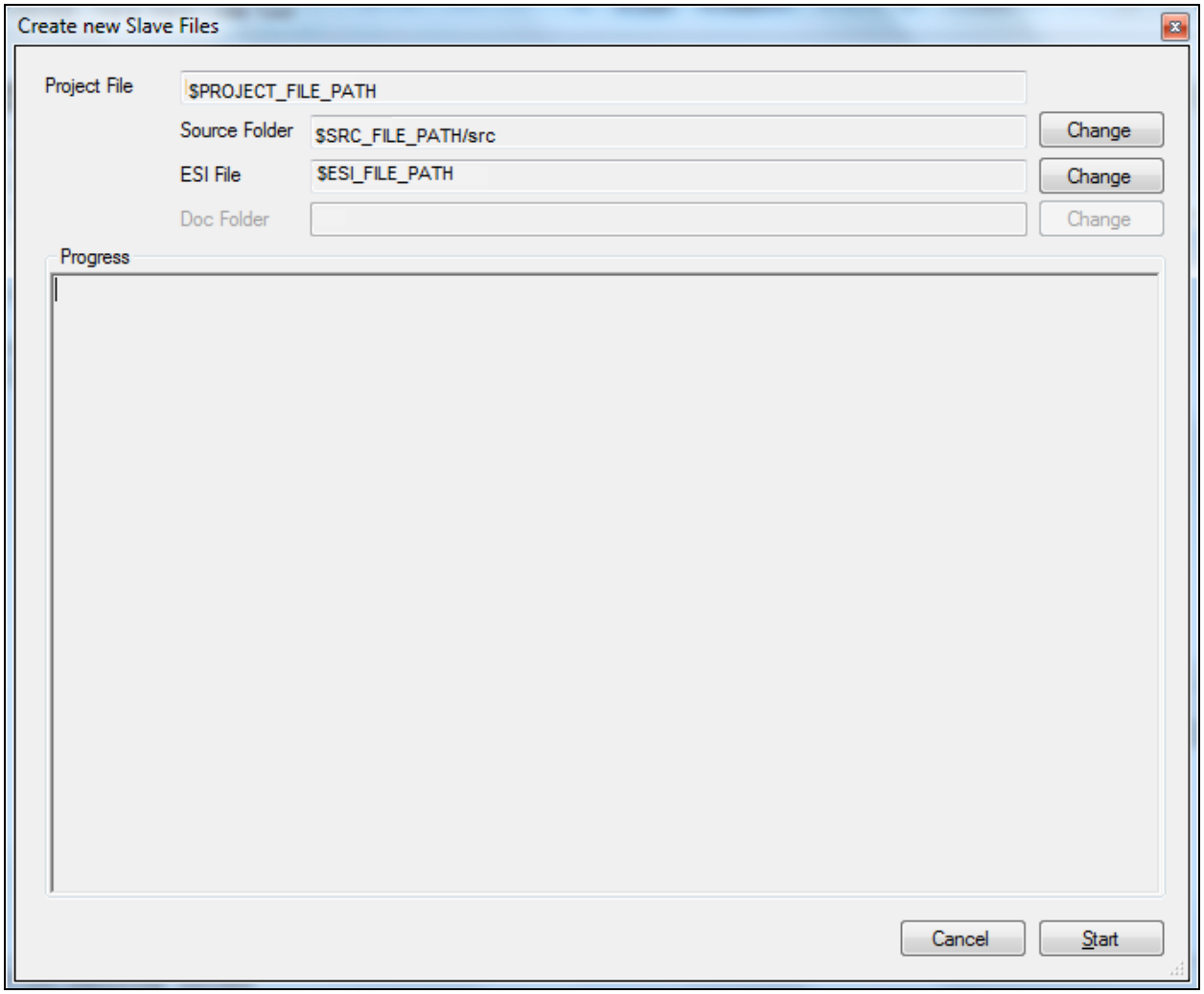
**FIGURE D-7: STATUS MESSAGE**




8. Click **OK** to continue.
9. From the menu bar, click *Project>Create New Slave Files*.

   The Create new Slave Files window displays, as in Figure D-8.

**FIGURE D-8: CREATE NEW SLAVE FILES**




**Note:** The above values signify the following:

- `$PROJECT_FILE_PATH` - The location where the SSC project file is saved.
- `$SRC_FILE_PATH` - Default path is `$PROJECT_FILE_PATH`. It can be changed by clicking its corresponding **Change** button.
- `$ESI_FILE_PATH` - Default path is `$PROJECT_FILE_PATH`. It can be changed by clicking its corresponding **Change** button.

10. Click the Windows **Start** button to create a new project file, Src folder, and ESI file (Slave Information file) in the desired directory path.

    A pop-up window will indicate that the files have been successfully created.

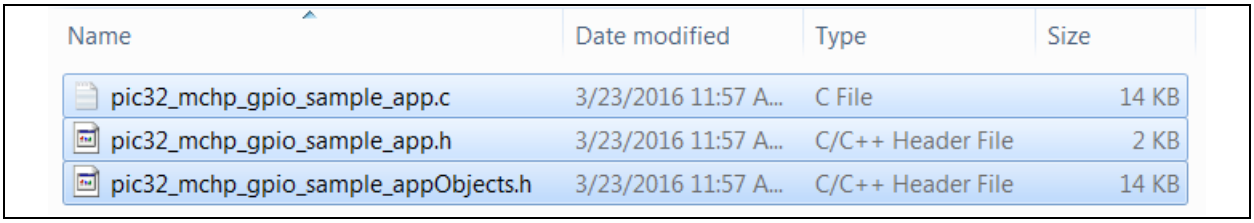
11. Click **OK** to continue.

    Along with generated new slave files, an ESI file (.xml file) also will be generated. This ESI file will have information about new Vendor ID and object configuration. Program this ESI file into EEPROM as mentioned in **Appendix B. "EEPROM Programming"**.

12. Replace generated application files with SDK application files as displayed in Figure D-9.

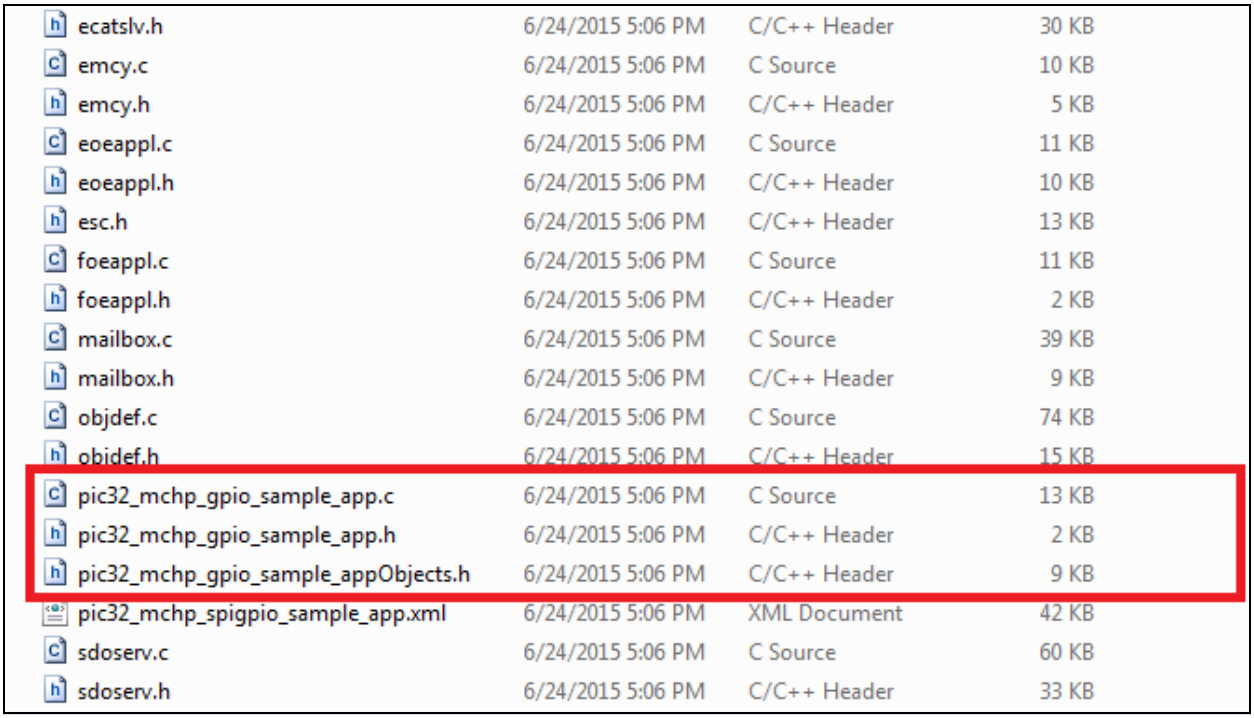
    SDK Application files can be found the either the HBI Application or SPI Application and then Sample Application Files depending on the board configuration.

**FIGURE D-9: SDK APPLICATION FILES**




**Note:** Application files would be named as `pic32_mchp_gpio_sample_app` as in Figure D-10. This is because in this demo, input object file is given as `pic32_mchp_gpio_sample_app.xlsx`.

**FIGURE D-10: APPLICATION FILES**




13. Browse to the directory where the new files were created, as shown in the example:
    - `Src (Folder)`: This folder contains the Beckhoff Slave Stack code.
    - `Microchip PIC32 Slaves (ESP)`: This is the SSC Tool project file.
    - `Microchip PIC32 Slaves (XML)`: This is the EtherCAT slave information file that must be used as an input to the EtherCAT master tool to configure EtherCAT slave controllers.
14. Copy all the files inside the Src folder to the following directory:
    `{SDK_INSTALL_PATH}/EVB-LAN9252-HBI_PIC32_SDK_VX.X/SSC/Common`

### D.1.1.1 WHY REPLACE IS REQUIRED

Generated application files will not have the code for accessing the GPIO lines. GPIO support is provided in delivered SDK application files. Hence, the replace is required to get the demo application.

# Appendix E. Compiling and Programming SoC Firmware

## E.1 INTRODUCTION

This appendix details how to compile and program SoC firmware.

### E.1.1 Compiling and Programming SoC Firmware

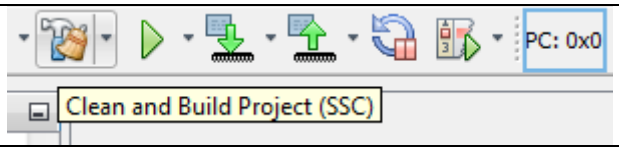
To compile and program SoC firmware:

1. Open the MPLAB IDE and import the SSC project.

   The MPLAB project file is located under `{SDK_INSTALL_PATH}/EVB-LAN9252-HBI_PIC32_SDK_VX.X/SSC/`.

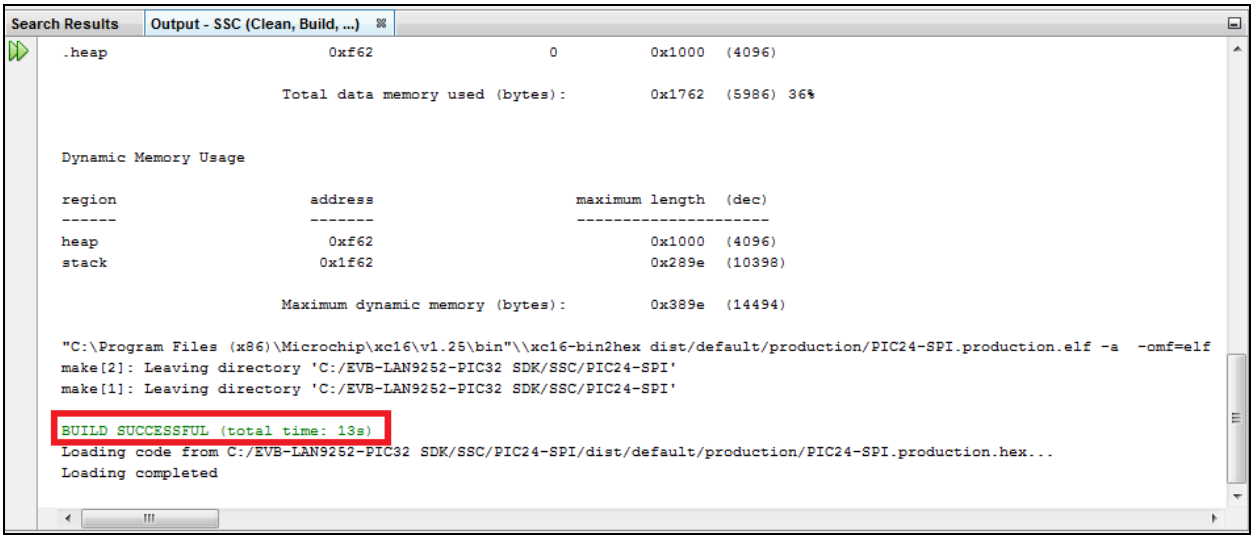
2. Compile the source code as displayed in Figure E-1.

**FIGURE E-1: SOURCE CODE**




If the compilation is successful, the output window will display “BUILD SUCCESSFUL” as shown in Figure E-2.

**FIGURE E-2: BUILD SUCCESSFUL**

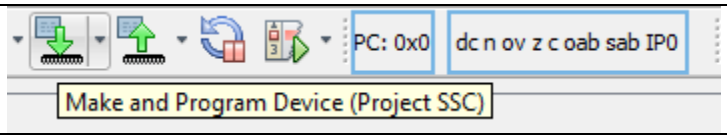



3. Before initiating the firmware download, ensure the debugger/programmer is connected to the EVB’s JTAG pins.

**Note:** This demo project is debugged with the PICkit-3 In-Circuit debugger/programmer.

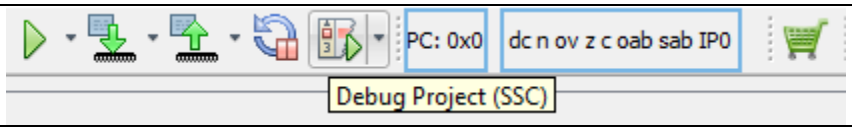
4. To program the PIC32 SoC, click the **Make and Program Device Main Project** button, as displayed in Figure E-3.

**FIGURE E-3: MAKE AND PROGRAM DEVICE MAIN PROJECT BUTTON**




5. To debug the PIC32 SoC, click the **Debug Main Project** button, as displayed in Figure E-4.

**FIGURE E-4: DEBUG MAIN PROJECT BUTTON**



# Appendix F. Programming PIC32 Firmware Using Pre-Built Binaries

## F.1 INTRODUCTION

This appendix shows how to program PIC32 firmware.

### F.1.1 Programming PIC32 Firmware Using Pre-Built Binaries

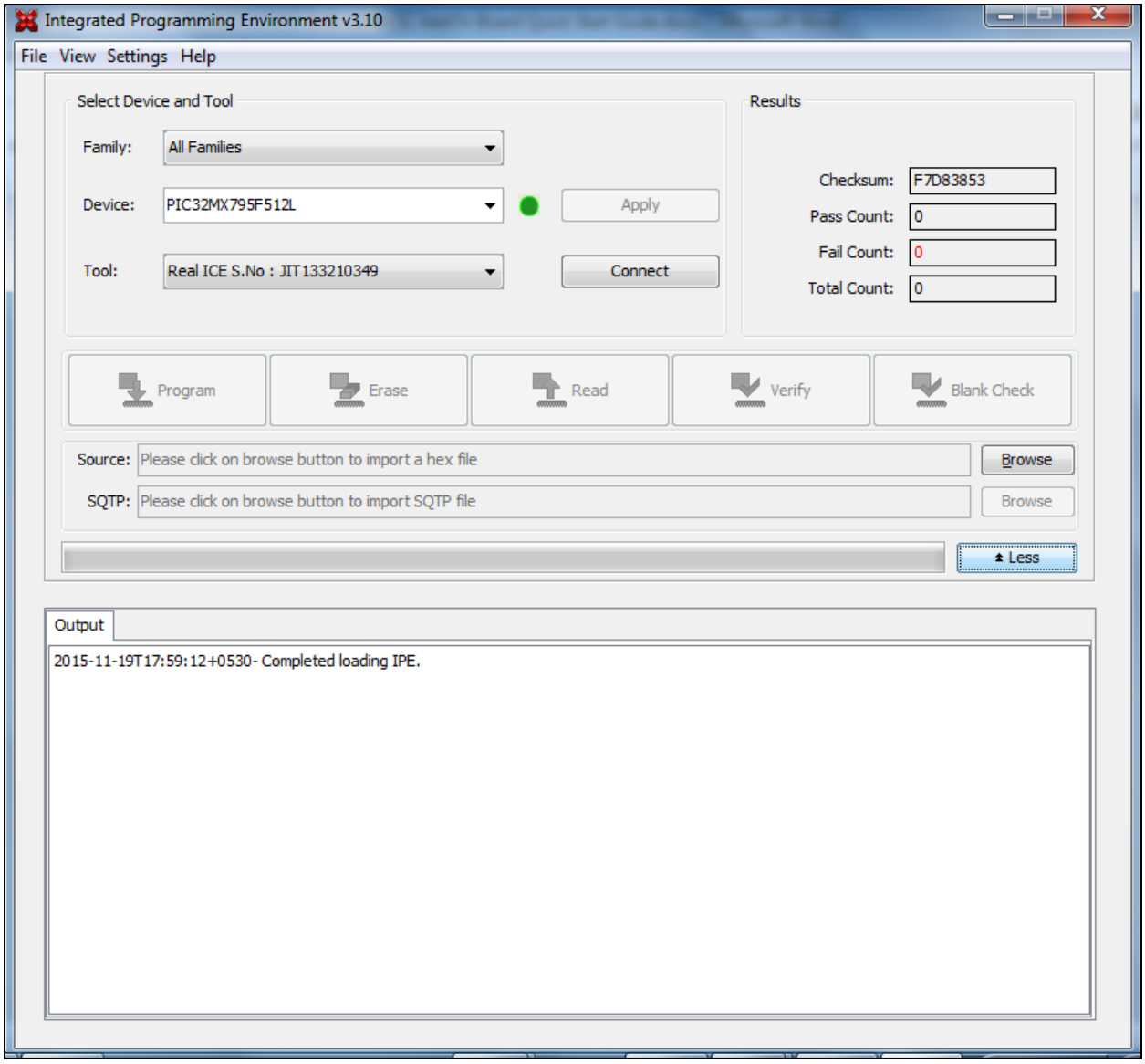
To program the PIC32 firmware using pre-built binaries:

1. Download and install `MPLAB IPE V X.X` from the following link:
   http://microchip.wikidot.com/ipe:installation

| **Note:** | x.xx denotes the version number of the MPLAB IPE. |
|---|---|

2. Before initiating the firmware download, ensure the debugger/programmer is connected to the EVB's JTAG pins.
3. Open the MPLAB IPE.
   The window displays as in Figure F-1.

**FIGURE F-1: MPLAB IPE**




4. Select the corresponding device from the “Device” drop-down box and then click **Apply**.
5. Select the debugger/programmer from the “Tool” drop-down box and then click **Connect**.
6. From “Source,” click the **Browse** button and select the hex files which can be found in the “Binaries” directory of `EVB-LAN9252-HBI_PIC32_SDK V X.X`.
7. Once the hex files are loaded, click **Program**.

# Appendix G. Troubleshooting

## G.1 INTRODUCTION

This appendix details how to troubleshoot some issues that may occur when using the EVB-LAN9252-HBI+. If the issue cannot be resolved using this troubleshooting appendix, please use the Microchip website to request further assistance.

### G.1.1 Cannot Program PIC32

If the situation arises where the PIC32 will not program, ensure the proper header is being used.

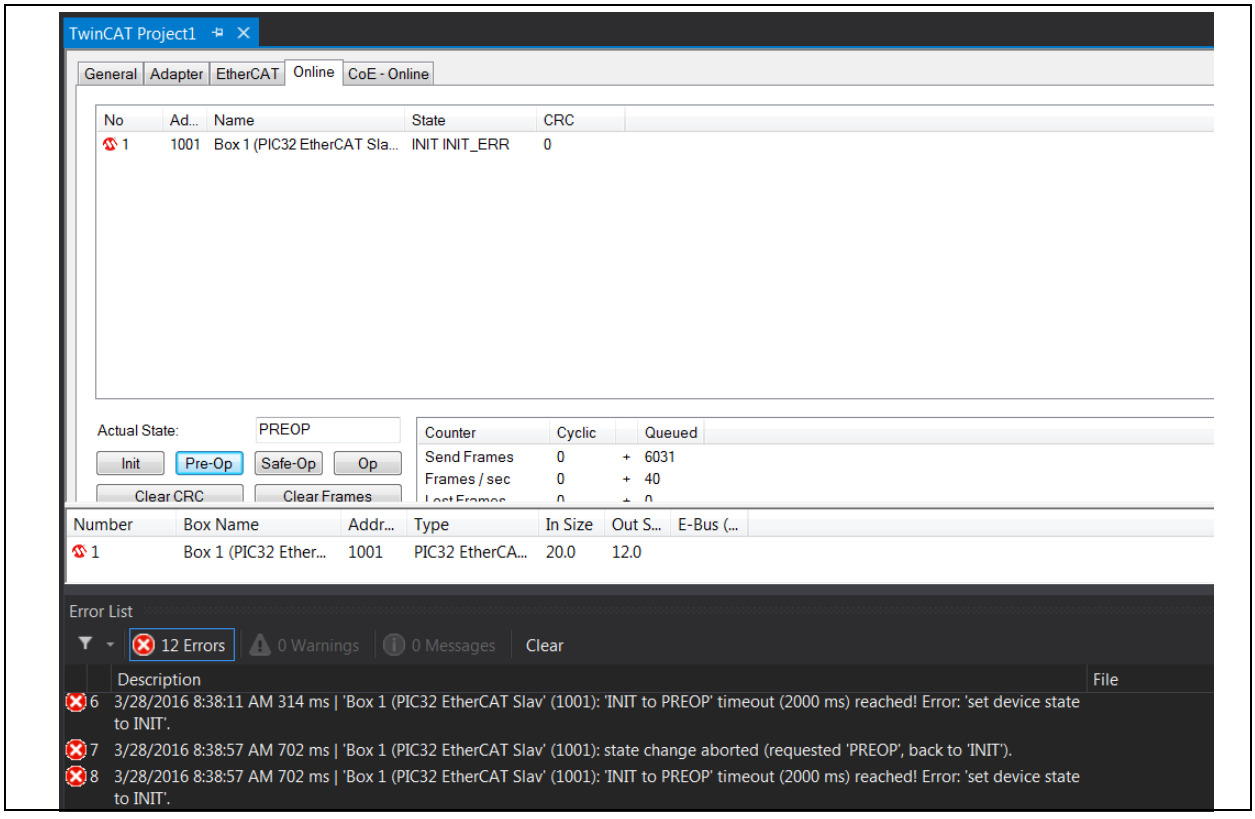
DO NOT USE J14 to Program the PIC32.

DO USE J13 to program the PIC32. Align PIN1 of the programming device with PIN1 of the header as labeled on the board.

### G.1.2 Error when board requests PREOP

If an error similar to that seen in Figure G-1 occurs, it could be the result of two possible issues:

**FIGURE G-1: PREOP FAILURE**

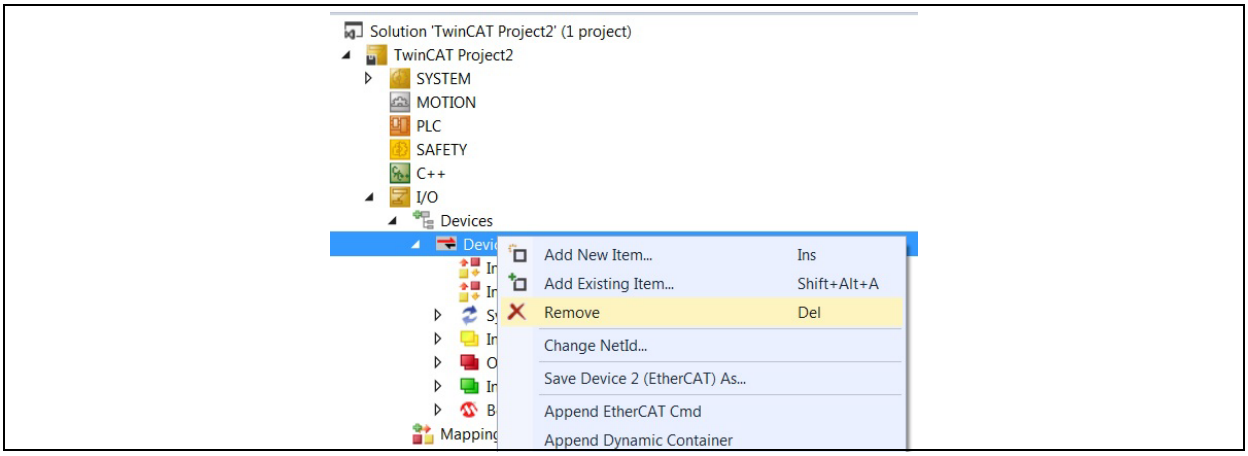



1. The board is not configured correctly to use the desired mode. Please refer back to **Section 2.1.1 “EtherCAT Master and Slave Configuration”** for information on the proper configuration of the board for HBI mode and **Section 2.2.1 “EtherCAT Master and Slave Configuration”**

for information on the proper configuration of the board for SPI mode.

2. After programming the board's EEPROM, one must follow the following steps:
   **1:** Remove the device as seen in Figure G-2
   **2:** Power cycle the board
   **3:** Rescan for devices

**FIGURE G-2: REMOVING A DEVICE**




### G.1.3 Values Do not Update in Application

If this issues occurs, please power cycle or reset the board and try changing the output value again. If the input values do not update please also power cycle or reset the board.

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